Obesity and Poverty: A New Public Health Challenge *is an essential source for understanding the new face of poverty in the Americas. This up-to-date examination of the prevalence of overweight and obesity in Latin American and Caribbean countries looks at these conditions' medium- and long-term harmful consequences and explores their implications for planning public health interventions.*

The book analyzes how the region's countries experience the nutritional transition process that is under way worldwide, a process that is tied to the global demographic and epidemiologic transition. In this context, the increase in obesity and overweight observed in Latin America and the Caribbean coexists with a risk factor that differs from traditional risk factors seen in developed countriesæthe persistence or the increase of inequalities and inequities in health.

The Pan American Health Organization offers this publication to the general public and to researchers, students, communicators, and politicians charged with planning and executing activities designed to promote the population's health and well being.

Pan American Health Organization
Pan American Sanitary Bureau, Regional Office of the
World Health Organization
525 Twenty-third Street, N.W.
Washington, D.C. 20037 U.S.A.

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OBESITY *and* POVERTY

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OBESITY *and* POVERTY

A New Public Health Challenge

Editors:
Manuel Peña y Jorge Bacallao

Pan American Health Organization
Pan American Sanitary Bureau, Regional Office of the
World Health Organization

Mission of the Pan American Health Organization
The Pan American Sanitary Bureau is the Secretariat of the Pan American Health Organization (PAHO), an international agency specializing in health. Its mission is to cooperate technically with the Member Countries and to stimulate cooperation among them in order that, while maintaining a healthy environment and charting a course to sustainable human development, the peoples of the Americas may achieve Health for All and by All.

Obesity and Poverty: A New Public Health Challenge

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CONTENTS

PREFACE

Throughout history, obesity and overweight have been underestimated as public health problems in Latin America and the Caribbean. Both conditions are on the rise in the region, however, although this is difficult to measure, given the fact that the studies that have been carried out are not very representative. For many years, the harm to health from these conditions was overlooked. And even when it became apparent, it was viewed as an issue that was valid only in other socioeconomic contexts, and it was seen as insignificant or less important than protein-energy malnutrition and other nutritional deficiencies specifically linked to poverty.

The rising trend in obesity and overweight is part of the global demographic and epidemiologic transition that the Region's countries are undergoing. This trend should not be seen simply as a concomitant manifestation of development, however, or merely as a minor evil that emerges as other, more serious, ills fade away. Although the term "transition" connotes change, substitution, and irreversibility in demographic, socioeconomic, and epidemiologic profiles, it would be ingenuous to assume that obesity in Latin America and the Caribbean represents the same byproduct of excess that it does in high-income societies.

It also is incorrect to think that the variation in the "epidemiologic transition" process between developed and developing countries is a simple temporal phenomenon, whereby the former begin the process before the latter. Moreover, it is mistaken to believe that the efforts to cope with the consequences of obesity and overweight undertaken by some wealthy countries can be effectively cloned. The problem in poor countries is altogether different—and probably more serious.

The Pan American Health Organization is pleased to present this book, which includes contributions from well respected researchers in nutritional science. The book is the product of an editorial endeavor that aims at defining the problem of obesity and establishing its particular features in the region, as well as its trends and determinants; it also highlights the most promising research efforts and activities for the near future.

Our support for this publication and for its dissemination underscores our commitment to integrate facts, information, research, knowledge, and action. If this message reaches the scientific community and decision makers, the objectives that sparked this publication will have been fulfilled.

George A. O. Alleyne
Director

INTRODUCTION

This book presents an up-to-date overview of the prevalence of overweight and obesity in the countries of Latin America and the Caribbean, their medium- and long-term adverse effects, and their implications for planning public health actions. It also analyzes the characteristics specific to these countries in the worldwide process of nutritional transition, which is in turn related to the processes of demographic and epidemiological transition.

In the epidemiological transition, the most diverse manifestations of the morbidity and mortality profile coexist: non-communicable chronic diseases, infectious diseases, emerging and reemerging diseases, violence, addiction, and diseases associated with environmental deterioration. In this context, the increase in obesity and overweight seen in the region is overlaid by an additional risk factor that differs from the traditional risk factors in the developed countries: the persistence or growth of inequalities and inequities in health.

The four sections that make up this publication do not presume to be a full discussion of the complexity of the regional problem but seek rather to present its economic, sociocultural, and environmental determinants and to describe the specific characteristics of the epidemiological transition in a few selected countries of the Americas. In addition, they suggest some methodological aspects for studying obesity from the public health perspective, and discuss the relationship between certain factors of intrauterine life and adolescence that may be associated with obesity in adults.

In the first section, the article by Manuel Peña and Jorge Bacallao places obesity in the context of the demographic, epidemiological, and nutritional transition in Latin America and the Caribbean. Using a health promotion and disease prevention approach, the authors suggest that the monitoring of obesity is the foundation for a strategy to confront the growing prevalence of non-communicable chronic diseases associated with nutrition, a trend that emerges as a result of the aforementioned transition. The authors point out that the increased prevalence of obesity should not be interpreted as a sign of the transition to development and that obesity should not be considered solely as a disorder derived from an energy imbalance but rather as a nutritional disorder that can coexist with micronutrient deficiencies and other deficiency diseases, particularly in the most vulnerable socioeconomic groups. As a result, they suggest the existence of "various obesities," with probable differences in geographic, ethnic, and cultural patterns, an understanding of which should be reflected in research, policy formulation, and decision-making.

Patricia Aguirre's article deals with the socioanthropological aspects of obesity in poverty: dietary habits and a predisposition to obesity are created through an ongoing interrelationship with social conditions, and depend more on the influence of economic factors than on nutritional education, because foods are chosen on the basis of price, the

level of satiety they produce, and the family's economic situation. The author indicates that in Argentina there is a mechanism whereby the mother sacrifices her own dietary requirements to afford her children and husband a more balanced and adequate diet. Gender is another important aspect in the prevalence of obesity among women of low socioeconomic status. Cultural norms make women victims of an urban segregation process that limits their opportunity for activity and sources of cultural stimulation and, in turn, diminishes the social value of their bodies by limiting their social role solely to procreation.

Albert J. Stunkard analyzes the relative influence of genetic, socioeconomic, and cultural factors in obesity and interprets studies that calculate the contribution of hereditary and environmental factors to obesity. He also includes a review of works that lay the foundation for an inverse relationship between socioeconomic status and the prevalence of obesity in women. The author uses as a reference the large number of studies conducted on women, men, and children, both in developed and developing countries, in which the socioeconomic and cultural determinants of obesity are different. As a corollary, he suggests the need to study the relationship that exists among the prevalence of obesity, socioeconomic status, acculturation processes, and generational effects.

In the article on the patterns of physical activity in Central America, Benjamín Torún describes the effects of urbanization and industrialization on the lifestyles of rural populations. Economic pressures and incentives that promote migration to urban peripheral areas (more health centers, schools and communication channels, and more free time for recreational activities) determine an increase in the risk of obesity. A population that prior to migrating engaged in the demanding physical activity associated with agricultural production becomes a marginal urban population that engages in less physical labor, consumes an imbalanced diet high in fat and calories, increases its consumption of alcohol and sweet beverages, and adopts a sedentary lifestyle. Based on the hypothesis that humans have a natural tendency to maintain energy equilibrium, the author indicates that the changes that promote inadequate dietary habits and discourage physical activity create conditions favorable to the increase in the risk of obesity and other associated morbidities.

The second section of the publication includes four articles that describe the epidemiological transition in Chile, Cuba, and Brazil, as well as the proposed typology of the Latin American and Caribbean countries according to the characteristics of the phase of the demographic and epidemiological transition in which each country is found.

In the article on the epidemiological transition in Chile, Cecilia Albala and Fernando Vío analyze the socioeconomic, demographic, and epidemiological factors and the lifestyles associated with obesity in Chile. In addition, they describe the characteristics of risk factors for nutritionally based chronic diseases. The authors assert that, as a result of the nutritional transition that occurred in Chile over a period of less than 20 years, cardiovascular diseases became the leading cause of death and now account for the highest percentage of the overall national burden of disease. Due to increased total consumption of fats, decreased consumption of antioxidants, deficiencies in essential micronutrients, and a sedentary lifestyle, obesity and hyperlipidemias increased at an alarming rate, particularly in small children and pregnant women, especially those in the lowest income groups. The conclusion is that it is imperative to actively intervene to reduce nutritionally based risk factors for chronic diseases. If the risks of a true epidemic of these diseases are to be avoided, primary prevention measures must be applied from infancy, with a focus on actions that promote lifestyle changes.

Carmen Porrata, Arturo Rodríguez-Ojea, and Santa Jiménez describe the characteristics of the epidemiological transition in Cuba in recent decades and highlight the dietary and nutritional aspects associated with it. They begin with an analysis of the socioeconomic characteristics of the population, its educational level, access to community and health services, food marketing dynamics, the availability of food and food consumption trends, breast-feeding, dietary habits, and the morbidity and mortality profile. They then describe the effects of the economic changes that occurred as a result of the disappearance of the Union of Soviet Socialist Republics and the socialist bloc in Eastern Europe. They place Cuba in an advanced phase of the epidemiological transition, similar to the situation of the developed countries, though Cuba suffers greater economic underdevelopment. The authors conclude that the prevalence of obesity is high for both sexes. Inadequate dietary patterns, sedentary lifestyles, the cultural influence of a favorable view of overweight, and ignorance of adequate nutritional principles would be some of the factors that determine this high prevalence. Consequently, the authors suggest an integrated primary care approach that would give priority to health promotion and community participation in order to deal with the risk factors for obesity, take preventive measures, and perform early diagnoses.

Carlos Monteiro presents the results of his research on some aspects of the nutritional transition in Brazil in recent decades. The prevalence of malnourished children fell 60% in all socioeconomic strata and the prevalence of infant obesity, which is relatively low in Brazil, remained unchanged. The percentage of malnourished adults also fell substantially, but the percentage of obese adults nearly doubled. The changes also indicate a continuation of the strong inverse relationship between family income and the prevalence of malnutrition and increased frequency of obesity in the poorest families. There is also a change in the relationship between family income and the body mass index (BMI) in women. Favorable changes in eating patterns do not seem to have been a result of the population's awareness of the benefits of a healthy diet, but rather the result of availability and affordability of various foods. The greatest gap in information relates to the population's patterns of physical activity, an aspect that is very important in explaining the increase in obesity. The author points out that the nutritional transition in Brazil should be taken into account when establishing public health priorities and action strategies: the prevention and control of non-communicable chronic diseases and education on food and nutrition for all socioeconomic strata must be definitively incorporated, and the supply of healthy foods and access to them must be promoted.

In his proposed typology of the countries of Latin America and the Caribbean in the context of the epidemiological and demographic transition, Jorge Bacallao presents and interprets the results of an exploratory analysis of demographic and epidemiological indicators in 22 Latin American and Caribbean countries. The analysis is directed towards building a typology of countries that could be used to formulate a strategy for researching the trends and determinants of changes in health profiles. The most important elements of the typology would be two classification axes (the first axis would compare countries with a high prevalence of infectious diseases to countries with a high prevalence of non-communicable chronic diseases, and the second axis would divide the latter according to the higher or lower predominance of cardiovascular diseases and their evolution over the last 10 to 20 years); a classification into three groups according to the phase of the demographic and epidemiological transition in which the countries are found; and an analysis of that classification that demonstrates the existence of different phases or rates of transition.

The third section of the publication contains two articles on the methodological aspects that should be taken into account when studying obesity from the public health perspective. The work of David F. Williamson explains the basic measurements of the presence of a disease that are indispensable for monitoring obesity: prevalence, incidence, and secular trends. The author comparatively analyzes the application of these three indicators and, based on the recognized functional relationship among them, develops procedures for calculating the incidence and average duration of obesity, stressing the need to discern secular trends or temporal changes in prevalence using longitudinal or cohort designs.

In his article, John J. Himes asserts that developing appropriate anthropometric indicators for obesity poses three critical questions: the objective of identifying obese or overweight people; the selection of an anthropometric indicator; and the selection of an optimum cutoff point for that indicator. The objectives must take into account the level of analysis (individual or population group), use (screening, evaluation of prevalence, or program evaluation), and the foreseeable measures involved in obtaining information. The selection of the indicator must consider the objective, the intrinsic attributes of the indicator (sensitivity, specificity, and predictive value), and the practical aspects of obtaining it in the actual sociocultural setting. Finally, the selection of the optimum cutoff point will depend on the objective and the attribute of the indicator that is considered most important in terms of the objective (specificity and positive predictive value). In addition, the selection of the cutoff point for screening purposes should be adapted to the resources available for the intervention.

The final section of the publication presents two works. In the first, Dirk G. Schroeder and Reynaldo Martorell analyze the so-called hypothesis of the programming or fetal origin of chronic diseases and obesity in the context of the epidemiological and nutritional transition in the countries of Latin America. They suggest that the confirmation of the hypothesis would yield valuable clues for explaining and anticipating the long-term effects of the epidemiological and nutritional transition. Although to date the evidence is less conclusive in the case of obesity than in the case of hypertension, diabetes, and other risk factors for cardiovascular disease, this could be due to methodological problems associated with intrinsic difficulties in controlling confounders for empirical confirmation of the hypothesis in the case of obesity. Nonetheless, if the hypothesis is confirmed, we should expect a substantial increase in the prevalence of cardiovascular diseases during the next few decades, for which dietary and lifestyle changes would also be contributing factors. Given this possibility, the highest priority must be given to formulating effective strategies to provide adequate nutrition during intrauterine life and early childhood, and to prevent obesity and other risk factors for cardiovascular disease in adults.

Manuel A. Amador divides his article into three parts: changes in adiposity and fat distribution during puberty; characteristics of the obese adolescent; and reduction of risks of obesity and associated morbidity in adults. In the first part, the author presents various findings on the changes occurring in body fat and in the growth process at each stage of sexual maturation. One of the findings is the predictive capacity of the body mass index in terms of the height reached at age 14 and the maturation process. The evidence of the interaction between growth and maturation during puberty indicates that these processes must be taken into account in the design of any intervention directed at obese adolescents. The second part lays the foundation for the thesis that obesity may be related to some other specific deficiencies and reaffirms the importance of characterizing each individual in order to manage his or her case appropriately. The

final part analyzes the predictive value of obesity in childhood for obesity in adulthood. The author suggests some measures that should be considered in adolescence for reducing or preventing the risks associated with obesity in adulthood.

Although this work does not completely cover the problem of obesity in poverty, it does seek to inform and hold the active interest of the general public, researchers, students, communicators, and politicians responsible for planning and implementing activities designed to promote health and welfare for the entire population.

Manuel Peña and Jorge Bacallao

Obesity and Its Economic, Sociocultural, and Environmental Determinants

OBESITY AMONG THE POOR: AN EMERGING PROBLEM IN LATIN AMERICA AND THE CARIBBEAN

Manuel Peña[1] and Jorge Bacallao[2]

ECONOMIC CHANGES AND NUTRITIONAL STATUS

The 1980s had a negative effect on economic growth in Latin America and the Caribbean. Conditions of inequity among social groups, characterized by very uneven distribution of income, were exacerbated with the implementation of stabilization measures that helped to increase poverty and its extreme forms. Migration of rural inhabitants to the urban periphery and from poorer countries to countries with better conditions brought about significant changes in the living conditions and lifestyles of these groups. For example, in 1983 there were more than 917,000 displaced persons and refugees due to armed conflicts in Central America (*1*).

The social, economic, and demographic transformation of the last two decades coincided with changes in the epidemiological profile and in eating patterns (*2*) and physical activity in the region. The processes of demographic, epidemiological (*3, 4*), and nutritional transition show specific characteristics in each country, depending on the onset and speed of change. This diversity is consistent with the different models described by Omran (*4, 5*).

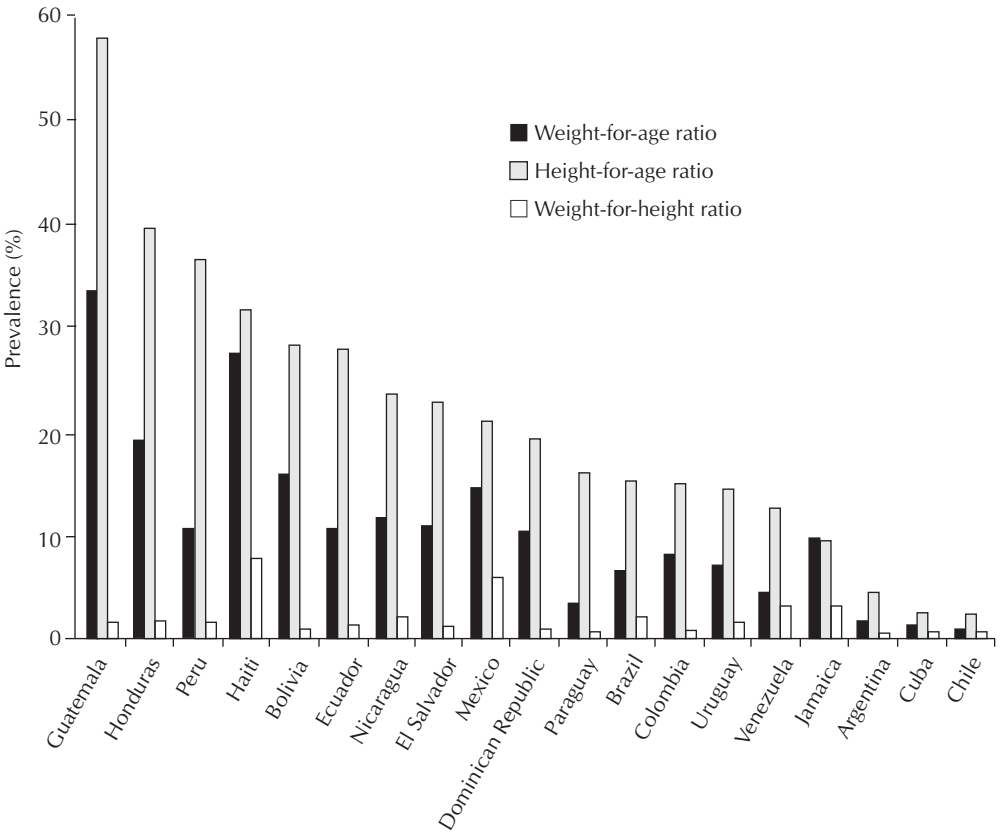
A universal characteristic of the epidemiological transition in Latin America and the Caribbean is increased life expectancy and reduced mortality rates in different age groups for most infectious diseases. The use of oral rehydration salts, family planning, and the success of mass immunization campaigns, as well as other techniques, have played a decisive role in reducing mortality, particularly during the first years of life. However, the fact that some infectious diseases still exist or are reappearing poses new challenges for public health.

Despite the general reduction in the prevalence of protein-energy malnutrition (*6*) in Latin America and the Caribbean, in 1995 there were some six million children under the age of 5 with low weight-for-age. This figure (11% of the population in this age group) (*7*) is one of the more visible manifestations of poverty. Figure 1 shows that low height-for-age due to inadequate nutrition, and associated with frequent and prolonged episodes of infection and a harmful environment, is the most frequent anthropometric manifestation of nutritional deficiency in the region (*8*).

Micronutrient (iron, iodine, and vitamin A) deficiencies are also relevant nutritional prob-

[1] PAHO/WHO Country Office, Kingston, Jamaica.
[2] Instituto Superior de Ciencias Médicas, Havana, Cuba.

FIGURE 1. Prevalence (%) of low weight-for-age, height-for-age, and weight-for-height among preschool children, 1987–1996.



lems. Iron deficiency and its effects on physical, functional, and intellectual capacity affect most children in poor areas of Latin America and the Caribbean. It is estimated that 45% of children between 6 and 23 months of age, 30% of preschool and school children, 20% of women who are not pregnant, and 35% of pregnant women (*9*) suffer some degree of anemia due to iron deficiency. In 1997, it was estimated that 25% of the children under the age of 5 in Latin America suffered from a subclinical vitamin A deficiency (*10*) (weighted average of mean prevalence in the countries with information available), contributing to the high incidence of infectious diseases.

OBESITY: A GROWING PROBLEM

In many Latin American and Caribbean countries, a notable increase was reported in the prevalence of overweight (BMI[3] between 25 kg/m^2 and 29 kg/m^2) and obesity (BMI ≥ 30 kg/m^2). For example, in Chile, 3.7% of the children under age 6 fall below one standard deviation of the reference average weight established by the United States National Center for Health Statistics (NCHS) and the percentage of those who fall above that deviation

[3]BMI = Body mass index (ratio of weight (kg) to height^2 (m)).

is 21.6%. These values reflect a notable displacement to the right in the distribution of the weight-for-age indicator (*11*).

Household surveys conducted in Brazil from 1974 to 1975 and during 1989 (*12*) showed a notable increase in overweight between those periods in all age groups between 18 and 65 years, for both women and men. The rising trend is confirmed in a 1996 report (*13*) that indicates an even higher prevalence of overweight. In São Paulo, Brazil, a study of 535 families (2,411 individuals) in a marginal urban population (*14*) showed that 30% of the children had a relative height deficit and that 5.8% of the boys and 6.8% of the girls were overweight. In addition, 9% of the adult family members were obese. These findings show the coexistence of malnutrition and obesity in the same setting.

The results of the ENDES survey conducted in Peru in 1996 (*15*), which examined 9,600 women who had given birth to at least one child during the preceding five years, showed an average BMI of 25.1 (± 3.8 kg/m^2). It was also estimated that 34.5% of the women had a BMI between 25 kg/m^2 and 29.9 kg/m^2, and that 9.4% had a BMI above 30 kg/m^2. The average BMI in the metropolitan area of Lima was 25.8 kg/m^2. Diachronic studies conducted in Costa Rica and Panama also show an increased prevalence of obesity among adults (*16*).

Table 1 shows the prevalence of overweight and obesity among women in various Latin American and Caribbean countries based on Demographic and Health Surveys sponsored by the United States Agency for International Development (USAID) (*17*).

STUDIES ON OBESITY

Obesity is a current pandemic and its study as a priority public health issue is justified for the following reasons:

- It is a risk factor for various nutrition-related non-communicable chronic diseases (NCCDs), some of which are significant causes of death in the region. Examples of such diseases are ischemic heart disease, type II or non–insulin-dependent diabetes mellitus (NIDDM), hypertension, some types of cancer, osteoarthritis, and osteoporosis, among others;
- The measures for preventing obesity, particularly those that aim to improve nutrition and increase systematic physical activity, coincide to a great extent with the measures for preventing other NCCDs;
- Obesity is a useful indicator for monitoring because it is easy to detect using traditional anthropometric measurements.

From the anthropometric point of view, fat distribution, the total amount or percentage of fat, and bodyweight, in that order, have

TABLE 1. Prevalence of overweight and obesity in women aged 15 to 49 in Latin American countries.

Country (Year)	*n*	Body mass index/*s*	Overweight (%) (25–29.9 kg/m^2)	Obesity (%) (≥30 kg/m^2)
Bolivia (1994)	2,347	24.3/3.7	26.2	7.6
Brazil (1996)	3,158	24.0/4.3	25.0	9.7
Colombia (1995)	3,319	24.5/4.0	31.4	9.2
Dominican Republic (1996)	7,356	24.3/4.9	26.0	12.1
Guatemala (1995)	4,978	24.2/3.9	26.2	8.0
Haiti (1994–1995)	1,896	21.2/3.4	8.9	2.6
Honduras (1996)	885	23.5/4.7	23.8	7.8
Mexico (1987)	3,681	23.7/4.3	23.1	10.4
Peru (1996)	10,747	25.1/3.6	35.5	9.4

Source: Martorell R, Kettel Khan L, Hughes ML, Grummer-Strawn LM. Obesity in women from developing countries. (Submitted for publication).

great explanatory value as additional risk factors for NCCDs. According to data from the second United States Health and Nutrition Survey (*18*), obese people between the ages of 20 and 75 have 2.9 times greater relative risk of developing NIDDM than people of normal weight. The same survey shows that this relative risk is 3.8 for obese people between the ages of 45 and 75, and 2.1 for those between 20 and 25. The survey also indicates the importance of the type of distribution of body fat. Pi-Sunyer (*19*) referred to the effect of weight loss on reducing morbidity and mortality among diabetics and recommended that the BMI values be no higher than 25 kg/m^2. Must (*20*) states that the risk of suffering health problems throughout the life cycle doubles in individuals who were overweight in childhood, and that the risks are higher if the excess weight was retained during adolescence. Meisler and St. Jeor (*21*) feel that being moderately overweight is also associated with high mortality during adulthood. The data from the Framingham study (*22*) show that overweight significantly increases the frequency of NCCDs. Twenty-six years of longitudinal follow-up indicated that an increase of one standard deviation for relative weight was associated with greater frequency of cardiovascular complaints: 15% in women and 22% in men.

There are specific suggestions on "healthy weight" or recommended weight for preventing NCCDs, including cardiovascular diseases (*22*) and NIDDM (*19*). It has also been shown that there is an association between weight reduction and improvement in certain clinical parameters. However, there are no reliable data for making recommendations regarding diseases such as hypertension (*23*) and colon cancer (*24*). In addition, there is unanimity regarding the need for further study of overweight in children and the elderly before recommendations regarding "ideal weight" can be made (*25*). Promoting appropriate eating behaviors and regular physical exercise consistent with economic, social, and cultural realities is an important remedy for preventing obesity at any age.

Obesity as a Marker of the Risk of Nutrition-related NCCDs

Compared to diseases related to other environmental conditions and diseases with a genetic origin, nutrition-related NCCDs represent a very high percentage of all NCCDs. Obesity, particularly overweight, can be a very useful marker for monitoring activities due to its sensitivity and because the screening and detection of at-risk subjects are procedures that are easily applied and cost little. Any other more specific condition would doubtless be much more expensive and difficult to detect.

For epidemiological purposes, obesity is evaluated using anthropometric techniques, customarily by measuring weight and height, and using established reference and cut-off points. The measurement of these variables requires a simple, relatively low-cost technology that allows us to determine whether there is a high association with the risk factors for obesity and other NCCDs (*25*). In addition, training in measurement-taking is simpler than the training required to apply the diagnostic techniques for evaluating other NCCDs. For example, to detect high blood pressure one must use a sphygmomanometer and the subject must meet the minimum conditions of rest and relaxation. In the case of NIDDM, biochemical techniques are used, the subject must be prepared, and the rules for preserving samples must be followed.

Preventing Obesity and NCCDs

Actions to prevent obesity coincide with many of the measures taken to prevent most NCCDs. They must begin at conception and continue throughout the life cycle. Thus, adequate nutrition for pregnant women makes it possible to prevent intrauterine malnutrition and its future consequences (*26*), and exclusive breastfeeding during the first four months of life and adequate supplemental food in the next 12 months until the infant eats the regular family diet establishes the bases for avoiding future nutrition-related ailments.

Subsequently, an adequate diet and systematic physical activity are two key elements for preventing most NCCDs.

From the age of 4, it is necessary to reduce the relative contribution of fats as a source of energy, to control the quality of fats eaten by reducing saturated fats and increasing the relative amount of polyunsaturated (omega-3) fatty acids and monounsaturated fatty acids, to reduce the consumption of simple carbohydrates and increase the consumption of complex carbohydrates, to increase the consumption of fiber, reduce the consumption of sodium, and systematically meet the requirements for all essential nutrients. The benefit of regular physical exercise not only makes it possible to maintain an adequate energy balance but it also has favorable effects on the circulatory, respiratory, endocrine and osteomuscular, and other systems (*27, 28*).

OBESITY AND SOCIOECONOMIC STATUS

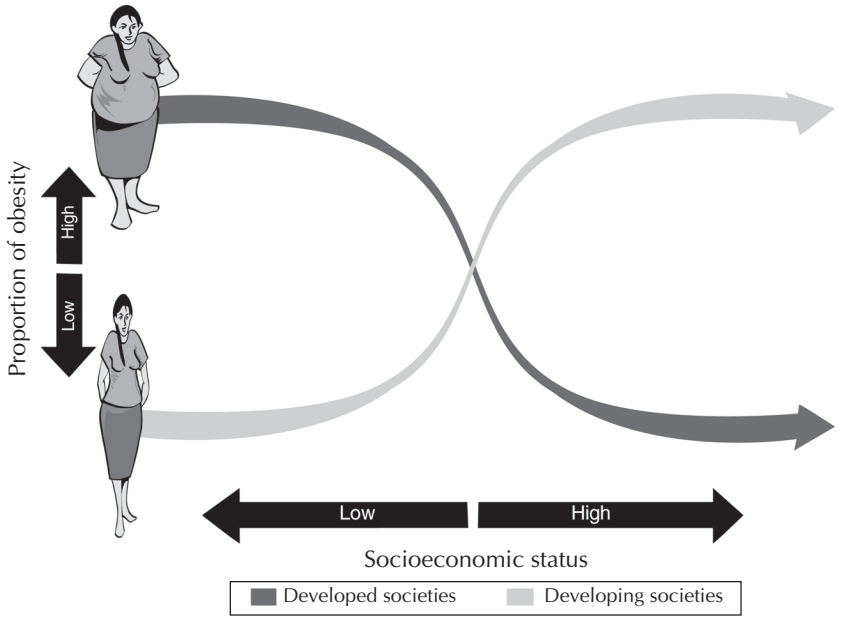
The relationship among malnutrition, infectious disease, and poverty, and the relationship among obesity, chronic disease, and economic well-being are no longer applicable in the developed countries and are being reduced daily in the developing countries in the region (*29*). In peri-urban areas it is normal to find a family in which the father has high blood pressure, may be fat or not, is short, and has a probable history of malnutrition; the mother is anemic, probably obese, and short; and the children suffer frequent infections and show stunting.

In 1989, Sobal and Stunkard (*30*) performed a broad review of 144 publications that related socioeconomic status to obesity. Thirty studies of women in developed countries found a direct relationship between these factors, 28 studies found an inverse relationship, and two found no relationship. In the case of men, 12 studies found an inverse relationship, 11 found a direct relationship, and three found no relationship. In contrast, the studies conducted in the developing countries found a direct relationship between obesity and socioeconomic status (SES) for both men and women (Figure 2). Although the diversity of the indicators and cut-off points used to qualify obesity and to characterize socioeconomic status are limitations of these studies, the trends are significant.

Studies conducted in the 1980s in the metropolitan region of Santiago, Chile found that 5% of the male population and 28% of the female population were obese (weight-for-height values were 120% higher than the reference value) (*31*). The stratification of the sample according to socioeconomic status makes it possible to note that obesity is more frequent in the poorest socioeconomic sectors. Monteiro (*32*) analyzed two national diachronic samples in Brazil and noted that there was increased obesity in groups at the poorest socioeconomic level over a period of 15 years. Working with the same data, Sichieri et al. (*12*) showed that the percentage of women with low weight decreased during the same period and the percentage of overweight men and women increased. In a document from the Nutrition Institute cited in Uruguay's report to the International Conference on Nutrition held in Rome in 1992, Bove, Severi, and González pointed to a higher percentage of obesity among women of low SES (37.6%) than among women of high SES (*33*) and, when gender-related factors were considered, the greatest differences were also recorded at the low socioeconomic levels. Another study conducted in popular restaurants in the poor neighborhoods of a district in metropolitan Lima found a direct association between obesity and SES: the prevalence of overweight and obesity among women was 32.6% and 13.1%, respectively (*33*).

Two factors make it very difficult to establish definitive conclusions regarding the relationship between obesity and SES. First, the relationship may vary from country to country or among different regions within a single country. Second, the relationship may remain hidden due to cultural, ecological, or social

FIGURE 2. Relationship between obesity and socioeconomic status.



factors. In some countries of the Americas, the relationship between obesity and SES is similar to the relationship in the developed countries. In other countries, the relationship may be the inverse. It is likely that this variable behavior pattern is heading toward an inverse relationship pattern, according to the pace and the model of epidemiological and nutritional transition specific to each country.

THE "POOR" OBESE PERSON AND THE "RICH" OBESE PERSON

The characteristics of obesity may be different among the poorest and richest people of the same country, or between the poorest and richest people of the developed or developing countries. In order to analyze these differences, it is important to consider the effect of different types of factors.

Adaptive Genetic Factors

According to the thrifty genotype hypothesis (*34*), the obese poor may have developed a mechanism for metabolic adaptation. The hypothesis postulates that populations exposed to inadequate or fluctuating food consumption generate adaptive methods to achieve a high level of efficiency in the use of energy and depositing of fats. If these methods are retained when these groups succeed in having food regularly available, there may be an increase in the prevalence of overweight and NIDDM.

Nutritional Factors

Urban populations in different countries have changed their diets, increasing fat and sugar consumption and decreasing fiber consumption (*35–37*). In some low-income urban sectors, the percentage of fat in daily energy intake increased considerably over the last 25 years (*38*). High prices for fresh fruits and vegetables and other foods with high nutritional quality make these foods inaccessible to the lowest income groups (*39*). In addition, the food industry offers various foods that have high energy density (rich in fats and sugars) but are deficient in other essential nutrients: their great

ability to satiate, their pleasing taste, and their low cost make them socially acceptable and preferable to the poorest groups.

Sociocultural Factors

The aggressive and insecure environment that characterizes life in peri-urban areas prevents the poor population from engaging in systematic physical exercise. In addition, those who live in these areas usually receive less information on the health and quality-of-life benefits of exercise. Inequities in access to health promotion messages, health education, and adequate health care services make it difficult to know the importance of changes in behavior needed to achieve a healthier lifestyle (*40, 41*).

Acculturation at a Distance

As a result of contact with the cultural patterns of the developed countries, the process of acculturation in Latin America and the Caribbean throughout the 20th century took on particular nuances due to rapid advances in science and communications. This "acculturation at a distance," skillfully manipulated by consumer industry, tends to awaken in people the need to incorporate some elements of the projected image and leads them to adopt inappropriate habits and lifestyles. Studies of Mexican-American populations showed the differential influence of acculturation in men and women (*42, 43*) and that the process generates more obesity in women (*43*).

The more prosperous groups manage to adapt to these changes more easily. In contrast, the poorer groups suffer from the conflict between their abilities and the ideal image with which they identify. As a result, those who have more limited cultural and social opportunities and live in a violent and insecure environment show micronutrient deficiencies and excess bodyweight and are at the same time at risk of contracting infectious diseases and chronic non-communicable diseases associated with their diets.

Gender-based Factors

If gender-based factors are taken into account, the difference between the "two types of obesity" is even more striking: women have more limited opportunities, bear heavier social burdens, and have an undervalued body image. In addition, their traditional social subordination to men increases their susceptibility to that complex set of unfavorable influences. The sum of these factors shows the need to conduct further studies of them.

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SOCIOANTHROPOLOGICAL ASPECTS OF OBESITY IN POVERTY

Patricia Aguirre[1]

Observation of the direct relationship between malnutrition and obesity in the poorest sectors of Argentine society, particularly among women, demonstrated the need to investigate the causes of the problem and the factors promoting its development. The decision was then made to conduct a retrospective study of people living in a poor environment in order to analyze the socioeconomic factors that influence access to food, the practice of physical exercise, and body image. The study considered the information obtained between 1965 and 1995 by the National Development Council (CONADE) (*1*), the National Institute of Statistics and Censuses (INDEC) (*2–4*), and the Social Programs Information and Monitoring System (SIEMPRO) (*5*).

The study found that the poor do not eat what they want, or what they know they should eat, but what they can afford. Restrictions on access to food determine two simultaneous phenomena that are two sides of the same coin: the poor are malnourished because they do not have enough to feed themselves and they are obese because they eat poorly, with a significant energy imbalance. The foods available to them are industrialized, mass-produced, undifferentiated, and inexpensive products. In the Buenos Aires metropolitan area, Argentina's major urban conglomerate, prices for fruits and vegetables, lean meats, and dairy products tend to increase faster than the average rate of inflation. Given this situation, the poor choose foods that are rich in carbohydrates, fats, and sugars, which do not provide them with adequate nutrition, but do satisfy their appetites and are easily incorporated in their traditional consumption patterns and their standards of commensalism (group meals). For its part, the food industry fosters this behavior by compartmentalizing supply and marketing mass, low-quality products with a higher fat and sugar content that are targeted to sectors with less purchasing power.

In addition, we note that the close association between obesity and malnutrition has a greater effect on poor women. Because they skip meals to allow their children and husbands who work outside the home to eat, they sate themselves by consuming teas and bread. This diet, together with the social devaluation of a poor woman's body, fosters a process of deterioration, and obesity is its most visible sign. In Argentina, these processes occur within a social and economic environment in which capital accumulation and the opening of markets are promoted in order to maintain economic stability. This economic model has advantages and disadvantages: although the decline in inflation causes a reduction in the "inflation tax" that weighs more heavily upon

[1] Ministerio de Salud y Acción Social, Dirección Salud Materno-Infantil, Buenos Aires, Argentina.

the poorest sectors, it also promotes a strong concentration of income. As a result, the poor become increasingly poor and the magnitude of their poverty grows more and more.

This situation was used as a frame of reference and justification for studying variations in consumption patterns among the poor population of the Buenos Aires metropolitan area during the period 1965–1995 as well as the effects of these variations on people's nutritional status. Considering that consumption patterns, or food habits, are built over the long term through the selection of those foods that bring more economic and nutritional advantages, an effort was made to determine the relative advantages that the poor find in the foods they eat. The anthropological approach used to describe the strategies and rationality of food consumption among the poor made it possible to analyze macroeconomic factors that determine the level of access to foods and the microsocial factors that determine that access in the household setting.

In Argentina, with an urban population of 86.4% and a virtually unrestricted market economy, consumption patterns are strongly influenced by the components of food access: purchasing power, social assistance policies, and consumption strategies. Food purchasing power, which is the relationship between the prices of products and the incomes of buyers, changes with fluctuations in the economic cycle (which determines incomes) and the agro-industrial cycle (which determines food prices). Both factors currently have a greater impact on the nourishment of the poor than do health and education plans, as government adjustment policies significantly reduced investment in these areas.

Although the poor know the advantages of harmonious and balanced nourishment, they eat those foods that allow them to obtain the greatest possible yield (primarily economic) from their limited incomes. When they do this, their diet becomes monotonous and the nutritional content of the products they eat is inadequate because of their high carbohydrate and fat content. However, comparative advantages in terms of access do not of themselves determine the adoption of a consumption pattern if they are not related to the standards of commensalism and gender- and age-based activity that are characteristic of each social group. Thus, obesity among poor women is associated not only with their restricted access to food but also with their particular living conditions, their self-image, the work they do, and their eating habits.

