



Technology, transport, globalization and the nutrition transition food policy

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Abstract

Diet and activity have been affected by the rapid worldwide shifts in technological innovations reducing energy expenditures during leisure, transportation, and work; globalized modern food processing, marketing and distribution techniques; global mass media. The increases occur increasingly in rural areas on all continents. The resultant global increase in obesity increasingly is shifting the burden of obesity to the poor. While few direct linkages between globalization of trade in goods, services, and technology can be directly linked to diet and activity, a strong case exists for globalization's role as a key underlying force behind this stage of the nutrition transition.

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Introduction

Globalization has resulted in many positive and negative changes in the developing and developed worlds. Globalization, with its focus on freer movement of capital, technology, goods, and services has had profound effects on lifestyles that are linked with diet, activity, and subsequent imbalances that have led to the obesity epidemic. The rapid changes of these factors are linked in quite complex ways, with very rapid shifts in dietary and activity patterns seen on a global level (Popkin, 2003). These globalization-related changes are tak-

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ing place, particularly fast in the low- and middle-income countries of the developing world. Adult obesity levels, adult-onset diabetes and many other noncommunicable diseases are increasing far more rapidly than in the higher-income countries; overweight and obesity levels of some lower-income countries match, or exceed, those of the United States (Popkin, 2002, 2003). Currently, child obesity is reaching high levels at a rapid rate in many higher-income countries, but lags behind in the lower- and middle-income countries (Lobstein et al., 2004; Wang et al., 2002).

While many researchers have placed the global food production, marketing, and distribution sector (including soft drinks, fast food and other multinational food companies) at the center of blame for these changes, there are other profound, and equally responsible factors, that must be understood to enact effective public policy to address them (Brownell and Horgan, 2004). These other factors include: (a) the worldwide shifts in trade of technology innovations that affect energy expenditures during leisure, transportation, and work; (b) globalization of modern food processing, marketing and distribution techniques (most frequently linked with westernization of the world's diet); (c) vast expansion of the global mass media; and (d) other changes that constitute the rubric of impacts resulting from an increased opening of our world economy.

Globalization has certainly enhanced the interconnectedness of the world in terms of trade in goods, technology, services, and spread of the modern mass media. These changes began in the last half of the previous century and were accelerated by the push from the higher-income countries for more open markets for these items. During this period, international agencies (e.g., the International Monetary Fund [IMF] and the World Bank) and most of the higher-income countries, have promoted a “free trade” agenda as the panacea for the ills of the developing world. This article does not focus on the exact linkages between each aspect of globalization and how it affects the increased trade in services, commodities, processed products, technology, and investments; rather, the focus is on understanding how technological and other shifts are linked to, and affect diet, activity, and obesity throughout the world. Since it is impossible at this time, with the available databases, to fully link each aspect of globalization exactly to each one of these elements, we can, however, document many threads of change that clearly relate to their global shifts.

A range of studies published during the last few years by this journal and others have discussed the increases in noncommunicable diseases and many other critical worldwide health issues; certainly obesity is a major factor in these increases (McMichael and Beaglehole, 2000; Mann, 2002). Equally important is research showing that, not only is obesity a major burden of the poor in the developed higher-income countries, but the poor in the developing world countries are increasingly more likely to be obese than are their higher-socioeconomic (SES) brethren (Monteiro et al., 2004; Mendez et al., 2005).

After briefly reviewing some of the evidence about the rapid changes in obesity, this paper proceeds to examine the major shifts in physical activity patterns in market work, transportation, and leisure that are occurring in the developing world. Next, the shifts in diets and the food system, (including the processing, distribution and marketing of food) are addressed. This is followed by a review of changes in the penetrations of the modern mass media and the modern food sector. A brief discussion ends the article. Examples of all key changes are presented. One critical point is emphasized: the heterogeneity of diet and activity pattern shifts that are leading to the same end product – increased obesity in the developing world.

The global obesity pandemic: a quickening of change in the developing world

Not only is the high prevalence of overweight and obesity in many developing countries of particular importance, but also the quite rapid rate of change. There are few developing countries which have comparable, nationally representative or random samples of adults who have been directly weighed and measured. We utilize only surveys with direct measures of weight and height. The term body mass index (BMI) is a mathematical calculation used to determine whether a person is overweight or obese. BMI is calculated by dividing a person’s body weight in kilograms by their height in meters squared (weight [kg]/height [m]²). Errors in classification can occur due to pregnancy or increased musculature. Being obese and being overweight are not the same condition. A BMI of 30 or more is considered obese and a BMI between 25 and 29.9 is considered overweight (WHO Expert Committee, 1995; WHO/FAO, 2003). There are many factors that impact a person’s health risk relative to their BMI such as a waist size, smoking, the types of foods someone eats regularly, exercise, and medical conditions associated with obesity including diabetes, high blood pressure, high cholesterol, and coronary heart disease.

