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The Nutrition Transition in the Developing World

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This article explores shifts in nutrition transition from the period termed the receding famine pattern to one dominated by nutrition-related non-communicable diseases (NR-NCDs). It examines the speed of these changes, summarises dietary and physical activity changes, and provides some sense of the health effects and economic costs. The focus is on the lower- and middle-income countries of Asia, Africa, the Middle East and Latin America. The article shows that changes are occurring at great speed and at earlier stages of countries' economic and social development. The burden of disease from NR-NCDs is shifting towards the poor and the costs are also becoming greater than those for under-nutrition. Policy options are identified.

Two historic processes of change occur simultaneously with or precede the 'nutrition transition'. One is the demographic transition – the shift from a pattern of high fertility and mortality to one of low fertility and mortality (typical of modern industrialised countries). The second is the epidemiological transition, first described by Omran (1971): the shift from a pattern of high prevalence of infectious disease, associated with malnutrition, periodic famine and poor environmental sanitation, to one of high prevalence of chronic and degenerative disease, associated with urban-industrial lifestyles (see also Olshansky and Ault, 1986).

The nutrition transition is closely related to the other two. Large shifts have occurred in diet and in physical activity patterns, particularly in the last one or two decades of the twentieth century. Modern societies seem to be converging on a diet high in saturated fats, sugar and refined foods and low in fibre – often termed the 'Western diet' – and on lifestyles characterised by lower levels of activity. These changes are reflected in nutritional outcomes, such as changes in average stature, body composition and morbidity.

The nutrition transition is described in more detail in Figure 1. In Stage 1, famine begins to recede as income rises. In Stage 2, changes in diet and activity pattern lead to the emergence of new disease problems and increased disability. In Stage 3, behavioural change begins to reverse the negative tendencies and make possible a process of 'successful ageing' (see Manton and Soldo, 1985; Crimmins et al., 1989). The changes are all driven by a range of factors, including urbanisation, economic growth, technical change and culture. For convenience, the patterns can be thought of as historical developments: however, 'earlier' patterns are not restricted to the periods in which they first arose, but continue to characterise certain geographic and socio-economic sub-populations.

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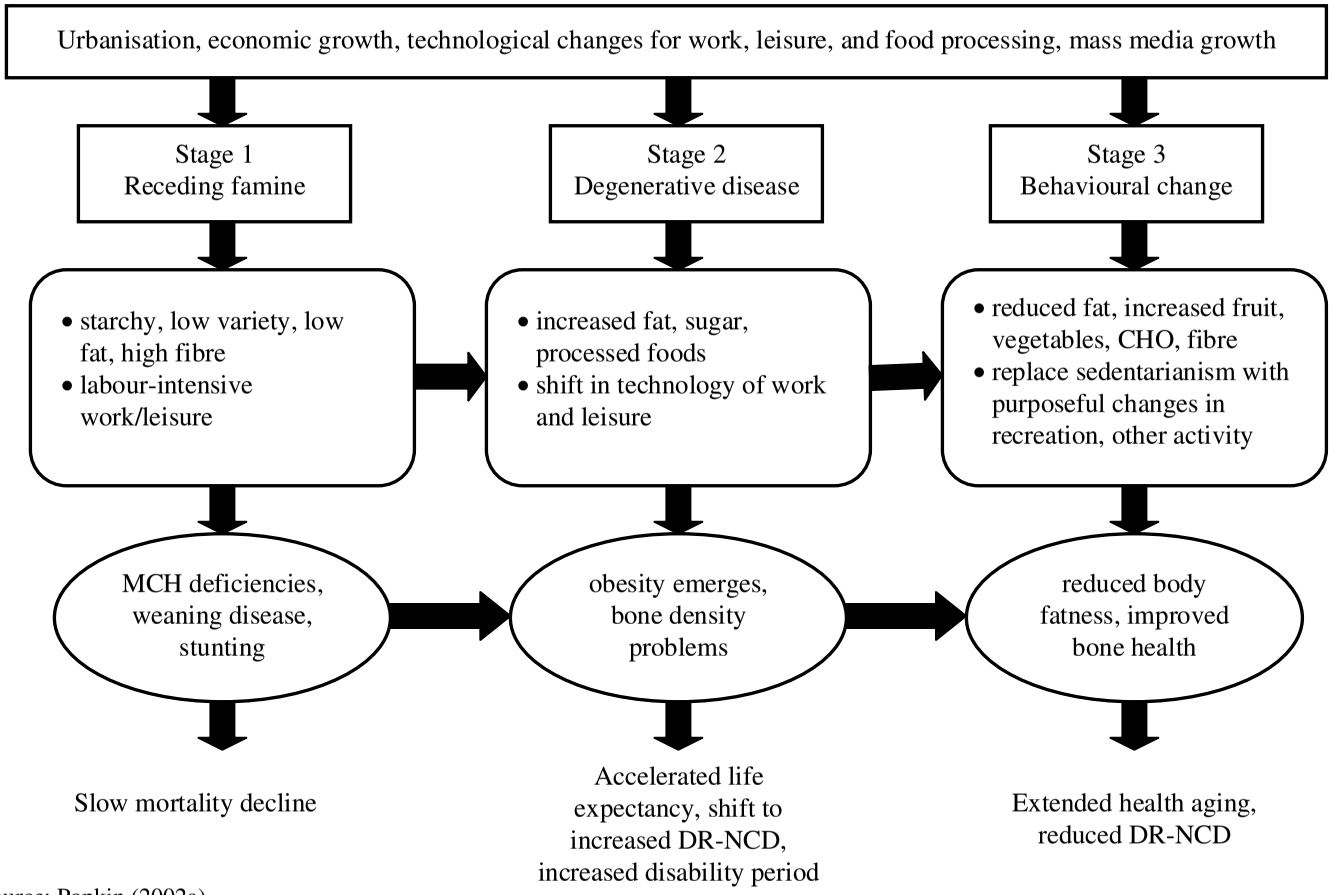
Figure 1: Stages of the nutrition transition



