

Will food safety jeopardize food security?

Jean Kinsey*

Abstract

By a new definition proposed here, food safety is not just about safe food but the safe consumption of food. This draws attention to the issue of overeating as well as undernourishment. With the transition of diets and a rapid rise in obesity, worldwide, chronic illnesses join acute illness (from microbiological contamination) as health issues related to food consumption. The economics of obesity overwhelms the costs of microbiological contamination, with large impacts on private and social health care costs. In food-insecure areas, producing and consuming unsafe food does not build a healthy population nor does it allow export of food to other nations. Safety and security must work hand in hand to enhance human health.

JEL classification: I12

Keywords: food safety; food security; obesity; hunger; health costs

1. The safe consumption of food

This paper will conclude by saying no, food safety and food security reinforce each other. But first, some new definitions are in order. Food is an edible substance that will nourish the human body, provide it with energy for normal activities, and maintain or enhance its healthy state. Safe food consumption makes a person feel good in the short and the long run. It does not make you ill! This defines food by its fundamental purpose and how well it performs, rather than its physical characteristics like grams of nutrients, production technology like organically grown, or implied freedom from pathogens due to being “triple washed” or irradiated. Safe food consumption focuses on a simple but comprehensive performance standard. That is, eating (or drinking) food facilitates the health and growth of the human body.

When consuming food does not achieve this end it cannot be defined as safe food consumption. Unsafe food consumption constitutes ingesting a fast-acting poison or a set of substances that lead to debilitating diseases over a long period of time. Some

dangerous food substances are well known (e.g., wild mushrooms); some are unknowable until long after the damage is done (e.g., pesticides). At the University of Minnesota there was a course in food safety titled “The Dose Makes the Poison.” This is an incredibly insightful title. There are many substances in this world that are harmful to human health; some of them are in the foods we eat every day. In minute quantities they are not harmful. However, there is some quantity of exposure that tips the scales; at some dose they become dangerous. That dose differs by the size, genetics, and immunities of individuals, but at some critical level food that carries potentially harmful substances interferes with nourishment and, therefore, diminishes health, normal cell growth, and bodily functions. This is consistent with the educational slogans of many nutritionists who say, “There are no bad foods, just bad diets.” Rather than focus on substances in food that make it unsafe, this new definition focuses on *the safe consumption of food*. It requires the acceptance of some risk, an acknowledgement that quantity matters, and responsibility for the dietary context and needs of people in various situations and cultures.

In this paper the boundaries of the safe food consumption and public policies that might alleviate unsafe consumption will be explored. The implications

* *Applied Economics Department and The Food Industry Center, University of Minnesota, St. Paul, MN, USA.*

for food security, which also now has two distinctly different definitions, will be considered as a function of how well food and diets enhance the health and well-being of people. Unsafe consumption of food and subsequent health issues include:

1. Foods that contain microbes in sufficient quantities to lead to short-term illness or death such as botulism or *E. coli* O157 H7.
2. Foods that contain substances that are believed to pose potential long-term health problems such as pesticide residues or bovine spongiform encephalopathy.
3. Foods that have unknown, but suspected, health consequences such as foods that have been genetically modified or irradiated.
4. Foods that contain nutrients or ingredients such as trans-fats or simple sugars that, when consumed in excess quantities, lead to chronic diseases such as diabetes, cancer, and cardiovascular heart disease.

2. Microorganisms and the safe consumption of food

Traditionally, those who study and regulate food safety concentrate their research and policy analysis on microbial contamination. Table 1 lists the ten most

Table 1
Reported foodborne illnesses from bacteria, viruses, or parasites in the United States

	Cases/Year (millions)	Hospitalization	Deaths
Norwalk-like virus	9.20	20,000	124
Campylobacter (1/1,000 cases lead to Guillain-Barre syndrome)	2.00	10,500	1,000
Salmonella	1.413*	15,600	550
Clostridium perfringens	0.25	50	10
Giardia lamblia	.200	500	1
Escherichia coli	.173	2,800	80
Listeria monocytogenes	.003*	2,500	500
Taxoplasma gondii	.113	22,600	375
Shigella	.09	1,250	14
Total reported	13.44	75,896	2,654
CDC estimated total incidents	76.00	325,000	5,000

Source: Ropeik and Gray (2002).

