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Part II. What is unique about the experience in lower- and middle-income less-industrialised countries compared with the very-high-income industrialised countries?

The shift in stages of the nutrition transition in the developing world differs from past experiences!

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Abstract

Objective: This paper explores the unique nutrition transition shifts in diet and activity patterns from the period termed the receding famine pattern to the one dominated by nutrition-related non-communicable diseases (NR-NCDs). The paper examines the speed and timing of these changes; unique components, such as the issue of finding both under- and overnutrition in the same household; potential exacerbating biological relationships that contribute to differences in the rates of change; and political issues.

Setting: The focus is on lower- and middle-income countries of Asia, Africa, the Middle East and Latin America.

Results: These changes are occurring at great speed and at earlier stages of these countries' economic and social development. There are some unique issues that relate to body composition and potential genetic factors. The significance of the high number of persons exposed to heavy insults during pregnancy and infancy (foetal origins hypothesis) and the subsequent rapid shifts in energy imbalance remains to be understood. Countries that are still addressing major concerns of undernutrition are not ready to address these NR-NCDs.

Conclusions: The developing world needs to give far greater emphasis to addressing the prevention of the adverse health consequences of this shift to the nutrition transition stage of degenerative diseases.

Keywords
Nutrition transition
Dietary change
Physical activity
Obesity

Scholars and policy-makers who focus on obesity and nutrition-related non-communicable disease (NR-NCD) issues in the developing world often assert that the situation facing developing countries is unique. But is the experience related to the rapid onset of obesity and NR-NCDs in the lower- and middle-income countries of Asia, Africa, the Middle East, Latin America and Oceana different from what occurred in Western European countries, the United States and Japan at a similar stage in their economic development? An exploration of the 'differences' in the speed of the nutrition transition across the globe is beyond the scope of this paper but certainly is worthy of future exploration. This paper summarises some arguments and evidence that lead us to assert that the experience (rapid onset of obesity and NR-NCDs) may be unique. Understanding this topic is important for planning a strategy to prevent obesity and its complications in the developing world. In this paper we focus on several ways the conditions in higher-income Western European countries, the USA and Japan differ from those in lower- and middle-income countries. Essentially the key assertions are as follows.

- The speed of change appears unique due to the timing of the economic, technological and social transformations faced by lower- and moderate-income transitional societies now, and that faced by higher-income industrialised societies decades ago.
- The unique issue of finding both under- and overnutrition in the same household is indicative of the different sets of stresses and societal changes currently facing lower- and moderate-income countries shifting to a pattern of NR-NCDs.
- The differences in the rates of change may be exacerbated by some biological relationships.
- The politics differ, as does the capacity of these countries to address the rapid increase in the prevalence of NR-NCDs.

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Assertion 1 – The shifts in dietary and activity patterns and body composition seem to be occurring more rapidly

The pace of the rapid nutrition transition shifts in diet and activity patterns from the period termed the receding famine pattern to one dominated by NR-NCDs seems to be accelerating in the lower- and middle-income transitional countries. We use nutrition rather than diet so that the term NR-NCD incorporates the effects of diet, physical activity and body composition rather than solely focusing on dietary patterns and their effects. This is based partially on incomplete information that seems to indicate that the prevalences of obesity and a number of NR-NCDs are increasing far more quickly in the lower- and middle-income world than they have in the West. Another element is that the rapid change in urban populations is much greater than that experienced a century or less ago in the West; yet another is the shift in occupation structure and the rapid introduction of the modern mass media. Underlying such changes is a general concern for rapid globalisation as the root cause.

Clearly, there are quantitative and qualitative dimensions to these changes. On the one hand, changes towards a high-density diet, reduced complex carbohydrates and other important elements and inactivity may be proceeding faster than in the past. The shift from labour-intensive occupations and leisure activities towards more capital-intensive, less strenuous work and leisure is also occurring faster. On the other hand, qualitative dimensions related to multidimensional aspects of the diet, activity, body composition and disease shifts may exist. The social and economic stresses people face and feel as these changes occur might also be included.

At the start of the new millennium, scholars often feel as if the pace and complexity of life, reflected in all aspects of work and play, are increasing exponentially; there are also unanticipated developments, new technologies and the impact of a very modern, high-powered communications system. It is this sense of rapid change that makes it so important to understand what is happening and anticipate the way changes in patterns of diet, activity and body composition are occurring. While the penetration and influence of modern communications, technology and economic systems – related to what is termed globalisation – have been a dominant theme of the last few decades, there seem to be some unique issues that have led to a rapid increase of 'globalisation and its impact'. Placing the blame on globalisation is, on the one hand, focusing on a broad and vaguely measured set of forces; this ignores the need to be focused and specific, which would allow us to develop potentially viable policy options. It is difficult to measure each element of this globalisation equation and its impact. These processes certainly have been expanded, as indicated by enhanced free trade, a push towards the reduction of trade barriers in the developing world, and the increasing penetration of international corporations into the commerce in each country (measured by share of gross national product (GNP) or manufacturing). Similarly, other economic issues related to enhanced value given to market forces and international capital markets are important. Equally, the increasing access to Western media and the removal of communication barriers enhanced by the World Wide Web, cable TV, mobile telephone systems, etc. are important. The accelerated introduction of Western technology into manufacturing, the basic sectors of agriculture, mining and services is also a key element.