The prevalence of overweight and obesity presented in Fig. 1, Panel A represents direct measures of the proportion of adults in each country under varying levels of development; countries such as Egypt, Mexico, and the Black (African) population of South Africa have a similar overweight and obesity profile with the United States. Fig. 1, Panel B presents, for a set of countries with comparable representative data at two points in time, the percentage of the adult population that is becoming overweight in each year (if a linear pattern of growth in overweight prevalence is assumed). For instance, Panel B shows that 2.4% of the adult Mexican female population becomes overweight each year, while among US adult women, only 0.39% become overweight each year. The shifts in becoming overweight for the larger countries with populations over a hundred million (e.g., Brazil, Mexico, and China) are also much greater than for the United States. The gross national incomes per capita are added to show for Panel A and B how the US compares with these other countries.

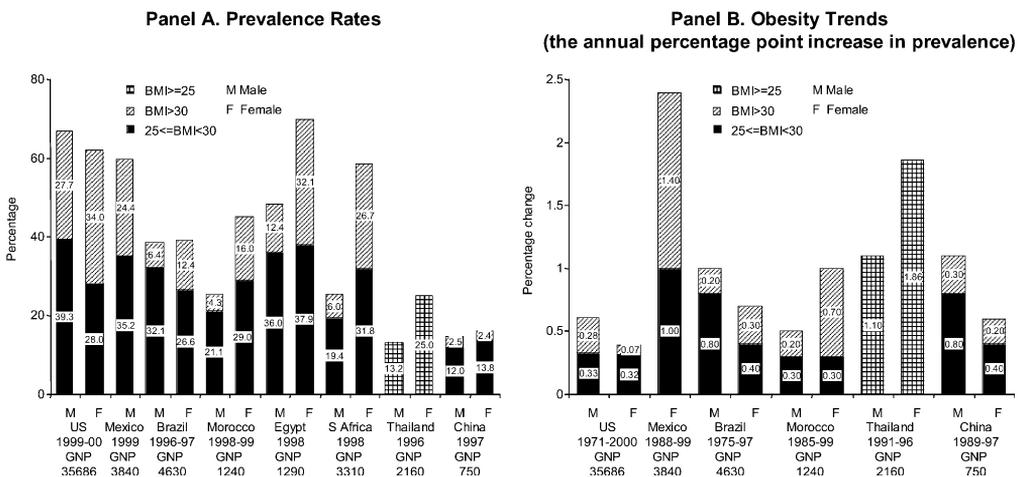


Fig. 1. Obesity patterns and trends across the world, adults aged 20 years and older. Panel A: prevalence rates. Panel B: obesity trends (the annual percentage point increase in prevalence).

While many scholars have felt thought these shifts in obesity were limited to urban areas and that most of the developing world faces much greater underweight than overweight problems of malnutrition, this is no longer the case (at least among women of child-bearing age) (Mann, 2002; Lang and Heasman, 2004).

Data on the body mass index (BMI) distribution are the only nutrition-related data available on a nationally representative comparable basis for many countries; individual dietary intake and physical activity patterns and trends are available for few countries. Food balance data as well as household food expenditure surveys do abound but little individual intake data are available. The full scope of dietary changes are not presented in this article; however, evidence is provided elsewhere on the rapidity of diet shifts in countries with quality, detailed dietary data (Popkin, 2002). Fig. 2 presents (for a set of countries with identical methods of measuring weight and height for women of child-bearing age) data on underweight and overweight. As shown, far more obesity (than underweight) is found in rural and urban areas in most countries; however, underweight [in rural regions of Haiti, India, and a few subSaharan countries exceeds obesity (Mendez et al., 2005).

Unfortunately there are few systematic studies of child obesity trends in the developing world (Wang et al., 2002) or even of systematic studies using the same measurement standards for children. The Wang et al. study, utilizing large nationally representative samples and the same standards for measuring obesity found that child overweight trends in most countries lagged behind those of the United States. In a new study it is shown that absolute rates of increase in overweight tended to be higher among adults than children in most countries – much higher in the two low income countries (China