Note: *Adjusted from data on <http://www.ers.usda.gov/data/foodborneillness/>.

known and tracked pathogens leading to foodborne illnesses in the United States. The Centers for Disease Control (CDC) estimates that these pathogens represent only about 20% of the cases and hospitalizations, and less than half of the deaths actually caused by foodborne pathogens. Norwalk-like viruses generate the largest number of reported cases of foodborne illnesses per year, *Taxoplasma gondii* (a parasite) generates the largest number of hospitalizations, and campylobacter causes the largest number of deaths (Ropeik and Gray, 2002). Identifying a hazardous organism and the probability of it causing a foodborne illness and then deciding on an acceptable level of risk in order to set food safety standards involves long and arduous study and debate. The tasks involve science, politics, culture, and international consensus. It is one thing to say that regulations should be based on science. It is quite another to agree on the scientific evidence and how to apply it. Two organizations intimately involved in setting standards for food safety as it relates to microbial contamination are the International Commission on Microbiological Specifications for Foods (ICMSF, 2002) and Codex Alimentarius. The former is a group of scientists that assess risk and establish protocol for setting food safety objectives and standards;¹ the latter is the consensus-building arm of the United Nations that identifies international standards for food safety. Figure 1 depicts the complex decision process proposed by ICMSF to manage food safety and prevent as many foodborne illness as possible (ICMSF, 2002, p. 5).

Hazard is the measurable probability that contamination exists in an amount sufficient to cause illness. This can generally be determined by laboratory tests. Risk refers to the hazard plus the consequences that consumers will suffer when they are subjected to the hazard and become ill. To assess the risk, one needs to know the probability that people of various ages and lifestyles will become ill when exposed to various hazards in their food. This involves epidemiological data that track outbreaks of foodborne illnesses and identify their cause. Tracking such data requires some nationally agreed upon reporting system by doctors and hospitals. A national food safety management

¹ A Commission of the International Union of Microbiological Societies.

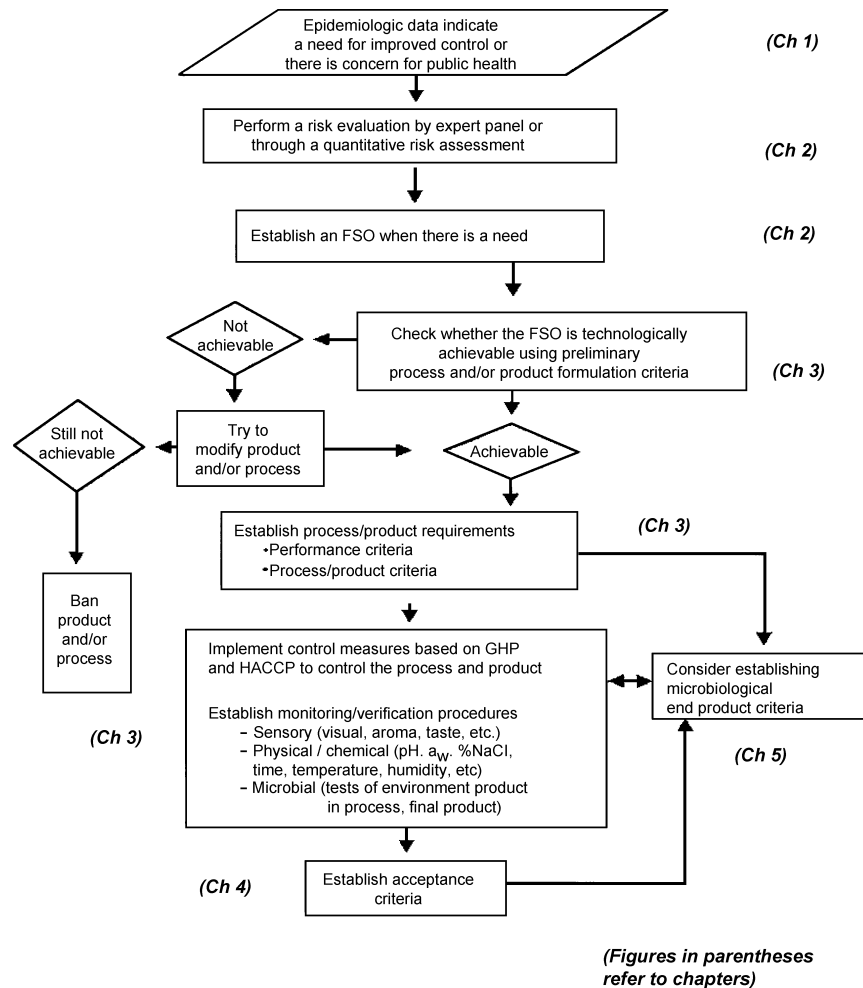


Figure 1. Food safety management scheme. Source: ICSMF, 2002, p. 5.

system involves identifying the hazards, the risks, and the magnitude of the problem for consumers' health (van Schothorst, 1998). It also involves identifying the magnitude of the problem for a nation's economy.