Another way to consider the types of change the developing world is facing is to consider an urban squatter's life and a rural villager's life in China, 20 years ago and today. During the 1970s, food supply concerns still existed, there was no television, limited bus and mass transportation, little food trade, minimal processed food existed, and most rural and urban occupations were very labour-intensive. Today, work and life activities have changed: small gas-powered tractors are available, modern industrial techniques are multiplying, offices are quite automated, soft drinks and many processed foods are found everywhere, TVs are found in about 89% of households (at least a fifth of which are linked to Hong Kong Star and Western advertising and programming), younger children do not ride bicycles, and mass transit has become heavily used. Multiply such changes by similar ones occurring in much of Asia, North Africa, the Middle East, Latin America and many areas (particularly cities) in sub-Saharan Africa and it is evident that the shift from a subsistence economy to a modern, industrialised one occurred in a span of 10–20 years. In Europe and other industrialised, high-income societies, this occurred over many decades or centuries.

To truly measure and examine these issues, we would need to compare changes in the period 1980–2000, for countries that are low- and middle-income, with changes that occurred half a century earlier for the developed world. However, data on diet and activity patterns are not available and there are only minimal data on NR-NCDs and obesity.

The elements of the nutrition transition that we know to be negatively linked with NR-NCDs are obesity, adverse dietary changes (e.g. shifts in structure of the diet towards a greater role for higher fat and added sugar foods, reduced fruit and vegetable intakes, reduced fibre intake, greater energy density and greater saturated fat intake), and reduced physical activity in work and leisure. We focus on these first and then a few select underlying factors. The causes of these elements of the nutrition transition are not as well understood as the trends in each of them. In fact, there are few studies attempting to study the causes of such changes and there are only a few datasets that are equipped to allow such crucial policy analyses to be undertaken.

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Obesity trends

Many of the papers in this volume, and others we have published (e.g. Popkin and Doak[1]), highlight the trends in obesity. In this paper, we present one set of comparable results for children and adolescents and another for Chinese adults to highlight the rapidity of change. In China, we examined shifts in body composition among adults, aged 20–45 years, over an 8-year period[2]. As we have shown[2], not only did mean body mass index (BMI) increase, but the shape of the BMI distribution curve changed over the 8-year period (Fig. 1). From 1989 to 1997 the proportion of underweight men and women dropped considerably and the prevalence of both overweight and obesity increased greatly. In fact, the proportion of overweight or obese men more than doubled from 6.4.0% to 14.5% and the proportion of overweight or obese women increased 50% from 11.5% to 16.2%.

China might be unique; we cannot show such a dramatic shift for other countries owing to a lack of baseline data (except for Brazil where surveys in the 1970s, '80s and '90s exist[3–6]). Other comparable data do not exist for in Africa, the Middle East, Latin America and Asia that show very high levels of current obesity (e.g. Egypt) which would allow us to understand if these current high levels are the result of recent changes.

One of the regions representing a combination of middle- and lower-income countries that is experiencing very high obesity rates is North Africa and sub-Saharan Africa. Figure 2[7–15] summarises results from representative surveys in a number of countries in North Africa and the Middle East. Although these are very high levels, they are no less astonishing than the results of a recent, nationally representative survey of women of child-bearing age, 15–45 years, from South Africa. The South African Demographic and Health Survey collected weight and height data from women[16] and found that among black (African) women, 44.4% had a BMI above 30.0 kg m^{-2}. Only 7.9% of the adult men in these households were obese.

We have looked at the trends in underweight and overweight older children, aged 6–10 years, and adolescents, aged 11–18 years, in China, Russia, Brazil and the USA[17]. In this case, we found the average rate of increase in the prevalence of overweight status over the last two decades to be comparable among US and Brazilian children and adolescents, but lower among the Chinese. Use of more recent data shows a more rapid and very high increase in Brazil in the last decade whereas obesity declined in Russia, where an economic crisis and the removal of food subsidies for meat and dairy products led to a remarkable decline in the energy density of children's diets[18].

Dietary changes: shift in the overall structure over time

The diets of the developing world are shifting equally rapidly. We do not have good data for most countries on total energy intake, but we do have reasonable data to examine shifts in the structure of the diet. Food balance data were used to examine the shift, over time, in the proportion of energy from fat[19].

