Common Drivers Common Solutions:

Chronic disease, Climate Change, Nutrition and Agriculture

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Common Drivers - Common Solutions

Introduction

The British Medical Journal recently declared climate change to be the biggest public health threat of the 21st century. This year, the Centers for Disease Control called obesity our nation's largest public health threat. Seemingly disparate issues, obesity and other diet- related disorders, climate change, and the healthcare sector share a variety of linkages, and at the nexus, is our current industrial agriculture-food complex. It is our conclusion, that appropriate changes in our food and agriculture system and associated agriculture policy could address drivers of climate change and common chronic diseases.

The global food system accounts for approximately one third of all climate change gas emissions through land use change and direct emissions. Moreover, food produced and promoted by this system increases the risk of a host of common, nutritionally- related disorders, including obesity, diabetes, cardiovascular disease, and various kinds of cancer, among others. Thus, many chronic diseases and climate change share common drivers.

For example, nutrition-related healthcare costs can be traced to dietary salt, fats, and insufficient intake of dietary fruits, vegetables, and various micronutrients, as well as excessive calories. One analysis estimates that a population-wide 9.5% reduction in salt consumption would result in a reduction of $32 billion in medical costs over the lifetime of people 40-85 alive today. [1] But since most dietary salt comes from processed food and restaurant meals, it is difficult for individuals to limit their consumption without action by the food industry.

The healthcare system is also intimately involved. People with nutritionally-related diseases require medical services. According to the CDC, obesity-related diseases alone account for nearly ten percent of all US medical spending, or an estimated $147 billion annually. The current healthcare delivery model uses energy intensive equipment, prescribes pharmaceuticals, and on average produces sixteen pounds of solid waste and two pounds of medical waste per adjusted patient day[2]. Healthcare is second only to food services in intensity of energy use, [3] thus making this sector a significant contributor to greenhouse gases. The climate footprint of pharmaceuticals' lifecycle has the same magnitude as the energy used in healthcare buildings. The climate footprint resulting from the treatment of all nutritionally related diseases has in itself environmental and public health costs and consequences.

The healthcare economic crisis provides an opportunity to mitigate climate change and shift healthcare towards a primary prevention agenda. Hospital costs for coronary artery disease alone in the US in 2006 were estimated at nearly $42 billion.[4] Health professional fees and costs related to nursing homes, pharmaceuticals, and other medical equipment increase this to $75 billion. In addition to the direct costs of diet-related diseases, indirect costs associated with the environmental and public health impact of healthcare activities are substantial, although they are generally externalized and do not appear on the healthcare ledger. Most importantly, health impacts resulting from climate change will logically add another layer of financial resources needs to an already financially-stressed healthcare system.

As a result, the healthcare community not only has a moral obligation and the authority to engage and promote sustainable agriculture and food policy, but a vested interest.

Importantly, the stage may be set as a result of a nascent ecological ethic within the healthcare community. Changes in our food system and associated agricultural policies can help to mitigate climate change and prevent chronic disease.

In this paper, we first discuss the food system as a driver of climate change and summarize the well-known links among diet, the food system, and common chronic diseases. Following this, using several examples, we explore the climate-related impacts of treating select diet-related diseases in the healthcare sector. And finally, we discuss the prospects for prevention of diet-related diseases as a strategy for reducing drivers of climate change, disease burden, and health care utilization.

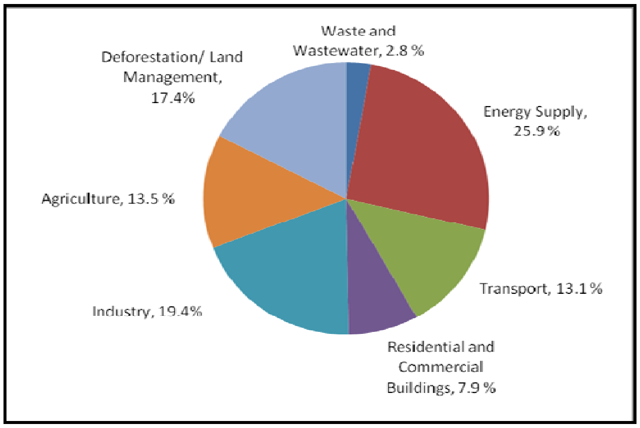
Food System Climate Impacts

Through agricultural activities (*e.g.*, land clearing, cultivation of annual crops, irrigation, grazing of domesticated animals) humans are extensively altering the local, national and global land-cover physical characteristics and function. The US agriculture system contributes to climate change emissions, not only through the production of crops and animals but also through industrial processing and distribution that often dilutes the nutritional value of the original product. Globally, the expansion of agriculture into natural ecosystems has had a significant climate impact [5], through land use changes such as deforestation. In the US, this agricultural deforestation is historical and no longer considered significant.

The global impact of deforestation/ land use green house gas contributions is estimated at 17.4% of total global emissions[6] while direct agricultural activities are estimated at 13.5%. [7]. Thus, the global contribution of agriculture to green house gas (GHG) emissions, including agriculture related deforestation, has a value of approximately 30%.

Animal agriculture is a large contributor to GHGs, estimated at 18% of total global emissions by the Food and Agriculture Organization. This estimate includes both direct agriculture and forestry/land management related contributions. Within the United States, the agriculture sector is estimated to contribute 6.4% of total green house gas emissions[8] and 13% of global emissions—the majority coming from industrial livestock operations.[9] The US contribution is important to view within a global context, as the US food and agriculture model has expanded across the globe, increasingly influencing diet, agricultural production, community and environmental health, and climate emissions.

Experts have determined that synthetic fertilizers, manure lagoons, and other mainstays of industrial agriculture are the main reason for these emissions, mostly in the form of nitrous oxide (N_2O).[10] Climate change adds considerably to existing uncertainty in agricultural production, and agricultural producers should therefore have an inherent incentive to mitigate impacts. Yet, the US agriculture lobby has fought climate change legislation. [11]



Global Green House Gas Emissions IPCC 2007 [12]

Though there are a variety of recognized green house gases, the three largest contributors include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) each with varying global warming potential. Agricultural sources such as animal husbandry, manure management and agricultural soils account for about 52% of global methane (CH_4) and 84% of global nitrous oxide (N_2O) emissions.[13] Global deforestation and intensive agriculture (e.g., cultivating grasslands) have contributed significantly to the increase in atmospheric carbon dioxide (CO_2). For example, until the 1970s when global energy use increased, more CO_2 had been released into the atmosphere from agricultural activities than from fossil-fuel burning.

Common Name(s)	Chemical Formula	Relative Global Warming Potential	Common Sources
Carbon Dioxide	CO_2	1	Fossil fuel Combustion
Methane	CH_4	23	Ruminant Animals, Organic matter decomposing in Landfills
Nitrous Oxide	N_2O	298	Fertilizer Overuse

Emissions of the three main GHGs, CO_2, CH_4 and N_2O,, can be reduced by changes in agricultural practices. Carbon dioxide can be removed from the atmosphere through sequestration in soil and biomass. [14]. Reduced or more precise application of nitrogen (N) fertilizer or livestock manure can reduce N_2O emissions if greater N-use efficiency can be achieved.

Changes in animal agriculture that would reduce GHG emissions include: 1) raising fewer livestock, particularly ruminants and animals in confinement; 2) shifting to monogastrics (from ruminants to poultry, rabbits, and hogs, 3) improving feeding and manure management practices such as covering lagoons, shifting away from confinement operations that generate methane in lagoons, or capturing methane through use of anaerobic digesters, 4) continued efficiency gains in the production of feed and livestock. In properly managed grass-based systems, grazing and mowing will contribute to increased ecosystem productivity and biodiversity. Other mitigation options include increased feeding efficiency, through improved forages, as well as dietary additives that suppress methanogenesis[15,16].

Despite the improvements in GHG emission per unit of meat product, because of the increasing demand for meat over this time period, animal production has increased substantially and total GHG emissions have continued to increase. Hence a reduction in GHG emissions per animal has not helped agriculture reduce its impact on the environment.[17] Thus, reducing meat consumption, particularly consumption of red meat, will have favorable climate impacts as well as positive health impacts, as discussed below. [18].

Atmospheric carbon can be sequestered in the soil and in vegetation. Soil management practices that increase sequestration include conservation tillage (e.g. mulch till, ridge till and no till – practices that minimize soil disturbance) and crop residue management (keeping what is left after the grain is harvested on the ground during the winter until the next growing season).[19],[20] Organic matter in the soil is critical to reducing GHGs. Vegetative carbon storage can be enhanced through perennial grass plantings and grazing management[21] . Good crop rotations and returning organic matter to the soil through appropriate residue and application of compost aids in this process. Although some existing agricultural practices already play a role in mitigating the global warming effect of some fossil fuel emissions that result from fertilizer production and fuel use, there is considerable potential to expand and improve upon existing practices.

Cover crops (quick-growing crops planted between production seasons to protect the soil), well-managed pastures, and other mainstays of organic and sustainable agriculture mean not only that those farming systems have much lower direct emissions, but that they also can serve as “sinks” for carbon emitted elsewhere by sequestering it in the soil. These systems have other benefits as well. They are more resilient to the extreme weather climate change is triggering, and less dependent on fossil fuel-based inputs. That means farmers face less risk as energy prices rise.[22]

In the past 20 years, about 75% of global CO2 emissions have been attributed to fossil-fuel burning and the remainder to land-use change[23]. The major impacts of agricultural land-use change are occurring in tropical rainforest regions such as Brazil, Congo, and Indonesia where native rainforests are being cleared for cultivation and pasture. Some of the meat and edible oils eaten in the United States come from these regions. Domestic consumption increases the demand for land clearing outside of the United States and its negative impacts on GHGs.

Changes in the production of crops are needed as well as changes in animal production. Moving away from confined animal feeding operations will not only reduce GHG emissions from concentrated manure holding pens, but reduce the need for input-intensive row crops for feed. Improved crop and grazing land management (e.g., improved agronomic practices, nutrient use, tillage, and residue management), restoration of organic soils that are drained for crop production and restoration of degraded lands will also help. Significant GHG mitigation is also achieved with improved water and rice management; set-asides, land use change (e.g., conversion of cropland to grassland) and agro-forestry, an approach that integrates trees with livestock and/or crops. Many mitigation opportunities use current technologies and can be implemented immediately, but, according to the IPCC (2007) technological development will be a key driver ensuring the efficacy of additional mitigation measures in the future.

The sequestration of carbon in soils with crops represents a major opportunity for mitigating climate change. Agricultural management practices such as reduced tillage, converting cropland to forage crops, permanent cover crops, fall-seeded crops, better crop cultivars, more efficient use of nutrients, optimized irrigation, reduced summer fallow, more chemical fallow and leaving tall stubble standing to reduce evaporation and trap snow have all been identified as beneficial for increasing C sequestration and/or reducing GHG emissions. It is estimated that, globally, agricultural soils could be a significant potential sink over the next century[24].

In agriculture, cultivation is the main cause of artificially enhanced reactive nitrogen (Nr) availability in natural ecosystems.[25] Sustainable food production should thus minimize Nr use while maximizing human destined caloric output per acre. It is possible to design realistic, nutritionally sound plant based diets which requires a shift from confined animal operations and reduced meat consumption[26]. Eshel et al. argue that incorporating environmental considerations into official dietary recommendations would reduce food production's environmental impacts dramatically[27].

The authors conclude that, "Gradually shifting human diet toward much heavier reliance on plants – also with a clear corollary of recent decades' advance in nutritional science[28]– must therefore be viewed as a central element in the broader national and global food policies that emphasize renewed commitment to minimizing food disparities, hunger and climate change beyond magnitudes to which we have already committed"[29].

The authors do not differentiate among animals nor the different ways of raising animals (i.e. range fed versus grain fed, free range vs. confined animal operations). Additional research would help determine the degree to which a reduced meat diet could maximize the productivity of land where plant cultivation is difficult[30].

Attention to meat consumption, complete agricultural systems, decrease in animal feeding by high input grains, and increase in dispersed fruit and vegetable production all have the potential of decreasing the contribution of U.S. agriculture to GHG emissions while contributing a great diversity of high quality foods to the American people.

Dietary Trends Linked to Changes in the Food Supply

At the same time that crop and animal production and industrial processing contribute to climate change, the food supply generated by our industrial food and agriculture complex has changed what and how people eat. Over the past 30 years, the average calories available per person per day in the US increased from 2,234 to 2,757, after adjusting for waste and spoilage. (USDA) Highly-processed, salt-laden, calorie-rich, and nutrient- poor food has become readily available and is heavily promoted, especially to children, increasing risks of obesity, cardiovascular disease, diabetes, and their consequences.

In addition to excessive calories, many people consume large amounts of high glycemic carbohydrates. These are refined grains and sugars that are rapidly absorbed from the intestine and cause rapid spikes in blood sugar and the insulin response. Sugar and sweetener use has increased by over 30 percent during the past 25 years, including a dramatic increase in corn syrup consumption. Considerable evidence shows that diets with a high glycemic index increase the risk of cardiovascular disease, diabetes, obesity, and metabolic syndrome.[31,32,33,34,35,36,37,38,39,40,41,42,43,44] Emerging evidence also suggests an increased risk of some kinds of cancer associated with a high glycemic diet.[45,46,47] Multiple mechanisms are likely to be involved including reduced levels of HDL cholesterol (good cholesterol), elevated triglycerides, increased insulin resistance, and increases in markers of systemic inflammation and oxidative stress.

In the past ten years, the average consumption of fruits and vegetables declined slightly. Today, only about 20% of men and 29% of women consume five or more servings of fruits and vegetables daily.[48] Fruits and vegetables are important sources of essential nutrients and anti-oxidants, Inadequate fruit and vegetable consumption increases the risk of cardiovascular disease and, over a lifetime may influence cancer risk as well. Considerable evidence also links lack of dietary green, leafy vegetables with an increased risk of age-related macular degeneration, a common cause of vision loss. Diets with increased amounts of fruits and vegetables are associated with decreased risks of chronic diseases.[49 50 51] Some epidemiologic studies also conclude that higher consumption of fruits and vegetables reduce the risk of cognitive decline.[52 53 54 55 56 57]

A dramatic rise in the consumption of dietary fats and oils during the past 50 years has largely been driven by increases in processed food and fried food in the fast food industry. Fats fall into two broad categories—saturated and unsaturated. Saturated fats come primarily from fatty meat and whole-milk dairy products.

Unsaturated fats are both polyunsaturated and monounsaturated. Olive oil, for example, contains a monounsaturated fatty acid. Polyunsaturated fatty acids (PUFA) include omega-6 and omega-3 fatty acids, which are essential to the diet and help keep cholesterol at healthy levels. Major sources of omega-3 fatty acids are fish, canola, flax, green vegetables, walnuts, and products from grazed animals. Omega-6 sources include many fast and processed foods, corn, sunflower, safflower, and peanut oils. Because linoleic acid (an omega-6) is less likely than omega-3s to turn rancid, it is used in many processed foods, helping to explain why diets commonly contain omega-6s far in excess of omega-3s. Linoleic acid can actually contribute to inflammation, particularly when intake of omega-3 fatty acids is not adequate. This effect can be sharply reduced by increasing consumption of food containing omega 3 fatty acids.[58 59 60] The meat of grain-fed animals raised in confined feedlots also has significantly higher ratios of omega-6 to omega-3 fatty acids than do pasture-fed or free-range counterparts.[61]

Saturated fats tend to raise LDL (“bad”) cholesterol levels and can also increase markers of inflammation by directly or indirectly triggering the innate immune system.[62 63] These mechanisms are important in the origins of atherosclerotic cardiovascular disease and other conditions in which chronic inflammation plays a role. Increased total dietary fat and saturated fat consumption also increase the risk of cognitive decline and dementia.[64 65 66 67 68] Replacing saturated fat with polyunsaturated fatty acids, with an emphasis on omega 3 fatty acids, reduces the risk of coronary disease and may also be helpful in preventing or delaying the onset or progression of cognitive decline and dementia, including Alzheimer’s disease. [69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90] In addition dietary PUFAs may also improve insulin sensitivity[91 92] A review of this extensive literature is readily available.[93]

In sum, dietary trends for many people have led to today’s excessive calories, salt, and high glycemic carbohydrates with too few fruits, vegetables, whole grains, nuts, seeds, and legumes.

Common chronic diseases/disorders with established dietary links

Obesity

Obesity is a major public health threat in the US and in many other countries throughout the world as they adopt a more Western lifestyle. Two-thirds of American adults are overweight and 1/3 is obese.[94] Trends in all age groups have been progressively upward. From 1980 to 2008, the prevalence of obesity in children aged 6-11 years increased from 6.5% to 19.6%. Obesity is a risk factor for diabetes, cardiovascular disease, Alzheimer's disease, some kinds of cancer (endometrium, cervix, post-menopausal breast, ovary, colon, prostate, and pancreas), gall bladder disease, and degenerative joint disease.[95, 96, 97, 98]

Diabetes:

Diabetes has become more prevalent in all age groups in the US in the past 25 years. In 1980 fewer than 3% of the general US population had diabetes compared to 7.8% in 2007.[99] Type 2 diabetes (non-insulin dependent) has historically been extremely rare among children but in recent years, it has become more common.[100] According to WHO, people with diabetes generate health care costs that are two to three times those without the condition[101]

Cardiovascular disease:

Cardiovascular disease incidence sharply increased in the US during the middle of the 20th century, although related mortality has declined due to a combination of early detection, smoking reduction, blood pressure control, decrease in blood cholesterol levels through dietary changes, and improvements in medical care.[102] Nonetheless, heart disease remains the leading cause of death in men and women in the US.[103]

Metabolic syndrome:

Metabolic syndrome is a term used to describe the clustering of various combinations of glucose intolerance, elevated insulin levels, abnormal blood lipids, and hypertension in association with abdominal obesity. Obesity and a sedentary lifestyle are likely to play important roles in the origins of metabolic syndrome.[104] Inherited genes, the intrauterine environment, and environmental chemicals are also likely to be involved.