The Problem of Knowing What to Eat

A very widespread idea is that malnutrition is the result of ignorance, that the poor fill their food baskets with bread and pasta because they do not know what constitutes adequate nourishment. To demonstrate the fallacy of this notion, a comparison was made of food baskets over a period of 20 years (Table 1). It was apparent that the same products appeared throughout the period, showing a stable consumption pattern, but that the total average volume of the foods consumed fell by 20%.

This decrease can be attributed to increased poverty (which rose from 9% to 27%) in the sectors that reduced their consumption during the years under consideration. The table shows that consumption increased in only five categories and fell in another 14. Among those that increased most, we see three products that, due to price, are consumed in greater proportions in medium- and high-income sectors (lean cuts of hindquarters in the beef category, poultry, and cheeses). The only mass consumption product that increased 1.9% was maté (the tea made of *yerba mate*). It should be pointed out that the increased consumption of powdered milk occurred for different reasons in different sectors: consumption in the middle- and high-income sectors changed because the food industry made skimmed, fortified, and reduced-fat milks available to them, and consumption in the poor sectors changed because powdered milk was the main product that State social assistance provided to them. Although the size of this assistance varies over the years and according to policy,

TABLE 1. Variation in food product consumption (in kilograms), 1965 and 1985.

Product	1965 (kg)	1985 (kg)	Variation (%)
Grains	105.71	79.08	–25.2
Beef (fatty cuts)	13.19	8.16	–38.1
Beef (lean cuts)	38.24	47.52	24.3
Pork and lamb	5.40	1.20	–77.8
Poultry	11.00	16.80	52.7
Cold cuts and sausages	7.92	5.88	–25.8
Fish and shellfish	6.78	4.56	–32.7
Fresh milk	102.45	71.40	–30.3
Powdered milk	0.31	0.60	93.5
Cheeses (soft and hard)	10.14	11.28	11.2
Butter	3.49	1.68	–51.9
Fruits (fresh and preserved)	64.26	48.12	–25.1
Vegetables and legumes	129.56	91.68	–29.2
Sugar and sweets	73.45	66.32	–9.7
Coffee	4.21	1.68	–60.1
Maté tea	7.06	7.20	20.0
Bottled water and carbonated beverages	87.00	51.72	–40.6
Beer	5.15	4.68	–9.1
Wine	55.78	32.16	–42.3

Sources: Argentina, Consejo Nacional de Desarrollo; Argentina, Instituto Nacional de Estadística y Censos.

it is always significant for the poor and for industry. For example, in 1985 food assistance represented 12% of total income for households below the poverty line, and the State purchased 30% of the powdered milk produced in the country in order to use it in its assistance programs. In conclusion, the analysis indicates that the food pattern remains stable and that the overall decline in food consumption cannot be attributed solely to a problem of education, but must be attributed to a problem of access as well.

Trends in the Components of Access

Income Distribution

The distribution of income in Argentine society in recent years shows that all population groups, with the exception of the wealthiest, have suffered a loss. Table 2 shows that between 1980 and 1995 there was a decrease in the incomes of the first eight deciles and an increase in the last two deciles. The progressive impoverishment of the society is not only a reflection of an increase in the number of poor. Poverty becomes worse in poor households because incomes decline. For example, the poorest groups in the first decile received 3.6% of total income in 1980, but received only 2.6% in 1995—a 25% loss (*6*). As the decline seen in the surveys indicates, when poor households receive less income, they change their diet and they eat less.

Food Prices

The comparison between the Food and Beverage Relative Price Index and the Consumer Price Index between 1991 and 1995 indicates that the decline in income was accompanied by a permanent increase in food prices. Even in a period of stability, food and beverage prices remained above the average inflation rate (Table 3). The combination of rising prices and falling incomes meant that all of Argen-

TABLE 2. Percentage distribution of per capita family income in the Buenos Aires metropolitan area, Argentina, 1980, 1985, and 1989–1995.

Decile	1980	1985	1989	1990	1991	1992	1993	1994	1995
1	3.6	3.3	2.6	3.4	3.2	3.0	2.6	2.9	2.7
2	4.5	4.7	3.4	4.1	4.4	4.7	4.2	4.4	4.3
3	5.4	6.1	4.8	6.0	6.0	3.9	5.0	4.9	4.5
4	6.2	5.3	5.1	6.1	5.3	6.2	6.1	6.2	5.9
5	7.2	6.9	4.7	5.8	6.0	7.7	7.6	7.3	7.2
6	8.7	9.1	7.7	8.6	9.5	9.0	8.5	8.3	7.8
7	10.5	10.9	9.0	9.3	9.9	10.1	10.2	9.9	9.6
8	12.5	12.2	11.6	11.9	11.8	12.5	12.4	12.7	11.7
9	15.4	16.6	17.0	15.6	14.1	16.5	16.8	16.0	16.0
10	25.9	25.0	34.2	29.0	29.9	26.6	26.5	27.4	30.3

Source: Argentina, Instituto Nacional de Estadística y Censos. *Encuesta de Gastos e Ingresos de los Hogares: cantidades consumidas.* Buenos Aires: INDEC; 1992.

tine society had to devote a larger percentage of their overall household budget to food. In 1970, the poorest groups spent 45.23% of their incomes on food; by 1985, the figure had risen to 53% and unofficial surveys indicate that this spending reached 67.27% in 1992 (Table 4).

An analysis of the characteristics of the diet of the poor is even more justified given evidence that restrictions on access affect half the population and all social strata (*7*). In the case of the poorest groups, the decline in consumption must also be associated with differences in the foods they eat. As shown in Table 5, the food baskets of the poor contain more bread, grains, potatoes, tubers, and sugar, an equal amount of oils, and fewer meats, dairy products, fruits and vegetables, eggs, wine, and carbonated drinks than do the baskets of the other socioeconomic strata.

TABLE 3. Comparison between the Consumer Price Index (general level) and the Food and Beverage Relative Price Index, Argentina, 1991–1995[a].

Year	Consumer Price Index	Food and beverage portion
1991	100	100
1992	130	143
1993	145	158
1994	153	162
1995	160	168

[a] March 1991 = 100.

Source: Argentina, Instituto Nacional de Estadística y Censos. *Estadística Mensual. Índice de Precios al Consumidor, serie 1980–1996.* Buenos Aires: INDEC; 1997.

Trends in Relative Food Prices

To determine the underlying causes for the composition of the food basket, the factors that determine the poor's access to the products they eat most, the products they always eat, and the products they stopped eating were analyzed. According to INDEC's surveys of general spending, food product consumption depends on the amount of income: the foods that are consumed more when incomes decline (bread, potatoes, pasta, wheat flour, sugar, soy oil, maté, and popular cuts of meat) are the foods that are consumed less when incomes rise. Figure 1 shows that the foods the poor eat when their incomes fall remained below the increase in inflation (Consumer Price Index, general level), although in recent years they tended to become equal. The comparative advantages of carbohydrates and fatty meats are evident: not only are they less

TABLE 4. Food cost by income level, Argentina, 1970, 1985, and 1992.

	Quintile					
Year	1	2	3	4	5	Total
1970	45.23	41.15	35.96	29.84	22.91	31.22
1985	53.00	40.50	44.20	39.00	29.50	38.20
1992[a]	67.27	52.38	49.14	45.00	25.48	47.86

[a] Unofficial estimates.

Source: Argentina, Instituto Nacional de Estadística y Censos. *Encuesta de Gastos e Ingresos de los Hogares: cantidades consumidas.* Buenos Aires: INDEC; 1992.

TABLE 5. Average monthly percentage of food consumption by product and per capita income level, Argentina, 1992.

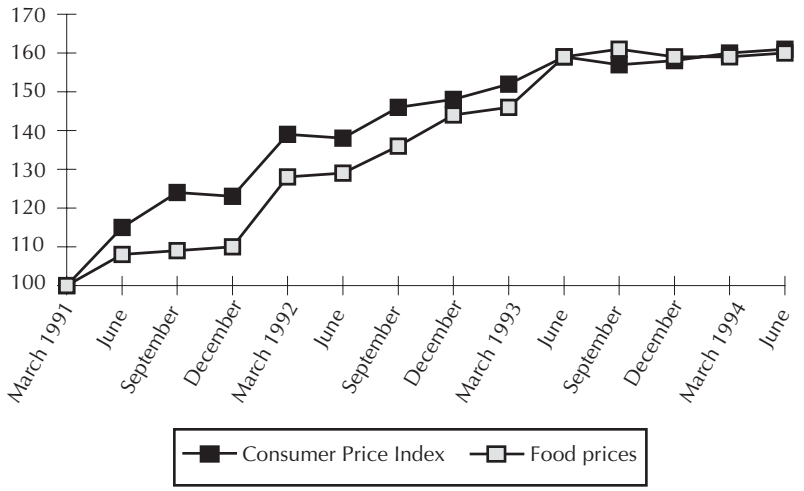
Product	Quintile 1 (%)	Quintile 3 (%)	Quintile 5 (%)
Oil	2.20	2.12	2.18
Sugar	4.03	3.56	3.45
Meat	14.86	15.93	15.95
Grains	17.77	13.43	10.30
Spices	0.78	0.86	0.89
Fruits and vegetables	13.69	16.31	19.39
Carbonated beverages	15.62	17.35	19.10
Eggs	1.49	1.76	1.69
Tea	1.27	1.31	1.53
Dairy products	13.47	14.33	14.13
Potatoes	9.40	7.27	5.52
Wine	5.32	5.77	5.87

Source: Argentina, Instituto Nacional de Estadística y Censos. *Encuesta de Gastos e Ingresos de los Hogares: cantidades consumidas.* Buenos Aires: INDEC; 1992.

expensive but they also produce a feeling of being full. The poor do not choose this group of products because they do not know better but because they cannot afford to eat other more expensive foods. They recognize that they "don't nourish" (a characteristic of proteins in the popular belief), but that they "fill" or "fool the stomach." In addition, the trends in prices for the food products eaten by the middle-income sectors coincided with increased inflation (Figure 2), and the prices for foods eaten by the high-income sectors exceeded average inflation (Figure 3). According to INDEC's Household Spending and Income Survey, the cost for 1000 kcal in each sector according to income level shows a positive cost-benefit ratio for the low-income sectors (Table 6).

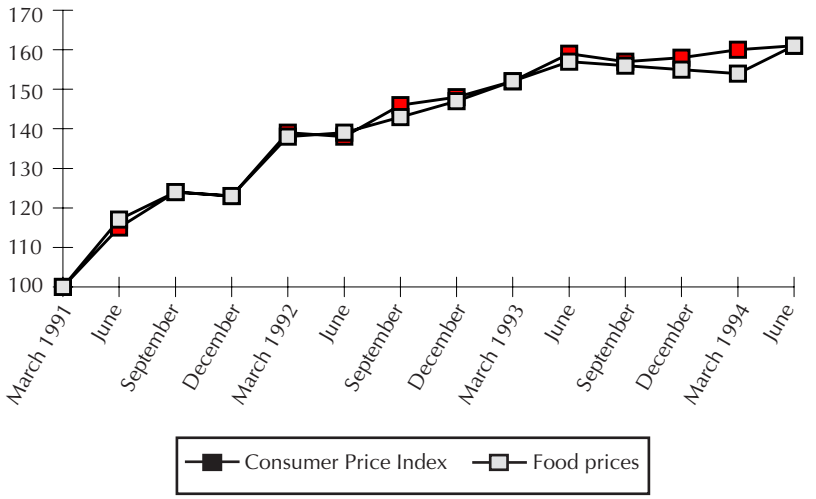
However, the poor do not fill up their baskets with the foods that cost least and provide 1000 kcal at the lowest price based solely on the cost-benefit criterion. They also consider the satiety and satisfaction they obtain from these foods, and whether these foods are easily incorporated with the group's patterns of commensalism, with the customary method of preparing products, and with beliefs regarding the contribution each food makes to the body image endorsed by society.

FIGURE 1. Trend in relative weighted prices for consumption tracer foods in low-income sectors, Argentina, March 1991 to June 1994.



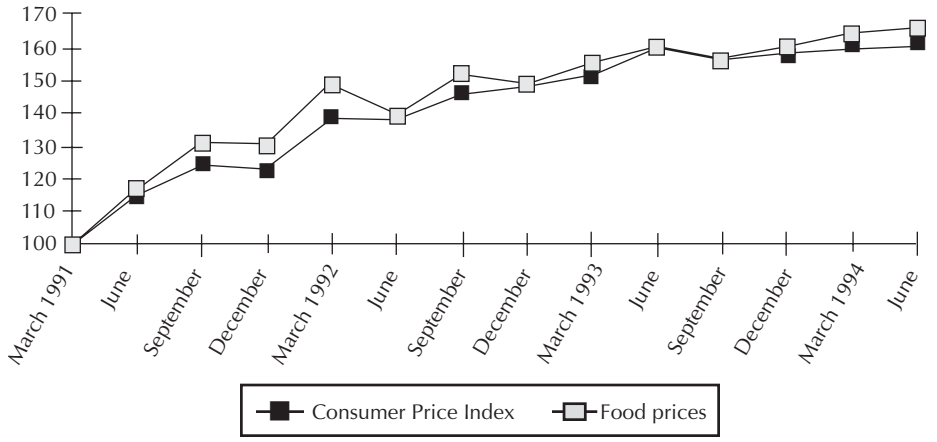
Source: Argentina, Instituto Nacional de Estadística y Censos. Encuesta de Gastos e Ingresos de los Hogares e Índice de Precios al Consumidor.

FIGURE 2. Trend in relative weighted prices for consumption tracer foods in middle-income sectors, Argentina, March 1991 to June 1994.



Source: Argentina, Instituto Nacional de Estadística y Censos. Encuesta de Gastos e Ingresos de los Hogares e Índice de Precios al Consumidor.

FIGURE 3. Trend in relative weighted prices of consumption tracer foods in upper-income sectors, Argentina, March 1991 to June 1994.



Source: Argentina, Instituto Nacional de Estadística y Censos. Encuesta de Gastos e Ingresos de los Hogares e Índice de Precios al Consumidor.

Prices Compared

Comparing the prices of the foods the poor eat most (bread, pastas, and fatty cuts of meat) and the foods they eat least (vegetables and fruits) indicates that between 1980 and 1994 the poor were able to buy 700 g of beef or 1.5 k of pasta or 1.3 k of bread for the price of 500 g of lettuce and 500 g of tomatoes. It is obvious that fresh vegetables or fruits do not meet

TABLE 6. Cost of 1000 kcal by income level, Argentina, 1992 and 1994.

Quintile	December 1992 (Arg$)	December 1994 (Arg$)
1	5.5	6.60
2	7.6	8.20
3	8.7	9.98
4	9.6	11.15
5	12.4	14.34

Source: Argentina, Instituto Nacional de Estadística y Censos. Encuesta de Gastos e Ingresos de los Hogares e Índice de Precios al Consumidor.

the criteria of satisfaction or convenience because their prices are very high and they are not very filling (Table 7).

The price structure is contradictory in a country with a temperate climate: fruit and vegetable products are as expensive as beef, even though beef requires a more costly and complex industrial process (slaughter, cutting, cold storage, packaging, distribution, etc.), plus the time to raise the animal. However, the stable relationship among prices since 1980 indicates that the price the consumer must pay will keep the poor from consuming these products if the marketing of fruits and vegetables does not change (7). In addition, we note that the cuts of meat selected differ according to the various sectors' income levels. The high-income population chooses lean, juicy, tender meats from the animals' hindquarters, which are the most expensive cuts. The poor choose tougher and fattier cuts of meat (brisket and topsides) from the forequarters because they are cheaper. All social sectors eat the three "multi-function" cuts (ground meat, rump, and sirloin). It should be emphasized that the cuts of meat consumed by the low-income sectors provide them with protein at a lower price, but that the fat content is also much higher. If the composition of 100 g of topside meat is compared with 100 g of steak meat, it can be seen that topside meat provides more kilocalories than steak (331 kcal versus 248 kcal, respectively), but it also provides less protein (15.9 g versus 17.8 g, respectively) and more fat (29.7 g versus 19.7 g, respectively). In conclusion, in order for the poor to vary their food selection and consume fewer carbohydrates and fats and more fruits, vegetables, fish, and cheese, the real conditions for access to these latter products must be changed.

TABLE 7. Equivalence between average price for a kilogram of fresh fruits and vegetables and a kilogram of beef, dry pasta, and bread, Argentina, 1980, 1985, 1990, and 1994.

Product	1980	1985	1990	1994
Peaches				
Brisket	0.702	0.990	1.360	0.743
Ground beef	0.506	0.714	0.981	0.679
Pasta	1.129	1.075	1.418	1.676
Bread	1.340	1.593	2.045	1.188
Lettuce				
Brisket	0.953	0.645	0.633	0.717
Ground beef	0.687	0.465	0.457	0.655
Pasta	1.532	0.859	0.660	1.618
Bread	1.821	1.226	0.952	1.146
Apples				
Brisket	0.537	0.691	0.757	0.735
Ground beef	0.387	0.498	0.546	0.671
Pasta	0.863	0.750	0.789	1.657
Bread	1.026	1.111	1.139	1.174
Tomatoes				
Brisket	0.914	0.944	1.042	0.613
Ground beef	0.659	0.681	0.752	0.560
Pasta	1.469	1.025	1.086	1.328
Bread	1.745	1.519	1.567	0.979

Source: Argentina, Instituto Nacional de Estadística y Censos. Índice de Precios al Consumidor.

Integration with Standards of Commensalism

The poor eat foods rich in carbohydrates and fats because, in addition to being inexpensive, they are suited to their standards of commensalism. Meals based on pasta, flour, potatoes, and oil (stews and soups) are easily included in group meals. Bread, the product consumed most, makes it possible to "stretch" any meal and obtain a feeling of satiety. Sugar is included in the diet to sweeten maté, which is consumed all day long and in abundance by the poor.

The food baskets of the low-income population are filled with "high-yield" foods that are cheap, "filling," and "tasty." An inexpensive food that filled one up would be worthless if it remained on the plate. More than the nutritional quality of foods, the family consumption strategy seeks to ensure that each meal provides satisfaction and satiety, and can be eaten every day (*6*). Moreover, if the price differential is high, the poorest people will not include the most nutritional foods in their diet. The advice of food education messages cannot be acted upon if the chances for obtaining access to more harmonious and balanced nourishment do not improve. The poor know what foods they should eat, but they cannot afford them. It can be seen that to the extent that poverty diminishes because incomes increase, the consumption of fruits and dairy products increases. Otherwise, variety is reserved for children to the point that fruits are considered food for children (a custom that is disappearing due to the introduction of packaged juice that is consumed like a dessert).

If the declining income and increasing price trends continue, it can be inferred that the food consumed by the poorest urban population will contain increasingly more carbohydrates and fats. The comparison between the trend in the food and beverage relative price index and the trend in the fruit and beverage relative price index between 1991 and 1994 shows that economic order and price stability have not succeeded in reversing this increasingly marked rising historical trend (Table 8). Food and beverage prices continue to increase faster than the general rate of inflation, and the highest increases are concentrated in the prices of fruits and vegetables.

Ideal Cost of Adequate Nourishment

In order to determine the cost of nutritionally adequate nourishment, a comparison was made between the price for an ideal basket containing the foods necessary to maintain a good diet and the price of the basket that is actually consumed (Table 9). The higher carbohydrate and fat content cheapens the latter basket by 31.78%. If the cost of a minimum and adequate food basket were projected over time, a poor family in the first two income distribution deciles would be able to eat for 20.7 days in a month. With the foods that actually make up the basket, with an abundance of grains, fatty meats, oils, and sugars, the family is able to eat for the entire month (30.2 days).

The Role of Industry

The 1965 survey shows that the foods eaten by the poor at that time had little added value. At that time, agribusiness gave preference to the supply of fresh, bulk, and minimally processed foods that were prepared by women. In addition, the economically active female population represented barely 11% of the total population and a single salary was enough to maintain a household. Throughout the

TABLE 8. Trend in the food and beverage component, and in the fruit and vegetable component of the Consumer Price Index, Argentina, 1991–1994[a].

Year	Consumer Price Index	Food and beverage component	Fruit and vegetable component
1991	100.0	100.0	100.0
1992	130.3	143.8	165.9
1993	144.5	155.3	175.6
1994	155.6	162.2	183.5

[a] 1991 = 100.

Source: Argentina, Instituto Nacional de Estadística y Censos.

TABLE 9. Comparative cost for a food basket with nutritious foods and the food basket usually eaten, Argentina, 1992.

Monthly cost for a nutritionally adequate family basket	Arg$ 346.74
Income needed to cover all needs in addition to the adequate basket	Arg$ 717.75
Actual cost of family basket consumed	Arg$ 236.56
Average family income	Arg$ 473.12

Source: Argentina, Instituto Nacional de Estadística y Censos. Encuesta de Gastos e Ingresos de los Hogares e Índice de Precios al Consumidor.

1980s, this industry segmented the market according to income levels and began to produce foods for mass consumption, differentiated by brand and quality. The general decline in purchasing power during those years meant that the companies that chose that strategy had to operate for most of the decade with a high idle capacity (poultry production with 50%, milling with 30%, and bakeries with 45%).

In contrast, during the 1990s the food industry offered a better relative price for its products and the informal sector was increasingly concerned with distributing fresh foods. Recognizing the existence of the "market for the poor," manufacturers now try to exploit it by re-orienting their production: they offer industrialized, mass-produced, undifferentiated, low quality products under secondary brands, and they keep the supply of small-scale, high-quality, first class brands for the high-income sectors. Thus, the triangular market configuration of the 1950s, with a large base that consumed foods with little value added, a middle sector that ate industrialized, mass-produced, and undifferentiated products, and an apex that consumed differentiated foods, has given way to the current rhomboidal configuration in which a small population group living in conditions of extreme poverty eats foods with little added value, a large group of people who receive low and medium incomes consumes mass-produced and industrialized products, and a small, very exclusive group consumes highly differentiated products with high added value (7).

Popularly consumed products differ not only in terms of packaging, advertising, and distribution; quality also changes with price: the same company produces two different quality pastas and markets them with different brand names and prices for each income sector. Judging by product content labels, the lower the purchasing power of the public that consumes a product, the higher its fat content (Table 10). In the case of crackers, the difference in price is on the order of 30% but the difference in fat content is greater. The difference in price would disappear if we subtracted the crackers that break in the box because the higher fat content makes them more fragile. In the poorer sectors, the purchase value is not lost due to the custom of soaking ("dunking") crackers, bread, or crumbs in the snack bowl. Thus, it can be concluded that agribusiness found an "empty niche" and exploited it by using the logic of a market economy.

In addition, the consumption of foods high in carbohydrates, fats, and sugars is functional in terms of the poor's lifestyle and predates the current economic model. Agribusiness now offers products that reinforce these characteristics within a positive feedback loop, whereby demand conditions supply and specific supply in turn creates demand. From the nutritional viewpoint, the loop creates negative feedback and it becomes increasingly more difficult to change eating habits.

Income distribution trends indicate that what was once a niche will become the "normal sector" due to the increase in the number of people who are entering the poor sector. In the 1960s, the informal sector and small and medium-sized industries supplied the poor sectors. In the 1990s, poor and medium-sized industries engaged in food production are disappearing due to the strong reconversion of the sector and the competitive advantages of vertical integration and industrial

TABLE 10. Fat content percentage and prices of products marketed for different socioeconomic groups, Argentina, 1992.

Product	Manufacturer	Socioeconomic group	Fat (%)	Price (Arg$)
Crackers	Terrabusy	Mass undifferentiated	13.0	1.69
	Gold Mundo	Poor differentiated	19.0	1.45
Milk	La Serenísima	High differentiated	1.5	0.88
	La Serenísima	Mass undifferentiated	3.0	0.62
	Sancor	Low differentiated	3.0	0.59
Pasta	Buitoni	High differentiated	0.0	1.10
Soup noodles	Terrabussi	Mass undifferentiated	0.0	0.99
	Irene	Low differentiated	0.0	0.90

concentration. Thus, the market for the poor is increasingly supplied by the large industrial conglomerates that produce foods with secondary brands and by a changing informal market that is transforming industrial products by copying the model of the more powerful producers.

Consumption Standards and Gender-based Activity

Although all individuals who belong to the low-income sectors consume carbohydrates, fats, and sugars, obesity among the poor is more visible among women. In order to explain the difference, we must consider the standards of physical activity and commensalism according to gender and age. These standards are different for adult men and women due to the influence of extremely well-rooted, gender-based conditioning and prejudices. Poor men work in activities that require intensive labor and a high level of physical exertion, they sleep two more hours than women on average, and work fewer hours because of the greater energy expended in their labors. In addition, they have three meals (breakfast, snack, and dinner) and since they have their own money, are able to eat another meal outside the home. In contrast, poor women perform various non-specialized domestic tasks and, though they may alternate tasks that require more or less energy expenditure, they have a longer workday than men. It might be thought that women eat the four meals served at home, but this is not the case. Their daily diet includes only sweet maté and bread. Dinner is the only family meal in which they participate, but even then they forgo more nutritious foods in order to allow the children and adults who work outside the home to eat them (*6*). Thus, obesity and mal-

TABLE 11. Unemployment rate trends by income quintile and by gender, Argentina, 1980, 1986, 1989, 1992, and 1993.

	Quintile 1		Quintile 2		Quintile 3	
Year	Women (%)	Men (%)	Women (%)	Men (%)	Women (%)	Men (%)
1980	5	2	4	2	6	1
1986	12	8	6	4	7	2
1989	12	16	11	8	7	7
1992	15	13	11	8	7	9
1993	28	19	19	12	14	7

Source: World Bank; Argentina, Instituto Nacional de Estadística y Censos. Encuesta Permanente de Hogares.

nutrition are concentrated in female domestic workers and poor women.

Thirty-five percent of the country's total economically active population are women. Of this percentage, 28% were unemployed in 1993, since unemployment generally affects women more, particularly women in the poorer groups (Table 11). In addition to the relative exclusion of these women from the salaried working world, urban segregation (*8*) and their own body images foster limited physical activity. Thus, income restrictions that keep them from moving within a larger sphere of action and often confine their movements to the neighborhood combine with the persistent traditional concepts that force them to remain at home. At the same time, the widespread belief that sports and social activity are part of masculinity helps to reduce still further women's limited participation. A clear example of this situation is seen in land appropriation cases: when public lands are illegally settled, open spaces are left for the institutions that the group needs most (post office, school, police station, first aid station) and a plaza. In practice, the space reserved for the future plaza serves as a recreation area where men of different ages come to play soccer, but very few women appear (*8*).

The same conditions that segregate and immobilize women cause a devaluation of their bodies and selves as social subjects. The perceptions and the "uses" of one's own body are different for each income sector and social class. For example, a poor man's ideal body is "corpulent," as a result of his nutrition, manual labor, and patterns of activity. In contrast, the ideal body of the medium- and high-income population is "thin," and encompasses both aesthetic and health criteria. In those sectors, the practice of sports, gymnastics, and dance hold an important place for women. While everyone's body is a tool for work, be it the body of a model or a stonecutter, the model's body is a valued tool that is cared for; the stonecutter's body is devalued and receives less care. This difference can even affect the perception of pain: a pain of the same intensity leads the model to see the doctor immediately; the stonecutter waits for the pain either to disappear or to increase before seeing a doctor (*9*).

For the professional or upper-income woman, her body is part of her value and she cares for it using the resources that the culture, society, and fashion indicate. In her social perception, "being slim" allows her to meet the criteria of "health and beauty." Thus, these women feed themselves, wear makeup, and undergo surgical procedures to make themselves beautiful, and practice sports as part of a "movement towards the ideal" (*10*). Like the stonecutter, a poor woman's body is a devalued work tool, except when supporting the social value of motherhood. Since the social ideal of the population to which she belongs is to have a "strong" body, she does not need to approach the social ideal of thinness and beauty of the higher-income sectors. The silence regarding her body is only broken when it deteriorates or pain occurs, and this situation generally occurs at a late stage.

Quintile 4		Quintile 5		Total	
Women (%)	Men (%)	Women (%)	Men (%)	Women (%)	Men (%)
1	1	1	1	3	2
2	2	2	1	5	3
6	3	2	2	7	7
5	4	2	1	6	6
10	6	5	3	13	8

The processes that lead to obesity with nutritional deficiencies are slow. Thus, the deterioration is not noticed until it is complete and its consequences appear many years after it began. As a result, disorders remain hidden and are not treated in the early stages because of the high social value of being "strong."

In popular language, there are two expressions for two types of women: the woman who "takes care of herself" and the woman who "lets herself go." The first reflects the ideal of the wealthy sectors and recognizes a woman's efforts when she diets and exercises. The woman who "lets herself go" is not concerned about her own body and is not eager to work; she is "lazy." A poor woman views herself as someone without energy, always tired, who does everything slowly and reluctantly. Although her typical exhaustion reflects a state of depression and undernutrition, language usage converts the victim into the guilty party by blaming her for her situation. In addition, it robs meaning from the social determination that places her in a different food and nutritional situation. The woman belongs to a population group that does not receive enough income and that does not have access to adequate nourishment, well-paid work, or appropriate health education. When we consider together the diet of poor women (based on products high in carbohydrates and fat), the characteristics of commensalism that lead them to fill themselves with bread and sweet maté, their limited or moderate energy expenditure due to lack of access to physical recreation, and the perception of their bodies as devalued tools, it is not surprising that these women comprise the population group exhibiting the highest levels of overweight and obesity.

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FACTORS IN OBESITY: CURRENT VIEWS

Albert J. Stunkard[1]

This discussion of factors in obesity will address three major topics: genetic determinants of obesity, the distribution of body fat in obesity, and the influences of social factors, particularly socioeconomic status (SES).

Any consideration of the role of social factors in the determination of obesity today must consider what we know about the role of genetic determinants of obesity. This information is of recent origin and it is necessary to put it into context so that genetic influences are neither exaggerated nor minimized.

GENETIC DETERMINANTS OF OBESITY

For some time, the existence of numerous forms of genetic obesity in animals and the ease with which adiposity can be produced by the selective breeding of farm animals have suggested that genetic factors may play a similarly important role in human obesity. The stunning advances in our knowledge during the past decade have made it clear that genetic factors do indeed play an important role in human obesity.

A previous study, utilizing the classic twin method, estimated very high levels of heritability (the percentage of variance accounted for by genetic influences) for the body mass index (BMI–weight (kg)/height^2 (m)). In this study, heritability was estimated at approximately 80% (*1*). Even studies of identical twins separated at birth, a method that avoids some of the bias inherent in classic twin studies, estimated heritability at 66% (*2*). These studies are still widely cited, but there is growing consensus that they overestimate the influence of heredity.

The results of adoption studies and of complex segregation analysis agree on approximately 33% heritability of BMI (*3, 4*), a value now viewed as a more reasonable estimate than that of the twin studies. Genetic influences appear to play a more important role in determining the distribution of body fat, with a particularly strong influence on the critical visceral fat depot that is described in the next section.

The recent entry of molecular genetics into the study of obesity, with the identification of mutations of two genes (*5–7*) that cause obesity in mice, promises to greatly advance our understanding of the genetic determinants of human obesity. Nevertheless, if, as seems likely, the heritability of human obesity is no more than 33%, then 66% of the variances in BMI must be environmental. Thus, although human obesity develops within genetic constraints, environmental determinants play an enormously important role in its development.

Genetic and environmental determinants of obesity are not in conflict. It is not a question of genes *or* environment or of genes *versus* environment, but of genes *and* environment;

[1]Professor Emeritus of Psychiatry, University of Pennsylvania, School of Medicine, Department of Psychiatry, Philadelphia, Pennsylvania, United States of America.

neither acts alone to determine the clinical outcome. This outcome is determined instead by the combination of genetic vulnerability and adverse environmental events (*8*). This combination is diagrammed in Figure 1, in which the small inner circle represents those persons who are genetically predisposed to a disorder. The wedge represents adverse environmental conditions to which these individuals may be exposed. The model indicates that only those genetically predisposed persons who are exposed to adverse environmental conditions are clinically affected, as in the case of obesity.

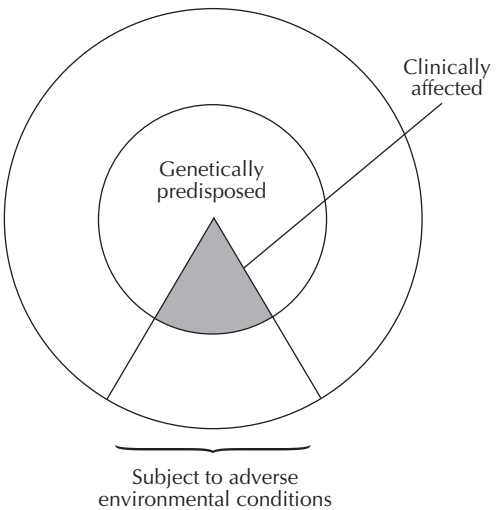
DISTRIBUTION OF BODY FAT

In the past, various classifications of obesity have been based upon the character of the predominant adipose tissue, the severity of the obesity, and the age of onset. All of these classification methods are still used to some extent, but they have been superseded to a considerable degree by the distribution of body fat.

Interest in the distribution of body fat was aroused in the early 1980s by the finding that persons whose fat was located primarily in the upper part of the body suffered far higher mortality and morbidity from ischemic heart disease than did persons whose fat was located primarily in the lower part of the body (*9*). Body fat distribution is measured clinically by the waist:hip ratio, calculated from the waist circumference halfway between the lower rib margin and the iliac crest and the hip circumference at the level of the greater trochanter. Upper body obesity is defined as a waist:hip ratio of more than 1.0 for men and 0.8 for women. Risk, however, is directly proportional to the size of the waist:hip ratio, independent of gender; the greater mortality and morbidity of men is a function of their greater waist:hip ratio.

Although the waist:hip ratio is still the most widely used clinical measure of body fat distribution, a major refinement has been introduced by imaging techniques that have shown that essentially all of the risk of upper body obesity is conveyed by the visceral fat depot, within the abdominal wall (*9*). This finding has greatly expanded our understanding of the complications of obesity and has provided a rationale for the metabolic cascade that mediates many of the steroid hormones, which increases free fatty flux and leads to decreased hepatic insulin clearance as well as hyperinsulinemia, hyperlipidemia, hypertension, and ultimately, cardiovascular disease.

FIGURE 1. Combined effect of genetic predisposition to a disorder and exposure to adverse environmental conditions on clinical outcomes.

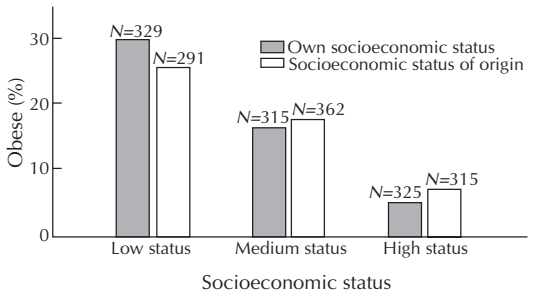


SOCIAL DETERMINANTS OF OBESITY

The fact that genetic influences account for only one-third of the variance in body weight means that the environment exerts a profound influence. One measure of the extent of this influence is the dramatic increase (33%) of the prevalence of obesity in the United States during the past decade (*10*). Unfortunately, our understanding of these important environmental determinants is limited and systematic studies of the topic are rare. Most of these studies focus on socioeconomic status.

An influential report in 1965 delineated the influence of SES on obesity. In a stratified sample of 1660 persons in the Midtown Manhattan Study, as shown in Figure 2, obesity was six times more prevalent among women of lower SES than among those of upper SES (*11*). These results were important because of the strength of the relationship between current SES and obesity, but the study went further. It measured parental SES when the respondents were eight years old, the so-called "SES of origin," and assessed its relationship to the prevalence of obesity. As shown in Figure 2, SES of origin was related to the prevalence of obesity almost as strongly as was the respondents' own SES. The respondents' obesity could hardly have influenced their SES of origin, strongly suggesting that SES of origin was a determinant of obesity in this population at least. Note, however, that the prevalence of obesity in SES of origin was lower than current SES among persons of lower SES and was higher among persons of upper SES. These differences indicate that, in addition to SES influencing obesity, obesity also influences SES, in that it leads to a decrease in SES. Thus, the prevalence of obesity was nearly twice as high (22%) among women who fell in social class as it was (12%) among those who rose in social class. The relationship of social factors and obesity was far less important among men than among women. A recent prospective study had provided powerful support for the view that obesity has a deleterious influence on social functioning: women who had been obese in adolescence suffered significant social disability in adult life (*12*).

FIGURE 2. Prevalence of obesity among women, by own socioeconomic status and socioeconomic status of origin.



Source: Goldblatt PB, Moore ME, Stunkard AJ. Social factors in obesity. *JAMA* 1965;192:1039–1044.

The Midtown Manhattan Study also revealed another social factor related to the prevalence of obesity—acculturation to the U.S. The prevalence of obesity decreased in a monotonic manner over four levels of increasing acculturation—foreign-born, second generation in the United States, one parent second generation and, finally, third and later generations.

These findings have been confirmed in no fewer than 54 studies in developed countries, which found a strong inverse relation between SES and obesity among women (*13*). Furthermore, two prospective longitudinal studies from England have provided strong confirmation that SES is a determinant of obesity. They have shown that both girls and boys born into a lower SES were more overweight as adults than those born into a higher SES (*14, 15*).

The simplest explanation for these findings is that the relation of SES and obesity is bidirectional; SES determines the prevalence of obesity and obesity leads to a decline in SES. There is, however, a complication. Another factor or factors may influence both SES and obesity (*16*). An example of such a common factor is heredity. As we have noted, genetic factors influence obesity. Less well-known is the fact that genetic factors may also influence SES. Thus, studies of Danish adoptees have revealed that the SES of biological parents influences the SES of their offspring, even though they have had no personal contact with them (*17*). A path analysis helps to explain this surprising finding. It shows that the influence of SES on obesity is mediated via the intelligence quotient (IQ). Biological parents influence the IQ of their children and IQ, in turn, influences obesity: the higher the IQ, the lower the prevalence of obesity. It is noteworthy that this influence was present even when the SES of the adoptee was controlled. It ap-

pears that the relationship between SES and obesity is indeed complex (*16*).

The relationship between SES and obesity among women in developed societies is not found regularly among men or children. Among these groups, a significant percentage manifest either no relationship between SES and obesity or a direct relationship: the higher the SES the greater the prevalence of obesity.

When we turn from developed to developing societies, there is a complete reversal in the relationship between SES and obesity. In every developing society that has been studied, there is a direct and often very strong relationship between SES and the prevalence of obesity in men, women, and children (*13*).

