

The outlook for long-term changes in food consumption patterns: Concerns and policy options

Paper Prepared for the FAO Scientific Workshop on Globalization of the Food System:
Impacts on Food Security and Nutrition, FAO, Rome, October 8-10, 2003

Josef Schmidhuber¹
Global Perspectives Studies Unit, FAO

1. Introduction and overview

The last two centuries have seen a fundamental transformation of the diets in essentially all affluent countries. At the beginning of this transformation was the agro-industrial revolution of the 19th century which provided mankind the know-how to produce more and the income to consume more and increasingly sophisticated food products. Modernization of agriculture has played a pivotal role in bringing about change. The rigorous application of scientific advances to traditional agriculture, mechanization, genetic improvements and the development of fertilizers and pesticides enabled a doubling and redoubling of food production within the time span of a few decades. In fact, productivity growth was so strong that growth in production comfortably exceeded growth in demand and afforded a rapidly growing population with more and better food at declining real prices. Agricultural productivity growth also promoted the industrialization of the then largely agrarian societies. It helped accumulate capital, free-up labour and provide ever more and more nutritious food. Eventually, a virtuous circle was created where productivity growth, rising income incomes and better nutrition became mutually supportive and thus spurred overall economic development². At least for the 19th century, however, these developments remained largely limited to industrial countries.

It took more than a century before the agro-industrial revolution started to reach the first developing countries. With the beginning of the 1960s, the same factors that had initiated the agro-industrial revolution in the developed world a century got a foothold in the food and agricultural sectors of parts of the developing world. The combination of modern varieties, expansion of irrigation, more and improved input supplies and the wide-spread mechanization of production made more food available to consumers in developing countries. Since the early 1960s, the average calorie availability in the developing world has increased from about 1950 to 2680 Kcals per person and day while protein availability nearly doubled from about 40 to 70 grams per person per day. The prevalence of undernourishment has declined from 37% in 1970 to 17% in 2000 and, while more than 840 million of people (FAO, 2003) are still food-insecure, this is often the result of adverse local production conditions and often war and civil strife, a lack of income and access to food rather than the inability of the world as a whole to produce and provide enough food.

As in the industrial world of the 19th century, the consumers in developing countries have benefited the most from the advances in agricultural productivity. In real terms, food prices have declined to the lowest levels in history and, together with the gains in broader

¹ The views expressed by the author in this document do not necessarily represent those of FAO.

² Fogel (1994) estimates that half of the overall economic growth in France and England of the 19th century was due to better nutrition.

economic growth, have enabled them today to eat better while spending less and less of their budget on food. However, not all countries and regions have benefited from these advances. In parts of the developing world, notably in sub-Saharan Africa, these advances have not even started to yield a meaningful impact. But in many developing countries, the progress in access to providing more, better and cheaper food was impressive³. The rapid decline in real food prices allowed consumers in developing countries to embark on food consumption patterns that were reserved for consumers in industrialized countries at much higher GDP levels. Today, a consumer in a developing country can purchase more calories than ever before and more than consumers in industrialized countries ever could at comparable income levels. In China, for instance, consumers today have about 3000 kcal/day and 50 kgs of meat at their disposal - at less than US\$ 1000 nominal income per year.

The rapid increase in purchasing power for food (itself partly the result of the gains in agricultural productivity through the lower food prices and the growth impulse on the overall economy) has probably been the most important contributor to shifts in food consumption patterns. But it is certainly not the only one. Popkin (1993) identified several other factors determining the form and the pace of these nutritional transitions: demographic variables, above all shifts in population growth, age structure, urbanization; food industry and state intervention (promotion of animal husbandry); socioeconomic transformations bringing changes in women's roles (different time allocation promoting processed foods); changes in public understanding of diet's role in health (a factor with potential for very positive developments, but also one producing dubious results in populations searching for alternative healing through nutrition). Smil (2000) adds the effects of growing international trade and globalization of tastes.

The past evolution of these changes has been well-documented. Popkin (2003) and Smil (2000) describe the salient steps in the nutritional transition in considerable detail. This paper will venture into the likely changes in food consumption patterns over the next 30 years, based on FAO's outlook for global food and agriculture (Bruinsma, 2003). The rest of the paper is organized as follows: The first part will provide an outlook for how the main drivers of the ongoing nutrition transition are likely to evolve. It will then analyze the main prospective shifts in changes of consumption patterns. These shifts will be analysed against the prevailing phenotypic and genotypic differences in developing countries, which are likely to compound the adverse effects of the nutrition transition, notably the prevalence of obesity and non-communicable diseases (NCDs) in developing countries. Finally, the paper will present and analyse the principal effects, the advantages and disadvantages of various policy measures that may help to contain nutritional problems underway in developing countries.

2. The main factors affecting the nutrition transition over the next 30 years

Population growth to slow

As far as overall population growth is concerned, the previously projected decline in population growth has been confirmed by the recently published 2002 global population

³ While not all developing countries have benefited from rapid income growth and while not all developing countries have experienced the same rapid socio-economic transformations that come along with rapid industrialization and urbanization, the number of countries that are in the process of a profound transformation of their food economies is steadily increasing. As population giants such as China, India, Indonesia, Brazil or Mexico are amongst the most rapid transformers, the nutrition transition affects a large and growing share of the developing world's population.

assessment by the United Nations (UN, 2003). The latest assessment suggests that the slow-down in population growth will even be more pronounced than hitherto assumed: world population in 2030, for instance, is forecast to reach “only” 8.1 billion compared to 8.3 billion in the preceding assessment. The slowdown is expected to continue beyond 2030 with a population peak of around 9.5 billion people expected by around 2070. This is a remarkable development in its own right. It means that the process of rapid growth seen over the past 300 years is expected to come to a complete halt with the next 70 years and may even begin to reverse thereafter⁴.

The slow-down in population growth could provide the much needed breathing space for the world’s resource base. It also suggests that the ability of mankind to feed itself should not be weakened and that global neo-Malthusian scenarios may not be warranted. More detailed analyses (Bruinsma, 2003) support this general assessment and suggest that a slower growing global population will have more food available in the future. The average dietary energy availability over the next 30 years is projected to increase from 2800 to 3050 kcal/person/day globally, in developing countries the increase will even be more pronounced with an increase from 2680 to 2980 kcal/person/day. But the results of this study also suggest that there will be vast differences between countries and regions as well as within countries.

Urbanization to accelerate

Even more dramatic than the slow-down in overall population growth will be shifts in the urban–rural population balance. Virtually all population growth between 2000 and 2030 will be urban (Figure 1). As for total population growth, the aggregate picture of a rapidly

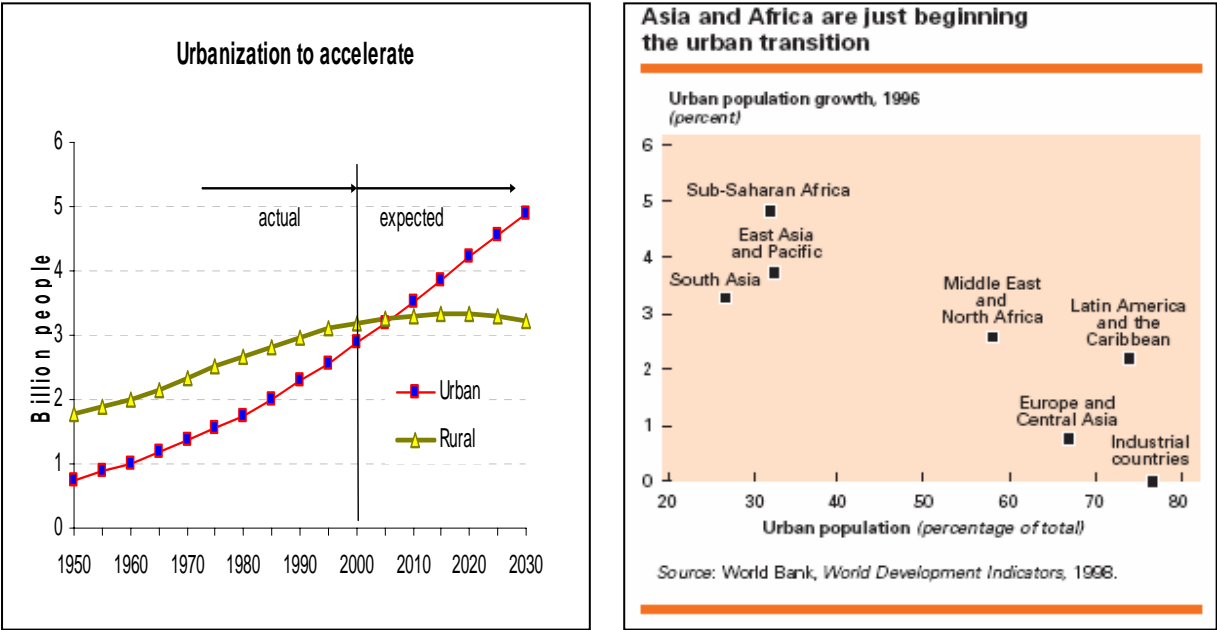


Figure 1: Urbanization, global outlook and regional differences (data from FAOSTAT and WDI)

⁴ While this is positive evolution from many developmental perspectives, some of the underlying factors of this slowdown are not necessarily so. On the negative side are the impacts of HIV/AIDS which over the 30 years alone will mean that world population will be 200 million smaller than otherwise (UN, 2003). Much more positive as well as more significant is the rapid reduction in fertility rates which accounts for the lion’s share of the slow-down in growth.

urbanizing world masks large regional differences. Urbanization will proceed slowly in many developed and transition countries, where the vast majority of the population is already living in urban areas. At the other end of the scale are sub-Saharan Africa and Asia, where urban populations will be growing at an astounding rate of nearly 5% per year. Also remarkable is the outlook for Latin America, traditionally the most urbanized developing region, with urban populations forecast to continue to grow at a rate of more than 2% annually.

Urbanization also means a higher female participation in the work force and with that a shift away from traditional time-intensive food preparations towards precooked, convenience food at home or fast food and snacks for outside meals. Particularly for the urban poor, the shift towards fast and convenience foods is also a shift away from fresh fruits and vegetables, pulses, potatoes and other roots and tubers towards a much more sugary, salty, and fatty diet (Smil, 2000). It is also often a shift from a diet rich in fibre, minerals and vitamins towards one rich in energy, saturated fats and cholesterol.

But urbanization not only affects changes in dietary patterns within a country, it also promotes changes and convergence across borders. Urbanization provides infrastructure, transportation facilities, ports and roads, trains and airports, thereby facilitating trade both within and across countries. It affords international suppliers advantages of the high proximity to locally concentrated masses of consumers, allowing their foreign distribution channels (international supply chains, supermarkets, fast food chains) to operate efficiently and profitably. Foreign distribution channels bring foreign diets, i.e. more processed, sugary, fat and in general energy rich food.

The FAO outlook to 2030 (Bruinsma, 2003) suggests that foreign food will account for a rising share in overall supplies over the next 30 years. Net imports of food by developing countries as a whole will increase by the factor of five, from about US\$ 11 billion in 1997/99 to about US\$ 50 billion in 2030 in real terms. In fact, in many metropolitan areas it may be easier to feed whole populations through imported food rather than through supplies from the domestic hinterland, particularly where infrastructure deficiencies and difficulties in meeting food standards make the supply from domestic sources cumbersome and expensive. Examples for such a scenario exist already today, perhaps most visibly from the metropolitan areas in transition economies (Moscow or St. Petersburg)⁵.

Urbanization is likely also to heighten the burden of non-communicable diseases regardless of the shifts towards an urban diet and a more sedentary lifestyle. What is known as the “Roseto effect” (Egolf, 1992) in a more general context, applies to the socio-economic changes associated with urbanization. The “Roseto effect” describes the role of cultural factors related to a stable family structure, social cohesion and the supportive nature of the community protecting against risk of heart disease and being conducive to longevity despite similar dietary and lifestyle risk factors. Urbanization affects many of these factors. It severs the traditional family links and creates a new geographic, social and cultural environment that

⁵ The growing role of traded food in total food availability will promote a growing convergence in food consumption patterns. Taking the US as a comparator country, the FAO outlook to 2030 suggests that the similarity between consumption patterns is likely to increase in tandem with income growth and urbanization. But this outlook also points at important regional differences. While convergence to the industrialized countries’ diet will grow in East and even South Asia, diets in countries of sub-Saharan Africa will remain largely unaffected by this convergence in food consumption patterns. And, even where convergence will increase, the importance of cultural or religious factors will remain important.

affects existing family structures and social cohesion. Loosening of family ties and a loss of social cohesion predispose to increased risk in the same population (Shetty, 1997).

The globalization of the food distribution system and the emergence of supermarkets in developing countries

The acceleration in the nutrition transition is driven by a radical change in the food marketing and distribution system. The emergence of supermarkets in developing countries is at the heart of this development with Latin America taking the lead. Reardon and Berdegué (2002) summarize the most important changes for the region. They found that, over the 1990s, supermarkets have been taking over much of food retailing in Latin America. In 2000 they had roughly 60% on average of the national retail sectors in South America and Mexico, up from 15% in 1990. This means that the structural changes that took 50 years in the United States have taken place in little more than a decade in Latin America. This rapid expansion was only possible as supermarkets moved far beyond their original niches, expanded from large to small and poor countries, from metropolitan areas to rural towns and expanded the customers from the upper/middle to the working class.

Reardon and Berdegué (2002) also venture into the likely developments for other regions. They suggest that East and South East Asia as well as Eastern and Central Europe are only 5 to 7 years behind the developments in Latin America and expect that the transition will even be faster in these regions. Even South and East Africa are thought to catch-up to Latin America over the next decade, albeit at a slower pace. Where supermarkets have made such massive inroads into the food retailing system, they affect the entire food economy. For farmers they are crucial as they determine quality and safety standards, packing and packaging, as well as payment practices. For consumers supermarkets often mean an abrupt change in available food supplies with mixed nutritional outcomes. In Brazil for instance, supermarkets have provided a boost to milk consumption, which was driven by a rapid increase in yoghurt and UHT milk (Ultra High Temperature). Here the expansion of supermarkets created a very positive outcome making safe and cheap milk available to the poor. But Reardon and Berdegué also find that supermarkets are often also distribution channels for cheaper, unhealthy snacks and provide the platforms for fast food chains and junk food.