Source: Popkin (2002a).

Dynamics of the food system and related changes

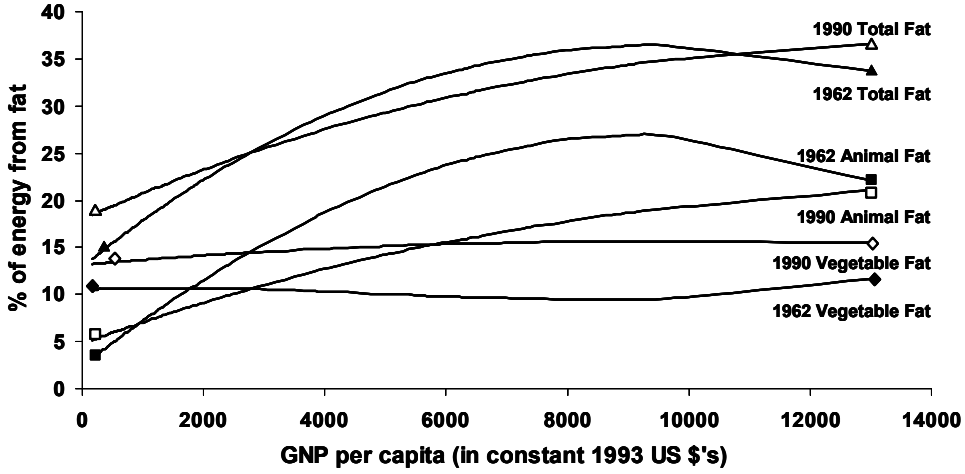
Dietary shifts: more fat, more added caloric sweeteners, more animal source foods

The diets of the developing world are shifting rapidly, particularly with respect to fat, caloric sweeteners and animal source foods (Popkin, 2002b; Popkin and Du, forthcoming).

Edible oil In the popular mind, the Westernisation of the global diet continues to be associated with increased consumption of animal fats. Yet the nutrition transition in developing countries typically begins with major increases in the domestic production and imports of oilseeds and vegetable oils, rather than meat and milk. Between 1991 and 1996/7, global production of vegetable fats and oils rose from 60 to 71 million metric tons (USDA, 1997). In contrast, the production of visible animal fats (butter and tallow) has remained steady at approximately 12 million metric tons. Principal vegetable oils include soybean, sunflower, rapeseed, palm and groundnut oil. With the exception of groundnut oil, global availability of each has approximately tripled between 1961 and 1990.

Fat intake increases with income, but there have also been dramatic changes in the aggregate income-fat relationship. These are displayed for the period 1962-90 in Figure 2. Most significantly, even poor nations had access to a relatively high-fat diet by 1990, when a diet deriving 20% of energy (kcal) from fat was associated with countries having a GNP of only $750 per capita. In 1962, the same energy diet (20% from fat) was associated with countries having a GNP of $1475 (both GNP values in 1993 dollars).

Figure 2: Relationship between the % of energy from fat and GNP per capita, 1962 and 1990



Source: Nonparametric regressions run with food balance data from FAO, UN and GNP data from the World Bank for 132 countries; Guo et al., 2000.

This dramatic change arose principally from a major increase in the consumption of vegetable fats. In 1990, these accounted for a greater proportion of dietary energy than animal fats for countries in the lowest 75% of countries (all of which have incomes below $5800 per capita) of the per capita income distribution. The change in edible vegetable fat prices, supply, and consumption is unique because it affected rich and poor countries equally, but the net impact is relatively much greater on low-income countries.