What is the reason for this striking difference in the relationship between SES and obesity in developed and developing societies? Four factors may mediate the inverse relationship between SES and obesity among women in developed societies, particularly factors that control obesity among women of upper SES.

One influence, and probably the most important one, constraining the prevalence of obesity among women of upper SES in developed societies is dieting and dietary restraint. Women of higher SES diet more often than do women of lower SES, have greater access to resources that facilitate dieting, have greater knowledge of nutrition, and are more committed to the view that slimness is desirable and, therefore, are more motivated to achieve it.

A second direct influence on the control of obesity among upper SES women is their greater physical activity, derived from their greater leisure time and greater opportunity for recreational exercise. Interestingly, pathologically increased physical activity characterizes the young women of upper SES whose dieting leads to anorexia nervosa.

A third factor mediating the inverse relationship between SES and obesity among women is social mobility. As noted in the Midtown Manhattan Study, the prevalence of obesity is nearly twice as high among women who fall in social class than it is among women who rise in it (*11*). One of the longitudinal studies in Britain confirmed and extended this finding. It showed that obesity was significantly less prevalent (5%) among women who rose in social status than among those (11%) who remained in their social class of origin (*14*). As is the case with SES itself, social mobility plays a far less important part in determining the prevalence in obesity among men.

A fourth factor influencing the relationship between SES and obesity is heredity. As we have seen, studies of Danish adoptees have revealed a significant influence of the SES of biological parents upon the prevalence of obesity in their children, with whom they have had no personal contact. This influence appears to be genetically transmitted via IQ.

The strong direct relationship between SES and obesity in developing societies has a more straightforward rationale than does the inverse relationship in developed societies. The low prevalence of obesity in developing societies appears to be due to a lack of food, coupled with cultural values favoring fat bodies. Obesity may be a sign of health and wealth in these societies, the opposite of its significance in developed societies. In such societies, the biological propensity to store fat is associated with, and may even influence cultural evolution that selects "fatness" as a valued trait. Among most of the 58 traditional cultures for which information is available, "plumpness" is viewed as an ideal of feminine beauty and a symbol of prestige (*18*). In circumstances of relative deprivation, members of the upper SES may have access to sufficient food to become fat; members of lower SES do not.

Because of the enormous importance of environmental factors in determining obesity, it is unfortunate that our information about factors influencing the prevalence of obesity is largely limited to SES. The effort to control obesity will require a far better understanding of the social factors that promote it than is now available. There is, therefore, an urgent need to explore other social factors in addition to SES. A few recent examples illustrate the direction in which such study may profitably be conducted.

Among adolescent girls in the United States, the inverse relationship between SES and obesity, which had been so firmly established among women, is absent among African-American adolescent girls. Evidently these girls were not affected by the messages on body shape that prevail in U.S. culture. Analysis of the recent Hispanic Health and Nutrition Examination Survey (HANES) has revealed a similar lack of relationship between SES and obesity among certain groups: Puerto Rican women and Mexican-Americans and Cuban-Americans of both genders (*19*). This study also suggests social determinants different from those that have been the subject of most of the research to date (Kahn LK, personal communication).

Along with these essentially negative findings, an interesting positive finding has emerged from the Hispanic HANES analysis. Acculturation to the American lifestyle by Mexican-American men is associated with an *increased* prevalence of obesity.

FUTURE DIRECTION

In the future, epidemiologic studies of obesity will benefit from measurement and control of genetic influences. A measure of genetic influence may be obtained through assessment of parental obesity, but a more precise measure awaits the detection of genetic markers.

There is an urgent need to move beyond the traditional environmental measure of socioeconomic status as a determinant of the prevalence of obesity. One useful measure has been the disaggregation of the three traditional components of SES—income, occupation, and education—relating each of them individually to the prevalence of obesity. Among the three components, years of education is the easiest to measure and has the greatest cross-cultural relevance. It may also be the most powerful.

New measures of social influences should be sought and Latin America provides an excellent opportunity for such a search. Acculturation is a promising candidate. Other measures undoubtedly will present themselves to the inquisitive investigator; they should be explored with vigor and dispatch.

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PHYSICAL ACTIVITY PATTERNS IN CENTRAL AMERICA

Benjamín Torún[1]

Physical activity plays an important role in weight control and prevention of obesity through its influence on metabolic and behavioral functions, and its relation to dietary energy intake. Humans tend to maintain an energy equilibrium, whereby a decrease or increase in energy intake often is accompanied by corresponding changes in energy expenditure, mainly through modifications in physical activity. This has been shown to occur in children (*1*–*3*) and in adults under free-living (*4*, *5*) and experimental conditions (*6*). For example, a group of rural workers in Guatemala with dietary intakes of 2693 ± 441 kcal/day had a mean daily energy expenditure of 2700 ± 432 kcal/day. When the diet of another group of men with similar cultural, ethnic, and social characteristics was improved to provide 3555 ± 712 kcal/day, their energy expenditure was 3694 ± 464 kcal/day (*4*). The observed increment in energy expenditure occurred with the men living in their normal environment under attractive conditions to perform additional wage-earning chores and nonsalaried or leisure activities.

PHYSICAL ACTIVITY AND AGING

Physical activity has beneficial effects on cardiovascular, respiratory, musculoskeletal, metabolic, and psychological function until about 30 years of age. After that, most functions decline at a rate of approximately 0.75% to 1% per year and a series of physiological changes take place (Table 1) (*7*, *8*). Consequently, physical fitness and work capacity diminish, reaction time is slower, strength is reduced, body structures become less resilient, and recovery from effort is prolonged. Thus, the aging process leads to a less active lifestyle, which is accentuated by social, cultural, and economic factors that reduce the physical activity of mature and older people in most societies. This coincides with an often observed increment in the prevalence of obesity.

Regular exercise, whether through leisure activities or work, has a training effect that permits higher level physical performance at all ages. Although exercise does not stop the aging process, it allows individuals to be more physically active, thereby counteracting or retarding some of the physiological effects of aging. This is illustrated by the contrast of the effects of age over the maximal aerobic capacity of trained and sedentary men (Figure 1). It can be inferred that persons who are more physically fit will continue to be active at a more advanced age than their less fit counterparts.

Demographic indicators show that the Central American population is becoming older. The decline in infant and child mortal-

[1]Institute of Nutrition of Central America and Panama, Guatemala City, Guatemala.

TABLE 1. Physiological effects of aging and their functional significance.

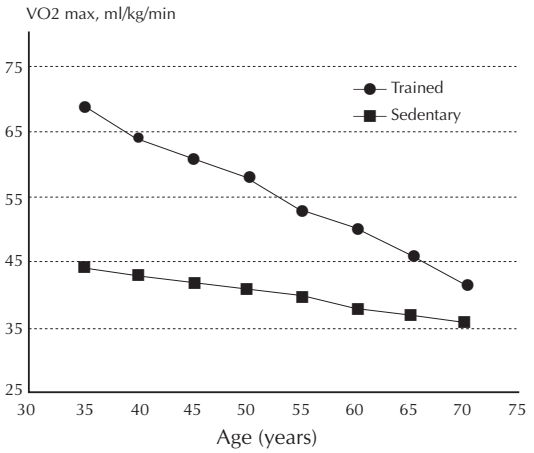
Effect	Functional significance
Cardiovascular	
Capillary:fiber ratio ↓	Decreased muscle blood flow
Cardiac muscle and heart volume ↓	Decreased maximal stroke volume and cardiac output
Elasticity of blood vessels ↓	Increased peripheral resistance, blood pressure, and cardiac afterload
Myocardial myosin-ATPase ↓	Decreased myocardial contractility
Sympathetic stimulation of SA node ↓	Decreased maximum heart rate
Respiration	
Condition of elastic lung support structures ↓	Increased work of breathing
Elasticity of support structures ↓	Decreased lung elastic recoil
Size of alveoli ↑	Decreased diffusion capacity and increased dead space
Number of pulmonary capillaries ↓	Decreased ventilation/perfusion equality
Muscle and joints	
Muscle mass ↓	
Number of Type II a and b fibers ↓	
Size of motor units ↓	
Action potential threshold ↓	Loss of strength and power
(Ca^{++}, myosin)-ATPase ↓	
Total protein and N_2 concentration ↓	
Size and number of mitochondria ↓	Decreased muscle respiratory capacity
Oxidative enzymes: SDH, cytochrome oxidase, and MDH ↓	Decreased muscle respiratory capacity
Lactate dehydrogenase ↓	Slowed glycolysis
Stiffness of connective tissue in joints ↑	Decreased joint stability and mobility
Accumulated mechanical stress in joints ↑	Stiffness, loss of flexibility, and osteoarthritis
Water content in intervertebral cartilage ↓	Atrophy and increased chance of compression fractures in spine
Bone	
Bone minerals ↓	Osteoporosis, increased risk of fracture
Body composition and stature	
Body fat ↑	Impaired mobility and increased risk of disease
Kyphosis ↑	Loss of height

Source: Brooks GA, Fahey TD. *Exercise physiology: human bioenergetics and its applications.* New York: Macmillan; 1984.

ity (Figure 2, Table 2) and the increase in life expectancy (Figure 3, Table 2) are changing the population age structure from a pyramidal shape with a broad young base to a bottle or rectangular shape. Children under 15 years of age, who represented 42% of the population in 1995, are expected to represent only 30% by the year 2025 (*9*). Conversely, the proportion of persons over 64 years of age is expected to increase from 4% to 6% in that same time span.

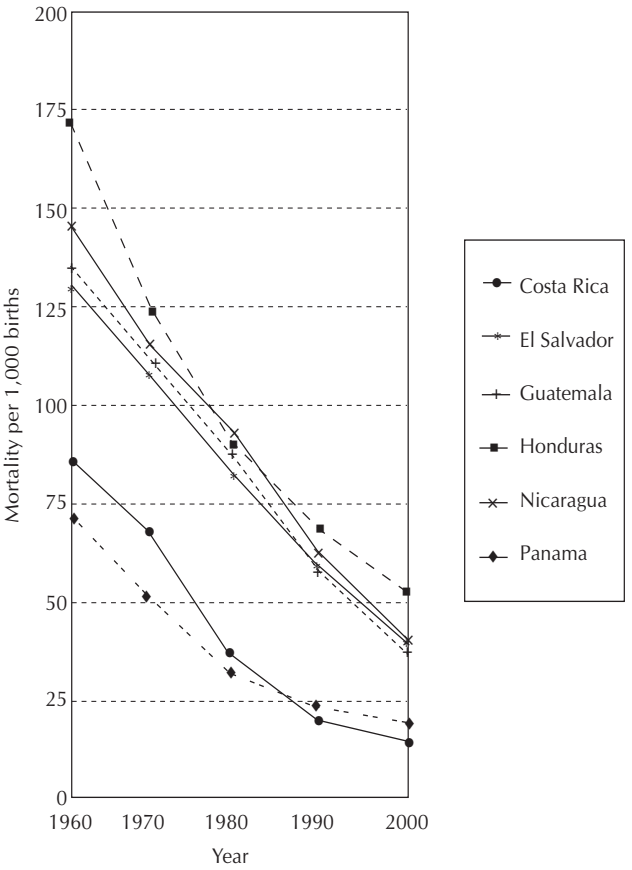
Unless a successful program is developed and sustained to stimulate people to remain physically active throughout their lives, it is expected that the proportion of sedentary people will continue to increase in Central America. This trend will likely be associated with an increased prevalence of obesity.

FIGURE 1. Effects of age on maximum aerobic capacity of trained and sedentary men.



Source: Adapted from Brooks GA, Fahey TD. *Fundamentals of human performance.* New York: Macmillan; 1987.

FIGURE 2. Infant mortality trends in Central America, 1960–2000.



Source: Latin American and Caribbean Demographic Centre. Population projections calendar years 1950–2000. *Demographic Bulletin* 1991:48.

PHYSICAL ACTIVITY AND URBANIZATION

During the process of development, communities often evolve from rural societies in which physical activity is required for agricultural production to more industrialized, urbanized, and affluent societies in which the demand for physical labor decreases progressively (*10*). In addition, the use of mechanical and electric tools for domestic chores is more common in urban environments, motor vehicles are used often, and much leisure time is spent in such physically passive activities as socializing and watching movies or television. Thus, a sedentary lifestyle becomes a prominent feature of urbanization.

This is sometimes counterbalanced by the regular practice of such physically demanding leisure activities as brisk walks, active sports, jogging, aerobics, and other exercises. However, this is seen mainly among people in the middle and upper socioeconomic circles. Many impoverished people migrate from rural areas to urban slums where an atmosphere of violence inhibits them from walking, jogging, or cycling in the streets, and where there are no indoor or fenced-in facilities where they can exercise regularly. Unless they engage in occupations demanding vig-

TABLE 2. Child mortality and life expectancy in Central America, 1995 [*Italics: projections for the year 2005*].

	Mortality risk < 5 years per 1,000	Life expectancy at birth
Honduras	62	67
	[*44*]	[*70*]
Nicaragua	52	68
	[*34*]	[*71*]
Guatemala	50	66
	[*35*]	[*69*]
El Salvador	50	67
	[*34*]	[*70*]
Belize	40	71
	[*27*]	[*74*]
Panama	20	74
	[*14*]	[*76*]
Costa Rica	16	76
	[*12*]	[*78*]

Sources: World Bank. *Trends in developing economies, 1991*. Washington, DC: World Bank; 1991.

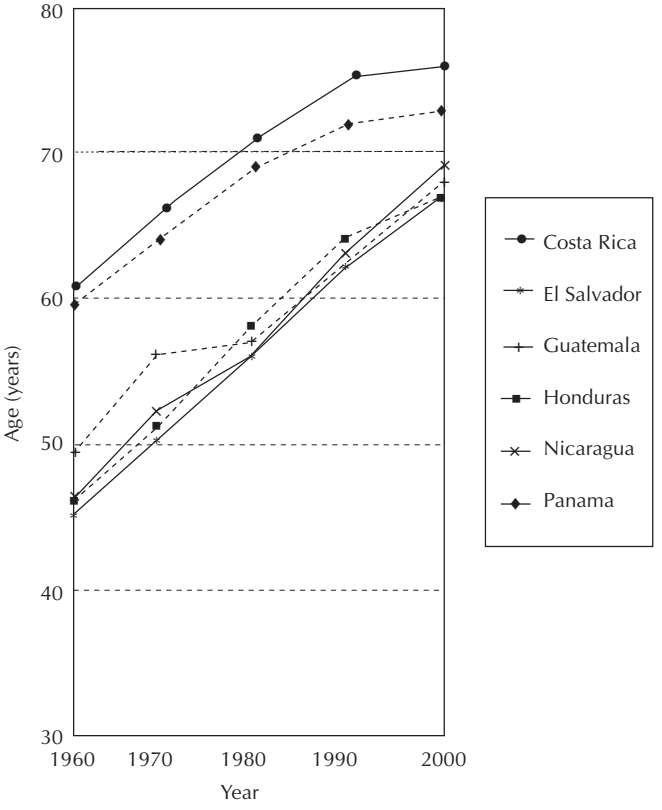
United Nations Development Programme. *Human Development Report 1993*. New York: Oxford University Press; 1993.

orous physical activity, the urban poor have a large chance of being sedentary. If, in addition, their diet is rich in fried and other fatty foods, and there is a high intake of sweet soft drinks, beer, and other alcoholic beverages, the risk of obesity may be high.

Central America has an annual population growth of 2.5%, ranging from 1.4% to 2.8% in its component countries (Table 3). That growth has been greater in cities, and the urban population has increased in absolute and relative terms; this trend is expected to continue (Table 3, Figure 4).

An important proportion of urban population consists of people who recently migrated from rural areas and small towns to the large cities, which in Central America are almost exclusively the countries' capitals (*11*). As in

FIGURE 3. Life expectancy trends of Central American men and women, 1960–2000.



Source: Latin American and Caribbean Demographic Centre. Population projections calendar years 1950–2000. *Demographic Bulletin* 1991:48.

TABLE 3. Demographic estimates for Central America, 1995 [*Italics: projections for the year 2005*].

	Population millions	% annual growth	Density per km²	% urban (1991)
Central America	32.7	2.5	—	45
	[*41.5*]		—	[*53*]
Guatemala (32%)[a]	10.6	2.7	97	38
	[*13.8*]		[*127*]	[*44*]
El Salvador (18%)[a]	5.8	2.2	281	44
	[*7.2*]		[*348*]	[*52*]
Honduras (18%)[a]	5.9	2.8	53	44
	[*7.7*]		[*70*]	[*54*]
Nicaragua (14%)[a]	4.5	2.8	37	60
	[*5.9*]		[*49*]	[*67*]
Costa Rica (9%)[a]	3.1	1.7	61	47
	[*3.6*]		[*71*]	[*55*]
Panama (8%)[a]	2.6	1.4	35	53
	[*3.0*]		[*40*]	[*59*]
Belize (0.7%)[a]	0.22	2.6	9	50
	[*0.28*]		[*12*]	[*58*]

[a]% of Central American population.

Sources: World Bank. *Trends in developing economies, 1991.* Washington, DC: World Bank; 1991. United Nations Development Programme. *Human Development Report 1993.* New York: Oxford University Press; 1993.

most other Latin American countries, the number of poor people has increased more in cities than in rural areas (*12*). They live in slums and marginal periurban neighborhoods and lack easy access to many of the advantages that city living may offer, such as better housing, education, sanitation, health services, and facilities for leisure activities.

Physical Activity in Rural Central America

People in rural Central America usually are very active. They walk long stretches, often carrying loads over steep or rugged terrain, they work in non-mechanized agriculture, and perform such vigorous domestic chores as fetching water, chopping and gathering firewood, and washing clothes manually.

Total energy expenditure of Guatemalan Ladino (non-Indian) men has been measured in several studies by time-motion techniques and indirect calorimetry (*4*, *5*, *13–15*). Group means have ranged from 2700 to 3694 kcal/day (coefficients of variation, CV: 12%–16%), depending on the men's dietary conditions and the nature of their agricultural tasks. This corresponds to physical activity indices (or multiples of basal metabolic rate) between 1.85 to 2.35, which have been classified as moderately heavy and very heavy, respectively (*16*).

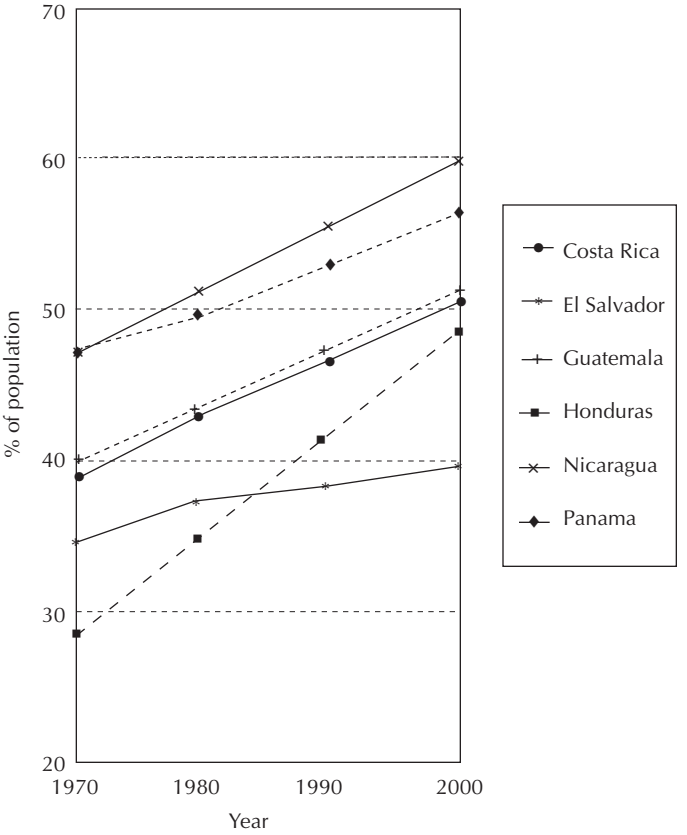
Similar measurements in Ladino women showed mean expenditures between 1878 and 2055 kcal/day (CV: 10%–14%) (*17*), corresponding to physical activity indices between 1.58 (light) and 1.73 (moderately heavy). Indian women in the Guatemalan highlands, assessed by heart rate monitoring, spent between 2224 and 2837 kcal/day, depending on living conditions and the time of year (Diaz E et al., unpublished). Their physical activity indices were between 1.85 and 2.35 (*19*).

It should be noted that although it is not commonly seen in these rural communities, obesity tends to be more prevalent among Ladinos than Indians and more prevalent among women than men.

Physical Activity in Central American Cities

There is a sharp contrast between the intense physical activity that prevails in rural areas and the level of physical activity seen in

FIGURE 4. Urbanization trends in Central America, 1970–2000.



Source: Latin American and Caribbean Demographic Centre. Population projections calendar years 1950–2000. *Demographic Bulletin* 1991:48.

cities. This is illustrated by findings from studies about risk factors of chronic diseases associated with diet and lifestyle in a representative sample of adults living in a low-income neighborhood of Panama City (San Miguelito) (*18*) and in a middle- and lower middle-income neighborhood of San José (Tibás) (*19*).

In a survey of men and women aged 35–60, 98% of the 98 men and 156 women interviewed in San Miguelito and 96% of the 40 men and 73 women interviewed in Tibás believed that exercise was beneficial to their health. In San Miguelito, however, 50% of the men and 75% of the women reported that they did little or no regular exercise and were not involved in vigorous physical work (Table 4). Thirty-five percent of the men and 21% of the women said they did some exercise, but not enough. In Tibás, 25% of the men and women reported doing little or no regular exercise, and another 50% believe that they should exercise more (Table 4). In addition, 89% of the men and women in the Panamanian neighborhood, and 73% in the Costa Rican neighborhood did not practice any sports. The reasons most frequently cited were similar in both communities: lack of time or interest, and laziness.

It should be noted that although sedentarism was considerable in the Costa Rican neighborhood, it was more common among the lower-income Panamanian neighborhood. Obesity was also more prevalent among

TABLE 4. Proportion (%) of sedentary and active people, 35–60 years of age, in San Miguelito (Panama) and Tibás (Costa Rica).

	Amount of exercise performed regularly			
	None or very little	Some, but not sufficient	Sufficient	Does not know if sufficient
Panama				
Men (*n* = 98)	50	35	13	2
Women (*n* = 156)	72	21	5	2
Costa Rica				
Men (*n* = 40)	23	50	25	2
Women (*n* = 73)	27	47	22	4

Sources: Unpublished data, Cooperativa de Salud Integral y Nutrición and Institute of Nutrition of Central America and Panama (data for Costa Rica), and Ministry of Health/Social Security and INCAP (data for Panama).

the Panamanian group (Table 5), but it must be borne in mind that, in addition to their socioeconomic differences, the two groups have different ethnic, cultural, and dietetic characteristics.

Those high prevalences of sedentarism and overweight are consistent with the findings reported by the Pan American Health Organization in a multicenter study in Porto Alegre and São Paulo (Brazil), Havana (Cuba), Santiago (Chile), Ciudad Acuña and Piedras Negras (Mexico), and Caracas (Venezuela) (*20*). As shown in Figure 5, sedentarism—defined as doing fewer than two sessions of exercise per week, lasting at least 15 minutes each—ranged from 42% to 68% among men and 65% to 82% among women in those cities.

TABLE 5. Proportion (%) of overweight and obese people, 35–60 years of age, in San Miguelito (Panama) and Tibás (Costa Rica).

	Body mass index (kg/m^2)		
	< 25	25–29.9	≥ 30
Panama			
Men (*n* = 98)	42	33	25
Women (*n* = 156)	32	43	25
Costa Rica			
Men (*n* = 40)	48	40	12
Women (*n* = 73)	41	44	15

Sources: Unpublished data, Cooperativa de Salud Integral y Nutrición and Institute of Nutrition of Central America and Panama (data for Costa Rica), and Ministry of Health/Social Security and INCAP (data for Panama).

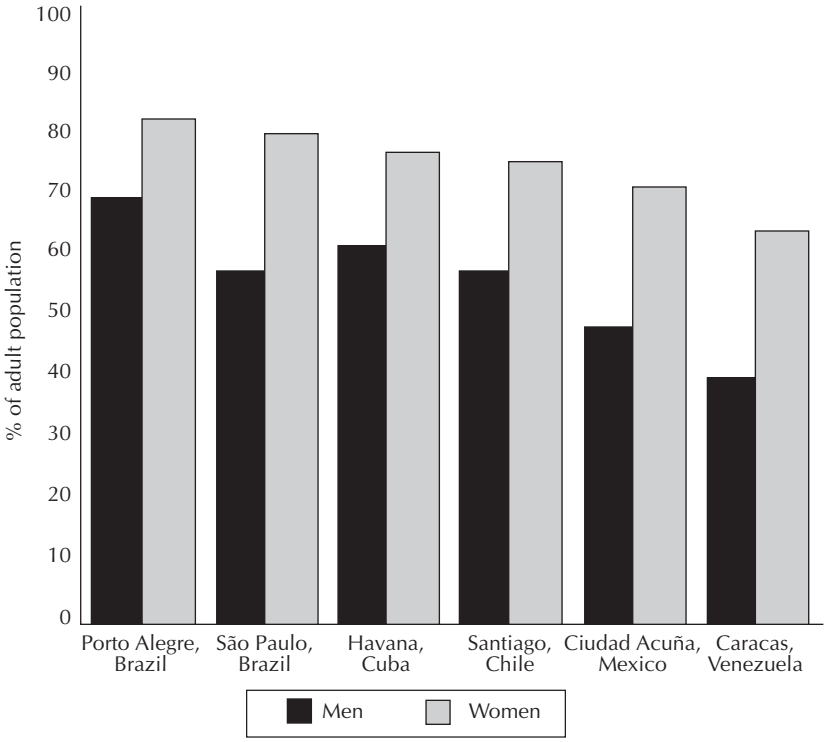
MODIFICATIONS IN LIVING ENVIRONMENT, DIET, AND ACTIVITY PATTERNS

In most rural areas of Guatemala and other Central American communities, adult men have mean dietary energy intakes of 2900–3100 kcal/day, although, as previously noted, this figure varies among communities and time of year (*5, 21, 22*).

It can be assumed that, overall, the men are in energy equilibrium, since they maintained fairly constant bodyweights, except for seasonal fluctuations associated with temporary migrations and changes in physical work related to the agricultural cycle.

The influence of changes in living environment on the physical activity and body composition of low-income men is illustrated by a study performed in Guatemala City on peasants-turned-soldiers (*23, 24*). A group of such men, aged 20 ± 2 years, was studied at the time they were drafted and after 16 months in the army (*23, 24*). Their dietary intake prior to entering the army was comparable to that of similar rural Guatemala males (*21*). At 16 months, the group's mean intake was calculated by inventory method and composite analysis of representative diets. Total energy expenditure prior to conscription was assumed to be equivalent to the mean energy intake, since all men reported stable bodyweight for several months before joining the

FIGURE 5. Prevalence of sedentarism in six Latin American cities, 1987.



Source: PAHO Risk Factors for Chronic Disease Study. Preliminary Data.

army. At 16 months it was assessed through activity diaries and measurement or estimation of the energy cost of activities. Body composition was evaluated for measurements of total and extracellular body water (antipyrine and thiocyanate dilution techniques).

After the initial weeks of basic training, the soldiers reported that their physical activity was substantially less than the demands of their agricultural lifestyle prior to entering the army. As Table 6 shows, after 16 months in the army their mean energy intake exceeded expenditure by 470 kcal/day. They had gained an average of 6.4 kg of bodyweight, mainly as fat, which increased by 88%.

A contrasting effect of physical activity on the body composition of healthy young men was illustrated by the changes observed in 12 cadets, aged 18 ± 1 year, who were studied on admission to Guatemala's military school, and 8 and 16 months later (*23, 24*). The group's mean energy intakes were calculated by inventory method and composite analysis of representative diets. Energy expenditure and body composition were assessed as described for the soldiers.

After joining the military academy, the cadets became and remained more active through daily participation in physical exercise and sports. Their energy intake increased in proportion to their energy expenditure, but they gained 4.3 kg of bodyweight in 16 months (Table 7). This was mainly as lean body mass, since they showed a reduction in body fat, an increase in urinary creatinine excretion, and changes in anthropometric measurements indicative of muscle growth.

These studies show that when men move to an environment where their dietary intake increases, they will gain lean body mass if their

TABLE 6. Mean daily energy intake, energy expenditure, and changes in bodyweight and composition of rural men, on induction and after 16 months in the Guatemalan Army (*n* = 17, 20 ± 2 years of age).[a]

	Energy Intake (kcal/d)	Energy expenditure (kcal/d)	Weight (kg)	Height (cm)	Body mass index	% body fat[b]
Initial	3000	3000	54.9 ± 6.6	155 ± 6	22.8 ± 2.8	7.8 ± 5.5
16 months	3170	2700	61.3 ± 7.5	156 ± 6	25.2 ± 3.0	14.7 ± 5.8

[a]Mean ± standard deviation. Only mean values are given for energy intake and expenditure because of the methods used to estimate them.

[b]Calculated from total body water measured by antipyrine dilution.

Sources: Saravia-Camacho F. Estudios sobre la composición corporal del adulto Guatemalteco [master's thesis]. Guatemala: Universidad de San Carlos, Facultad de Medicina; 1965.

Viteri FE. Considerations on the effect of nutrition on the body composition and physical working capacity of young Guatemalan adults. In: Scrimshaw NS, Altschul AM, eds. *Amino acid fortification of protein foods.* Cambridge, MA: MIT Press; 1969:350–375.

TABLE 7. Mean daily energy intake, energy expenditure, bodyweight, and body composition of cadets on admission to military school, and 8 and 16 months later (*n* = 12, 18 ± 1 years of age on admission).[a]

	Energy Intake (kcal/d)	Energy expenditure (kcal/d)	Weight (kg)	Height (cm)	Body mass index	% body fat[b]
Initial	3031	3000	59.9 ± 8.1	168 ± 6	21.2 ± 2.9	15.2 ± 6.3
8 months			61.5 ± 9.1	169 ± 6	21.5 ± 3.0	9.3 ± 4.7
16 months	3279	3200	64.2 ± 8.6	169 ± 6	22.5 ± 3.1	8.1 ± 5.8

[a]Mean ± standard deviation. Only mean values are given for energy intake and expenditure because of the methods used to estimate them.

[b]Calculated from total body water measured by antipyrine dilution.

Sources: Saravia-Camacho F. Estudios sobre la composición corporal del adulto Guatemalteco [master's thesis]. Guatemala: Universidad de San Carlos, Facultad de Medicina; 1965.

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physical activity also increases. If their physical activity decreases, they will become fatter.

CONCLUSIONS

Although there are no longitudinal studies on the physical activity of Central American persons as they grow older or when they move from a rural to an urban environment, the effects of aging on physical activity, the changes in the population's age structure, the results of studies on energy expenditure and activity patterns in some rural and urban Central American communities, and the urbanization trends in the region strongly suggest that there is a tendency toward sedentarism that is accompanied by increments in overweight and body fat. This affects people of low socioeconomic level, and probably others as well. Therefore, a comprehensive program to reduce the risk of obesity must include measures to improve the population's physical activity and reduce sedentarism.

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The Epidemiologic Transition in Selected Countries: Case Studies

OBESITY AND POVERTY: A PENDING CHALLENGE IN CHILE

Cecilia Albala[1] and Fernando Vío[2]

The health situation in Latin America has undergone significant transformations in the last decades due to demographic and socioeconomic changes, particularly rapid urbanization and increasing industrialization. Declining mortality and fertility rates have modified the age structure of the population as well as the causes of mortality and morbidity, resulting in increased life expectancy and an increase in the population over the age of 60. In addition, deaths due to avoidable causes shifted from childhood to older ages, and communicable diseases gave way to chronic illnesses as causes of death (*1*).

In Chile, these changes occurred with notable speed. In the 1960s, Chile's health indicators were, on average, similar to those of other Latin American countries: high maternal and infant mortality rates and high prevalence of infectious diseases and malnutrition. In the 1990s, the national scene changed completely: public investments in education, drinking water, environmental sanitation, health, and nutrition (*2*) played a very important role in reducing communicable diseases and malnutrition and, by extension, in improving the overall health status of the population (*3*).

Epidemiological changes in the country were characterized by a reduction in pathologies of infectious origin and a gradual increase in chronic diseases and accidents. In 1970, accidents represented 53.7% of all causes of death; in 1990, this percentage reached 75.1% (*1*). At the same time, there was a notable increase in the prevalence of risk factors for chronic diseases. Inadequate diets, obesity, habitual use of tobacco, alcoholism, delinquency, sedentary lifestyles, and poor working conditions have contributed to the predominance of cardiovascular diseases, cancer, and accidents (*4*). Mental illness has also gained in importance among adults, as have perinatal and congenital diseases in children.

The inversion of the nutritional situation, with a significant decline in childhood malnutrition and an increase in obesity among all age groups (*5, 6*), is very evident in the lower socioeconomic strata (*7*). It is important to point out that, although the causal relationship among obesity, health, and illness is not clearly established, epidemiological studies indicate that obesity among adults is directly associated with increased mortality rates and constitutes an important risk factor for hypertension, diabetes, dyslipidosis, and coronary heart disease (*8*).

[1]Universidad de Chile, Instituto de Nutrición y Tecnología de los Alimentos, Departamento de Epidemiología Nutricional, Santiago, Chile.
[2]Universidad de Chile, Instituto de Nutrición y Tecnología de los Alimentos, Santiago, Chile.

The multicenter collaborative study of the International Clinical Epidemiology Network (INCLEN) conducted in urban populations in five Latin American countries and seven Asian countries (*9*) studied the relationship between body mass index (BMI), biomedical variables, and socioeconomic level. The results of the study showed a positive relationship between BMI and cholesterol and high blood pressure, and stressed the importance of efforts to reduce BMI in order to reduce the risk of cardiovascular diseases. A similar relationship was also found between obesity and other chronic diseases such as cholelithiasis; some types of cancer; and osteomuscular, respiratory, and mental illnesses (*10–12*).

Although the consensus is that obesity is the result of a genetic predisposition plus adverse environmental conditions, the influence of the genetic trait alone is not enough to explain the increase in this disease in most countries. The clear contribution of environmental factors in the development of obesity is evidenced by the fact that the percentage of obese people has increased over the last 50 years but there have been no changes in the genetic makeup of the Chilean population. This chapter analyzes the socioeconomic, demographic, and epidemiological factors and the lifestyles associated with obesity in Chile. It also describes the characteristics of the risk factors for chronic diseases of nutritional origin.

THE SOCIOECONOMIC, DEMOGRAPHIC, AND EPIDEMIOLOGICAL SITUATION IN CHILE

Socioeconomic Situation

Since the 1930s, Chile has been experiencing a gradual process of urbanization; its urban population reached 83.5% in 1994. During the same period, illiteracy was reduced and important improvements were made in environmental sanitation and drinking water availability (Table 1). In recent years, the country has experienced sustained economic growth, averaging 6.4% per year during the period 1990–1995. However, income distribution is very asymmetrical and has not changed since the 1970s: the quintile with the highest incomes represents 20% of the total population but receives 51.6% of national income; the quintile with the lowest incomes receives only 4.6% of national income (Table 2).

Demographic Variables

In recent years, the total fertility rate has remained low (2.6 children per woman) and general mortality has declined; most notably, the infant mortality rate was 12 per 1,000 live births in 1995. As a result, life expectancy at birth increased by almost 10 years between 1970 and 1993 (*4*), and both the age structure

TABLE 1. Socioeconomic changes, Chile, 1970–1994.

	1970	1994	Variation between 1970 and 1994 (%)
Urban population (%)	75.1	83.5	+11.2
Urban dwellings with potable water (%)	58.0	95.2	+64.1
Urban dwellings with sewer system (%)	35.0	84.4	+141.1
Illiterate adults (%)	11.0	5.7	–48.2
GDP[a] per capita (US$)	2,230.0	3,020.0	+35.4
GDP[a] upper income quintile (%)	44.5	57.8	+29.9
GDP[a] lower income quintile (%)	7.6	5.4	–28.9

[a]GDP = Gross domestic product.

Source: Chile, Instituto Nacional de Estadística. *Anuario Demográfico 1994.* Santiago: INE; 1994.

TABLE 2. Distribution of total income, Chile, 1978 and 1994.

	Total income	
Income quintile	1978 (%)	1994 (%)
1 (poorest)	4.6	4.6
2	9.5	8.5
3	14.1	12.4
4	19.9	18.4
5 (richest)	51.9	56.1

Source: Chile, Ministerio de Planificación y Cooperación. *Encuesta de Caracterización Socioeconómica Nacional (CASEN).* Santiago: MIDEPLAN; 1994.

of the population and the percentage of deaths by age group changed significantly: the figures for both variables increased in the 64 years and older age group and fell in the group under 15 years of age (Table 3).

Epidemiological Situation

Between 1970 and 1995, the infant mortality rate fell from 82.2 to 12.0 per 1,000 live births (an 85% decrease). These figures represent approximately one-third of the average value in the countries of Latin America and one-half the reduction in this indicator for Latin America and the Caribbean as a whole during the same period, which saw a 46.3% decrease. Nonetheless, the Chilean percentage is twice that of the developed countries. Although deaths due to infectious and parasitic diseases fell from 10.9% to 2.7% of all deaths for all age groups, the percentage of deaths due to cardiovascular diseases and malignant tumors (the two leading causes of death) increased (Table 4). Although mortality rates for cardiovascular diseases fell from 189.6 to 161.1 per 100,000 population between 1970 and 1992, these diseases continue to be the leading causes of death in Chile, and their relative share among all the causes of death increased from 22.3% to 28.5% during the period. Although mortality rates for ischemic heart disease and cerebrovascular diseases have fallen slightly since about 1975 in the group aged 34 to 74, the risk of getting cancer increased, particularly cancers associated with unhealthy lifestyles such as vesicular cancer, prostate cancer, breast cancer, lung cancer, and colorectal cancer (i.e., cancers associated with obesity, diet, and the habitual use of tobacco) (*8*). Similarly to what occurs in the developed countries, mental illnesses emerged as important causes of morbidity and disability and as risk factors for chronic diseases due to alcoholism and drug addiction. These illnesses also contribute to accidents and violence.

In recent years, the risk factors for chronic diseases are very prevalent and show an alarming increase among the Chilean population. The studies conducted by Berríos et al. between 1988 and 1992 (*7*, *15*) in representative samples of the population in the metropolitan region of Santiago show an increase in all risk factors, except habitual smoking among men (*16*) (Table 5).

NUTRITIONAL STATUS AND OBESITY

Chile's nutritional profile has changed rapidly in the last two decades. The high rates of

TABLE 3. Percentage distribution of population and deaths by age group, Chile, 1970–1993.