The dramatic changes in the aggregate income–fat relationship from 1962 to 1990 are displayed in Fig. 3 by the estimated regression lines based on cubic polynomial regressions[19]. Most significantly, even the 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. On the other hand, in 1962, the same energy diet (20% from fat) was associated with countries having a per capita GNP of $1475 (both GNP values in 1993 US$). This dramatic change arose from a major increase (from 10 to 13%) in the consumption of vegetable fats by poor and rich nations;

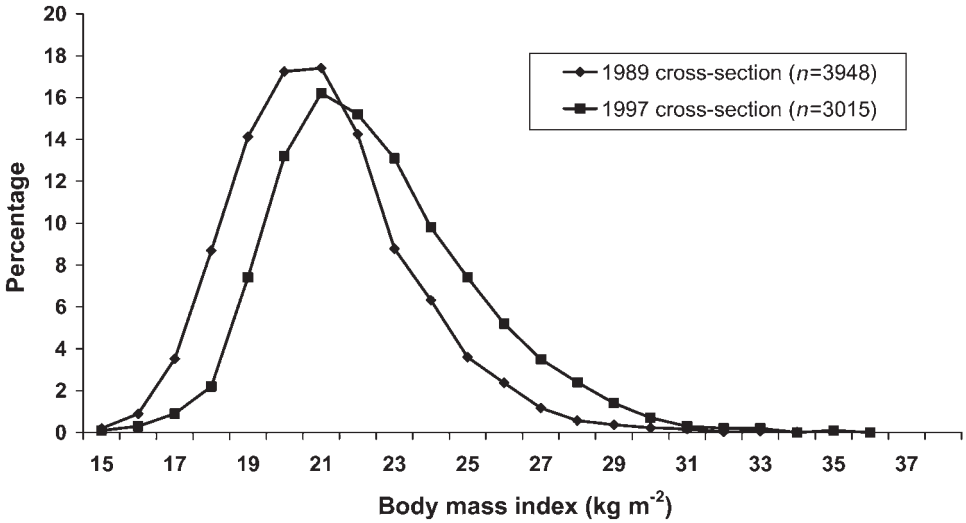

Fig. 1 Shift in the distribution of BMI among Chinese adults, aged 20–45 years, in 1989 and 1997. *Source*: Bell *et al.*[2]

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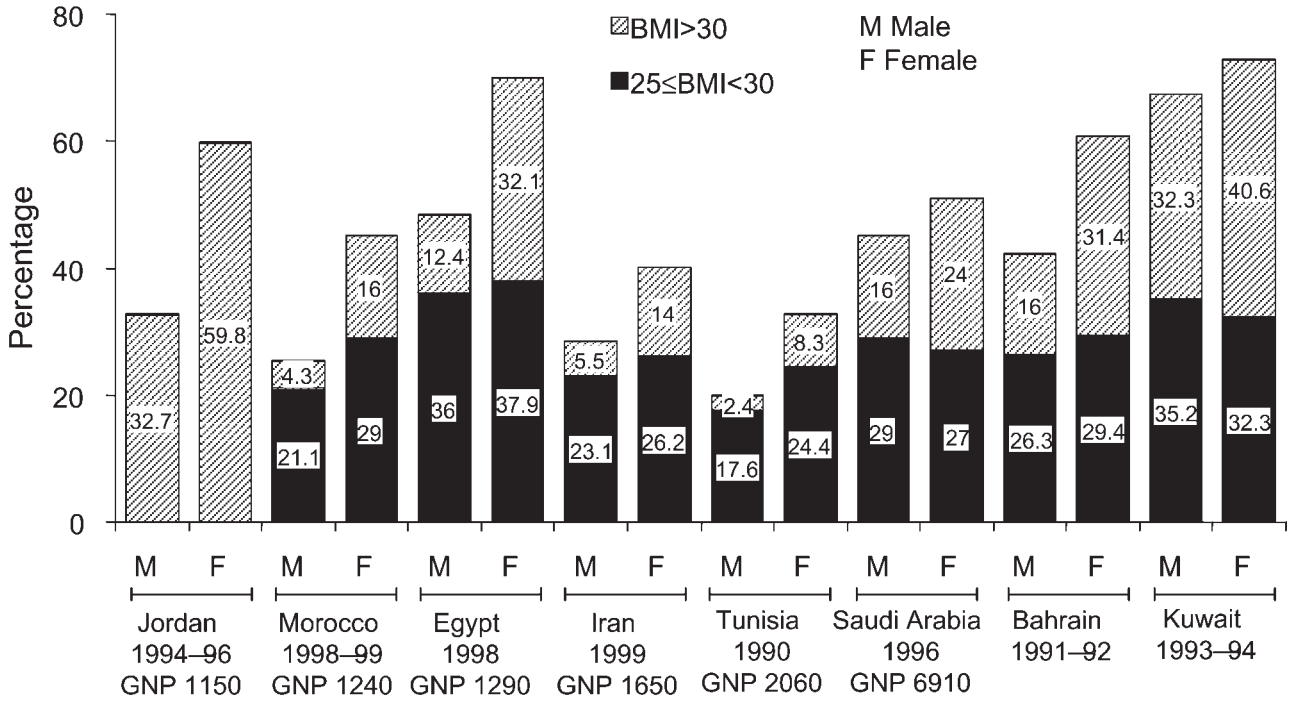