Caloric sweetener Sugar is the world's predominant sweetener.[1] For this article, however, we use the term caloric sweetener instead of added sugar, as there is such a range of non-sugar products used today. High fructose corn syrup is a prime example as it is the sweetener used in all US soft drinks.[2]

The overall trends show a large increase in caloric sweetener consumed (see Table 1). In 2000, 306 kcals were consumed per person per day, about a third more than in 1962; caloric sweeteners also accounted for a larger share of both total energy and total carbohydrates consumed.

Unsurprisingly, Table 1 shows that all measures of caloric sweetener increase significantly as GNP per capita of the country and urbanisation increase. However, the interaction between income growth and urbanisation is important. Figure 3 shows the relationship between the proportion of energy from different food sources and GNP, for two different levels of urbanisation (see Drewnoswski and Popkin, 1997 for a description of the analysis). In the less urbanised case (Panel A), the share of sweeteners increases sharply with income, from about 5% to about 15%. In the more urbanised case, the share is much higher at lower income (over 15%), and hardly increases with income. The analysis confirms previous observations, that people living in urban areas consume diets distinct from those of their rural counterparts (Popkin and Bisgrove, 1988; Solomons and Gross, 1995).

Animal source foods The revolution in animal source foods (ASF) refers to the increase in demand and production of meat, fish, and milk in low-income developing countries. IFPRI's Christopher Delgado has studied this issue extensively in a number of seminal reports and papers (summarised in Delgado, forthcoming; Delgado et al., 1999). Most of the world's growth in production and consumption of these foods comes from the developing countries. Thus, developing countries will produce 63% of meat and 50% of milk in 2020. It is a global food activity, transforming the grain markets for animal feed. It also leads to resource degradation, rapid increases in feed grain imports, rapid concentration of production and consumption and social change.

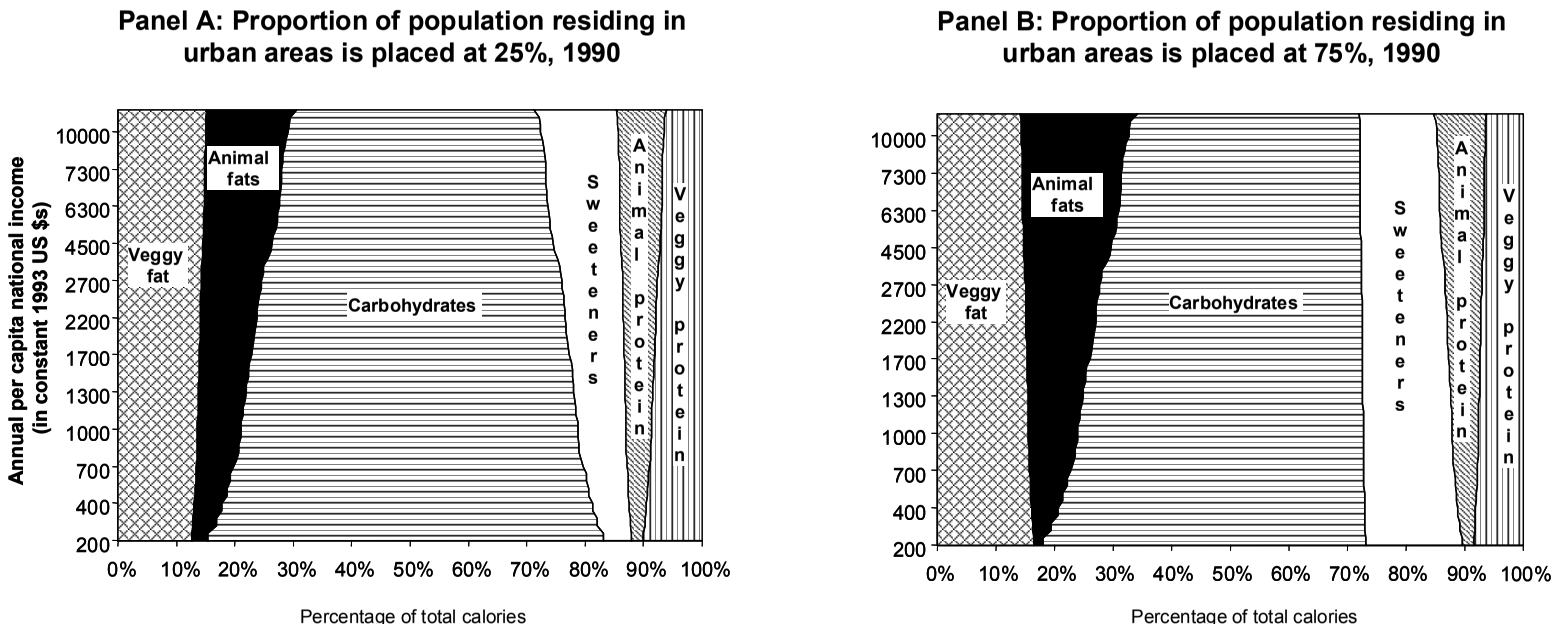
1. It is not clear exactly when sugar became the world's principal sweetener – most likely in the 17th or 18th century, as the New World began producing large quantities of sugar at reduced prices (Galloway, 2000; Mintz, 1977).
2. Under the name sweeteners, the FAO includes products used for sweetening that are either derived from sugar crops, cereals, fruits, milk or produced by insects. This category includes a wide variety of monosaccharides (glucose and fructose) and disaccharides (sucrose and saccharose), which exist either in a crystallised state as sugar or in thick liquid form as syrups. Included in sweeteners are maple sugar and syrups, caramel, golden syrup, artificial and natural honey, maltose, glucose, dextrose, glucose (also known as high-fructose corn syrup), other types of fructose, sugar confectionery and lactose. In the last several decades, increasingly larger quantities of cereals (primarily maize) have been used to produce sweeteners derived from starch.