	Population (%)			Deaths (%)		
Age group (years)	1970	1993	Variation (%)	1970	1993	Variation (%)
0–14	39.2	29.4	–25.0	31.8	7.8	–75.5
15–64	55.8	64.0	+14.7	33.6	32.2	–4.2
65 and older	5.0	6.6	+32.0	34.6	60.0	+73.4

Source: Chile, Instituto Nacional de Estadística. Informes demográficos de Chile de 1969, 1971, 1979, 1980, 1981, 1982, 1991, 1992 y 1993. Santiago: INE.

TABLE 4. Total percentage of deaths by groups of causes, Chile, 1970, 1982, and 1993.

Groups of causes	1970	1982	1993
Diseases of the circulatory system (A80–88)[a], (390–459)[b]	22.3	27.6	28.5
Malignant neoplasms (A45–59)[a], (140–208)[b]	12.0	16.8	20.9
Accidents and violence (AN138–150+AE138–149)[a], (800–999)[b]	19.0	12.1	12.0
Diseases of the respiratory system (A89–96)[a], (460–519)[b]	17.4	8.5	11.8
Diseases of the digestive system (A97–104)[a], (520–579)[b]	6.9	8.6	6.2
Symptoms, signs, ill-defined conditions (A137)[a], (780–799)[b]	4.5	8.8	5.8
Infectious and parasitic diseases (A1–44)[a], (1–139)[b]	10.9	3.8	2.7
Certain conditions originating in the perinatal period (A131–135)[a], (760–779)[b]	5.0	3.5	1.6
All other causes	2.0	10.3	10.5
Total	100.0	100.0	100.0

[a]International Classification of Diseases, Eighth Revision.

[b]International Classification of Diseases, Ninth Revision.

Source: Chile, Instituto Nacional de Estadística. Informes demográficos de Chile de 1969, 1971, 1979, 1980, 1981, 1982, 1991, 1992 y 1993. Santiago: INE.

malnutrition seen among children in the 1970s (15.5% in 1975) fell to very low figures in the 1990s (5% in 1995), and low birthweight fell from 11.0% to 5.1% (*5*). In contrast, obesity among children under age 6 increased by 57% between 1985 and 1995 (Table 6) and, together with stunting, is the most important abnormal growth problem among lower-middle and lower-class children. Chile's National Health Services System (SNSS) indicated that the prevalence of obesity[3] in children under age 6 (1.2 million children) was 7.2% in 1995 (*17, 18*). For its part, in March 1996 the National Board of Nursery Schools (JUNJI) showed a prevalence of 9% among its beneficiaries using the same cutoff point (*6*). These data also coincide with the data submitted by the National Board of School Assistance and Scholarships (JUNAEB): students in the first year of elementary education reached average obesity rates of 7.7% and 12.4% in 1994 and 1995, respectively, using the same reference standard (*19*).

In a study of cases and checkups for obese and normal children aged 4 to 5 who visited primary care centers in Santiago between 1995 and 1996, Kain, Albala, et al. (*19*) found that obese children were heavier than normal children since birth and were already obese at 36 months of age. In addition, they noted that obese children were significantly taller than normal children, agreeing with the observations of Amador, Bacallao, et al. in a longitudinal study conducted in Cuba (*20*). In the Santiago study, the analysis of the combined effect of anthropometric and socioeconomic variables on childhood obesity indicated that obesity in the mother was the variable with the highest explanatory value.

As can be seen in Table 7, the situation is similar among pregnant women. Between 1987 and 1994, the number of underweight pregnant women decreased and the number of overweight and obese pregnant women increased (*21*). Despite the high prevalence of obesity, nutritional anemia during pregnancy is also very prevalent: 20% of mothers present

[3]Weight-to-height ratio whose value is greater than 2 SD, according to the standard used by the United States National Center for Health Statistics and the U.S. Centers for Disease Control and Prevention (NCHS/CDC) adopted by the World Health Organization.

TABLE 5. Percentage variation of risk factors for chronic diseases by gender, Santiago, Chile, 1988–1992.

	Men (%)			Women (%)		
Risk factor	1988	1992	Variation 1988–1992	1988	1992	Variation 1988–1992
Tobacco use	47.1	43.6	–7.4	40.3	44.7	+10.9
Sedentary lifestyle	55.4	57.8	+4.3	77.4	80.1	+3.5
Alcoholism	57.1	61.7	+8.1	19.2	29.8	+55.2
Overweight[a]	33.0	47.9	+45.2	45.1	58.8	+30.45
Hypertension	19.7	35.5	+80.2	16.7	33.4	+100.0
Hypercholesterolemia	33.8	43.3	+28.1	34.0	45.8	+34.7

[a]Body mass index ≥ 25 kg/m^2.

Sources: Berríos X, Jadue L, Zenteno J, Ross MI, Rodríguez H. Prevalencia de factores de riesgo de enfermedades crónicas. Estudio en población general de la región metropolitana, 1986–1987. *Rev Med Chile* 1990;118(5):597–604.

Berríos X. Tendencia temporal de los factores de riesgo de las enfermedades crónicas: ¿la antesala silenciosa de una epidemia que viene? *Rev Med Chile* 1997;125(11):1405–1407.

anemia at the end of their pregnancies. This percentage doubles when iron deficiency is defined using more sensitive indicators (such as transferrin saturation rates, ferremia, etc.).

Although Chile has no national system to monitor nutritional status in adults like its system for children and pregnant women, there are data representative of the population of Santiago, a city where more than 45% of the Chilean population lives. In 1987, Berríos et al. (*7*) conducted a survey of risk factors for chronic diseases in a representative sample of the metropolitan region. The survey results indicated that 13.2% of men and 22.7% of women were obese, using the body mass index as the indicator with a cutoff point of ≥ 27.3 kg/m^2 for women and ≥ 27.8 kg/m^2 for men. Obesity was more frequent at older ages and among women. At the poorest socioeconomic levels, the situation was even worse: 29.3% of the women interviewed were obese. In 1992 the same population was again studied using a similar methodology (*15*): prevalence was close to 20% among men and 40% among women. Using a cutoff point of 30 kg/m^2, prevalence in 1988 fell to 6.0% among men and 14.0% among women. Based on the estimates in the Study of the Burden of Disease in Chile, overall prevalence of obesity in adults would be 17% among men and 27%

TABLE 6. Prevalence of obesity in children aged 0 to 6 treated by the National Health Services System, Chile, 1985–1995.

	Obesity[a] (%)		
Age group (months)	1985	1995	Variation 1985–1995
0–11	3.8	8.2	+115.8
12–23	3.8	6.6	+74.0
24–72	5.0	7.1	+42.0
Total	4.6	7.2	+57.0

[a]Obesity = Weight-to-height ratio greater than 2 SD (NCHS/CDC standard).

Source: Chile, Ministerio de Salud, Unidad de Nutrición. *Datos antropométricos de población bajo control del SNSS*. Santiago: MINSAL; 1995.

TABLE 7. Prevalence of overweight and obesity in pregnant women treated by the National Health Services System, Chile, 1987–1994.

Nutritional status[a]	1987 (%)	1994 (%)	Variation 1987–1994 (%)
Normal	42.6	35.7	–16.2
Underweight	25.7	16.9	–34.2
Overweight	18.8	23.5	+25.0
Obese	12.9	23.9	+85.3

[a]According to Rosso-Mardones standard. Rosso P, Mardones-Santander F. *Gráfica de crecimiento de peso para embarazadas. Curva patrón.* Santiago: Chile, Ministerio de Salud; 1985.

Source: Chile, Ministerio de Salud, Unidad de Nutrición. *Datos antropométricos de población bajo control del SNSS*. Santiago: MINSAL; 1995.

among women using the same cutoff point (*22*). The data agree with those obtained in 1996 in a representative sample of adults in Valparaiso by the baseline survey of the CARMEN project (directed at preventing and controlling the risk factors common to noncommunicable diseases): the prevalence of obesity (BMI ≥ 30 kg/m^2) was 15.7% among men and 23% among women, with higher values at older ages and in the lower socioeconomic strata.

Diet

The customary diet is associated with many of the main causes of death in Chile. Information available at the national level allows us to assume that the average caloric distribution of macronutrients is close to the international recommendations. However, average carbohydrates (between 60% and 65%), average proteins (between 12% and 18%), and low fat content (between 20% and 25%) probably obscure large differences among the social strata. Significant differences have been shown between the diet of the population receiving the highest incomes and the population receiving the lowest incomes (*13*): fat consumption and lipid profiles are higher in the higher-income groups (*23*). In addition, both the food industry and dietary habits in Chile have changed significantly in recent decades. The country's economic growth and technological development are reflected in new lifestyles. In addition, the gradual incorporation of women into the workforce and the increase in the number of people eating one or more meals outside the home led to the expansion of fast food restaurants and food services companies.

As a result, the population's current diet is very different from what it was 10 years ago. The Ongoing Survey of Nutritional Status (ECEN) conducted in 1973–1974 was the most recent representative follow-up study on food consumption in the Chilean population. The 1994 study by Atalah et al. (*24*) on antioxidant consumption among adults indicated that 70% of those interviewed consumed fewer than two fruits, that 59% ate fewer than two portions of vegetables per day, and that the amount of fruits and vegetables eaten by the population was not sufficient to obtain the protective effect needed against certain types of cancer. Espinosa et al. (*25*) analyzed the evolution of apparent consumption of 11 index foods and macronutrients in Chile between 1975 and 1994. Results to be noted in this study were increased consumption of meats and cured meats and decreased consumption of grains (Table 8).

In the process of developing the Food Guidelines for Chile (*26*), a study was conducted in October 1995 of men and women aged 20 to 55 who visited 120 health facilities in the metropolitan region, where care is provided to the lower-middle and lower socioeconomic strata of the population. Survey participants had to recall what foods they had eaten during the previous 24 hours. The results of interviewing 412 men and 449 women indicated a significant increase in daily fat consumption in comparison with other earlier studies (Table 9). The same study indicated that no one in the sample had eaten fish the day before, that the average consumption of fruits and vegetables among men was only one fruit and two portions of vegetables, and

TABLE 8. Apparent consumption of index foods, Chile, 1980–1994.

Food [(kg/person)/year]	1980	1994	Variation 1980–1994 (%)
All meats	32.6	55.2	+69.3
Beef	15.0	21.2	+41.3
Lamb	1.1	0.7	–36.4
Pork	5.0	11.0	+120.0
Poultry	10.3	21.5	+109.0
Fish	4.9	4.4	–10.2
Cured meat	3.5	9.9	+183.0
Eggs (units)	116.0	132.0	+13.8
Bread	97.0	90.0	–7.2
Milk (liters)	115.0	145.0	+26.1
Potatoes	50.0–54.0	50.0–54.0	0.0
Kidney beans	4.5	2.0	–55.6

Source: Espinosa F, Valiente G, Valiente S. Sistema de Información para la Vigilancia Alimentaria y Nutricional de Alimentos Índices. Santiago: Universidad de Chile, Instituto de Nutrición y Tecnología de los Alimentos; 1996.

TABLE 9. Average daily intake of nutrients and percentage of total daily caloric intake in the population seen by the Metropolitan Health Service, Santiago, Chile, 1995.

	Men		Women	
Daily intake	Daily average	Calories (%)	Daily average	Calories (%)
Proteins (gr)	84	14.4	58	13.9
Fats (gr)	70	27.1	53	28.6
Carbohydrates (gr)	340	58.5	240	57.5
Energy (cal)	2,324	100.0	1,668	100.0

Source: Benavides X, Castillo C, Cárdenas R, Jury G, Taibo M, Urteaga C. Desarrollo de Guías Alimentarias para Chile. Antecedentes. Segundo borrador. Santiago: Universidad de Chile, Instituto de Nutrición y Tecnología de los Alimentos; 1996.

that women ate more fruit and dairy products and less bread (Table 10).

Physical Activity

Increasing urbanization is associated with decreased physical activity and with changes in the population's food habits. One of the principal causes of decreased physical activity is the availability of motor vehicle transport and sophisticated tools that make work easier in all areas of activity. Under such conditions, less energy is spent, the imbalance in terms of consumption is greater, and obesity increases as a result (*27*).

Berríos et al. studied sedentary lifestyles in Chile by surveying a representative sample of Santiago (*7*). When the World Health Organization's criterion of considering a person sedentary if they do not exercise for at least 20 minutes twice a week was used, they found that 55.4% of men and 77.4% of women were sedentary. The same survey repeated four years later indicated that the percentage had increased to 57.8% among men and 80.1% among women (*15*). Various studies of children have shown that passive games and educational activities contribute to reduced energy expenditure (*28*), and thus are risk factors for childhood obesity. A recent study conducted in Santiago (*19*) indicates that both obese children and normal children watch more than three hours of television per day and that this figure increases to four hours on holidays.

TABLE 10. Average daily consumption of selected foods in a selected population of the metropolitan region of Santiago, Chile, 1995.

	Daily consumption	
Product	Men	Women
Dairy (ml)	180	200
Sugar (g)	28	20
Bread (g)	280	200
Meat (g)	100	60
Fish (g)	0	0
Fruits (g)	83	140
Vegetables (g)	190	178

Source: Benavides X, Castillo C, Cárdenas R, Jury G, Taibo M, Urteaga C. Desarrollo de Guías Alimentarias para Chile. Antecedentes. Segundo borrador. Santiago: Universidad de Chile, Instituto de Nutrición y Tecnología de los Alimentos; 1996.

Cholesterol

The relationship between high serum levels of cholesterol and cardiovascular diseases is well known. Obesity is also known to produce changes in the lipid profile, particularly with respect to cholesterol associated with high-density lipoproteins (*8–12*). Studies of more than 2,000 children and adolescents of both sexes conducted in Concepción by Casanueva et al. (*29*) showed average total cholesterol levels of 160 mg/dl; 9% of boys and 12% of girls showed levels higher than 200 mg/dl. In an earlier study (*30*), the same author had shown a significant difference between children in urban and rural areas: children living in rural areas had average cholesterol levels of 130 mg/dl due to their different diet, which has a higher proportion of vegetables, fruits, and tubers.

The study of persons over age 15 conducted by Berríos et al. (*31*) showed average total cholesterol levels of 179.6 mg/dl in men and 187.9 mg/dl in women. Despite these low averages, 34% of the men and 40% of the women had values higher than 200 mg/dl. Of these numbers, 40.8% of the men and 42.3% of the women had a high socioeconomic level. In contrast, only 27.1% of the poorest men and 30.7% of the poorest women had cholesterol levels over 200 mg/dl. This observation agrees

with the study by Albala et al. on the lipid profile of obese women at high and low socioeconomic levels: the poorest women had lipid profiles that were significantly lower than those of women of high socioeconomic status (*23*).

CONCLUSIONS

The global nutritional situation has undergone rapid changes in just a few years. In Latin America and Asia in particular, the situation shifted from problems of nutritional deficit to problems of obesity and hyperlipidemia caused by an excess of certain foods. Increasing urbanization was associated with changes in the population's lifestyles (*27*), primarily with respect to diet and physical activity. A diet traditionally rich in grains, plants, and tubers and low in fat and animal protein was replaced by processed foods high in fat and sugar (*32, 33*). The change affected not only the content and the manner of preparing food but the entire food culture as well. Thus, advertising strategies designed to encourage consumption of processed foods bombard the public with commercials during popular television programs, while television viewing also contributes to a sedentary lifestyle.

Rapid urbanization, the increased supply of high-calorie processed and packaged products, and the opening of international fast-food restaurants in Latin America have greatly influenced the dietary habits of the urban population. Changes in firmly established habits occurred with surprising speed, particularly in lower-income groups that tend to imitate behaviors associated with groups that enjoy greater socioeconomic well-being.

In the case of Chile, the nutritional transition happened in less than 20 years. At present, cardiovascular diseases are the primary causes of death in the country and account for the highest percentage of the overall national burden of disease (*22*). Sedentary lifestyles, obesity, and hyperlipidemias, important risk factors for cardiovascular diseases (*8*), have increased at an alarming rate as a result of the increased total consumption of fats and decreased consumption of antioxidants. When we consider that the problem affects small children and pregnant women in particular, the increase in obesity in all age groups presents an urgent challenge because of its serious future consequences. It is also particularly significant that obesity and deficiencies in essential minerals and micronutrients, the symptoms of which may be masked by obesity, are more frequent in lower-income groups. The higher prevalence of almost all risk factors for chronic diseases, combined with limited access to health care services and timely treatment, mean that people belonging to these groups are particularly vulnerable, since they seek health care late and their conditions consequently become worse and have more catastrophic effects.

The serious health risks that obesity entails make it necessary to include the problems of this condition in the agenda for implementing Chilean policies on food and nutrition. Although the treatment of obesity often fails due to frequent relapses, secondary preventive actions directed to women (who suffer most from this condition) can lead to primary prevention in their families and future generations. In order to avoid the risk of a true epidemic of chronic diseases, active intervention is imperative to reduce the nutritionally based risk factors by implementing primary prevention measures from infancy, focusing on actions that promote changes in lifestyles.

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THE EPIDEMIOLOGIC TRANSITION IN CUBA

Carmen Porrata[1], Arturo Rodríguez-Ojea[1], and Santa Jiménez[1]

An epidemiologic transition consists of long-term changes in the mortality, disease, and disability profiles that characterize a specific population. In general, these changes coincide with demographic, social, and economic changes and changes in dietary patterns. The transition follows a characteristic direction: infectious diseases associated with vital primary deficiencies (nutrition, water, housing) are gradually replaced by chronic and degenerative diseases, injuries, and mental disorders associated with genetic factors and vital secondary deficiencies (personal or environmental safety, emotional support, and opportunities for full realization of individual potential) (*1*).

In Latin America and the Caribbean this epidemiological transition began to become apparent in the second half of the 20th century (*1*). In Cuba, the phenomenon appeared toward the end of the 1950s with a decline in mortality due to infectious diseases in the youngest age groups and the appearance of cardiovascular diseases and malignant neoplasms among the five leading causes of death (*2*). However, social changes and the implementation of a comprehensive health policy starting in 1959 led to progressive improvements in the health situation and had a significant effect on the epidemiological transition process.

[1]Instituto de Nutrición e Higiene de los Alimentos, Havana, Cuba.

This work describes the characteristics of the epidemiological transition in Cuba in recent decades and emphasizes the dietary and nutritional aspects associated with the transition.

METHODS

The description of the epidemiological transition in Cuba starts with an analysis of the aspects most closely associated with it: the demographic situation, socioeconomic characteristics, the educational level of the population, access to community and health services, food marketing dynamics, food availability and food consumption trends, breastfeeding, dietary habits of the population, and the morbidity/mortality profile.

Primary data are taken from the official information published in national and international sources, Cuba's report to the Multicenter Project of the Regional Operating Network of Food and Nutrition Institutions (RORIAN) (*3*), the National Food and Nutrition Monitoring System (SISVAN), the Statistics Department of the Ministry of Public Health, the Statistical Research Institute of the State Statistics Committee, the Cuban Institute for Research and Guidance of Domestic Demand, the Research Institute for the Food Industry, the Central Planning Board, the National Hygiene and Epidemiology Institute, and the Nutrition and Food Hygiene Institute (INHA).

The per capita availability of energy and nutrients was obtained from the national food balance sheets. Apparent per capita consumption was calculated by subtracting from total availability the amounts allocated to international tourism, foreign personnel in general, and estimated waste for each food. In addition, the standardized age group- and gender-specific annual mortality rates were analyzed, following the guidelines for the typical population recommended by the World Health Organization (WHO). The causes of mortality were grouped according to the *International Statistical Classification of Diseases and Related Health Problems, Ninth Revision* (4) and mortality trends were studied by analyzing annual rates for the period 1970–1993.

The morbidity data on diabetes mellitus were taken from the National Clinic Registry established in 1979. The diagnostic criteria established by WHO were used for data from 1980 on (5). Since 1992, the Registry data come from reports by family physicians who by then were caring for 90% of the population. The information on morbidity due to malignant neoplasms for the period 1979–1990 was obtained from the National Cancer Registry. The effects of economic changes on the supply of foods and on the population's nutritional status since 1989 are described separately.

RESULTS

Demographic Aspects

In 1993, Cuba's total population was 10,939,714 inhabitants (50.26% men and 49.73% women), an increase of 3,911,199 since 1960. The distribution by sex was very similar, even at advanced ages. Starting in 1960, a declining trend began to be noted in the size of the population under the age of 15 (11.7%), and an increase of 4% to 8% was seen in the 65 years and older age group. These trends clearly indicate a gradual aging of the population.

Between 1960 and 1990, population density increased by about 32 inhabitants/km^2, which is considered slow to moderate growth. The urban population increased 15.9% (Table 1) and the internal flow of migration was from the eastern provinces to the western provinces, and from rural areas to urban areas. As a result, 75.7% of the population was residing in urban areas in 1990.

The birth rate fell 62% between 1963 (35.1 per 1,000 inhabitants) and 1994 (13.4 per 1,000 inhabitants). Life expectancy at birth increased by 9.93 years from the 1960s to the 1990s and reached 75.03 years for both sexes, with a difference of 3.8 years between the sexes. This is a relatively small difference when compared to that of developed countries with similar life expectancies (Table 2).

Economic Aspects

Up to 1989 and for nearly 30 years, the country consolidated a model of economic relations with the countries of the Mutual Economic Assistance Council (CAME) that allowed it to establish a program of development and economic integration that was very specialized but also very dependent on foreign trade. Imports to Cuba from the CAME market

TABLE 1. Demographic data, Cuba, 1960, 1970, 1980, and 1990.

	1960	1970	1980	1990
Density (inhabitants/km^2)	63.4	77.3	87.8	95.9
Urbanization (%)	58.4	60.5	68.4	74.3
Population growth rate (per 1,000 inhabitants)	18.2[a]	19.8	12.7	8.9

[a]Covers the period from 1950 to 1960.

Source: Cuba, Instituto de Investigaciones Estadísticas.

TABLE 2. Life expectancy at birth, Cuba, 1960–1995.

Years	Women	Men	Total	Difference
1960–1965	67.05	63.26	65.10	3.79
1969–1971	71.28	68.55	70.04	2.73
1981–1982	75.77	72.32	73.93	3.45
1988–1989	76.80	72.89	74.75	3.91
1990–1995	76.98	73.18	75.03	3.80

Source: Cuba, Instituto de Investigaciones Estadísticas.

amounted to 63% of foods, 86% of raw materials, 98% of fuels, and 80% of machinery and equipment (*6*).

Education

In 1961, a reduction was achieved in illiteracy among the general population, with the rate falling from 23.6% to 3.9%. In 1995, the illiteracy rate for the population aged 10 to 49 years was 1.9% and average schooling, which did not reach the third grade in 1953, was higher than the eighth grade. Of the population aged 6 to 14 years, 98.5% attend school, and about 80% of young people graduate from the ninth grade.

Health and Community Services

All the country's inhabitants have equal access to complete, free health care since implementation of the National Immunization Program (1960), the Program for Control of Acute Diarrheal Diseases (1962), the National Maternal and Child Care Program (1980), and health education programs (*7*). Starting in 1984, a new concept of primary care emerged with the introduction and rapid expansion of the family physician model that currently covers 94% of the population.

In 1993, 94.2% of the urban population and 83.0% of the rural population were covered by drinking water supply services; the national total coverage was 91.5%. In that same year, 96.6% of the urban population and 72.0% of the rural population had sanitation service coverage, through the sewerage network or through septic tanks and latrines; the national total coverage was 90.6% (*6*).

Food Marketing

Until 1985, food imports made it possible to increase food availability and to achieve food consumption more consistent with nutritional requirements. Imports were concentrated on foods that the country was not in a position to produce (Table 3). In 1989, 99% of the available beans, 94% of fats, 79% of grains, 44% of fish, 38% of milk and milk derivatives, and 21% of meats were imported. This situation led to a great dependency on foreign trade. Imports in that year represented 53% and 56% of available energy and proteins, respectively.

Starting in the early 1960s, a rationed distribution system was established to afford the population equitable access to the available foods, with regulated prices subsidized by the State. A network was established in 1981 to market a broad range of non-rationed foods at higher prices. In addition, food assistance programs distributed a significant portion of the food supply at low cost to students at all educational levels, to the hospital population, and to workers. Until 1989, the rationing system and national food programs afforded a large segment of the population equitable access to 72% of the supply of energy and proteins consumed.

TABLE 3. Selected food imports, Cuba, 1975, 1980, 1983–1985, and 1986–1989[a].

Food	1975	1980	1983–1985	1986–1989
Wheat	54.4	89.3	123.8	113.6
Wheat flour	34.5	30.5	17.5	17.2
Rice	21.5	23.5	21.2	20.6
Potatoes	3.0	4.1	2.9	1.9
Beans	8.2	10.7	12.0	11.2
Canned fruits and vegetables	0.8	2.7	1.6	0.7
Powdered milk	5.4	4.0	3.6	3.4
Poultry	3.3	2.0	2.1	2.4
Canned meat	3.6	3.6	4.3	3.4
Fish	6.7	4.2	4.7	4.6

[a]Figures in (kg/year)/capita.

Source: Cuba, Junta Central de Planificación. Informe estadístico, 1989.

Food Availability and Consumption

In the three decades studied, the availability of foods made possible a gradual increase in the intake of energy (11%) and proteins (33%) (Table 4). The data from food consumption surveys conducted between 1980 and 1989 indicate that the percentages for energy and protein intake were within normal limits (*3*) and that the contribution of proteins to total energy consumption was 11% to 15%; carbohydrates accounted for 40% to 58%, and fats for 27% to 48%. In a 1990 technical report, INHA indicated that despite the figures achieved in energy intake, consumption of vitamin A, vitamin C, iron, and calcium, among other nutrients, was inadequate in many cases.

The characteristics of the Cuban diet that favored the presence of chronic and degenerative diseases during that period include excessive sugar consumption (52.7 kg per capita in 1988, or 19% of total energy consumption); low consumption of whole grains; low consumption of vegetables and fruits due to seasonal availability and the lack of appropriate dietary habits; the low percentage of plant fats, which accounted for less than one-third of total fat consumed; excessive consumption of fried foods; customary use of reheated fats; low consumption of fish; and inadequate distribution of energy intake among the different meals of the day: 4.4% of total daily energy is consumed at breakfast and 42.6% of total daily energy is consumed at dinner (*3*).

TABLE 4. Per capita availability of energy and nutrients, Cuba, 1960, 1970, 1980, and 1989.

	1960	1970	1980	1989
Energy (kcal)	2,550	2,565	2,867	2,835
Proteins (g)	57	69	75	76
Animal (g)	17	31	34	35
Plant (g)	40	38	41	41
Fats (g)	—	61	76	74
Carbohydrates (g)	—	436	470	466

Source: Cuba, Instituto Cubano de Investigaciones y Orientación de la Demanda Interna, y Oficina Central de Estadísticas.

Breast-feeding

The national study on the prevalence of breast-feeding conducted in 1973 found that 90% of children were breast-fed until the seventh day of life. That percentage fell to 45% at three months, including nursing babies and babies who received mixed feeding. In 1990, the prevalence of exclusive breast-feeding was 63% during the first week of life, 25% at three months, and 16% at six months. The prevalence and duration of breast-feeding were greater in rural areas. In addition, a high rate was noted for early introduction of fruits and meats and late introduction of vegetables and fish (*8*, *9*).

MORTALITY

There was a striking decline in the infant mortality rate and in the mortality rate for children under age 5 starting in 1970. The standardized general mortality rates for the population also fell (Table 5). In 1994, the infant mortality rate reached 9.9 per 1,000 live births and 12.8 per 1,000 live births in children under age 5.

In 1970, 1980, and 1990, heart disease occupied first place and malignant neoplasms occupied second place among the ten leading causes of death. Enteric diseases and congenital anomalies ceased to appear among the ten leading causes of death after 1980. Another significant change was the rise in diabetes

TABLE 5. Gross and standardized mortality rates per 1,000,000 population, infant mortality rates and mortality rates for children under age 5 per 10,000 live births, Cuba, 1970, 1980, and 1990.

Mortality	1970	1980	1990
Gross rate	627.4	569.6	680.4
Standardized rate	688.8	582.4	607.0
Infant mortality rate	38.7	19.6	10.7
Mortality rate for children under age 5	43.8	24.3	13.1

Source: Cuba, Ministerio de Salud Pública, Departamento de Estadísticas.

TABLE 6. Mortality rates per 100,000 population, by main causes of death, Cuba, 1970, 1980, and 1990.

Cause	1970	1980	1990
Heart disease	85.2	165.3	173.6
Malignant neoplasms	115.3	108.7	114.9
Cerebrovascular diseases	70.8	55.2	56.9
Accidents	37.2	33.3	43.0
Influenza and pneumonia	43.6	41.7	25.5
Diabetes mellitus	12.1	11.1	19.1
Suicide	13.1	21.3	18.4
Bronchitis, emphysema, and asthma	14.3	7.3	9.8
Cirrhosis and other chronic liver diseases	7.9	6.0	7.8
Certain perinatal disorders[a]	300.7	170.7	89.9
Enteritis[b]	15.2	4.0	—
Congenital anomalies[b]	12.3	11.3	—

[a]Specific rate.

[b]Not included among the 10 leading causes of death.

Source: Cuba, Ministerio de Salud Pública, Departamento de Estadísticas.

mellitus from the eighth place to the sixth place (Table 6). The standardized mortality rates for diseases of the circulatory system (ICD-9 codes 390 to 459) (*4*) tended to decline, with the exception of mortality due to ischemic heart diseases, which increased among men aged 25 to 64. The most frequent clinical expression of these diseases was acute myocardial infarction, with a fatality rate of 72% in 1991, which is high when compared to the rates of the more developed countries.

The main neoplasm sites in men, in decreasing order of frequency, were the lungs, prostate, colon and rectum, and stomach. In women, they were the breast, lungs, colon and rectum, and uterine cervix. The standardized mortality rates for malignant neoplasms (ICD-9 codes 140 to 208) (*4*) remained stable, except for mortality due to prostate cancer, which increased in men over age 45. Mortality from breast cancer also increased in women over age 65. Mortality due to diabetes mellitus exhibited a rising trend, with similar age- and sex-specific rates up to age 45; at older ages, the rates were higher in women. Mortality due to infectious and parasitic diseases (ICD-9 codes 001 to 139) and acute respiratory infections (ICD-9 codes 460 to 487) (*4*) showed a clear declining trend, except for mortality due to diarrheal diseases in the 45 years and older age group.

MORBIDITY

Obesity

According to the data from SISVAN, between 1985 and 1990 the percentage of obese persons fell from 2.3% to 1.9% in children under 1 year and from 1.6% to 1.0% in children aged 1 to 4.[2] In some isolated studies that analyzed both sexes, the frequency interval for obesity among adults in the 1980s was 15% to 31%. In other studies, the observed frequency was 8% to 39% in men and 20% to 47% in women. In those under age 15, the frequency interval was 7% to 19% (*3*).

In order to obtain anthropometric data for adults of both sexes aged 20 to 60, a measure was taken of the parents of selected individuals in the Second National Growth and Development Survey in 1982 ($n = 31{,}662$) residing in urban and rural areas in the country's 14 provinces. Based on body mass index (BMI) figures, 26.4% of men and 27.2% of women showed grade I obesity, and 5.1% of men and 11.7% of women showed grade II obesity. Grade III obesity was detected only in women (0.5%). In addition, a direct relationship was seen be-

[2] Diagnostic criterion: Above the 97th percentile for weight-for-height, according to national standards (INHA Technical Report, 1991).

tween a high educational level and the grade of obesity in men. In women, this observation was valid only for grade I obesity (*10*).

Hypertension

Starting in 1979, the statistics on patients treated in clinics showed a rising trend in the prevalence and incidence of hypertension in adults of both sexes (Figures 1 and 2). A study of adults of both sexes begun in Havana in 1988 (n = 3,011) found a prevalence for this disease of 27.4% (A. Dueñas, Instituto de Cardiología y Cirugía Cardiovascular, personal communication).

Diabetes Mellitus

Isolated studies on the prevalence of diabetes mellitus conducted between 1968 and 1981 using non-uniform diagnostic criteria indicated values between 0.5% and 11%, with higher figures in areas with greater socioeconomic development and urbanization. In adults aged 30 to 59, the figures for prevalence of glucose intolerance were higher in women (13.9%) than in men (5.6%) (Technical report, Instituto de Endocrinología y Enfermedades Metabólicas, 1985). The prevalence (Figure 3) and incidence of diabetes mellitus tended to increase, particularly the former. These rates were higher for women in all age groups. The people most affected were those over 60 years of age, with a rate of 76.4 per 1,000 population aged 60 to 64 treated at the clinics, and a rate of 66.6 for every 1,000 population over 65. The group aged 25 to 29 had a rate of 15.0, and the group aged 15 to 24 had a rate of 2.7. Higher prevalence and incidence were seen in the western provinces, which are the most urbanized. In Havana, prevalence was higher (Technical report, Instituto de Endocrinología y Enfermedades Metabólicas, 1985).

Malignant Neoplasms

The highest incidences of malignant neoplasms in women were seen in the following sites: breast, lungs, and colon. In men, the sites with the highest incidences were the lungs, prostate, and colon, in that order. The trend in the rates for malignant lung neoplasms was rising, and the male rates were three times greater than the female rates (Figure 4) (*11*). Rates were also tending to rise for malignant breast, prostate (Figure 5), and colon (Figure 6) neoplasms. The rates for malignant stomach neoplasms remained stable in both sexes, with higher figures for men. The rates for malignant cervical neoplasms also remained stable. In the case of malignant liver neoplasms, the rates tended to rise, but with higher values for men.

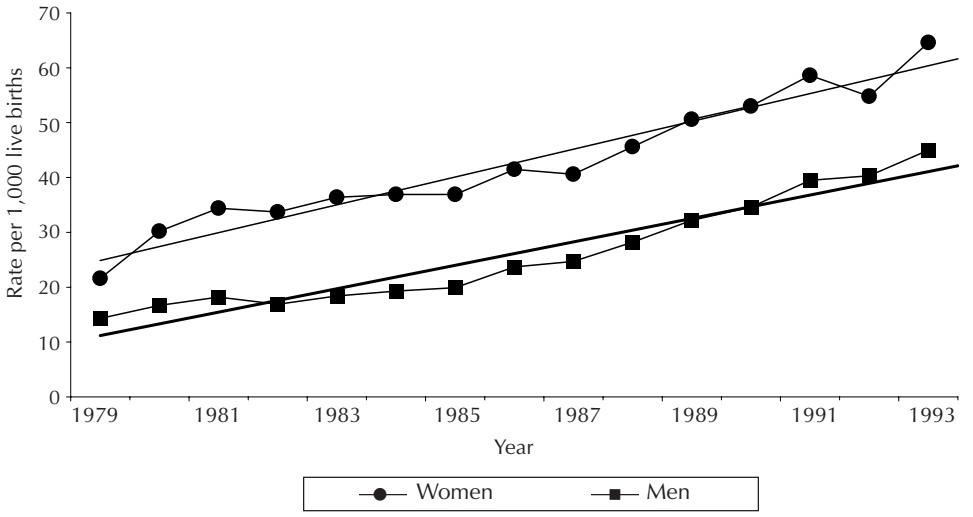
COMMUNICABLE DISEASES

The incidence of respiratory and diarrheal diseases (Figures 7 and 8), infectious hepatitis, and sexually transmitted infections (Figure 9) clearly showed rising trends in the period under study.

Nutritional Deficiencies

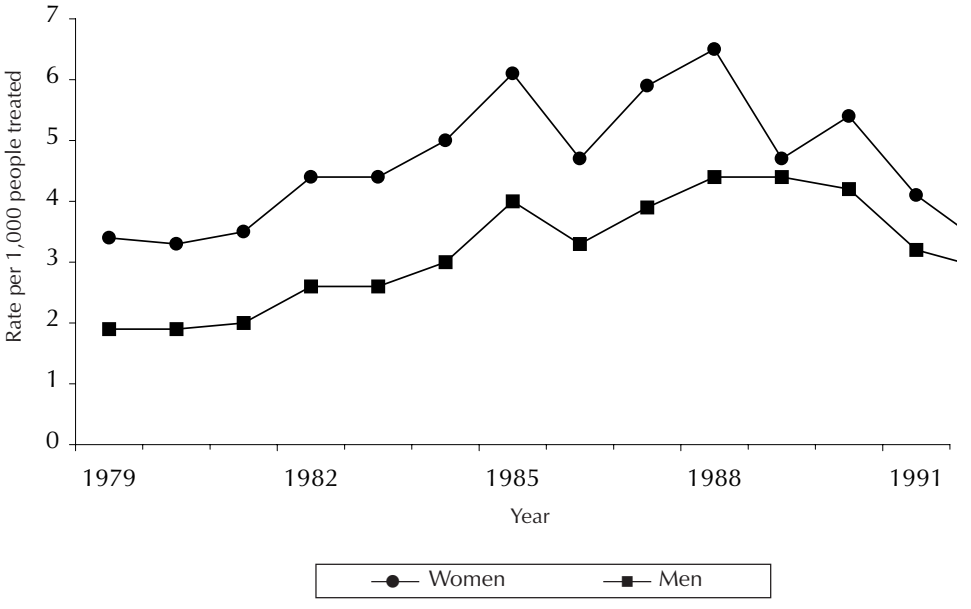
Protein-energy malnutrition is not a public health problem in Cuba (*12*). In 1985, 10.9% of pregnant women began their pregnancy underweight; this figure fell to 8.7% in 1990. During the same period, the percentage of pregnant women who did not gain enough weight also declined. The percentage of low birthweight newborns fell progressively until reaching its lowest level in 1991 (7.8%) (*12*). Iron deficiency was the most prevalent nutritional deficiency in the country during the 1980s. The frequency of iron deficiency anemia among pregnant women in the third trimester increased from 22% to 32%; in children aged 6 to 11 months, it increased from 40% to 60%; in children aged 12 to 36 months, it increased from 25% to 40%, and in adolescents and women of childbearing age, it increased from 20% to 30%. In general, slight anemia predominated. In addition, a marginal vitamin A deficiency was noted in some groups of the population (*3*).

FIGURE 1. Prevalence of hypertension by gender, Cuba, 1979–1993.



