

Epidemiologic and economic consequences of the global epidemics of obesity and diabetes

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Overweight and obesity, the main drivers of type 2 diabetes, have long been regarded as health risks associated with affluence. Over the last decade, profound changes in the quality, quantity and source of food consumed in many developing countries, combined with a decrease in levels of physical activity among the population, have led to an increase in the prevalence of diabetes and its complications. Here, we present quantitative estimates of the epidemiological and economic impact of obesity and diabetes on developing countries. We provide the economic rationale for public policy action. We stress the importance of creating a roadmap to guide the development of comprehensive policies involving governments and private companies, and emphasize the need for experimentation in building the evidence while testing theories.

The recent World Health Organization (WHO) report "Preventing Chronic Diseases: A Vital Investment" highlights the need for global action to address the major risks associated with chronic diseases worldwide¹. Of these, tobacco use has received the most attention so far. But in recent years, additional risks, epitomized by the global rise of overweight and obesity, and the resulting impact on diabetes, cardiovascular disease and certain cancers, have become prominent. About 1 billion people in the world are overweight or obese, compared to 850 million who are underweight.

Table 1 provides the latest estimates for obesity. Although the US is the world leader, several Latin American countries are only about a decade or less behind. In China alone, the results of a 2002 nationwide survey of 270,000 adults indicate that 200 million people are overweight. Over 20% of children in major Chinese cities are either clinically overweight or obese, a rise in prevalence of 1–2% from 1985 (ref. 2). Recent studies from India also indicate

extremely high levels of physical inactivity in men and women³. Worldwide, overweight and obesity affect an estimated 10% of children⁴. And in opening the 18th International Union of Nutrition Science Congress in Durban in September 2005, South African Minister of Health Manto Tshabalala-Msimang emphasized that "obesity has become a global challenge. Our concern is the increasing rate of obesity amongst our children. Seventeen percent of our school learners were found to be overweight and four to five percent were obese"⁵.

Overweight and obesity have become to diabetes what tobacco is to lung cancer. Roughly 60% of all cases of diabetes can be directly attributed to weight gain⁶. Once considered primarily a disease of adulthood, and hence labeled 'adult-onset diabetes,' type 2 diabetes was diagnosed in only 1–2% of diabetes cases

in children two decades ago⁷. With the rising incidence of obesity, type 2 diabetes has begun to surface in children at alarming rates, in some countries representing up to 80% of all the cases of diabetes reported in the pediatric population^{7,8}.

Several recent reviews have concluded that trends in diabetes strongly relate to the environmental factors present at birth: the mother's body mass index and the child's birth weight, growth trajectories of children in the earliest years of life, subsequent eating and activity patterns, and behavior in adulthood. Children who have overweight or diabetic mothers are more likely to be diagnosed with diabetes. As with their parents, many childhood cases of type 2 diabetes are undiagnosed, indicating that the current prevalence of the disease is likely to be underestimated⁹. The relationship between type 2 diabetes in family members

Table 1 Adult obesity in 2002 and estimated level in 2010, expressed as percent of people ≥15 years of age with a BMI ≥30.

Country	2002		2010	
	Males	Females	Males	Females
Bangladesh	0.1	0.1	0.2	0.2
Brazil	6.9	15	12.4	24.5
China	1	1.5	4.1	3.6
India	0.9	1.1	1.7	2
Indonesia	0.2	2	0.2	3.9
Japan	1.5	1.5	2.3	1.1
Malaysia	1.6	6.8	1.7	11
Mexico	20.3	31.6	30.1	41
Nigeria	1.6	4.9	3	8.1
Pakistan	0.8	2.9	1.6	5
United States	32	37.8	44.2	48.3
World	5.7	9.4	8.0	12.3
High income ^a	18.1	20.4	24.3	25.9
Upper middle income	14.0	21.1	19.7	29.0
Lower middle income	4.1	9.9	6.6	12.6
Low income	1.1	2.8	1.7	4.2

^aWorld Bank Income Groups (figures in US dollars): high income, ≥9,206; upper middle income, 2,976–9,205; lower middle income, 746–2,975; low income, ≤745. Data source: *World Development Indicators*, World Bank, Washington DC, 2003.