Table 1: World trends in caloric sweetener intake for GNP and urbanisation quintiles

	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Total
A. Quintiles of GNP (using 1962 GNP levels for each country)						
Caloric sweetener (kcal/capita/day)						
1962	90	131	257	287	402	232
2000	155	203	362	397	418	306
% caloric sweetener of total energy						
1962	4.5	6.2	11.9	12.0	13.5	9.5
2000	6.4	8.3	13.4	13.7	12.7	10.9
% caloric sweetener of total carbohydrates						
1962	6.2	8.5	16.8	17.7	24.4	14.6
2000	9.0	12.1	20.6	22.4	24.6	17.7
GNP						
1962	216	478	983	2817	12234	3282
2000	435	839	2836	5915	28142	7198
% urban						
1962	10.0	21.6	37.3	46.7	66.2	36.1
2000	27.7	41.3	58.7	70.0	78.0	54.9
B. Quintiles of % urban (using 1962 values for each country)						
Caloric sweetener (kcal/capita/day)						
1962	79	131	236	335	389	232
2000	151	201	339	403	441	306
% caloric sweetener of total energy						
1962	3.8	6.3	11.0	13.2	13.8	9.5
2000	6.5	8.1	12.3	13.7	13.9	10.9
% caloric sweetener of total carbohydrates						
1962	5.4	8.5	15.4	20.3	24.1	14.6
2000	6.0	12.1	19.2	22.7	25.7	17.7
GNP						
1962	287	734	1294	4696	9606	3282
2000	653	1798	8798	11739	20568	7198
% urban						
1962	7.1	20.4	33.9	47.6	73.0	36.4
2000	27.0	42.3	57.6	64.9	84.0	54.9

Source: Popkin and Nielsen (forthcoming); FAO, FAOSTAT data set for food balance data.

Figure 3: Relationship between the proportion of energy from each food source and GNP per capita and urbanisation



Sources: Drewnowski and Popkin (1997); food balance data from the FAO; GNP data from the World Bank; regression work by UNC-CH.

Summary of food changes: the China example Data from China are useful for summarising these changes for a typical fast growing economy (Table 2). The shift in the Chinese diet follows a classic Westernisation pattern (for more detail on these Chinese changes, see Du et al., 2002; Popkin et al., 1993).

Table 2: Shift in consumption in Chinese diet (mean intake grams/per capita/per day)

Food	Urban		Rural		Low income		Mid income		High income		Total	
	89	97	89	97	89	97	89	97	89	97	89	97
Total grains	556	489	742	581	811	615	642	556	595	510	684	557
Coarse	46	25	175	54	226	68	98	43	78	30	135	46
Refined	510	465	567	527	585	546	544	513	517	479	549	511
Fresh veg.	309	311	409	357	436	356	360	357	335	325	377	345
Fresh fruit	14.5	36	14	17	5.5	8	13	18	26	38	15	21.7
Meat and meat products	73.9	97	44	58	36	40	58	64	67	96	53	67.8
Poultry and game	10.6	16	4.1	12	4.1	7	6.6	10	7.7	20	6.1	12.7
Eggs and egg products	15.8	32	8.5	20	6	14	11	22	16	32	11	22.7
Fish and seafood	27.5	31	23	27	12	16	29	26	33	40	25	27.9
Milk and milk products	3.7	4	0.2	0.9	0.8	0.1	0.2	1.4	3.5	3.6	1.3	1.7
Plant oil	17.2	40	14	36	13	32	16	37	16	42	15	37.1

Source: China Health and Nutrition Study, 1989-97, for adults age 20 to 45.