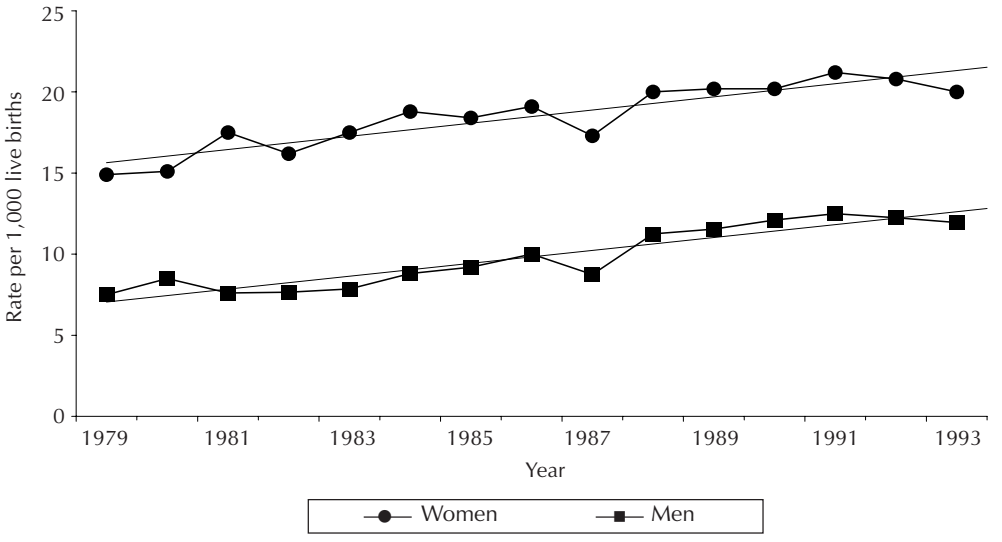
Source: Cuba, Ministerio de Salud Pública, Departamento de Estadísticas.

FIGURE 2. Incidence of hypertension by gender, Cuba, 1979–1991.



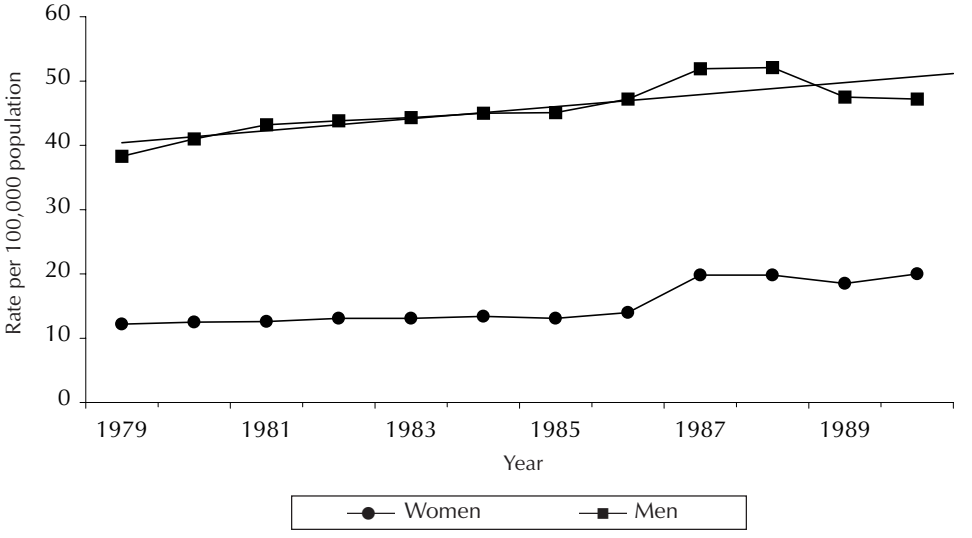
Source: Cuba, Ministerio de Salud Pública, Departamento de Estadísticas.

FIGURE 3. Prevalence of diabetes mellitus by gender, Cuba, 1979–1993.



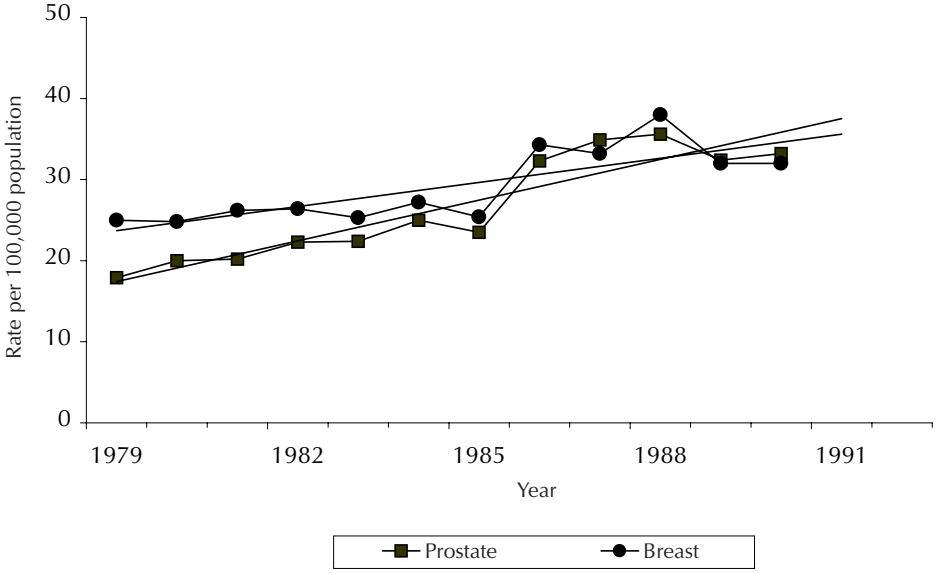
Source: Cuba, Ministerio de Salud Pública, Departamento de Estadísticas.

FIGURE 4. Incidence of lung cancer by gender, Cuba, 1979–1989.



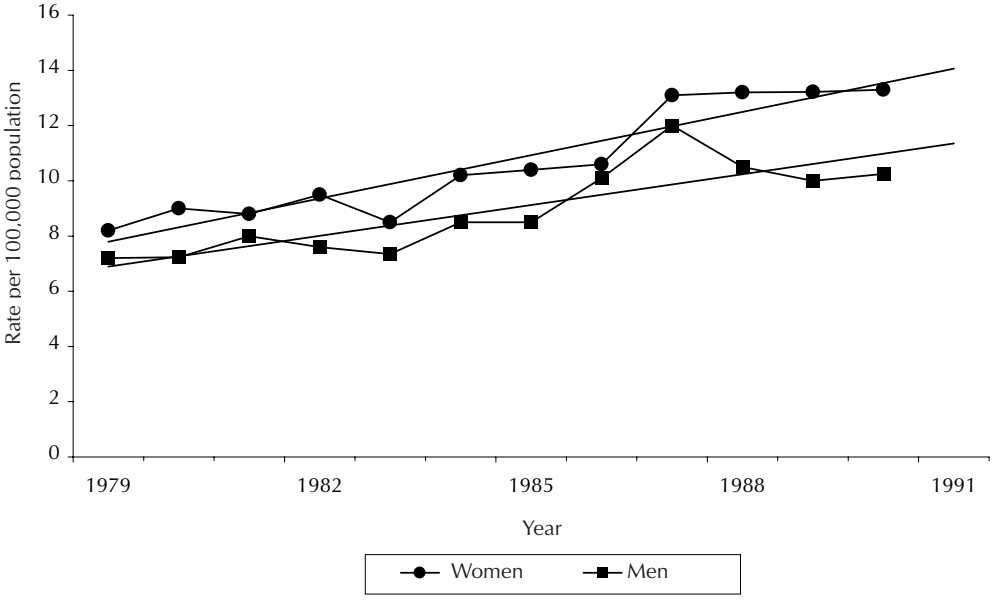
Source: Cuba, Ministerio de Salud Pública, Departamento de Estadísticas.

FIGURE 5. Incidence of breast and prostate cancer, Cuba, 1979–1991.



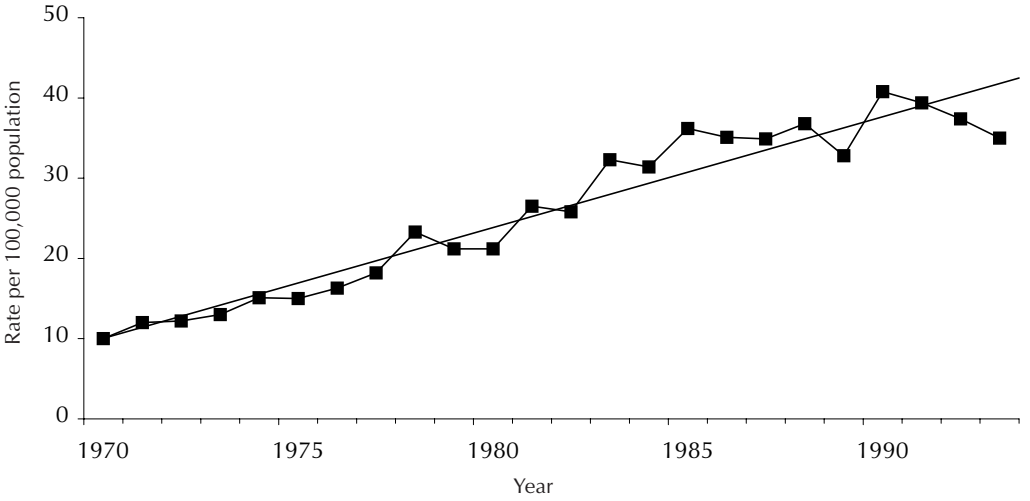
Source: Cuba, Ministerio de Salud Pública, Departamento de Estadísticas.

FIGURE 6. Incidence of colon cancer by gender, Cuba, 1979–1991.



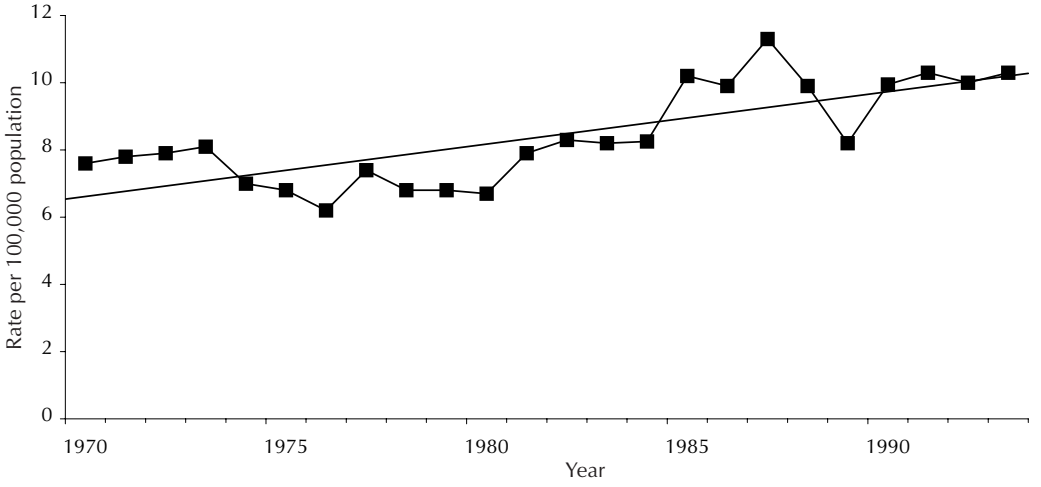
Source: Cuba, Ministerio de Salud Pública, Departamento de Estadísticas.

FIGURE 7. Morbidity due to acute respiratory infection, Cuba, 1979–1991.



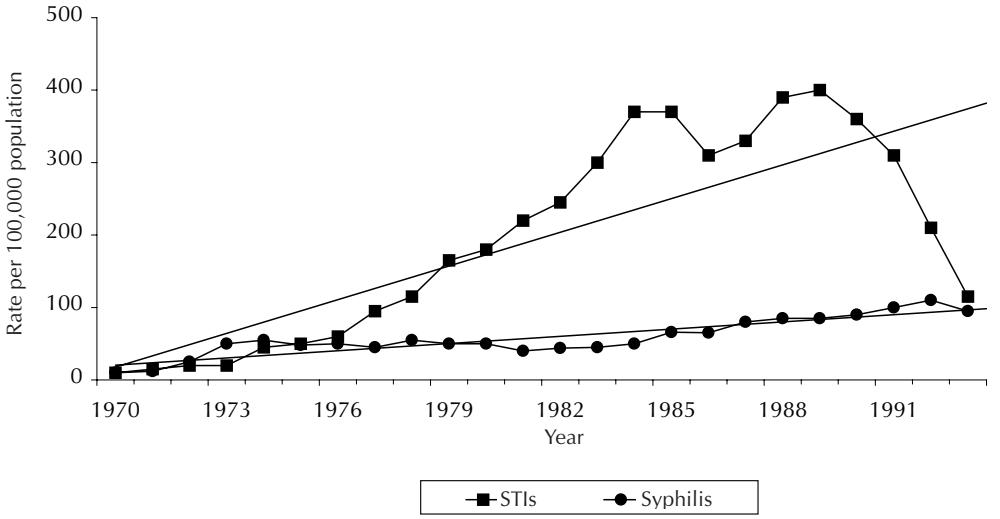
Source: Cuba, Ministerio de Salud Pública, Departamento de Estadísticas.

FIGURE 8. Morbidity due to acute diarrheal diseases, Cuba, 1970–1990.



Source: Cuba, Ministerio de Salud Pública, Departamento de Estadísticas.

FIGURE 9. Morbidity due to sexually transmitted infections (STIs) and syphilis, Cuba, 1970–1991.



Source: Cuba, Ministerio de Salud Pública, Departamento de Estadísticas.

ECONOMIC CHANGES AND THE FOOD AND NUTRITIONAL SITUATION

The disappearance of the Union of Soviet Socialist Republics and the socialist bloc in eastern Europe led to a reduction in imports, which dropped from US$ 8,000 million in 1989 to US$ 1,700 million by late 1993 (*13*). During these four years, global social product fell by 50%. During the same period, agricultural and livestock production for sale to the population declined markedly: per capita annual production of cow's milk fell from 84 L to 29 L, production of eggs fell from 230 units to 125 units, production of pork (on the hoof) fell from 9 kg to 2 kg, production of (live) fowl fell from 11 kg to 2.5 kg, production of rice (unhulled) fell from 48 kg to 22 kg, production of plants and vegetables fell from 57 kg to 38 kg, and production of citrus fruits fell from 78 kg to 58 kg. In addition, the anticipated increase in domestic production of tubers, roots, and bananas was not achieved.

Starting in 1990, the unrationed supply of foods gradually disappeared and the supply offered through the gastronomy network and rationing system declined. This situation led to the decline in apparent per capita intake of energy and nutrients (Table 7). In 1993, proteins contributed 10% of total energy intake, fats 13%, and carbohydrates 77%. Sugar provided 26% of total energy, and approximately half of total energy was contributed by only two foods: sugar and (polished) rice.

The new methods for marketing foods not subsidized by the State limit the access of lower-income sectors of the population. As a result, in recent years it has been possible to note that the diet has been inadequate and unbalanced, with low energy density, and little variation. This trend has been reflected in the results of nutritional surveys conducted in open population groups (sentinel sites for dietary and nutritional monitoring) and in observations made by some isolated studies. All these studies emphasize the low intake of ani-

TABLE 7. Daily recommended intake and apparent intake of energy and nutrients, Cuba, 1992 and 1993.

Nutrient	Recommended intake	Apparent intake 1992	Apparent intake 1993
Energy (kcal)	2,400.00	2,183.00	1,863.00
Protein (g)	72.00	50.30	46.00
Fat (g)	75.00	36.90	26.00
Thiamin (mg)	1.20	0.79	0.91
Riboflavin (mg)	1.50	0.86	0.78
Niacin (mg)	17.00	8.81	7.70
Pyridoxine (mg)	1.50	1.15	1.05
Vitamin B_{12} (µg)	2.80	1.94	1.70
Folate (µg)	225.00	177.00	152.00
Vitamin A (µg)	700.00	415.00	285.0
Vitamin C (mg)	57.00	73.00	58.00
Iron (mg)	14.00	11.91	11.00
Calcium (mg)	850.00	738.00	706.00

Source: Cuba, Instituto de Investigaciones de la Industria Alimenticia; Oficina Central de Estadísticas, e Instituto de Nutrición e Higiene de los Alimentos.

TABLE 8. Nutritional status of the population by gender and body mass index (BMI), Havana, Cuba, 1982 and 1994.

BMI (kg/m^2)	Men 1982	Men 1994	Women 1982	Women 1994
< 18.5	4.0	7.5	5.8	13.6
18.5–19.9	6.8	14.1	7.1	14.6
25–30	35.9	17.8	31.8	19.2
> 30	7.1	2.7	13.6	6.2

Source: Cuba, Departamento de Crecimiento y Desarrollo.

mal proteins, fats, A and B complex vitamins, iron, and calcium, and a relative excess in carbohydrate consumption, particularly sugar (*6*). Starting in 1990, this new situation, which produced changes in the nutritional status of some groups of the population, combined with a forced increase in the level of physical activity. As a result of the general scarcity of motorized transport, the population began to walk and use bicycles for their daily movements.

An anthropometric survey of adults of both sexes residing in Havana (n = 3,995) during 1993 and 1994 indicated an appreciable decline in the percentage of obese people in comparison with a similar study conducted in 1982 (n = 5,833). It addition, a marked increase was shown in the percentage of individuals with chronic protein-energy deficiency (BMI < 18.5 kg/m^2). In general, the distribution of relative weights shifted substantially toward lower values, without appreciable differences between the sexes (Table 8) (A. Berdasco and M. Esquivel. Technical report, Julio Trigo School of Medicine, 1995).

The percentage of pregnant women who were underweight at the beginning of pregnancy increased from 8.7% in 1990 to 10.4% in 1994 and, similarly, the percentage of low birthweight newborns increased gradually from 7.8% in 1991 to 8.9% in 1994 (*6*, *12*). From 1991 to 1994, an increase was noted in the frequency of anemia among pregnant women and women of childbearing age. A study conducted in Havana in 1992, which included 10% of all pregnant women in each health area, found anemia in 56.8%, although 66% of that figure was classified as slight anemia (*14*).

Sentinel site surveillance, which began in 1993 in the provinces of Havana and Pinar del Río, indicated that 20% of the children aged 1 to 5 and 35% of the women of child-bearing age who were studied were anemic. In addition, serum vitamin A deficiency was found in 3.8% of the children aged 1 to 5, 4.9% of the children aged 7 to 11, and 4.3% of adolescents aged 12 to 15. Low levels of vitamin A were also found in 40% to 45% of those making up the groups mentioned. The level of thiamin, assessed from erythrocyte transketolase levels, was deficient in 25.5% of the adolescents aged 12 to 15 and in 18.4% of the adults aged 20 to 59, and was low in 20.6% and 14.4% of each group, respectively (*15*).

DISCUSSION

The results presented come from a descriptive study that did not use the complex statistical techniques that are currently used in epidemiology. For this reason, the information is not subject to the risk of the lack of emphasis on biology nor the exaggerated emphasis on so-called "positive" studies (*16*). Due to the

unavailability of representative studies, in some cases value has been assigned to the reproducibility of results from small studies.

Chile, Costa Rica, and Cuba are the Latin American countries that have the most favorable health indicators (*1*). However, in analyzing the epidemiological transition, it is useful to know the pace at which each country goes through the various stages. According to Omran, among the Latin American and Caribbean countries, Cuba has been in an advanced stage of the epidemiological transition since the 1970s, with a modality similar to that of the developed countries but with greater economic under-development. Omran placed Cuba, together with Chile and Costa Rica, in the context of what he called the "late model" (*17*).

Social changes, particularly in national coverage of health services, produced a rapid decline in mortality due to communicable diseases. Thus, infectious and parasitic diseases accounted for only 1.4% of total mortality in 1990. Since 1972–1974, the five leading causes of death have been well defined and, among them, heart disease, malignant neoplasms, and cerebrovascular diseases have had the greatest weight. In the three-year period 1972–1974, the five causes accounted for 69% of all deaths; in the three-year period 1988–1990, they accounted for 75%. Thus, Cuba entered its current epidemiological situation, in which chronic diseases are the leading causes of death. With respect to morbidity, a high prevalence was found for diabetes mellitus, obesity, hypertension, infectious diseases, and iron deficiency. This transition was influenced by the notable increase in life expectancy, which in turn raised the population's level of exposure to risk factors for chronic and degenerative diseases.

The decline in infant mortality is the factor that had the greatest effect on increased life expectancy. In addition, despite economic limitations, Cuba has the lowest infant mortality rate in Latin America, with figures comparable to those of the developed countries. The advances made in education and inclusion of women in the job market affected fertility rates, which fell from 2.2 to 0.89 children per woman over the course of approximately two decades. This is another element that should be considered when observing changes in the morbidity profile.

The determinants of the increase in chronic and degenerative diseases in the country include, in particular, excessive intake of saturated fats, cholesterol, and sugar; insufficient consumption of fruits and vegetables; low consumption of milk; excessive consumption of foods during the last meal of the day; the low rate of breast-feeding and early weaning; incorrect eating habits; inadequate nutritional education; increasingly sedentary lifestyles; and high consumption of tobacco products and alcoholic beverages. Although between 1990 and 1994 an apparent decline was seen in tobacco use and in hypercholesterolemia, two of the principal risk factors for ischemic heart disease, there is a notable increase in mortality due to heart disease in working-age men, which is the most frequent cause of death in that group. This situation calls for comprehensive analysis of the associated risks and the implementation of immediate actions.

Increased mortality from diabetes mellitus has converted the disease into a significant national public health problem, particularly in persons over age 60. Although the combination of increased life expectancy and unhealthy lifestyles would lead us to assume that this rising trend will continue, the incidence and prevalence of diabetes mellitus declined in the early 1990s. This phenomenon could be attributed in part to changes in diet, to increased physical activity, and to the results of these factors (e.g., decline in the prevalence of obesity). However, the factors contributing to this situation should be identified and better studied.

The breadth of the intervals found in the prevalence of obesity could be related to the diagnostic criteria used and the different characteristics of the groups studied (e.g., the intensity of physical activity). Nonetheless, the percentage of obesity in both sexes is high.

Inadequate dietary patterns influenced the evolution of obesity in Cuba, particularly excessive carbohydrate consumption and excessive food consumption at night—which contributed to obesity being frequently associated with micronutrient deficiencies—as well as sedentary lifestyles. The popular tendency to favorably view overweight and obesity when evaluating one's own body image is also a contributing factor. This phenomenon could reflect national cultural aesthetic standards and ignorance of correct nutritional principles.

The results of epidemiological studies indicate that malignant neoplasms can be attributed to nutritional factors in 20% to 30% of men and approximately 60% of women (*18*). Elements of the country's diet that stand out are low fiber intake, excessive use of reheated fats, and low consumption of vitamin A, beta-carotene, and antioxidant vitamins in general. The higher incidence of malignant lung and stomach neoplasms in men could be explained by higher consumption of cigarettes and alcoholic beverages.

Poor water quality, low iron content in food, low consumption of foods containing vitamins (particularly vitamins A and C), incorrect handling of foods, and incorrect cooking methods that destroy vitamins sensitive to heat and oxidation are among the key determinants of high morbidity from infectious diseases and specific nutritional deficiencies. Although vaccine-preventable infectious diseases have been practically eradicated, respiratory infections and acute diarrheal diseases are still the first and second causes of morbidity, respectively. In addition, although mortality from these diseases has declined drastically, there are still environmental factors that contribute to their high incidence and which are very costly for the country to control.

The unfavorable economic changes that have occurred since 1989 have caused an increase in the percentage of low birthweight newborns, in the number of pregnant women who begin their pregnancies underweight, and specific nutritional deficiencies of iron, vitamin A, and thiamin. The deficiency of these vitamins and the remaining B complex vitamins, low consumption of proteins and essential amino acids, and excessive intake of carbohydrates were closely associated with the epidemic of neuropathy that occurred in Cuba in 1993, affecting more than 50,000 people (*19*).

In order to favorably modify the pattern of the epidemiological transition in the region, the countries of Latin America and the Caribbean must overcome the problems of morbidity due to infectious diseases and specific nutritional deficiencies, without copying the lifestyles and food consumption patterns of the developed countries. The region faces a distinct and difficult challenge in the epidemiological transition: the coexistence of rising mortality due to non-communicable chronic diseases, obesity, and hypertension; high morbidity due to infectious diseases; delayed growth; and specific nutritional deficiencies. In order to turn these trends around it is necessary to quickly identify the regions, populations, and family groups at highest risk and to carefully develop dietary guidelines and intervention projects that combine the development of habits and lifestyles appropriate to each country with accessibility in socioeconomic terms.

The comprehensive approach of primary care with a model that favors health promotion will make it possible to deal with risk factors, take preventive measures, and perform early diagnoses. Despite the difficulties caused by the country's current economic situation, Cuba's cumulative experience in implementing this model indicates the importance of substantially improving prevention, promotion, and community participation activities.

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THE EPIDEMIOLOGIC TRANSITION IN BRAZIL

Carlos Monteiro[1]

The concept of nutritional transition refers to secular changes in nutritional standards due to changes in the structure of people's diet as a result of economic, social, demographic, and health changes (*1*). Although we see particular aspects of the nutritional transition that has occurred during this century in all the countries and regions of the world, common aspects are a diet rich in fats (particularly of animal origin), sugar, and refined foods, and poor in complex carbohydrates and fiber, i.e., what is frequently called the "western diet." Concomitant changes in body composition, particularly increased obesity, are related to the predominance of this diet and to a gradual decline in physical activity.

There are many indications of the relationship between the spread of the "western diet" and increased obesity on the one hand, and the high prevalence of chronic degenerative diseases and decreased years of life spent free of disease on the other (*2–4*). The interdependence of demographic, socioeconomic, and epidemiological changes leading to the nutritional transition is very complex. As the younger age groups are changing more quickly, the predominance of this western diet grows and obesity increases. The changes, accompanied by a sedentary lifestyle, seem to originate in urban areas and later spread to the strata of the rural population with higher incomes, where population groups that still exhibit an energy deficit can often be found (*5*).

The changes in food patterns described have been occurring slowly and gradually in the United States and in most European countries since the second half of the 19th century (*1*). In contrast, the pace of change has been much more rapid in the developing countries. The data on countries as diverse as South Korea, China, Thailand, South Africa, and the Caribbean countries indicate an accelerated modification of the food structure after having achieved national self-sufficiency in the area of energy. Similarly, the progression of obesity is very marked in many of these countries (*5*). In Latin America we see a rapid demographic and epidemiological transition (*6, 7*): in most of the more developed countries of Central and South America we note the classic trend toward morbidity and mortality rates in which cardiovascular diseases, cancer, and other chronic degenerative diseases predominate. At the same time, fertility rates show a trend toward fewer numbers of children and gradual aging of the population.

The role of the nutritional transition as cause and effect of the epidemiological transition is a phenomenon that is still not clearly understood. Indeed, recent research on the epide-

[1] Universidade de São Paulo, Faculdade de Saúde Pública, Departamento de Nutrição, São Paulo, Brazil.

miological transition in the field of health in Latin America overlooked the nutritional transition as an important dimension that should be taken into account. This fact contrasts with the pioneering spirit of Latin American research that in the past had already indicated the fundamental role of nutritional deficiencies as causes of morbidity and mortality due to infectious diseases (*8–11*).

In the case of Brazil, great economic and demographic changes occurred between the 1960s and 1990s. In that period, national income increased more than three-fold and the agricultural and livestock sector's participation in the economy fell from 17.8% to 6.9% (*12*). At the time, the population doubled and the urban population increased from 45% to 75%, while fertility rates fell from more than six children per woman to less than three (*13*). The country's traditional social disparities increased during this period, producing what is now considered the most unequal modern society in the world (*14*). The objective of this study was to examine some aspects of the nutritional transition in Brazil in recent decades.

MATERIALS AND METHODS

Evaluation of Nutritional Status

The data on the nutritional status of the Brazilian population come from two national surveys on nutrition conducted by the Brazilian Geography and Statistics Institute (IBGE): the National Family Spending Study (ENDEF 1974–1975) and the National Health and Nutrition Study (PNSN 1989) conducted by the National Food and Nutrition Institute of the Ministry of Health (*15, 16*). The ENDEF survey covered more than 55,000 households and the PNSN study more than 14,000 households. Both surveys used stratified sampling by groups in multiple phases and, despite having been limited to studying children aged 1 to 4 (27,960 in 1974 and 5,969 in 1989) and adults aged 25 to 64 (94,699 in 1974 and 23,544 in 1989), data were obtained from all people residing in each household. The methods for gathering data on age, sex, weight, height, and per capita family income were similar: birth certificates or equivalent documents were used to determine age, weight and height were measured by someone properly trained using standardized techniques, and the data on family income were obtained through standardized IBGE questionnaires that included all sources of family income.

In order to evaluate the nutritional status of the children, anthropometric indices of weight-for-age and weight-for-height were used and expressed as standard deviation scores (*z*-scores), the standard recommended by the World Health Organization and the United States National Center for Health Statistics (WHO-NCHS System) (*17*). Children whose weight-for-age *z*-scores were less than –2 SD were classified as malnourished, and those whose weight-for-height *z*-scores were above 2 SD were classified as obese. The body mass index (BMI) was used to classify adults. Individuals classified as malnourished had a BMI $< 18.5\ kg/m^2$ (*18*) and those classified as obese had a BMI $> 30.0\ kg/m^2$ (*19*).

The changes in the nutritional status of the Brazilian population were determined by comparing the prevalence and respective standard errors for malnutrition and obesity in the two studies. To evaluate the relative importance of consuming an insufficient or excessive amount of food, the ratio between the prevalence of malnutrition and the prevalence of obesity was used. Children and adults were compared separately, taking into account the total number of the population and the different economic strata to which the individual subjects belonged.

Evaluation of Food Consumption

The data on food consumption analyzed in this study were taken from two surveys on family budgets conducted in the country in the periods 1961–1962 and 1987–1988 (*20, 21*), as well as the ENDEF study cited earlier. The

family budget surveys included a representative sample of households in seven metropolitan areas in the country: Belo Horizonte, Rio de Janeiro, and São Paulo in the southeast; Fortaleza, Salvador, and Recife in the northeast; and Curitiba in the south. Ninety percent of the country's metropolitan population and nearly one-fourth of the entire Brazilian population are concentrated in these seven areas combined. In the period 1961–1962, 7,309 households were studied, and in the period 1987–1988, 13,611 households were studied. The procedures for calculating average daily per capita food consumption in the family were similar in the two family budget surveys. The ENDEF calculation was restricted to families living in the metropolitan areas included in the surveys on family budgets and the average daily per capita consumption of families was estimated directly by weighing the foods that were eaten in each household during seven consecutive days (*22*).

The food pattern corresponding to each of the surveys was described by taking into account the relative participation of the different food groups in the diet and the relative consumption of simple or complex carbohydrates, animal or plant proteins, and animal or plant lipids for every 1,000 kcal. The relative consumption of cholesterol and saturated and polyunsaturated fatty acids was also calculated. The food groups used were: grains and their derivatives (rice, corn flour, wheat flour, bread, pasta, and crackers); roots, tubers, and their derivatives (cassava, cassava flour, and potatoes); meats (beef, goat, and fish); milk and its derivatives (fresh milk, powdered milk, and cheeses); and fruits (oranges and bananas). The translation of the amount of food into nutrients was based on the ENDEF food composition tables (*23*) and on the work on food composition by McCance and Widdowson (*24*).

Given that the family budget studies did not compile data on family incomes, the decision was made to use the regions of the country as substitutes for the population's economic situation. In this sense, in addition to presenting the evolution of food patterns for all the inhabitants of Brazilian metropolitan areas, we present the differentiated evolution of the northeast region, which is the country's least developed region, and the southeast region, which is the most developed.

RESULTS

Nutritional Status of Children and Adults

In the 15-year period from 1974 to 1989, the prevalence of malnourished children aged 1 to 4 fell by more than 60%; the prevalence of childhood obesity, relatively low in the two surveys analyzed, remained unchanged. During the same period, the percentage of malnourished adults also fell considerably, but the percentage of obese adults almost doubled, rising from 5.7% to 9.6%. These changes did not affect gender-related differences: boys and girls showed a similar frequency of malnutrition and obesity, and women surpassed men in both malnutrition and obesity (Tables 1 and 2). The ratio between the prevalence of malnutrition and the prevalence of obesity as an indicator of the relative importance of each problem in the population changed drastically from one survey to the next. The high prevalence of malnutrition in children seen in the period 1974–1975, with more than four malnourished children for every obese child, fell in 1989 to slightly less than two malnourished children for every obese child. This ratio was the inverse for adults: in 1974 malnutrition was 1.5 times higher than obesity, whereas in 1987 obesity was more than 2 times higher than malnutrition.

The data from the 1974–1975 and 1989 surveys indicate that all economic strata experienced a sharp decline in the prevalence of malnutrition in children and slight differences in the prevalence of obesity in children. It should be pointed out that these changes did not affect the strong relationship between per capita family income and the frequency of malnutrition and obesity in children. In both

TABLE 1. Percentage of prevalence and standard deviation (in parentheses) of malnutrition and obesity in children, Brazil, between 1974–1975 and 1989.

	Children aged 1 to 4					
	Malnutrition			Obesity		
	Boys % (s)	Girls % (s)	Total % (s)	Boys % (s)	Girls % (s)	Total % (s)
Years						
1974–1975	20.2 (0.48)	19.3 (0.47)	19.8 (0.33)	4.6 (0.25)	4.6 (0.25)	4.6 (0.17)
1989	7.1 (0.66)	8.2 (0.72)	7.6 (0.48)	3.8 (0.49)	5.3 (0.58)	4.6 (0.38)

surveys, as family income increased, malnutrition declined and obesity increased (Table 3). Once again, what changed from one survey to the next was the relative importance of malnutrition and obesity: in the poorest families (30% of the population with the lowest incomes), the prevalence of malnutrition fell slightly, from 7:1 to 5:1; in middle-income families (40% of the population), the malnutrition/obesity ratio reversed, falling from 2.5:1 to 1:1.3; and in the richest families (30% of the population with the highest incomes), the relative excess of obese children seen in 1974 tripled in 1989, rising from 2.3:1 to 7.6:1.

The percentage of malnourished adults in the 1974–1975 and 1989 surveys in the same levels of per capita family income described above shows a relatively uniform decline in both sexes and indicates that the strong inverse relationship between family income and the prevalence of malnutrition continues. In addition, it indicates the virtual disappearance of the problem in adults in the highest-income segment. In the three segments, we see an increase in the frequency of obesity in both sexes, but this tends to be greater in the poorest families. This characteristic determines important changes in the direct relationship between family income and obesity in adults: although the obesity gradient for men decreases linearly from the high-income strata to the low-income strata, the highest prevalence of obesity in women was seen in the intermediate strata. We can also see that in 1989 poverty ceased to be a factor protecting women from obesity: approximately 10% of the poorest women were obese, while 15.4% of middle-income women and 14.1% of upper-income women were obese. In addition, the greatest increase in the prevalence of obesity is seen precisely among the poorest women (Table 4).

In general, the relationship between malnutrition and obesity changed significantly from one survey to the next and showed an increase in the importance of the problem of obesity among adults in all the economic strata. In the

TABLE 2. Percentage of prevalence and standard deviation (in parentheses) of malnutrition and obesity in adults, Brazil, between 1974–1975 and 1989.

	Adults aged 25 to 64					
	Malnutrition			Obesity		
	Men % (s)	Women % (s)	Total % (s)	Men % (s)	Women % (s)	Total % (s)
Years						
1974–1975	6.8 (0.16)	10.4 (0.19)	8.6 (0.13)	3.1 (0.11)	8.2 (0.17)	5.7 (0.10)
1989	3.4 (0.24)	5.1 (0.28)	4.2 (0.18)	5.9 (0.31)	13.3 (0.44)	9.6 (0.27)

TABLE 3. Percentage and standard deviation of malnourished and obese children, by level of per capita family income, Brazil, 1974–1975 and 1989.

	1974–1975				1989			
	Malnutrition		Obesity		Malnutrition		Obesity	
Income level (% of population)	%	*s*	%	*s*	%	*s*	%	*s*
Low income (30%)	26.5	0.49	3.8	0.21	12.2	0.83	2.5	0.39
Middle income (40%)	11.6	0.49	4.5	0.32	3.8	0.63	4.9	0.71
High income (30%)	3.9	0.44	9.0	0.65	1.4	0.59	10.6	1.54

period 1974–1975, obesity exceeded malnutrition only among high-income adults. In contrast, in 1989 obesity exceeded malnutrition among high- and middle-income men and among women at all income levels. In addition, the data from the latest survey indicate a change in the relationship between family incomes and the body mass index of women.

Food Patterns of the Brazilian Population

The changes in the food patterns observed during the course of the three surveys are similar for the urban population in the southeast and northeast of the country. These changes include decreased consumption of grains and grain derivatives, beans, roots, and tubers, occurring primarily during the 1970s and 1980s; sustained increase in consumption of eggs, and milk and its derivatives; replacement of fat, lard, and butter with plant oils and margarine; and increased consumption of meat, particularly since the second half of the 1970s (Table 5). These changes indicate a generalized tendency to a lower carbohydrate contribution to total caloric intake and to a replacement of carbohydrates with fats, particularly in the 1970s and 1980s. The contribution of proteins to the diet changed very little throughout the period covered by the study (Table 6). Table 7 shows additional information on food consumption trends for the country's urban population. There we can see that sugar represented close to one-fourth of all dietary carbohydrates in the three surveys, with few differences between northeast and southeast. Consumption of animal proteins tended to rise in both regions by 1% to 2% between the 1962 survey and the 1975 survey and by 8% to 10% between the 1975 survey and the 1988 survey. The most important changes are seen in the great increase in the consumption of plant fats and the resulting decline in consumption of animal fats: the plant/animal fats ratio was 4:6 in all the cities studied in the first survey; in the second sur-

TABLE 4. Percentage and standard deviation (in parentheses) of malnourished and obese adults, by level of per capita family income, Brazil, 1974–1975 and 1989.

	Men				Women			
	1974–1975		1989		1974–1975		1989	
Income level (% of population)	Malnutrition % (*s*)	Obesity % (*s*)	Malnutrition % (*s*)	Obesity % (*s*)	Malnutrition % (*s*)	Obesity % (*s*)	Malnutrition % (*s*)	Obesity % (*s*)
Low income (30%)	9.0 (0.37)	0.7 (0.10)	4.8 (0.49)	2.7 (0.37)	16.7 (0.47)	3.6 (0.23)	7.7 (0.60)	9.7 (0.66)
Middle income (40%)	7.2 (0.27)	2.8 (0.17)	3.4 (0.38)	5.5 (0.48)	9.9 (0.30)	9.8 (0.30)	4.6 (0.44)	15.4 (0.75)
High income (30%)	4.1 (0.22)	5.7 (0.26)	1.9 (0.35)	9.3 (0.74)	5.4 (0.24)	10.4 (0.33)	3.2 (0.45)	14.1 (0.88)

TABLE 5. Relative percentage of different food groups in total caloric intake, metropolitan areas of Brazil, 1962, 1975, and 1988.