The role of the food processing and the fast food industry

The growing processing of foodstuffs itself has an increasing influence on food consumption patterns. Vegetable oils, for instance, are important sources of essential fatty acids, but are as such not readily useable as ingredients for many sophisticated food products. Hydrogenation allows to turn fluid oils into spreadable margarine but the same process turns valuable unsaturated fatty acids into non-essential fats and into potentially harmful trans-fatty acids. Likewise, the almost universal shift to refined grain flour has a direct impact on the nutrient intakes particularly where wheat and maize are staple foods. Modern milling procedures produce refined flour which has better digestibility but destroys its texture, structure and valuable fibre and decimates their minerals and vitamins. Smil (Smil 2000) stresses that producing white flour makes little sense from a nutritional perspective (its production entails high losses of total protein as well as the lower quality), but it makes baking a lot easier.

Since the 1950s, bread made of white wheat and maize flour, the dominant staple of

European diets for millennia, has made major inroads in all parts of the world. The spread of bread, together with expanding sales of a large variety of other baked goods, has been a key ingredient of adopting Western diet. This trend is expected to continue, it may even accelerate, driven by a growing internationalization of food distribution systems; as already discussed, the spread of supermarkets and the rapid urbanization are major factors behind that diffusion (Smil, 2000). Many of the developing countries are likely to consume not only higher levels of wheat but also much higher levels of white flour which is largely void of the fibre, minerals and vitamins the basic cereals they are made of contained.

Urbanization also means more frequent eating outside of the home, often under time constraints and sometimes also under budgetary constraints. The fast food industry has catered for these constraints providing fast access to cheap meals, take away services, or alternatively, home delivery services. The fast food meals also cater for other needs, most importantly the desire to eat a salt, sugar and fat rich diet, an old, evolutionary desire to benefit from access to these formerly scarce resources. Fats and sugars also provide a desirable mouth feel and produce satisfactory satiety (Smil, 2000). Smil also underlines that the most popular items - hamburgers, pizza, fried chicken, doughnuts, quasi-Mexican dishes - have more than 30% of their food energy in fats. In addition to the increased fat and sugar content, the size of the typical servings has substantially increased, resulting in energy supplies of up to 1200 Kcal per meal.

Robust income growth globally, but large regional differences

The slower-growing and increasingly urban population will also be a more affluent one. Over the next 30 years, average of global per capita income is expected to rise at a rate of more than 2% per annum. Again, regional differences are considerable and global averages hide more than they reveal. Developing countries, starting from a very low basis, are expected to grow faster than the average. At nearly 4%, their economies are expected to expand at twice the speed as those in the developed world. The upbeat outlook for developing countries is predicated on a number of factors. A crucial contributor to high growth will be a favourable shift in the population structure. The rapid transition from high to low population growth means that a large share of their future population will be economically active in the future, with only a small share of very old and very young people. These economies will therefore enjoy a period of high economic activity, with lower than average education costs and lower than average pension obligations, the so-called “population dividend”. In relative terms, developing countries also stand to gain more from freer trade and should, again in relative terms, reap greater efficiency gains from trade liberalization. Similarly, they are also expected to gain relatively more from freer capital and technology flows which are expected to translate into substantive increases in overall factor endowment and productivity.

Regional differences are again more important than the overall averages. At the lower end of the scale is sub-Saharan Africa where GDP growth per capita will barely reach 2%. Even this depressed outlook seems upbeat when compared with the dismal performance of the past 15 years, when per capita incomes had actually been shrinking. Low per capita income combined with rapid rural-to-urban migration is likely to result in “premature” urbanization in many countries of the region, with slums, HIV/AIDS and urban poverty rising at a rapid rate. UN habitat speaks of an “urbanization of poverty” (UN Habitat, 2003).

At the upper end of the scale is East Asia, likely to experience both robust income

growth and rapid urbanization. Particularly China's population is still "under-urbanized"⁶ and expected to transform rapidly into a much more urban society. A recent change in the government policy is expected to accelerate the current urbanization trend (Kynge and Dickie, 2003). Over the next 30 years, its urban population is expected to nearly double from 456 million to 883 million, while its rural population is expected to shrink from 819 million to 601 million people (UN, 2003). Combined with the prospect for high income growth and increasing international trade integration, food consumption is likely to change as well⁷.

Ageing populations and "little emperors"

As already mentioned, a crucial driver for future income growth is the shift in the population structure. A large portion of the overall population will be economically active, earning incomes that are being spent on a rapidly shrinking number of children. Particularly in Asia, buying more food is often seen a first "investment" in the younger generation which is increasingly suffering from overweight and child obesity. The problem has become particularly acute in urban China, where 20 years of a strict one-child policy and a booming economy have meant that growing incomes are often spent on the family's only child. The result is a sharp rise in child obesity for a whole generation of "little emperors"⁸. The Shanghai Preventive Medical Association, for instance, found that nearly 30% of city's children were overweight with almost half of them obese (Shanghai Preventive Medical Association, 2002).

The long-term population prospects suggest that the impacts of ageing populations will not be limited to East Asia. Other developing regions may follow suit and the impacts are likely to be felt most strongly where rapid income growth, a significant slow-down in population growth and rapid urbanization are in the offing. In the long-run, the problem may gradually also include the wealthier metropolitan areas of South Asia and the Near-East North Africa region.

⁶ The State Council's Development Research Center (DRC) underlines that China's current urbanization rate of 39% is equivalent only to that of the UK in the 1850s, that of the US in 1911 and that of Japan in 1950 (Kynge and Dickie, 2003).

⁷ How this will affect consumption patterns depends on the responsiveness of consumers to changes in income and prices. Probably the most comprehensive recent overview on income and price responsiveness is available from Seale et al. (2003). Based on data from the 1996 International Comparison Project (ICP), they calculate income and price elasticities of food demand for a 144 countries.

⁸ The "Beijing Scene" provides an illustrative description of the problem in an article of April 2003 and write that Chinese children are now commonly referred to as "raised on sugar water" ("zai tangshui li zhangdade") who enjoy all the privileges that come with being the only child (du shengzi). The little emperors are being so pampered (jiaoguan) and spoiled (chonghuai) by their parents that they become incapable of doing anything for themselves and eventually become overnourished (yingyang guosheng). Many parents still have a notion that more food equals more wealth and happiness and the growing number of obese children is regarded as a living testament to their family's affluence.

well as on health and life expectancy of her people. The entire African continent was heavily undersupplied, without exhibiting the today's differences between a well-supplied North African region and the grossly undersupplied sub-Saharan Africa (Figures 2a/b/c). All in all, nearly 40% of the population in developing countries was chronically undernourished, while over-nutrition and obesity were marginal and geographically narrowly defined problems.

Many developed countries by contrast were already approaching or even exceeding energy supply levels of around 3000 kcal/person/day. But even amongst the rich countries, large differences remained. While the most advanced industrialized countries (US, Canada, Germany, etc.) already attained DES levels of 3300 calories and more, DES levels in the less advanced industrial countries like Greece, Portugal or Spain remained at or below the 2500 kcal mark. The diets of the latter group resembled then those of advanced developing countries today (Mexico, Brazil, China). But it was also the group of low-income industrial countries that experienced the fastest nutrition transition, catching up rapidly to the group of the richest countries, both in terms of energy supplies and food components. The nutrition transition in many of these countries could be a harbinger for dietary changes in many developing countries over the next 15 years and for most developing countries over the next 30 years.

From 1970 to 2000: the nutrition transition gathers momentum

The next three decades (1970s to 1990s) brought about a radical change in the nutritional situation for many developing countries. Energy supply improved swiftly throughout much of East Asia, Latin America and the Near-East/North African region. There are numerous reasons behind these improvements; probably the most important contributors were the success of the "Green Revolution" and the shifts towards a more market-oriented agricultural sector in China ("The household responsibility system" and other subsequent policy reforms). By the end of the 1990s, the rather homogeneous picture of undersupplies and hunger of the 1960 had changed completely. The prevalence of undernourishment had fallen in all regions except for sub-Saharan Africa and a few countries in south Asia to levels below 10%. Outside these areas, energy supplies have surged to levels that are giving rise to new concerns. Particularly the more rapidly developing countries begin to suffer from oversupply of food energy and a growing rate of obesity. And where incomes are unequally distributed, hunger and obesity now often co-exist in the same country or region.

The rapid shift towards higher DES and animal food consumption has attracted considerable public attention. It was associated with a rapidly rising prevalence of obesity and non-communicable diseases in these previously low-income developed countries and is likely to be associated with the same problems in developing countries. The pace of change for developing countries may even be faster. As already noted, falling real prices and rising purchasing power allow consumers in developing countries today to adapt a diet that was reserved for consumers in developed countries at much higher per capita income levels.

The rapid nutrition transition also means that these countries need to design and implement policy responses that help avoid or at least mitigate the health problems that most developed countries are grappling with today. What is more, the hardships associated with obesity and NCDs may be felt more intensely in developing countries. Even if cheaper calories mean that many in developing countries will no longer be "food-poor" (more specifically food-energy poor) they remain poor otherwise. Large parts of the population will not be able to afford the benefits of an elaborate health care system that make NCDs in

developed countries expensive but manageable problems. In the absence of an appropriate health care system, too high energy supplies will become an equally heavy burden as too low supply levels used to be.

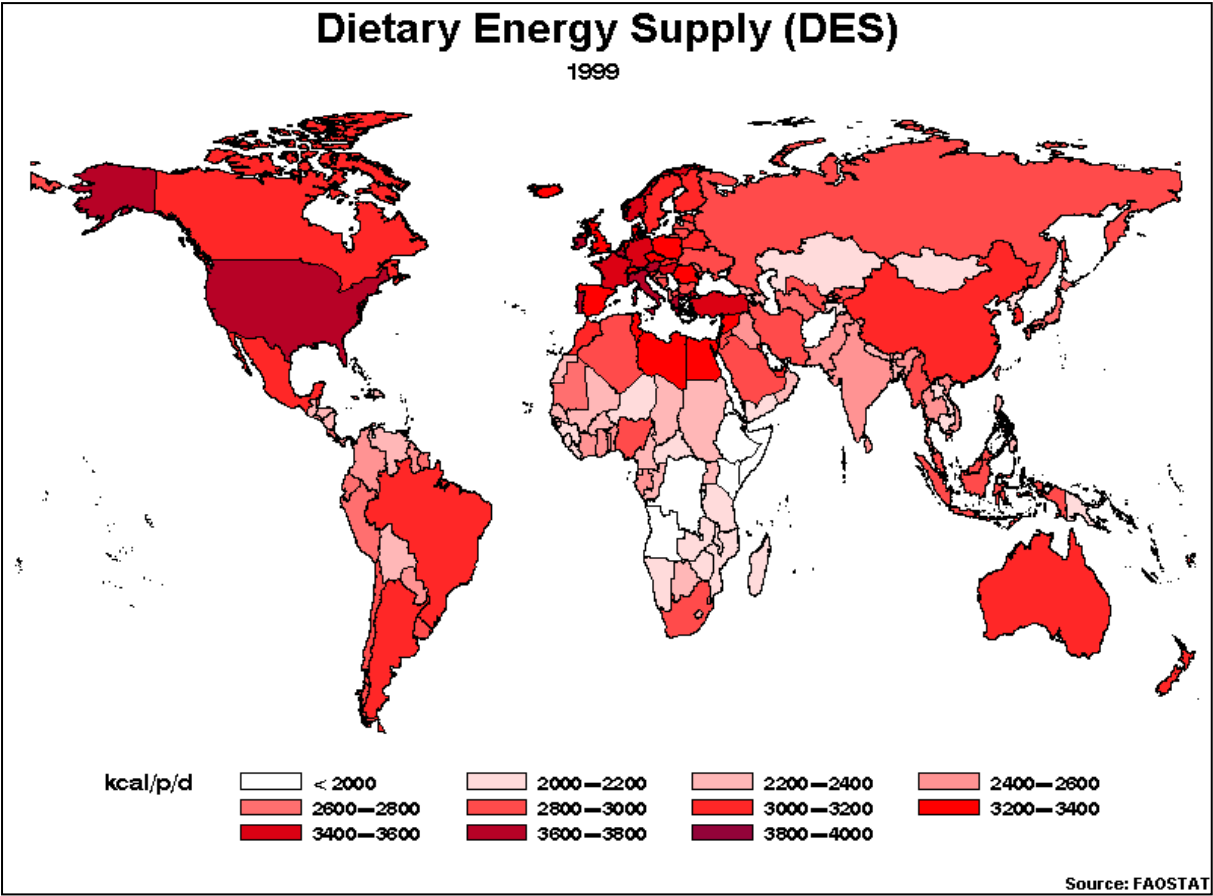


Figure 2b: Dietary Energy Supply (DES) of the late 1999s

Probably the most unexpected development was the steady further increase in energy supplies in many developed countries. Even countries like the US with DES levels of 3300 in the early 1960s further increased food energy supplies to reach levels of 3800 kcal/person/day and more by 2000/01. Presumably, the largest share of food supplies above 3000 calories per day is wasted; nonetheless, quantitative analysis for the US (Kantor et al., 1997) suggests that actual energy intakes, albeit at levels of 1000 kcal below energy availability, continued to increase. Many other developed countries followed the US path, reaching DES levels of 3500 kcal and more. The result of such a development is more predictable than the development itself, particularly if it is combined with a shift towards a more sedentary lifestyle and lower calorie expenditures: The prevalence of obesity and overweight soared, in the US exceeding 30% and 60%, respectively. Alongside the epidemic increase in obesity was a massive increase in the prevalence of NCDs, notably of NIDDM (Non-Insulin-Dependent Diabetes Mellitus) and CHD (Coronary Heart Diseases), and the symptoms that are subsumed under the label “Syndrome X”. NCD related health costs increased in tandem, and are estimated at about US\$ 120 billion in the US (Wolf, 1997), €15 billion in Germany, €3 billion in the UK. Australia, New Zealand, and Canada are facing similar problems.

Many of the factors that caused the rapid increase in obesity in developed countries

are expected to determine the health and nutritional outcomes in many developing countries, particularly those that are expected to enjoy high growth rates in GDP and experience rapid urbanization, mechanization and improvements in transportation infrastructure.

The outlook to 2030

Even only a cursory inspection of the DES map for the year 2030 reveals that the largest part of the developing world will have accomplished energy supply levels of 2700 kcal and more. On average, consumers in developing countries will have nearly 3000 kcal per day at their disposal (Bruinsma, 2003). Most countries will have reached the very high calorie supply brackets of developed countries today. On average, only 6% of the developing countries’ population will be chronically undernourished. In fact, the hunger problem should be largely limited to sub-Saharan Africa, but even there the prevalence of undernourishment is projected to be down to 15%, less than half of current levels.