First, we find that intake of cereals decreased considerably during the past two decades in both urban and rural areas and among all income groups (Table 2). During the eight-year period from 1989 to 1997, the total intake of cereals decreased by 127g per capita per day (67g for urban residents and 161g for rural residents). The decrease in the low-income group was the largest, at 196g per capita, compared with their counterparts in mid- and high-income groups (86g and 85g respectively). However, there remains an inverse relationship between income and cereal intake. For example, in 1997, the intake in low-, mid- and high-income groups was 615g, 556g and 510g per capita, respectively.

The shift away from coarse grain consumption such as millet, sorghum and corn, is a key component of this change. CHNS data showed a 38g decrease in refined cereals between 1989 and 1997, but an even larger decrease in coarse cereal consumption of 89g.

Second, consumption of animal products increased, more so for the rich than the poor, and for the urban than the rural. As shown in Table 2, urban residents' intake of animal foods per capita, per day in 1997 was higher than for rural residents (178.2g for urban vs 116.7g for rural) and also showed a larger increase (46.7g vs 36.8g) from 1989 to 1997. The amount and growth of intake of animal foods were positively associated with income levels. The intake level and the increase in the high-income group from 1989 to 1997 were almost three times those in the low-income group.

Third, and partly as a result of this change, data from the CHNS also show a shift in the diet away from carbohydrates to fat (Table 3). Energy from carbohydrates fell for all residents, and by over 20% for urban residents. Energy from fat increased sharply, from 19.3% in 1989 to 27.3% in 1997. Other data show that over 60% of urban residents consumed more than 30% of energy from fat in 1997.

Table 3: Shifts in energy sources in Chinese diet for adults aged 20 to 45 (%)

	% energy from fat				% energy from carbohydrates			
	89	**91**	**93**	**97**	**89**	**91**	**93**	**97**
Urban	21.4	29.7	32.0	32.8	65.8	58.0	55.0	53.3
Rural	18.2	22.5	22.7	25.4	70.0	65.6	65.2	62.1
Low-income	16.0	19.3	19.7	23.0	72.9	69.2	68.6	64.4
Mid-income	20.3	25.2	25.5	27.1	67.5	62.6	62.2	60.3
High-income	21.5	30.0	31.5	31.6	65.4	57.5	55.4	54.8
Total	**19.3**	**24.8**	**25.5**	**27.3**	**68.7**	**63.2**	**62.1**	**59.8**

Source: China Health and Nutrition Survey, 1989-1997.

Finally, when we specifically examine the combined effect of these various shifts in the structure of rural and urban Chinese diets, we find an upward shift in the energy density of the foods consumed (Popkin and Du, forthcoming). The kcal of energy intake from foods and alcohol per 100 grams of food in both urban and rural Chinese adult diets increased by 13% between 1989 and 1997. These are really very rapid shifts.

Critical related reductions in physical activity

There are several linked changes in physical activity occurring jointly. One is a shift away from the high energy expenditure activities such as farming, mining and forestry towards the service sector. Elsewhere we have shown this large effect (Popkin, 1999). Reduced energy expenditures in the same occupation are a second change. Other major changes relate to mode of transportation and activity patterns during leisure hours.

China again provides interesting illustrations. Table 4 shows that the proportion of urban adults (male and female) working in occupations where they participate in

Table 4: Labour force distribution among adults, aged 20 to 45, by level of activity (%)

		Light		Vigorous	
		1989	**1997**	**1989**	**1997**
Urban	Male	32.7	38.2	27.1	22.4
	Female	36.3	54.1	24.8	20.8
Rural	Male	19.0	18.7	52.5	59.9
	Female	19.3	25.5	47.4	60.0

Source: China Health and Nutrition Survey, 1989-1997.

vigorous activity patterns has decreased. In rural areas, however, there has been a shift for some towards increased physical activity linked to holding multiple jobs and more intensive effort. For rural women, there is a shift towards a larger proportion engaged in more energy-intensive work, but there are also sections where light effort is increasing. In contrast, for rural men there is a small decrease in the proportion engaged in light work effort.

In China, 14% of households acquired a motorised vehicle between 1989 and 1997. In one study we showed that the odds of being obese were 80% higher ($p<0.05$) for men and women in households which owned a motorised vehicle compared to those which did not own a vehicle (Bell et al., 2002).

Television ownership has skyrocketed in China, leading to greater inactivity during leisure time (see Du et al., 2002).