In the US, metabolic syndrome is now present in over 40% of adults aged 60 years and older, and 24% among the population at large.[105] Metabolic syndrome increases the odds of developing overt type 2 diabetes and clinically relevant cardiovascular disease. In addition, several studies find metabolic syndrome in mid-life to be a risk factor for cognitive decline and dementia.[106, 107, 108, 109, 110] Metabolic syndrome in childhood increases risk of cardiovascular disease in adulthood 15-fold.

Cognitive decline, dementia, Alzheimer's disease:

About 5 percent of all men and women ages 65 to 74 have Alzheimer's disease, while nearly half of those age 85 and older are affected.[111] Thus, nearly 4.5 million people in the US have Alzheimer's disease, and current trends project this will nearly triple by mid-century to over 13 million.[112]

Early-onset Alzheimer's disease is generally thought to have a significant underlying genetic predisposition associated with abnormalities in amyloid protein production and processing resulting in protein deposits in plaques in the brain. Plaques and related pathologic markers are also present in the more common later-onset Alzheimer's disease, but a mixture of underlying pathologic processes, including atherosclerotic vascular disease, is a better predictor of the degree of cognitive impairment and is quite common.[113, 114]

Older age is just one of many risk factors for Alzheimer's disease and other types of dementia. Diabetes is associated with a sharply increased risk of developing cognitive decline and dementia later in life, as are midlife obesity and metabolic syndrome.[115, 116, 117, 118, 119, 120, 121, 122, 123] Some but not all studies conclude that elevated mid-life cholesterol also increases the risk of dementia.[124, 125, 126] Cumulative exposures to lead, air pollution, other environmental contaminants, social isolation, and lower socioeconomic status also increase risks. Thus, dementia is yet another multi-factorial condition in which environmental factors, including diet/nutrition, are causally related.

Healthcare's Climate Foot Print

Now that we have discussed the climate-related footprint of our food production system and its contribution to common chronic diseases, we turn to climate-changing impacts of the medical system responding to that disease burden. Although comprehensive data on the healthcare sector's climate footprint are missing, the National Health System (NHS) of the United Kingdom has undertaken a comprehensive assessment of its climate footprint and the development of a climate mitigation and adaptation strategy[127]. The NHS Green house Gas (GHG) footprint in 2004 was calculated as 18.6 Megatonnes (Mt) (or million metric tonnes (MMT)) $C0_2$ equivalents, representing 3% of the total UK GHG footprint.

Although data on specific contributions to healthcare's climate footprint are available, no standardized collection or analysis that allows for comparison between countries exists. So for example, in the United States, the EPA's Energy Star program collects data on building energy use, but these are not necessarily comparable to similar data from the NHS or other agencies. But, they do provide a better understanding of relative contributions to sectoral or national emissions inventories.

The NHS analysis is important because it helps illustrate the collective contributions of healthcare services to the overall carbon footprint, through a very detailed analysis. While energy use associated with the built environment is often targeted as a key carbon reduction strategy, the NHS data illustrate that this represents only 22% of total NHS emissions (Figure 1). In fact, 60% of the NHS carbon footprint is associated with embodied energy in materials procured for use in healthcare. (Figure 2). A detailed breakdown of the total NHS emissions is provided in Figure 3.

NHS carbon footprint 1992-2004

The NHS carbon footprint in 2004 was 18.6 $MtCO_2$, which represents 25% of England public sector emissions. The breakdown of emissions in the three primary sectors is as follows:

Travel:	3.41 $MtCO_2$	(18%)
Building energy:	4.14 $MtCO_2$	(22%)
Procurement:	11.07 $MtCO_2$	(60%)

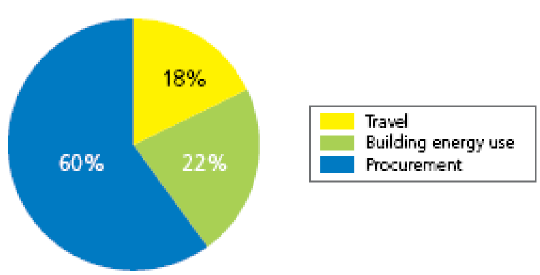


Figure 1 Breakdown of NHS Emissions 2004 [128]

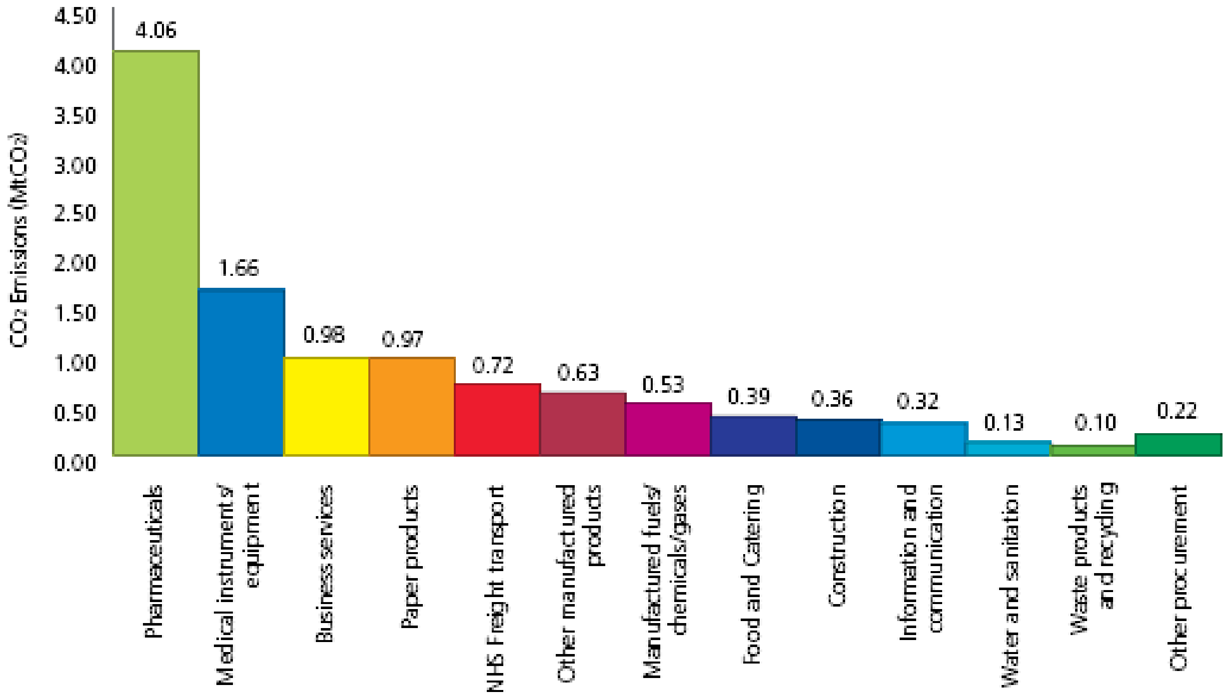


Figure 2 Breakdown of NHS Procurement Emissions 2004 [129]

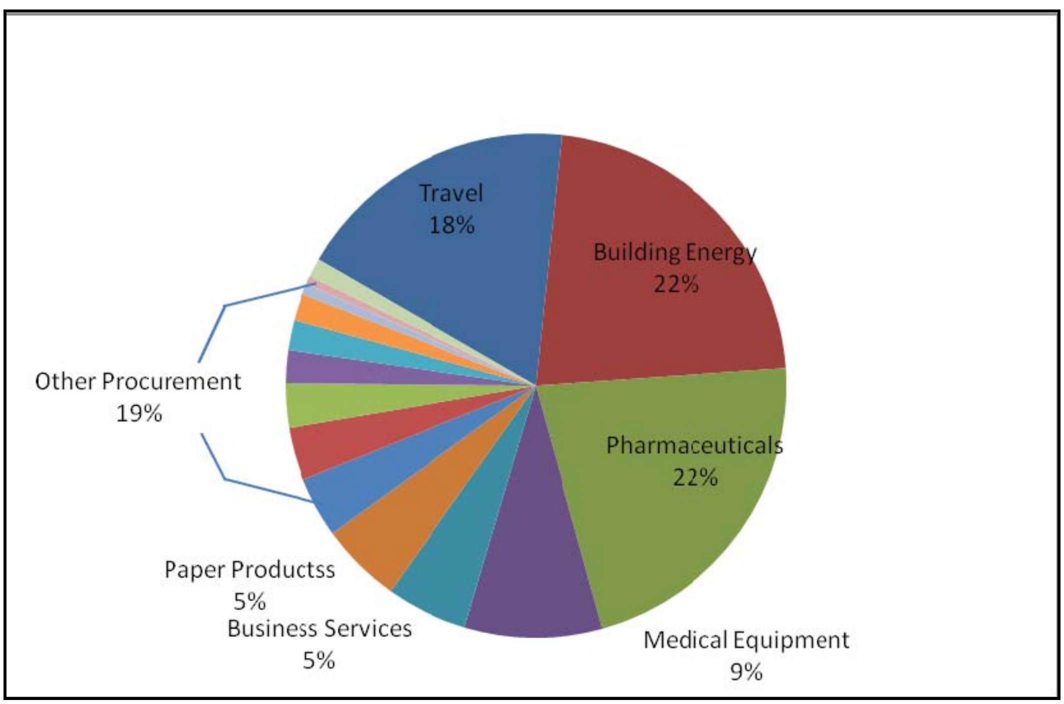


Figure 3 Detailed Breakdown of Total Emissions NHS 2004
(adapted from NHS procurement breakdown) [130]

The limited emissions associated with healthcare food and catering (0.39 MtC02) might suggest that food is of minimal importance with respect to climate emissions. However, inasmuch as diet-related diseases contribute considerably to the healthcare burden, it is worth taking a closer look at the extent to which the manufacture and distribution of pharmaceuticals and other resource-intensive interventions used in their treatment may impact climate through GHG emissions. Arguably, some portion of this impact should be attributed directly to the industrial food and agriculture system that helps set the stage for these diet-related diseases.

A research letter published in the November 2010 issue of the Journal of the American Medical Association estimated that 8% (or 545 MMT CO2) of total US Green House Gas (GHG) emissions in 2007 were attributable to the US health system.[131] Prescription drugs were responsible for about 14% of total US Healthcare GHG emissions (vs 21% NHS).

	Population (2010)	Carbon Foot Print (MMT $C0_2$ e)	Pharmaceutical Footprint (MMT $C0_2$ e)
United Kingdom 2004 (NHS)	61 million	18.6	4.06
USA healthcare 2007 (Chung, Meltzer)	306 million	545	78.9

Table 1 NHS - US Health System Relative Comparison

Each of these analyses used an Economic Input-Output Life Cycle Assessment (EIOLCA) model. Life cycle assessment (LCA) is a method for investigating, estimating, and evaluating the environmental burdens caused by a material, product, process, or service throughout its life span. The combined Input-Output model results represent impacts through the production of output by the sector with increased economic demand. EIOLCA is a top down approach, which breaks up the entire economy into sectors. Process based LCA models are bottom up and attempt to sum all GHG's across all the processes required to produce, process, and transport a product. Importantly emissions during use or end-of-life phases, such as disposal, or incineration of a product, are not directly included. For a detailed discussion of strengths and limitations of the EIOLCA model see http://www.eiolca.net/Method/Limitations.html.

The key point that the modeling illustrates is the significant role that healthcare services and products play with respect to healthcare climate footprint. Moreover, while it is clearly important to reduce footprint associated building energy use, a reduction in healthcare demand, or services, is a key mitigation strategy. Furthermore, though healthcare food service emissions are relatively low, emissions associated with the treatment of nutritionally related diseases are highly significant and their primary prevention represents an important opportunity for mitigating treatment-related climate impacts.

Diet Related Treatment and Climate Impact

We are experiencing a growing recognition of how specific services and products within the treatment setting impact climate emissions. For example, researchers have recently estimated how much different anesthetics can contribute to a hospital's climate footprint[132], differing in their respective global warming potential by a magnitude of 26. A footprint for a heart bypass in the UK was recently calculated as contributing more than 1 tonne of CO_2 equivalents. [133] A green house gas analysis of clinical trials, which included patients' recruitment procedures, drug manufacture, transport, of treatment packs, investigators' travel, and data analysis has been performed.[134]

Because nutrition-related diseases and disorders are common, it is reasonable to explore GHG emissions associated with them. Their treatment takes place in hospitals, outpatient clinics, patients' homes, and nursing homes, and includes prescription drug use. Over the last 50 years, prescription drug growth has consistently increased, and the annual rate of increase was less than 5% only three times in this period.[135] In 2009, US prescription drug sales reached $300 billion dollars and much of this is attributable to the treatment of nutritionally related diseases.

Thus, in the same way that the footprint of certain products or procedures has been estimated, we can begin to estimate the climate footprint of nutritionally related diseases. The following examples provide an illustration of the added "nutrition footprint" associated with poor diet.

Disease-Treatment Footprint of Nutritionally Related Diseases

Cancer, heart disease, diabetes, and hypertension are common diet- related diseases. In order to estimate the degree to which individual risk factors contribute to the development of multifactorial disorders, the concept of population attributable risk (PAR) is frequently used. Population attributable risk is the reduction in incidence of some condition that would be observed if the population were entirely unexposed to some risk factor, compared with its current exposure pattern. In our context, we are interested in the reduction of diet-related diseases that would likely to be observed if unhealthy diets were replaced with healthier ones.

Although the concept of PAR has limits because of underlying assumptions and the complexity of risk factor interactions, it does give some indication of the general magnitude and relative importance of various contributors to disease. For example,

- one study of modifiable lifestyle factors responsible for the development of hypertension in women estimates that about 54% of new cases are attributable to the combination of diet, lack of exercise, and overweight/obesity. About 40% of cases of hypertension could be attributed just to a body mass index (BMI) of 25 or greater.[136]
- Unhealthy diets are estimated to be responsible for between one- quarter and one-third of all cancers in developed countries.[137]
- One analysis of dietary patterns and the risk of acute myocardial infarction (heart attack) estimated that poor dietary habits are responsible for about 30% of the risk.[138]
- Nutrition also plays a major role in the development of type 2 diabetes and much of the risk is attributable to obesity, also strongly influenced by diet.[139]

Thus, without looking for more precision than is justified, it seems likely that unhealthy diets contribute substantially (25%-50% of the risk) to these common diseases or disorders.

To get some sense of the magnitude of the climate footprint associated with treating these diseases we used data from the Center for Financing, Access and Cost Trends, Agency for Healthcare Research and Quality: Medical Expenditure Panel Survey (MEPS) 2007.

		Percent Distribution by Type of Service				
Conditions [a]	Total Expenses (in millions)	Hospital Outpatient or Office-Based Provider Visits	Hospital Inpatient Stays	Emergency Room Visits	Prescribed Medicines	Home Health
Cancer	97,916.88	44.5	42.2	0.8*	9.6	2.9
Trauma-related disorders	83,177.63	37.6	44.8	12.0	2.0	3.6
Heart conditions	82,166.71	16.7	60.6	4.7	10.3	7.7
Mental disorders	61,347.56	22.1	17.1	1.6	42.6	16.7
COPD, asthma	51,085.14	21.1	31.8	3.6	38.0	5.5
Diabetes mellitus	41,181.71	24.0	19.1	1.1	46.7	9.1
Hypertension	40,677.61	24.0	15.2	1.6	50.2	9.0
Osteoarthritis and other non-traumatic joint disorders	40,175.39	42.0	25.8	0.7	19.7	11.7
Normal birth/live born	33,353.25	28.1	69.4	1.5	0.8	0.2*
Hyperlipidemia	31,475.91	23.3	3.4*	0.4*	70.4	2.5

Figure 4 Medical Expenditure Panel Survey (MEPS) 2007 [140]

Using cancer, heart conditions, diabetes mellitus, hypertension and hyperlipidemia we distributed the total expenses by the type of service (Table 2). So, for example, we found the cost of prescribed medicines associated with cancer in 2007 to be $97,916.88 million X 9.6% = $9,400 million.

	(Millions)		Hospital Outpatient or Office Based		Hospital Inpatient		ER Visits		Prescribed Medicines		Home Health
	Total Expenses										
Cancer	$97,917	44.5	$43,573	42.2	$41,321	0.8	$783	9.6	$9,400	2.9	$2,840
Heart Condition	$82,167	16.7	$13,722	60.6	$49,793	4.7	$3,862	10.3	$8,463	7.7	$6,327
Diabetes	$41,182	24	$9,884	19.1	$7,866	1.1	$453	46.7	$19,232	9.1	$3,748
Hypertension	$40,678	24	$9,763	15.2	$6,183	1.6	$651	50.2	$20,420	9	$3,661
Hyperlipidemia	$31,475	23.3	$7,334	3.4	$1,070	0.4	$126	70.4	$22,159	2.5	$787
Total 2007 Dollars	$293,418		$84,274		$106,232		$5,875		$79,674		$17,362
Total 2002 Dollars (.868 CPI Factor)	$254,687		$73,150		$92,209		$5,099		$69,157		$15,070

Table 2 Distribution of Total Medical Expenses (2007) by Service Type for Five Selected Conditions

The EIOLCA is a model that provides an output of GHG, based on a variety of economic activity inputs. For our calculations, we use 2002 purchase price models. In the example below we can see that an input of $73,150 million dollars (2002) of outpatient expenses, resulted in a total of 11.5 MMT CO_2E Global Warming Potential.