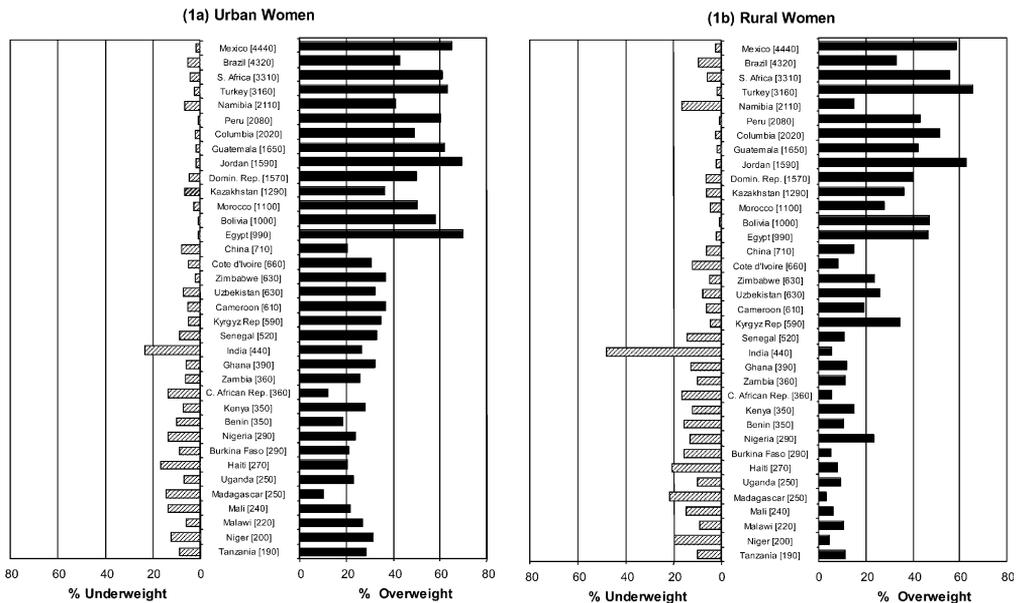


Fig. 2. Overweight and underweight prevalence in women aged 20–49 years in 36 developing countries ranked by gross national income (GNI) per capita. (a) Urban Women. (b) Rural women. Overweight = BMI \geq 25; underweight = BMI \leq 18.5. Source: Mendez et al. (2005). The AJCN is thanked for providing permission to reprint this figure.

and Indonesia) and moderately higher in Brazil and two of the three high income countries (UK, USA) (Popkin et al., 2006). Only in Australia, overweight increased more among children than adults. However, relative rates of increase in overweight indicate faster increase in overweight among children in Brazil and the three high income countries. As a result, the relative excess of overweight among adults, seen initially in all countries, increased in China, Indonesia, and Russia, but it decreased in Australia, Brazil, UK, and USA. In the case of Brazil, time trends indicate an acceleration in the speed of increase in overweight for children and a deceleration for adults while in the case of the USA, the increase in overweight shows acceleration for both children and adults (Popkin et al., 2006).

Diabetes, heart disease and other noncommunicable diseases are rapidly emerging as the major causes of death in most of the developing world

Linked with the rapid increase in obesity, inactivity, and changes in dietary intake patterns has been a rapid increase in morbidity and mortality linked from diabetes, hypertension, stroke and cardiovascular disease and many cancers. For instance, these changes are so rapid that many predict countries like China will see a marked increase in total adult mortality rates over the next several decades (Dong et al., 2005; Lazar, 2005; Pan, 2005). This is seen in large increases in medical costs and other health-related costs (Popkin et al., 2001, in press; Beaglehole and Yach, 2003). The age structure of diabetes has been younger in the developing world, indicative of even larger economic and health care consequences than is found in the higher income world (Zimmet, 1992; Zimmet et al., 1997).

There is a large literature that shows how a larger BMI, particularly as populations shift from BMI's in the low 20's and upwards, are linked with major increases in a large array of diseases. Diabetes, stroke, hypertension, osteoarthritis, gall bladder, cardiovascular disease, and selected cancers are all directly linked with obesity (Must et al., 1999; Kopelman, 2000; WHO/FAO, 2003; Calle and Kaaks, 2004; Popkin et al., in press).

It is also critical to note that obesity is not the only way that poor dietary intake and physical activity patterns can affect health. Factors such as high saturated fat intake, low intake of fruits and vegetables, high intake of *trans* fatty acids, and sedentarianism are associated with much higher levels of many noncommunicable diseases (Popkin et al., in press).

A rapid shift in technology innovations for work and transportation is occurring!

Beginning in the 1990s, quite pervasive shifts in the technology innovations for performing work in urban areas have been provided and observed to be increasing in rural areas. While there are several major shifts occurring – a global increase in the proportion of service sector jobs and a reduction of efforts required by each job, it is the change of energy expended in each occupation that appears to be most important. In China, where the China Health and Nutrition Survey has been longitudinally observing 16,000 adults and children since 1989 using six panel surveys, the shifts in activity among the adults have been carefully documented (Bell et al., 2001).