Fig. 2 Obesity patterns in North Africa and the Middle East. GNP – per capita gross national product (in 1998 US$). *Sources*: Benjelloun[7], Galal[8], Ghassemi *et al.*[9], Al-Isa[10,11], Al-Nuaim *et al.*[12], Al-Mannai *et al.*[13], Shetty and James[14], Ajlouni *et al.*[15]

similar increases (3–6%) also occurred in middle- and high-income nations.

At the same time there were decreases in the consumption of fat from animal sources for all except the low-income countries. The availability of animal fats continued to be linked to income, though less strongly in 1990 than in 1962. These decreases, combined with the increase in vegetable fat intake for countries of all incomes, resulted in an overall decrease in fat intake for moderate-income countries of about 3%, but an increase of about 4–5% for low- and high-income countries. Figure 3 indicates these substantial shifts in the relationships between GNP and the composition of diets over time.

Vegetable fats in 1990 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 absolute level of vegetable fat consump-

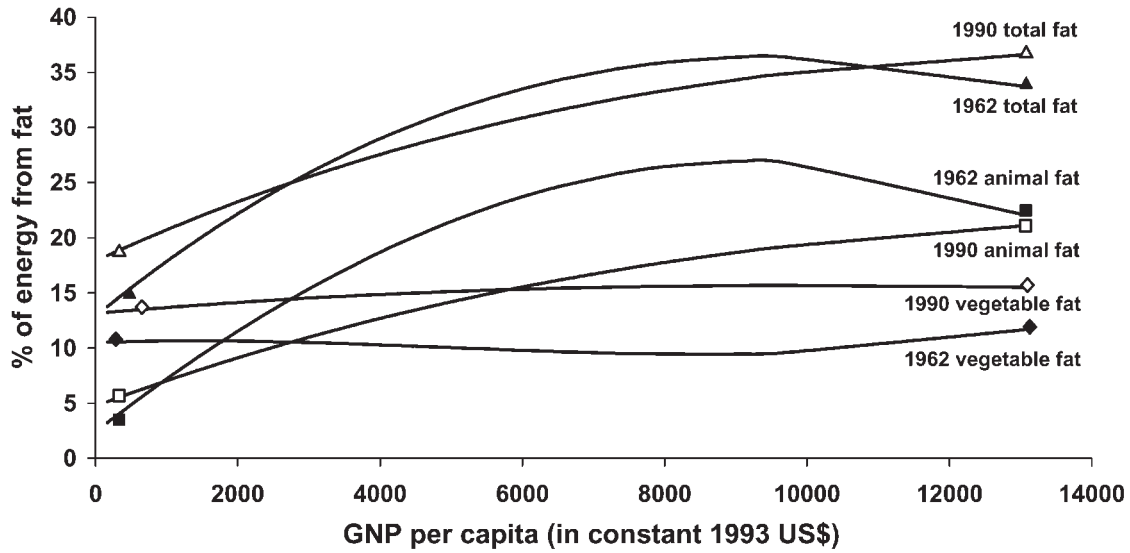

Fig. 3 Relationship between the percentage of energy from fat and GNP per capita, 1962 and 1990. *Source*: Non-parametric regressions run with food balance data from the United Nations Food and Agriculture Organization (FAO) and GNP data from the World Bank for 134 countries; Guo *et al.*[19]

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tion increased, but there remained at most a weak association of GNP and vegetable fat intake in these aggregate data. The change in edible vegetable fat prices, supply and consumption is unique because it equally affected rich and poor countries, but the net impact is relatively much greater on low-income countries.

We have shown elsewhere that there was also an equally large and important shift in the proportion of energy from added sugar in the diets of lower-income countries[20].