In assessing the magnitude of the problem one looks at the pain and suffering caused to individuals, the costs of health care, and the value of lost productivity due to illness and death. The value of these losses is a measure of the benefits that could be derived from eliminating, or drastically reducing, the foodborne illness. Finding policies and practices that can be used to ensure the safe consumption of food involves assessing the public and private consequences of foodborne illnesses. Yes, there is a "public good" aspect to the safe consumption

of food. The benefits are nonrival and nonexclusive. That is, the safety, health, trust, and security that one person enjoys from safe food consumption are not diminished by a neighbor's enjoyment of the same. In fact, the more healthy people there are in a society, the better off everyone is. There is a positive (negative) spillover effect from having a community of healthy (unhealthy) people. The role of governments and food industry executives is to discover the right combination of policies and practices that will work in a given economy and culture in order to deliver the optimum level of safe food consumption.

Figure 2 presents a continuum of types of policies that may be implemented to match various levels of

Continuum of Food Attributes

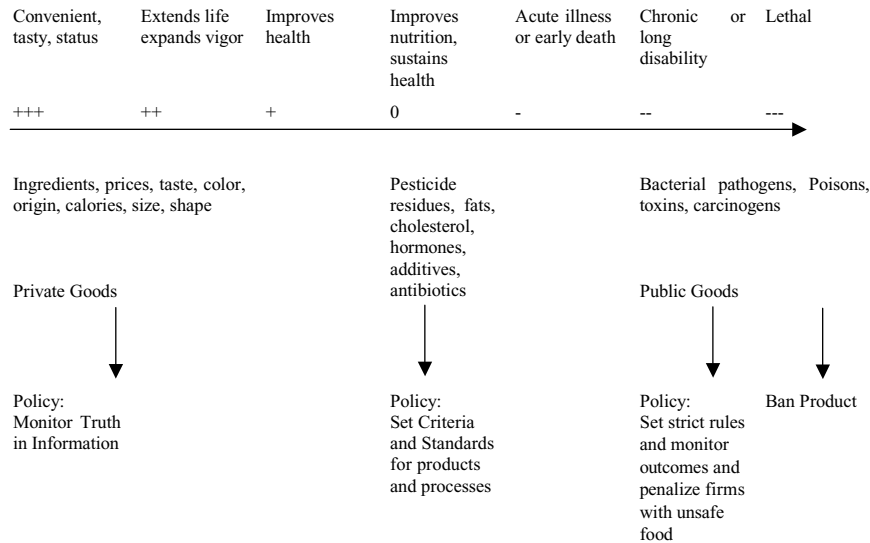


Figure 2. Food safety policy depends on nature of the risk.

hazard and risk to appropriate public policies (Kinsey, 1993). Moving from left to right along the continuum the characteristics of food and their accompanying hazards and risks increase from disappointment in the taste or convenience to acute and then chronic illnesses and even death. At the left end, policies and practices that focus on consumer information are adequate. Here the characteristics of food under consideration are largely private goods and the characteristics are transparent or can be readily made so with labeling and education. Moving to the right, food characteristics become increasingly nontransparent and the consequences of consumption more uncertain. Pesticide residues are believed to make people ill, even cause cancer, but there is little proof. Food additives, antibiotics, fats, and hormones may lead to illness in some people at some dose, but the amounts are uncertain. As you move to the far right, there are some contaminants that cause violent illnesses or immediate death (e.g. *E. coli* 0157H7 or botulism). They are not transparent and the only way to effectively deal with them is to eliminate them from the food supply. In the center of the continuum appropriate practices and policies are less clear. Here is where scientists and policymakers alike debate the standards for products and processes in order to protect people

from harm and provide some regulatory clout to monitor and penalize offending food providers. Examples in the middle of the continuum might include pesticides, trans-fatty acids, and antibiotics in animal feed. Designing public and private policies to maximize the potential for good health and longevity is a balancing act between the cost of regulation and/or building safety into a product and the benefits of healthy, productive people who might be incapacitated from a foodborne illness.

Which food safety problems are consumers most concerned about? In surveys taken by the Food Marketing Institute consumers have ranked microbes and the chance of being exposed to microbes higher than pesticides since 1995 (Figure 3, FMI, 1993–2000). The concern about microbes leads to concern about food-handling practices and spoiled food. With consumers relying on many strangers' hands to prepare their food, its freshness and how it is handled is a proxy for fear of microbes and the illnesses they can cause. Between 1995 and 1997 when FMI asked consumers to identify the most serious health hazards related to food they consistently ranked microbes first, pesticides second, antibiotics third, and biotechnology last FMI, 1993–2000.