	Region								
	Southeast			Northeast			Brazil		
Food	1962	1975	1988	1962	1975	1988	1962	1975	1988
Grains and derivatives	37.2	37.9	35.9	34.1	34.8	31.7	36.7	37.8	35.4
Pasta	7.2	8.8	6.2	9.1	9.9	7.7	7.6	8.9	6.4
Roots and tubers	4.0	3.0	2.7	12.8	14.0	11.0	5.6	4.8	4.0
Meat	8.6	8.6	9.4	11.5	10.4	11.1	9.1	8.8	9.6
Eggs	1.1	1.4	1.6	0.5	1.0	1.6	1.0	1.4	1.6
Milk and derivatives	5.5	6.6	8.9	3.1	4.8	6.0	5.1	6.3	8.4
Fruit	3.8	2.2	2.4	3.8	2.1	3.3	3.8	2.1	2.5
Butter	7.9	3.5	1.6	4.6	2.3	1.3	7.2	3.3	1.6
Margarine and oil	8.9	13.6	17.0	4.7	6.1	10.8	8.1	12.3	16.0
Sugar	15.8	14.3	14.3	15.6	14.3	15.7	15.8	14.3	14.5

vey it was 5.5:4.5, and in the third survey it was 4:6. In addition, the decrease in the relative consumption of animal fats in the southeast region is higher between the first and second surveys; in the northeast, the decrease is equally significant throughout the period covered by the three surveys.

Table 8 shows the evolution in the country of certain characteristics of the diet, in comparison with the values recommended by WHO in 1990. First, according to the 1988 survey, the relative consumption of fats in the southeast already exceeded the WHO-recommended maximum value and should be cause for concern as a public health problem. In addition, excessive sugar consumption as seen in the three reference studies and in all areas studied is another cause for concern. The insufficient consumption of complex carbohydrates seen since the 1962 survey in the southeast and in the 1988 survey in the northeast is also a matter of concern. The positive characteristics of the changes include the general increase in the consumption of polyunsaturated fatty acids—to the point of reversing their relationship to saturated fatty acids, and the declining trend in the consumption of dietary cholesterol in the southeast region.

DISCUSSION

As the results show, the problem of excess food consumption in Brazil is quickly replacing the problem of scarcity. Although malnutrition persists, particularly in children of low-income families, it has declined in all age groups and in all socioeconomic strata. The increase in the prevalence of obesity among adults is also present in all socioeconomic strata, with a higher percentage increase in individuals in lower-income families. In the late 1980s, lower-income Brazilian women had a greater tendency to become obese; in contrast, currently we see a higher percentage of

TABLE 6. Relative percentage of participation of carbohydrates, proteins, and lipids in total food consumption, metropolitan areas of Brazil, 1962, 1975, and 1988.

	Carbohydrates			Proteins			Lipids		
Region	1962	1975	1988	1962	1975	1988	1962	1975	1988
Southeast	60.9	60.0	56.4	11.9	12.7	12.8	27.2	27.3	30.8
Northeast	67.4	66.9	62.4	12.2	13.4	13.2	20.4	19.7	24.4
Brazil	62.1	61.2	57.4	11.9	12.8	12.8	26.0	26.0	29.8

TABLE 7. Percentage consumption of nutrients according to origin, metropolitan areas of Brazil, 1962, 1975, and 1988

	Region								
	Southeast			Northeast			Brazil		
Nutrient	1962	1975	1988	1962	1975	1988	1962	1975	1988
Carbohydrates	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Complex	74.0	76.1	74.7	76.8	78.6	74.7	74.5	76.6	74.7
Sugar	26.0	23.9	25.3	23.2	21.4	25.3	25.5	23.4	25.3
Proteins	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Animal	47.8	49.4	57.1	45.6	46.6	56.1	47.8	48.7	56.5
Plant	52.2	50.6	42.9	54.4	53.4	43.9	52.2	51.3	43.5
Lipids	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Animal	60.0	43.2	37.9	64.3	54.4	45.0	60.7	45.4	39.3
Plant	40.0	56.8	62.1	35.7	45.6	55.0	39.3	54.6	60.7

obesity in the middle-income segment than in the high-income segment.

The comparison of the three household surveys over the course of a 26-year period reveals important changes in the composition of the diet in the country's urban population. While carbohydrates make a smaller contribution to total caloric intake and are replaced by fats, with a higher relative participation of plant fats, the participation of proteins in the customary diet is practically unchanged. It should also be noted that there is no evidence that total energy consumption has declined and become inadequate during the period covered by the study. On the contrary, the sustained increases in the relative consumption of animal products (which are the foods most valued and with higher relative cost) indicate a favorable evolution of sufficient caloric intake during the period. Animal products (meat, eggs, and milk and its derivatives) represented 15.7%, 16.5%, and 19.6%, respectively, of total dietary calories in the surveys of 1962, 1975, and 1988.

The results presented provide information on the nutritional transition in Brazil, something that is difficult to find in the developing countries either because surveys on nutrition are conducted in low-income population groups or because they are limited to the preschool child population. In general, representative samples of the national scene are very rarely studied. As a result, the only obvious pattern observed in many countries is the decline in malnutrition (*25*).

Although the nutritional transition in Brazil is similar to that of China (*26–28*), it differs mainly in that the increase in obesity among adults is higher in low-income groups in Brazil rather than in middle- or upper-income

TABLE 8. Relative percentage of selected nutrients in total caloric intake, metropolitan areas of Brazil, 1962, 1975, and 1988.

	Region									WHO-recommended
	Southeast			Northeast			Brazil			
Nutrients	1962	1975	1988	1962	1975	1988	1962	1975	1988	value
Lipids	27.2	27.3	30.8	20.4	19.7	24.4	26.0	26.0	29.8	15% to 30%
Saturated fats	7.7	6.9	7.4	5.3	4.9	5.8	7.3	6.6	7.0	0% to 10%
Polyunsaturated fats	6.5	8.4	10.0	3.8	4.2	6.3	6.0	7.7	8.8	3% to 7%
Cholesterol	205.9	166.0	165.2	154.9	128.2	147.7	195.7	158.5	160.8	0 to 300 mg/day
Carbohydrates	60.9	60.0	56.4	67.4	66.9	62.4	62.1	61.2	57.4	55% to 75%
Complex	45.1	45.7	42.1	51.8	52.6	46.6	46.4	46.9	42.9	50% to 70%
Sugar	15.8	14.3	14.3	15.6	14.3	15.8	15.8	14.3	14.5	0% to 10%
Proteins	11.8	12.7	12.8	12.2	13.4	13.2	11.9	12.8	12.8	10% to 15%

groups as in China. Another difference is the increased malnutrition in the low-income rural population, which is seen only in China, and is surprising given the history of both countries in terms of social equity. The principal difference between the two countries' food patterns is the increased energy density in the diet that occurred in China, but not in Brazil, as a result of increased consumption of animal fats.

The results of this study indicate that the decline in malnutrition among children in Brazil between 1974 and 1989 could be attributed to a moderate increase in family incomes coupled with the exceptional expansion of public health, sanitation, and education services, and a favorable demographic situation characterized by rapid urbanization of the country and a sharp decline in fertility rates (*29*). The same factors could explain, at least in part, the decline in malnutrition among adults.

The trend noted in Brazil to consume fewer grains and tubers, to replace carbohydrates with lipids, and to choose plant proteins rather than animal proteins was already seen in earlier decades in various developed countries (*30*) and more recently in developing countries (*1*). In the developed countries, the changes were associated with increases in obesity and various non-communicable chronic diseases (*2–4*). In particular, the increase in the prevalence of obesity in the United States between 1910 and 1976 coincided with the increase in the relative percentage of fats in the diet and was independent of the increase in total caloric intake (*31*). In Brazil, while the relative energy consumption of fat and lard fell from 4.9% to 1.0% between the first and third surveys, the relative energy consumption of oils rose from 7.7% to 13.5%. The replacement of butter by margarine was also important, as butter consumption fell from 2.2% to 0.6% and margarine consumption rose from 0.4% to 2.5% in the same period.

The changes in the composition of lipid intake are important because they produce a considerable increase in the relative consumption of polyunsaturated fatty acids and a more favorable ratio between these acids and saturated fatty acids. The situation allows us to infer the existence of beneficial effects on the incidence of some non-communicable chronic diseases, particularly arteriosclerosis (*32*). The magnitude of the change in the polyunsaturated fatty acid/saturated fatty acid ratio seems to have been so great that it would not be unreasonable to cite it as a factor in the decline in mortality due to cardiovascular diseases seen in cities like Belém, Curitiba, Fortaleza, São Paulo, and Salvador (*33*).

The major gap in the information on the determinants of energy balance relates to the population's patterns of physical activity, which are very important in explaining the increase in obesity. For example, in China it was shown that the increase in obesity, which coincided with the country's development and modernization, was directly related to great changes in workers' physical activity (*5, 27*). In Brazil, the progressive decline in the population engaged in agriculture and livestock activities, the automation of the manufacturing sector, and the expansion of the service sector, in which activities that do not require a high expenditure of energy predominate, indicate that a similar phenomenon could occur.

The nutritional transition in Brazil has important repercussions for the formulation of priorities and action strategies in the field of public health. The principal priorities should include the definitive inclusion of prevention and control of non-communicable chronic diseases in the national public health agenda, a firm commitment to make educational activities on food and nutrition effectively reach all socioeconomic strata, and the responsibility of government institutions to actively promote the supply of healthy foods and access to them.

The favorable changes seen in the Brazilian population's diet do not seem to be the result of the population's becoming aware of the health benefits of a healthy diet, as occurs in some developed countries (*19, 30,*

34). This assumption is based on the absence of promotion and education campaigns to improve access to and consumption of foods in the country and on the fact that changes in food patterns began in the 1960s and 1970s, when the Brazilian population was still ignorant of the relationship between diet and personal health.

The principal factor explaining the replacement of grains, beans, and tubers by plant oils and the predominance of plant oils over animal oils would be the behavior of the food supply and relative food prices. In this respect, the data on the domestic availability of foods in Brazil indicate that access to such products as rice, beans, and wheat stagnated or diminished during the 1970s and 1980s, while the supply and price accessibility of soy increased considerably (*35*). On the other hand, the data from a historical series on food price variations in the city of São Paulo show that between 1962 and 1975 the relative price of beans, and grains and grain derivatives increased and the price of milk and eggs decreased (*36*).

Finally, the problem of malnutrition continues to exist in the country although, unlike obesity, it affects smaller groups of the population. For this reason, malnutrition prevention and control programs should be established that define their beneficiaries carefully and make them the target of measures that have proven to be effective.

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EPIDEMIOLOGIC AND DEMOGRAPHIC TRANSITION: A TYPOLOGY OF LATIN AMERICAN AND CARIBBEAN COUNTRIES

Jorge Bacallao[1]

Over the last two decades, the health and demographic profiles of many low-income countries have been changing gradually, though not always at the same pace or time. In some Latin American and Caribbean nations, various forms and degrees of undernutrition have been coexisting with obesity and overweight. This article provides a short, descriptive meta-analysis of the reports contained in the multicenter project, "Diet and Health in Latin America and the Caribbean" (*1*), and in *Health Conditions in the Americas*, *1994 edition*, published by the Pan American Health Organization (PAHO) (*2*). The exploratory and confirmatory data analysis of epidemiologic, demographic, and nutritional variables has yielded three clusters of countries differing in population composition and growth and in the pace of the transition from one health profile to another.

This article builds on an exploratory paper (*3*) that was the basis of a presentation at a workshop on obesity and poverty held in Havana, Cuba, in May, 1995 (*4*). That paper also was based on country reports contained in "Diet and Health in Latin America and the Caribbean" (*1*). Countries were grouped into clusters exclusively on the basis of the relative contribution of infectious diseases, chronic non-communicable diseases, and other external causes to the overall mortality rate. The classificatory axes were generated by correspondence analysis (*5*), which yields a simultaneous representation of countries and factors of the mortality profile in the plane defined by the factorial axes. Five relatively compact clusters of countries were reported. The first cluster was composed of most of the English-speaking Caribbean countries and by Costa Rica, Puerto Rico, and Panama, all of which are small countries experiencing a fast decrease in population growth and a clear increase in chronic non-communicable diseases. The second cluster included Cuba, Chile, and, less typically, Argentina, which has a very similar epidemiologic profile to the first cluster, but in which the transition started earlier and proceeded more slowly. The third cluster included Peru, Honduras, and Guatemala, all of which have a high prevalence of infectious diseases, a high percentage of population under 15 years of age, and high rates of malnutrition and infant mortality. Brazil and Venezuela, large countries with intermediate values in the mortality and morbidity indicators, formed the fourth cluster. The fifth clus-

[1]Instituto Superior de Ciencias Médicas de La Habana, Havana, Cuba.

ter included Colombia and three of the poorest English-speaking Caribbean countries—Guyana, Belize, and Dominica—all with similar high mortality rates due to accidents and violence.

In this article, new variables have been added. Some were used to obtain the classificatory axes and to build the typology, and others to test its consistency and to screen associative hypotheses. The typology generated by this study provides empirical support for Omran's theoretical model of transition (*6*), and particularly for the "prolonged polarized model" proposed by Frenk et al. (*7*).

PROCEDURES

The starting point for this study is a data matrix whose rows are the countries in Box 1 and whose columns are the variables in Box 2. Of the English-speaking Caribbean countries, only Jamaica, Trinidad and Tobago, and Barbados were included. The information on the rest of the Caribbean countries and Bolivia was inadequate to perform the analysis described in the following paragraph.

A principal components analysis (*8*) was done on the correlation matrix defined by the following variables reported by the different countries around 1990: fertility rate, life expectancy, daily energy intake, and mortality from communicable diseases, cancer, cardiovascular diseases, and external causes of death. The last four variables were expressed as percentages and measure the relative contribution of each cause of death to overall mortality.

The first two axes, which explained more than 70% of the overall variance, were used to build a typology based on the *k*-means clustering algorithm (*9*). Among the variable options for *k*, the one with three clusters was chosen because it was the most interpretable and consistent with previous results (*1*, *2*, *6*, *7*). Mexico and Paraguay were atypical and, therefore, were not assigned to any cluster. The remaining variables were used to characterize the clusters and to interpret the results.

BOX 1. Countries included in the study.

Caribbean
- Barbados
- Cuba
- Dominican Republic
- Jamaica
- Puerto Rico
- Trinidad and Tobago

Central America
- Costa Rica
- El Salvador
- Guatemala
- Honduras
- Nicaragua
- Panama

North America
- Mexico

South America
- Argentina
- Brazil
- Chile
- Colombia
- Ecuador
- Paraguay
- Peru
- Uruguay
- Venezuela

RESULTS

Table 1 shows the coordinates of the latent vectors that define the first two factorial axes, together with their explained relative variances. On the negative side of this first axis (which explains close to 60% of the total variance) are the countries with high fertility rates and high mortality rates for infectious diseases and for external causes. On the positive side are the countries with high mortality rates for

BOX 2. Variables included in the study.

Demographic
- Fertility rates (1950, 1970, 1990)
- Life expectancy (1950, 1970, 1990)
- Birth rate[a]
- General mortality rate[a]
- Median age of the population[a]
- Percentage of urban population[a]
- Percentage of economically active population
- Percentage of the population 15 years of age or less (1950, 1990)
- Percentage of the population 65 years of age or more (1950, 1990)

Epidemiologic
- Infant mortality rate[a]
- Maternal mortality rate[a]
- Mortality rate for infectious diseases[a]
- Mortality rate for cancer (men and women)[a]
- Mortality rate for cancer in the population over 65 years of age (1960, 1990)
- Mortality rate for cardiovascular diseases (men and women)[a]
- Mortality rate for cardiovascular diseases in the population over 65 years of age (1960, 1990)
- Mortality rate for external causes (accidents and violent deaths) (men and women)[a]
- Mortality rate for external causes in the population over 65 years of age (1960 and 1990)
- Prevalence of low weight-for-age in children under 5 years of age[a]

Dietary intake
- Daily energy intake (1970, 1990)
- Daily protein intake[a]

Other variables
- Health expenditure as percentage of the gross national product[a]
- Annual per capita health expenditure[a]

[a]For each country, the indicator corresponds to the year closest to 1994 in the period 1990–1994. All rates are adjusted.

chronic non-communicable diseases and with the highest life expectancies. The second axis is practically dominated by cardiovascular diseases. Among countries in a late stage of epidemiologic transition, this axis separates those in which the predominance of cardiovascular diseases over cancer is more marked. There is a striking coincidence between the classification yielded by this axis and the distinction between the rapid and intermediate transition models identified by Omran (*6*).

The typology yielded by the clustering algorithm applied to the countries referred to the factorial axes is shown in Box 3. Cluster 1 is composed of small countries (Costa Rica, Panama, Uruguay, and several Caribbean islands). Ecuador, Peru, and the poorest countries in Central America are grouped in cluster 2, which corresponds to Omran's "slow" model (*6*). The third cluster is composed of four large South American countries (Argentina, Brazil, Colombia, and Venezuela), the Dominican Republic, and Trinidad and Tobago. Mexico and Paraguay are outliers within this taxonomy because of their extreme positions on the second axis: mortality due to car-

TABLE 1. Parameters of the first two factorial axes (principal components).

Variables[a]	Components I	II
FER	–.89	–.20
LE	.84	.43
ENER	.77	.25
INF	–.81	.11
CAN	.76	.03
CV	.59	–.74
EXT	–.65	.34
% of variance explained	58.4	13.8

[a] For each country, the indicator corresponds to 1990.
FER: fertility rate
LE: life expectancy
ENER: daily energy intake
INF: % mortality from infectious diseases
CAN: % mortality from cancer
CV: % mortality from cardiovascular diseases
EXT: % mortality from external causes (violence and accidents)

diovascular diseases is relatively too low in Mexico and relatively too high in Paraguay.

Table 2 contains descriptive statistics of each variable in the three clusters. For nearly all variables, countries in cluster 1 fit the patterns of the so-called "rapid non-Western" model; countries in cluster 2, the patterns of the "slow" model; and countries in cluster 3, the patterns of the "high or low intermediate" model (*6*).

BOX 3. Typology of Latin American and Caribbean countries.

Cluster 1
- Barbados
- Chile
- Costa Rica
- Cuba
- Jamaica
- Panama
- Puerto Rico
- Uruguay

Cluster 2
- Ecuador
- El Salvador
- Guatemala
- Honduras
- Nicaragua
- Peru

Cluster 3
- Argentina
- Brazil
- Colombia
- Dominican Republic
- Trinidad and Tobago
- Venezuela

Countries not classified
- Mexico
- Paraguay

A CHARACTERIZATION OF THE TYPOLOGY

Demographic Indicators

Since 1950, the countries in cluster 1 have had the lowest fertility rates; the highest rates correspond to cluster 2. The trend toward decreasing fertility rates has been more or less similar in all three clusters, though slightly faster in cluster 2 during the last decade. This suggests that the countries in cluster 1 entered the transition period earlier, not that they progressed through it faster.

Also since 1950, life expectancy has been highest for countries in cluster 1 and lowest for those in cluster 2. The difference between these two extreme groups tends to decrease evenly (15 years in the 1950s, 13 years in the 1970s, and 8 years in the 1990s). Growth rates in clusters 1 and 3 are nearly equal and much lower than in cluster 2. The overall mortality rate is very similar in clusters 1 and 3 and slightly higher in cluster 2. The population in cluster 1 has the highest median age; the population in cluster 2 has the lowest. The average difference is 3 years between clusters 1 and 3, and 8 years between clusters 1 and 2.

Cluster 2 has the lowest percentages of urban population and economically active population. The highest percentages of urban population are found in cluster 3 (Argentina, Brazil,

TABLE 2. Means and standard deviations (in parentheses) by clusters.

Variables	Clusters 1	2	3
Demographic			
Fertility (children per woman) (1950)	4.78 (1.12)	6.96 (0.32)	5.54 (1.49)
Fertility (children per woman) (1970)	3.77 (0.89)	6.46 (0.54)	4.43 (0.94)
Fertility (children per woman) (1990)	2.40 (0.47)	4.43 (0.78)	2.90 (0.27)
Life expectancy (years at birth) (1950)	58.90 (4.4)	44.10 (2.5)	53.90 (5.9)
Life expectancy (years at birth) (1970)	68.50 (2.7)	56.10 (2.2)	62.40 (3.3)
Life expectancy (years at birth) (1990)	74.20 (1.7)	65.80 (0.9)	69.30 (2.1)
Birth rate (per 1,000 population)[a]	20.60 (3.9)	34.80 (4.8)	24.20 (2.7)
General mortality rate (per 1,000 population)[a]	6.80 (2.1)	7.20 (0.4)	6.60 (1.2)
Median age of population (years)[a]	27.20 (3.3)	19.10 (2.1)	24.10 (2.1)
% of urban population[a]	66.90 (16.9)	55.30 (11.8)	77.00 (11.2)
% of economically active population[a]	44.60 (9.9)	38.70 (3.0)	38.80 (5.4)
% of population ≤ 15 years (1950)	39.20 (4.3)	43.20 (1.3)	40.40 (4.9)
% of population ≤ 15 years (1990)	29.80 (5.1)	41.10 (4.2)	33.60 (3.7)
% of population ≥ 65 years (1950)	4.20 (0.8)	3.10 (0.9)	3.20 (0.9)
% of population ≥ 65 years (1990)	7.00 (2.7)	3.70 (0.4)	5.40 (2.2)
Epidemiologic			
Infant mortality rate (per 1,000 live births)[a]	14.50 (3.2)	59.80 (16.6)	36.80 (19.4)
Maternal mortality rate[a, b]	45.80 (30.8)	170.00 (48.2)	88.50 (42.4)
Mortality from infectious diseases[b]	53.30 (7.9)	137.90 (8.6)	91.40 (24.5)
Mortality from cancer (men)[a, b]	116.00 (33.8)	90.30 (23.0)	103.60 (18.2)
Mortality from cancer (women)[a, b]	106.70 (24.5)	124.70 (12.2)	106.40 (7.9)
Mortality from cancer > 65 years[b] (1960)	1244.00 (341)	664.00 (202)	1197.00 (375)
Mortality from cancer > 65 years[b] (1990)	1294.00 (294)	760.00 (302)	1037.00 (170)
Mortality from cardiovascular diseases (men)[a, b]	211.90 (37.1)	173.60 (28.1)	267.00 (30.7)
Mortality from cardiovascular diseases (women)[a, b]	205.70 (30.8)	176.30 (93.9)	280.80 (28.0)
Mortality from cardiovascular diseases > 65 years[b] (1960)	3288.00 (477)	1694.00 (548)	3077.00 (1061)
Mortality from cardiovascular diseases > 65 years[b] (1990)	2663.00 (331)	2161.00 (341)	3226.00 (304)
Mortality from external causes (men)[a, b]	91.40 (26.0)	168.00 (67.0)	132.80 (61.7)
Mortality from external causes (women)[a, b]	28.70 (9.5)	41.80 (9.3)	35.00 (7.1)
Mortality from external causes > 65 years[b] (1960)	182.40 (64.6)	258.70 (45.9)	188.30 (45.1)
Mortality from external causes > 65 years[b] (1990)	197.00 (75.8)	333.70 (120.4)	228.50 (47.2)
% of children < 5 years with low weight-for-age[a]	8.20 (4.4)	20.70 (11.4)	9.00 (2.8)
Dietary intake			
Daily energy intake (kcal) (1970)	2702.00 (226)	2219.00 (39)	2644.00 (326)
Daily energy intake (kcal) (1990)	2738.00 (321)	2224.00 (116)	2595.00 (271)
Daily protein intake (g)[a]	76.90 (12.9)	57.70 (3.6)	68.30 (17.3)
Other variables			
Health expenditure as a percentage of the gross national product[a]	4.80 (3.5)	4.80 (1.3)	5.80 (2.0)
Annual per capita health expenditure (US$)[a]	114.80 (18.2)	45.60 (18.8)	166.50 (14.4)
First principal component[c]	0.82 (0.49)	–1.35 (0.53)	0.29 (0.47)
Second principal component[d]	0.60 (0.63)	0.11 (0.66)	–0.83 (0.33)

[a]For each country, the indicator corresponds to the year closest to 1994 in the period 1990–1994.
[b]Per 100,000 population.
[c]Factor scores on the first component of a principal components analysis.
[d]Factor scores on the second component of a principal components analysis.

Colombia, and Venezuela) and the highest percentages of economically active population are found in cluster 1.

Since at least the 1950s, cluster 1 has had the lowest proportion of population under 15 years of age and the highest proportion above 65 years of age. Differences among clusters with respect to these proportions have increased.

Epidemiologic Indicators

Infant and maternal mortality rates show the expected trends: they are low in cluster 1, high in

cluster 2, and intermediate in cluster 3. Rates in cluster 3 are more than double those in cluster 1.

The highest mortality rates for cancer occur in cluster 1 for men, and in cluster 2 for women. In the population over 65 years of age, cancer mortality has remained virtually constant over the last 30 years in cluster 1, has decreased in cluster 3, and has increased in cluster 2.

Mortality rates for cardiovascular diseases are considerably higher in cluster 3 than in cluster 1 for both men and women. Clusters 1 and 3 have had opposite trends in mortality rates for cardiovascular diseases in the population over 65 years of age during the last three decades: countries in cluster 1 have experienced a clear decrease, while countries in clusters 2 and 3 have had a notable increase. This polarization of clusters 1 and 3 with respect to the two most frequent causes of death by chronic non-communicable diseases is consistent with Omran's contention of an accelerated transition model for countries in cluster 1, which resembles the classic model of transition in the United States and Canada (*6*).

In the population over 65 years of age, the mortality rate for infectious diseases tends to decrease in the three clusters, but at a faster rate in cluster 2, which is in a belated stage of transition.

Mortality rates for external causes (which include accidents and violent deaths) show the same pattern for both men and women: cluster 2 has the highest rates and cluster 1 the lowest. Differences are greater in men, as expected. Mortality rates for external causes are increasing steadily in the three clusters.

The percentage of children under 5 years of age with low weight-for-age is twice as large in cluster 2 than in clusters 1 and 3, which are very similar. There is no reliable information about the prevalence of obesity. Almost all the available data are based on a few low-coverage studies.

Indicators of Dietary Intake

There is insufficient information to compare either the present diet composition or its trends among the three clusters. The only dietary information available deals with protein-energy intake. Daily protein intake is greater in cluster 1 than in cluster 3, despite the fact that the country with the greatest intake—Argentina—is in cluster 3. The same relation is observed in energy intake between 1970 and 1990. However, it is interesting to note that energy intake has been practically constant in cluster 1 countries and has fallen in cluster 3 countries. It is not possible to relate this fact to any epidemiologic event, since the source of the changes in the energy intake is unknown.

Other Indicators and Compound Variables

The countries in cluster 3 devote the highest percentage of gross national product to public health expenditure. The countries in this cluster also have the highest annual per capita health expenditure. These statistics suggest that the health systems of the countries in this cluster are less efficient than those in cluster 1. However, their relation to the epidemiologic indicators is difficult to interpret because of such confounding variables as health services costs, the proportion of services that are public or private, and the costs of the rest of the services not directly related to public health.

Factor 1[2] separates cluster 2 from clusters 1 and 3, and factor 2 separates cluster 1 from cluster 3. The discriminatory capacity of factor 1 is due to high or low mortality from infectious diseases, while the discriminatory capacity of factor 2 is due to the relative prevalence of cardiovascular diseases among chronic non-communicable diseases. When countries are referred to the system of axes defined by these factors, their relative positions are strikingly coincident with the classification derived from Omran's transitional models (*6*).

[2] The terms factor and component are used interchangeably throughout this article. Factors 1 and 2 are meant to designate scores on the first and second components, respectively.

CONCLUSIONS

The approach adopted in this article is subject to the well-known limitations of exploratory studies: no hypotheses are verified and no relations are set forth that could be generalized or extrapolated to other contexts. Another limitation, due to the study subject, is that descriptions at the country level mask the country's great internal heterogeneity and inequities, which are some of the characteristic features of the epidemiologic transition in the Region (*7*).

The inductive, exploratory-confirmatory approach (*9, 10*), starting from available and well-known sources of information (*4*), confirms or suggests the following conclusions:

- A transition that affects demographic composition and epidemiologic profiles is under way. The appropriateness of the term transition—which has already been criticized by several authors (*7, 11*)—is arguable, because it implies the substitution of certain essential characteristics with other characteristics. The Region is showing clear signs of coexistence of morbidity and mortality traits, which are predominant in different stages of the classic model. This enforces the theory of prolonged transition and epidemiologic polarization proposed by several authors (*1, 7, 11*).
- The process of change is not uniform throughout the Region. Certain uniformity exists, however, when the countries are stratified according to natural modes of classification suggested inductively by the indicators that define the demographic and epidemiologic change. The resulting typology is consistent with theoretical models that have been used to typify the changes (*6*).
- The metric procedure that yields the typology does not make any previous assumption, even when the typology itself is closely related to the size of the countries, their geographic situation, and several macroeconomic indicators of development. This typology could be used as the basis for a Regional strategy to address the challenge of the epidemiologic transition.
- Countries in different clusters experience epidemiologic changes at different paces and times. For instance, since the 1970s, the countries' demographic and epidemiologic profiles would have yielded essentially the same typology. Order relations among groups with respect to the majority of the indicators have remained virtually unchanged for at least the last 20 years. In the 1970s, and probably much earlier, countries in cluster 1 were undergoing a faster transition process. However, during the past decade there has been a faster relative decrease in the demographic indicators (birth and fertility rates) and a faster relative increase in mortality by chronic non-communicable diseases in the countries of cluster 2 than in the countries of the other clusters.
- Among the countries that are more advanced in the process of epidemiologic and demographic change (cluster 1), some have experienced a reduction in the mortality rates for cardiovascular diseases. The mortality rates for different forms of cancer have been stable or have increased slightly (cluster 1), yet other mortality rates have shown the opposite trend, particularly the striking increase in cardiovascular disease mortality (cluster 3). This finding is consistent with the models proposed by Omran (*6*), and could suggest that the countries in cluster 1 have entered the stage of lifestyle modification and decreasing cardiovascular disease mortality, or that the reduction in mortality is due to lifestyle modification (*7*).
- Despite its limitations, the present approach could be used at national or subnational levels to reveal similarities or differences among regions within a country, which could be useful in planning and designing intervention strategies.

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Methodologic Aspects for Studying Obesity from a Public Health Perspective

ISSUES FOR PUBLIC HEALTH SURVEILLANCE OF OBESITY: PREVALENCE, INCIDENCE, AND SECULAR TRENDS

David F. Williamson[1]

Although obesity[2] has been considered a clinical problem for many centuries (*1*), only recently has it gained recognition as a public health problem. This is because the conditions necessary for obesity to become common in human populations are of relatively recent origin. These conditions include a sedentary lifestyle, wide availability of inexpensive and highly palatable energy-dense foods, and a low risk of infectious, wasting diseases. Such conditions have led to marked increases in the prevalence of obesity in a number of countries, including the United States (*2*) and Brazil (*3*).

In addition to being an increasingly prevalent condition, obesity is a public health problem because of the health care costs associated with it. It has been estimated that in the United States, obesity is responsible for as much as 8% of total health care costs (*4*). Obesity is also a public health problem because it is an etiologic risk factor for a number of other chronic debilitating conditions that are also of major public health importance, including diabetes mellitus, coronary heart disease, osteoarthritis, and some cancers (*5*).

Ongoing systematic collection, analysis, and interpretation of obesity-related data for use in the planning, implementation, and evaluation of public health programs and policies are essential for the development of a rational public health approach to obesity prevention and control. This process of using objective data to inform decision-making is defined as public health surveillance (*6*). Although the idea of public health surveillance has long since evolved away from surveillance of persons with disease to surveillance of data on disease, public health surveillance continues to focus most heavily on infectious diseases. Surveillance of chronic health conditions, such as obesity, is much less developed in public health. This is because changes in the occurrence of chronic conditions take place much more slowly than in infectious diseases, the impact of chronic conditions on morbidity and mortality occurs over a much longer period of time, and prevention and control methods for chronic conditions often are viewed as less efficacious and more logistically complicated than methods of infectious disease control. Nevertheless, without an organized and systematic approach to obesity surveillance we

[1]United States Centers for Disease Control and Prevention, Division of Diabetes Translation, Atlanta, Georgia, United States of America.

[2]This article uses the term "obesity" throughout, rather than "overweight," even when referring to studies that have measured only height and weight.

will not be able to answer such critical questions as: What proportion of the population is currently obese? Is this proportion changing? If so, why is it changing? and, in which population groups has the proportion of obese persons changed the most?

This article develops the basic measures of disease occurrence that are essential to public health surveillance of obesity.

EPIDEMIOLOGIC MEASURES TO STUDY DISEASE OCCURRENCE

Epidemiology uses three basic measures to study the occurrence of disease (*7*):

- **Prevalence.** Prevalence is the proportion of a population that has a condition at a given point in time. Prevalence can range in value from 0 to 1 (0% to 100%), is unitless, and can be estimated from cross-sectional data. Synonyms for prevalence are "point prevalence" and "prevalence rate."
- **Cumulative incidence.** Cumulative incidence is the proportion of a population that converts from non-diseased to diseased during a specific period of time. Cumulative incidence can range in value from 0 to 1 (0% to 100%), is unitless, and can be estimated only from longitudinal data. A synonym for a cumulative incidence is "risk."
- **Incidence density.** Incidence density is the instantaneous rate of disease occurrence. Incidence density can range in value from 0 to 4, is expressed in units of time minus one, and can be estimated only from longitudinal data. Synonyms for incidence density are "incidence rate," "hazard rate," and "force of morbidity."

When studying the occurrence of diseases and conditions that develop over extended periods of time, such as obesity, epidemiologists generally consider incidence density to be the best measure of disease occurrence because it takes into account not only the number of individuals in the population that develop the condition, but also the time periods during which they are afflicted by the condition during the observation period (follow-up time).

COMPARING THE TWO MEASURES OF INCIDENCE

Prevalence is a very limited measure of disease occurrence because it does not differentiate between the occurrence of a condition and survival with the condition. What is less obvious is why cumulative incidence is inferior to incidence density as a measure of disease occurrence. As an example, consider two hypothetical populations with four persons each that are followed prospectively from birth until each member of the population becomes obese. In Population 1, the four people become obese at 40, 43, 45, and 45 years of age. In Population 2, the four people become obese at ages 3, 7, 30, and 33. At the instant that a person becomes obese, their age is recorded so their follow-up time can be computed. If we ignore the information on follow-up time, we can compute the cumulative incidence of obesity (hereafter referred to as the risk) in each population. In this example, everyone ultimately became obese, hence the risk of obesity in both populations is identical—1 or 100%. This is misleading, however, because Population 2 became obese much more quickly (i.e., at an earlier age) than Population 1. If we now take into account each person's follow-up time, we can compute the incidence density of obesity (hereafter referred to as the rate) for each population. This is done by dividing the number of persons who became obese by the sum of the time periods during which all members of the population were observed. In Population 1, the rate of obesity is $4 \div (40 + 43 + 45 + 45 \text{ years}) = 4/173 \text{ years} = 0.023 \text{ years}^{-1}$. Similarly, the rate of obesity in Population 2 is computed as 0.055 years^{-1}. These results indicate that the obesity rate in Population 2 is more than twice that of Population 1.

Because the units of the rate are the inverse of time (years^{-1} or "per year"), its interpretation may not be entirely clear. However, one can think of the rate of obesity as the inverse of the average "waiting time" until a person becomes obese (*8*). For example, if we take the inverse of the two rates in Figure 1, we see that for Population 1 the average waiting time until obesity onset was 43.3 years, compared to only 18.3 years for Population 2.

THE RELATIONSHIP OF PREVALENCE TO INCIDENCE RATE

Prevalence has a formal mathematical relationship to the incidence rate. Consider a total population of obese and non-obese persons of size N, within which there are two "prevalence pools" of obese and non-obese persons of size P and N – P, respectively (Figure 2) (*7*). In this population, there is an underlying incidence rate of obesity, I. During any time interval, Δt, the number of non-obese persons who enter the obesity prevalence pool (inflow) is equal to $I \times \Delta t \times (N - P)$. At the same time, the outflow from the obesity prevalence pool is equal to $I' \times \Delta t \times P$, where I′ is the incidence rate of non-obesity (i.e., the rate at which obese persons leave the obesity prevalence pool because of weight loss or death). As mentioned previously, the inverse of an incidence rate is equivalent to the mean waiting time until the occurrence of a disease or condition. In the case of I′, the rate of becoming non-obese, the inverse $(1 \div I')$, is the mean duration of obesity, or D. Thus, $I' = 1 \div D$.

Prevalence, incidence rate, and duration have an exact relationship when the inflow and outflow from the obesity prevalence pool are equal. In order to equate the inflow and outflow from the obesity prevalence pool we must assume that during the observation period the size of the population is in a steady state (i.e., the total number of births plus immigration is equal to the total number of deaths plus emigration) and that both the prevalence and incidence rate remain constant

FIGURE 1. A hypothetical comparison of two populations with equal risks of obesity but different rates of obesity.