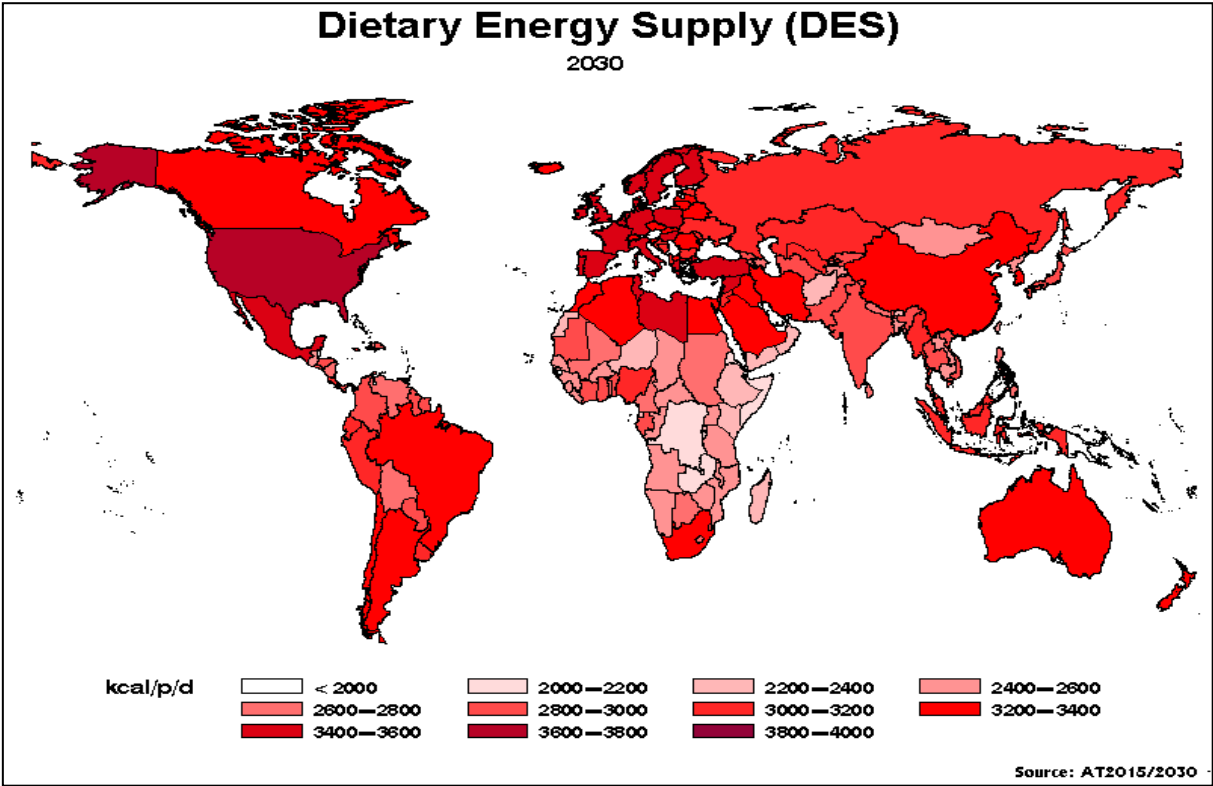


Figure 2c: Projected Dietary Energy Supply (DES) for 2030

At these high levels of average dietary energy supply, overnutrition is likely to become a growing problem. Where the income disparities remain high, undernourishment and overnutrition are likely to co-exist within the same country. The rapid urbanization scenario may mean that overnutrition will largely be concentrated in urban areas, with a shift towards an energy-rich, convenience and fast food diet and an increasingly sedentary lifestyle, while hunger will be more prevalent in rural areas, where food energy supplies may barely match the continuously high requirements for physical work. Overall, high energy supplies combined and the increasingly sedentary lifestyle could result in a rapid increase in obesity and related NCDs. This is particularly so as many developing countries will also have to cope with a genotypic and phenotypic predisposition for a more energy-efficient metabolism (see below).

3.2 Changes in the composition of the diet

The rapid increase in food energy supply has been accompanied by a shift in the composition of the diet. The principal steps of change seem to follow a common pattern: The first step is could be described as an “*expansion*” effect. At low income levels, the main thrust of change is one towards higher energy supplies whereby the additional calories come largely from cheaper foodstuffs of vegetal origin. This has been an almost universal development and seems to take place regardless of cultural, religious factors, food traditions or agricultural production patterns. This first step applied as much to the developed countries

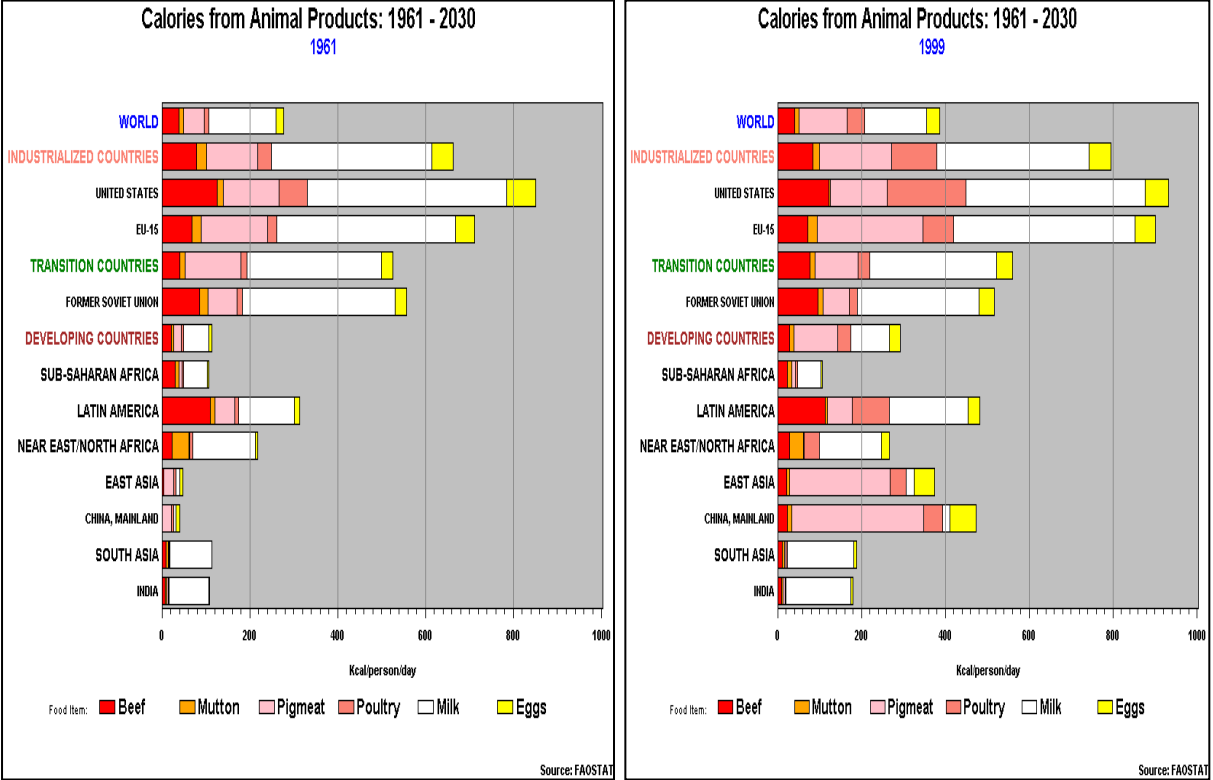


Figure 3a: Calories from animal products, 1961 and 1999

of Western Europe⁹, Japan or Australasia as it applies to the ongoing shifts in many developing countries. Countries in the Near East/North African region, East Asia, Latin America and even the more developed parts of South Asia. Exceptions are largely limited to a few special cases, such as the pastoral food systems of Africa, Central Asia or Latin America where ruminant meat is the traditional food staple. The second step is largely a “*substitution*” effect and reflects a shift from calories of carbohydrate rich staples (cereals, roots and tubers) to calories from animal sources, vegetable oils and sugar -- largely at the same overall energy supply. The substitution effect exhibits much more country-specificity and is often influenced by cultural or religious food traditions. These specificities determine both the extent to which animal products substitute for vegetal products as well as the composition of animal products that enter the diet.

⁹ The dietary shifts in Portugal, Spain or Greece witnessed over the past 40 years are a perfect case in point. With growing affluence, dietary energy supplies rapidly rose from about 2500 Kcal per day in the 1960 to more than 3000 kcal in the 1980s and 1990s. The expansion was largely based on higher consumption of vegetal products. In the next step, the total energy supply rose only slowly but was characterized by a strong substitution effect from calories of vegetal origin to calories of animal origin.

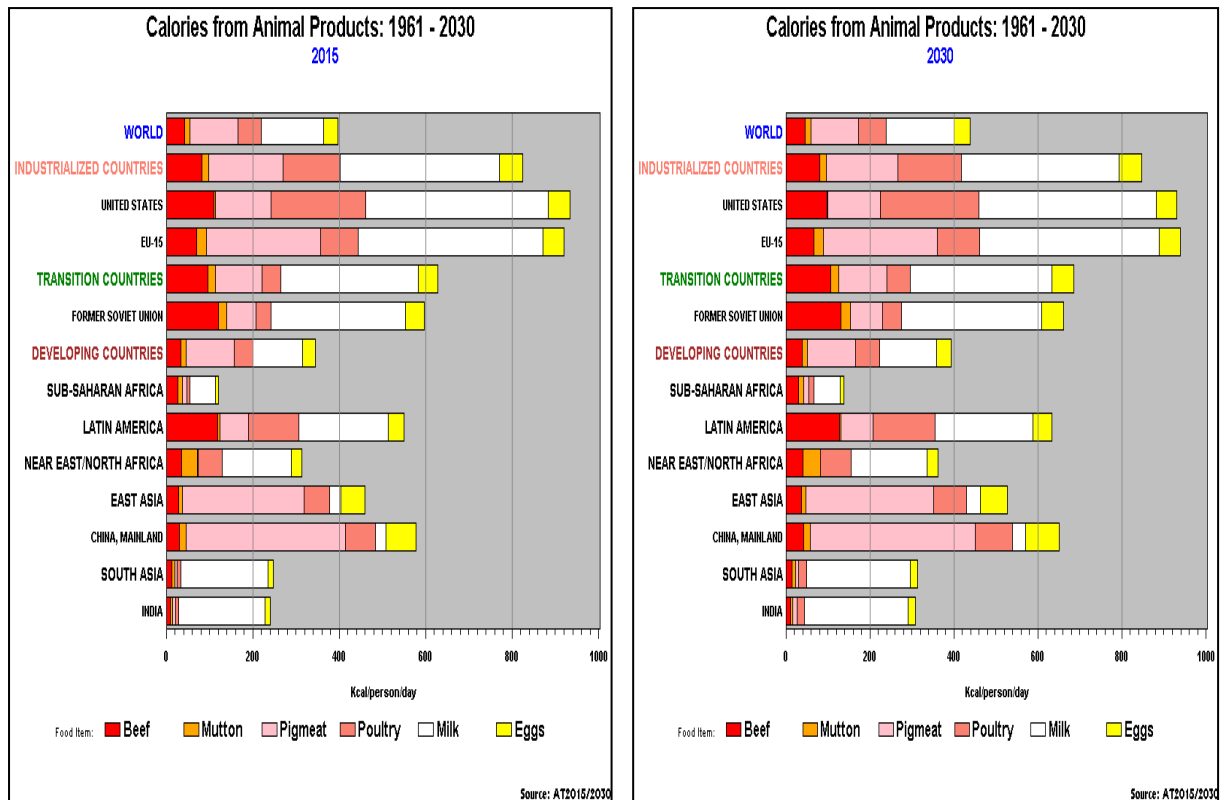


Figure 3b: Calories from animal products, 2015 and 2030

Figure 3a/b depict the increasing importance of calories from animal products and the country/region-specific differences in the composition of the various animal products. A comparison of the figures underlines the rapid expansion of consumption of animal products in essentially all countries. Growth was particularly pronounced in East Asia while sub-Saharan African countries showed no growth at all. The rapid expansion in East Asia was dominated by soaring (pig) meat consumption in China¹⁰, while growth in South Asia was driven by rapidly rising milk consumption over the past three decades (“White Revolution”). Both China’s and India’s growth in consumption of animal products are projected to continue, albeit at a somewhat slower pace. But even at this slower pace, China will reach meat consumption levels that will exceed those of many developed countries in the past (more than 65 kg and more than 500 kcal from animal food stuffs). At the same time, meat and milk consumption will continue to rise in Latin America and the Near East/North African region. Again, while the expansion effect will be remarkable for both regions, cultural and agricultural factors will determine the composition of the shift. The expansion in the Near East/North Africa region will be driven by higher milk, eggs and poultry consumption, while higher beef and poultry consumption will continue to dominate the expansion in Latin America.

¹⁰ There are indications that China’s overall meat consumption may be overstated, even after the downward corrections by more than 20% in 1996/97.