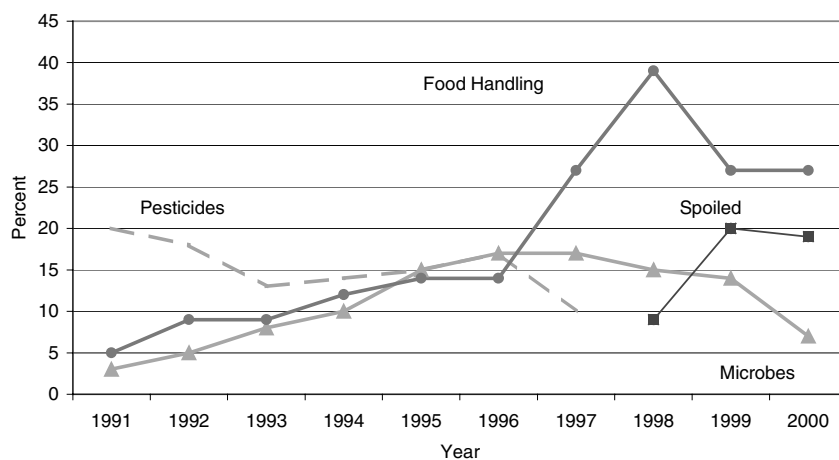


Figure 3. U.S. consumer perceptions of food safety problems. *Source:* Consumer Trends, Food Marketing Institute, Washington D.C. 1993–2000.

3. Acute illnesses and costs

The cost of foodborne illnesses caused by microbes is estimated at \$6.9 to \$33 billion per year (USDA). This includes direct medical costs as well as lost wages, productivity, and the estimated value of life lost to premature death. Figure 4 illustrates the types of costs and considerations included in the calculations. It makes one realize the vast number and types of costs involved in foodborne illnesses and the great loss to individuals and society. The numbers quoted herein do not even begin to include the costs to the food industry or to the public health sector.

Dollar estimates have a wide range, partly because foodborne illnesses are vastly underreported both by consumers and doctors. Most consumers who become ill think they have the flu and, though violently ill in many cases, they recover in a few days and go on about their lives. A few, less fortunate, die. There are an estimated 2,654 to 5,000 deaths per year in the United States attributable to foodborne illness.

These acute and temporary illnesses are largely preventable by good manufacturing practices (GMP) and good handling practices in the supply chain starting at the farm and ending with the consumer. Many studies have been conducted to estimate the cost of diminishing these illnesses. They typically find that safe handling and storage practices cost less than the resulting benefits. For example, Ollinger and Mueller (2003) found that a Pathogen Reduction/Hazard

Analysis and Critical Control Point program in meat and poultry plants would cost plants about 1.1 % of their total costs, adding about 1.2 cents to a pound of beef, 0.7 cents to a pound of pork, and 0.4 cents to a pound of poultry. The benefits were estimated to range from \$1.9 to \$171.8 billion annually. This translates into a benefit value (in terms of health cost savings) that is at least two times the cost to the industry. Lakhani (2000) estimated that the benefit–cost ratio from reducing salmonella enteritidis in shell eggs by refrigeration to be 0.65, 3.56, 2.56, and 8.87 depending on the method used to calculate the benefits. Since three of four estimates are greater than one, measures to reduce salmonella-caused foodborne illness was deemed to be worthwhile. A third example comes from an analysis of adopting HACCP programs in meat and poultry slaughterhouses in the United States using a Social Accounting Matrix (SAM) method (Golan et al., 2000). This provides a comprehensive picture of how well an entire economy fares as a result of investments in food safety. Their model showed that for every dollar saved by preventing a premature death from a foodborne illness, there is an economy-wide gain of \$1.92. They also found that for every dollar of household income saved due to lower medical expenses, the whole economy lost \$0.27. On the cost side, they found that for every dollar spent implementing a HACCP program, the economy gained \$0.66, leading to a net increase in production output of \$10.63 billion, an increase in factor payments of \$6.08 billion, and an increase in household