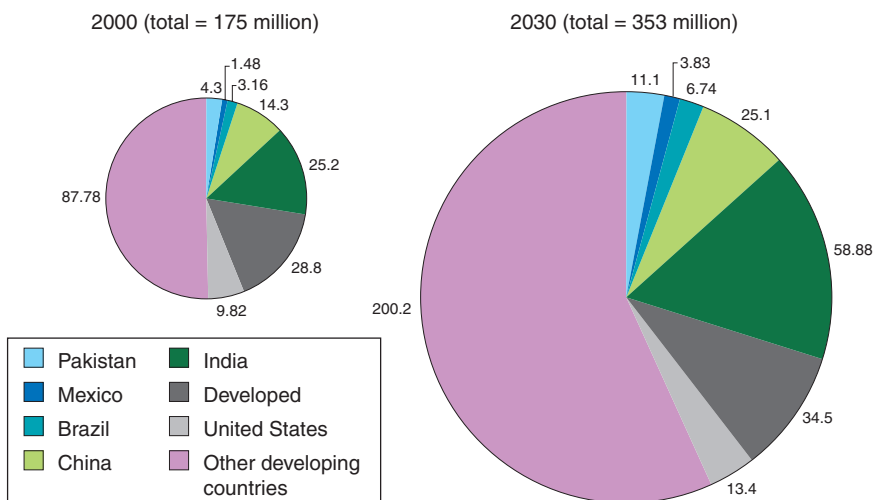


Figure 1 Number of people with diabetes: 2000 estimated for 2030

and eventual onset in children is so close that some researchers are calling for children living in areas experiencing epidemic diabetes to be considered at risk¹⁰.

Figure 1 provides a summary of the latest current and projected estimates for the prevalence of diabetes¹¹. Using modest assumptions about future growth, the number of people with diabetes will increase from 175 million in 2000 to 353 million in 2030, with the biggest increases expected in India (25 million to 59 million) and China (14 million to 25 million). Figure 2 indicates that diabetes will become an increasingly common problem in developing countries within 25 years.

Economic causes, costs and consequences of obesity and diabetes

The global emergence of obesity and diabetes is as much an economic issue as it is a health issue^{12,13}. Physical inactivity and unhealthy diet have been identified as primary determinants of the increase in the incidence of obesity, but these behavioral risk factors are themselves manifestations of changing social and economic conditions. Within the past several decades, five developments have tipped the balance between caloric intake and expense to an unfavorable equilibrium: (i) expanding labor market opportunities for women^{14,15}; (ii) increased consumption of food away from home^{14,16,17}; (iii) rising costs of healthy foods relative to unhealthy foods^{12,18,19}; (iv) growing quantity of caloric intake with declining overall food prices^{20–22}; and (v) decreased requirements of occupational and environmental physical activity^{14,23}. Given the important role of these economic factors outside the control of individuals, obesity can no longer simply be relegated to the domain of personal responsibility. Preferences, willpower and even genetics cannot explain the increase

in the prevalence of obesity over time; rather, the changing incentives that people face have conditioned unhealthy choices to become the economically smarter choices.

Economic burden of obesity and diabetes on healthcare systems

Beyond the toll they take on the health and well-being of individuals, epidemic obesity and diabetes impose a considerable economic burden on societies. There is a well-established body of evidence that the medical and treatment costs for these conditions siphon considerable resources from health systems. Table 2 presents a sampling of the economic costs

currently associated with obesity and diabetes globally²⁴.































Developing countries have been undergoing rapid ‘obesogenic’ social and economic transformations and, as a result, the pace of nutrition transition is proceeding, even accelerating, at a rate never before seen in developed countries²⁵. Seven of the ten countries with the greatest number of diabetics are in the global south. Within the next two decades, the number of persons living with diabetes in Brazil, China and India is projected to increase at nearly twice the rate observed in the US. As these costly conditions continue to strike with greater incidence at earlier stages of life within populations, the economic burden can only be expected to worsen.