Up to a certain level, the shift towards higher meat and milk consumption reflects a desirable nutritional development, increasing both the quantity and quality of protein of the diet. It benefits infants and children by promoting steady growth in the first years of life. It improves the dietary availability of micronutrients in general and of iron in particular, a particular advantage to women who are liable to anaemia in their most productive years. But these benefits decline rapidly as intake levels rise and, when and where intake reaches

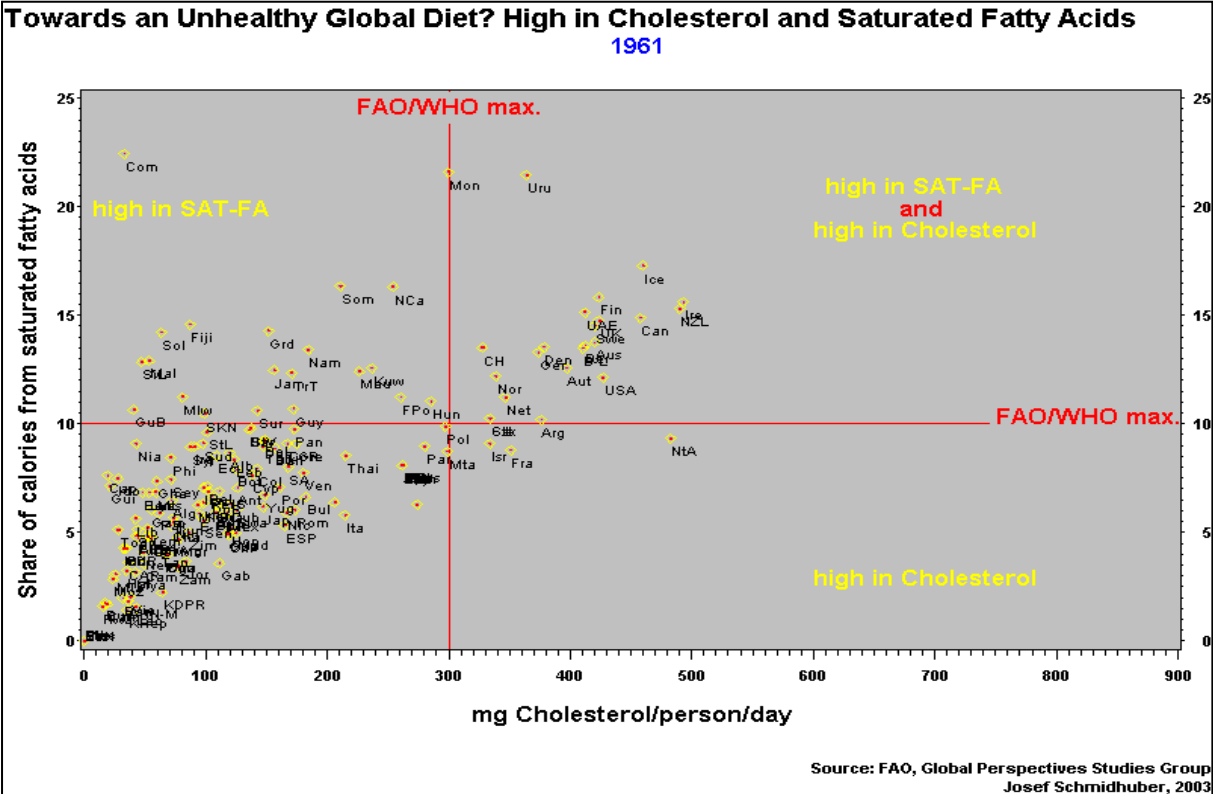


Figure 4a: Saturated fatty acids and cholesterol levels versus WHO/FAO recommendations, 1961

adequate levels¹¹, there are no good arguments for further increases. On the contrary, high intakes are associated with considerable risk and detrimental health effects. Increased consumption of red meat tends to increase the risk of colon cancer and increased intakes of saturated fat and cholesterol from meat, dairy products and eggs increases the risk of coronary heart diseases.

More meat and milk consumption was indeed associated with a marked shift towards higher intake levels of saturated fatty acids and cholesterol. Figure 4a/b provide a snapshot of daily intake levels for cholesterol and saturated fatty acids, juxtaposed to the recommended FAO/WHO maxima for these nutrients. A comparison of the figures reveals that (i) intake levels of both saturated fatty acids and cholesterol have increased almost everywhere over the past four decades (ii) that increases have been more pronounced in developed countries where high consumption levels of animal products have also lifted consumption levels of saturated fatty acids and cholesterol in many countries above the recommended maxima (iii) that in some cases, both levels are being exceeded often by a considerable margin, and (iv) an increasing number of developing countries is exceeding one or both thresholds.

¹¹ A joint WHO/FAO report (WHO, 2003) provides detailed recommendations for appropriate nutritional minima and maxima.

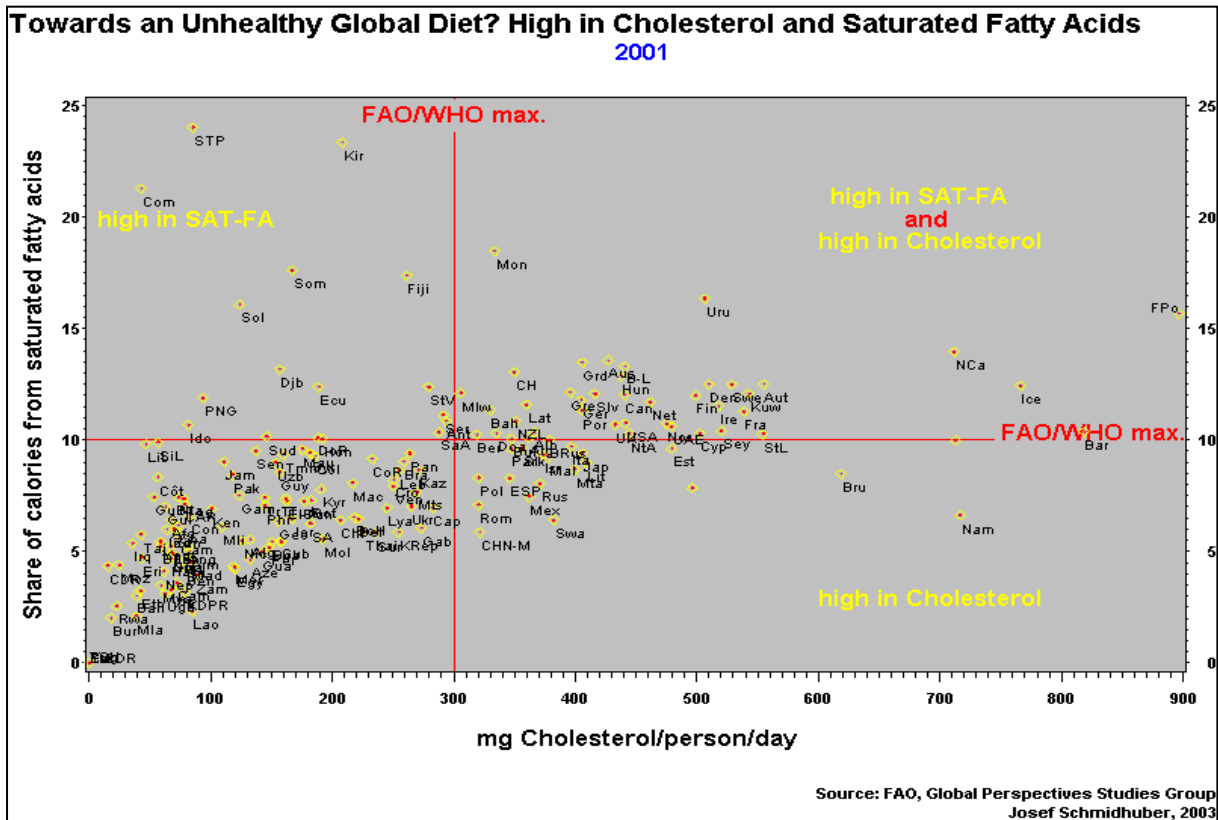


Figure 4b: Saturated fatty acids and cholesterol levels versus WHO/FAO recommendations, 2001

The same analysis of cholesterol and saturated fat consumption for the next 30 years is unfortunately not possible without risking major data problems. Most importantly, the FAO long-term projections (Bruinsma, 2003) do not provide the commodity breakdown necessary to calculate the dietary contents of saturated fatty acid and cholesterol, at least not with the same precision as for the past. However, as both cholesterol and saturated fat intakes are highly correlated with meat, milk and egg consumption, the projections implicitly suggest a swift and substantial increase in intakes of these nutrients. The most pronounced increases can be expected for East Asia and Latin America, driven by further increases in poultry and beef consumption respectively. But even developed countries are likely to top the already high levels of intake of saturated fatty acids and cholesterol as consumption of animal products is expected to increase further. Other things equal, this suggests a further deterioration in the dietary quality of many developed as well as the rapidly growing developing countries.

4. Nature versus Nurture

The principal links between changes in dietary patterns and a whole range of diet-related diseases has been established and described in detail. A vast and growing body of studies documents these links. Excess energy supply or dietary imbalances can cause a whole range of NCDs, including obesity, cancer, CHD and NIDDM. The 1990s have added a new dimension to the traditional understanding of the links between nutrition and NCDs. A better understanding of human genetics, our evolutionary heritage and the significance of ethnical differences have added a new dimension to the understanding of the interactions between “nature” and “nurture” in the emergence of NCDs. As these new insights may play a crucial role in the design of nutritional policies, both for fighting hunger and obesity, it may be useful at this point to present the principal hypotheses.

4.1 Foetal Programming¹²: “the thrifty phenotype”

The 1990s have seen a series of studies that explored the importance of prenatal nutrition and foetal growth for the development of obesity and NCDs in adult life. Amongst the most important of these studies are by Hales (1991), Stein and Susser (1991), and Barker (1994 and 1995). The basic proposition of these studies is that foetal undernutrition is an important contributor to the development of obesity and degenerative diseases in adult life. While the exact mechanism that cause this link is still being explored, the most widely accepted hypothesis (the so-called “Barker hypothesis”) postulates that hunger during certain stages of pregnancy (intra-uterine growth retardation, IUGR) “programmes”¹³ the foetal tissues such that food energy in adult life is more efficiently utilised¹⁴. As a result, low birth weight babies are more likely to become obese in a less austere adult life.

The consequences of this link in the context of the accelerating nutrition transition described above could be dramatic. Mid-income developing countries are likely to be most severely affected. Where rapid income growth and falling real prices for food raise the dietary

¹² Delisle (2002) provides an overview of the evidence and implications for policy and intervention strategies.

¹³ The exact biological mechanism underlying the concept of “foetal programming” is still unclear. Most likely, it involves alterations in gene expression that modify tissue differentiation as well as hormonal and metabolic regulation. The hypothesis of an alteration in gene expression is supported by results from animal experiments that show clear inter-generational persistence of the programming. If true, this would mean that transient effects in pre-natal life have not only a permanent generational but also a persistent inter-generational effect on our metabolism and activity levels. In response to an adverse nutritional environment (hunger, protein deficit, micronutrient deficiency), a resetting of the metabolism may be involved to become more “thrifty” when nutrient supply is reduced (Hales, 1991). These metabolic changes give the offspring a crucial advantage in times of scarcity, but they also become a liability in an environment of abundance, increasing the risk of obesity and related NCDs.

¹⁴ Epidemiological and experimental data reveal that foetal growth is a complex, dynamic process that depends on a continuous supply of nutrients from the mother. Severing this supply, even only over a brief period of time, may lead to irreversible changes in the offspring and to degenerative diseases in adulthood. There is also evidence that programming is not only the result of malnutrition in developing countries, but also of nutritional imbalances in affluent populations. Numerous projects are underway in developed countries to broaden the scientific basis for the foetal origin hypothesis of degenerative diseases such as glucose intolerance, diabetes, obesity, hypertension and cardiovascular diseases (e.g. Remacle, 2001).

energy supplies for large parts of a population in a fast and massive manner, today's hunger problems could be a harbinger for tomorrow's obesity problems. In fact, it may already explain the rapid increase in the prevalence of obesity in those developing countries that experienced at rapid transition from paucity and hunger to relative affluence and ample food energy supplies (South Pacific region, Brazil, China, many countries in the Near East and North African region). Delisle (2002) underlines that particularly the sharp increases in CHD and diabetes in developing countries undergoing a rapid nutrition transition are highly congruent with the early origin (Barker) hypothesis.

With a view to the future, developing countries with a high prevalence of low birth weights (LBW) today and high projected growth in dietary energy supply over the next 30 years could suffer a considerable obesity and NCD problem tomorrow. This will be particularly so where urbanization, better transportation infrastructure, or mechanization of the work will lead to an increasingly sedentary lifestyle and reduce calorie expenditure. Moreover, the impacts of obesity and NCDs on people's health could be felt more strongly in developing countries than in developed countries today. While consumers will no longer be "food-poor", they still too poor to afford the blessings of modern medicine ("health poor"). They may suffer from NIDDM, CHD and obesity without access to the medication that makes these diseases manageable in developed countries. A drop in overall economic productivity and eventually in life expectancy could be the consequence.

More recent studies suggest that foetal programming may not only affect the efficiency of adult metabolism but also their overall activity levels. Based on an experiment with rats, Vickers (2003) found that foetal undernutrition causes not only obesity but also a significant fall in the physical activity levels in adults¹⁵. If confirmed by other studies and if applicable to the human metabolism and behaviour, the burden of undernutrition in today may have a doubly heavy cost in the future.

¹⁵ Vickers et al. found that offspring of rats that were undernourished in the womb were significantly more sedentary in postnatal life than those born of mothers with a standard diet for all parameters measured, and independent of postnatal diet. Analysis of ingestive behavior revealed overeating in mature offspring that had been exposed to maternal undernutrition. This was independent of postnatal diet, although sedentary behavior was exacerbated by hyper-caloric nutrition.

4.2 Ethnicity: “The thrifty genotype¹⁶”

In addition to the thrifty-*phenotype* hypothesis, there is also the thrifty-*genotype* hypothesis which postulates a *genetic* predisposition for a more efficient metabolism independent of the effects of IUGR and foetal programming. It essentially suggests that natural selection favoured those hunter-gatherers who were better at depositing fat and putting weight on quickly, because they would survive periods of food shortages. Where this selection pressure prevailed over long periods of time and where populations remained largely isolated from other gene pools, relatively homogeneous population clusters with a high prevalence of the thrifty genotype have survived to present times. The most frequently described examples of such populations clusters are the Pima Indians (in the US and Mexico), the aborigines of Australia, or the inhabitants of the Island of Nauru.

Those thrifty gene clusters that have also experienced rapid nutrition transition are particularly interesting for research. They epitomise the extreme case scenario for the development of obesity and related NCDs that may plague thrifty phenotype populations that are or are expected to undergo a very fast transition from low levels to high levels of energy supply. The fate of the Nauruans may help illustrate the case. For millennia, Nauruans have lived as fishermen and farmers, with food supply alternating between bouts of starvation and times of abundance. When the island was discovered to be full of high-quality phosphate rock in 1922 its residents became wealthy and they shifted from their traditional lifestyle of feast and famine to a lifestyle of permanent affluence and food abundance. Their new-found wealth had a profound effect on the people and their health. They turned to eating a high-sugar high-

¹⁶ The thrifty genotype hypothesis was first formulated by Neel (1962, 1982). The earliest paper to examine the genetic aspects of insulin resistance as it relates to diabetes mellitus is Neel (1962). Neel put forward that the diabetic genotype was in a sense a "thrifty" genotype that promoted the efficient utilization of large amounts of food. This could afford a survival advantage in an environment in which both feast and famine were common. The apparent overproduction of insulin by certain individuals today could thus be a remnant from evolutionary times, when it helped to accumulate fat storage for times of food scarcity. When Neel (1982) revisited the 1962 research, he notes that subsequent research has invalidated several details of his 1962 paper. In the 1982 paper, Neel provides three new possibilities which could help explain the original hypothesis of the "thrifty genotype". Two of the approaches revolve around having non-functional or insensitive insulin receptors, and the third approach suggests differences in insulin sensitivity between glucose and lipid pathways in each individual. More recently Miller and Colagiuri (1994) have suggested the *carnivore connection hypothesis*. It provides an explanation, based on evolution: Populations that have a relatively "long" history of agriculture, e.g., those of European descent, have a relatively low incidence of NIDDM, that is, non-insulin-dependent diabetes mellitus, also known as adult-onset diabetes. Populations that adopted agriculture more recently i.e. discontinued the evolutionary hunter-gatherer diet more recently, have relatively higher incidence rates of NIDDM. In some former hunter-gatherer populations, incidence levels of NIDDM range from epidemic levels (Nauruans; the Pima tribe of the U.S.), to rates that are "only" several times that of Europeans. The major points of the hypothesis are as follows (from Miller and Colagiuri (1994, p. 1280 (abstract)): “*Our primate ancestors ate a high-carbohydrate diet and the brain and reproductive tissues evolved a specific requirement for glucose as a source of fuel... [T]he Ice ages which dominated the last two million years of human evolution brought a low-carbohydrate, high-protein diet. Certain metabolic adaptations were therefore necessary to accommodate the low glucose intake. Studies in both humans and experimental animals indicate the adaptive (phenotypic) response to low-carbohydrate intake is insulin resistance... We propose that the low-carbohydrate carnivorous diet would have disadvantaged reproduction in insulin-sensitive individuals and positively selected for individuals with insulin resistance*”. Insulin resistance is therefore a disadvantage in the high-carbohydrate diets provided by agriculture, as the metabolism of sugar (and starch) requires far more insulin than the metabolism of fats or proteins. That is, an agricultural diet requires more insulin than a hunter-gatherer diet. Because of longer history of agriculture, selection pressure for insulin resistance was released sooner in European populations - resulting in lower incidence of NIDDM.

energy diet, and adopted an extremely sedentary lifestyle. In only one generation, they fell victim to an epidemic of obesity. The prevalence of NIDDM soared with two-thirds of those over the age of 35 affected by the disease.