When we specifically examine the combined effect of these various shifts in the structure of rural and urban Chinese diets[21], we find an upward shift in the energy density of the foods consumed. In this study, the kcal of energy intake from foods and alcohol per 100 g of food in both urban and rural Chinese adult diets increased by over 10% (to 2.42) between 1989 and 1997. These are very rapid shifts in energy density. It is important to note that this value of 2.42 is not comparable with the normal measure of energy density of the diet. The normal method includes full measures of all beverages, while the Chinese Food Composition Table, from which these data were extracted, measures only a few beverages (milk, coconut juice, sugarcane juice, spirits, beer, wine, champagne and brandy) and excludes many beverages, in particular tea and coffee. There are a number of clinical studies that varied the energy density of the diet in *ad libitum* studies. Each finds that higher density increases, often only an increase as low as from $1\,kcal\,g^{-1}$ to $1.3\,kcal\,g^{-1}$, can increase total energy intake[22,23]. For these reasons, energy density changes in China, and most likely in other developing countries, are critical components of dietary change to be monitored.

Physical activity shifts are equally rapid

There are much fewer data and less analysis on the shifts, over time, in energy expenditures and physical activity patterns in general. Some published studies have demonstrated the remarkable shift in the structure of occupations, as well as in the activities performed in each occupation[24,25]. However, we have few publications or data that have documented either physical activity patterns or precisely measured data on the physical activity component of total energy expenditures for adults and children in the developing world. There is no basis to state that there have been shifts in the other components of energy expenditures (e.g. basal metabolic rates), so we focus on physical activity except for selected disease shifts (e.g. reductions in parasitic infection and other infectious disease that might have some independent effect on energy expenditures).

We rely on the China Health and Nutrition Survey (CHNS) results with adult physical activity patterns measured over the 1989–97 period to examine this topic. Figure 4 shows a remarkable downward shift for the proportion of adults, aged 20–45 years, whose daily activity profile categorises them in a moderate category, compared with those in the light category, over the last decade. In other work, we have shown that light and moderate activity profiles are linked with greater obesity[2,26].

Rapid social change is important: urbanisation, rapid demographic change and other behavioural changes are occurring simultaneously

In this section, our focus is on the ways diets have shifted in urban areas and with other sociodemographic changes

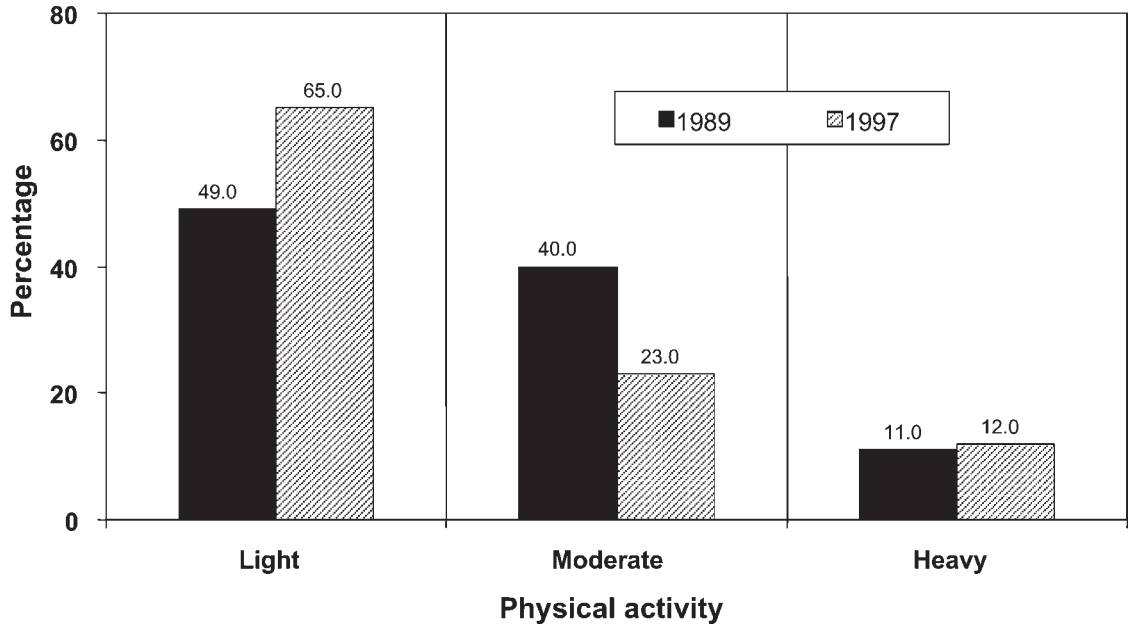

Fig. 4 Physical activity profiles of urban Chinese adults, aged 20–45 years, 1989–97. *Source*: China Health and Nutrition Surveys, 1989 and 1997

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in the past several decades, rather than on how the age structure and spatial distribution of the population in the developing world have changed dramatically during the past three decades[27]. Although we do not address these issues here, there are several points to note about these key elements:

- rapid reductions in fertility have enhanced the shift in the age distribution;
- urbanisation continues unabated in Asia and Africa. More poor will reside in urban than rural areas in future decades;
- economic changes, in particular increased income and income inequality, appear to define changes in many regions of the developing world; and
- globalisation of mass media is occurring at an earlier stage of economic development than faced higher-income countries in the past.