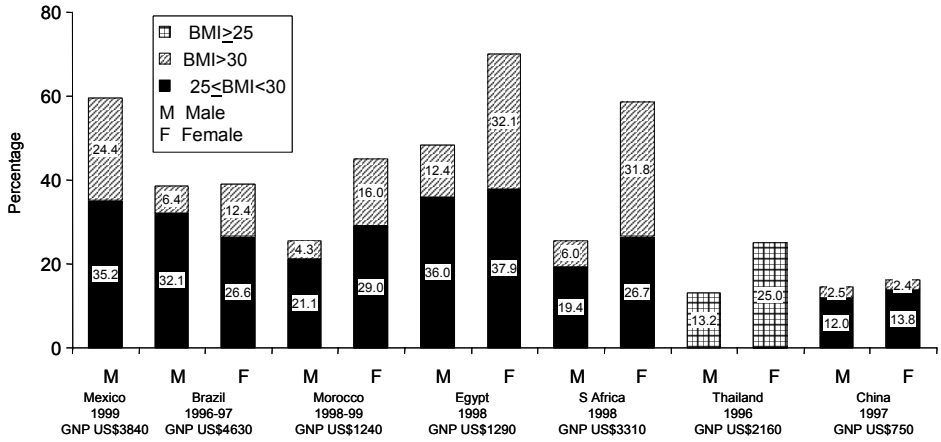
Resultant changes in obesity, diabetes and mortality profile

The interaction of dietary shifts and changes in physical activity has significant consequences for obesity, diabetes and mortality. The burden lies most heavily on the poor.

Obesity In a series of papers published in a recent issue of *Public Health Nutrition*,[3] the current levels of overweight in countries as diverse as Mexico, Egypt, and South Africa are shown to be equal to or greater than those in the United States. Moreover, the rate of change in obesity in lower- and middle-income countries is shown to be much greater than in higher-income countries (see Popkin, 2002a, for the overview).

Figure 4 presents the level of obesity and overweight in several illustrative countries (Brazil and Mexico, Egypt and Morocco, South Africa, Thailand and China).

Figure 4: Obesity patterns across the developing world



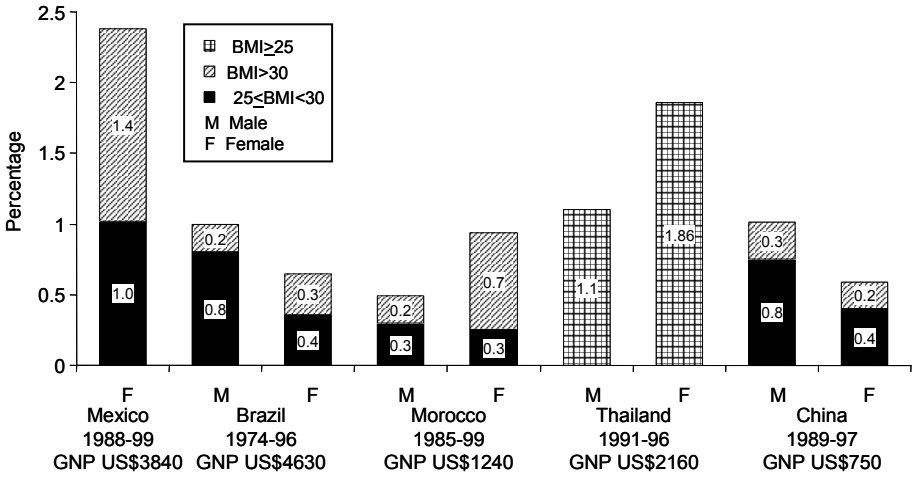
Source: Popkin (2002a).

3. All available as pdf files in the Bellagio papers section of www.nutrans.org

Most interesting is the fact that many of these countries with quite high overweight levels are very low-income. Moreover, it probably surprises many people that the levels of obesity of several countries – all with much lower income levels than the US – are so high.

Figure 5 shows how quickly overweight and obesity status has emerged as a major public health problem in some of these countries. Compared with the US and European countries, where the annual increase in the prevalence of overweight and obesity is about 0.25 for each, the rates of change are very high in Asia, North Africa, and Latin America – two to five times greater than in the US.

Figure 5: Obesity trends among adults in selected developing countries (annual % increase in prevalence)



Source: Popkin (2002a).

Diabetes The rising burden of non-communicable diseases (NCDs) has been the most globally pervasive change among nutrition-related health transitions. There is a growing literature documenting rapid increases in diabetes in many lower-income countries, caused mainly by diet change and inactivity (Levitt et al., 1993; Hodge et al., 1996, 1997, Zimmet, 1991; Zimmet et al., 1997). Diet is, however, the least understood determinant. A clear literature has shown that, in terms of mechanisms and epidemiology, obesity and activity are closely linked to Non-Insulin Dependent Diabetes Mellitus. Several reviews lay out the case for these factors.

The prevalence of this debilitating and health care-intensive disease in a number of regions of the developing world, particularly Latin America, North Africa, and the Middle East, is such that the prevalence is already equal or greater than in the US (King et al., 1998). Furthermore, the prevalence already covers 4% of Chinese adults and 2% of Indian adults. Together there are more new cases each year in these two countries than in the rest of the world combined (ibid.). Interestingly, the age-specific prevalence in the developing regions of the world shows a higher proportion of new cases occurring at younger ages than in the higher-income countries.