The Pima Indians in the US reservations in Arizona have experienced a similar transition in diets and lifestyle. And, they suffer problems of the same nature and a similar extent. Their tribal relatives across the border in Mexico, who largely maintained their diet and lifestyle, however, also managed to eschew the related health problems. The policy message from this experience is straightforward. Where a predisposition, regardless of whether it is phenotypic or genotypic, increases the risk of developing obesity and related NCDs, policies have to put in place at the right time (as early as possible) and to a significant extent to avoid an epidemic increase in obesity and related NCDs.

As food consumption patterns can move to a given ethnical group, whole ethnical groups can shift into new food environment. Probably the most important cases are Indians moving to the United Kingdom, Ethiopian Jews airlifted to Israel, Mexican and other Latino immigrants moving to the US. More generally, globalization not only means a faster move in food consumption patterns across borders but also means cross-border migration of people into new patterns of food consumption and different types of lifestyle. The effects observed for migration of people are symmetrical to those for the migration of food consumption patterns. As migrants adopt the food consumption patterns of their new environments, they often experience obesity and NCDs – at rates that significantly exceed the average of the new ethnic environment.

Not only the phenotypic but also the genotypic predisposition is more likely to affect developing countries. Developed countries temperate zone populations have embarked much earlier on the transition from hunter-gatherers to agriculturalists. With this transition, the evolutionary advantage of the thrifty genotype largely disappeared or even reversed and the frequency for the thrifty gene thus declined. Developing country populations', by contrast, are residing predominantly in tropical and subtropical areas and still have to endure long bouts of food shortages. They kept the greater need for a more energy-efficient ("thrifty") metabolism but may not yet have developed one that can cope with ample supplies of carbohydrates.

The rapid shift towards high energy supplies combined with a genotypic and phenotypic predisposition for an energy efficient metabolism may cause an obesity epidemic over the next 30 years that would surpass the problems in developed countries today. Asia, Latin America, Near East/North Africa would probably be the most affected regions. This poses the question as to whether and how developing countries could avoid such an outcome or mitigate its impacts. A few options will be discussed in the following section.

5. Some policy options

If the insights gained from foetal programming, intergenerational persistence and socio-economic changes are put into the projected changes in global nutritional environments, a whole array of questions of potentially global importance emerges. Are hunger of past and surplus of the future a precarious combination for obesity and diet related diseases? What role plays programming for the epidemic increase in obesity and NCDs in developed countries today? And, will the rapid nutrition transition of many developing countries in conjunction with the effects of socio-economic change cause a pandemic of obesity and NCDs in developing countries before we have a chance to intervene? Are the millions in developing countries, who just managed to shrug off hunger and poverty, programmed to suffer from obesity and NCDs tomorrow? And, will they pass the heritage of a changed metabolism and a possibly even a genetically predetermined sedentary lifestyle on to their children, and if so, when can we expect the genetic burden to disappear? And, most importantly, what can be done today to eschew a health disaster tomorrow?

The rapid increase of NCDs suggests that some of these concerns have already become a reality, at least in developed countries. The rapid nutrition transition in conjunction with the genotypic and phenotypic predisposition to develop NCDs suggests that developing countries may even face bigger problems in a shorter period of transition. The policy messages emerging from these links are straightforward: First, all efforts that help fight hunger today and improve the nutritional situation of women in the reproductive age have the potential to yield an extra dividend for the coming generations. Second, nutritional education and supplementary feeding programmes for pregnant women that ensure a balanced and healthy diet are even more important than hitherto assumed¹⁷. Third, policy makers in developed and developing countries alike have to think about possible policy measures that can help contain a growing obesity problem without hurting progress in fighting hunger.

As far as the fight against hunger is concerned, there is no shortage of programmes and projects that would provide or at least would promise success. But policy approaches that would help contain or reverse the global obesity problem are rather new. The various proposals and their pros and cons are being discussed at the moment in many developed countries (Australia, US, UK). This analysis aims to shed some light on the various proposals and will also try to assess possible interactions and incompatibilities with other policy measures.

5.1 Food price interventions

One of the most popular proposals to come to grips with the growing obesity epidemic and the associated public health costs has been the consideration of a tax on energy-rich foodstuffs. These proposals are now being discussed by health officials and public policy makers with a view to identifying their *effectiveness* in reaching their stated objectives, their *efficiency* relative to other measures, as well as their shortfalls and side-effects. In principle, interventions could take place at two different levels. The first would be to influence producer prices for food, i.e. interventions at the agricultural producer level. There is a long history of such interventions in OECD countries and an equally long debate about the effects and problems that has emerged with such interventions on agriculture but relatively little on

¹⁷ They could be of critical importance in those developing countries, where the prospects for a rapid increase in calorie availability combined with a more efficiently “programmed” metabolism could result in a disproportionate increase in obesity and related NCDs.

consumers and food consumptions. The second entry point for price interventions would be the consumer price level. These interventions are currently largely limited to VAT charges and total or partial exemptions from VAT surcharges. The following will try to shed some light on possible impacts of the two types of intervention and will try to provide answers that arise in the context of policy interventions.

The case for food price interventions

The basic case for food price interventions rests on the notion that higher prices could provide a means to reduce excess food consumption, which is in turn associated with significant societal externalities. Differently put, the price of food energy set by a free market reflects the costs of producing them rather than their true cost, i.e. (which is the production cost *plus* the external costs of treating CHD, NIDDM, etc.). If food markets fail to capture the full costs of excess consumption, a tax - set at the level where production cost plus tax will equal the production cost plus external costs would provide an economically efficient solution.

But there may be important rejoinders to the tax argument. For instance, that a tax on excess food consumption could be a regressive tax as it creates an extra burden on people with higher calorie needs and lower incomes. Moreover, interventions on food prices in a system of increasingly freer trade in food and agriculture are likely to create incompatibilities with commitments taken elsewhere, notably those taken within the WTO. Not liberalizing trade means to forego efficiency gains to be had from a better allocation of production, which would need to be taken into account in the overall cost-benefit analysis of such a tax. How effective and efficient such taxes are in practice, and how compatible they are with other policy reforms will be discussed in the following section.

Price interventions at the producer level: “A tax on fat food”

As already mentioned, producer price interventions for food products are a commonly used tool of agricultural policies in developing and developed countries alike. Numerous studies have analysed their impacts on agriculture, farm households, incomes, the environment or rural development. But relatively little is known about their impacts on consumers and food consumption patterns. In fact, many analyses simply assume that, changes in producer prices are fully transmitted to the consumer level or that consumers are implicitly assumed to change their consumption patterns according to a change in producer prices.

Interventions at the producer level have been subject to controversial policy debates, particularly those associated with higher border protection, intervention price systems and export subsidies. Any suggestion to increase such measures for the sake of possible health benefits of such measures would therefore add to an already contentious debate and should be most carefully vetted before any inference is drawn.

Much of the rationale brought forward by the proponents of agricultural price interventions rests on the observations that countries with massive support to agriculture, high producer prices and high border protection are enjoying relatively moderate prevalence levels for obesity. This relationship is depicted in Figure 5 which in fact suggests that the OECD countries with the highest PSE rates (Japan, Korea, Norway, Switzerland) enjoy the lowest prevalence rates of obesity, while Australia, New Zealand of the US, all with low or middling

levels of protection suffer relatively high prevalence rates of obesity. The question that arises in this context is whether this relationship is of a causal nature, i.e. whether it is a matter of correlation or in fact causation.

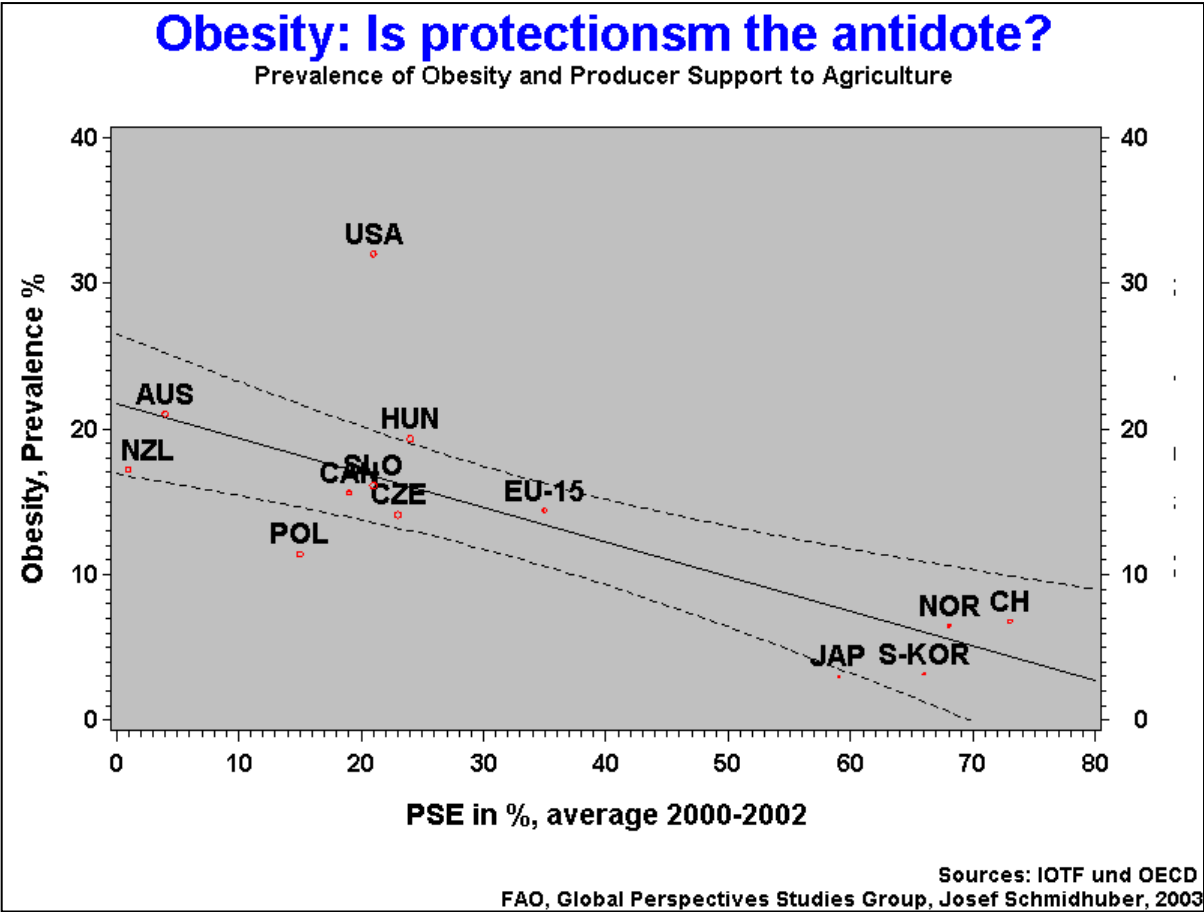


Figure 5: Agricultural support and the prevalence of obesity

A necessary condition for a causal relationship is that a price increase at the level of the protected agricultural product has a substantial impact on final consumer prices. Differently put, the question is one of price transmission within the food chain and one of the value share of farm products in the final consumer price. A number of empirical studies help find an answer to this question (e.g. Wohlgenant). These studies show that (i) the value share of primary products in the final consumer good has been declining over time and with rising value share of services included in the product and (ii) that there are considerable differences across commodities (very low for e.g. wheat/bread, high for eggs). The high service element in the differences also means that the margins between producer and consumer prices are typically much higher in developed countries than in developing countries. For some products at least, an increase in the producer price in a developed country (regardless whether through higher border protection, higher support prices or a combination of the two) may therefore not create a sizeable increase in consumer prices.