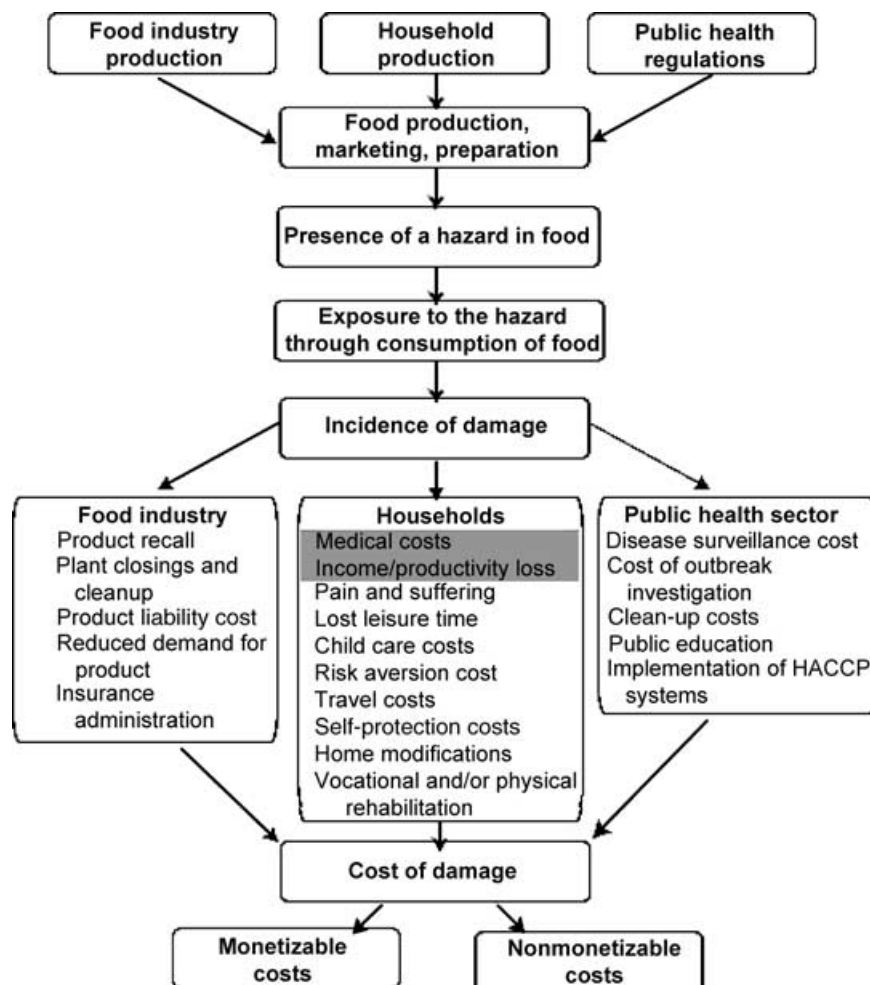


Figure 4. Foodborne disease, exposure, and types of costs. *Source:* <http://www.ers.usda.gov/Briefing/FoodborneDisease/gallery/FoodborneDiseas.gif>.

income of \$9.38 billion (in 1993 dollars) not considering the benefits from reduced work-loss days.

Antle (2001) points out that studies indicate that consumers are willing to pay more for safer food than the losses that might incur due to illness, using the cost-of-illness approach to measure the benefits of safer food. In the real world consumers demonstrate their willingness to pay at the supermarket when they buy organic food to avoid pesticides. They pay for safer food at tax time when they support government agencies such as the Food and Drug Administration, Department of Agriculture, and state health departments who test,

inspect, and regulate the processes by which food is produced, labeled, and sold. In most developed countries consumers have come to expect their government to ensure safe food and they are generally willing to pay for it.

4. Chronic and long-term illnesses

Foodborne illnesses due to microbes are well known; cause and effect are relatively well established. The relationship between food, diet and chronic diseases,

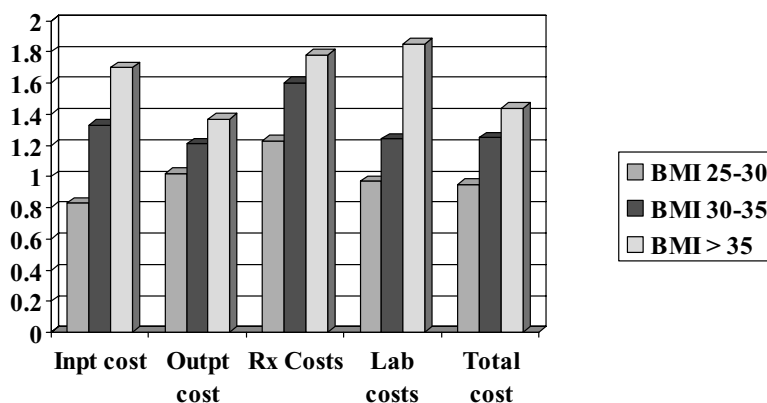


Figure 5. Health care costs index by body mass index. *Source:* Wolf (1998).

and delayed illnesses is less well established. For example, there is virtually no known link between pesticide residue in food and cancer even though most believe it to exist. Many believe that there is a link between antibiotic resistance in humans and eating meat from animals that have been routinely fed antibiotics to keep them healthy and fast growing. Some fear that feeding growth hormones to cattle or genetically modifying plants and animals will lead to human illness, though there is little to no scientific evidence to support these suspicions. The link between spongiform encephalopathy (mad cow disease) and variant creutzfeldt Jakob disease (vcjd) was confirmed using transgenic mice in 1999 (Acheson, 2001) but the time lag between exposure and illness is several years, making epidemiological evidence in humans hard to establish. Many chronic and long-term illnesses suspected of being linked to unsafe food consumption are difficult to trace to the source due to time lags and intervening genetic and environmental factors.