Sector #621A00: Offices of physicians, dentists, and other health practitioners
Economic Activity: $66784 Million Dollars
Displaying: Greenhouse Gases
Number of Sectors: Top 10

Documentation:
The sectors of the economy used in this model.
The environmental, energy, and other data used and their sources.
Frequently asked questions about EIO-LCA.

Change Inputs (Click here to view greenhouse gases, air pollutants, etc...) **This sector list was contributed by Green Design Institute.**

	Sector	GWP MTCO2E	CO2 Fossil MTCO2E	CO2 Process MTCO2E	CH4 MTCO2E	N2O MTCO2E	HFC/PFCs MTCO2E
	Total for all sectors	*10500000*	*8610000*	*374000*	*1000000*	*203000*	*271000*
221100	Power generation and supply	4590000	4520000	0	12400	28100	29100
211000	Oil and gas extraction	513000	145000	94100	275000	0	0
621A00	Offices of physicians, dentists, and other health practitioners	437000	437000	0	0	0	0
562000	Waste management and remediation services	404000	14800	0	385000	4370	0
484000	Truck transportation	369000	369000	0	0	0	0
324110	Petroleum refineries	319000	318000	0	987.0	0	0
325190	Other basic organic chemical manufacturing	311000	279000	0	0	32000	0
481000	Air transportation	295000	295000	0	0	0	0
325120	Industrial gas manufacturing	215000	24900	0	0	0	190000
331110	Iron and steel mills	193000	72800	119000	1170	0	0

Figure 5 – Example of EIOLCA Model Output for OutPatient Services Economic Activity

	Hospital Outpatient or Office Based	Hospital Inpatient	ER Visits (applied hospital as sector)	Prescribed Medicines	Home Health	Total
Total 2002 Dollars (.868 CPI Factor)	$73,150.00	$92,209.00	$5,099.00	$69,157.00	$15,070.00	$254,685.00
EIOLCA MMTCO$_2$ Eq	11.5	33.7	1.86	21	3.55	71.61

Table 3 - Climate Footprint (EIOLCA Model) for Type of Service for Five Conditions

Applying the model, we find that the total carbon footprint associated with treatment of just these four nutritionally related conditions is 71.61 MMT CO_2 Eq. Using a similar method, we calculated the total healthcare footprint for all selected conditions (see Appendix A). This footprint is 221 MMT CO_2 Eq. This differs from the previously referenced US healthcare footprint of 545 as it uses economic activity associated with service treatment of specific conditions services and does not include research, investments, etc. A comparison of methodologies is beyond the scope of this paper.

Thus, 71.61/ 221 = .324 or approximately 32% of the US healthcare carbon footprint is associated with the treatment of these nutritionally related diseases or disorders. As we have seen, perhaps as much as half of this could be mitigated by dietary changes.

The authors want to acknowledge that there are clear limitations and assumptions associated with this analysis. For example, the dollar value for the health care services may come from a different data source than that used to calculate the EIOLCA. But the analysis was performed to provide an illustration of the approximate magnitude of the potential climate impact associated with the treatment of these nutritionally related diseases.

Caloric Sweetened Beverages Obesity Treatment Footprint

Over the last three decades there has been a huge increase in the consumption of sodas (not including diet sodas) and other caloric sweetened beverages (CSB).[141] Over the last three decades energy intake has increased by 278 calories/day with levels of physical activity relatively unchanged. Among the biggest changes in diet during the past 20 years is the 300% increase in soda consumption, now representing 43% of all new calories. [142]

Adults who drink soda with caloric sweeteners are 15% more likely to be overweight or obese, and adults who drink one or more sodas per day are 27% more likely to be overweight or obese than adults who do not drink soda, even after adjusting for poverty status and race/ethnicity. [143] Forty-one percent of young children (2-11 years) are drinking at least one soda or sugar-sweetened beverage every day. Adolescents (12-17 years) are the biggest consumers with over 62 percent (over 2 million youths) drinking one or more sodas daily, which equates to the consumption of 39 pounds of sugar each year. [144]

A recent study by the City of San Francisco estimated that 8.66% of the costs of obesity were attributable to CSB. [145] The Centers for Disease Control and Prevention (CDC) estimates that annual healthcare costs associated with obesity are $92.6 billion (2002) dollars[146], while the Beverage Digest estimates annual CSB consumption at 738 eight-ounce servings per capita.[147]

Together these estimates provide the ability to estimate an approximate climate footprint associated with CSB-related health treatment. To do so, we will use the EIOLCA model. As before, we acknowledge similar limitations. In this example we apply San Francisco's estimate attributable to CSB to national healthcare costs.

$92.6 billion X 0.0866 = $8.04 billion (2002) dollars healthcare costs attributable to CSB

We then apply EIOLCA model and find a total of 1.32 MMT CO_2 associated with national CSB-related outpatient treatment costs.

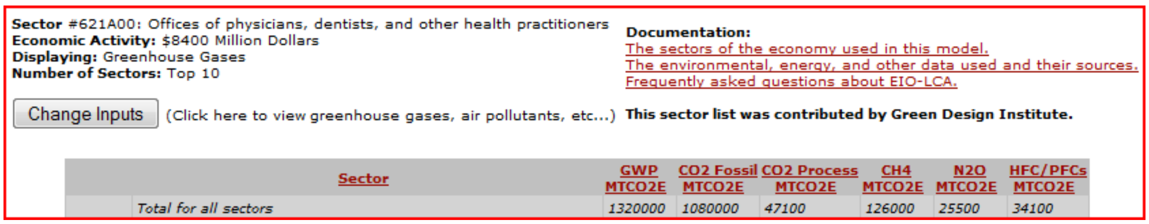


Figure 6 Example EIOLCA Model Output for Outpatient Economic Activity

Per capita servings CSB	US population[148].	Annual consumption of 8 oz CSB	Annual CO_2 Emissions from CSB treatment (MMT)	Annual CO_2 Emissions from CSB treatment (grams x 10^9)	CO_2 Emissions (g) from CSB Treatment / 8 oz. can.	Annual per capita Emissions (g $C0_2$ Eq) from CSB Treatment
738	307000000	226.6 billion	1.32	1320	5.82	4295

Table 4 Per Capita Emissions for CSB Treatment

Using a 1.226 Consumer Price Index factor, $8.04 billion 2002 dollars are equivalent to $10.3 billion 2011 dollars. Thus, outpatient obesity-related healthcare costs are about 4.6 cents/ 8 oz. can of CSB. ($10.3 / 226.6 annual consumption (billions) = 4.6 cents) At a web advertized price of $5.99/ 12 pack or $.50/can we find that the outpatient healthcare cost of a can of CSB consumed by the US population is 9.2 cents/ dollar spent.

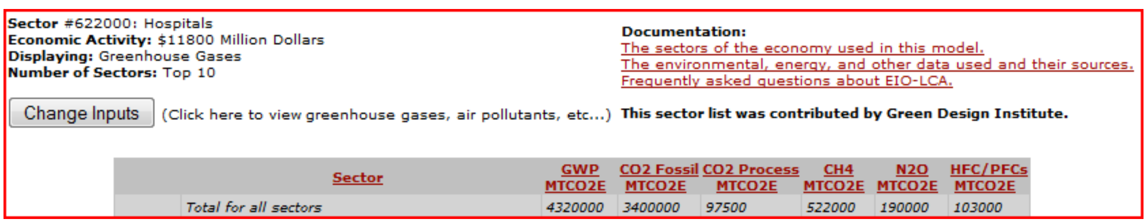
According to a soda manufacturer, the climate footprint for the production of a can of soda is 170 g $C0_2$ Eq. [149] . In this case, we estimate that the treatment-related climate footprint for a can of CSB is (5.82 / 170) = 3.42 % of the production footprint.

Meat and Saturated Fat Disease Footprint Example

The typical US diet contains significant amounts of red meat, and meat production is associated with a significant climate footprint. Moreover, US agriculture policy helps to subsidize industrial meat production through support for commodity programs[150]. A variety of studies have demonstrated that changes in meat production practices and associated reductions in meat consumption can help to mitigate climate change and improve public health. A recent study explored several agricultural mitigation strategies that would be needed to meet 50% emissions targets in the UK by 2030. [151] The results required technological changes in the agriculture sector and a 30% reduction in livestock production with anticipated 15% reduction in ischemic heart disease (though these changes still resulted in a 9% shortfall of targets). The associated reduction in GWG from production was estimated to be 13 MMT CO_2 eq.The authors did not estimate the potential climate benefits from the climate footprint reduction associated with the decrease in heart disease. We will attempt to estimate the climate mitigation benefits in the US, from such a decrease.

Recognizing that there are differences in US and UK diets, agriculture, economic systems and healthcare delivery models, it would still be interesting to explore the relative magnitude of the climate footprint associated with a 15% decrease in heart disease in the USA. Direct treatment costs associated with heart disease in the USA are estimated to be 95 billion dollars annually (2010).[152] Thus, a 15% decrease would be equivalent to 14.3 billion dollars ($11.8 billion 2002).

Using the EIOLCA model we determine that a decrease in hospital related expenditures from a decrease in heart disease treatment, results in a reduction of 4.32 MMT $C0_2$ eq.


Sector #622000: Hospitals
Economic Activity: $11800 Million Dollars
Displaying: Greenhouse Gases
Number of Sectors: Top 10

Change Inputs (Click here to view greenhouse gases, air pollutants, etc...)

Documentation:
The sectors of the economy used in this model.
The environmental, energy, and other data used and their sources.
Frequently asked questions about EIO-LCA.

This sector list was contributed by Green Design Institute.

Sector	GWP MTCO2E	CO2 Fossil MTCO2E	CO2 Process MTCO2E	CH4 MTCO2E	N2O MTCO2E	HFC/PFCs MTCO2E
Total for all sectors	*4320000*	*3400000*	*97500*	*522000*	*190000*	*103000*

Figure 7 Example EIOLCA Model Output Hospital Economic Activity

The UK population is one fifth that of the USA. Our diets are not identical and we experience differences in our agriculture and health systems. Yet, if we assume that they are the same, we might say that the health treatment footprint benefit of 4.32 MMT C02 eq would come with a comparable reduction in agricultural production footprint. For the US that would mean approximately 5 (population ratio) X 13 MMT C02 e (UK production reduction) = 65 MMT $C0_2$ eq. In summary, if these assumptions held, we could say that a 30% reduction in livestock production (with technological changes) would result in 65 MMT $C0_2$ eq. reduction with an associated the meat/heart disease-related treatment footprint reduction of 4.32 MMT $C0_2$ eq.

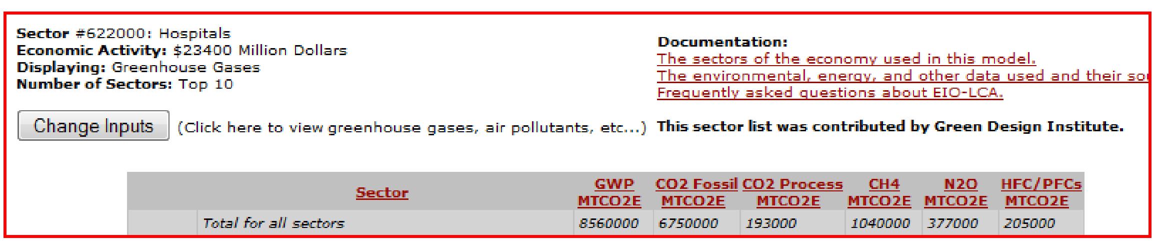
Dietary Salt-related Disease Footprint Example

Analysis of the entire food supply chain indicate that food preparation activities of households and the foodservice industry have been substantially outsourced to food processors.[153] The majority of the processed food industry is based on meats, grains, dairy, sugar, sweets, and/or fats. [154] By comparison, the fruit and vegetable component of the processed food industry is 11% and 12 % respectively by jobs and by value of product segment shipped. Moreover, foods high in fat, sugar, and calories, such as cooking oils, snacks, fast food, and sugared sodas, are some of the least expensive foods per calorie in the U.S. food environment.[155] Healthy foods cost more than sweets and fats and these unhealthy foods are the most inflation-resistant part of the U.S. diet.[156] [157] The food system and underlying agriculture policy promotes these foods.[158]

Another important health concern posed by processed foods is their high salt content. The U.S. diet is high in salt, with a daily mean intake of 3407 mg sodium. The majority of this comes from processed foods.[159] The Institutes of Medicine has called on the Food and Drug Administration to regulate the amount of salt and decrease the amount of sodium in the American diet. [160] Only 15% of those two years of age and older meet the recommended dietary intake of sodium of less than 2300 mg/day [161] It has been estimated that a reduction in dietary salt to 1200 mg of sodium per day would reduce the annual number of new cases of coronary heart disease (CHD) by 60,000 to 120,000, stroke by 32,000 to 66,000, and myocardial infarction by 54,000 to 99,000, resulting in $10 billion to $24 billion savings in health care costs annually.[162]

Though fruits and vegetables have one of the lowest salt concentrations of all processed foods, they make up only a small percentage of foods produced. [163] If our food system preferentially promoted production and consumption of fresh fruits and vegetables, our dietary intake of salt would be less than what is currently produced and marketed through our current industrial agriculture food system. The dietary salt-related disease climate footprint is clearly significant.

Following earlier examples, we assume salt-related cardiovascular disease healthcare costs at $24 billion (2010) dollars. To apply the model we convert to 2002 dollars using CPI factor 1.207, or $23.4 billion (2002) dollars.


Sector #622000: Hospitals
Economic Activity: $23400 Million Dollars
Displaying: Greenhouse Gases
Number of Sectors: Top 10

Documentation:
The sectors of the economy used in this model.
The environmental, energy, and other data used and their so
Frequently asked questions about EIO-LCA.

Change Inputs (Click here to view greenhouse gases, air pollutants, etc...) **This sector list was contributed by Green Design Institute.**

Sector	GWP MTCO2E	CO2 Fossil MTCO2E	CO2 Process MTCO2E	CH4 MTCO2E	N2O MTCO2E	HFC/PFCs MTCO2E
Total for all sectors	*8560000*	*6750000*	*193000*	*1040000*	*377000*	*205000*

Figure 8 Example of EIOLCA Model Output for Hospital Economic Activity

We use EIOLCA modeling to find the cardiovascular disease footprint associated with excess dietary salt and attribute economic activity to hospital services. The treatment footprint for our current salt consumption is 8.56 MMT $C0_2$ eq.

The challenge for the food processing industry is that it is difficult to remove salt without changing the consistency and taste of their products. The recent IOM recommendations to decrease salt in the diet included labeling and regulation. An equally important salt reduction recommendation is for the USDA to promote production and access to fresh fruit and vegetables rather than processed vegetables, through production subsidies and other strategies.

Healthcare Climate Treat Footprint Summary

These examples paint a picture of the relative magnitude of the multiple climate impacts resulting from our healthcare treatment associated with our industrial food and agriculture system. It is important to recognize that this paper does not explore other multiple health benefits, and thus climate mitigation, that would accrue through the reduction of pesticide use, decreased antibiotic resistance, and improved community socio-economic health, all of which are positively associated with sustainable food production.

The following table summarizes these treatment costs:

Healthcare Treatment All Conditions	Treatment of Cancer Heart conditions Diabetes mellitus Hypertension, Hyperlipidemia	Dietary Salt-related Disease Treatment	Meat and Saturated Fat-related Disease Outpatient Treatment	CSB-related Obesity Outpatient Treatment
221	71.6	8.56	65	1.32

Table 5 Climate Footprints (MMT CO_2 Eq.)

In Figure 9 below, we provide an illustrative overview of the discussion to date.

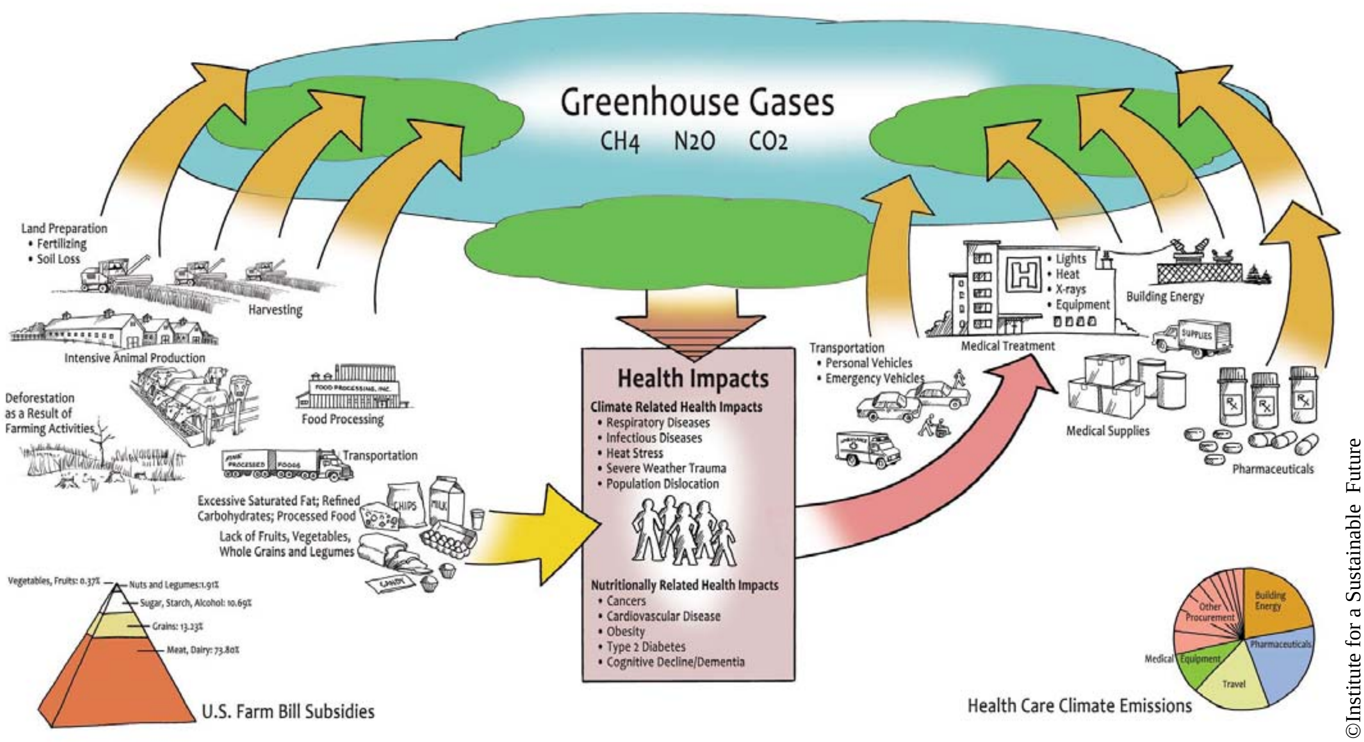


Figure 9 Agriculture, Food, Healthcare Climate Connection ©ISF

Cost Savings of Climate Mitigation - A Prevention Measure in Itself

Many organizations and individuals, including The World Health Organization, recognize that the health impacts of anticipated climate change will create a global public health crisis. Climate change is already having direct and indirect effects on human health, with considerable geographic variability, and these will continue to grow and spread. For example, early snow melt, changes in air quality, urban heat islands, wildfires, heat waves, changes in patterns of drought, storms, and flooding, and population displacement will each tend to affect some areas more than others.