Mortality The most comparable set of mortality patterns by cause, as well as projections of mortality, come from the global Burden of Disease project (Murray and Lopez, 1996). These and other studies show that a remarkable decline in deaths related to infectious and parasitic morbidity has occurred in China and is still occurring in India. At the same time, the rapid increase in NR-NCDs is already leading in China to an increase in mortality caused by heart disease and cancer. The same will occur soon in India.

The burden is shifting towards the poor In a forthcoming paper, we show that a large number of low- and moderate-income countries already have a greater likelihood that adults residing in lower-income or lower educated households are overweight and obese relative to adults in higher income or education households (Monteiro et al., 2003). This study, based on multi-level analysis of 37 nationally representative data sets, shows that countries with a GNP per capita over about $1700 are likely to have a burden of obesity greater among the poor. It also provides some idea of the set of risk factors causing obesity and other NCDs that are changing rapidly, including poor diets, inactivity, smoking, and drinking.

What are the costs?

Malnutrition of various kinds carries significant costs in all countries. Data from India and China illustrate both the general point and the relative importance of under-nutrition compared with 'new' nutrition problems. The data come from a series of studies conducted in 2000-2002, using large national health service cost data obtained from the 1998 National Survey of Health Services for China, and the 1995-96 National Sample Survey for India. A study of the costs of diet-related non-communicable diseases (focusing only on the diet component, DR-NCDs) was undertaken and linked with another study of under-nutrition undertaken by Horton (Popkin et al., 2001a, b; Horton, 1999; Ross and Horton, 1998).

It is true that under-nutrition accounts for significant economic costs in China and India. For China, individual nutritional deficiencies account for between 0.5% and 1.8% of lost GDP, and for India between 0.7% and 1.1%. The overall cost of under-nutrition, also including cognitive costs, is almost certainly higher. The costs of under-nutrition are projected to diminish by 2025 for China (when individual nutritional deficiencies account for 0.2% of lost GDP), but remain important for India (ranging from 0.4% to 0.7% of lost GDP).

However, the costs of DR-NCD are already substantial and will grow rapidly. Taking health care costs alone, these amounted to 1.6% of GDP for China and 0.35% for India.[4] By 2025, the patterns change considerably in each country. Using current health and nutrition data combined with government and WHO projections, predictions of future health costs were made. The economic analysis shows that, for China, current costs of DR-NCDs are of similar magnitude to costs of under-nutrition, but that DR-

4. In 1995, they accounted for 22.6% of costs to the health care system in China. Costs include hospitalisation costs, out-patient costs, and prescription drugs; the large majority of costs were state expenditures. In India, the corresponding share was 13.9%; private expenditures constitute approximately 90% of the costs and the rest are state expenditures.

NCDs will dominate by 2025. For India, current costs of under-nutrition are greater, but the two are more likely to become equal by 2025.

Why have these changes occurred?

How do we understand the causes of the changes that have occurred?

First, economic theory would clearly predict the changes in diet and activity that we see. Obtaining a more varied and tasteful diet and a less burdensome work pattern is an important choice desired by most individuals. The choices being made are rational. Preferences for dietary sugars and fats are regarded by many as an innate human trait. Sweetness, in particular, serves as the major cue for food energy in infancy and childhood, and preferences for sweet taste are observed in all societies around the globe (Drewnowski, 1987). An argument has been made that preferences for dietary fats are also either innate or learned in infancy or childhood (Drewnowski, 1989). References to the desirable qualities of milk and honey (i.e., fat and sugar), cream, butter and animal fats are found throughout recorded history.

Second, an important factor is the interaction between income and consumption preferences. As we have shown in several studies, not only is income increasing, but the structure of consumption is shifting, and additional higher-fat foods are being purchased with additional income (Popkin and Du, forthcoming; Guo et al., 2000). The China example illustrates the point: for the same extra dollar of income, an average Chinese person is purchasing higher calorie food today than s/he would have done for the same extra yuan a decade ago.

A third element is lower food prices. Delgado (forthcoming) documents the large long-term reduction in the real costs of basic commodities in the developing world over the past several decades. He has shown that inflation-adjusted prices of livestock and feed commodities fell sharply from the early 1970s to the early 1990s, stabilised in the mid-1990s in most cases, and fell again thereafter (Delgado et al., 2001). Others have shown how important cost constraints might be (Guo et al, 1999; Darmon et al, 2002).