The two major themes in this section – (1) rapid change for some and (2) how greater social inequality between rich and poor defines the current nutrition transition facing lower- and middle-income countries – will be addressed.

Urbanisation

In other published work we have shown how the structure of the diet has shifted markedly as populations have urbanised[20]. This relationship will, by itself, shift the structure of the diet significantly at the national level as urbanisation continues and as the proportion of the population in urban areas grows.

Structural shifts in income–diet relationships are occurring

Economists speak of two types of behavioural change. One relates to shifts in the composition of society regarding the plurality of the educated, rich or urban residents. The other type relates to the way persons with different characteristics behave and, in our case, economic behaviour. This latter type, termed changes in behaviour, means that for the same level of education or income, a person would buy different amounts or types of commodities at different points in time. Research conducted in China shows there have been profound behavioural shifts during the last decade (i.e. for each extra dollar of income, additional high-fat foods are purchased vs. what would have been purchased in previous years for the equivalent extra dollar)[19]. Economists speak of this effect as one that shows how the decision-making demand pattern for food has changed, so for the same income level the patterns of demand have changed significantly from earlier periods. Figure 5 shows how extra income in China affects the poor differentially than the rich, enhancing the fat intake of the poor more than the rich; the changes from 1989 to 1993 were statistically significant for both groups. The explosion in access and exposure to mass media may very well have created this situation.

Mass media

There is no doubt that access to modern mass media has grown very rapidly, particularly in the last decade. Elsewhere, we have shown world-wide trends. It is very useful to look at the proportion of households in a country that own a television set to gain insight into this topic. Again we use CHNS data to reflect the types of change in one setting. Figure 6 shows the proportion of low-, middle- and upper-income tertile households that owned a TV during the 1989–97 period. Overall, 88.5% of Chinese households in the CHNS sample owned a TV in 1997. It is important to note that, in China, not only was the

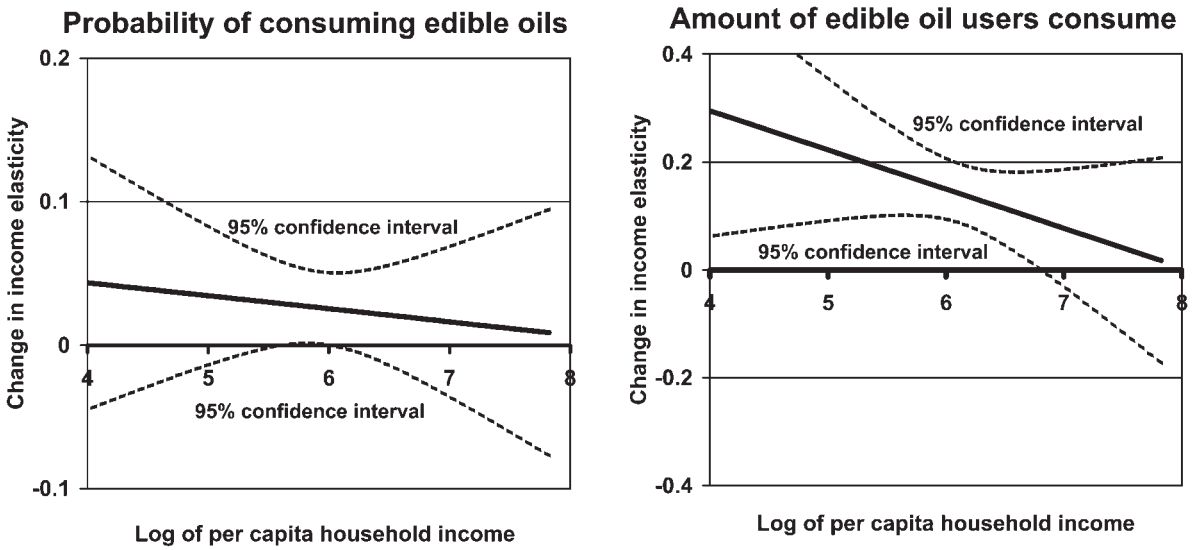

Fig. 5 Changes in the income elasticity for edible oil food consumption in China (increases in income elasticity between 1989 and 1993). *Source*: Guo *et al.*[19]