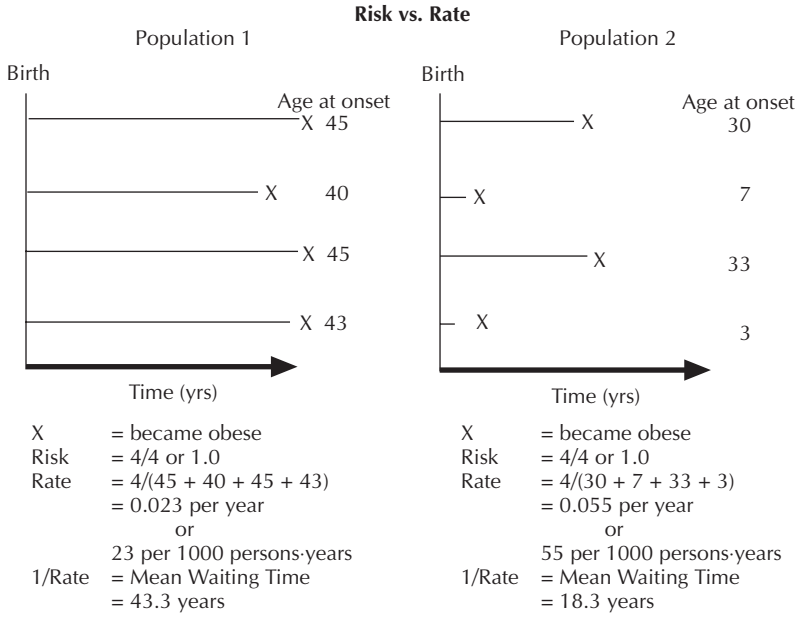
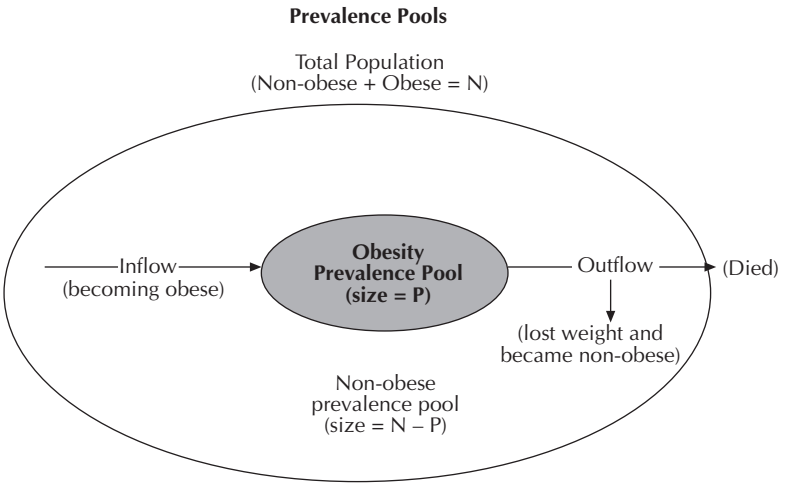


FIGURE 2. The interrelationship between obese and non-obese prevalence pools.



(These assumptions are likely to hold reasonably well for populations that are observed for only a few years.) (*7*, *8*).

$$\text{Inflow} = \text{Outflow}$$
$$\text{or}$$
$$I \times \Delta t \times (N - P) = (1/D) \times \Delta t \times P$$
$$I \times D = P/(N - P)$$

If we divide the right hand side of the equation by N (total population), we convert the absolute number of obese persons into the proportion of the population that is obese, P* (i.e., the prevalence of obesity). Thus,

$$I \times D = (P/N)/((N/N) - (P/N))$$
$$I \times D = P^*/(1 - P^*)$$
$$P^* = (I \times D)/(1 + I \times D)$$

Thus, the prevalence of a condition is directly related to the incidence rate of the condition and the mean duration of the condition. Knowledge of any two of the components in the prevalence equation will allow calculation of the third component.

ESTIMATING THE INCIDENCE RATE AND MEAN DURATION OF OBESITY

In practice, unfortunately, it is not feasible to directly estimate the incidence rate of obesity from a longitudinal sample of the free-living population. This is because each person's body weight must be recorded frequently enough so that the time of the first onset of obesity is accurately known. In addition, it is likely that by being enrolled in a study that closely monitors body weight participants will achieve better weight control than members of the general population; this could lead to a substantially biased underestimate of the true obesity incidence rate. For analogous reasons it is unlikely that the mean duration of obesity in a population could be directly and accurately estimated in a longitudinal study.

There appear to be no published estimates of the mean duration of obesity, and only one published estimate of the incidence rate of obesity (*9*). This estimate was made on a cohort of persons with insulin-dependent diabetes mellitus who were enrolled in a 10-year

randomized controlled trial for the prevention of microvascular complications of diabetes. Based on quarterly weighings over the duration of the trial, the authors estimated that the incidence rate of overweight (men: > 27.8 kg / m^2, women: > 27.3 kg / m^2) was 5.0 per 100 person-years in the control group, and 8.7 per 100 person-years in the treatment group.

It may be possible, however, to estimate the mean duration of obesity from cross-sectional data. It has been shown mathematically that the mean duration of an illness for incident cases can be estimated from the reported "durations-to-date" in a representative series of prevalent cases (*8, 9*). For many illnesses that have an acute onset, such as chicken pox or flu, it is possible to get quite accurate reports of date of onset from the patients. For such a slowly developing condition as obesity, however, it may be more problematic for obese persons to recall when they first became obese. Although several studies have demonstrated that recall of past body weight is generally quite accurate (*11–15*), no effort has been devoted to developing recall methods to estimate the durations-to-date of obesity.

ESTIMATING THE CUMULATIVE INCIDENCE OF OBESITY

Cumulative incidence or risk of obesity can be estimated directly from longitudinal studies of the general population. In order to estimate the risk of obesity, a cohort of non-obese persons is weighed at the beginning of the observation period (risk period) and reweighed after a fixed period of time. The risk is calculated by dividing the number who are obese at the end of the risk period by the total number of persons in the cohort. Some of the few published estimates of the cumulative incidence of obesity (*16–18*) were recently reviewed.

It is often difficult to compare estimates of the cumulative incidence of obesity across studies because of differences in definitions of obesity and the lengths of the risk periods. Studies with longer risk periods are likely to have higher risks of obesity because participants have more time to gain weight and cross the cut-off to become classified as obese. Differences in the cohorts' starting body weights also can confound the comparison of risks among studies because persons who are heavier at the beginning of the risk period will be closer to the definitional cut-off than their leaner counterparts (this also would be true for the comparison of incidence rates of obesity). For example, differences in starting body weight may partially explain why Samoans have consistently higher risks of obesity than Americans, even though the risk period in the Samoan study (*17*) was only half as long as the risk period in the American study (*18*).

Unfortunately, the cumulative incidence cannot be used as a substitute for the incidence density in the prevalence equation because the cumulative incidence is not measured in units of time. However, if representative population studies estimate the cumulative incidence of obesity across several distinct time periods, one could begin at least to judge whether the incidence of obesity was changing.

SECULAR TRENDS IN OBESITY

In public health surveillance, a secular trend is a time-trend in the prevalence of obesity that is *not due* to changes in the demographic structure of the population (i.e., changes in age or gender). A secular trend can be estimated by comparing the age-adjusted prevalences of a condition from two or more cross-sectional surveys of the population carried out at different points in time. Kuczmarski and colleagues recently documented a marked secular increase between 1976–1980 and 1988–1991 in the prevalence of obesity in United States adults between 20 and 75 years of age (*2*). They defined obesity as a body mass index (kg / m^2) of ≥ 27.8 for men and ≥ 27.3 for women, and found that the prevalence had increased nearly eight percentage points from 25.4% in 1976 to 33.3% in 1991, which is a relative in-

crease of 31%. This strong secular trend appeared to be fairly uniform across age, gender, and racial-ethnic groups.

As demonstrated earlier, only two factors can explain this increase in obesity prevalence. Either United States Americans are becoming obese at a faster rate (increased incidence rate) because they are consuming more calories and/or becoming less physically active or, obese United States Americans are remaining obese longer (increased duration) because they are less likely to lose weight and/or they are living longer. Of course, it is also possible that both the incidence rate and the mean duration of obesity have increased in the United States. Although information on secular trends in the prevalence of obesity can be used to determine whether obesity is more or less common, it is difficult to determine exactly why the prevalence of obesity is changing without data on changes in the incidence rate and duration of obesity. Currently, no data are available on changes in either the incidence rate or the mean duration of obesity in the United States. In the U.S. case, however, it is doubtful that greater longevity among the obese accounts for the secular trend because substantial increases in obesity prevalence were observed in adults aged 20–29 and in adults aged 65–74 years (*2*).

Great care must be taken when interpreting data on secular trends, especially when they are estimated in smaller subpopulations of a country. For example, if the secular trend in obesity is being monitored in an urban area, an influx of thinner migrants from rural areas may cause a spurious decrease in the prevalence of obesity. Such a scenario was recently documented in a study of secular trends in obesity among Danish men (*19*).

CONCLUSION

Public health surveillance is an integral part of any public health program for the control of a disease or health condition. In the case of obesity control programs, obesity surveillance goals should include the accurate and timely estimation of obesity prevalence in the relevant age-, gender-, ethnic-, social-, and geographic-specific subgroups of the population. In addition, estimates of changes in prevalence over time, or secular trends, are critical in order to determine if obesity is becoming more or less common. Reliance on prevalence data alone, however, will not provide insights into why obesity prevalence is changing. This requires knowledge about the rate of obesity occurrence as well as the duration of obesity in the population. Direct estimates of the incidence rate of obesity and the duration of obesity are not feasible in the population setting. The cumulative incidence, or risk, of obesity can be practically estimated, however, using a longitudinal cohort approach. Information from separate cohort studies carried out at different points in time can be used to suggest whether the incidence of obesity is changing.

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ANTHROPOMETRIC INDICATORS OF OBESITY: EPIDEMIOLOGIC AND PUBLIC HEALTH ASPECTS OF THEIR DEVELOPMENT AND USE

John H. Himes[1]

Omran was the first to describe the epidemiologic transition through which pandemics and infectious diseases lose prominence as chief sources of morbidity and mortality, and degenerative and chronic diseases become the principal causes (*1*). In this formulation, he linked the fundamental changes in historical patterns of mortality and fertility with determinants related to environmental, socioeconomic, political, cultural, medical, and public health factors. Omran used life expectancy at birth as a chief indicator of the stage of the epidemiologic transition. By this criterion, recent data from the Pan American Health Organization (PAHO) indicate that life expectancy at birth in all of the countries in the Americas currently exceeds 50 years (*2*), Omran's level distinguishing the "age of degenerative and man-made diseases."

In the developing countries of the Americas, however, socioeconomic and political measures to improve poverty, overall hygiene, and nutrition generally have not developed as rapidly as medical and public health measures to extend life, and life expectancy at birth is probably higher for a corresponding stage of the epidemiologic transition than that seen in historical patterns for industrialized countries of Europe. A consequence of this pattern in many developing countries is that the infectious diseases and nutritional insufficiency that accompany poverty may coexist with increasingly prevalent chronic diseases that characterize an aging population. The data presented at the meeting on obesity and poverty held in Havana, Cuba in May, 1995 make it clear that obesity and other chronic diseases are becoming more prevalent in developing countries in the Americas, and that in many cases infectious diseases and undernutrition persist as well.

The development of appropriate anthropometric indicators of obesity requires that three questions be answered: (1) What is the specific purpose of identifying those who are overweight or obese?, (2) Which anthropometric indicator best serves that purpose?, and (3) What is the best cutoff for the indicator?

SPECIFIC PURPOSES OF IDENTIFYING THE OVERWEIGHT OR OBESE

Appropriate purposes for anthropometric indicators of obesity should be linked to ac-

[1]University of Minnesota, Division of Epidemiology, Minnesota, United States of America.

tions to be taken based on the data collected for individuals or populations. Specific purposes and actions for the developing anthropometric indicators have been elaborated fully in a World Health Organization (WHO) expert committee report (*3*). For example, appropriate public health purposes for anthropometric indicators for individuals may include targeting individuals for further medical evaluation or referral; for populations, they may include assessment of prevalence, or planning programs in the context of nutrition surveillance activities.

Purposes for developing indicators must be sufficiently detailed to include the specific groups to be targeted. For example, the best indicator for adolescents may not be the best indicator for pregnant women, even for the same purpose. Similarly, the purpose should include the anticipated setting where the measurements will be taken, so that limitations and requirements for personnel, training, and facilities may be considered properly when choosing the best indicators.

A critical aspect of defining the purpose of an anthropometric indicator of obesity is to answer the question: "Indicator of what?" Common anthropometric indicators are presented in Box 1. These indicators represent various measures of body fat, subcutaneous fat, fat distribution, and estimates of total body mass.

Measures of fatness and obesity are not interchangeable; they not only measure different aspects of fatness, but they fail to identify the same individuals within a population. Table 1 presents the chance-adjusted agreement (coefficients) among anthropometric indicators for adults classified as the fattest for that population (*4*). Overall, the different measures agree poorly in identifying the fattest individuals. The median change-adjusted agreement is 0.57 for men and 0.64 for women, with single values as low as 0.4. For example, of the test individuals classified by hydrostatically-determined percentage body fat, only about half are considered the fattest when triceps skinfold thickness is used.

BOX 1. Common anthropometric indicators of obesity and fat distribution.

- Weight
- Weight:height indices
  - Body mass index (BMI)
    BMI = wt (kg)/ht^2 (m)
  - Relative weight
    100 × wt/target wt
- Skinfold thickness
  - Triceps, subscapular, others
  - Sum of multiple skinfolds
  - Ratio of skinfolds (subscapular:triceps)
- Body circumferences
  - Arm, waist, hips
  - Ratio of circumferences (waist:hip)
- Prediction equations for total body fat

In practice, we have to decide exactly what the anthropometric measures are meant to indicate. Total body fatness, specific patterns of fat distribution, concurrent or subsequent morbidity, and subsequent mortality may all be outcome targets for the indicators. In most public health situations, fatness, obesity, and fat distribution are only of concern inasmuch as they are associated with morbidity and mortality. Chief morbidities associated with overweight or obesity include cardiovascular disease; non–insulin-dependent diabetes mellitus (NIDDM); gallbladder disease; osteoarthritis; and cancers of the breast, endometrium, prostate, and colon. The patterns of increasing relative risks for subsequent mortality with increasing overweight, as indicated with such a measure as body mass index (BMI), are striking and have been published widely (*3, 5*).

SELECTING THE BEST INDICATOR

Anthropometric indicators should be evaluated quantitatively and practically to determine which one is best for the expressed purpose. General approaches and rationales for

TABLE 1. Change-adjusted agreement (kappa) in upper quintiles of obesity-related measures (men, upper triangle; women, lower triangle).[a]

	Weight	Body mass index	Relative weight[b]	Triceps skinfold	Subscapular skinfold	Sum of skinfolds[c]	% body fat[d]
Weight	—	0.72	0.79	0.43	0.50	0.53	0.55
Body mass index	0.64	—	0.86	0.42	0.46	0.50	0.55
Relative weight[b]	0.71	0.92	—	0.46	0.46	0.60	0.57
Triceps skinfold	0.47	0.57	0.57	—	0.58	0.64	0.51
Subscapular skinfold	0.50	0.55	0.51	0.54	—	0.74	0.40
Sum of skinfolds[c]	0.54	0.64	0.65	0.75	0.70	—	0.50
% body fat[d]	0.49	0.58	0.56	0.54	0.55	0.70	—

[a]*N* = 225 men; 212 women

[b]Relative to Metropolitan Life Insurance Tables

[c]Sum of triceps, biceps, subscapular, and suprailiac skinfolds

[d]Determined by underwater weighing

Source: Himes JH, Bouchard C, Pheley AM. Lack of correspondence among measures identifying the obese. *Am J Prev Med* 1991;7(2): 107–111.

specifying the best indicator using quantitative criteria have been discussed fully elsewhere (*3*, *6*). As an example for discussion, we will use screening adults in public health clinics for risk of subsequent impaired glucose tolerance and NIDDM as the purpose for the indicator. In our example, positively screened individuals will be referred for more detailed medical evaluation and diagnosis.

A basic approach is to choose the indicator that maximizes both the sensitivity (proportion of those who will become ill who are identified correctly by the indicator) and specificity (proportion of those who will not become ill who are identified correctly by the indicator) relative to the specific outcome, i.e. risk of subsequent NIDDM (Figure 1). This selection method yields the indicator with the best overall efficiency, or correct classification of individuals relative to the outcome. If possible, these analyses should be done using data obtained in the intended setting, and with methods and personnel corresponding to the intended uses, because the attending measurement reliabilities and biases will affect the indicators' observed sensitivities and specificities.

Figure 2 presents the receiver operating characteristic curves for two hypothetical indicators that have been analyzed at different cutoff levels. For this example, the indicator corresponding to the darkened circles is pre-

FIGURE 1. Validity characteristics for a hypothetical indicator of impaired glucose tolerance or subsequent non–insulin-dependent diabetes mellitus.

	Actual status		
Anthropometric indicator	Abnormal	Normal	Totals
Positive (Abnormal)	A 36	B 31	A + B 67
Negative (Normal)	C 24	D 409	C + D 433
Totals	A + C 60	B + D 440	A + B + C + D 500

Prevalence (%) = (A + C)/(A + B + C + D) × 100 = 600/500 × 100 = 12%
Sensitivity (%) = A/(A + C) × 100 = 36/60 × 100 = 60%
Specificity (%) = D/(B + D) × 100 = 409/440 × 100 = 93%
Positive predictive value (%) = A/(A + B) × 100 = 36/67 × 100 = 54%
Efficiency (%) = (A + D)/(A + B + C + D) × 100 = 445/500 × 100 = 89%

ferred because of the pattern of higher levels of sensitivity and specificity relative to the targeted outcome.

Often, practical considerations related to the implementation of anthropometric assessments in public health settings are deciding factors in selecting the most appropriate anthropometric indicator. Location, physical facilities, and personnel have important implications for equipment needs, training, quality control, and measurement reliability. Cultural acceptability of measures, frequency of needed visits, and transportation or child care requirements may impose limitations on which target groups or anthropometric indicators are considered most feasible.

SELECTING THE BEST CUTOFF

As portrayed in Figure 2, different cutoffs of the same indicator are associated with different sensitivities and specificities. Theoretically, arguments can be made for selecting a cutoff based on maximal sensitivity, maximal specificity, or maximal efficiency of an indicator or screen, depending on the purpose (*6*). In practice, the range of probable purposes for anthropometric indicators of overweight or obesity in public health settings suggests that in most cases indicators should be selected based on maximal specificity (*7*).

Although it may seem counterintuitive to select an indicator based on specificity rather than sensitivity, the reasons for this may be appreciated more easily in terms of the resulting positive predictive value (PPV), or the proportion of individuals considered to be at risk by the indicator who actually became ill (Figure 1). Selecting for the highest specificity also selects for the highest PPV (*6*). The higher the PPV, the more effectively resources will be spent on those who screened positively, and the smaller the proportion of resources that will be spent on those who do not need it.

For a fixed sensitivity and specificity, PPV increases with the prevalence of the target outcome (Figure 3). Using typical levels of sensitivity and specificity for anthropometric indicators (0.6, 0.9, respectively), PPV does not

FIGURE 2. Receiver operating characteristic (ROC) curve for two hypothetical indicators evaluated at different cutoff points.

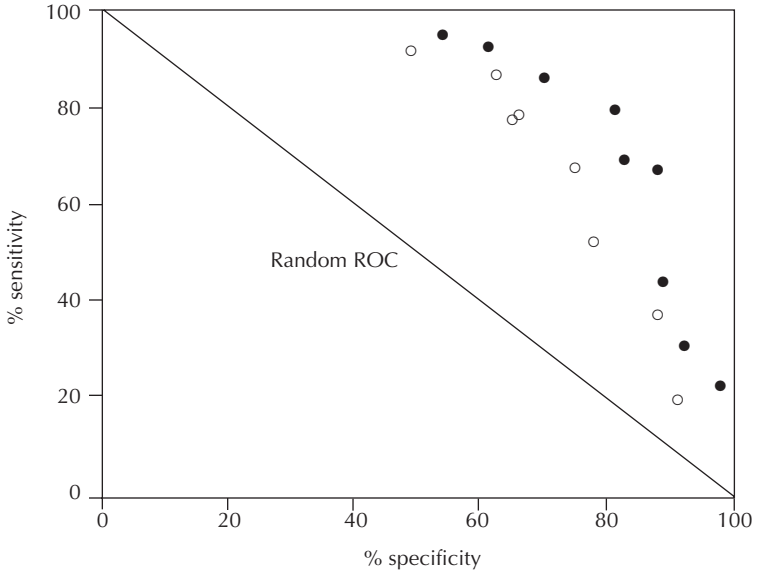
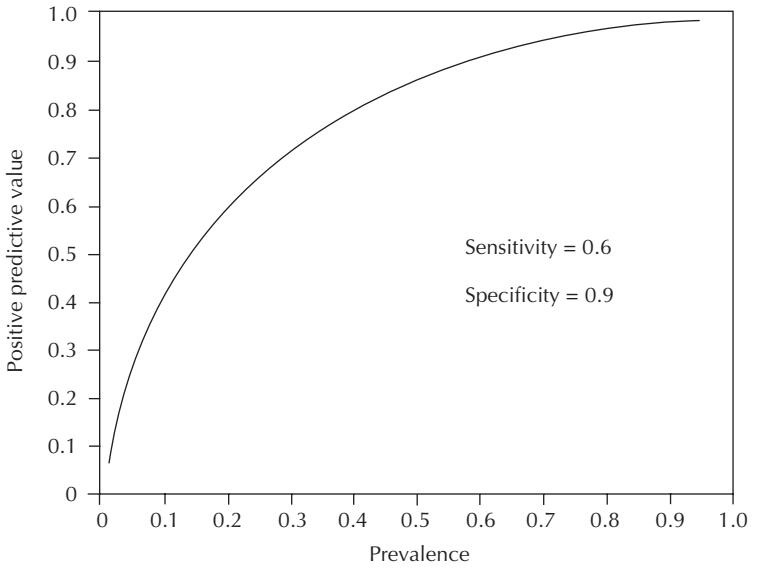


FIGURE 3. Positive predictive value (PPV) as a function of prevalence for fixed levels of sensitivity and specificity.



exceed 50% until prevalence rises to about 15%. Because PPV is so closely linked to prevalence, selecting an indicator based on high PPV avoids situations where anthropometric screening, even with good indicators, would be cost-ineffective and otherwise inappropriate. Specificity and PPV can be raised by making the cutoff for the anthropometric indicators more extreme. The ideal cutoff should match the yield of the anthropometric screening to the available resources of the community (*3*).

When the purpose of the anthropometric indicator is to estimate the prevalence of a concurrent problem (e.g., obesity, NIDDM), any indicator with known sensitivity and specificity may be used. The population prevalence of the underlying condition may then be estimated using established formulas (*8*).

WHO-RECOMMENDED INDICATOR OF OVERWEIGHT

A recent WHO Expert Committee recommended that BMI (kg/m^2) be used as an anthropometric indicator of overweight in adults under 60 years of age (*3*). The main reasons for recommending BMI are listed in Box 2. Unfortunately, various BMI cutoff levels (25.0–29.99, grade 1 overweight; 30.0–39.99, grade 2 overweight; and ≥ 40.0, grade 3 overweight) have not been evaluated systematically for purposes other than determining total subsequent mortality.

BOX 2. Reasons in favor of using body mass index as an indicator of overweight or obesity.

- Measurements are routinely collected.
- Reliability generally is good.
- Appropriate equipment is easy to procure.
- No population-specific reference data are needed.
- It is valid relative to morbidity and mortality.
- Standard reporting categories are provided by the World Health Organization.
- Tables and nomograms for calculations are available.

The term "obesity" was not considered appropriate for this indicator based on height and weight, because it denotes high levels of body fat, while BMI measures only body mass and does not distinguish between fat and lean tissues.

CONCLUSION

Purposes, indicators, and cutoffs cannot be extrapolated from one setting to another because they are contextually specific.

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Factors in Intrauterine Life and Adolescence Linked to Obesity in Adulthood

POOR FETAL AND CHILD GROWTH AND LATER OBESITY AND CHRONIC DISEASE: RELEVANCE FOR LATIN AMERICA

Dirk G. Schroeder[1] and Reynaldo Martorell[1]

Latin America is in the midst of what has been referred to as an "epidemiologic transition" (*1*). Public health problems that have characterized poor, developing countries (i.e., undernutrition and infectious diseases) now are being supplanted by those that commonly have been associated with Western industrialized countries (i.e., cardiovascular disease and cancer). The mechanisms underlying the epidemiologic transition are complex and relatively poorly understood, but likely include the extreme changes in lifestyle, physical activity, and diet that accompany urbanization and rapid economic development (*2*). The shift away from traditional diets to higher fat, processed diets within this context is referred to as the "nutrition" transition (*2–5*).

An outstanding feature of these epidemiologic and nutrition transitions is the concurrent existence, within a given country, of health conditions and diets associated with *both* developing and Western industrialized countries. Significantly, these contrasting circumstances do not exist in isolation from each other. For example, individuals who are born into rural poverty frequently migrate to urban areas during early adulthood and thus, experience both undernutrition and overweight within their lifetimes. A similar phenomenon can be seen within families (usually urban) in which malnourished children are being raised by obese parents. The coexistence of such diverse nutritional conditions within a single society hinders governments' abilities to articulate priority areas and determine the optimal distribution of resources.

Attempts to understand the etiology and implications of the epidemiologic and nutrition transitions have led to widespread discussion of the so-called "fetal origins" or "programming" hypothesis. The basic tenet of this hypothesis is that insults during critical stages of fetal development or early childhood, followed by relative affluence, result in increased risk for chronic disease later in life (*6–8*). The most ardent advocate for this hypothesis is David J. P. Barker of the United Kingdom, who is credited with bringing it to its current form and promoting its widespread discussion (*9*); popularly, the fetal origins hypothesis is often referred to as the "Barker Hypothesis" (*10*).

In spite of its long history, the fetal origins hypothesis remains controversial. Evidence supporting the hypothesis has been widely criticized based on study design deficiencies, improper control for confounders, and inconsistent results (*11, 12*). If the fetal origins hy-

[1]Emory University, Department of International Health, Atlanta, Georgia, United States of America.

pothesis is valid, however, it may provide important guidance in explaining and anticipating the long-term effects of the epidemiologic and nutrition transitions in Latin America and elsewhere.

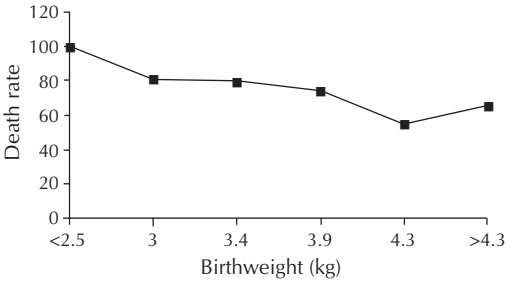
This chapter summarizes the evidence for the fetal origins hypothesis and discusses its relevance for obesity in Latin America. Such outcomes as blood pressure and non–insulin-dependent diabetes are examined as well, because they generally have been studied more thoroughly and because they commonly coexist with obesity. The current theoretical basis for the fetal origins hypothesis is summarized and the model is applied to an analysis that tested the fetal origins hypothesis for fatness and fat distribution in Guatemala. The chapter concludes by noting optimal characteristics of future studies on the fetal origins hypothesis.

EVIDENCE FOR THE FETAL ORIGINS HYPOTHESIS

The notion that early life experiences determine risk of cardiovascular disease mortality originated from ecological studies that found, for example, a high correlation between regional rates of arteriosclerotic heart disease and past infant mortality (*8*) or a strong correlation between adult death rates and short adult stature, apparently due to a worse environment in early life as compared to later life (*13–16*). Notably, the ecological association between adult shortness and morbidity and mortality patterns persists, even when socioeconomic status and such potential confounders as adult body size (i.e., body mass index and weight) are controlled for (*17*). Still, such ecological studies provide only weak evidence for a causal relationship (*11*).

Using a retrospective cohort study design, Barker and his group traced the birth records of over 15,000 men and women born in Hertfordshire, United Kingdom (*18–20*). A wide variety of analyses using this data set have found an association between birth and infant growth measures and later cardiovascular disease and cardiovascular disease mortality (*21, 22*). For example, they observed a relation between increasing death rate from coronary heart disease and decreasing birthweight in this population (Figure 1). Studies by the Barker group and others have attempted to identify the mechanisms behind these early growth-mortality associations by examining the relation between fetal growth and cardiovascular risk factors, including hypertension, non–insulin-dependent diabetes, dislipidemia, and obesity and abdominal fatness. "Syndrome X," characterized by the coexistence of these cardiovascular disease risk factors in the same individual (*23*), also has been examined. In the following sections, the evidence for a causal relation between indicators of poor fetal growth and each of these outcomes, separately and as syndrome X, are summarized briefly.

FIGURE 1. Death rates from coronary heart disease among 15,726 men and women according to birthweight.



Source: Barker DJP, Winter PD, Osmond C, Margetts B, Simmonds SJ. Weight in infancy and death from ischaemic heart disease. *Lancet* 1989;i:577–580.

Hypertension, Non–insulin-dependent Diabetes, and Hyperlipidemia

Blood pressure is the most studied outcome within the fetal origins hypothesis line of research (*24–26*). Law and Shiell identified 32 papers that examined the association between birthweight and later blood pressure, 17 of which controlled for weight or body mass index (BMI) at adult examination (*27*). There is a clear tendency for blood pressure to increase

with decreasing birthweight, even in those studies that adjusted for current socioeconomic status and current weight or BMI. In fact, adjustment for weight or BMI at the time blood pressure was taken generally *increased* the strength of this association, perhaps because birthweight was positively correlated with later weight and/or blood pressure is correlated with current body weight and BMI (*9*). Cortisol regulation may be the potential biological mechanism underlying the relation between higher blood pressure and fetal growth retardation, as evidenced by animal studies (*28, 29*).

Non-insulin-dependent diabetes is a well-recognized risk factor for cardiovascular disease and is another widely studied outcome of fetal origins hypothesis research (*30–35*). For example, using the same Hertfordshire cohort, Hales et al. found that birthweight was inversely associated with impaired glucose tolerance or diabetes (Table 1) (*33*). In a review of this literature, McKeigue concluded that the evidence for an association between poor fetal growth and non–insulin-dependent diabetes is strong, even after adjusting for potential confounders and current body mass index (*36*). The proposed biological mechanism behind the association between poor fetal growth and non–insulin-dependent diabetes mellitus is that intrauterine malnutrition leads to impaired B-cell production (*37*) due to a lowered insulin-like growth factor (IGF-1) concentration in response to fetal hypoglycemia (Figure 2) (*34, 35*).

Dislipidemia is another well-recognized risk factor for cardiovascular disease. The evidence for a relation between poor fetal growth and dislipidemia, however, is weaker. A study from the Barker group found that a small abdominal circumference at birth predicted raised serum low-density lipoprotein cholesterol concentrations (*38*). On the other hand, another study by this group (*39*) and a study in Croatia (*40*) found no relation between birthweight and blood lipid levels.

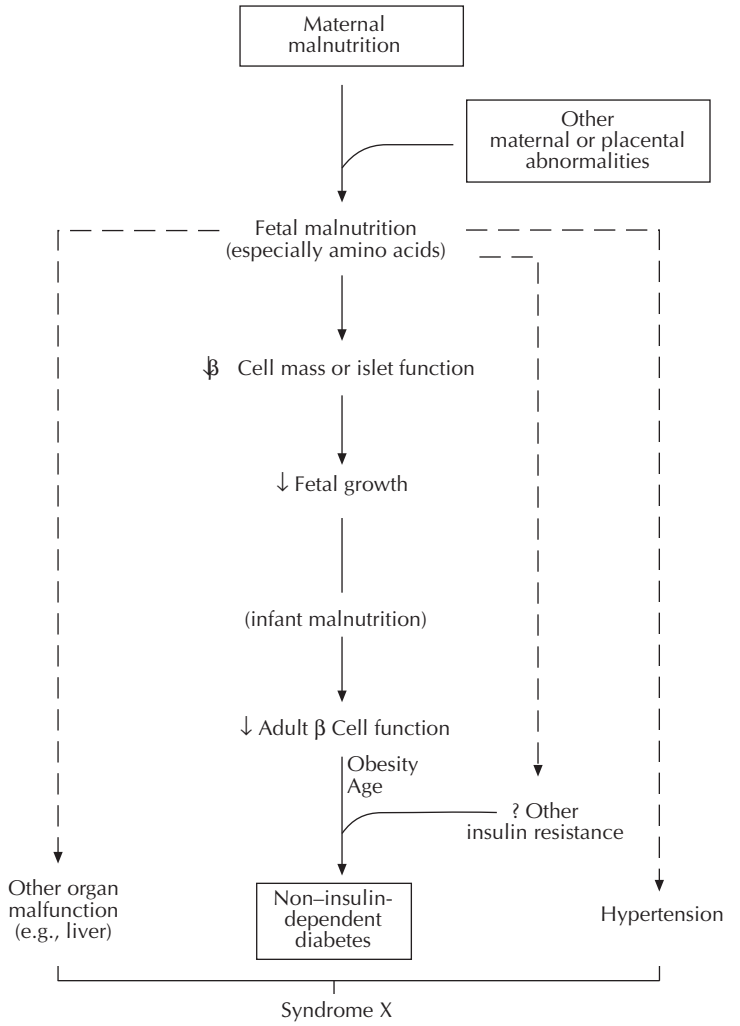
In sum, the evidence that poor fetal growth results in higher blood pressure and increased

TABLE 1. Prevalence of non–insulin-dependent diabetes and impaired glucose tolerance in men 59–70 years of age.

Birthweight in pounds (kg)	Number of men	% with impaired glucose tolerance or diabetes	Odds ratio adjusted for BMI[a] (95% CI[b])
< 5.50 (2.49)	20	40	6.6 (1.5–28)
5.51– 6.50 (2.50–2.94)	47	34	4.8 (1.3–17)
6.51–7.50 (2.95–3.40)	104	31	4.6 (1.4–16)
7.51–8.50 (3.41–3.85)	117	22	2.6 (0.8–8.9)
8.51–9.50 (3.86–4.31)	54	13	1.4 (0.3–5.6)
> 9.50 (4.31)	28	14	1.0
Total	370	25	

[a]BMI = body mass index.
[b]CI = confidence interval.
Source: Hales CN, Barker DJP, Clark PMS, Cox LJ, Fall C, Osmond C, et al. *Br Med J* 1991;303:1019–1022.

FIGURE 2. Non–insulin-dependent diabetes: thrifty phenotype hypothesis.



Diagrammatic representation of key features of the "thrifty phenotype" hypothesis of the etiology of non–insulin-dependent (type II) diabetes. Also outlined is the suggestion that the features of syndrome X may have closely related origins in failures of early growth and development. Not shown for the sake of simplicity and clarity are the additional possibilities that (i) an early reduction of insulin production could have secondary consequences for the growth and development of other organs affected in syndrome X; (ii) infant malnutrition may be involved in processes contributing to components of syndrome X.

Source: Hales CN, Barker DJP. Non–insulin dependent (type II) diabetes mellitus: Thrifty phenotype hypothesis. In: Barker DJP, ed. *Fetal and infant origins of adult disease*. London: British Medical Journal Books; 1992:258–272.

risk for non–insulin-dependent diabetes later in life appears robust and reasonable biological mechanisms behind these associations have been suggested. The impact of poor fetal growth on dislipidemia, however, is weaker. The following section examines the evidence that fetal insults result in increased obesity and detrimental body fat distribution.

OBESITY AND BODY FAT DISTRIBUTION

Overweight, particularly abdominal fatness, is a well-established risk factor for cardiovascular disease, adult-onset diabetes, stroke, and mortality (*41*).

It has been suggested that exposure to famine prenatally or early in life leads to increased risk for fatness later in life (*42*). Some of the most intriguing epidemiologic evidence for this observation comes from a study of men who were exposed *in utero* to the Dutch famine of 1944–1945 (*43*). Food rations declined from 1800 kcal/day to 600 kcal/day during the six-month, embargo-induced famine and then rose to 1700 kcal/day after it ended. Men who were exposed to the famine during the first two trimesters of gestation showed significantly higher rates of obesity at induction into the army at 19 years of age, while those exposed during the last trimester or the first months of life showed significantly lower obesity rates; women were not studied. Studies by the Barker group concluded that men (*44*) and women (*39*) in England who had low birthweights had greater waist:hip ratios (an indicator of abdominal obesity) than those with higher birthweights. However, a close examination of the results of the study of 297 women aged 60–71 years suggests that this association is weak, even when BMI is controlled for (Table 2) (*39*).

TABLE 2. Mean waist:hip ratio according to birthweight and current body mass index.

	Current body mass index (kg/m^2)			
Birthweight in pounds (kg)	≤ 24.5	24.6–28	> 28	All
≤ 7.0 (3.18)	0.78	0.81	0.83	0.80
7.1–8.0 (3.22–3.63)	0.78	0.79	0.83	0.80
> 8.0 (3.63)	0.76	0.79	0.82	0.80
All	0.78	0.80	0.83	0.80

Source: Fall CHD, Osmond C, Barker DJP, Clark PMS, Hales CN, Stirling Y, et al. Fetal and infant growth and cardiovascular risk factors in women. *Br Med J* 1995;310:428–432.

Additional evidence for a relation between early malnutrition and later overweight comes from studies that found that stunted children in certain developing countries are more likely to be of relatively high weight-for-height (*45–47*). Using data from China, Brazil, Russia, and the Republic of South Africa, Popkin et al. found a significant association between stunting and overweight, defined as weight-for-height *z*-scores two standard deviations above the United States National Center for Health Statistics/World Health Organization reference in children 3–6 and 7–9 years of age (*47*). It is important to note, however, that overweight may be a poor indicator of fatness. In Peru, Trowbridge et al. used $H_2{}^{18}0$ stable isotope dilution to examine fatness and fat distribution in 139 stunted, yet heavy, preschool-age children and found that skinfold thicknesses and fat area were lower, but total body water was higher in these children compared to reference values. The researchers thus concluded that the high weight-for-height values seen in these short children should not be considered obesity, but reflect greater lean tissue or lean tissue hydration (*46*). Another possibility is that malnourished children may have altered body proportions, with short legs and relatively long trunks, giving higher weight-for-height values; thus, studies of overweight children in developing countries should include the measurement of skinfolds at various sites. In spite of these caveats, a short, heavy physique in childhood may place the individual at risk for adult obesity in populations undergoing the nutrition transition(*47*).

Studies in animals have revealed potential biological mechanisms for an association between intrauterine malnutrition and later adiposity (*48–51*). For example, effects in rats often differ by sex, suggesting that hormones may interact with deprivation during early growth (*50*). Animal studies also provide evidence for the importance of the timing of intrauterine malnutrition. Consistent with the Dutch Famine Study, male rats whose dams were food restricted during the first two

weeks of pregnancy (equivalent to the first two trimesters of human pregnancy) were more obese at five weeks as compared to non-restricted controls (*49*), with the body fat increase due to hyperphagia. A postulated mechanism for an impact of early malnutrition on high-risk body composition and obesity is that malnutrition during hypothalamic development (mid-gestation in human beings) permanently impairs the appetite and food-regulating centers of the hypothalamus (*22*).