The following relationships have been observed in China:

- Adults who purchased motor scooters/motor bikes or cars to travel to work doubled their likelihood of becoming overweight, in comparison to those that made no change in their mode of transportation (Bell et al., 2002).
- Occupational changes accounted for a significant proportion of the weight gain and incident overweight of Chinese adults, especially in urban areas (Bell et al., 2001).
- In a four-year period, 16% of Chinese adults' overall work-related physical activity patterns in urban areas shifted significantly to lighter activity, a shift related to significant increases in BMI and overweight (Paeratakul et al., 1998; Popkin, 1999; Bell et al., 2001).
- The proportion of Chinese adults, aged 20–45 years, performing light physical activity work increased from 24% to 34% (see Table 1) during the 1989–2000 period. Most of the shift toward lighter work occurred in urban areas, while concurrent changes found many in the rural sector increasing their activity patterns.

Among all adults in the developing world, there was a significant increase in the proportion working in service sector jobs and a large decrease in those involved in farming, forestry and mining – very strenuous occupations (Popkin, 1999).

There is limited evidence on adult physical activity trends in other developing countries, but what evidence does exist, seems to mirror the Chinese experience.

Diets are changing equally fast!

The vast shifts in diets in the developing world have been documented in detail elsewhere (Drewnowski and Popkin, 1997; Popkin, 2003; Popkin and Nielsen, 2003). The structure of diet in the world is changing. The shift is from a diet dominated by starchy staples – mainly coarse grains and other partially processed grains, vegetables, and legumes to one where processed foods predominant and animal source foods represent a far greater proportion of all calories. The major shifts have been in the remarkable increase in the consumption of edible vegetable oils, the increase in consumption of added caloric sweeteners, and the increased intake of animal source foods (e.g., dairy, egg, poultry, beef, pork, and fish). Other shifts include a marked shift away from fruits, vegetables, and whole grains, as well as the calcium intake. Table 1 documents some of these changes for adults in China.

Globally vegetable oil intake is one of the key engines of the diet change in most low and middle income countries (Popkin and Drewnowski, 1997). Edible oil intake per capita in China has increased during these 11 years from 58 to 72 g/day, most of that increase coming in the 1989–1993 period (Table 1). This is a doubling in the proportion of energy from edible oil in the Chinese diet and a second major reason along with added animal source foods for the increased energy density in the Chinese diet. The next section provides details on the role that technological change and its spread paid in the shift in the increased intake of edible oil. Edible oil intake almost doubled from 7.8% to 15.0% of total daily caloric intake.

Increased consumption of caloric sweetener is another element in the world's dietary changes, represented by a 74 calorie/day increase between 1962 and 2000 (Popkin and Nielsen, 2003). US data showed a greater intake and that 80% of the US increase came

Table 1
Nutritional and health status measures of Chinese adults, ages 20–45 years of age, 1989–2000^a

Exposure element	Exposure parameters	Exposed adult group	Prevalence	
			1989	2000
Physical activity	Heavy (%)	Total	41.9	47.4
	Moderate (%)	Total	33.9	19.0
	Light (%)	Total	24.2	33.6
% Energy from edible oil	%	Total	7.8	15.0
% Energy from animal source foods	%	Total	9.2	16.3
Vegetable oil intake	g/day	Total	58.1	71.9
Total fat energy	% >30% energy from fat	Total	13.9	44.0
Saturated fat	% >10% from saturated fat	Total	38.8	59.7
Fruit/vegetables	% < 300 g/day ^b	Total	59.0	65.9
Whole grains	% <100 g/day ^b	Total	84.0	93.4
Refined grains	% 500 g/day ^b	Total	39.0	22.8
Calcium	% <400 mg/day	Total	61.7	80.8
TV Households	% Black/white	Total	48.5	18.5
	% Color	Total	32.7	67.7
	% Either black/white or color	Total	63.1	91.4
Overweight	% BMI \geq 25 and <30	Male	6.0	19.6
		Female	10.3	21.3
		Total	8.2	20.5
Obesity	% BMI \geq 30	Male	0.4	3.1
		Female	0.8	3.7
		Total	0.6	3.4
Overweight and obesity	BMI \geq 25	Male	6.3	22.7
		Female	11.1	25.0
		Total	8.8	23.9
Hypertension	Diastolic pressure \geq 90 mmHg or systolic pressure \geq 130 mmHg	Male	13.6	31.1
		Female	8.2	21.8
		Total	10.8	26.3

^a China Health and Nutrition Survey, 1989 and 2000.

^b Chinese nutrition Society. Chinese Dietary Guidelines and Dietary Pagoda. Beijing, People's Medical Publishing House, 2001.

from sugared beverages. Comparable individual intake data on caloric sweetener consumption are available for few countries.