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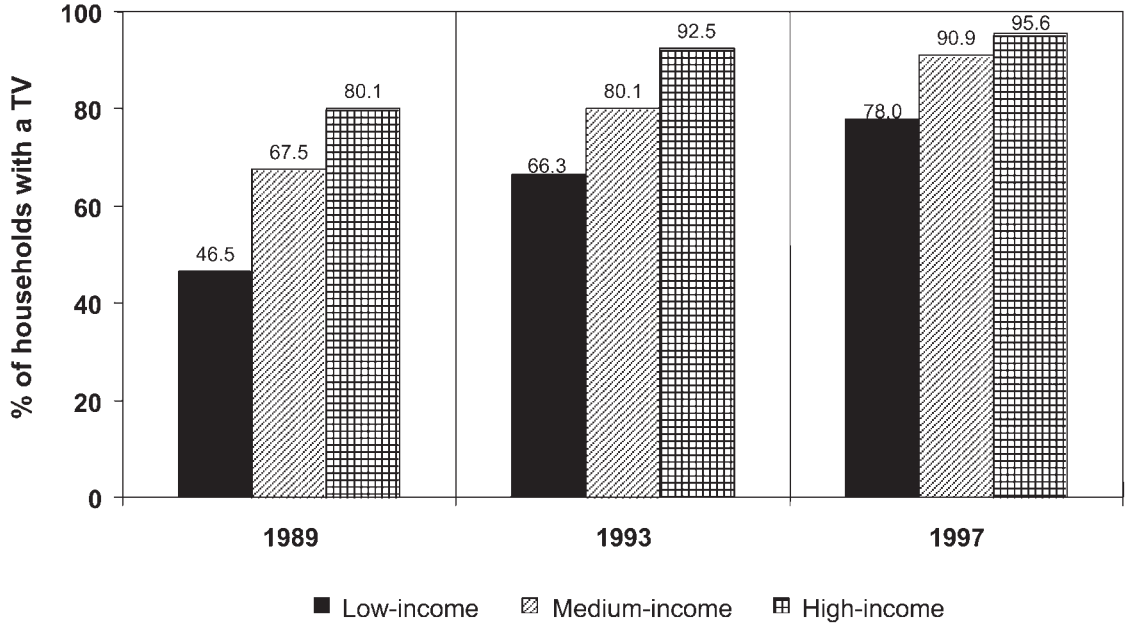

Fig. 6 TV ownership in China, 1989–97 (% of Chinese households who own a TV). *Source*: China Health and Nutrition Surveys, 1989 and 1997

proportion of people with access to television shifting, but the types of programmes and access to Western influences were also shifting. In the 1980s, cable systems in China did not provide outside programming, but by 1997 many provinces provided access to China Star, a Hong Kong television system that relies heavily on US and British programming and provides modern TV advertising.

Again, while there are no extensive data on the proportion of Chinese households with access to mass media 30–70 years ago, we certainly know that the penetration into Chinese households in 1997 is far greater than it was into US households 50 years ago; TV was in its infancy then.

Assertion 2 – The joint presence of undernutrition and overweight seems to be important

There are two related issues: (1) at the societal level, endemic levels of undernutrition and overnutrition exist in many countries and (2) often at the same time in the same household. India is a prime example of the first point. One well-designed representative survey (the National Family Health Survey, 1998–99) of nearly 83 000 women aged 15–45 years found that one main problem continues to be undernutrition, with 36% of the women having a low BMI ($<18.5\,kg\,m^{-2}$)[28,29]. However, 11% of the women can be classified as overweight (BMI $> 25\,kg\,m^{-2}$) and 2% are obese (BMI $> 30\,kg\,m^{-2}$). There were significant differences between urban and rural residents, with 41% of the rural women having a low BMI contrasted with 23% of the urban women; and only 6% of the rural women were overweight or obese, compared with 24% for urban women. Many other examples abound; South Africa has a very high rate of adult female overweight and obesity (44%) and also large proportions of malnourished children[16].

The work of Doak and others to highlight the large proportion of households in which persons with both low and high BMI coexist, reflective of undernutrition and overnutrition, is important. She and her colleagues have shown that this is the case in both rich and poor families from many developing countries. A representative sample in Indonesian households revealing the prevalence of almost 10% of all households having members with both low and high BMI is most interesting[30,31].

The fact that low-income households in many regions of the world have high levels of overweight members is indicative of a rather new phenomenon in the developing world, one of household food insecurity coupled with an energy imbalance. The exact implications of this phenomenon need to be much more fully understood.

Assertion 3 – Is the biology different? Or rather, do we have different social structures and body composition patterns that affect BMI–disease relationships? Or are there genetic variants that are important?

There are a number of different ways these questions could be answered in the affirmative. One is if the body composition and other unmeasured race–ethnic factors affect susceptibility to NR-NCDs. Another might be if previous disease patterns (e.g. the presence of malaria or other tropical diseases) led to disease patterns that predisposed the population to certain problems. One

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component of this might be the foetal insult syndrome developed and popularised by Barker[32,33].