On the other hand, Type 2 diabetes (Knowler et al., 2002) and 20–40% of cancers in U.S. adults (Calle et al., 2003) are known to be linked to obesity and are rising at a near-epidemic rate. The rapid rise in obesity in the United States, and around the world, leads us to redefine the boundaries of safe food consumption. With obesity individual food characteristics are not the problem, but the quantity eaten—the total dose—is a problem. Just as it is the quantity of microbes in the food that leads to acute illness, it is the quantity of calories in the diet, relative to energy expended by the

body, that leads to diabetes and other obesity-related complications.

In 1999, an estimated 61% of adults and 13% of children and adolescents in the United States were overweight. Adult obesity has doubled since 1980 to 24% of the population and overweight adolescents have tripled since 1980 to 15%. (FDA; CDC). Overweight children aged 2–5 years have increased from 7% to 10% since 1994. Eight percent of U.S. adults (Knowler et al., 2002) and about 4% of children in the United States have Type 2 diabetes. The rise in this non-inherited, Type 2 diabetes in children is of great concern, since diabetes is a chronic disease that absorbs over 10% of all health care dollars. It is growing along with obesity in children; it is a health care disaster in slow motion. Obese children with diabetes will absorb an increasing amount of our health care dollars for as long as they live. Figure 5 illustrates the higher cost of all types of health care for people with body mass indexes (BMI)² more than 30 or 35 (obese and morbidly obese). One study estimated that health care for overweight and obese people costs an average of 37% more than for people of normal weight, adding an average of \$732 to the annual medical bills of every American (Connolly, 2003). This places the problem of obesity squarely in the realm of a public good (bad) and one that will take

² BMI is measured by dividing an individual's weight in kilograms by height in meters squared (weight in pounds by the height in inches squared \times 703). BMI of 20–25 is considered healthy. BMI over 25 is considered overweight and over 30 is obese.

Table 2
Costs associated with the unsafe consumption of food leading to obesity: United States, 2000

Type of health care problem	Health care costs	Deaths
Microbial contamination	\$6.9*-\$37 billion (includes losses due to death)	2,654-5,000
Obesity-related diseases	\$93-\$230 billion (direct and indirect costs)	300,000
Diabetes (10% of all health care costs)	\$132 billion** (direct and indirect costs)	
Ratio of obesity costs to microbial costs	Low: $93/6.9 = 13.5$ High: $230/37 = 6.2$	$300/5 = 60$
Ratio of diabetes costs to microbial costs	Low: $132/37 = 3.5$ High: $132/6.9 = 19.1$	

Notes: *Estimated cost based on four types of microbes: Campylobacter, Salmonella, E.-coli, Listeria. <http://www.ers.usda.gov>
**2003 update on www.cdc.gov/diabetes/pubs/estimates.htm

a concerted effort on the part of many agents in society to correct.

What does it cost for obesity-related diseases in the United States? Total and indirect costs were estimated to be \$93 billion (Connolly, 2003) to \$117 billion in 2000 (FDA). Some public officials are quoting \$230 billion (T. Thompson, Secretary of Health and Human Services). Table 2 compares the costs of microbial-related foodborne illnesses to health care costs related to obesity. By any comparison you want to select, the cost of obesity is much larger than the costs of microbial contamination. The \$117 billion for obesity health

care costs are 1.1% of the 2002 U.S. gross domestic product of \$10,623.7 billion (Economic Report to the President) and, as indicated on Figure 4, these costs do not include all the costs to industry or the public health sector.

Obesity and related health problems are not just an American problem. Obesity is being documented around the world and, ironically, it exists side by side with poverty and undernourishment. Haddad (2003) points out that in seventy-eight developing countries under and over-nutrition coexist with 5% of the population being obese and 7% being underweight. Often this condition exists in the same household (Garrett and Ruel, 2001). Around the world it is estimated that 53% of children and 18% of the total population are undernourished, while in Australia 20% of children are overweight or obese, as are 17% of Malaysian boys, 8% of Malaysian girls, and 7% of urban Chinese children (IFIC, 2001). Most of the undernourished in 1998 were in India, China, and sub-Saharan Africa (FAO, 2002). Figure 6 shows the global prevalence of both underweight and obese adults in 2000 (WHO). On balance 8.2% are obese and 5.8% are underweight, only a 2.4 percentage point difference. In developing countries more than two thirds as many people are obese as are undernourished. In the poorest countries, 20% as many people are obese as are undernourished. The magnitude of these dual food and diet issues clearly poses new challenges for global food policy and food security.