One major change in China and other developing countries is the proportion of energy that has come from animal source foods, including pork, beef, poultry, fish, and eggs mainly. This has resulted in an increase in saturated fat intake. Elsewhere we have presented these shifts using the standard FAO structure of diet associated with varying income levels to show this shift (Drewnowski and Popkin, 1997; Guo et al., 2000). Here we just show the large increases in the key components. Over the past three to four decades, major subsidies in feed grains, livestock research, and livestock production have resulted in marked declines in the cost of 100 kg of beef – from US \$500 to less than \$200 by 1994–1996 (Delgado et al., 1999; Delgado, 2003). In China, this is reflected in the large increase in the proportion of the adult population whose saturated fat consumption was greater than 10% of their energy intake; this proportion increased to 60% by 2000.

Another increase previously found in the West has now been observed in China [i.e., a shift from higher-fiber more satiating whole grains to lower-fiber refined grain products (Table 1)] markedly shifting some of the healthier aspects of the Chinese.

By 2000, Chinese adults had inadequate intake levels of fruit and vegetables, whole grain, and calcium. Nearly 66% were deficient in fruits and vegetable intake, more than 93% were deficient in whole grain intake, and 81% had low levels of calcium intake. Many of these changes were the result of marked shifts in production, processing, and distribution of foods as expanded in subsequent sections.

Food system changes are equally profound!

Two important examples of the changes in the global food system are found in (a) the rapid increase in consumption of low-cost edible vegetable oils and (b) the way large supermarkets and supermarket chains have gained control of food distribution. One of the earliest food system changes provided inexpensive, readily available oils and related commodities to the developing world; the result being that lower-income countries can now consume fat levels equivalent to the consumption in higher-income countries (Drewnowski and Popkin, 1997).

The edible vegetable oils story is particularly important as its effects have been quite profound. Until the decade following World War II, the majority of fats available for human consumption were animal fats, milk, butter, and meat. Subsequently, a revolution in the production and processing of oilseed-based fats occurred. Principal vegetable oils include soybean, sunflower, rapeseed, palm, and peanut oil. Technological breakthroughs in the development of high-yield oilseeds and in the refining of high-quality vegetable oils greatly reduced the cost of baking and frying fats, margarine, butter-like spreads, salad oils, and cooking oils in relation to animal-based products (Williams, 1984). Worldwide demand for vegetable fats was fueled by health concerns regarding the consumption of animal fats and cholesterol. Furthermore, a number of major economic and political initiatives led to the development of oil crops, not only in Europe and the United States, but in South East Asia (palm oils), in Brazil, and in Argentina (soybean oils). The net effect was that from 1945 to 1965, there was almost a fourfold increase in the US production of vegetable oils, while animal fat production increased by only 11% (US Department of Agriculture, 1966).

In developing nations, one of the earliest shifts toward a higher-fat diet began with major increases in the domestic production and imports of oilseeds and vegetable oils, rather than increased imports of meat and milk. At this stage, vegetable oils contributed far more energy to the human food supply than meat or animal fats (Morgan, 1993). With the exception of peanut oil, global availability of the vegetable oils (i.e., soybean, sunflower, rapeseed, and palm) has approximately tripled from 1961 to 1990. Soybeans now account for the bulk of vegetable oil consumption worldwide. It is also important to note that many of these processed oils are not regulated well and some of the new edible oils or other foods are highly pathogenic (Wallingford et al., 2004).

The other important change in the global food system is occurring in food distribution. There is no research to date that can provide any analysis of the consequences of these food distribution shifts on dietary intake patterns. The fresh (wet) market is disappearing as the major source of supply for food in the developing world. They are being replaced by multinational, regional, and local large supermarkets – supermarkets which are usually

part of larger chains (e.g., Carrefour or Walmart) or in other countries such as South African and China local domestic chains patterned to function and look like these global chains. Increasingly, large megastores are found. For example, in Latin America, supermarkets' share of all retail food sales increased from 15% in 1990 to 60% by 2000 (Reardon et al., 2003). For comparison, 80% of retail food sales in the United States in 2000 occurred in supermarkets. In one decade, the role of supermarkets in Latin America has expanded equivalent to about a half century of expansion in the United States. Supermarket use has spread across both large and small countries, from capital cities to rural villages, and from upper- and middle-class families to the working class (Hu, 2004). This same process is also occurring at varying rates and different stages in Asia, Eastern Europe, and Africa.