Similarly, some groups and individuals will experience the impacts of climate change more than others. The elderly, infants and children, those with some pre-existing diseases, and refugees are all more vulnerable to climate-related impacts.[164] [165] People of color and those who are poor will suffer more health effects because of fewer resources to respond and less economic cushion for adapting to heat and related stressors. [166] [167]

As a result of climate change, according to the Intergovernmental Panel on Climate Change (IPCC) and the US EPA,[168]:

- Asthma, allergies, and airway diseases will increase because of increased exposure to pollen, molds, air pollution, and dust.
- Heat stress and increased particulate air pollution will increase the risk of heart attacks.
- Food shortages; malnutrition; and food contamination with chemicals, biotoxins, microbes, pesticides will increase
- Heat-related morbidity and mortality will increase, particularly in vulnerable groups, such as the elderly, people taking certain medications, and those with underlying illnesses that make them more vulnerable.
- Mental health and stress-related disorders will increase;
- Changing distribution and intensity of droughts and floods will force more people to migrate from their traditional homes, creating social stressors and refugee status.
- Vector-borne and zoonotic diseases, such as malaria and dengue fever, will increase and arise in new geographic areas as the range of their vectors expand. [169]
- Increased water temperature and more frequent and severe precipitation will increase water-borne diseases.
- Increased frequency and severity of floods, hurricanes, droughts, and wildfires will increase weather related morbidity and mortality in many areas of the world
- Crop failures will become more common; forest fires will increase in frequency; water shortages for drinking, hygiene will become more common

- Population displacement, migration.

Clearly, healthcare and public health sector budgets will need to increase in order to manage the demands caused by health impacts associated with climate change.

Preventing Diet-Related Disease Can Reduce the Health Care Carbon Footprint

Prevention of chronic disease *in the first place* is the most effective strategy for reducing the climate footprint of treating nutritionally-related disease. And, of course, disease prevention direct benefits for quality of life as well. An estimated 365,000 premature deaths per year in the United States are attributed to poor diets and physical inactivity.[170] Conversely, better diets and physically active lifestyles are strong protective factors, along with eliminating tobacco use, for reducing the risk for cardiovascular disease, certain cancers, and diabetes. Furthermore, these healthful habits are prime strategies for slowing and even reversing the advancement of chronic disease when clinical disease is already evident.

Concerns about the public health threat posed by rising obesity rates, a symptom of poor dietary habits and sedentary lifestyles has catalyzed numerous scientific reviews that recommend strategies for prevention of childhood obesity and promoting healthy eating and active living across the population. Experts including the CDC, the Institute of Medicine, and the American Medical Association have all concluded that improving eating and activity habits requires a comprehensive multifaceted approach that changes the environments where we live, work, learn, and play to support healthy choices.[171,172,173,174] Changing these environments requires action by government, businesses, schools, child care and after school centers, places of worship, and other community-based organization, working in collaboration with community residents.

Healthy Diets Help Prevent Chronic Disease

Most studies of the costs and efficacy of primarily or secondarily preventing diabetes or cardiovascular disease are based on a pharmaceutical approach, along with other risk reduction strategies.[175] One analysis prepared by representatives of the American Diabetes Association, the American Heart Association, and the American Cancer Society estimated that the cost of caring for cardiovascular disease, diabetes, and coronary heart disease over the next 30 years will be about $9.5 trillion. The authors concluded that if all currently recommended drug and health education interventions were applied with 100% success, those costs would be reduced by about 10%. Since these intervention activitiesdrugs, smoking cessation classes, weight control classesthemselves would cost about $8.5 trillion and increase total medical costs by $7.6 trillion. Esselstyn argues that our current approach to preventing coronary heart disease is deeply flawed to the extent that it continues to promote a diet containing oils, meat, and dairy.[176] He and others refer to the data showing the marked benefits of a largely plant-based diet with fewer than 10% of calories coming from fat discussed above. To the extent that this approach reduces the need for pharmaceutical interventions, the associated costs would be substantially less. As described in the later section on preventing diet-related diseases, individually based approaches to changing diets will not succeed in reducing chronic disease rates across the population. Community prevention strategies are needed and are cost-effective. A national analysis of community-based programs to increase physical activity, improve nutrition, and prevent tobacco use concluded that there is a substantial return on investment in prevention. For every $1 invested in community-based prevention, the return amounts to $5.60.[177]

Indeed, the 2010 U.S. Dietary Guidelines for Americans specifies eating patterns that can prevent chronic disease and promote optimal health. These guidelines call for a shift in U.S. eating patterns to a more plant-based diet, recommending diets rich in vegetables, cooked beans and peas, fruits, whole grains, nuts, and seeds, along with increased intakes of seafood and low-fat and nonfat dairy products. According to the guidelines, the U.S. population also needs to significantly reduce intakes of sodium, solid fats, and added sugars, along with refined grain products.[178] These recommendations were developed based on an extensive review of the clinical and epidemiological evidence, which, among other findings, concluded that certain dietary patterns around the world are associated with beneficial health outcomes. For example, these recommendations are similar in many respects to the Mediterranean Diet. Studies show that the Mediterranean diet reduces cardiovascular disease progression, recurrent heart attacks, abnormal blood lipids, diabetes, obesity, metabolic syndrome, chronic inflammation, and total mortality.[179,180,181,182,183,184,185,186] Notably, these dietary patterns echo earlier descriptions in this paper of how shifts in agricultural production – reducing meat production and highly processed products – could reduce the carbon footprint of food production.

The Diabetes Prevention Program, a U.S. multi-center randomized clinical trial, found that the diabetes incidence for high risk adults was reduced by 58% less with intensive lifestyle interventions and 31% by participants taking metformin. High risk was defined as elevated fasting and pre-loading glucose levels. The lifestyle interventions focused on achieving a 7% weight loss, reducing fat consumption, and participating in at least 150 minutes of moderate physical activity per week. The recently published ten-year follow- up found that the diabetes incidence was reduced by 34% in the lifestyles group and 18% in the metformin group.[187] A meta-analysis of 21 randomized controlled trials similarly concluded that lifestyle interventions can delay or prevent type 2 diabetes in individuals with impaired glucose tolerance.[188] The American Heart Association considered findings from cardiovascular disease risk reduction interventions and concluded that four key lifestyle goals – cessation of cigarette smoking, achieving healthy weight (BMI < 25 kg/m2, engaging in moderate to vigorous physical activity, and adopting diets consistent with the U.S. Dietary Guidelines – could greatly reduce cardiovascular disease at the US population level.[189,190]

Changing Community Environments to Shift Dietary Trends

The research demonstrates that lifestyle changes can have a powerful impact on preventing chronic disease. Preventing chronic disease at a sufficient level to lower the carbon footprint of health care requires shifting eating behaviors across the population. In order to have an impact on disease rates, it is necessary to move beyond individually focused interventions which by their nature reach only a small set of highly motivated individuals. Tom Frieden, Director of CDC, and colleagues recently emphasized that the U.S. needs policy interventions that change the social and physical environments to make healthy dietary choices the default choice.[191] The current environment produces the opposite effect; the preponderance of marketing messages and available options encourage unhealthy choices. Changing dietary patterns, thus, requires changing this environment. As the Institute of Medicine concluded in its seminal report on effective behavior change, “It is unreasonable to expect that people will change their behaviors easily when so many forces in the social, cultural, and physical environment conspire against such change.”[192] Health education and individual nutritional counseling can help develop skills and motivation for changing food choices. However, it is difficult for patients to follow through in face of the negative food environment.

The dietary trends described earlier have occurred in the context of changes in the food environment that has been well-characterized by Nestle, Brownell, and Finkelstein among others. High calorie low nutrient foods are easily accessible and heavily marketed, while more health producing foods are rarely promoted, less convenient, and frequently more expensive on a per calorie basis.[193,194, 195]

This food environment has largely been shaped by the business practices of corporations that dominate the U.S. food industry and the ways in which these practices interact with consumer preferences. The U.S. food industry is highly concentrated. In 2002, four companies accounted for 52 percent of the $32 billon total value of shipments in the soft drink industry. Similarly, the four largest snack food manufacturers took in 56 percent of the industry's $17 billion in total shipments.[196] Fierce competition for consumer food dollars has contributed to a proliferation of new foods and beverages formulated to tap into our biological preferences for foods high in calories, especially fat and sugars.[197] Over the last 30 years, the food marketplace has seen an explosion in high-fat salty or sweet snacks, desserts, and sweetened beverages, all offered in ever larger portion sizes. U.S. food marketers introduce fifteen to twenty thousand new food products every year into a food system that already contains more than three hundred thousand food products. More than two-thirds of new products are condiments, candies and snacks, baked goods, soft drinks, and dairy products (cheese products and ice cream novelties).[198] Studies by marketers and public health researchers have demonstrated that this abundance makes a difference in consumers' choices; the more grocery store shelf space devoted to a product, and the more locations it exists in a store, the greater the sales.[199]

A large proportion of meals are now consumed outside of the home, comprising nearly 42% of family food budgets in 2007,[200] and therefore, prepared food options have an important influence on consumption. Societal trends including more single parent and two working parent families, longer commute distances, and more highly scheduled after school activities for children and youth have helped fuel a device for convenience and prepared foods. These highly processed foods are available in more locations. Snack foods, sweetened beverages, and coffee drinks are now found in gas stations and bookstores. Vending machines for these products have made their way into junior high and high schools, healthcare institutions, park and recreation facilities, and other public spaces. Therefore, it is not surprising that an analysis of dietary data in 2004 found that at least one quarter of foods in the U.S. diet come from foods high in refined sugar or fat and containing few micronutrients.[201] A closer look at sources of energy for 2-18 year olds found that nearly 40% of calories consumed by 2-18 year olds were empty calories –solid fat and added sugars. Top sources of energy were grain desserts, pizza, and soda.[202]

Fast food and chain restaurants feature meals built around large portions of meat, chicken, and seafood with liberal addition of cheese. Refined grains are prominent in the form of buns, rolls, tortillas, pasta, or pizza dough. Very little is offered in the way of fruits and vegetables, except for french fried potatoes. Supersizing has been a technique to increase sales.[203] Adults and youth who eat more meals way from home consume more calories compared to meals prepared at home.[204] Numerous experimental studies have demonstrated that when children and adults are served larger portion sizes they eat more; yet, they report the same feelings of satiety when served smaller portions.[205]

Marketing has played an important role in increasing purchases of these snacks, beverages, and meal items. According to data solicited by the Federal Trade Commission, corporations spend 1.6 million dollars annually promoting food and beverages to children. The vast majority of these ads are for foods high in sugar, fat, or sodium – high-sugar breakfast cereal, fast food soft drinks, candy, and snack foods.[206] The Institute of Medicine in its review of the evidence of the impact of food marketing to children and youth concluded that "food and beverage marketing targeted to children 12 and under leads them to request and consume high-calorie, low nutrient products, and the dominant focus of marketing to children and youth is on foods and beverages high in calories and low in nutrients and is sharply out of balance with healthful diets."[207] Marketing techniques have expanded beyond TV advertising to include social and mobile media, website games, and school-based promotions. Children's beloved characters are often featured on ads or on packages to draw children's attention. A 2010 study by the Yale Rudd Center for Food Policy and Obesity found that fast food advertising to children and teens has been increasing between 2003 and 2009 despite public recognition that obesity is a major public health threat.[208] Fast food companies are targeting youth of color, especially African American youth and Spanish language audiences.[209] Food marketers have not ignored early childhood. Extensive dollars are spent marketing infant formula and baby foods through advertising and direct promotions to pregnant women and new mothers and in some cases, using healthcare clinics and hospitals as the venue.

The loss of full service grocery stores from poor urban and rural areas have left residents with limited options for healthful food.[210] Low-income, urban, communities of color have higher numbers of convenience stores, which tend to offer high-calorie, low-nutrient foods.[211,212] A recent comprehensive review concluded that national and local studies across the country suggest that low-income, minority, and rural neighborhoods are most impacted by poor access to supermarkets and healthful food.[213] The presence of grocery stores and fresh food retailers is associated with increased fruit and vegetable intake and more healthful diets.[214] Communities with more unhealthy food outlets have the opposite effect. A California analysis found residents with more unhealthy food outlets compared to healthy food outlets have higher rates of diabetes.[215]

With nearly 10 years of analysis about the problem, there is now agreement among national health officials about what is required to shift the dietary patterns across the population to help reverse rising diabetes rates and prevalence of cardiovascular disease risk factors. The CDC, the Institute of Medicine, and private foundations have summarized key strategies, community indicators, and policy options to improve food environments[216,217,218,219] No singular action is expected to change behavior. Rather it is a combination of environmental changes that is expected to tip community norms towards healthful choices. As Frieden describes it, three types of environmental changes are needed: 1) increase exposure to healthy food while decreasing exposure to unhealthy food, 2) altering the relative costs of healthful to unhealthy food, and 3) improve the image of healthful food while making unhealthy food less attractive.[220] Policy is a key tool for achieving these changes.

A policy and an environmental change approach has been utilized in other successful public health efforts aimed at changing behaviors -- including reductions in smoking rates, driving under the influence, and increasing seat belt and child passenger car seat use. In each case, individual knowledge, skill building, and community education was supported and reinforced by organizational practices and public policies.[221] For example, despite the public education campaigns about the alarming impact of failing to use car seats, usage rates for infants crested at 15 percent nationally until the passage of state laws in the 1970s.[222] Now virtually every infant is in a car seat. Tobacco control efforts that adopted policies to restrict locations for tobacco use, enact tobacco taxes, conduct hard-hitting social marketing campaigns to highlight tobacco industry efforts to promote smoking despite the health risks, and support for smoking cessation have led to dramatic success. California is credited with reducing heart disease and rates for lung cancer. Additionally, the California Tobacco Control Program resulted in a savings of $86 billion in health care costs during the same period, or 50 times the rate of return on the program's expense.[223] California lung cancer rates are nearly 25 percent lower than those in other states.[224] In addition, the state of Washington recently reported that their Tobacco Prevention and Control Program has prevented about 13,000 premature deaths and nearly 36,000 hospitalizations. This study showed that every state dollar spent on tobacco prevention saved five dollars in health care costs.[225]

Shape Up Somerville, a citywide campaign in Somerville, Massachusetts, was one of the first in the nation to focus on increasing daily physical activity and healthy eating through a combination of programming, physical infrastructure improvements, and policy work. Environmental changes included providing healthier school food, establishing safe and walkable routes to school, extending the community path, and promoting more nutritious restaurant options, farmers markets, and community gardens. In its first phase, evaluation found that the campaign slowed rates of weight gain in 1st to 3rd graders.[226] Policy and environmental change initiatives to reduce chronic disease can be cost effective. As cited earlier, a national analysis of community-based programs tthat altered the community social and physical environment to increase physical activity, improve nutrition, and prevent tobacco use concluded that this approach can lead to cost-savings.For every $1 invested in community-based prevention, the return amounts to $5.60.[227]

In recent years, there has been community-based effort all around the United States to change the food environment to provide more healthy food and decrease the availability of unhealthy foods. Efforts have included changes to health care, school, and childcare menus, policies to eliminate sweetened beverage sales and set nutrition standards for foods sold in schools and park and recreation facilities, an expansion of farmers markets, policies to require calorie information on fast food menu boards, public-private ventures to return food stores to underserved communities, and zoning efforts to limit fast food outlets, among other strategies.[228] These strategies at the "retail end" are one part of the effort needed to prevent diet related chronic disease.

An additional set of public policies is needed to realign incentives at the production level to improve the healthfulness and reduce the carbon footprint of the food supply.[229] The dominant industrial food system, from farm to table, as it has evolved is currently organized around the production of an abundance of these unhealthy products. Changes in federal agricultural policies that depressed the price of commodities, such as corn and soy, have made it cheaper for corporations to purchase animal feed, vegetable oil/trans fats, and sweeteners to use as ingredients.[230] The developments of new food technologies, including flavoring agents, food dyes, texturizers, and preservatives, have made it possible to sell uniform products that are palatable and have long shelf.[231] The establishment and maintenance of transportation systems to ship ingredients to central processing hubs and to distribute products to retail locations over long distance has also been necessary to support this food system. In addition, the establishment of concentrated animal feeding operations and large industrial growing operations has also helped lower retail prices. There are many hidden costs associated with these systems. These include inadequate income and occupational health hazards faced by farmers and agricultural and food production workers; destruction of soil, air pollution, irreversible lowering of the water table, and toxic contamination of ground water and large bodies of water, including the Mississippi River and the Gulf of Mexico. As described earlier, many of these elements of the system contribute to greenhouse gas emissions and climate change. These costs of destruction to the environment – and the costs of poor health – are not factored into our retail food costs.