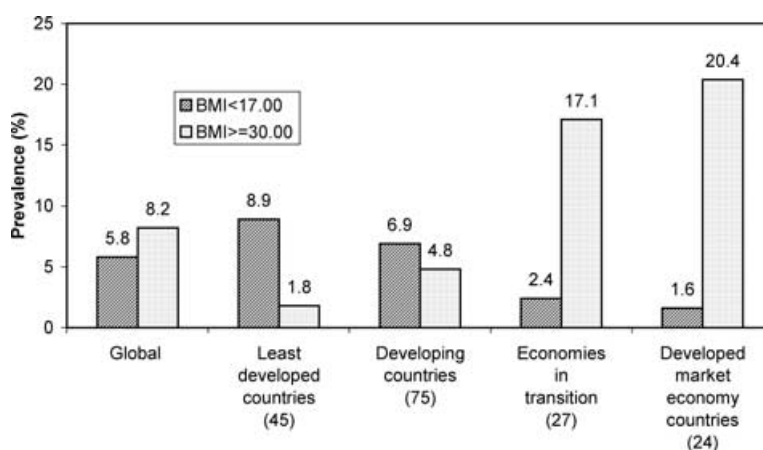


Figure 6. Global prevalence of underweight and obesity in adults for year 2000, by level of development. Source: Nutrition for Health and Development, A Global Agenda for Combating Malnutrition, WHO 2000. www.who.int/nut/db_bmi.htm.

5. Food security and safe food consumption

There are now two distinct definitions of food security. The traditional well-known definition refers to having enough food to maintain growth and health. The USDA defines food security as having access to enough food, at all times, for an active, healthy life (Nord, 2002). The new definition of food security refers to the production, processing, and distribution chain being secure from bioterrorists so that food cannot be *deliberately* contaminated with an agent that would make people ill, cause death, or economic chaos. Arguably, if food is produced according to good farming and manufacturing practices the chances of it being compromised by a deliberate terrorist is small but certainly not zero. Government agencies such as FDA and USDA in the United States are actively studying this new hazard, developing educational programs, and taking precautionary measures to minimize the impact of any such event. Consequently, for the purposes of this discussion I will focus on the traditional definition of food security.

The proposition here is that food security is not jeopardized by activities designed to improve the safety of food consumption. People who do not have enough to eat and are undernourished obviously benefit from more food availability, but food that makes them ill is not helpful. Making the food delivered to all people as safe and nourishing as possible should be a paramount criterion for delivering nourishment at all levels of income and caloric intake. Arguments that focus on the inability of developing countries to meet the food safety standards of countries that are potential importers and, therefore, should be allowed a lower food safety standard, end up jeopardizing the health of people everywhere, including the poor in a potentially exporting, developing nation. It is well known that hunger and poverty go together, everywhere. If resources are focused on helping poor nations to meet health and safety standards for their citizens and to be able to participate in world commerce, their incomes should rise, and food security problems can start to be alleviated.

Even in the United States, almost 11%, or 11.5 million households, were not food secure in 2001. One third of them were hungry at some time. They spent an average of 15% of their income on food per year compared to 5.5% for food-secure households (Nord,

2002). Several studies have shown that people, especially women, in these food-insecure households are also overweight (Olson, 1999; Townsend et al., 2001). Women between the ages of 19 and 55 years, who were in food-insecure households, were found to be significantly more likely to be overweight, and consumed ninety-one calories more per day than women in food-secure households (Basiotis and Lino, 2002). Based on the standard conversion of calories to body weight of 100 calories per day leading to 10 pounds of weight gained (or lost) per year, it is easy to see how those who are food insecure are more likely to be overweight. It begs the question of whether cheaper food has more calories and fat than more expensive foods, but it is a common observation that inexpensive and fast food is often higher in calories than higher priced food or food that is prepared slowly from scratch. The point is that poverty, hunger, and being overweight exist simultaneously, and that being overweight jeopardizes health, which jeopardizes the ability to work and be productive, which in turn jeopardizes the ability to earn income to buy healthy food. Therefore, safe consumption of food is compatible and consistent with food security in all parts of the world. The goal of food consumption is to nourish the body and improve health over a lifetime. If the food available is not safe or its consumption does not improve health, it does not contribute to food security.

In conclusion I quote Lawrence Haddad, "The diet transition in the developing world seems to be accelerating. It seems to be a transition towards an increased burden of chronic disease. It is increasing human costs in terms of mortality and the disease burdens. It is increasing the economic costs in terms of lower productivity. It is driven by changing preferences fuelled by growing incomes, changing relative prices, urbanization; by changing options fuelled by changes in food technology and changes in the food distribution systems; and by a legacy of low birth weights from the previous generation." He posits that there is a good case for public investment in efforts to influence the diet transition toward increasingly healthy outcomes. To do so will require us to address the dual issues of over and under consumption of food.

Food safety does not jeopardize food security; both act together to enhance human health. New definitions of both food safety and food security broaden the scope of concern and provide applied economists and policy

makers with new challenges in analysis and public policy.