The case of the US demonstrates the explosive potential of the uncontained costs of obesity and diabetes. In the span of five years, the medical costs due to diabetes more than doubled, shooting from \$44 billion to \$92 billion. Much of this growth relates to rising levels of obesity, which were estimated to impose health-system costs roughly equivalent to 20 years of natural aging²⁶. Yet despite this outpouring of resources, individuals are receiving only a fraction of the preventive and chronic care they need²⁷. The largest fraction of diabetes expenditures covered hospital admissions for the treatment of long-term complications such as heart disease, stroke, blindness, renal failure and lower-limb amputations. At least 7% of these diabetes-related hospitalizations could have been avoided²⁸. Nonetheless, only a small fraction of the resources devoted to the care

Table 2 Macroeconomic burden of obesity and diabetes for selected developed and developing countries

Country	Year of estimate	Total costs (percent of GDP) ^a	Percentage of total indirect	Reference
Diabetes				
United States	2002	1.3	30.7	52
Canada	1998	0.78	30.4	53
Mexico	2000	2.6	n/a	29
Brazil	2000	3.8	82.5	29
Tanzania	1992	0.5	n/a	54
Obesity				
United States	2000	1.2	47.8	55
Canada	2001	0.7	69.8	56
Switzerland	2002	0.6	n/a	57
Germany	1998	0.2	48.2	58
India	1995	1.1	67.3	59
China	1995	2.1	23.8	59

^aGross Domestic Product (GDP) calculations based on 2000 constant US\$ GDP estimates, *World Development Indicators*, World Bank, Washington DC, 2005. It should be noted that these costs are not directly comparable across studies as a result of methodological differences. But they can be viewed as illustrative of the sizeable and robust impact of epidemic obesity and diabetes on ‘sickness’ systems.

Countries (population >100 million)	Diabetes prevalence in 2000 (>20 years of age as a percentage)	Estimated prevalence in 2030 (>20 years of age as a percentage)
Bangladesh	4.6 	7.7 
Brazil	4.3 	7.0 
China	2.4 	3.7 
India	5.5 	8.0 
Indonesia	6.7 	10.6 
Japan	5.3 	7.3 
Malaysia	7.6 	10.8 
Mexico	3.9 	6.4 
Nigeria	3.4 	4.0 
Pakistan	7.7 	8.7 
Russia	4.2 	5.3 
United States	8.8 	11.2 
World	4.6 	6.4 
All developed	6.3 	8.4 
All developing	4.1 	6.0 

Simon Fenwick

Figure 2 Diabetes prevalence in people over 20 years of age in 2000 and predicted for 2030 in countries with more than 100 million inhabitants.

of diabetes-related complications are spent for strategies that can help avoid obesity and diabetes in the first place. Today, the American epidemic shows no sign of receding and seriously threatens to temper the gains achieved by reductions in the prevalence of cardiovascular disease.

Although the epidemics are in the early stages of their upward trajectory in developing countries, the economic burden is already very important. It is estimated that nearly one out of every three hospital bed-days in Latin America are occupied for diabetes-related causes, with average costs for a year of diabetes care at roughly \$550 per person, exceeding most per capita gross domestic product (GDP) health expenditures²⁹. Furthermore, the costs associated with treating individuals with diabetes tend to be substantially higher than those for nondiabetics³⁰.

The danger of globalizing US solutions

A major threat to the health systems of developing countries may not be only the importation of ‘Westernized lifestyles,’ but also the importation of Westernized medical responses. As in the US, healthcare services for developing countries tend to be oriented toward acute, reactionary medical care rather than cost-saving preventive approaches²⁹. Many of the high-priced tertiary- and specialist-care treat-

ments driving growth of medical spending are poorly suited for developing health systems. The race is on for the pill to control obesity, with pharmaceutical companies betting heavily on potential market prospects³¹. While this occurs, bariatric surgery is seen by many as the only proven means of reducing the impact of severe obesity³². Evidence of how this view is spreading worldwide can be seen in the recent formation of the Asia-Pacific Bariatric Surgery Group by surgeons from 11 Asian countries³³. Research-funding agencies favor medical and surgical solutions over health promotion and health systems interventions and policies. It is therefore not surprising that relatively few large-scale, community-based interventions to address overweight, obesity and physical activity together have been undertaken.