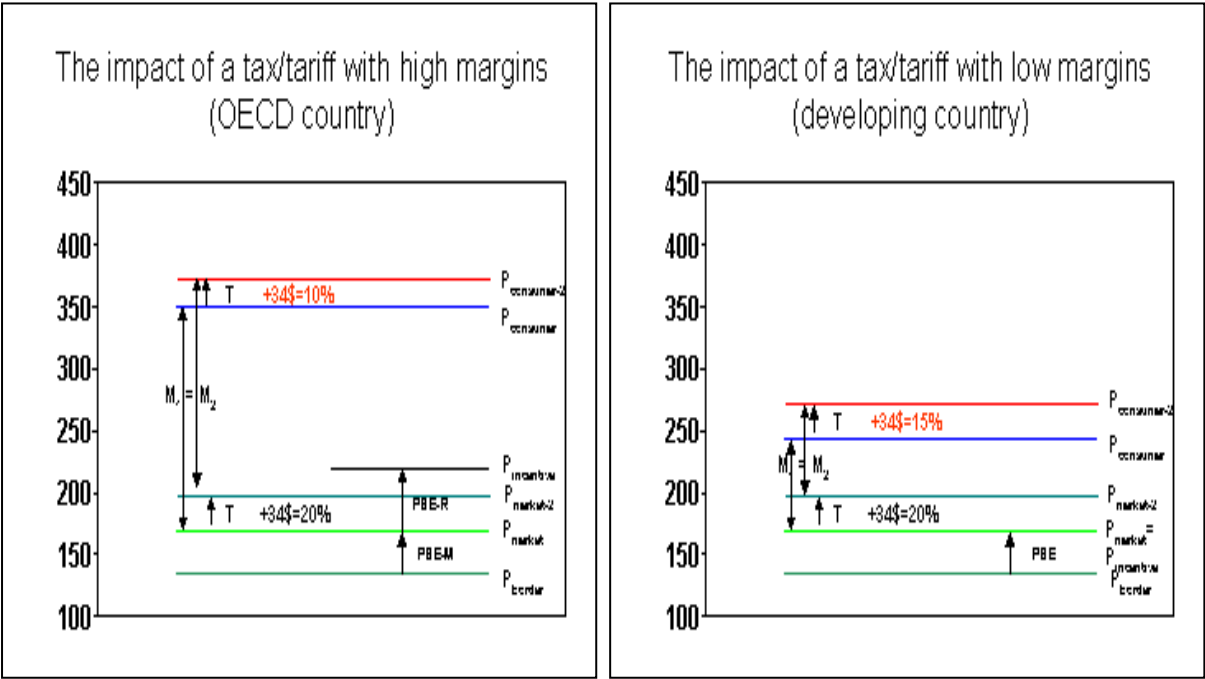


Figure 6: Examples of the agricultural price formation at support levels and processing margins

Figure 6 (left pane) depicts the main factors that affect the *horizontal* and *vertical* price transmission for food products in a developed country (Schmidhuber, 2002). What is referred to as the horizontal transmission is essentially the transmission of primary product prices across the border from international markets to the domestic commodity market. In many OECD countries, this process is often heavily affected by agricultural policy measures. In this process, the internal price formation starts from a (low) border price that is raised e.g. through a tariff to the level of the domestic market price. For producers, this market price is further increased (e.g. through a direct transfer) to the level the farm incentive price which drives the level of input applications and allocated area. The domestic market price is where the vertical price transmission process starts. It starts with a wholesale operation (co-operative) pooling supplies from farmers; the primary products (cereals) are then further processed at various stages (flour, bran, etc.); intermediate products are further refined (different types of flour), added to other products and eventually sold as the final consumer good (bread, breakfast cereals, etc.) by a retailer (supermarket, bakery). In this multistage process, the various agents add often considerable margins for the processing or marketing services they provide. As a result, the value share of primary good (wheat) eventually accounts only for a small share of the final value of consumer good (bread). In Figure 6 (left pane) the margin between producer prices and consumer prices is assumed to be 100%. For cereals, the margin may exceed 500% and more, while it should be less than 100 % for eggs.

Figure 6 also illustrates how an agricultural policy change (ad valorem tariff on the primary commodity) would be transmitted – both horizontally and then vertically - into the final consumer price. Even though the margins are fairly small in the illustrated case, the introduction of a tariff T of 20% would only cause a consumer price increase of 10%. If margins are higher as for instance for wheat and bread, the effects would be even smaller. In practice, the margins are often so high that a primary price increase is hardly traceable for the

final consumer price¹⁸.

The situation is quite different where primary products account for a larger value share in the final consumer good (Figure 6, right pane) -- not an atypical case for the price formation in many developing countries. Any price increase at the producer level would translate into more substantial increase in consumer prices and, where consumers are price responsive, result in a reduction of consumption. Higher consumer prices for food in developing countries, however, may also mean that – other things equal - undernourishment may increase. It also explains – though not justifies - why many developing countries have chosen to tax their agriculture to the benefit of (urban) consumers rather than protecting it.

From the consumers' point of view, the impacts of low shares on the final product is in effect described by Marshall's theory of derived demand (Marshall, 1920, v.vi.2), i.e. that demand is typically fairly inelastic where the primary commodity forms only a small component of the final good. It may therefore be necessary to move on to a tax that is directly levied at the consumer level, again distinguishing the impacts of low and high price elasticities of demand.

Price interventions at the consumer level: A Tax on "Fat Food"

A similar, though in its impacts somewhat different, proposal to come to grips with the growing obesity epidemic has been a tax on consumer prices of food. Particularly in developed countries, the discussion has recently advanced from the theoretical proposition into examining actual and operational issues. Public health officials¹⁹ in particular have been proposing concrete measures how to increase the costs of energy-rich and "saturated" foods by adding an extra tax on energy-rich food or reducing the food VAT exemptions that are still in place in many countries.

While the enthusiasm amongst public health advisors for such a tax is understandable, issues pertaining to the economic effectiveness and the operational efficiency of such measures in reducing obesity are less clear. Again, the effectiveness of such a measure depends crucially on how responsive consumers of these foods would react to price changes induced by (higher) taxes. The elasticities used in the FAO @2030 model in Figure 7 provide an idea for the general link between income levels and the

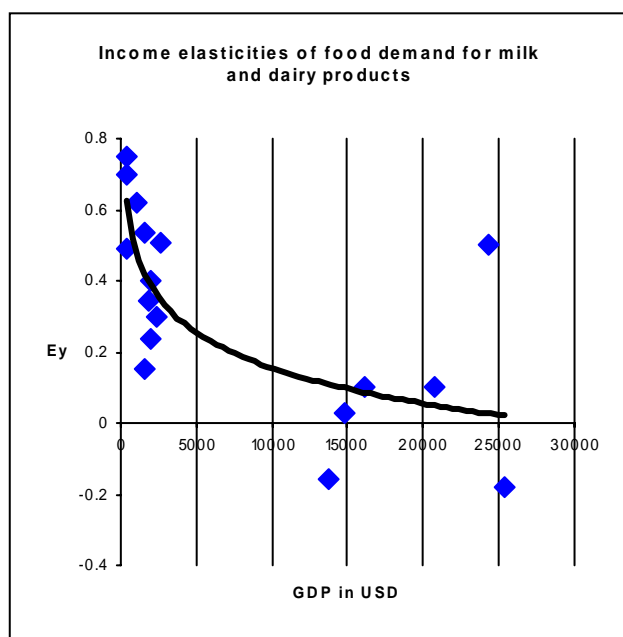


Figure 7: Income elasticities at different income levels (Source: Schmidhuber and Britz, 2002)

¹⁸ Notable consumer price impacts are only likely if tariffs are extraordinarily high and/or processing and marketing margins are very small. Rice in Japan could be a case for more significant impacts on consumer prices, except that consumers in Japan have shown little responsiveness in their consumption of rice.

¹⁹ Dr. Martin Breach, spokesperson for the British Medical Association, for instance, proposed the 17.5% Value Added Tax (VAL) on high-fat foods. The Australian Medical Association is promoting similar measures.

responsiveness of demand with respect to income levels.

In general, income elasticities decline with rising incomes and even become negative (inferior goods) once a certain income level is exceeded. In tandem with lower income elasticities, price elasticities tend to decline (in absolute values) with rising incomes²⁰. A

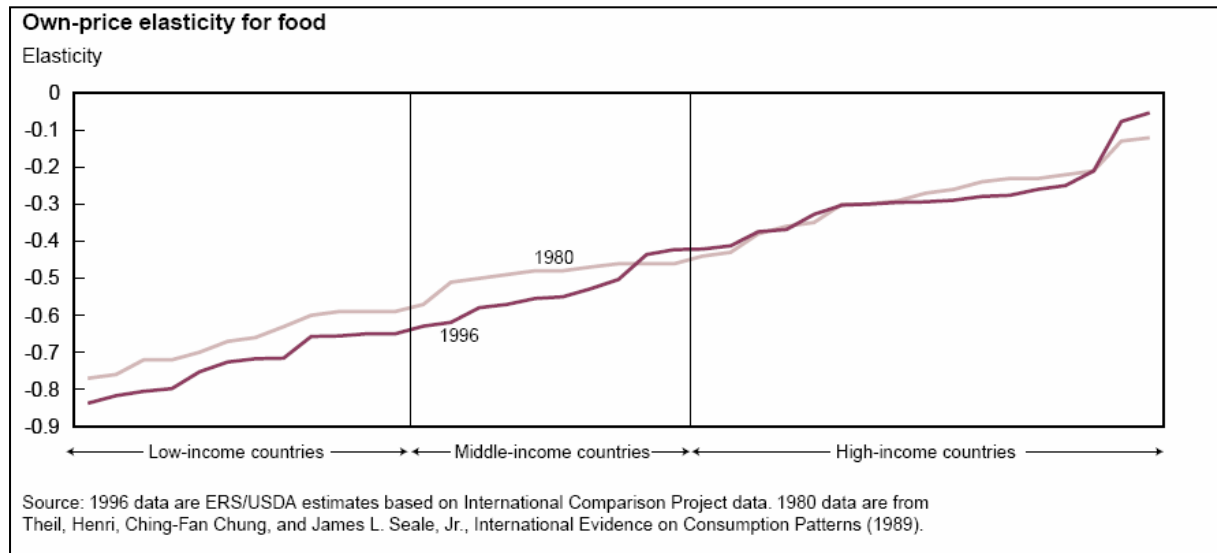


Figure 8: Price elasticities for food across income ranges (Source, Regmi et al., 2003)

detailed study by USDA (Regmi, et al.) fully confirms the theoretical expectation with ample evidence from more than 100 countries. As depicted in Figure 8, rising incomes are associated with a sharp decline in own price elasticities from -0.9 in low income countries to close to zero in the top range of the high income countries.

The results of this research are summarized in Seale (2003). They confirm many of the results obtained and established by earlier studies, notably that (i) low income countries spend a greater portion of their budget on necessities, such as food, while richer countries spend a greater proportion of their income on luxuries, such as recreation; (ii) low-value staples, such as cereals, account for a larger share of the food budget in poorer countries, while high-value food items, such as dairy and meat, are a larger share of the food budget in richer countries; (iii) low-income countries are also more responsive to changes in income and food prices and, therefore, make larger adjustments to their food consumption pattern when incomes and prices change. However, Seale et al also find that adjustments to price and income changes are not made uniformly across all food categories. Staple food consumption changes the least, while consumption of higher-value food items such as dairy and meat changes the most. Additionally, the results indicate that when price changes are accompanied by equivalent income changes, wealthier low-income countries and middle-income countries make the most adjustments to their food demand (Seale, 2003)

Assuming the basic relationships between food demand, incomes and prices, the principal impacts of a change in food prices, e.g. through a tax can be examined. Figure 9 depicts the demand response to a tax on excess calories with price elastic and price inelastic

²⁰ Falling income elasticities do not necessarily mean that also price elasticities are falling with higher incomes. In fact, it is possible to construct a globally well-behaved demand system with low income elasticities as well as high own and cross price effects. In reality, however, low income elasticities for food are also associated with low price and cross price effects.

demand. Where demand is inelastic (rich consumers, left pane of Figure 9) a tax on fat food will bring about only a small reduction in demand, thus only provide a small contribution to reducing food intakes and thus possibly obesity. In fact, the impact of the tax on demand will decline with the elasticity, while the tax revenues will increase. This low-responsiveness situation characterises many food markets in developed countries, particularly where income differences within an economy are relatively small. The effect could be quite different in middle income developing countries or in developed countries where incomes are less evenly distributed. Here a tax on excess calorie consumption – applied uniformly across all income strata – would do little to reduce obesity in the high income-low elasticity strata but could have a consumption-contracting effect on poor elastically reacting consumers.

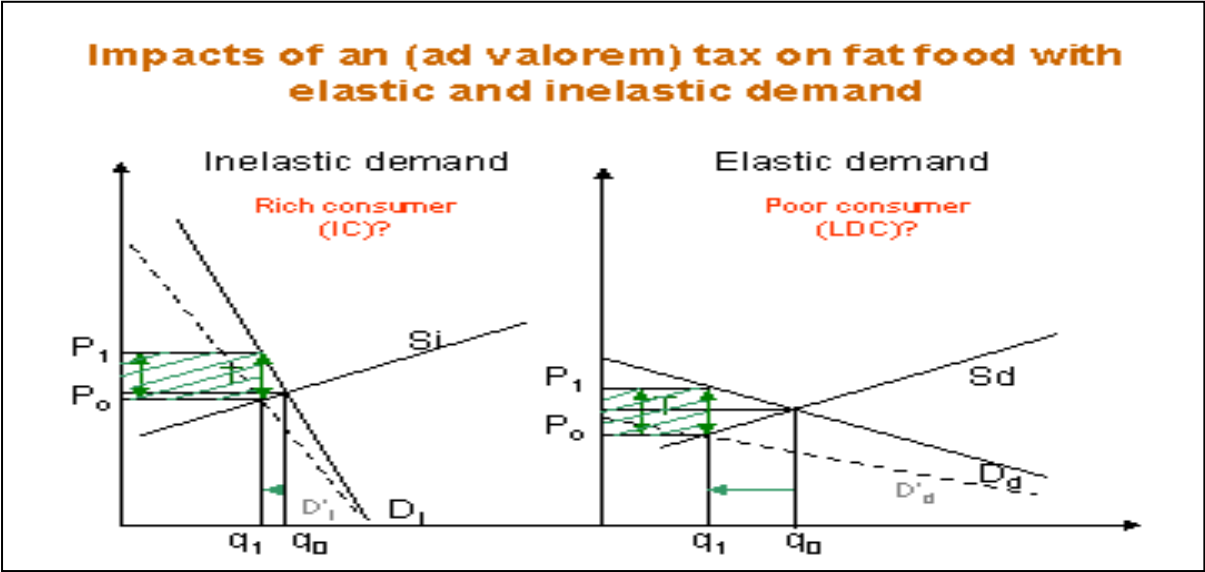


Figure 9: A tax on food with elastic and inelastic demand

There is empirical work that – by and large – confirms these theoretical expectations. For China, for instance, Guo has documented the possible reactions of consumers to price changes on various food items across a range of income strata. They found that (i) consumers in low income strata are more responsive to price changes for certain food items than rich consumers, e.g. for pork consumers in the poorest strata are reacting three times as elastically as consumers in the richest strata; that (ii) “an increase in the price of a food tends to drive consumption away towards its substitutes” (iii) and finally conclude that “increases in food prices have much less favourable effects for the poor” (Guo et al. 1999).

Where income elasticities are low but substitutability between the various foodstuffs is high, a price-induced reduction of consumption in a given good is associated with higher consumption of its substitutes. In such a situation, taxes may well help to direct consumption of a single food components into the desired direction, the impacts on overall energy intake however is likely to be limited. If for instance calories from animal fats are being taxed, consumption of vegetable oils and fats is likely to increase²¹. Numerous other side-effects could result.