References

- Acheson, D., "You Are What I Eat," *Food Quality* (July/August, 2001), pp. 22–33.
- Antle, J., "Economic Analysis of Food Safety," in B. Gardner and G. Rausser, eds., *Handbook of Agricultural Economics*, Vol. 1B (Elsevier: New York, 2001).
- Basiotis, P. P., and M. Lino, "Food Insufficiency and Prevalence of Overweight among Adult Women," *Nutrition Insights* (USDA, Center for Nutrition Policy and Promotion: Washington, DC, 2002).
- Calle, E. E., C. Rodriguez, K. Walker-Thurmond, and M. J. Thun, "Overweight, Obesity, and Mortality from Cancer in a Prospectively Studied Cohort of U.S. Adults," *The New England Journal of Medicine* 348, no. 17 (2003), 1625–1638.
- Centers for Disease Control, <http://www.cdc.gov/nccdphp/dnpa/obesity/Trend/index.html>, accessed 28 October 2004.
- Connolly, C., "Health Costs of Obesity Near Those of Smoking," *Washington Post* (May 14, 2003), p. A9.
- FAO, "State of Food Insecurity in the World," http://www.fao.org/DOCCREP/x8200E/x8200e03.htm#P0_0 *FDA Consumer* (March–April, 2002), p. 8.
- Food Marketing Institute (FMI), *Consumer Trends*. Relevant years (1993–2000).
- Garrett, J., and J. C. Ruel, "Stunted Child–Overweight Mother Pairs: An Emerging Policy Concern?" *17th International Congress of Nutrition: Annals of Nutrition and Metabolism* 45, Suppl 1 (2001), 404.
- Golan, E. H., K. Ralston, P. Frenzen, and S. Vogel, "The Costs, Benefits and Distributional Consequences of Improvements in Food Safety: The Case of HACCP," in L. J. Unnevehr, ed., *Economics of HACCP: Costs and Benefits* (Eagan Press: St. Paul, MN, 2000).
- Haddad, L., "Redirecting the Diet Transition: What Can Food Policy Do?" Presented at OEDC Conference, Amsterdam, The Netherlands (January 2003). (l.haddad@cigar.org)
- International Food Information Council Foundation (IFIC), "Childhood 'Globesity'," *Food Insight* (January/February, 2001). (http://ific.policy.net/proactive/newsroom/release.vtml?id=19401&PROACTIVE_ID=cefcfc)
- International Commission on Microbiological Specifications for Foods (ICMSF), *Micro-organisms in Foods 7: Microbiological Testing in a System for Managing Food Safety* (Kluwer Academic/Plenum: New York, 2002).
- Kinsey, J., "GATT and the Economics of Food Safety," *Food Policy* (April, 1993), pp. 163–175.
- Knowler, C. W., E. Barret-Connor, S. E. Fowler, R. Hamman, J. M. Lachin, E. A. Walker, and D. M. Nathan, "Reduction in the Incidence of Type 2 Diabetes with Lifestyle Intervention or Metformin," *The New England Journal of Medicine* 346, no. 6 (2002), 393–403.
- Lakhani, H., "Benefit–Cost Analysis of Reducing Salmonella Enteritidis: Regulating Shell Egg Refrigeration," in L. J. Unnevehr, ed., *Economics of HACCP: Costs and Benefits* (Eagan Press: St. Paul, MN, 2000).
- Nord, M., "Household Food Security in the United States," *ERS Information* (November, 2002), p. 1.3. (<http://ers.usda.gov/publications/fanrr29/>)
- Ollinger, M., and V. Mueller, "Managing for Safer Food: The Economics of Sanitation and Process Controls in Meat and Poultry Plants," Washington DC: USDA, ERS, Agricultural Economics Report No. 817 (April 2003).
- Olson, C. M. "Nutrition and Health Outcomes Associated with Food Insecurity and Hunger," *Journal of Nutrition* 131 (1999), 521S–524S.
- Ropeik, D., and G. Gray, *Risk* (Houghton Mifflin, Co.: Boston, 2002), pp. 98–100.
- Townsend, M. S., J. Peerson, B. Love, C. Achterberg, and S. P. Murphy, "Food Insecurity Is Positively Related to Overweight Women," *Journal of Nutrition* 131 (2001), 2880–2884.
- USDA, USDA, ERS, at <http://www.ers.usda.gov/data/foodborneillness/>, accessed 28 October 2004.
- U.S. Government Printing Office, *Economic Report to the President, 2004* H. Doc. 108–145, p. 284, available at <http://www.gpoaccess.gov/eop/>, accessed 26 October 2004.
- Van Schothorst, M., "Principles for the Establishment of Microbiological Food Safety Objectives and Related Control Measures," *Food Control* 9, no. 6 (1998), 379–384.
- WHO. http://www.who.int/nit/db_bmi.htm, accessed June 2003.
- Wolf, A., "Impact of Obesity on Healthcare Delivery Costs," *American Journal of Managed Healthcare* 4, no. 3, supplement (1998), S141–S145.