The interrelationship between the food supply and the system of production suggests several positive directions for reducing the common drivers that contribute to climate change and chronic disease: 1) reducing production of meat and poultry, 2) shifting agricultural lands used to produce corn and soy to growing more whole grains and dry beans and peas that are directly recommended, 3) reducing production of crops turned into sweeteners, starches, and oils used in processed foods, and 4) complementing agricultural production changes with policies to promote and incentivize consumption of healthier foods.

The Responsibility of Healthcare Systems

The mission of most healthcare systems emphasizes their responsibility to provide competent, compassionate care for people who are sick or injured. Some systems explicitly mention a responsibility to improve the health of people in the communities they serve. Many systems emphasize health promotion and disease prevention (HPDP) activities for a variety of reasons, including pressures from third-party payors to provide cost-effective services, maintenance of tax-exempt status of not-for-profit institutions, and community expectations.[232] One study finds that for-profit hospitals tend to provide fewer HPDP services than not-for-profit hospitals unless the for-profit institution is the sole provider in a community. In that case, the services tend to be similar.[233] Regardless, the services are often not well integrated into more general public health approaches to disease prevention and may be the first to be cut for economic reasons. The question remains as to whether or not healthcare systems have an obligation to do what they can to provide HPDP services or to provide only those services that are profitable or satisfy licensure requirements.

From the discussion above, it seems clear that health care has the opportunity to adopt strategies that improve health outcomes while simultaneously reducing greenhouse gas emissions. Helping to shifting the food supply towards more whole plant-based foods, with less meat, dairy, and added fats, sugar, and salt will decrease the risk for chronic disease and reduce the carbon footprint of food production.[234] Thus, healthcare has the opportunity to help reduce treatment demands--and greenhouse gas emissions associated with treatment - through a greater focus on primary prevention of food related chronic diseases. That these food production methods release toxins into air, water, and soil, and these exposures have been linked to asthma, cancer, birth defects, and other chronic diseases provide a multiplier effect on reducing disease and greenhouse gas emissions as the strategies both reduce chronic disease and carbon emissions. Climate disruption is perhaps the clearest manifestation that human beings are part of an ecological system, and it is clear that our health and survival is tied to the status of the system.

The responsibility of healthcare institutions to engage in HPDP activities deserves renewed emphasis and reimbursement policies should be re-worked so that systems have incentives to engage in this approach in order to help:

- prevent new cases of chronic disease that will require medical care
- improve management of diagnosed chronic disease, thus reducing treatment interventions
- ensure that adequate capacity exists in the health care system to accommodate new individuals entering the system through the patient accountability and affordable care act
- demonstrate a commitment to supporting the public good by promoting health and environmental sustainability

Health Care Actions

Health care institutions can contribute in several ways to the mobilization for sustainable food production, healthier food environments, and reduction of chronic disease rates. The impact of healthcare institutions goes beyond the specific measurable reduction in greenhouse gas emissions in a particular institution. Healthcare institutions and health professionals are viewed by the public as credible sources concerned about the public good. Therefore the practices and advocacy efforts of these institutions can set the tone for the broader society about community norms. The urgent challenges presented by the growing chronic disease burden and by climate change should not be ignored. Specific actions health care can take include:

1) Incorporate prevention into clinical practice

- Assess eating behaviors as a routine aspect of medical exams for children and adults to help convey the importance of healthful eating habits in disease prevention and not only after risk factors such as elevated blood glucose or high cholesterol are detected. Provide effective health education classes for interested patients to received accurate information about healthful food choices and support in personal goal setting.

- Formally adopt and implement recommended policies for health clinics and hospitals to support women who have chosen to breast-feed. These practices include elimination of routine formula distribution, rooming newborns with their mothers, and access to a lactation consultant to address challenges.

2) Establish an institutional food and beverage policy to create a healthful healthcare food environment for patients and staff

- Serve meatless meals at least once per week
- Purchase local and organic produce
- Purchase only free range meat, poultry, and dairy products
- Eliminate vending and other sales of unhealthy food choices
- Provide healthful snacks for staff, especially those on night shifts
- Provide water fountains , refillable water bottles, or other measures to encourage staff to drink tap water
- Eliminate onsite fast food chain restaurants
- Provide a lactation room for patients and staff

3) Advocate for local, state, and federal policies to improve the food environment

- Stronger nutrition standards for school and child care meals and snacks
- Expanded access to federal nutrition programs (WIC, SNAP, School Meals, Child and Adult Care Food Program)
- Eliminate marketing of unhealthful foods and beverages to children in schools

- Consider investing in local public-private partnerships to improve retail access to healthful foods in underserved areas, applying for potential matching resources from the federal Healthy Food Financing Initiating.
- Support a sweetened beverage tax to reduce sweetened beverage consumption and support public health led community efforts to prevent chronic disease
- Adopt Green Guide or other food service benchmarks / metrics

4) Hospital Supported Agriculture and Food Knowledge and Culture

- Develop relationships with the local farm community
- Support community garden programs and school based educational initiatives
- Develop and support CSA and other drop off programs
- Model recipes on healthful food in hospital and community
- Establish or promote local farmers markets
- Educate staff and visitors on food systems and climate on hospital website, posters, and mandatory trainings
- Promote cooking/ culinary skills to youth

5) Advocate for sustainable agriculture and climate mitigation legislation and support inclusion of sustainable agriculture policies in climate policy.

- Restriction of pesticides and artificial fertilizers
- Elimination of concentrated animal feeding operations (CAFOs)
- Advocate on Farm Bill - research on sustainable agriculture practices, promotion of fruit, vegetables and legumes.
- Advocate and support climate change policy and ensure inclusion of sustainable food production mitigation strategies.

Hospitals and Climate Resilience in Action

In the summer of 2010, a drought and associated peat fires in Russia brought into stark relief the relationship between climate, food, and health. Breathing stations were established where citizens of Moscow could receive oxygen as a result of poor air quality caused by nearby fires. As a result of the drought, Russia, a major global wheat exporter, imposed a ban on the export of wheat. In North American, the price of wheat increased by 60% and in Mozambique, there were food riots and death caused by the increased in the price of wheat. We don’t know that the drought and fire intensity was caused by climate change, but they are consistent with the IPCC’s predictions.

Our food system is highly consolidated. Most communities are dependent on a global food supply, as over the last few decades we have lost family and mid-sized farms capable of supplying the diversity of crops needed to promote good nutrition and maintain health promoting social capital in rural communities. [235] [236] [237] Public health planners are recognizing the need not only to mitigate climate emissions but to develop adaptive strategies and resilience within ecosystems, communities and the public health infrastructure.[238] This applies to the structure and nature of our food production and distribution system.

Many hospital and health care leaders are calling for a transformation in the way or food is produced and distributed. Over 350 hospitals have signed the Healthy Food in Health Care Pledge, a commitment by hospitals to promote policies and practices that promote nutritious foods from sustainable food systems. The Kaiser Institute for Health Policy has published and distributed to health professionals a series of policy briefs on why health professionals should be engaged in agriculture policy. The American Medical Association conducted a series of webinars for health professionals on food and agriculture policy. In September 2010, Fletcher Allen Health Care, a hospital recognized nationally for healthcare delivery and support of nutrition and sustainable foods, hosted a national healthcare leadership food system workshop, with keynote by a nationally recognized climate change expert, Bill McKibben. Attendees were reminded that the healthcare business model and agriculture policy are oriented against health promotion, climate mitigation and adaptation. The following are some examples of hospitals promoting climate friendly food and nutrition policy, despite these obstacles.

Hospital Meat Reduction – Balanced Menus

Balanced Menus is a systematic approach to reduce the amount of meat protein in hospital food and a strategic pathway to serving the healthiest, most sustainably produced meat available. Through this initiative, hospitals commit to a 20% reduction in meat and poultry purchases over 12 months. Similar to other meat reduction initiatives such as Meatless Mondays, *Balanced Menus* was created to meet the needs of healthcare institution.

Like other institutions, hospitals purchase substantial amounts of meat, typically through large distributors who source from the U.S. commodity beef, pork and poultry markets. As the Balanced Menus program reminds us, "…there is a significant ecological cost associated with meat and poultry produced and distributed via our industrialized system including antibiotic resistance, arsenic, and hormones which further contaminate animal manure, polluting our air and water " [239], in addition to the climate footprint associated with animal production. Moreover, as Americans eat more than twice the global average of meat, and hospital food service follows this trend, hospitals can promote and educate about healthier eating habits by reducing their purchase of meat while mitigating their climate footprint.

The results, detailed in a report of the four hospitals engaged in a pilot program, were impressive. Together, these hospitals had reduced meat purchasing by an average of 28 percent and saved an annualized total of $402,000 on meat purchases. Moreover, these changes account for a reduction of 1,004 tons of CO2-equivalent GHG emissions per year, with 85% of the observed emissions reductions coming from beef.[240] Importantly, the program was generally well received by patients, staff and food service operators.

Plow to Plate – Healthcare at the Nexus of Food, Nutrition, Health and Education

In October 2006, a group of local physicians, chefs, farmers, nutritionists, public officials, and citizens concerned with the ill health and social effects of the existing food system in this country formed the Plow to Plate™ Community Coalition to promote local farms and food through a variety of activities. New Milford Hospital, which has a strong commitment to public health and the prevention of disease, agreed to provide leadership, administrative support and to obtain grant funding for the initiative. Plow to Plate™ became central to their mission as a community hospital. [241]

This initiative is multifaceted. It includes but is not limited to a community educational program, Healthy Food Learning Experiences, which involved farmers, chefs and doctors who discuss food production, preparation and nutrition. In a partnership with New Milford Youth Agency, which runs after school programs, they taught kids how to be peer advocates and peer navigators who educate about food preparation, health, and sustainable food systems. The hospital has become a regional model for changes in its food environment and its strong food and agricultural education and policy initiatives.

Healthcare Agriculture Policy Engagement and Food System "Anchors"

Fletcher Allen Health Care, Vermont

Fletcher Allen Health Care (FAHC) was an early signatory to the Healthy Food in Health Care pledge. Consistent with many institutions, they have implemented a nutrition plan, which includes more whole grain products, more fruits and vegetables, and healthier fats. Importantly, they also worked to reach out to more local producers to increase the amount of locally produced food they serve. FAHC has developed relationships with local vegetable, fruit, and beef producers, hosted Farmer's Luncheons at the hospital,l featuring local food. In August of 2007, their CEO communicated these initiatives across the state through a brochure included in the state's largest daily newspaper. In 2010, FAHC hosted a national food leadership workshop, with a keynote presentation on food system and climate change. FAHC recently launched the Center for Nutrition and Healthy Food Systems – with the goal of educating other health care institutions about sustainable food and announced their commitment to becoming **the most sustainable health care food service in the country.** As CEO Melinda Estes shares, 'it is important to talk about **WHY** we do all this and the reasons behind these efforts….**We do it because it improves the health of our patients and communities.** We feel strongly that the beginning of preventing disease -- as well as reducing the impact of disease -- starts with what you put in your mouth. It starts with how you approach diet and nutrition. Poor nutrition contributes to many chronic diseases and fatal illnesses. It is tied to the leading causes of death in this country. It is at the heart of our nation's obesity epidemic. As a health care organization and academic medical center, we have a responsibility to be leaders and models in this area – and teach others to do the same. With a sustainable food system, we can achieve multiple benefits, including improved nutrition, decreased resistance to antibiotics, climate change mitigation and the creation of vibrant, local communities. Sustainable food also has an impact on health care costs – as improving nutrition helps reduce the burden of chronic disease, one of the main drivers of health care costs." [242]

FAHC has reached out to physicians, their customers, local farm community, and the community in general, to involve them in helping achieve a goal of a strengthened food system. FAHC has supported Federal legislation that will help minimize the use of non-therapeutic antibiotics. FAHC now sources more than 30% local or sustainably produced food in their food service operations. Their engagement on agriculture and food policy and focus on obtaining locally-produced food and improvements in the socio-economic health of Vermont's farming community is central to the enhanced resilience of Vermont communities and food system.

Sacred Heart Hospital, Eau Claire, Wisconsin

Sacred Heart Hospital CEO Stephen Ronstrom believes that in five years his concept for bringing together farmers and institutional food buyers will go mainstream. Sacred Heart became the anchor for a wholesale cooperative when it committed to spending 10 percent of its $2 million annual food budget on local products. It purchases most of its beef, half its pork and one third of its chicken, through a local food cooperative it helped create. The hospital's local food purchases have included 11,000 pounds of beef, 2,400 pounds of pork and 12,000 pounds of chicken. Locally sourced meats have also included bison and fish (along with dairy products and fresh produce such as lettuce, strawberries and apples). The locally grown and processed meat is humanely raised in accordance with strict criteria that prohibit the use of hormones and antibiotics. The meat is also USDA inspected just like any bought through a large-scale food supplier. The hospitals perspective is that it better food safety and security are realized as result of the project because each order of meat delivered has the individual farm and animal and date clearly identified, allowing for immediate traceability. "Local food is good medicine for everyone," Ronstrom wrote in a 2008 newspaper editorial when the process was initiated. "It preserves and expands family farms, provides jobs in production and processing, and keeps money in our community."

Sugar Sweetened Beverage Elimination – Modeling Wellness

Fairview Hospital, a 25 bed Critical Access hospital in Great Barrington, MA is a national leader in health promotion through its adoption of comprehensive healthy food in healthcare policies and practices. In spring 2010, Fairview Hospital gained international recognition by adopting and implementing the first hospital policy to eliminate the sale of sugar sweetened beverages (SSB's). This step was consistent with the many other steps it has taken to provide ecologically healthy alternatives. The result, through the leadership of Fairview's CEO Eugene Dellea, was a complete change in the availability of these sugary beverages throughout the facility. Dellea stated, "As the leader of healthcare in the southern Berkshires, we are committed to creating a healthier community and will set the pace by influencing healthier lifestyle choices". Many hospitals considering changes to SSB or other food service policy have concerns about potential revenue impacts, employee complaints and consumer disatisfaction. Despite the potential challenges and lack of financial incentives, Dellea stood up for health.

Once the sodas were removed from all areas—cafeteria, catering, vending and patient menus, there seemed to be no noticeable change in sales revenue. While Fairview eliminated all SSB's in 2010, they do still offer diet sodas, diet iced tea, unsweetened iced tea, and bottled water (the only bottled water in the facility) via vending. The Cleveland Clinic and Glifford Hospital, NH, have adopted similar SSB policies with the Cleveland Clinic eliminating the sale of all add sugar snacks.

Summary

Over the last fifteen years, the healthcare community has been working to address the ecological health issues associated with the design, construction, and operations of healthcare buildings. We have experienced tremendous successes. For example, the sale and purchase of mercury containing medical equipment within the US healthcare sector is virtually phased out. This trend is now international, with mega cities such as Mexico City, Delhi, and Buenos Aires and countries such as Argentina and the Philippines that have eliminated mercury containing medical equipment sales. Within the United States, guidelines for the sustainable design, construction, and operation of healthcare facilities have been introduced and mandated in some states and/or cities.

US healthcare facilities are increasingly designed with the ecological health impacts to individuals, communities and the planet in mind. Examples abound. In 2009, Stony Brook University Hospital developed a memorandum of understanding with the US Environmental Protection Agency to work towards sustainable development as a healthcare institution, and agreed to numerous commitments, including recycling paper cardboard, bottles and cans; recycling computers and electronics, including toner and inkjet cartridges; reprocessing oxisensors, blades, burrs, bits, guide wires, and catheters, as well as investigating additional reprocessing opportunities; and reducing or eliminating mercury and DEHP/PVC containing products. [243]

The immediacy of the climate problem has helped to expand the focus of healthcare environmental issues from product toxicity, waste reduction, and green design to climate mitigation and adaptation. Education and awareness within the healthcare community about healthcare's climate change contribution and the predicted public health impacts that will ultimately result from climate change is expanding. As the healthcare community will be on the receiving end of the enormous public health burden associated with climate change, efforts to control healthcare costs require that we address not only healthcare's contribution to climate change but also contributions from society at large.

The American Medical Association recently passed a resolution supporting education and climate mitigation policy by physicians. The World Health Organization has published a report on key climate mitigation and adaptation strategies for the healthcare community. In response to this awareness, we are beginning to see engagement within healthcare community and the healthcare service industry promoting carbon reduction initiatives among healthcare customers. One US waste management company developed a Carbon Footprint Estimator designed to help any U.S. hospital determine the amount of plastic, associated cardboard containers, and CO2 emissions they would keep out of the environment by using reusable waste containers and avoiding the use of disposables.[244] In another, a large healthcare purchasing alliance is working to help its healthcare members by focusing on reducing energy costs and greenhouse gas emissions and related negative health effects, as well as increasing the use of cleaner, renewable energy. [245]

While these are important steps toward improving healthcare's carbon footprint, they ignore the urgency of the climate problem in the context of an ever increasing rise in healthcare spending. Prior to the 2010 Healthcare reform, the Congressional Budget Office estimated that total spending on health care would rise from 16 percent of gross domestic product (GDP) in 2007 to 25 percent in 2025, 37 percent in 2050, and 49 percent in 2082.[246] Clearly, regardless of how "green" or "efficient" future hospital hospitals and healthcare delivery will be, "more" is no longer ecologically or economically sustainable. Intuitively, we must ask whether we can afford continuous increases in healthcare spending, including reliance on increasingly expensive services and products geared at disease treatment, or if we will get serious about reducing the burden of preventable disease. As poor nutrition is at the heart of this burden, it is logical to begin with the agricultural system where nutrition begins.