Fourth, we might point to the centralisation of the mass media and the generation of major pushes to promote selected dietary patterns directly and indirectly via these media. There is as yet little in the way of rigorous analysis to link shifts in mass media coverage to the consumption or work patterns in the developing world, but there is an emerging literature on increased television ownership and viewing (for example, Du et al., 2002; Tudor-Locke et al., 2003). There is a profound cultural side not only to the globalisation of mass media, but also to the related penetration of Western-style fast food outlets into the developing world. There is some evidence that these changes affect the entire culture of food production and consumption (Jin, 2000; Watson, 1997).

Fifth, an added push has come from technological factors that affect work and leisure, productivity and effort. Most of the changes affecting home production, from piped water to electricity to microwave ovens and lower-cost gas and butane ovens, reduce domestic effort. Similarly, the onset of mass transportation, the availability of cheap motor scooters and cycles and buses reduce energy expenditure in transportation. Similar profound changes affect all types of work. The computer revolution, the availability of small gas-powered systems for ploughing and many others affect the work of farmers and other workers. Importantly, the reduction in the cost of producing and distributing food, and of work-related technology, is affected by urbanisation. More

dense residential development cuts the costs for marketing, distribution, and even production in many cases.

Finally, there are other changes in household purchasing, preparation, and eating behaviour that matter greatly. These include location of the purchase, consumption of food, and the processing of the foods purchased, *inter alia*. Elsewhere we have discussed the rapid shifts in sources of calories away from at-home preparation and consumption to away-from-home purchase and consumption (e.g., Nielsen et al., 2002; Bisgrove and Popkin, 1996; McGuire and Popkin, 1989). There are few systematic studies of location of preparation and consumption in the developing world; however, it is clear that many important changes are occurring in both the level of processed food consumed at home and the proportion of meals consumed away from home. As the food system changes and as incomes rise, these changes are expected to intensify. Reardon and Berdegué's work on supermarkets in Latin America represents one example of a major shift in the marketing of food in the developing world (Reardon and Berdegué, 2002).

Policy options

This article provides a strong case for public investment to find ways to improve the dietary and activity pattern and body composition patterns in developing countries in a way that will prevent the shift towards high levels of NR-NCDs. Health has been seen as a major component of international development for some time; however, most of the focus in the developing world has been on infectious diseases and under-nutrition (World Bank, 1993). For example, the World Bank's 1993 *World Development Report* on Investing in Health focused its entire assessment in the diet and nutrition area on under-nutrition. This article highlights the important economic and nutritional burden facing just two of the many countries confronting this transition. It shows that for many countries more than a quarter to as many as two-thirds of adults are overweight and obese and face a lifetime associated with enormous health care costs and unstudied related social costs and reductions in productivity.

From the individual perspective, having a tastier higher-fat and sweetened diet is desirable. Similarly, a reduction in stressful activity in market and home production is desired. The critical issue is finding effective social investments and regulations that will enhance the components of lifestyle that will reduce these NR-NCDs and provide for a healthier population. Solutions in the food system and physical environment are critical factors to consider. In particular, it is important to focus on changes that affect the poor, as they are the ones least prepared to incur the costs of these NR-NCDs and most likely now or in the future to face the greatest burden from these problems.

Issues to be addressed from the food sector include learning how to increase the intake levels of fruit and vegetables and higher fibre products, and to reduce the intake of caloric sweeteners and fat. We should note that there is great controversy about the need to reduce total fat intake or just the intake of selected types of fats (transfatty acids, erucic acid, saturated fats) (Bray and Popkin, 1998; Willett, 1998). Clearly all agree that the removal of carcinogenic or artherogenic edible oils is important, but the role of total fat is not as clear. Similarly there is some debate about the role of caloric sweeteners. For instance, an expert committee of the WHO has recommended a maximum of 10% of energy from caloric sweeteners, a level above that of caloric sweeteners consumed in

diets in high-, low-, and moderate-income countries (WHO/FAO, 2002). In contrast, the US Institute of Medicine conducted the same review and concluded that 25% of energy from caloric sweeteners was appropriate (Panel, 2002).

Similar shifts in the physical environment to enhance physical activity exist. There is a growing body of knowledge that points to the role of a spread of environmental factors ranging from connectivity of streets to availability of walking options and street safety to the organisation and layout of buildings and communities. Higher density of, and proximity to, opportunities for physical activity, such as recreation facilities (for example, private and public facilities, parks, recreation centres, green spaces, shopping centres) and transportation options (for example, sidewalks, cycle paths, public transportation, high road connectivity, and lower automobile transportation density), will increase physical activity levels and decrease overweight prevalence. Conversely, constraints to physical activity, such as crime and air pollution, will decrease physical activity and increase overweight prevalence.

For each of the desired changes in the food supply and the physical environment, there are clearly myriad options, some easy to implement and many quite complex. A few countries are already beginning to take some steps forward to address these issues (Coitinho et al., 2002; Zhai et al., 2002). There have also been some limited successes in the higher-income world (Puska et al., 2002).

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