There are many factors causing this food system phenomenon (Wilkinson, 2004). Consumer demand for processed and safer foods is on the rise in developing countries. Additionally, as countries modernize, the opportunity cost of women's time has grown; building a market for time-saving, prepared foods has become more important. Transportation and access to technology, such as refrigerators, has also played a role in the demand for, and access to, supermarkets. Other factors include the liberalization of direct foreign investment, trade liberalization, and the saturation of Western markets that has pushed growing companies into other locales. Furthermore, improvements in the logistics and procurement systems used by the supermarkets have allowed them to compete on cost with the more typical outlets in developing countries: the small "mom-and-pop" stores and wet markets (open public markets) for fruits, vegetables, and all other products.

Supermarkets are large providers of processed higher-fat, added-sugar, and salt-laden foods in developing countries, but they have also been the purveyors of some good. For example, supermarkets (a) were instrumental in the development of UHT ultra heat treatment, milk giving it a long shelf life and providing a safe source of milk for all income groups and (b) were key players in establishing food safety standards (Balsevich et al., 2003). Most importantly, they have solved the cold chain and in many instances have brought higher-quality produce to the urban consumer throughout the year.

It remains to be understood how the shift in food marketing to these mega supermarkets will affect the structure of the diet and also the amount of total food consumed. There needs to be research on the ways these new food markets affect overall prices as well as relative prices of different food group categories. Furthermore, other research needs to be done how this shifts the consumption of refined versus complex carbohydrates, calorically sweetened foods, animal source foods, fruits and vegetables, among other key issues.

Mass media changes are equally profound!

One of the least discussed and least understood areas of change affecting dietary and physical activity patterns is the role of the modern mass media. Throughout the developing world, there has been a profound increase in the ownership of television sets and the penetration of modern television programming. This has been accompanied by a proliferation of modern magazines and ready access to DVDs of Western movies. Documentation of the health implications of this phenomenon are not understood. Examples from China are used to illustrate this set of changes. Many scholars accuse television viewing as being directly responsible for child obesity, due both to its effect on energy expenditure as well as

to the direct marketing of food on the television. This remains to be studied in most developing countries in a rigorous causal manner.

Television (TV) set ownership and modern TV programming are recent phenomena in China. In China, less than two-thirds (63%) of households owned a TV in 1989, and most (49%) owned a black and white set. By 2000, more than 91% of Chinese households owned a TV, with most (68%) owning a color set (see [Table 1](#)).

While the majority of American children watched more than 5 h of TV a day in the late 1990s, the average Chinese child spent about an hour a day watching TV and/or playing video games. Only about 10% watched TV more than 1 h a day, and fewer than 5% played video games for more than 1 h ([Bu, 2002](#)).

Programming and advertisements have been rapidly shifting toward more modern and Western content. For instance, the first TV advertisements began with one advertisement in 1979 on a Shanghai TV station and only began in earnest with a large increase in the 1990s. Today, China is considered the world's fastest growing advertising market ([Weber, 2000](#)).

Similar increases in TV ownership and viewership are noted throughout the developing world.

What about Coca-cola and McDonald's – do these sectors of the food industry have any responsibility?

There is a view among some researchers that the US fast food sector and soft drink industry have led to the declines of diets throughout the developing world ([Bell et al., 2002](#); [Lobstein et al., 2004](#)). The growth of American food companies has certainly spread across the globe. Coca-Cola is sold in more than 200 countries and more than half of McDonald's sales are made outside the United States. Many other examples can be found to show that the McDonald's, Pizza Huts, and Kentucky Fried Chicken restaurants are rapidly spreading across the globe. They are quickly followed, or even preceded, by local food chains that follow their models, even to the point of serving the same dishes and being equally hygienic and efficient ([Wang et al., 2002](#); [Lobstein et al., 2004](#)).

Major questions include: What are these companies doing to impact the diet of the developing world? Are they leading people away from their healthy traditional diets to higher-fat and added sugar-laden away-from-home prepared food products? Are they leading to increased portion sizes worldwide, as they have in the United States? The answer might be “yes” or “no”, depending on which country you study and how you examine the data.

On one hand, research which collected individual dietary intake data in detailed, precise ways for large representative samples of children from the Philippines, Russia, and China (together with US data), shows very mixed results ([Adair and Popkin, 2005](#)). The most noticeable difference among these countries is in the intake of away from home food. US and Filipino youth consume more than a third of their total daily calories from foods prepared away-from-home (see [Fig. 3](#)). More meals are purchased away-from-home, and either eaten away (in restaurants or fast food establishments in the United States), or brought home from small cafeterias and street vendors as in the Philippine city of Cebu. In contrast, Chinese children consume very little of their total energy from foods prepared or eaten away-from-home, although more snack foods are purchased away-from-home. Chinese snack foods are typically a biscuit, some peanuts, or fruit. Eating in restaurants