Conclusions

We know that what and how we produce food are important for our health in the broadest sense. Despite its successes, our vertically-integrated, consolidated agricultural-industrial complex also produces and markets a large amount of food that is unhealthy and promotes disease, climate change, and other adverse environmental public health impacts.

The recent United Nations Millennium Ecosystem Assessment, provided a dire reminder of our connection to ecological processes, “At the heart of this assessment is a stark warning. Human activity is putting such strain on the natural functions of Earth that the ability of the planet’s ecosystems to sustain future generations can no longer be taken for granted.” The IPCC 2007 report provides an even more stark warning. Global warming is "unequivocal. “; climate change will bring "abrupt and irreversible changes”, unless we act within the next few years. The International Assessment of Agricultural Knowledge, Science, and Technology for Development (IAASTD) Synthesis Report, a consultative product of the United Nations and World Bank, makes clear not only the profound impact that agricultural activities can have on climate changing forces, as we have discussed, but also the fundamental dependence of agriculture on climate stability.[247] That is, as we force climate change though certain agricultural and other activities, we are undermining the functioning of the ecological systems that we rely on to produce our food and provide other services critical for public environmental health.

Clearly, we are beyond the point of “business as usual” in healthcare. One analysis estimates that by 2020 just diabetes and pre-diabetes will account for about 10 percent of total health care spending at **an annual cost of almost $500 billion.**[248] Not only is the economy at risk of bankruptcy because of the large and rapidly growing chronic disease burden but ecosystem services, also threatened by this economic activity, are nearing or in some cases, even beyond tipping points threatening their function. This should be wake-up call to healthcare leaders that continuous growth of the disease treatment business model is simply not sustainable. We need new models and new roadmaps forward.

Despite a healthcare business model that works against this transformation, we are witnessing the emergence of new healthcare food system leaders. It is important to recognize the integration of prevention, community health and environment in the new lexicon:

> **“Excellent care in our medical offices and hospitals isn’t enough; our members can’t be healthy if they live and work in unhealthy environments. Striving to make our communities healthier requires a commitment to environmental health”**
>
> Raymond J. Baxter, Ph.D, Senior Vice President, Community Benefit, Research and Health Policy
>
> **“Medical excellence can take Sacred Heart only so far. How could we extend our health system into prevention and wellness? And how could we do it in a way that was part of our geography?”**
>
> Steve Ronstrom, CEO Sacred Heart Hospital
>
> **“By breaking down barriers to accessing healthy food, we’re also having a positive effect on decreasing the rate of chronic disease in our community.”**
>
> Michael F. Roizen, MD, Chief Wellness Officer Cleveland Clinic

> **"With a sustainable food system, we can achieve multiple benefits, including improved nutrition, decreased resistance to antibiotics, climate change mitigation and the *creation of vibrant, local communities."***
>
> Melinda Estes, M.D, CEO Fletcher Allen Healthcare

The challenge is the limited window of time that the Intergovernmental Panel on Climate Change describes to us. We may not have all the answers we need, before we act, but that should not prevent us from moving forward on what we do know.

Clearly, significant vested interests in the economic status quo prefer that the system not change. These include players in the food and agriculture complex and many working throughout the supply chain of our disease treatment healthcare model. Perverse incentives support the existing systems. Diagnostic and therapeutic interventions are valued more than primary disease prevention. We promote and incentivize foods that are unhealthy and agricultural methods that threaten the health of many individuals and communities and lead to environmental degradation, including climate change.

The complexity of the system is challenging. The industrial agriculture food complex has taken advantage of multiple mechanisms for influencing the food choices of individuals, beginning early in life when food preferences are established. All too often, these choices are unhealthy. Nutritionists and other experts face a Sisyphean task as the system works against their efforts. If we are to influence individual behaviors, it must be done in the context of the transformation of our industrial food and agriculture system. As CDC director Tom Frieden has reminded us, the U.S. needs policy interventions that change the social and physical environments to make healthy dietary choices the default choice.

Clearly, the healthcare community has a vested interest in the development of climate legislation and changes in food and agriculture policy. Their engagement is essential if we are going to address meaningfully the common drivers of chronic disease. For example, the US Farm Bill which is the primary agricultural and food policy tool of the federal government and includes issues such as nutrition, food stamps, conservation programs, agriculture trade and more, will be reauthorized in 2012. The healthcare community can use this opportunity to help reshape the incentives and subsidies in the legislation to promote diets featuring less animal protein, fewer processed foods, and more fruit, vegetables, legumes and whole grains. Done right, the added benefit of climate change mitigation may also be realized.

Hopefully, the concepts discussed in this paper will suggest opportunities for healthcare and society more generally to design programs and interventions that solve multiple problems at the same time. The primary prevention of disease can be one of the outcomes, reducing the demand for resource-intensive medical services that also drive climate change. Healthy nutrition is among the core requirements of disease prevention strategies. And, as we have long known, food is medicine. How we grow food and what we grow profoundly impacts the health of individuals, communities and the planet.

Appendix A
Medical Expenditure Study
Table 3: Total Expenses and Percent Distribution for Selected Conditions by Type of Service: United States, 2007[249]

Conditions		Percent Distribution by Type of Service									
	Total Expenses (in millions)		Hospital Outpatient of Office Based Provider Visits		Hospital Inpatient Stays		Emergency Room Visits		Prescribed Medicines		Home Health
Cancer		44.5	43573	42.20	41321	0.80	783	9.60	9400	2.90	2840
Trauma-related disorders	83,177.63	37.6	31275	44.80	37264	12.00	9981	2.00	1664	3.60	2994
Heart conditions		16.7	13722	60.60	49793	4.70	3862	10.30	8463	7.70	6327
Mental disorders	97,916.88	22.1	13558	17.10	10490	1.60	982	42.60	26134	16.70	10245
COPD, asthma	51,085.14	21.1	10779	31.80	16245	3.60	1839	38.00	19412	5.50	2810
Diabetes mellitus	41,181.71	24	9884	19.10	7866	1.10	453	46.70	19232	9.10	3748
Hypertension	40,677.61	24	9763	15.20	6183	1.60	651	50.20	20420	9.00	3661
Osteoarthritis and other non-traumatic joint disorders	40,175.39	42	16874	25.80	10365	0.70	281	19.70	7915	11.70	4701
Normal birth/live born	33,353.25	28.1	9372	69.40	23147	1.50	500	0.80	267	0.20	67
Hyperlipidemia	31,475.91	23.3	7334	3.40	1070	0.40	126	70.40	22159	2.50	787
Back problems	30,467.10	60.6	18463	18.90	5758	2.80	853	14.60	4448	3.10	944
Disorders of the upper GI	25,272.95	20.4	5156	19.90	5029	4.10	1036	54.30	13723	1.30	329

Cerebrovascular disease	25,154.64	9.9	2490	71.00	17860	2.30	579	5.30	1333	11.50	2893
Kidney Disease	24,132.11	47.6	11487	37.20	8977	6.10	1472	5.50	1327	3.60	869
Skin disorders	22,296.27	37.5	8361	31.00	6912	3.60	803	20.50	4571	7.50	1672
Other circulatory conditions arteries, veins, and lymphatics	19,430.07	25.9	5032	60.90	11833	1.30	253	6.30	1224	5.60	1088
Other CNS disorders	19,270.04	54.4	10483	23.40	4509	4.70	906	9.20	1773	8.30	1599
Gallbladder, pancreatic, and liver disease	17,609.22	24.8	4367	65.40	11516	5.40	951	2.20	387	2.00	352
Systemic lupus and connective tissues disorders	16,036.72	61.6	9879	18.00	2887	2.40	385	12.10	1940	5.90	946
Residual Codes	15,927.79	31.1	4954	26.90	4285	0.90	143	34.00	5415	7.10	1131
Infectious diseases	15,911.51	29.8	4742	35.10	5585	4.60	732	28.30	4503	2.10	334
Other endocrine, nutritional & immune disorder	15,347.38	19.4	2977	42.50	6523	3.30	506	20.10	3085	14.70	2256
Pneumonia	14,918.84	6.3	940	81.90	12219	5.40	806	1.80	269	4.70	701
Other care and screening	14,456.58	30.1	4351	17.50	2530	0.20	29	49.30	7127	2.90	419
Other GI	12,891.42	28.6	3687	44.00	5672	5.30	683	18.70	2411	3.40	438
Other bone and musculoskeletal disease	12,512.79	32	4004	19.70	2465	0.10	13	31.60	3954	16.60	2077
Female genital disorders, and contraception	12,033.98	51	6137	21.40	2575	4.20	505	23.30	2804	0.00	0

Hereditary, degenerative and other nervous system disorders	11,032.98	24	2648	18.70	2063	0.10	11	51.30	5660	5.9	333.9
Acute Bronchitis and URI	10,466.49	54.3	5683	21.00	2198	6.40	670	17.20	1800	1.10	115
Congenital anomalies	9,966.66	31.5	3139	21.20	2113	1.20	120	2.80	279	43.30	4316
Epilepsy and convulsions	9,569.49	7	670	43.40	4153	5.70	545	23.70	2268	20.10	1923
Other eye disorders	8,676.08	72.1	6255	10.00	868	1.10	95	9.70	842	7.20	625
Headache	8,302.69	34.7	2881	9.70	805	14.40	1196	40.40	3354	0.80	66
Symptoms	7,626.18	28.1	2143	45.80	3493	14.80	1129	7.50	572	3.80	290
Hernias	7,291.98	41	2990	45.40	3311	2.90	211	8.90	649	1.70	124
Other stomach and intestinal disorders	7,187.20	21.4	1538	61.00	4384	5.10	367	10.10	726	2.50	180
Thyroid disease	6,263.38	42.6	2668	18.00	1127	0.10	6	31.60	1979	7.70	482
Cataract	6,163.54	94.9	5849	0.50	31	0.00	0	4.00	247	0.60	37
Non-malignant neoplasm	5,877.54	51.4	3021	46.10	2710	1.40	82	1.10	65	0.00	0
Urinary tract infections	5,786.08	25	1447	41.90	2424	13.40	775	13.20	764	6.40	370
Other urinary	5,090.93	42.5	2164	16.90	860	1.00	51	36.00	1833	3.60	183
Anemia and other deficiencies	4,913.53	35.3	1734	24.00	1179	1.10	54	36.40	1789	3.10	152
Male genital disorders	4,795.55	35.9	1722	30.20	1448	0.90	43	33.00	1583	0.00	0
Glaucoma	3,959.35	45.8	1813	0.00	0	0.00	0	45.50	1802	8.60	341
Intestinal infection	3,595.97	24.2	870	44.30	1593	19.50	701	11.00	396	1.00	36
Otitis media	3,365.58	76.5	2575	0.60	20	7.70	259	15.00	505	0.20	7
Allergic reactions	2,807.21	48	1347	16.30	458	10.60	298	25.10	705	0.00	0

Poisoning by medical and non-medical substances	2,466.53	16.2	400	57.70	1423	21.00	518	4.10	101	1.00	25
Complications of pregnancy and birth	2,380.82	33	786	44.80	1067	15.10	360	7.20	171	0.00	0
Hemorrhagic, coagulation, and disorders of White Blood cells	2,045.76	18.5	378	58.10	1189	2.50	51	16.40	336	4.50	92
Non-malignant breast disease	1,759.16	85.5	1504	8.30	146	3.60	63	2.10	37	0.60	11
Tonsillitis	1,331.44	68.5	912	24.70	329	3.40	45	3.40	45	0.00	0
Disorders of teeth and jaws	1,018.45	56.7	577	8.50	87	10.40	106	24.20	246	0.10	1
Influenza	478.89	64.1	307	4.40	21	8.20	39	23.30	112	0.00	0
Total 2007	1,020,446.66		331665		360378		3452		224223		9375
total 2002 dollars (.868)	885747.7009		287885		312808		2997		194626		8138
footprint			45		114		1		59		2
Total Footprint											221.31

Endnotes

[1] Smith-Spangler, Ann Int Med; 152(8): 481-7)
[2] Practice Greenhealth 2009 Award Metrics Benchmark Report A Practice Greenhealth Member Benefit October 2009
[3] Estimates adjusted to match the 1995, 1999, and 2003 CBECS definition of target population. More information available online: http://www.eia.doe.gov/emeu/cbecs/comparesampdesign.html
[4] Mensah, An Overview Of Cardiovascular Disease Burden In The United States Health Affairs, 26, no. 1 (2007): 38-48

[5] Lobell, D. B., G. Bala, and P. B. Duffy (2006), Biogeophysical impacts of cropland management changes on climate, *Geophys. Res. Lett.*, 33, L06708, doi:10.1029/2005GL025492
[6] http://www.ipcc.ch/publications_and_data/ar4/wg3/en/figure-ts-2.html
[7] http://www.ipcc.ch/publications_and_data/ar4/wg3/en/figure-ts-2.html
[8] http://www.epa.gov/climatechange/emissions/downloads/08_ES.pdf
[9] U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007, (Washington, DC, April 15, 2009).
[10] http://www.ifg.org/pdf/AgriBiz&Climate4-8.pdf
[11] http://motherjones.com/mojo/2010/01/ag-interests-renew-battle-against-climate-bill
[12] http://www.ipcc.ch/publications_and_data/ar4/wg3/en/figure-ts-2.html
[13] Smith P., D. Martino, Z. Cai, D. Gwary, H. Janzen, P. Kumar, B. McCarl, S. Ogle, F. O'Mara, C. Rice, B. Scholes, O. Sirotenko, M. Howden, T. McAllister, G. Pan, V. Romanenkov, U. Schneider, S. Towprayoon, M. Wattenbach, and J Smith (2008) Greenhouse gas mitigation in agriculture. Philosophical Transactions of the Royal Society, Biological Sciences. 363: 789–813.
[14] IPCC (2007) Climate Change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge, UK and New York, USA: Cambridge University Press.
[15] IPCC (2007) Climate Change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge, UK and New York, USA: Cambridge University Press
[16] Smith P., D. Martino, Z. Cai, D. Gwary, H. Janzen, P. Kumar, B. McCarl, S. Ogle, F. O'Mara, C. Rice, B. Scholes, O. Sirotenko, M. Howden, T. McAllister, G. Pan, V. Romanenkov, U. Schneider, S. Towprayoon, M. Wattenbach, and J Smith (2008) Greenhouse gas mitigation in agriculture. Philosophical Transactions of the Royal Society, Biological Sciences. 363: 789–813
[17] Desjardins, R.L.. The impact of agriculture on climate change. pp. 29-40 in NABC Report 21: Adapting Agriculture to Climate Change (2009) Edited by Alan Eaglesham & Ralph W.F. Hardy. Ithaca, NY: National Agriculture Biotechnology Council. http://nabc.cals.cornell.edu/pubs/nabc_21/NABC21_Module1_Dejardins.pdf
[18] Stehfest E, L. Bouwan, D.P. van Vuuren, M.G.J. den Elzen, B. Eickhout, and P. Kabat.. (2009) Climate benefits of changing diet Climatic Change In press DOI 10.1007/s10584-008-9534-6
[19] Lal R, J.M. Kimble, R.F. Follett and C.V. Cole (1998) The potential of U.S. cropland to sequester carbon and mitigate the greenhouse effect. Boca Raton: CRC Press.
[20] Lal R (2003) Global potential of soil carbon sequestration to mitigate the greenhouse effect. Critical Reviews in Plant Sciences 22 151–184
[21] Follett, R.F. 2007. Economic and Societal Benefits of Soil Carbon Management: Cropland and Grazing land Systems. Pp. 99-128. IN J.M. Kimble, C.W. Rice, D.R. Reed, S. Mooney, R.F. Follett and R. Lal (eds). Soil Carbon Management: Economic, Environmental, and Societal Benefits. CRC Press, Taylor and Francis Group.
[22] http://iatp.typepad.com/thinkforward/2011/01/a-climate-friendly-farm-bill.html
[23] IPCC (2007) Climate Change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge, UK and New York, USA: Cambridge University Press
[24] Lal R (2003) Global potential of soil carbon sequestration to mitigate the greenhouse effect. Critical Reviews in Plant Sciences 22 151–184
[25] Eshel and Martin (2006),
[26] Eshel, G., P. A. Martin, and E. E. Bowen 2010. Land Use and Reactive Nitrogen Discharge: Effects of Dietary Choices. Earth Interactions.

[27] Eshel, G., P. A. Martin, and E. E. Bowen. 2010. Land Use and Reactive Nitrogen Discharge: Effects of Dietary Choices. Earth Interactions.

[28] Willett, W. C., 2005: Eat, drink, and be healthy: The Harvard Medical School guide to healthy eating, New York: Free Press

[29] Eshel, G., P. A. Martin, and E. E. Bowen. 2010. Land Use and Reactive Nitrogen Discharge: Effects of Dietary Choices. Earth Interactions. P 14-15

[30] Peters, C. J., J.L. Wilkins, and G.W. Fick. (2007)Testing a complete-diet model for estimating the land resource requirements of food consumption and agricultural carrying capacity: The New York State example. Renewal Agriculture and Food Systems. 22: 146-153.

[31] Ludwig DS The glycemic index: physiological mechanisms relating to obesity, diabetes, and cardiovascular disease. JAMA. 2002 May 8; 287(18):2414-23.

[32] Ludwig DS, Majzoub JA, Al-Zahrani A, et al High Glycemic Index Foods, Overeating and Obesity *Pediatrics* 1999;103(3), e26.