There has been a growing body of research showing that the international standards used to delineate who is overweight and obese are not appropriate for many large sub-populations in the world. For instance, a BMI of 25 kg m^{-2} in an Asian adult appears to have a far greater adverse metabolic effect than in a Caucasian adult[34]. In fact, the World Health Organization (WHO) and the International Obesity Task Force (IOTF) formed a group of scientists and agencies in Asia to review this topic. This group held international meetings and has proposed a lower BMI cut-off for Asians of 23 kg m^{-2} for overweight and of 25 kg m^{-2} for obesity[35]. In one paper comparing China, the Philippines and US Hispanics, blacks and whites, the odds of being hypertensive were higher for Chinese men and women than for the other sub-population groups at lower BMI values in the 23–25 kg m^{-2} range[36]. Ethnic differences in the strength of the association between BMI and disease outcomes warrant further consideration.

Zimmet and others, who have focused on this issue as it relates to lower-income countries, felt that the highest genetic susceptibility for adult-onset diabetes was for Pacific Islanders, American Indians, Mexican Americans and other Hispanics, and Asian Indians. Those with modest genetic susceptibility include Africans, Japanese and Chinese[37,38]. The age of onset (usually after the age of 50 years) of non-insulin-dependent diabetes mellitus (NIDDM) is much lower for these susceptible populations and it appears that the prevalence is higher for a given level of obesity and waist/hip ratio. Zimmet and co-workers[37,38] summarise a large selection of literature that has explored these issues relating to diabetes among susceptible populations.

What is not clear is how much of this difference between sub-populations' BMI–diabetes or other BMI–morbidity relationships is a function of differences of body composition, metabolic or genetic factors, or social causes. Elsewhere we have shown that part of the apparent race–hypertension relationship may also be explained partially by socio-economic status[39].

There is another pathway related to the role of previous health problems for which we have less understanding and no real documentation of its impact. Examples would be malnutrition that caused a virus to mutate, parasitic infections that affected long-term absorption patterns, or a parasite that is linked with an unknown genotype – comparable to sickle cell anaemia and its evolutionary linkage with malaria. We have no basis for speculation about this potential pathway.

However, the final pathway – the effect of foetal and infant insults on subsequent metabolic function – is one that appears to be a critical area. If the rapid shifts towards positive energy imbalance are occurring concurrently with higher levels of low birth weight in a population, then this becomes a much more salient aspect of this argument. In the developing world, where intrauterine malnutrition rates are high and a high prevalence of nutrition insults during infancy exists, the work of Barker and many others portends important potential effects on the prevalence of NR-NCDs in the coming decades[33,40]. Not only is there an emerging consensus that foetal insults – in particular with regard to thin, low-birth-weight infants who subsequently face a shift in the stage of the transition and become overweight – are linked with increased risk of NR-NCDs, but infancy may equally be a period of high vulnerability. Three new studies by Hoffman *et al.*[41–43] suggest that the fat metabolism of stunted infants is impaired to the extent that this could lead to increased obesity and other metabolic shifts. Other work on the role of stunting on obesity had suggested such an effect, but Hoffman *et al.*'s work suggests the mechanism and fits with the correlational work[44].

Assertion 4 – The politics are different in the developing world and lead to a programme and policy dilemma! The capacity to address the rapid increase in NR-NCDs does not exist as it did at this stage in higher-income countries!

In the countries of the developing world, where the politicians have focused for decades on issues of hunger and infectious diseases, we face a major challenge in getting focus on the prevention of obesity and NR-NCDs. The rapidity of the increases in obesity and many NR-NCDs is an indication of the need for preventive action.

The ultimate challenge is to get countries that are poor to develop a preventive public health agenda rather than relying on subsequent treatment. The examples from Latin America, where hunger-oriented programmes that ignored the issues of obesity actually led to increased obesity[45], strengthen the arguments for this approach.

Another concern is the large proportion of lower-income households with separate individuals who have under- and overweight at the same time. The key point is Doak *et al.*'s findings of large proportions of households with underweight and overweight members simultaneously[30,31].

Finally, the NR-NCDs increased in prevalence slowly in the higher-income countries; medical systems had time to adjust to the needs; public health systems were able to begin addressing the situations; and individual treatments could be undertaken because incomes were higher. Effective public health interventions have rarely been adopted.

The collective wisdom of the Bellagio meeting will focus on this topic as one of the more important issues that ultimately needs to be addressed.

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Discussion

The shift towards the nutrition transition stage linked with a high level of NR-NCDs is finding most lower- and middle-income countries unprepared. The changes are occurring very rapidly and the costs, in terms of health, are great. Large populations are still undernourished and programmes and policies to address these new changes in a preventive way are not being developed. Further understanding of the causes and consequences of these shifts must be forthcoming and far greater priority needs to be given to the area of prevention.

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