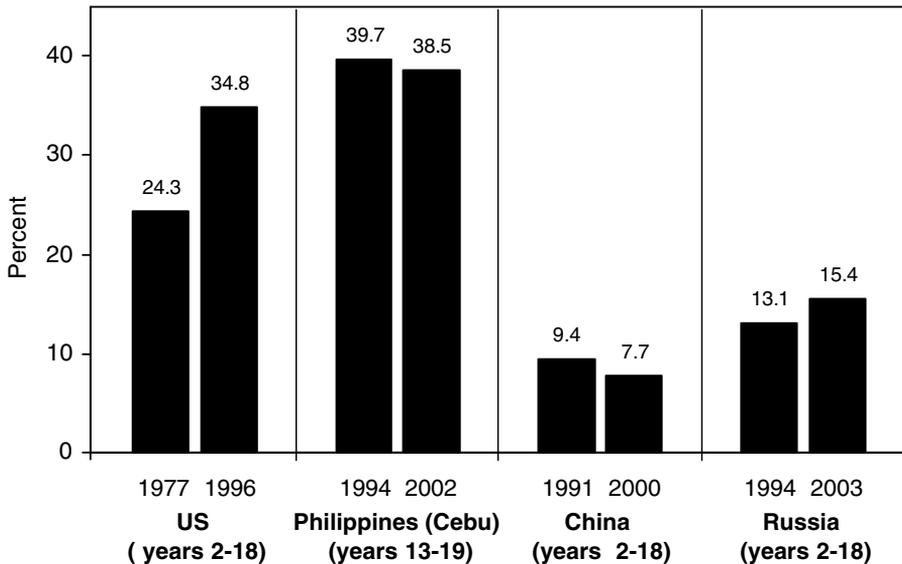


Fig. 3. The proportion of energy consumed from foods prepared away from home. *Source: Adair and Popkin (2005)*. Obesity Research is thanked for providing permission to reprint this figure.

is rare among Chinese families and there is not a tradition of purchasing inexpensive foods from street vendors, as is the case of Cebu. Similarly, in Russia, there is not yet a tradition of bringing ready-prepared foods into the home, nor is there a prevalent practice of taking children to eat in restaurants. Earlier research done with very small samples and some with larger samples found among adults that commercially prepared foods make up about one fourth of urban dweller's diets in the Philippines (Barth, 1983; Cohen, 1986).

The Philippines is not alone in its high of soft drinks. There are other countries, such as Mexico, where supersized US soft drinks have had a major affect on diets (Arroyo et al., 2004).

On the other hand, anthropologists who have tried to understand the impact of McDonald's from the consumer's perspective find a very complex picture. Despite widespread criticism of McDonald's as a symbol of global homogeneity and environmental degradation in East Asia, it was discovered that not all of these changes attributed to McDonald's have been negative (Watson, 1997). In Hong Kong and China, for instance, McDonald's has actually contributed to improving standards of bathroom cleanliness and table manners. The transformation has also affected McDonald's as well as the consumers; McDonald's itself has been forced to adapt to local culture and tastes. McDonald's has undergone a complex process of cultural accommodation, compromise, and change in its assimilation into Asian societies.

These descriptive results in no way allow us to implicate fast foods – either western or local equivalents – in the increase in obesity even in the Philippines. There is virtually no rigorous analysis of how either Western or local chains are affecting both the quantity and quality of food consumed and hence overall weight. In the US, there is an increasing body of longitudinal research that appears to show how increased consumption of fast foods does link with obesity and diabetes, among others (Bowman et al., 2004; Pereira et al., 2005).

A potential biological pathway: the development origin of disease

The shift toward greater obesity and higher levels of noncommunicable diseases in the developing world may well have the seeds planted a generation or more earlier. A growing body of research, centered on the concept of the developmental origins of health and disease, argues that early preconceptual and infant nutrition and other insults will subsequently enhance the subsequent propensity to obesity and related comorbidities (Gluckman and Hanson, 2004; Gluckman, Cutfield, et al., 2005; Gluckman, Hanson, et al., 2005; Hanson and Gluckman, 2005). This concept, first popularized by David Barker, fits particularly in a world where low birth weight and poor growth during infancy abound (Barker, 1998, 2001). Linking these insults with subsequent transitions in diet and activity creates a proclivity toward greater obesity (Popkin, 2001).

Discussion

It is possible to begin the identification and measurement of the very large shifts occurring in diet and activity in a few developing countries, and, to measure and identify the obesity patterns in a far larger set of countries. It is also clear that there are major shifts in the way market food and the technology innovations of work, travel, and leisure underlying these changes are processed. We truly live in one world today, where persons living in any major city in a low or moderate income country can eat and move in a manner akin to that of the higher-income cities of the world.