[33]Shikany J, Tinker L, Neuhouser M, Ma Y, et al. Association of glycemic load with cardiovascular disease risk factors: the Women's Health Initiative Observational Study. Nutrition 2010 26(6):641-647.

[34] Salmeron J et al. Dietary fiber, glycemic load, and risk of non-insulin-dependent diabetes mellitus in women. JAMA 277(6):472-7, 1997.

[35] Salmeron J et al. Dietary fiber, gycemic load, and risk of NIDDM in men. Diabetes Care 20(4):545-550, 1997.

[36] Schulze MB et al. Glycemic index, glycemic load, and dietary fiber intake and incidence of type 2 diabetes in younger and middle-aged women. AMCN 80(2):348-56, 2004.

[37] Villegas R et al. Prospective study of dietary carbohydrates, glycemic index, glycemic load, and incidence of type 2 diabetes mellitus in middle-aged Chinese women. Archives of Internal Med 167(21):2310-2316, 2007.

[38] Liu S et al. A prospective study of dietary glycemic load, carbohydrate intake, and risk of coronary heart disease in US women. Am J Clin Nutr. 2000 Jun;71(6):1455-61A

[39] McKeown NM et al. Carbohydrate nutrition, insulin resistance and the prevalence of the metabolic syndrome in the Framingham Offspring Cohort. Diabetes Care 27(2):538-46**,** 2004.

[40] Wolever TMS et al The Canadian Trial of Carbohydrates in Diabetes (CCD), a 1-year controlled trial of low-glycemic-index dietary carbohydrate in type 2 diabetes: no effect on glycated hemoglobin but reduction in C-reactive protein. 2008, American Journal of Clinical Nutrition, Vol. 87, No. 1, 114-125.

[41] Liu S et al. Relation between a diet with a high glycemic load and plasma concentrations of high-sensitivity C-reactive protein in middle-aged women. AJCN 75:492-8, 2002.

[42] Griffith, JA et al. Association between dietary glycemic index, glycemic load, and high-sensitivity C-reactive protein. Nutrition. 2008 May;24(5):401-6.

[43]Pelucchi C, Bosetti C, Rossi M, Negri E, La Vecchia C. Selected aspects of Mediterranean diet and cancer risk. Nutr Cancer 2009 61(6):756-766.

[44] Sieri S, Krogh V, Berrino F, Evangelista A, et al. Dietary glycemic load and index and risk of coronary heart disease in a large Italian cohort: the EPICOR study. Arch Intern Med 2010 170(7):640-647.

[45] Rossi M, Lipworth L, Polesel J, et al. Dietary glycemic index and glycemic load and risk of pancreatic cancer: a case-control study. Ann Epidemiol 2010 20(6):460-465.

[46] Galeone C, Pelucchi C, Maso L. Glycemic index, glycemic load and renal cell carcinoma risk. Ann Oncol 2009 20(11):1881-1885.

[47]Larsson S, Berqkvist L, Wolk A. Glycemic load, glycemic index and breast cancer risk in a prospective cohort of Swedish women. Int J Cancer 2009 125(1):153-157

[48] Blanck H, Gillespie C, Kimmons J, Seymour J, Serdula M. Trends in fruit and vegetable consumption among U.S. men and women, 1994-2005. Prev Chronic Dis 2008; 5(2):A35.

[49]US Department of Health and Human Services. Dietary guidelines for Americans, 2005. 6th edition. Washington (DC): US Government Printing Office; 2005.

[50] Hung H, Joshipura K, Jiang R, et al. Fruit and vegetable intake and risk of major chronic disease. J Natl Cancer Inst 2004;96(21):1577-1584.

[51] Krauss RM, Eckel RH, Howard B, Appel LJ, Daniels SR, Deckelbaum RJ, et al. AHA Dietary Guidelines: a statement for health care professionals from the Nutrition Committee of the American Heart Association. Circulation 2000;102(18):2284-99

[52] Beydoun MA, Kaufman JS, Satia JA, Rosamond W, Folsom AR. Plasma n-3 fatty acids and the risk of cognitive decline in older adults: the Atherosclerosis Risk in Communities Study. Am J Clin Nutr. 2007 85(4):1103-11.

[53] Dai, Q, Borenstein, AR, Wu, Y, et al. Fruit and vegetable juices and Alzheimer's disease: the Kame Project. Am J Med 2006; 119:751.
[54] Morris, MC, Evans, DA, Tangney, CC, et al. Associations of vegetable and fruit consumption with age-related cognitive change. Neurology 2006; 67:1370.
[55] Kang, J, Ascherio, A, Grodstein, F. Fruit and vegetable consumption and cognitive decline in aging women. Ann Neurol 2005; 57:713.
[56] Ortega, R, Requejo, A, Andres, P, et al. Dietary intake and cognitive function in a group of elderly people. Am J Clin Nutr 1997; 66:803.
[57] Lee, L, Kang, SA, Lee, HO, et al. Relationships between dietary intake and cognitive function level in Korean elderly people. Public Health 2001; 115:133.
[58] Simopoulos AP. The omega-6/omega-3 fatty acid ratio, genetic variation, and cardiovascular disease. Asia Pac J Clin Nutr. 2008;17 Suppl 1:131-134.
[59] Simopoulos AP. The importance of the ratio of omega-6/omega-3 essential fatty acids.
Biomed Pharmacother. 2002 Oct;56(8):365-379.
[60] Willett WC. The role of dietary n-6 fatty acids in the prevention of cardiovascular disease. J Cardiovasc Med (Hagerstown). 2007 Sep;8 Suppl 1:S42-45.
[61] Wood J, Enser M, Fisher A, et al. Manipulating meat quality and composition. Proc Nutr Soc 1999 58(2):363-370.
[62] Lee J, Hwang D. The modulation of inflammatory gene expression by lipids: mediation through Toll-like receptors. Mol Cells. 2006 21(2):174-185.
[63] Erridge C, Samani N. Saturated fatty acids do not directly stimulate Toll-like receptor signaling. Arterioscler Thromb Vasc Biol 2009 29(11):1944-1999.
[64] Morris MC, Evans DA, Bienias JL, Tangney CC, Bennett DA, Aggarwal N, Schneider J, Wilson RS.
Dietary fats and the risk of incident Alzheimer disease. Arch Neurol. 2003 Feb;60(2):194-200. Erratum in: Arch Neurol. 2003 Aug;60(8):1072.
[65] Luchsinger JA, Tang MX, Shea S, Mayeux R. Caloric intake and the risk of Alzheimer disease.
Arch Neurol. 2002 Aug;59(8):1258-63.
[66] Kalmijn S, Launer LJ, Ott A, Witteman JC, Hofman A, Breteler MM. Dietary fat intake and the risk of incident dementia in the Rotterdam Study. Ann Neurol. 1997 Nov;42(5):776-82.
[67] Engelhart MJ, Geerlings MI, Ruitenberg A, Van Swieten JC, Hofman A, Witteman JC, Breteler MM.
Diet and risk of dementia: Does fat matter?: The Rotterdam Study. Neurology. 2002 59(12):1915-1921.
[68] Greenwood CE, Winocur G. Cognitive impairment in rats fed high-fat diets: a specific effect of saturated fatty-acid intake. Behav Neurosci. 1996 Jun;110(3):451-9.
[69] Mozaffarian D, Micha R, Wallace S. Effects on coronary heart disease of increasing polyunsaturated fat in place of saturated fat: a systematic review and meta-analysis of randomized controlled trials. PLoS Med. 2010 7(3):e1000252.
[70] Zatonski W, Campos H, Willett W (2008) Rapid declines in coronary heart disease mortality in Eastern Europe are associated with increased consumption of oils rich in alpha-linolenic acid. Eur J Epidemiol 23: 3–10.
[71]McEwen B. Morel-Kopp M, Tofler G, Ward C. Effect of omega-3 fish oil on cardiovascular risk in diabetes. Diabetes Educ 2010 Jun 9 (Epub ahead of print)
[72] Morris, MC. Diet and Alzheimer's Disease: what the evidence shows. MedGenMed, 6(1): 1-5, 2004.
[73]van Gelder B, Tijhuis M, Kalmijn S, et al. Fish consumption, n-3 fatty acids, and subsequent 5-y cognitive decline in elderly men: the Zutphen Elderly Study. Am J Clin Nutr. 2007 85(4):1142-1147.
[74] Freund-Levi Y, Basun H, Cederholm T, et al. Omega-3 supplementation in mild to moderate Alzheimer's disease: effects on neuropsychiatric symptoms. Int J Geriatr Psychiatry. 2008 23(2):161-169.
[75] Freund-Levi Y, Eriksdotter-Jönhagen M, Cederholm T, et al. Omega-3 fatty acid treatment in 174 patients with mild to moderate Alzheimer disease: OmegAD study: a randomized double-blind trial. Arch Neurol. 2006 63(10):1402-1408.
[76] Schaefer E, Bongard V, Beiser A, Lamon-Fava S, et al. Plasma phosphatidylcholine docosahexaenoic acid content and risk of dementia and Alzheimer disease: the Framingham heart study. Arch Neurol 2006;63:1545–1550.
[77] Morris M, Evans D, Tangney C, et al. Fish consumption and cognitive decline with age in a large community study. Arch Neurol. 2005; 62(12):1849-1853.
[78] Kalmijn S, van Boxtel M, Ocké M, et al. Dietary intake of fatty acids and fish in relation to cognitive performance at middle age. Neurology. 2004; 62(2):275-80.
[79] Heude B, Ducimetière P, Berr C; EVAStudy. Cognitive decline and fatty acid composition of erythrocyte membranes--The Study. J Clin Nutr. 2003 Apr;77(4):803-808.
[80] Morris M, Evans D, Bienias J, et al. Consumption of fish and n-3 fatty acids and risk of incident Alzheimer disease. Arch Neurol. 2003;60(7):940-946.

[81] Tully A, Roche H, Doyle R, et al. Low serum cholesteryl ester-docosahexaenoic acid levels in Alzheimer's disease: a case-control study. Br J Nutr. 2003 89(4):483-489.
[82] Laurin D, Verreault R, Lindsay J, et al. Omega-3 fatty acids and risk of cognitive impairment and dementia. J Alzheimers Dis. 2003; 5(4):315-322.
[83] Engelhart M, Geerlings M, Ruitenberg A, et al. Diet and risk of dementia: Does fat matter?: The Rotterdam Study. Neurology. 2002; 59(12):1915-1921.
[84] Barberger-Gateau P, Letenneur L, Deschamps V, et al. Fish, meat, and risk of dementia: cohort study. BMJ. 2002; 325(7370):932-933.
[85] Conquer J, Tierney M, Zecevic J et al, Fatty acid analysis of blood plasma of patients with disease, other types of dementia, and cognitive impairment. Lipids. 2000; 35(12):1305-1312.
[86] Kalmijn S, Launer L, Ott A,et al. Dietary fat intake and the risk of incident dementia in the Rotterdam Study. Ann Neurol. 1997; 42(5):776-782.
[87] Kalmijn S, Feskens E, Launer L, et al. Polyunsaturated fatty acids, antioxidants, and cognitive function in very old men. Am J Epidemiol. 1997; 145(1):33-41.
[88] Middleton L, Yaffe K. Promising strategies for the prevention of dementia. Arch Neurol 2009 66(10):1210-1215.
[89] Cole G, Ma Q, Frautschy S. Omega-3 fatty acids and dementia. Prostaglandins Leukot Essent Fatty Acids 2009 81(2-3):213-221.
[90] Devore E, Grodstein F, van Rooij F, et al. Dietary intake of fish and omega-3 fatty acids in relation to long-term dementia risk. Am J Clin Nutr 2009; 90(1):170176.
[91] Summers L, Fielding B, Bradshaw H, et al. (2002) Substituting dietary saturated fat with polyunsaturated fat changes abdominal fat distribution and improves insulin sensitivity. Diabetologia 45: 369–377.
[92] Salmeron J, Hu FB, Manson JE, Stampfer MJ, Colditz GA, et al. (2001) Dietary fat intake and risk of type 2 diabetes in women. Am J Clin Nutr 73: 1019–1026.
[93] Stein J, Schettler T, Rohrer B, Valenti M. Environmental Threats to Healthy Aging: With a Closer Look at Alzheimer's and Parkinson's Diseases. Greater Boston Physicians for Social Responsibility and Science and Environmental Health Network. Boston, MA, 2008. Available at: www.agehealthy.org
[94] Wang Y, Beydouin M. The obesity epidemic in the United States—gender, age, socioeconomic, racial/ethnic, and geographic characteristics: a systematic review and meta-regression analysis. Epidemiol Rev. 2007; 29:6-28.
[95] Centers for Disease Control and Prevention. Overweight and obesity. Available at: http://www.cdc.gov/nccdphp/dnpa/obesity/. Accessed April 2, 2010.
[96] Kivipelto M et al. Obesity and vascular risk factors at midlife and the risk of dementia and Alzheimer disease. Arch Neurol 2005;62:1556-1560
[97] Reeves GK, Pirie K, Beral V, et al. Cancer incidence and mortality in relation to body mass index in the Million Women Study: cohort study. BMJ 2007;335:1134.
[98] Renehan AG, Tyson M, Egger M, Heller RF, Zwahlen M. Bodymass index and incidence of cancer: a systematic review and meta-analysis of prospective observational studies. Lancet 2008; 371:569–78.
[99] CDC http://www.cdc.gov/diabetes/pubs/pdf/ndfs_2007.pdf Accessed March 29, 2010.
[100] Centers for Disease Control and Prevention. Diabetes Projects. Available at: http://www.cdc.gov/diabetes/projects/cda2.htm. Accessed May 30, 2008.
[101] http://www.who.int/mediacentre/factsheets/fs172/en/index.html
[102] Centers for Disease Control and Prevention. Achievements in Public Health, 1900-1999: Decline in Deaths from Heart Disease and Stroke -- United States, 1900-1999. Available at. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm4830a1.htm. Accessed December 3, 2007.
[103] Centers for Disease Control and Prevention. National Center for Heath Statistics. Available at: http://www.cdc.gov/nchs/fastats/lcod.htm Accessed July 5, 2008.
104Bruce K, Byrne C. The metabolic syndrome: common origins of a multifactorial disorder. Postgrad Med J 2009;85(1009):614-21.

[105] Ford ES et al. prevalence of the metabolic Syndrome among us adults. Findings from the third national health and nutrition examination survey. JAMA 287:356-9, 2002.
[106] Razay, G, Vreugdenhil, A, Wilcock, G. The metabolic syndrome and Alzheimer disease. Arch Neurol 2007; 64:93.
[107] Kalmijn, S, Foley, D, White, L, et al. Metabolic cardiovascular syndrome and risk of dementia in Japanese-American elderly men. The Honolulu-Asia aging study. Arterioscler Thromb Vasc Biol 2000; 20:2255.
[108] Yaffe, K, Kanaya, A, Lindquist, K, et al. The metabolic syndrome, inflammation, and risk of cognitive decline. JAMA 2004; 292:2237.

[109] Yaffe K, Haan M, Blackwell T, Cherkasova E, Whitmer RA, West N. Metabolic syndrome and cognitive decline in elderly Latinos: findings from the Sacramento Area Latino Study of Aging study.
[110] Meigs, James B. **The metabolic syndrome (insulin resistance syndrome or syndrome X)** In UpToDate online medical text. UpToDate.com Accessed 8/13/08.
[111] U.S. Department of Health and Human Services, Administration on Aging. Available at: http://nihseniorhealth.gov/alzheimersdisease/defined/01.html. Accessed June 2, 2008.
[112] Hebert LE, Scherr PA, Bienias JL, Bennett DA, Evans DA. Alzheimer disease in the US population: prevalence estimates using the 2000 census. Arch Neurol. 2003 Aug;60(8):1119-22.
[113] Riley KP et al. "Alzheimer's Neurofibrillary Pathology and Spectrum of Cognitive Function: Findings from the Nun Study" Ann Neurol 2002;51:567-577.
[114] Bennett DA, Schneider JA, Arvanitakis Z, Kelly FJ, Aggarwal NT, Shah RC, Wilson RS. Neuropathology of older persons without cognitive impairment from two community-based studies. Neurology. 2006; 66:1837-1844.
[115] Biessels GJ; Staekenborg S; Brunner E et al. Risk of dementia in diabetes mellitus: a systematic review. Lancet Neurol. 2006 Jan;5(1):64-74.
[116] Shadlen MF et al. Risk factors for dementia. UpToDate online medical reference text. Uptodate.com Referenced 6/27/08.
[117] Gustafson D. Adiposity indices and dementia. Lancet Neurol. 2006 Aug;5(8):713-20. Review.
[118] Kivipelto M et al. Obesity and vascular risk factors at midlife and the risk of dementia and Alzheimer disease. Arch Neurol 2005;62:1556-1560.
[119] Gustafson DR, Rothenberg E, Blennow K, Steen B, Skoog I. An 18-year follow up of overweight and risk for Alzheimer's disease. *Arch Intern Med* 2003; 163: 1524–28.
[120] Rosengren A, Skoog I, Gustafson D, Wilhelmsen L. Body mass index, other cardiovascular risk factors, and hospitalization for dementia. *Arch Intern Med* 2005; 165: 321–26
[121] Luchsinger JA, Patel B, Tang MX, Schupf N, Mayeux R. Measures of adiposity and dementia risk in elderly persons. Arch Neurol. 2007 Mar;64(3):392-8.
[122] Whitmer RA, Gunderson EP, Barrett-Connor E, Quesenberry CP Jr, Yaffe K. Obesity in middle age and future risk of dementia: a 27 year longitudinal population based study. BMJ. 2005 Jun 11;330(7504):1360. Epub 2005 Apr 29.
[123]Naderali E, Ratcliffe S, Dale M. Obesity and Alzheimer's disease: a link between body weight and cognitive function in old age. Am J Alzheimers Dis Other Demen 2009 24(6):445-449.
[124] Solomon A, Kåreholt I, Ngandu T, et al. Neurology. 2007 Mar 6;68(10):751-6. Serum cholesterol changes after midlife and late-life cognition: twenty-one-year follow-up study.
[125] Whitmer RA, Sidney S, Selby J, et al. Neurology. 2005 Jan 25;64(2):277-81. Midlife cardiovascular risk factors and risk of dementia in late life.
[126] Mielke M, Zandi P, Shao H, Waern, M et al. The 32-year relationship between cholesterol and dementia from midlife to late life. Neurology 2010 Nov 10. [Epub ahead of print]
[127] http://www.climateandhealthcare.org/uploads/docs/200901_UK_NHS_carbon_reduction.pdf
[128] http://www.climateandhealthcare.org/uploads/docs/200901_UK_NHS_carbon_reduction.pdf pg 30
[129] http://www.climateandhealthcare.org/uploads/docs/200901_UK_NHS_carbon_reduction.pdf pg 31
[130] http://www.climateandhealthcare.org/uploads/docs/200901_UK_NHS_carbon_reduction.pdf pg 31
[131] Chung, J., Meltzer, D., Research Letter: Estimate of the Carbon Footprint of the US Health Care JAMA Vol. 302 No. 18, November 11, 2009
132 Anesth Analg. 2010 Jul;111(1):92-8. Epub 2010 Jun 2.Global warming potential of inhaled anesthetics: application to clinical use. Ryan SM, Nielsen CJ
[133] http://www.guardian.co.uk/environment/green-living-blog/2010/jun/03/carbon-footprint-healthcare
[134] Sustainable Trials Study Group. Towards sustainable clinical trials. *BMJ*2007; 334: 671–73.
135 http://www.reuters.com/article/idUSTRE6303CU20100401
[136] Forman J, Stampfer M, Curhan G. Diet and lifestyle risk factors associated with incident hypertension in women. JAMA 2009, 302(4):401-411.
[137] Willett W, Trichopoulos D. Nutrition and cancer: A summary of the evidence. Cancer Causes Control 1996, 7(1):178-180
[138] Iqbal R, Anand S, Ounpuu S, Islam S, et al. Dietary patterns and the risk of acute myocardial infarction in 52 countries: results of the INTERHEART study. Circulation 2008 118(19):1929-1937.
[139] Costacou T, Mayer-Davis E. Nutrition and prevention of type 2 diabetes. Annu Rev Nutr 2003 23:147-170.
[140] US Department of Health and Human Services, Agency for Health Care Research and Quality Medical Expenditure Panel Survery 2007