Microeconomic burden of obesity and diabetes

The burden of obesity and diabetes on health systems only reflects a fraction of the financial disruptions they cause to sick individuals, their families and communities. Empirical evidence shows that the full costs of diabetes accrue to society through lower returns on education^{34,35}, decreased household wages, earnings and incomes^{36,37}, increased premature retirement and unemployment^{39,40}, and higher dependence on welfare^{37,41}. Over time,

these indirect impacts can be more costly than the conditions themselves.

In poorer countries, individuals are more likely to pay for their own healthcare⁴², forcing many families to finance the considerable costs of treatment entirely on their own. For diabetic individuals in India, 15–25% of household income is required to cover treatment costs⁴³. In Tanzania, costs amount to 25% of the minimum wage or 20 times the per capita health expenditure⁴⁴. And in Bangladesh, the internalized expense totals 6–12 months’ wages or \$160 per year⁴⁵. This burden is often the greatest for the people who are the least able to afford it, making these conditions important sources of impoverishment and widening inequalities. A recent survey in China found that 30% of poor households attributed their poverty to healthcare costs². Not surprisingly, people in developing countries reportedly experience financial difficulties as a result of diabetes, and many avoid some medical treatment because of financial constraints^{29,30,46}. Even when families are able to afford insulin, in many cases the WHO-declared ‘essential medicine’ is simply unavailable.

Economic rationale for prevention of obesity and diabetes

Concerned by the growing health and financial burdens amenable to primary and secondary prevention approaches, advocates have begun to call for vigorous public policy intervention for obesity and diabetes²⁶. These sentiments have met with resistance from influential economists and policy analysts, who note that obesity is a byproduct of social progress⁴⁷. According to them, if consumers prioritize prevention of these diseases, the market should help them to achieve those objectives, as evidenced by the emerging health-food and weight-loss markets.

To stimulate the multisectoral involvement that can help curtail the rise of obesity and diabetes, a sound economic argument must show that the market, left uninhibited, will not produce socially desirable outcomes. As an example, the US Office of Management and Budget requires analysis to identify market failures solved by proposed regulations before cost-benefit assessments are even conducted⁴⁸. Furthermore, the rationale for intervention must link the causes of obesity and diabetes to these failures and show prospects for social gain. Would people be willing to pay others to lose weight or reduce their risk for diabetes? Do the short-term social gains from time savings of food preparation outweigh the cost of poor health in the future⁴⁹? For obesity and diabetes, these arguments have not been addressed to the extent that they have been for tobacco.

Several lines of recent evidence suggest that the behavioral risk factors for diabetes and its extended gestation period give rise to sub-optimal market behavior. As with tobacco, there is evidence of i) externalities by which the actions of one party spill over to impact others not directly involved, such as the cross-subsidization of obesity-related expenditures by the nonobese¹⁸; ii) imperfect and asymmetric information, by which individuals cannot use or interpret information adequately to make informed decisions or one party has access to private information that is not shared, such as in the case of the nutrition labeling, food addiction and false or deceptive advertising²⁴; and iii) time-inconsistent preferences or 'internalities, by which people fail to solve the tradeoff between immediate gratification and future harm, specifically when they expressly desire to behave otherwise but find themselves unable to do so without external 'help'^{12,24}. Each of those obstructions to the passive flow of markets toward efficient outcomes justifies a set of corrective interventions.

There is also evidence of effective and cost-saving strategies that would not require state intervention. Market-driven responses are increasingly emerging from food companies that have increased their profitability by entering into healthy-food and healthy-beverage markets. Other companies, such as Kraft, have drawn lessons from the tobacco industry and have begun to voluntarily restrict the marketing of some products to children in response to mounting pressure from evidence that advertising increases childhood obesity. Businesses are also increasingly becoming aware of the financial rewards that arise from investing in the health of their employees. A break-even scenario for one representative international company would require reducing health risks by 0.17% per year for 10 years⁵⁰. Pfizer, for example, has taken the lead to integrate workplace health promotion into its human resources strategy. As companies take advantage of the business case of these programs—a savings of \$3 for every \$1 invested on average—employee health will improve²⁴.