Has globalization mattered? The edible oil story and the examples of shifts in activity levels at work, travel, and leisure in China provide a few examples of the manner in which rapid technological shifts have influenced the adults in a country of more than one billion people; but, it is impossible to ascribe any one factor to any one of these shifts. These changes have been very rapid and certainly the shift to unimpeded direct foreign investments has opened the opportunities for the super markets of the world to rapidly become established in any country and have required domestic equivalent responses. These large supermarket chains ease the way to globally produce and sell modern food stuff but so many other forces have worked together to create these shifts. Further, there is great heterogeneity in these changes across the developing world.

Essentially, this means that one shoe will not fit all. There will need to be many different policy responses for different regions and countries to improve their dietary and physical activity patterns in a marked manner. Ultimately, a major global response is needed to create the evidence to base the array of food price policies, shifts in the food supply, and ways of moving foodstuffs so we can stem this global obesity pandemic. As of yet, at a time when the global health system is focused on infectious diseases and many of the classical diseases which still face hundreds of millions, this new silent global killer is growing rapidly and will require a similar focus.

It is important to note that not all shifts in trade will equally benefit or hurt the entire developing world. The developing world is heterogeneous and some countries are producers and consumers of potentially harmful products such as sugar cane. Reducing sugar intake globally would adversely affect sugar cane producing countries while only having potentially beneficial effects on other countries. The demise of the world coffee agreement in the late 1980s benefited Brazilian coffee growers but hurt Ethiopian and other East

African small producers while reducing coffee prices globally and increasing coffee intake. Also, the nutritional effects of reducing prices must increase an analysis.

What about the World Trade Organization (WTO) and the future? Globalization now has a new engine. In January 1995, after eight years of negotiations, the General Agreement on Tariffs and Trade (GATT) was replaced by a stronger organization – the WTO. Today, there are 148 WTO member countries and WTO rules apply to over 98% of international trade. The WTO has increasingly expanded the scope of its work from its original narrow GATT focus on reducing tariffs on manufactured goods. Now, the WTO also works to eliminate nontariff barriers and has essentially promoted a “free trade” agenda. Unlike United Nations treaties, the International Labor Organization conventions, or multilateral environmental agreements, WTO rules can be enforced through sanctions. This gives the WTO greater power to push and promote the increase of trade in services, commodities, processed products, technology, and investments. This means there are forces pushing for continued rapid integration of the world’s trade in goods, services, and technology. The onset of the WTO does not mean necessarily that we will see more rapid changes in diet or activity patterns and increased obesity. There are no definitive or clear linkages and there is a great need for case studies of relationships such as the one noted below for South Korean. Moreover, it would be naïve to suggest that the WTO would be the cause of any acceleration in obesity. As noted, the process of increasing interconnectedness of the world in terms of trade in goods, technology, services, and spread of the modern mass media started before the WTO and has been enhanced by this new organization.

The WTO has actually forced an opening for multinational entry of various international commercial entities. South Korea is a case where international fast food chains have used new laws to enter a previously restricted market. South Korea had used a focus on its traditional diet as a major nutrition intervention that allowed it to retain its more healthful, traditional diet for a very long time (Kim et al., 2000; Lee et al., 2002). Little rigorous research has been undertaken about the ways reduction of barriers to entry for Western food chains or even other foods is affecting South Korea; however, anecdotal and crude analysis shows a marked shift in the composition of the diet and obesity patterns in this country.

Other forces linked to the policies of various bilateral and multilateral agencies are involved in more subtle ways. For example, traditionally the agriculture sector in the higher income countries first developed basic grain commodities and then shifted to a focus on animal source foods, particularly livestock but also poultry. This pattern of development has continued to be followed by all international agencies involved in the developing world. Also, cash crops receive a major focus. This has meant that cheap sugar is produced and beef and other animal source foods have seen a marked reduction in prices while fruits and vegetable research and promotion has been ignored. Undoubtedly this has shifted relative prices so that fruits and vegetables are relatively more expensive while energy dense and obesogenic commodities have been subsidized. The entire focus of agriculture and rural sector development in many low and moderate income countries is focused on the creation of relatively cheaper sugar and animal source foods compared to fruits and vegetables consumption worldwide. Such distortions certainly affect diet and need to be considered in the future. As we attempt to develop a worldwide agenda related to creating a healthier future these agencies must examine the health implications of their development and agricultural policies.

In summary, globalization is a key force that has changed the world's patterns of energy expenditure, dietary intake, and the resulting diseases. The rapid increase in obesity and other noncommunicable diseases is one negative product of these global changes that the world will need to come to confront. While we can not stop the spread of modern technology, marketing, food processing and mass media, we must understand the associated negative effects and implement an aggressive research program that will lead to effective policy shifts to counteract the negative aspects being created.

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