A tax on animal fats, for instance, should promote the production and consumption of

²¹ As King puts it: “If the government regulates the content of, say, fast food, people will find fat elsewhere”, EconLog 2002-11-17.

so-called “light” products (light yogurts, low fat milk, etc.) while consumers would tend to reduce foodstuffs with high calorie contents. But the excess fat is likely to surface elsewhere in the food chain either domestically or abroad. One vent for surplus in many developed markets is the junk food industry where a lot of extra fat and sugar is added to ice cream, hamburgers, French fries. If also junk food were to be taxed, the fat and sugar added currently to ice creams hamburgers would occur elsewhere in the food chain. If not domestically, the high calorie parts of a food stuff could be exported and end up in developing countries. A case in point is poultry meat, where rich economies already consume predominantly the lean parts (breasts), while the fat parts (leg quarters) are disposed of on consumers abroad, with possible adverse effects on both their food consumption patterns and their agricultural economies.

More generally, a tax on fat/unhealthy foods may result in a pronounced deterioration of the dietary patterns of the poor (both with a country and through trade across countries). As a tax on unhealthy foods would stimulate demand of and boost prices for healthy food, and price the poor out of the market for healthier foods. This may mean that the poor end up consuming even higher quantities of the “bad” foods than before.

Another problem with a tax on excess calorie consumption is that in practice such a tax would have to be imposed on food items rather than on nutrients (energy) directly. As food items typically contain a bundle of different nutrients, a tax on a food item rather than a nutritional component can bring about undesired side-effects: Guo, for instance, found that higher pork prices in China may indeed help reduce the intake of energy and saturated fatty acids of rich consumers but may cause an undesired fall in protein consumption of the poor.

A look at excess body weights and DES levels across countries seems to confirm the described impacts of a food tax on overweight and obesity. The left pane of Figure 9 depicts the DES levels and *male overweight*^{22/23} in those countries for which the OECD and the IOTF provide information. This left pane of Figure 9 depicts of the graph captures various effects. First, it confirms that there can be a considerable overweight problem even when food supply levels are low on average. Second, the prevalence of excess body weight increases with the average food availability. Third, once the DES exceeds a certain level (about 3300 kcal per person per day) there is no more increase in the prevalence of overweight. In fact, if obesity estimates were included the curve would be flatter. The latter reflects the fact that a large share of calories above 3300 calories is wasted. All in all, the relationship between food availability and excess body weight resembles a typical input-output function (agricultural production function, i.e. diminishing production increments per unit of additional applications of an input, e.g. fertilizer, beyond a certain level).

The tax on fat food (input) – put in the context an input-output function – helps illustrate the possible impact of a change in input prices (tax on fat food) on the level of output (excess body weight). The right pane of Figure 9 combines the impacts of a tax on excess food energy intake in the input market with the likely effects on the output market (excess body weight). It underlines that the small impacts of the tax on actual food availability are even further reduced as the tax is effective in the flat part of the food energy/body weight curve. The flat part of the curve reflects the fact that a high DES is associated with high levels of waste, e.g. societies with more than 3300 Kcal also waste a lot more food and may thus not experience such a rapid increase in the prevalence of excess body weight.

²² Male overweight was chosen because of the largest sample size which also included low income countries.

²³ A look at the prevalence of excess body weight across different income strata within a country would have been preferable, but was – in the absence of data - impossible.

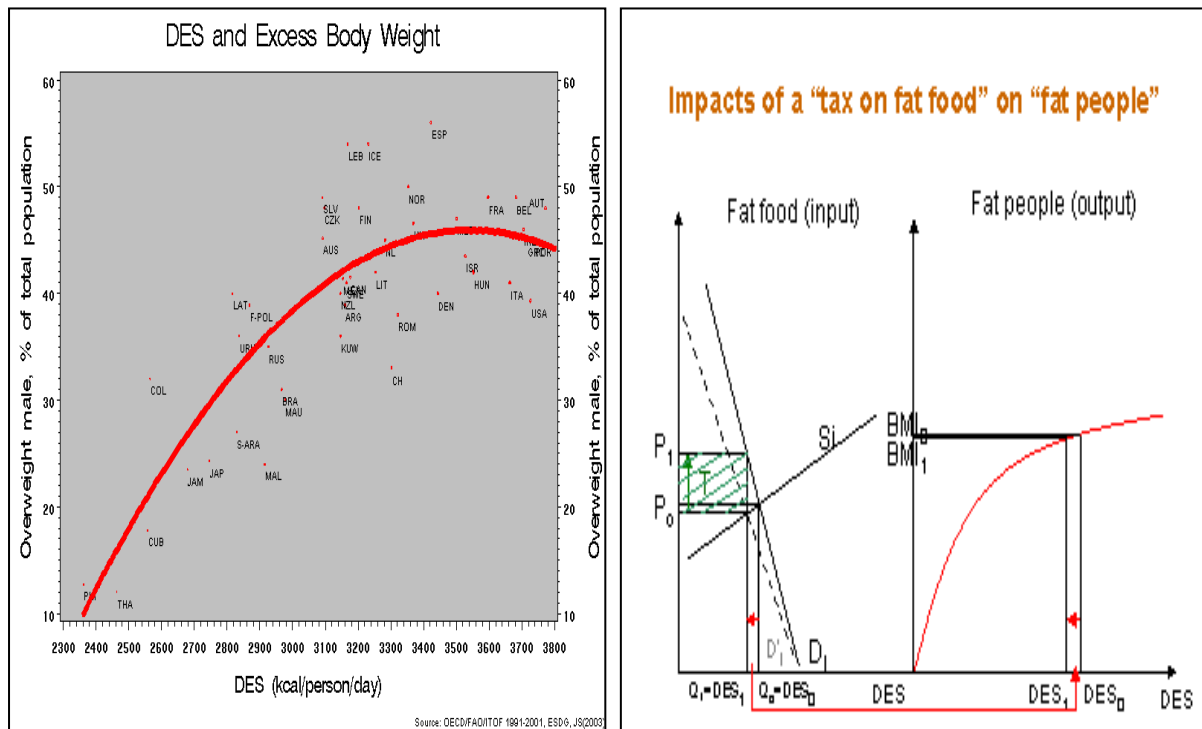


Figure 10: Impacts of a food tax on excess body weight

Waste is in fact usually the most elastic form of utilization and may therefore be the first to be reduced when prices rise (through the tax). Again, this buffer is likely to be more (less) pronounced where incomes and food availability is high (low). As DES levels climb above the 3300 kcal threshold, the largest part of the incremental food availability is likely to be wasted. This means that a tax on excess calorie (e.g. on calorie-rich foods) consumption may primarily reduce the level of waste in rich countries/for rich consumers while it may affect more directly the poorer consumers with lower waste levels. In the worst case (elastic poor and inelastic rich consumers and large income disparities), a tax on food may do little about obesity and increase undernourishment. In the best case (high level of equality, low food demand responsiveness), it will have a small impact on obesity, reduce waste to a certain extent and be an effective means to collect money that could be used to finance programmes for nutrition education.

As shown above, the link between calorie availability and excess body weight of Figure 9 is based on a cross country (inter-country) analysis of available data. It was also mentioned that an intra-country analysis of excess body weight would have been preferable but had to be dismissed due to a lack of income-stratified obesity data. The problem with the cross country data is that it may not be representative of the obesity distribution within a country. In fact there is growing evidence that - within rich countries - excess body weight is increasingly a problem for poorer consumers, who rely heavily on the cheap but empty calories of the fast food industry. M. Nestle (FT, 2003), for instance, claims that obesity is increasingly becoming a problem of the poor who are disproportionate high consumers of cheap dietary energy. In this case, a tax on certain energy-rich food items (“junk food”) could in fact have a curbing impact on consumption. The problem is of course whether poor consumers in developed countries have alternatives to which they could resort to in the case of an extra tax on such food items.

All in all, however, the disadvantages of food price interventions are likely to outweigh their advantages in reducing or reversing the trend towards a higher prevalence of obesity. For rich consumers, inelastic demand will limit the desired impacts on food demand, while for poor consumers high prices may create an added food insecurity problem. That said, targeted price interventions at the consumer level can have an impact on food consumption patterns if (i) they are targeted (ii) demand is reasonably elastic (iii) and consumers have a choice to shift to healthier foods. Where marketing and processing costs are high and taxes are applied to the final consumer good, the tax revenues could be considerable, the impacts on primary agriculture would be small and thus the trade distortions would be minimal. Where processing margins are small and demand is elastic, tax revenues would be small and the risk to create adverse impacts on food security could be considerable.

5.2. A tax on excess body weight: “Tax on fat people”

The low effectiveness and efficiency of a tax on food energy consumption in reducing excess body weight in affluent societies, the potential that it creates added trade problems, and the risk to increase food insecurity in poor societies or poor segments of rich societies poses the question of a more effective alternative. One of the most frequently discussed options is a tax on excess body weight rather than on excess calorie consumption. Colloquially, this proposal is being referred to as a tax on “fat people” as opposed to a tax on “fat food”.

While such a proposal may sound exotic at first sight, in practice it is not. In fact, there are already various forms of incentives or disincentives in place that aim at reducing excess body weight (or prevent increases in excess body weight). Surely, none of these measures is referred to as a tax on fat people. Health insurances for instance offer discounts on premiums for clients with normal body weights. Car insurers have started to offer discounts to normal weight customers as there is growing evidence that obese drivers have a higher risk of causing an accident. Even fast food chains introduce implicit taxes on overweight people by rejecting obese job applicants (Greenhouse, 2003). On the incentive side, employers offer free access to gyms to their employees even during working hours as there is ample evidence that excess body weight reduces the productivity of their staff, increases disability and sick leave claims (Figure 11). In the US, probably the most important incentive to reduce excess body weight was brought about by a new policy of Internal Revenue Service (IRS, 2002), stating that "Obesity is medically accepted to be a disease in its own right." For taxpayers, this now means that treatment specifically for obesity can be claimed as a medical tax deduction²⁴.

The basic case for these measures rests on the social costs that overweight people cause for the society (Figure 11). To the extent obesity creates external costs for the society, a tax on fat people could be perceived as a “Pigouvian” tax that helps bring private costs (low premium and low perception of personal health damage) in line with the social costs for the society, that is higher health expenditures, lower productivity, or more disability claims. One of the crucial questions for practical policy implementations is whether such a tax on the “output” (excess body weight) would be more efficient and more effective than a tax on the “input” (excess food consumption); and what differential impacts such measures would have on rich and poor consumers, food availability and food security, etc.

²⁴ "Uncompensated amounts paid by individuals for participation in a weight-loss program as treatment for a specific disease or diseases (including obesity) diagnosed by a physician are expenses for medical care that are deductible under § 213, subject to the limitations of that section."

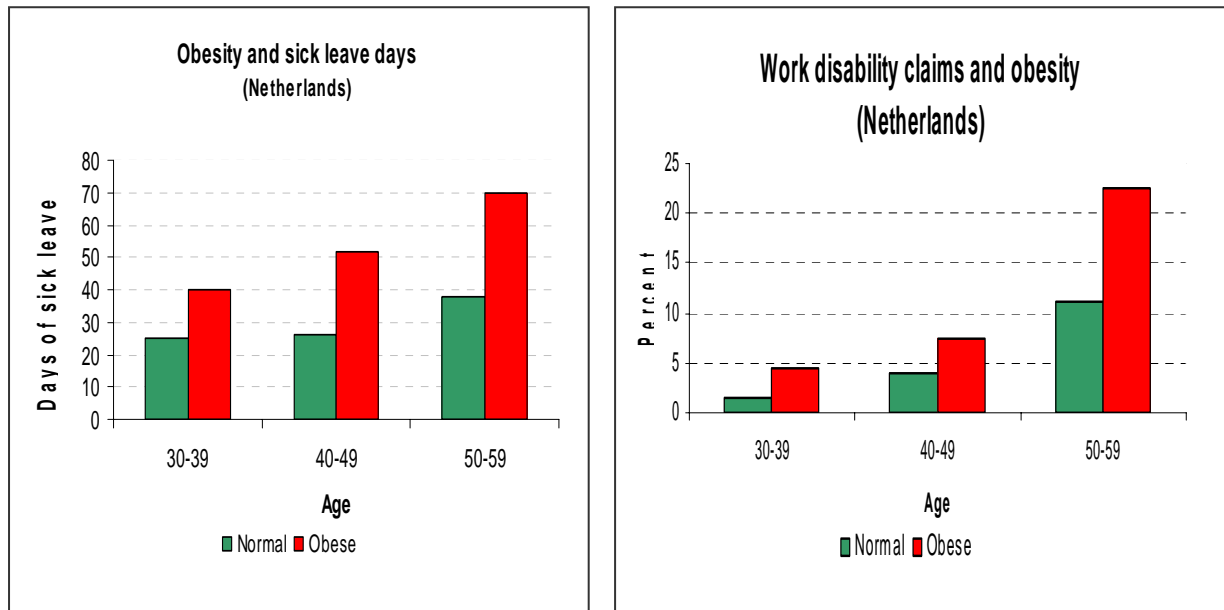


Figure 11: Economic costs of obesity. (Source: Nabro, 1996)

There are a number of reasons that suggest that a tax on excess body weight should be both more effective and more efficient than a tax on excess food energy intake. First, a tax on excess food energy would address only the calorie intake side of the dietary energy imbalance but leave the calorie expenditure side completely un-addressed. When calories requirements are high because of physical work, exercise or a less efficient metabolism, a tax on food may create additional private costs without creating a societal benefit. On the contrary, the extra food costs may reduce workers' productivity, lower their physical activity and thus create an extra cost for the society. Poor consumers would be hardest hit. A tax on fat people would avoid that problem as it directly taxes the result of the dietary energy imbalance rather than only the energy input side. Moreover, a tax on excess body weight should not have any trade distorting impact, as there is simply no need to maintain the food tax distortion through a price wedge for food at the border. Finally, to the extent to which the tax on excess body weight lowers food demand, food prices may actually fall and thus afford an added advantage to poorer consumers. But also a tax on excess body weight may not be without pitfalls. Most importantly, lower body weights per se are not a guarantor for a healthier diet and lifestyle. In fact, there is no shortage of unhealthy ways to reduce the excess body weight.

The discussion of the various price and tax intervention mechanisms suggests that there are considerable differences in the efficiency and effectiveness of these measures in helping to reduce the prevalence of obesity. Probably the least efficient and least effective measure would be an intervention at the producer price level. It would also be the measure that would be the least compatible with other policy objectives, notably freer trade. While probably more efficient, also a tax on consumer prices of food may cause undesirable side effects notably where income inequality is large and where low income strata react elastically to changes in food prices. A direct tax on excess body weight should be the most efficient and effective measure, but will neither be sufficient on its own nor would it ensure a better nutritional outcome.