Toward evidence-based solutions: an obesity and diabetes roadmap

Reports such as the WHO Global Strategy on Diet and Physical Activity and the recent WHO–Food and Agricultural Organization Technical Report “Diet, Nutrition and the Prevention of Chronic Diseases” provide guidance on which policies and interventions are most likely to prevent and reduce overweight and obesity. These represent ‘best guesses’ by experts and governmental bodies that balance incomplete evidence with the need to respond

with some action in the face of a public health crisis. Unlike all other major public health problems, there is still no demonstrated decline in overweight and obesity in any country or large section of the population outside of a war or famine. This suggests that a higher degree of experimentation that draws on sound economic and behavioral theory is needed—as was the case with tobacco in the early 1970s. Unlike the case of tobacco, market-led solutions, along with public policies, may combine to make healthy choices the economically easy and readily available choices.

Prevention and intervention approaches would ideally be based on a thorough knowledge of causes. In the absence of such knowledge, efforts will be scattered, evaluated too rarely and difficult to assess in terms of impact on public health. There is a crucial need to develop a roadmap that defines appropriate interventions based on the causes of obesity at the macro- and microscopic levels from which a coherent prevention plan can be constructed.

Developing a roadmap, a process that we are now undertaking through the Rudd Center for Food Policy and Obesity, is a substantial task. By necessity, it will involve input on the many factors that affect food intake, physical activity and, in turn, obesity, a defined research agenda to complete key gaps in the causal picture, and a means for estimating how to have the greatest effect at the lowest cost.

One part of the roadmap, economics, shows how complex the overall picture will be. Just one subset of economic forces, the relative price of healthy and unhealthy foods, requires broad knowledge and analysis. In countries such as the US, it is less expensive (and easier) to buy unhealthy foods. Several factors contribute to this fact, including international trade policies, subsidies to American farmers, properties of the food themselves (for example, spoilage of processed versus fresh foods), consumer perceptions of quality versus quantity of food, incentive to purchase some foods over other in large quantities (perceptions of value) and more. Would it be more effective to change subsidies or to educate consumers about healthy eating? One approach (changing subsidies) would target upstream factors that could have cascading influence on factors more proximal to eating and purchasing foods, whereas education is much further downstream. A completed roadmap would determine which approaches would have the greatest impact, as well as the factors that inhibit or promote proposed changes. It is important to note that roadmaps are likely to vary from country to country, given differences in political, economic and social structures.

What parts of a roadmap might be completed with our current knowledge? Much more is known about downstream than is known about upstream variables. For instance, there is a large literature on educational and behavioral programs aimed at helping people to improve their diet and increase their physical activity. Some modest successes have been obtained, but typically at high cost. Much less is known about changes targeting upstream variables, but there are promising leads, some of which come from related public health issues. For instance, high taxes on cigarettes have proven one of the most effective ways of reducing smoking rates. In the realm of heart disease prevention, large community programs that focus mainly on education have had limited or no effects, whereas the North Karelia project, which combined education with structural changes in the environment, produced impressive results⁵¹.

At the broadest level, the roadmap could begin with economic, political, social, psychological and biological factors. At the narrowest level, it might begin with the most proximal factors that affect eating and activity. In the case of eating, these would be taste, accessibility, convenience, cost and amount of promotion. The factors that lie between the broad and narrow ones must be defined so that the prevention can be based on estimates of the most powerful point at which to intervene in the causal chain.

Conclusion

The absence of definitive evidence of strategies that will work to reduce overweight and obesity should not delay action. When several Nordic countries as well as Canada, New Zealand and Singapore pioneered comprehensive tobacco control in the early 1970s, they relied on sound economic and consumer theory. Over time, their intuition that smokers would respond to price, marketing, access to treatment and ever-expanding education programs, has proven correct. Adapting these basic principles to the much more complex areas of food, nutrition and physical activity will be tougher and will require broader alliances between public, private and civil societies. The consequences of inaction-reversal of steady improvements in life expectancy, and rising costs should be sufficient motivation for urgent action.

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