Notably, a number of human epidemiologic studies have failed to find an association between early malnutrition and increased adiposity. An examination of birthweight and adult health outcomes in 564 young (average age approximately 30 years) Mexican-Americans and non-Hispanic whites found no relation between birthweight and waist:hip ratio in either men or women of either ethnicity (*52*). In another study, analyses of 4020 twin pairs from the Minnesota Twin Registry found that low birthweight was associated with reduced adult height, but not adult relative weight (*53*). Follow-up studies of intrauterine growth retarded (IUGR) newborns have found that IUGR was associated with a lower ponderal index at 7 years of age (*54*) and smaller subscapular skinfolds at 19 years of age (*55*). Adult body mass index, on the other hand, has been found to be similar in IUGR and non-IUGR infants (*56*).

One explanation for the inconsistent results may come from the large body of literature that suggests that weight "tracks" from birth to adulthood (*42*). In these studies, very heavy babies are found to be more likely to be obese as adults. Popkin suggests that the fetal origins and the tracking hypotheses are not incompatible. Rather, they could reflect two separate mechanisms, one associated with undernutrition during pregnancy and the other with gestational diabetes and unhealthy diets during pregnancy (*47*). Evidence for such parallel mechanisms can be seen in studies that find increased risk at the highest birthweights (Figure 1). Thus, an inverse "J", rather than linear, relation between fetal growth and a risk for later cardiovascular disease has been theorized (*9*).

In sum, although the animal literature commonly finds a relation between fetal malnutrition and later adiposity, the human epidemiologic evidence for such a relation is inconclusive. The next section examines a methodological issue that may have contributed to these inconsistent results.

METHODOLOGICAL AND THEORETICAL ISSUES

Indicators of Poor Fetal and Child Growth

One of the difficulties in interpreting the literature on the fetal origins hypothesis is the large number of indicators of poor fetal growth that have been used and the difficulty in interpreting what these anthropometric measures reflect in terms of the fetal environment. Further complicating this field is that although it is often referred to as the "fetal origins" hypothesis, the long-term impact of poor *postnatal* growth has also been hypothesized and examined. Notably, the biological mechanisms for the hypothesis regarding poor postnatal growth and later cardiovascular-related outcomes have not been clearly articulated. Table 3 is a sample of the many indicators of early malnutrition and potential confounders at various ages that have been used to examine this hypothesis.

Even the most frequently used indicator of prenatal growth—birthweight—may be a vague indicator of fetal growth. For example, newborns who are intrauterine growth retarded but of appropriate ponderal index (e.g., short, but not thin) are thought to have been malnourished throughout pregnancy while those with IUGR and a low ponderal index (e.g., thin, but not short) are thought to have grown well until the third trimester. Box 1 presents a more detailed description of IUGR and proportionality.

TABLE 3. Indicators of early malnutrition (independent variables) and potentially confounding factors found in the literature examining the association between early malnutrition and risk for cardiovascular disease in the adult.

	Indicators (independent variables)	Potential confounders
Prenatal (pregnant woman)	weight, triceps skinfold, weight gain during pregnancy, body mass index, anemia status, diet (especially protein intake)	age, height, parity, gravidity, blood pressure, maternal socioeconomic status (SES), family history of cardiovascular disease
Newborn	birthweight, length, head circumference, placental weight, head circumference/length, intrauterine growth retardation (appropriate and inappropriate gestational age), gender, heredity	gestational age, *plus all listed above*
Child	weight, weight gain, length, growth velocity	childhood SES, infection, diet *plus all listed above*
Adult	height (as an indicator of earlier growth)	adult SES, genetic potential, diet, smoking, geographical area, lipid metabolism, 'cohort effect', *plus all listed above*

BOX 1. Notes on intrauterine growth retardation (IUGR) and proportionality.

IUGR and prematurity

While about 55% of low birthweight newborns in such developed countries as the United States are also premature (< 37 weeks of gestation), only about 25% of newborns in such developing countries as Guatemala are premature.[1] The prevalence of prematurity in developing countries is double that found in wealthier nations (6.7% vs. 3.3% of newborns, respectively), but of those figures, the prevalence of small-for-date infants is much greater (17% vs. 2.6%, respectively) in an analysis of 36 studies.[1] It is the greater prevalence of term, small-for-gestational-age infants which explains the larger prevalences of low birthweight in developing countries.

IUGR and proportionality

The ponderal index may distinguish IUGR cases with late fetal malnutrition (LPI) from cases with early and chronic fetal malnutrition (API) (we lack ultrasound measurements of growth *in utero* which provide better measures). Weight gain is rapid at the later stages of pregnancy relative to growth in length; IUGR-LPI infants may represent those with acute undernutrition late in pregnancy. The IUGR-API, small but proportionate, may represent those with chronic undernutrition throughout the entire pregnancy. IUGR-API is the predominant type in developing countries (67%–79% of IUGR cases) whereas IUGR-LPI predominates in developed countries (60%–80% of IUGR cases) according to Villar et al.[2]

Kramer et al. believe that disproportionality is a proxy for severe IUGR and that it carries little or no risk above and beyond that associated with the degree of IUGR.[3] These views are based on studies in developed countries and the conclusion may not hold for developing countries, where a different mix of IUGR predominates.[2]

[1]Villar and Belizán, 1982.
[2]Villar et al., 1986.
[3]Kramer MS, Olivier M, McLean FH, Willis DM, Usher RH. Impact of intrauterine growth retardation and body proportionality on fetal and neonatal outcome. *Pediatrics* 1990;86(5):707–713.

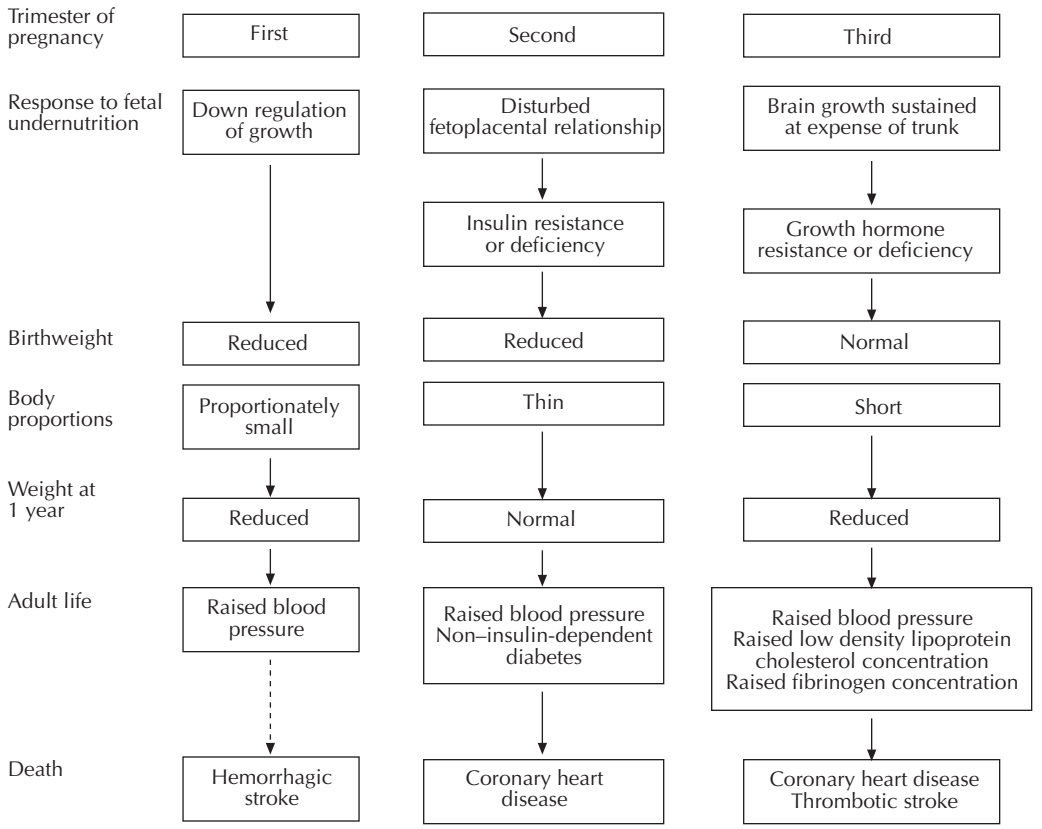
BARKER'S THEORETICAL FRAMEWORK

Part of the difficulty in making sense of the widely diverse literature on the fetal origins hypothesis has been the lack of agreement on the theoretical basis for the observed relations. David Barker has recently summarized his interpretation of the literature in the theoretical framework presented in Figure 3. He believes that the impact of intrauterine undernutrition on fetal growth and later outcomes varies significantly by the stage (i.e., trimester) of pregnancy. Although there is not even agreement on the timing of intrauterine malnutrition on birth outcomes that Barker suggests (*57*), much less the long-term outcomes on chronic disease risk, the framework provides a reference upon which future research may build. The next section summarizes analyses that tested the fetal origins using long-term, longitudinally collected data from Guatemala.

INFANT AND CHILD GROWTH, AND FATNESS AND FAT DISTRIBUTION IN GUATEMALAN ADULTS

Recently, we analyzed the relation between infant and child growth and fatness and fat

FIGURE 3. Framework of ideas in the fetal origins hypothesis linking fetal undernutrition with later abnormalities.



Source: Baker DJP. *Mothers, babies and disease in later life*. London: British Medical Journal Books; 1994.

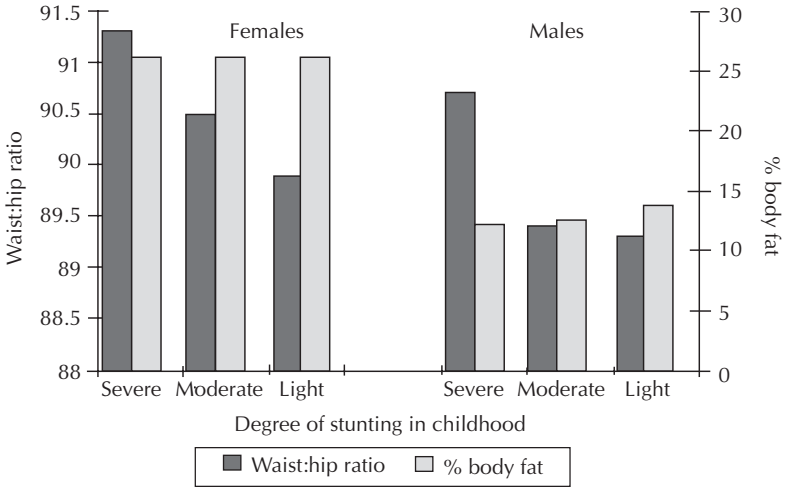
distribution of rural Guatemalans (*58*). The data for these analyses come from a longitudinal study of children conducted by the Institute of Nutrition of Central America and Panama and collaborating American universities between 1969–1977 and from follow-up studies of these children conducted since 1988 (*59*). Adult measures were collected once in 1988–1989 in both men and women and annually since 1991 in women only.

A sample of 372 women and 161 men who were poorly nourished and stunted by 3 years of age (mean = –2.57 height-for-age *z*-scores) were used to test the relation between early child growth and adult fatness. At follow-up, women were 17–28 years of age and were short (mean = 150.1 cm), but not thin (mean percent body fat = 26.2). Men were 18–24 years of age and were lean (mean percent body fat = 12.8). Body mass indices were at approximately the 50th and 15th percentiles for women and men, respectively, compared to reference values (*60*). In women, waist:hip ratio was significantly correlated with percent body fat (Pearson correlation coefficient = 0.80, $p < 0.0001$), BMI (0.5; $p < 0.0001$), parity (0.41; $p < 0.0001$), and age (0.2; $p < 0.0001$). In men, waist:hip ratio was significantly, though less strongly, correlated with percent body fat (0.3; $p < 0.0001$) and BMI (0.3; $p < 0.0001$), and was inversely correlated with smoking (–0.15; $p = 0.05$).

Fatness indicators were examined by tertile of childhood height-for-age *z*-scores, two of which are presented in Figure 4. Women and men who were severely stunted in childhood were shorter, lighter, and had lower BMIs as adults. In women, percent body fat tended to be higher for those more stunted in childhood, but this association was not statistically significant. Female waist:hip ratio was significantly associated ($p = 0.003$) with severe stunting, controlling for BMI, but this association was attenuated if percent body fat was controlled for instead ($p=0.08$). In men, severe childhood stunting was associated with a lower percent body fat ($p = 0.01$). Waist:hip ratio in men, however, showed a significant positive association with stunting if either BMI or percent body fat were controlled for ($p < 0.05$).

The association between birthweight and adult fatness and the relative importance of

FIGURE 4. Waist:hip ratio and percent body fat of Guatemalan adults according to degree of stunting in childhood, adjusted for adult age, socioeconomic status, village of residence, parity (females), alcohol (males), smoking (males), and body mass index.



Source: Schroeder DG, Martorell R, Flores R. Infant and child growth and fatness and fat distribution in Guatemalan adults. *Am J Epidemiol* 1999;149(2):177–185.

intrauterine versus postnatal growth in length was examined in 137 women who had complete data at birth, childhood, and adulthood. Table 4 presents the results of a series of multiple regression models in which each anthropometric variable of interest was entered separately along with potential confounders. Both birthweight and ponderal index at 15 days of age were significantly associated with percent body fat in adulthood. Controlling for adult percent body fat, birthweight showed a significant inverse association with waist:hip ratio. Additional analyses in which birthweight, perinatal, and childhood anthropometric indicators were entered simultaneously suggested that low birthweight was the strongest predictor of increased abdominal fatness in the adult (results not shown).

In conclusion, this prospective study found that Guatemalans who were stunted in childhood had higher abdominal fatness as measured by waist:hip ratio in adulthood, once overall fatness (i.e., BMI) was controlled for. Analyses in women suggested that poor intrauterine nutrition was a stronger predictor of higher abdominal fatness than poor postnatal growth.

RECOMMENDATIONS FOR FUTURE RESEARCH DESIGN

As repeatedly noted above, one of the reasons that the fetal origins hypothesis remains controversial is that relatively weak study designs often have been used to test the hypothesis. Methodologically superior studies clearly are needed to resolve this debate. Well-designed studies conducted in developing countries, including those in Latin America, are imperative. The optimal characteristics of such studies are outlined below.

- The population under investigation should be a cohort followed prospectively from early life until adulthood.
- The cohort should have experienced a range of deprivation in early childhood, from extreme to none.
- The cohort should be either socially or geographically mobile (i.e., migrants).
- Detailed information should be collected on the biological, proximate determinants of poor growth in childhood as well as the chronic disease risk factors in adulthood.
- Multiple measures of social class in childhood should be available to understand the underlying determinants of poor growth.
- Accurate, extensive data on potential confounders in adulthood (social class, smoking, activity level, diet, and others) should be collected.

CONCLUSIONS AND IMPLICATIONS FOR LATIN AMERICA

The above review found that an association between indicators of poor intrauterine

TABLE 4. Regressions of female adult percent body fat and waist:hip ratio on birth and child measurements.

		Percent body fat[a]		Waist:hip[b]	
Independent variables	mean (*s*)	slope	*p*	slope	*p*
Birthweight (kg)	3.017 (0.41)	1.27	0.03	–1.58	0.01
Length at 15 days (cm)	49.3 (1.92)	–0.03	0.84	–0.19	0.17
Ponderal index at birth (g/cm^3 x 100)	2.52 (0.33)	2.28	0.007	–1.61	0.08
Height-for-age at 3 years (*z*-score)	–2.49 (0.92)	0.17	0.55	–0.37	0.22

[a]Each anthropometric independent variable entered in a separate model along with gestational age, age measure taken in childhood, village of residence, adult age, adult socioeconomic status, and parity.

[b]Each anthropometric independent variable entered in a separate model along with gestational age, age measure taken in childhood, village of residence, adult age, adult socioeconomic status, parity, and percent body fat.

Source: Schroeder DG, Martorell R, Flores R. Infant and child growth and fatness and fat distribution in Guatemalan adults. *Am J Epidemiol* 1999;149(2):177–185.

growth and cardiovascular disease and/or certain cardiovascular disease risk factors (i.e., blood pressure, non–insulin-dependent diabetes) is identified consistently. The evidence is more mixed for other outcomes, such as obesity. However, the methodological problems with these studies, such as the wide range of indicators of fetal growth used and the difficulty in controlling for the confounding effects of the adult situation, require a cautious interpretation of these associations.

It is also important to note that the majority of the epidemiologic studies that have examined this hypothesis have been conducted in Western industrialized countries. A study from Jamaica (*61*) and our analysis from Guatemala, however, find results that appear consistent with those from industrialized countries. Additional well-designed studies that meet the conditions outlined above are needed urgently.

If, upon further study, the fetal origins hypothesis proves valid, the implications for Latin America are far reaching (*62*, *63*). The levels of poverty and undernutrition still experienced by large sections of Latin America, coupled with the extraordinary shifts in dietary and lifestyle patterns that are coming with rapid economic development and urbanization, would suggest that cardiovascular disease rates will rise dramatically in Latin America over the next few decades. Averting such an epidemic of cardiovascular disease will require both provision of adequate nutrition during the fetal and early childhood period and prevention of obesity and other cardiovascular risk factors in adulthood. The development of effective strategies for dealing with both of these risk periods simultaneously should be given the highest priority.

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OBESITY IN ADOLESCENCE

Manuel A. Amador[†1]

INTRODUCTION

Adolescents are particularly susceptible to environmental factors, particular those related to food and nutrition. In turn, the onset and pace of sexual development may influence food consumption. In a longitudinal study of Dutch children, Post and Kemper (*1*) noted that the biological maturation that occurs during adolescence affects food consumption: individuals who matured early had a lower energy and protein intake per kilogram of bodyweight than those who matured late, but they were stouter as adults. In addition, late maturation coincided with a more appropriate energy balance during puberty (*2*). Thus, the indicators of inadequate nutrition may reflect complex interactions among nutritional requirements, environmental factors, and the social values associated with food consumption (*2*). For example, total daily intake of foods with little variety and high sodium consumption affects the daily intake of nutrients in adolescents (*3*).

The dietary behavior of adolescents is influenced on the one hand by family customs, greater social connection with peers, and growing concern over body image, and on the other, by food energy requirements. Truswell (*4*) points to 10 factors that characterize this behavior: 1) skipping meals, particularly breakfast; 2) eating preserves and sweets; 3) eating fast foods; 4) eating unconventional foods; 5) starting the habit of drinking alcoholic beverages; 6) excessive drinking of carbonated beverages or other soft drinks; 7) preference for or aversion to specific foods; 8) high energy intake; 9) inadequate consumption of some nutrients; and 10) dieting to lose weight.

Various studies show that skipping breakfast or having an inadequate breakfast may lead to nutritional deficiencies that are rarely offset by other meals (*5–7*). Limited intake of certain nutrients as a result of a distorted diet, particularly iron, zinc, calcium, and vitamin A, may lead to marginal deficiencies or result in disorders associated with specific deficiencies. In a study conducted in New Zealand, almost half of the adolescents consumed less than 70% of the recommended daily amount of calcium, and more than one third of the adolescents surveyed consumed less than 70% of the recommended daily amounts of zinc and vitamin B_6 (*8*).

The course of obesity from childhood to adulthood (*9, 10*) and the associated risk of suffering from non-communicable chronic diseases highlight the importance of preventive measures during puberty: as the number of individuals who become obese at an early age grows, so do the repercussions of obesity as a public health problem. However, the problem can be resolved because most of the many factors related to the development of obesity dur-

[1] Instituto de Nutrición e Higiene de los Alimentos, Havana, Cuba.

ing infancy, childhood, and adolescence (*11*) are susceptible to preventive interventions.

CHANGES IN ADIPOSITY AND IN FAT DISTRIBUTION DURING PUBERTY

Changes in adiposity and fat distribution during puberty vary from person to person, and derive from the interactions between genetic and environmental factors affecting growth. Although our knowledge of the causal mechanisms of these interactions and the role they play in each structural and functional change is still very incomplete (*12–14*), we do know that there is a close relationship between sexual maturation and changes in body fat. In general, adolescents who mature earlier are usually fatter (*15, 16*); those who experienced adiposity changes early in childhood also tend to be fatter (*17*). Early maturation of adolescents is also linked to a higher percentage of fat in the trunk (*18*). Various studies show that fatter children are taller and reach somatic and sexual maturity before thinner children (*19–23*), and another as yet unconfirmed hypothesis maintains that the onset of menstruation in girls depends on their having a certain amount of body fat (*24, 25*).

Amador et al. (*26*) studied the association of the body mass index (BMI) at 1 year and at 4, 6, and 12 years of age with the evolution of the growth process and with height at age 14. The results suggest that the BMI at different ages and height at age 14 are related to the growth process and that this association has a direct component and an indirect component mediated by pubescent development. Another study by the same authors (*27*) also pointed to an association between birthweight and height at age 14.

THE OBESE ADOLESCENT

Obesity is one of the most common disorders in adolescence and, unlike other disorders affecting health, has greater personal, economic, and social consequences (*28*). The high energy contribution of fats (*29, 30*) can produce an energy imbalance that increases the accumulation of body fat, particularly in genetically predisposed individuals (*31*). Increased incidence of obesity during puberty, the tendency for both sexes to show an android or centralized distribution of fat (*32, 33*), and the high probability that obesity will persist after adolescence significantly affect health in that they increase the risk of morbidity and mortality due to non-communicable chronic diseases (*10, 15, 32, 34*).

Given that the phenomena that occur in puberty are closely related to the development of adiposity, reducing energy consumption is an inefficient and dangerous way to control bodyweight (*35*). In order to evaluate the contribution of energy and nutrients, and the extent to which they meet the Cuban recommendations (*36*), in 1992 Borroto et al. (*29*) paired 40 moderately obese adolescents (20 girls and 20 boys) aged 10.7 to 12.7 years according to sex, age, and height with 40 non-obese adolescents, all of whom were students in two schools of the *municipio* of Boyeros in the City of Havana. Each adolescent was subjected to a clinical and anthropometric evaluation, his or her serum lipid profile was analyzed (total cholesterol, HDL cholesterol, LDL + VLDL cholesterol, and triglycerides), and the foods he or she ate over a three-day period were recorded (*36*). The average percentage distribution of energy for each nutrient and for each meal was also recorded. Table 1 shows the results of the clinical, anthropometric, and biochemical characterization and Table 2 shows the characterization according to the contribution and distribution of food energy. Only six obese adolescents (four males and two females) had an energy intake higher than 110% of the recommended values. In contrast, the adequacy of the energy contribution of all the non-obese subjects was between 91%–110%. In addition, the obese subjects showed higher levels of total cholesterol and lower levels of HDL cholesterol, the obese female adolescents had higher levels of serum triglycerides, and

the obese adolescents consumed a higher percentage of energy in the form of proteins and fats than the non-obese adolescents. In both groups, energy intake per meal was considerably high at the evening meal (dinner) and considerably low at breakfast. Table 3 shows the statistics that describe the contribution of vitamins and minerals: low levels of folate, niacin, pyridoxine, and vitamin E were observed in all the groups, but the levels of folate and pyridoxine were lower in the obese adolescents of both sexes, the levels of vitamin E were lower in obese females, and levels of niacin were lower in obese males. The intake of iron, zinc, and copper was also low and, although calcium intake was closer to the recommended levels, it was significantly lower in obese adolescents of both sexes.

OBESITY AND MORBIDITY IN ADOLESCENCE AND ADULTHOOD

One of the most important aspects of obesity relates to the possibility of preventing or reducing during adolescence the health risk factors associated with excess fat. As shown in a study conducted in the United Kingdom that followed a large cohort of individuals from birth to 36 years (*37*), although the magnitude and age of onset of obesity influence the probability that the disorder will continue until adulthood, the predictive value of obesity in childhood is limited (*38*). However, the risk increases when there is an excess of fat from puberty (*39*) and increases even more when individuals have a genetic predisposition.

Identifying the segment of the population that has a genetic predisposition makes it possible to direct appropriate preventive measures. Twin studies indicated that at age 10 or 11 more than 70% of the weight-for-height variation or the thickness of subcutaneous fat can be explained by genetic factors (*40*, *41*). In addition, there are some environmental factors that operate at early stages in life and may become risk factors for obesity in adulthood, such as low or high birthweight (*42*) or deficient nutrition during the first two trimesters of intrauterine life (*43*). Early growth has also been related to fat distribution in specific areas of the body in adulthood. Adiposity measurements are also good predictors of the risk factors for cardiovascular diseases and hypertension.

The distribution of body fat at the end of adolescence is also associated with some morbidity indicators. Thus, Himes and Dietz (*44*) proposed cutoff points for the BMI that can be included as part of routine physical examinations of adolescents. Subjects with BMI values between the 85th and 90th percentiles should be considered as being at risk and should be sent for a follow-up examination that includes taking a family history and measuring blood pressure and total cholesterol level. If these indicators suggest that the adolescent might be at risk, he or she should be referred for treatment.

CONCLUSIONS

- At the individual level, measures to prevent obesity in adulthood must include identification of the genetic and environmental risks to which individuals are exposed during adolescence;
- A very heavy build or the tendency for it to increase in childhood, particularly near or during puberty, necessitates study in order to discern whether the cause is only excess weight or if there is also an increase in body fat;
- The phenomena of maturation during puberty can contribute to the development of excess fat, but knowledge of these phenomena may also guide the search for appropriate treatment;
- The characterization of the obese person is essential for diagnostic evaluation, treatment, and prognosis;
- Obesity may coexist with specific nutrient deficiencies that must be examined and treated immediately; and
- The health risks associated with obesity may be reduced or prevented when excess fat is reduced.

TABLE 1. Means, standard deviations, and results of analysis of variance for clinical-anthropometric and biochemical variables, Cuba, 1992.

	Males				Females					Analysis of variance (*F*)			
	Non-obese (*n*=20)		Obese (*n*=20)		Non-obese (*n*=20)		Obese (*n*=20)			Non-obese/obese		Male/female	
Variable	$\bar{x}$	*s*	$\bar{x}$	*s*	$\bar{x}$	*s*	$\bar{x}$	*s*	Total	Males	Females	Non-obese	Obese
Chronological age (years)	12.08	0.53	12.04	0.51	11.48	0.50	11.48	0.49	1.55^{ns}	0.72^{ns}	0.00^{ns}	1.62^{ns}	1.64^{ns}
Bodyweight (kg)	36.60	4.95	53.26	5.79	41.68	7.62	64.58	8.95	112.60^{***}	15.22^{***}	17.46^{***}	1.58^{ns}	5.02^{**}
Height (cm)	146.42	5.67	146.47	5.73	148.62	6.02	148.71	6.05	1.65^{ns}	1.06^{ns}	1.16^{ns}	1.63^{ns}	1.61^{ns}
Degree of maturation	3.80	0.41	3.60	0.50	3.95	0.22	3.90	0.31	2.58^{*}	1.62^{ns}	1.24^{ns}	1.77^{*}	1.92^{*}
Brachial circumference (cm)	20.17	1.25	28.88	1.27	20.77	1.59	31.26	2.46	216.02^{***}	258.41^{***}	374.39^{***}	19.35^{ns}	1.27^{ns}
Triceps skinfold (mm)	6.52	0.67	23.48	2.94	9.94	1.33	24.20	3.07	328.07^{***}	566.71^{***}	400.63^{***}	1.02^{ns}	23.04^{***}
Biceps skinfold (mm)	3.33	0.59	15.11	2.86	5.02	0.70	15.45	3.07	182.19^{***}	303.86^{***}	238.21^{***}	0.25^{ns}	6.25^{ns}
Subscapular skinfold (mm)	6.42	0.81	23.77	3.31	9.32	1.98	23.41	2.02	342.02^{***}	614.33^{***}	405.15^{***}	0.26^{ns}	17.16^{***}
Suprailiac skinfold (mm)	5.22	0.53	24.21	2.57	8.30	1.37	25.88	2.07	695.71^{***}	$1,105.63^{***}$	946.99^{***}	8.49^{ns}	29.08^{***}
Mid-calf skinfold (mm)	7.27	0.72	18.59	1.96	8.51	0.81	18.78	2.79	244.08^{***}	399.90^{***}	329.16^{***}	0.11^{ns}	4.79^{ns}
Fat bodyweight (kg)	7.31	1.12	17.46	2.03	10.65	2.67	22.32	3.93	129.85^{***}	147.07^{***}	194.52^{***}	33.73^{***}	15.90^{***}
Relative bodyweight (%)	20.08	2.46	32.27	1.80	25.05	2.66	35.03	1.97	182.81^{***}	293.03^{***}	196.33^{***}	15.06^{***}	48.83^{***}
Thin bodyweight (kg)	29.28	4.29	36.52	4.75	31.03	5.09	41.35	5.78	24.03^{***}	20.91^{***}	42.53^{***}	9.33^{***}	1.22^{ns}
Body mass index (kg/m^2)	16.99	1.29	25.09	1.17	18.71	2.22	28.68	2.71	156.15^{***}	171.46^{***}	260.21^{***}	33.72^{***}	7.68^{ns}
Energy/protein index	1.330	0.063	1.811	0.058	1.530	0.052	1.771	0.064	284.19^{***}	652.24^{***}	164.28^{***}	4.47^{ns}	112.52^{***}
Active substance index	0.93	0.05	1.15	0.04	0.94	0.06	1.27	0.10	123.67^{***}	111.61^{***}	240.37^{***}	30.85^{***}	0.38^{ns}
Total cholesterol (mmol/l)	4.79	0.70	5.72	0.69	4.69	0.55	5.02	0.86	8.71^{***}	17.40^{***}	2.20^{*}	9.90^{***}	0.21^{ns}
HDL cholesterol (mmol/l)	1.19	0.14	0.90	0.21	1.26	0.09	1.00	0.21	19.33^{***}	29.26^{***}	23.49^{***}	3.62^{*}	1.79^{*}
LDL + VLDL cholesterol (mmol/l)	1.34	0.10	1.39	0.24	1.23	0.09	1.25	0.17	4.35^{**}	0.83^{ns}	0.25^{ns}	7.04^{**}	5.01^{**}
Triglycerides (mmol/l)	1.09	0.12	1.13	0.12	1.09	0.11	1.14	0.11	1.17^{ns}	1.18^{ns}	2.33^{*}	0.09^{ns}	0.02^{ns}

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$; ^{ns} not significant.

Source: Borroto JM, Ramos LT, Moroño M, Hermelo M, Bacallao J, Amador M. Ingreso energético en niños y adolescents obesos. *Rev Cubana Pediatr* 1993;65(3):165–174.

TABLE 2. Means, standard deviations, and results of analysis of variance for food energy contribution and distribution, Cuba, 1992.

	Males				Females					Analysis of variance (*F*)			
	Non-obese (*n*=20)		Obese (*n*=20)		Non-obese (*n*=20)		Obese (*n*=20)			Non-obese/obese		Male/female	
Variable	$\bar{x}$	*s*	$\bar{x}$	*s*	$\bar{x}$	*s*	$\bar{x}$	*s*	Total	Males	Females	Non-obese	Obese
Daily energy contribution (kcal)	2341.10	181.57	2388.09	268.61	2143.30	296.66	2222.13	300.29	3.51^{**}	0.31^{ns}	0.87^{ns}	3.88^{*}	5.52^{**}
Adequacy of energy contribution (%)	100.82	3.75	104.09	9.87	97.88	4.11	101.24	5.14	3.33^{**}	2.76^{*}	2.91^{*}	2.09^{*}	2.23^{*}
Daily energy consumption by nutrient													
Proteins (%)	10.81	0.99	14.18	2.45	10.82	0.84	14.62	1.61	33.79^{***}	44.47^{***}	56.51^{***}	0.75^{ns}	0.01^{ns}
Carbohydrates (%)	63.96	1.92	51.36	4.21	63.87	2.23	46.69	4.00	146.13^{***}	149.59^{***}	130.35^{***}	20.55^{***}	0.01^{ns}
Fats (%)	25.23	1.37	34.38	3.63	25.31	1.68	38.45	3.56	115.75^{***}	109.71^{***}	229.02^{***}	21.71^{***}	0.01^{ns}
Daily energy consumption by meal													
Breakfast (%)	12.80	1.51	11.00	4.93	12.90	1.62	11.40	5.91	1.22^{ns}	1.97^{*}	1.64^{ns}	0.06^{ns}	0.01^{ns}
Snack (%)	20.52	2.44	18.32	5.11	21.62	2.73	17.42	4.12	5.31^{***}	2.95^{*}	0.63^{ns}	1.19^{ns}	1.24^{ns}
Lunch (%)	27.24	2.72	28.64	5.20	27.00	1.91	28.33	3.70	0.97^{ns}	1.54^{ns}	1.29^{ns}	0.06^{ns}	0.02^{ns}
Dinner (%)	39.71	3.64	42.10	5.52	38.44	2.63	42.93	7.94	2.91^{**}	3.64^{*}	4.94^{**}	0.18^{ns}	0.01^{ns}

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$; ^{ns} not significant.

Source: Borroto JM, Ramos LT, Moroño M, Hermelo M, Bacallao J, Amador M. Ingreso energético en niños y adolescents obesos. *Rev Cubana Pediatr* 1993;65(3):165–174.

TABLE 3. Means, standard deviations, and results of analysis of variance of vitamin and mineral contribution, Cuba, 1992.

		Males				Females					Analysis of variance (*F*)			
		Non-obese (*n*=20)		Obese (*n*=20)		Non-obese (*n*=20)		Obese (*n*=20)			Non-obese/obese		Male/female	
Variable		$\bar{x}$	*s*	$\bar{x}$	*s*	$\bar{x}$	*s*	$\bar{x}$	*s*	Total	Males	Females	Non-obese	Obese
Vitamin A	Daily contribution (g)	764.49	141.09	686.03	161.17	760.38	84.84	697.21	143.77	1.84^{*}	3.34^{*}	2.16^{*}	0.07^{ns}	0.009^{ns}
	Adequacy (%)	88.72	9.67	72.10	18.75	96.25	10.18	91.10	14.12	1.41^{ns}	0.27^{ns}	1.51^{ns}	3.92	0.055^{ns}
Vitamin C	Daily contribution (g)	44.58	7.57	42.19	11.53	49.77	5.170	52.88	7.12	7.05^{***}	0.86^{ns}	1.45^{ns}	17.09^{***}	4.02^{**}
	Adequacy (%)	100.47	8.15	87.22	22.77	100.47	9.15	106.71	13.5	6.25^{***}	1.02^{ns}	1.63^{ns}	15.84^{***}	2.87^{*}
Thiamine	Daily contribution (g)	0.82	0.15	0.74	0.13	0.82	0.15	0.82	0.14	0.71^{ns}	1.66^{ns}	0.00^{ns}	1.25^{ns}	0.02^{ns}
	Adequacy (%)	93.03	10.20	81.15	13.26	93.02	10.19	94.24	15.24	5.50^{**}	0.97^{ns}	0.10^{ns}	11.75^{***}	4.52^{**}
Riboflavin	Daily contribution (g)	1.16	0.16	1.16	0.19	1.16	0.16	1.19	0.15	0.25^{ns}	0.01^{ns}	0.58^{ns}	0.50^{ns}	0.03^{ns}
	Adequacy (%)	96.32	7.12	92.09	13.16	96.31	7.12	100.15	12.02	2.60^{*}	0.05^{ns}	1.40^{ns}	6.17^{**}	1.17^{ns}
Folate	Daily contribution (g)	244.47	58.97	210.12	53.62	244.47	58.97	221.98	61.88	2.41^{*}	5.49^{**}	1.68^{*}	0.47^{ns}	0.13^{ns}
	Adequacy (%)	63.93	11.32	57.98	13.92	63.93	11.32	56.63	14.38	4.29^{*}	3.54^{*}	0.12^{ns}	0.18^{ns}	1.66^{ns}
Niacin	Daily contribution (g)	10.29	1.54	9.73	2.74	10.29	1.54	9.48	1.62	3.11^{**}	5.93^{**}	1.50^{ns}	0.13^{ns}	2.48^{*}
	Adequacy (%)	70.74	9.27	64.13	15.56	74.74	9.27	65.98	9.86	3.46^{**}	8.54^{***}	1.62^{ns}	0.25^{ns}	1.33^{ns}
Pyridoxine	Daily contribution (g)	1.24	0.22	1.15	0.24	1.52	0.20	1.31	0.25	9.88^{***}	1.64^{ns}	9.19^{***}	4.79^{**}	15.54^{***}
	Adequacy (%)	72.17	12.02	66.74	13.67	85.96	10.85	73.53	14.11	8.14^{***}	1.82^{*}	9.53^{***}	2.85^{*}	11.74^{***}
Vitamin E	Daily contribution (g)	6.10	0.94	5.80	1.31	6.83	0.88	6.37	1.28	3.05^{**}	0.74^{ns}	1.67^{ns}	2.63^{*}	4.20^{**}
	Adequacy (%)	77.25	10.87	74.79	15.02	85.37	9.89	79.60	15.64	2.38^{*}	0.35^{ns}	1.93^{*}	1.35^{ns}	3.83^{*}
Iron	Daily contribution (g)	11.23	2.32	10.20	3.01	11.23	2.32	11.11	2.69	1.07^{ns}	3.11^{*}	0.02^{ns}	1.03^{ns}	0.38^{ns}
	Adequacy (%)	66.70	10.80	68.32	13.67	66.70	10.80	65.27	15.05	4.32^{***}	6.10^{**}	0.13^{ns}	0.61^{ns}	8.33^{**}
Zinc	Daily contribution (g)	9.88	1.71	8.80	2.02	9.88	1.71	9.69	2.44	1.44^{ns}	3.59^{*}	0.09^{ns}	1.89^{*}	0.05^{ns}
	Adequacy (%)	68.55	10.66	67.93	15.63	68.55	10.66	67.11	15.82	2.09^{*}	4.04^{*}	0.12^{ns}	0.04^{ns}	3.46^{*}
Calcium	Daily contribution (g)	978.04	182.69	901.42	169.67	1110.24	158.97	1040.55	181.03	5.27^{***}	1.95^{*}	1.62^{ns}	6.44^{**}	5.82^{**}
	Adequacy (%)	92.97	10.79	86.00	13.34	95.62	8.46	92.97	10.79	3.15^{*}	4.34^{*}	3.49^{*}	1.01^{ns}	0.63^{ns}
Copper	Daily contribution (g)	1.57	0.21	1.48	0.37	1.43	0.27	1.57	0.21	1.71^{*}	0.81^{ns}	0.45^{ns}	1.64^{ns}	2.27^{*}
	Adequacy (%)	78.53	10.64	74.22	18.46	71.51	14.02	78.53	10.63	1.63^{*}	0.81^{ns}	0.45^{ns}	1.52^{ns}	2.14^{*}

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$; ^{ns} not significant.

Source: Borroto JM, Ramos LT, Moroño M, Hermelo M, Bacallao J, Amador M. Ingreso energético en niños y adolescents obesos. *Rev Cubana Pediatr* 1993;65(3):165–174.

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