5.3 Integrated health and nutrition programmes

The discussion also suggested that there is no simple let alone single-instrument solution. Instead, there is empirical evidence that it takes a combination of policy instruments to address the problem of obesity and related NCDs successfully. Such an integrated programme has, for instance, been launched in Norway and has – overall - yielded very positive results. The details of the programme are available from Norum (1999). Without repeating the details, the correlates of success were: (i) a strong legal and institutional foundation of a population-wide effort in a national organization, i.e. the National Nutritional Council (NNC); (ii) a robust scientific and empirical backing²⁵; (iii) a combination of measures (from food price interventions to nation-wide food education programmes) embracing a great number of stakeholders. Practical experience in Norway also suggests that there can be a considerable time lag between the implementation of various measures and the first measurable success.

The Republic of Korea provides another example for a successful nutrition programme. Details are available for instance from Popkin (2001). Kim finds that food energy intake and obesity levels in the Republic of Korea are approximately half of what would be expected for a country at that economic level (Kim, 2000), while vegetable intake is much higher than would be expected. Popkin (2001) suggests that a number of factors have contributed to this outcome. First, there has been a strong movement to retain traditional diets and food preparations. At the heart of this movement was a training programme, offered by the Rural Development Administration since the 1980s. The Home Management Division of the Rural Living Science Institute (Suwon, Republic of Korea) has trained thousands of extension workers to promote cooking methods for traditional Korean foods, e.g., rice, kimchi (pickled and fermented cabbage), and fermented soybean products. The programme appears to reach a significant component of the newly married women in the Republic of Korea, however, exact statistics are not available. At least to a certain extent, food consumption was also curbed by higher food prices, which were backed by domestic producer price support and border measures. The same combination of food traditions, educational programmes and higher food prices may also help explain the positive nutritional outcome in Japan, where as in Norway and the Republic of Korea, the prevalence of obesity and NCD remained much lower than in other countries of comparable development and income levels (see Figure 5).

²⁵ E.g. the “Oslo Study” or the health surveys of the National Health Screening Service.

6. Summary and Conclusions

Many developing countries are currently undergoing a rapid nutrition transition. Falling real prices for food enable a growing number of consumers to move swiftly towards higher calorie intake levels and allow them to embark on consumption patterns that had hitherto been reserved for consumers in developed countries at a much higher level of (nominal) income. FAO's long-term outlook suggests that the shift towards higher energy supply levels will accelerate and encompass a growing number of countries.

In addition to falling real prices of food, rapid urbanization has and will continue to affect consumption patterns. Essentially the entire population growth over the next 30 years will be urban. Urbanization creates a new and improved marketing and distribution infrastructure, attracts supermarkets and their sophisticated food handling systems (cold chains, etc.), better roads and ports, thus improves the access of foreign suppliers and the importance of imports in overall food supply and, all in all, will promote a globalization of dietary patterns. Most importantly from a nutrition perspective, these changes include not only a shift towards higher food energy supplies but also a shift towards more fats and oils and more animal-based foodstuffs, and thus higher intakes of saturated fat and cholesterol.

The shift in consumption patterns and lifestyles have resulted in a rapid increase in the prevalence of obesity and related NCDs. Many developing countries are in the process of undergoing a similar nutrition transition, with probably even more adverse health impacts. The main compounding factor of these nutritional changes is a phenotypic and genotypic predisposition towards developing obesity and NCDs. The phenotypic predisposition is the result of rapid transition from hunger and undernourishment towards overnutrition and affluence. There is ample empirical evidence that hunger and malnutrition "programme" the next generation to developing a more efficient energy metabolism and thus to have a higher propensity to develop obesity and related NCDs. In addition, populations of developing countries have on average a genetic predisposition towards developing obesity and NCDs (*thrifty genotype*).

The combination of (i) the rapid nutrition transition with rapidly declining share of expenditure on food as percent of total expenditure/income, (ii) urbanization, (iii) the shift in diet towards more animal products, and (iv) the phenotypic and genotypic predisposition towards a more efficient metabolism and NCDs could spark a rapid increase in the prevalence of obesity and NCDs over the next 30 years. The human and economic toll could be dramatic and for many the exit out of food-poverty may be associated with a straight entry into health-poverty. This means that, while fewer people will suffer from hunger and chronic undernourishment, more will have health problems related to obesity and NCDs. The impacts will be felt more severely than in developed countries as fewer consumers in developing countries will be able to afford the needed medical treatment even if they can afford more food. Many NCDs can have a lethal impact if left untreated.

The policy messages from these developments are twofold. First, fighting hunger today and thus minimising the phenotypic predisposition to develop obesity and NCDs should receive an extra attention by national policy makers and the international community. Particularly food programmes that help improve pregnancy and pre-pregnancy nutrition should be promoted. By helping to curb a likely obesity epidemic, these programmes will yield an extra return in the future - over and above their current anti-hunger dividend. Second, given the speed of the nutrition transition and the higher susceptibility of consumers

in developing countries towards developing obesity and NCDs, there is a need to design and device policy measures that help avoid adverse nutritional outcomes in developing countries as soon as possible.

This paper has analysed some of the currently discussed (price) intervention mechanisms. Interventions at the producer price level have been identified as the least efficient and the least effective in changing nutritional outcomes and reducing excess body weight. They are also unlikely to be compatible with efforts to liberalize agricultural trade. Consumer price interventions are likely to be more efficient – at least in developed countries – particularly as their effects are not diluted by huge processing margins. But what plagues all price interventions is the fact that those consumers who should reduce excess energy intake are likely to be the least responsive to price increases and will thus not alter their consumption patterns only because food is more expensive. Alas, the opposite holds for poor countries or poor consumers in rich countries where that higher food costs could bring about or aggravate undernourishment problems.

Probably more effective and efficient than a tax on food would be a direct tax on excess body weight, i.e. a tax on obesity itself. In fact, many developed countries have already instituted such taxes, mostly in the form of penalties for extra body weight or incentives (premiums/tax brakes) to lose excess body weight. The main advantages are (i) no or at least no negative side-effects on the food markets; (ii) compatibility with other policy measures; and (iii) no penalty for consumers that need high energy intake levels because of a higher calorie expenditure. Moreover, the tax would not only have fewer side-effects but be more effective and efficient as it allows addressing the excess body weight problem from both sides of the energy balance, the calorie intake side but also the calorie expenditure side. The main drawbacks are possible difficulties in the actual implementation and the fact that a lower body weight in itself is no guarantor for a healthier diet.

The discussion of the various price intervention mechanisms also underlined that there is no single measure that is sufficient to address the problem. Where progress towards a healthier diet and - in the sequel a healthier population - has become reality, the underlying policy changes included a broad spectrum of measures. These measures encompassed not only price interventions and premiums but also measures to enhance nutrition transparency and education. But even for such integrated programmes, progress is not immediate and even in developed countries decades may pass before tangible impacts are being produced. The diversity and complexity of successful approaches, the time lag between policy measures and their impacts, the accelerating nutrition transition and predisposition to develop obesity and NCDs underline the urgency for action in developing countries.

References

- Barker D.J.P., (1994) “*Mothers, babies and disease in later life*”, BMJ Publishing Group, London.
- Barker D.J.P. , (1995), “*Fetal origins of coronary heart disease*”. British Medical Journal 311: 171 – 174.
- Bean, R. (2003), “*Retail Food Sector Report 2003, Peoples Republic of China*”, USDA Attaché Report of 12 November 2003, GAIN Report Number: CH3825.
- Bruinsma (ed), (2003), “*World agriculture: towards 2015/2030, An FAO Perspective*”, FAO, Rome and Earthscan, London.
- Delisle, H. (2002), “*Programming of Chronic disease by impaired Fetal Nutrition, Evidence and implications for policy and interventions strategies*”, WHO report WHO/NHD/02.3, Geneva 2002.
- FAO (2003), “*The State of Food Insecurity in the World 2003*”, Rome.
- Fogel, R. (1994), “*Economic growth, population theory and physiology: the bearing of long-term processes on the making of economic policy*”, American Economic Review, 84(3):369-95.
- Greenhouse, S. (2003), “*Obese People Are Taking Their Bias Claims to Court*”, New York Times, 3 August 2003.
- Guo X., B. Popkin, T. A. Mroz and F. Zhai (1999), *Food price Policy Can Favorably Alter Macronutrient Intake in China*, Journal for Nutrition No 129: 994-1001, 1999.
- Internal Revenue Service (IRS), (2002): Ruling 2002-19, Part 1 Section 213 – Medical, Dental, etc., Expenses 26 CFR 1.213-1 (also § 262; 1.262-1.) and Rev. Rul. 2002-19.
- Hales C.N., Barker D.P.J., Clark, P.M.S., Cox, L.J., Fall, C., Osmond,C., Winter, P.D. (1991), “*Fetal and infant growth and impaired glucose tolerance at age 64*”. British Medical Journal 303: 1019 – 1022.
- Kantor, L.S., Lipton, K., Manchester, A. and Oliveira,V (1997), “*Estimating and Addressing America’s Food Losses*”, Food Review, January 1997.
- Kim, S., Moon, S., Popkin, B.M., (2000), *The nutrition transition in South Korea*, American Journal of Clinical Nutrition, 2000; 71:44–53.
- King, A. (2002), *A Tax on Fat?* EconLog 2002-11-17.
- Kynge, J. and Dickie, M. (2003), “*China encourages mass urban migration*”, in: The Financial Times, 27 November 2003.
- Marshall, A. (1920), *Principles of Economics* (8th edition), London, Macmillan.

Miller, J. and Colagiuri, S. (1994) *The carnivore connection: dietary carbohydrate in the evolution of NIDDM*, *Diabetologia*, vol. 37, pp. 1280-1286.

Monteiro, C.A., Benicio, M.H.D.A., Iunes, R., Gouveia, N.C., Taddei, J.A.C. & Cardoso, M.A.A. (1992), “*Nutritional status of Brazilian children: trends from 1975 to 1989*”, *Bull. WHO*, 70(5): 657-666.

Narbro, K., Jonsson, E., Larsson, B., Waaler, H., Wedel, H. & Sjoström, L. “*Sick leave and disability pension before and after treatment for obesity*”: a report from the Swedish Obese Subjects (SOS) study.

Nestle, M., quoted in *Financial Times* (2003), “*Have fat, will sue*”, Supplement to the *Financial Times* of 14.12.2003.

Neel, J.V. (1962), *Diabetes mellitus: a 'thrifty' genotype rendered detrimental by 'progress'*” *American Journal of Human Genetics*, vol. 14, pp. 353-362.

Neel, J.V. (1982), *The thrifty genotype revisited*, in: *The Genetics of Diabetes Mellitus*, *Proceedings of the Serono Symposia*, vol. 47, pp. 283-293.

Norum, K.R. (1997), *Some aspects of Norwegian nutrition and food policy*, in “*Diet, Nutrition & Chronic Disease, Lessons from Contrasting Worlds*”, Shetty, P.S. and K. McPherson (Eds.), Wiley.

Popkin, B.M. (1993), *Nutritional patterns and transition*, *Population and Development Review* 19:138-157.

Popkin, B.M., Horton, S., and Kim S. (2001), *The Nutrition Transition and Prevention of Diet-related Chronic Diseases in Asia and the Pacific*, *Food and Nutrition Bulletin*, vol. 22, no. 4 (supplement), United Nations University Press, The United Nations University, Tokyo.

Reardon, T. and J.A. Berdegue (2002), “*The Rapid Rise of Supermarkets in Latin America: Challenges and Opportunities for Development*”, *Development Policy Review*, 2002, 20 (4): 371-388.

Regmi, A., Deepak, M.S., Seale, J.L., Bernstein, J. (2001) “*Cross-Country Analysis of Food Consumption Patterns*”, in *Changing Structure of Global Food Consumption and Trade*, Market and Trade Economics Division, Economic Research Service, U.S. Department of Agriculture, *Agriculture and Trade Report*. WRS-01-1.

Remacle C., Kalbe L., Reusens B. (2001), *Early Malnutrition and Programming of Adult Diseases: Experimental, Epidemiological and Preventive Studies*, Université Catholique de Louvain (UCL) Laboratoire de Biologie Cellulaire (SC/BANI/CELL), Louvain-la-Neuve, Belgium.

Schmidhuber, J. & Britz, W. 2002, “*The impacts of OECD policy reform on international agricultural commodity markets: first results of a quantitative assessment based on the @2030 model*”. *Schriften der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaues e.V.*, Band 36, Münster-Hiltrup, 2002.

Seale, J. Regmi, A. and Bernstein, J. (2003), “*International Evidence on Food Consumption Patterns*”, Electronic Report from the Economic Research Service (ERS, Technical Bulletin Number 1904, October 2003.

Shetty, P.S. (1997), “*Diet, Lifestyle and Chronic Disease: Lessons from Contrasting Worlds*”, in “*Diet, Nutrition & Chronic Disease, Lessons from Contrasting Worlds*”, Shetty, P.S. and K. McPherson (Eds.), Wiley.

Smil, V. (1999): “*China's great famine: 40 years later*”. British Medical Journal Volume 319, 18-25th December, pp 1619-1621

Smil, V. (2000), *Feeding the World – A Challenge for the Twenty-First Century*, The MIT Press, Cambridge, Massachusetts and London, England.

Stein C.E., Fall C.H.D., Kumaran K., Osmond C., Cox V., Barker D.J.P. (1996), “*Fetal growth and coronary heart disease in South India*”. *Lancet* 348: 1269 – 1273.

Susser, M. and Z. Stein (1994), “*Timing in prenatal nutrition: a reprise of the Dutch Famine Study*”. *Nutrition Reviews* 52 (3): 84-94.

UN Population Division of the Department of Economic and Social Affairs (2003), *World Population Prospects: The 2002 Revision*, New York: United Nations.

UN-Habitat (2003), “*Challenge of Slums*”, Global Report on Human Settlements in 2003, UN and Earthscan.

Vickers, M. H., B. H. Breier, D. McCarthy, and P. D. Gluckman (2003), “*Sedentary Behavior During Postnatal Life is Determined by the Prenatal Environment and Exacerbated by Postnatal Hypercaloric Nutrition*”, *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, July 2003.

WHO/FAO (2003), “*Diet, Nutrition and the Prevention of Chronic Diseases*”, Report of a Joint WHO/FAO Expert Consultation, WHO Technical Report Series – 916, Geneva.

Wolf AM, Colditz GA (1998), “*The economic impact of obesity in the United States: whither?*”, PUBMED, 1998 Mar; 6(2):97-106.