http://meps.ahrq.gov/mepsweb/data_stats/tables_compendia_hh_interactive.jsp?_SERVICE=MEPSSocket0&_PROGRAM=MEPSPGM.TC.SAS&File=HCFY2008&Table=HCFY2008_CNDXP_C&_Debug= accessed January 30, 2011

[141] J Sch Nurs. 2008 Feb;24(1):3-12. The role of sugar-sweetened beverage consumption in adolescent obesity: a review of the literature. Harrington S.

[142] Harrington S., The role of sugar-sweetened beverage consumption in adolescent obesity: a review of the literature, J Sch Nurs. 2008 Feb;24(1):3-12

[143] Babey SH, Jones M, Yu H, Goldstein H, Bubbling over: soda consumption and its link to obesity in California. 2009 Sep.

[144] Babey SH, Jones M, Yu H, Goldstein H, Bubbling over: soda consumption and its link to obesity in California,. 2009 Sep.

[145] http://www.sfphes.org/Sweetened_Beverage_Nexus.htm, accessed January 30, 2011

[146] http://www.cdc.gov/obesity/causes/economics.html accessed January 30, 2011

[147] http://www.beverage-digest.com/pdf/top-10_2010.pdf accessed January 30, 2011

[148]http://www.google.com/publicdata?ds=uspopulation&met=population&tdim=true&dl=en&hl=en&q=us+population accessed January 30, 2011

[149] http://www.environmentalleader.com/2009/03/09/coca-cola-uk-details-carbon-footprint/ accessed January 30, 2011

[150] http://www.iatp.org/iatp/publications.cfm?accountID=258&refID=98598 accessed January 30, 2011

[151] *Sharon Friel, Alan D Dangour, Tara Garnett, Karen Lock, Zaid Chalabi, Ian Roberts, Ainslie Butler, Colin D Butler, Jeff Waage, Anthony J McMichael, Andy Haines* Health and Climate Change 4 Public health benefi ts of strategies to reduce greenhouse-gas emissions: food and agriculture *Lancet* 2009; 374: 2016–25 Published Online November 25, 2009

[152] http://www.chronicdiseaseimpact.com/ebcd.taf?cat=disease&type=heart accessed January 30, 2011

[153] Patrick Canning, Ainsley Charles, Sonya Huang, Karen R. Polenske, and Arnold Waters Energy Use in the U.S. Food System, Economic Research Service Economic Research Report Number 94 March 2010

[154] http://trade.gov/td/ocg/report08_processedfoods.pdf

[155] Wallinga, D., Agricultural Policy And Childhood Obesity: A Food Systems And Public Health Commentary Health Affairs 29, NO. 3 (2010): 404–409

[156] Drewnowski A, Specter SE. Poverty and obesity: the role of energy density and energy costs. Am J Clin Nutr. 2004;79:6–16.

[157] Monsivais P, Drewnowski A. The rising cost of low-energy-density foods. J Am Diet Assoc. 2007;107 (12):2071–6.

[158] Wallinga, D., Agricultural Policy And Childhood Obesity: A Food Systems And Public Health Commentary HEALTH AFFAIRS 29, NO. 3 (2010): 404–409

[159] *Kirsten Bibbins-domingo, Glenn M Chertow, Pamela G Coxson, Andrew Moran*, et al., Projected Effect of Dietary Salt Reductions on Future Cardiovascular Disease, **The New England Journal of Medicine**. Boston: Feb 18, 2010. Vol. 362, Iss. 7; pg. 590

[160] http://www.medpagetoday.com/PrimaryCare/DietNutrition/19659 accessed January 30, 2011

[161] Strategies to Reduce Sodium Intake in the United States.Institute of Medicine (US) Committee on Strategies to Reduce Sodium Intake; Henney JE, Taylor CL, Boon CS, editors. Washington (DC): National Academies Press (US); 2010 page 5-4

[162]Bibbins-domingo K, Chertow G, Coxson P, Moran A, et al., Projected Effect of Dietary Salt Reductions on Future Cardiovascular Disease, New Engl J Med, 2010; 362(7):590-599

[163] Jacqueline L Webster, Elizabeth K Dunford, and Bruce C Neal **A systematic survey of the sodium contents of processed foods,** Am. J. Clinical Nutrition, Feb 2010; 91: 413 - 420.

[164] Basu R, Ostro B. A multicounty analysis identifying the populations vulnerable to mortality associated with high ambient temperature in California. Am J Epidemiol 2008 168(6):632-637.

[165] US EPA; http://downloads.climatescience.gov/sap/sap4-6/sap4-6-final-report-all.pdf accessed January 30, 2011

[166] Basu R, Feng W, Ostrow B. Characterizing temperature and mortality in nine California counties. Epidemiol 2008 19(1):138-145.

[167] O'Neill M, Zanobetti A, Schwartz J. Disparities by race in heat-related mortality in four US cities: the role of air conditioning prevalence. J Urban Health 2005 82(2):191-197.

[168]US EPA Climate change. Health and Environmental Effects. Available at http://www.epa.gov/climatechange/effects/health.html accessed January 30, 2011

[169] Hales S, de Wet N, Maindonald J, Woodward A Potential effect of population and climate changes on global distribution of dengue fever: an empirical model. Lancet. 2002 Sep 14;360(9336):830-4.

[170] Mokdad A, Marks J, Stroup D, Gerberding J. Actual causes of death in the United States, 2000. *JAMA.* 2004; 291:1238-1245 (original study). Mokdad A, Marks J, Stroup D, Gerberding J. Correction: Actual causes of death in the United States, 2000 (letter). *JAMA.* 2005; 293(3): 293-294 (correction of original study).

[171] Institute of Medicine. *Preventing childhood obesity: Health in the balance*. Washington, DC: National Academy Press; 2005.
[172] Institute of Medicine, National Research Council. *Local government actions to prevent childhood obesity*. Washington, DC: National Academy Press; 2009.
[173] Keener D, Goodman K, Lowry A, Zaro S, Kettel Khan L. Recommended community strategies and measurements to prevent obesity in the United States: Implementation and measurement guide. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 2009.
[174] National Summit on Obesity: Building a plan to reduce obesity in America. Executive summary and key recommendations- October 2004. *AMA.* Available at: http://www.ama-assn.org/ama1/pub/upload/mm/433/exec_sum.pdf Accessed November 29, 2010.
[175] Kahn R, Robertson R, Smith R, Eddy D. The impact of prevention on reducing the burden of cardiovascular disease. Circulation. (2008); 118:576-585.
[176] Esselstyn C. Is the present therapy for coronary artery disease the radical mastectomy of the twenty-first century? Amer J Cardiol (2010);106(6):902-904. Available at http://www.heartattackproof.com/Esselstyn_Caldwell_Article.pdf Accessed Sept 24,2010.
[177] Trust for America's Health. Prevention for a healthier America: Investments in disease prevention yield significant savings, stronger communities. Washington, DC: Trust for America's Health; 2008.
[178] US Department of Agriculture, US Department of Health and Human Services, Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2010. Washington DC, 2010
[179] de Lorgeril M, Salen P, Martin JL, Monjaud I, Delaye J, Mamelle N. Mediterranean diet, traditional risk factors, and the rate of cardiovascular complications after myocardial infarction: final report of the Lyon Diet Heart Study. Circulation. 1999 ; 99(6):779-85.
[180] van Dam RM, Rimm EB, Willett WC, Stampfer MJ, Hu FB. Dietary patterns and risk for type 2 diabetes mellitus in U.S. men. Ann Intern Med. 2002 Feb 5;136(3):201-9.
[181] Panagiotakos DB, Tzima N, Pitsavos C, Chrysohoou C, Zampelas A, Toussoulis D, Stefanadis C.
J Am Coll Nutr. 2007 Feb;26(1):32-8. The association between adherence to the Mediterranean diet and fasting indices of glucose homoeostasis: the ATTICA Study.
[182] Esposito K, Marfella R, Ciotola M, Di Palo C, Giugliano F, Giugliano G, D'Armiento M, D'Andrea F, Giugliano D. Effect of a mediterranean-style diet on endothelial dysfunction and markers of vascular inflammation in the metabolic syndrome: a randomized trial. JAMA. 2004 Sep 22;292(12):1440-6.
[183] Giugliano D, Esposito K. Mediterranean diet and metabolic diseases. Curr Opin Lipidol. 2008 Feb;19(1):63-8. Review.
[184] Estruch R, Martínez-González MA, Corella D, Salas-Salvadó J et al. Ann Intern Med. 2006 Jul 4;145(1):1-11. Effects of a Mediterranean-style diet on cardiovascular risk factors: a randomized trial.
[185]Babio N, Bullo M, Salas-Salvado J. Mediterranean diet and metabolic syndrome: the evidence. Public Health Nutr 2009 12(9A):1607-1617.
[186] Martinez-Gonzalez M, Bes-Rastrollo M, Serra-Majem L, Lairon D, et al Mediterranean food pattern and the primary prevention of chronic disease: recent developments. Nutr Rev 2009 67(suppl 1): S111-116.
[187] Diabetes Prevention Program Research Group. 10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program outcomes study. *Lancet*. 2009; 374: 1677-86.
[188] Gillies CL, Abrams KR, Lambert PC, et al. Pharmacological and lifestyle interventions to prevent or delay type 2 diabetes in people with impaired glucose tolerance: systematic review and meta-analysis. BMJ 2007;334:299.
[189] Simmons R, Unwin N, Griffin S. International Diabetes Federation: An update of the evidence concerning the prevention of type 2 diabetes. Diabetes Res Clin Pract 2010 87(2):143-149.
[190] Lloyd-Jones DM, Hong Y, Labarthe D, et al. Defining and setting national goals for cardiovascular health promotion and disease reduction: The American Heart Association's Strategic Impact Goal through 2020 and Beyond. AHA Special Report. *Circulation*. Available at: https://circ.ahajournals.org. Accessed November 29, 2010.
[191] Frieden TR, Dietz W, Collins J. Reducing childhood obesity through policy change: Acting now to prevent obesity. *Health Affairs*. 2010; 29(3): 357-363.
[192] Smedley BD, Syme SL. Institute of Medicine. *Promoting health: Intervention strategies from social and behavioral research.* Washington, DC: National Academy Press; 2000.
[193] Brownell KD, Horgen KB. Food fight: The inside story of the food industry, America's obesity crisis & what we can do about it. New York, NY: McGraw-Hill Companies, Inc.; 2004.
[194] Nestle M. *Food politics: How the food industry influences nutrition and health*. Berkeley, Los Angeles, CA: University of California Press; 2002.

[195] Finkelstein, EA, Zuckerman L. The flattening of America: How the economy makes us fat, if it matters, and what to do about it. Hoboken, NJ: John Wiley & Sons, Inc.; 2008.
[196] Cohen L, Chavez V, Chehimi S. Prevention Institute. Chapter 12: Creating healthy food environments to prevent chronic disease in *Prevention is primary: Strategies for community well-being. Second Ed*. San Francisco, CA: Jossey-Bass; 2010. 291-321.
[197] Brownell KD, Horgen KB. Food fight: The inside story of the food industry, America's obesity crisis & what we can do about it. New York, NY: McGraw-Hill Companies, Inc.; 2004.
[198] Nestle M. *Food politics: How the food industry influences nutrition and health*. Berkeley, Los Angeles, CA: University of California Press; 2002.
[199] Farley T, Cohen DA. *Prescription for a healthy nation: A new approach to improving our lives by fixing our everyday world*. Boston, MA: Beacon Press; 2005.
[200] Clauson, Annette, and Ephraim Leibtag. *Food CPI, Prices, and Expenditures Briefing Room*, Table 12, U.S. Department of Agriculture,Economic Research Service, 2008, http://www.ers.usda.gov/Briefi ng/CPIFoodAndExpenditures/.
[201] Block, G. (2004). Foods contributing to energy intake in the U.S.: Data from NHANES III and NHANES 1999-2000. Journal of Food Composition and Analysis, 17, 439–447.
[202] Reedy J, Krebs-Smith SM. Dietary sources of energy, solid fats, and added sugars among children and adolescents in the United States. *J Am Diet Assoc.* 2010.
[203] Finkelstein, EA, Zuckerman L. The flattening of America: How the economy makes us fat, if it matters, and what to do about it. Hoboken, NJ: John Wiley & Sons, Inc.; 2008.
[204] Mancino L, Todd JE, Guthrie J, Lin BH. United States Department of Agriculture. How food away from home affects children's diet quality. *USDA*. Available at: http://www.ers.usda.gov/Publications/ERR104/ERR104.pdf. Accessed October 10, 2010.
[205] Farley T, Cohen DA. Prescription for a healthy nation: A new approach to improving our lives by fixing our everyday world. Boston, MA: Beacon Press; 2005.
[206] Yale Rudd Center for Food Policy & Obesity. Food marketing to youth. *Yale Rudd Center for Food Policy & Obesity*. Available at: http://www.yaleruddcenter.org/what_we_do.aspx?id=4. Accessed December 24, 2010.
[207] Institute of Medicine. *Food marketing to children and youth: Threat or opportunity?* Washington, DC: National Academy Press; 2006.
[208] Harris JL, Schwartz MB, Brownell KD. Fast Food f.a.c.t.s.: Evaluating fast food nutrition and marketing to youth. *Yale Rudd Center for Food Policy & Obesity*. Available at: http://www.fastfoodmarketing.org. Accessed December 24, 2010.
[209] Harris JL, Schwartz MB, Brownell KD. Fast Food f.a.c.t.s.: Evaluating fast food nutrition and marketing to youth. *Yale Rudd Center for Food Policy & Obesity*. Available at: http://www.fastfoodmarketing.org. Accessed December 24, 2010.
[210] Treuhaft S, Karpyn A. PolicyLink, The Food Trust. *The grocery gap: Who has access to healthy food and why iIt matters*. New York, NY: PolicyLink; 2010.
[211] Morland K, Wing S, Diez Roux A, Poole C. Neighborhood characteristics associated with the location of food stores and food service places. *Am J Prev Med.* 2002;22(1):23–29.
[212] Morland K and Filomena, S. Disparities in the availability of fruits and vegetables between racially segregated urban neighborhoods. *Public Health Nutrition*. 2007;10(12):1481-9.
[213] Larson, NI, Story MT, and Nelson MC. Neighborhood environments: Disparities in access to healthy foods in the U.S. *Am J of Prev Med*. 2009; 36(1): 74-81.
[214] Larson, NI, Story MT, and Nelson MC. Neighborhood environments: Disparities in access to healthy foods in the U.S. *Am J of Prev Med*. 2009; 36(1): 74-81.
[215] *Designed for disease: The link between local food environments and obesity and diabetes.* California Center for Public Health Advocacy, PolicyLink, and the UCLA Center for Health Policy Research; April 2008.
[216] Keener D, Goodman K, Lowry A, Zaro S, Kettel Khan L. Recommended community strategies and measurements to prevent obesity in the United States: Implementation and measurement guide. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 2009.
[217] Institute of Medicine. *Preventing childhood obesity: Health in the balance*. Washington, DC: National Academy Press; 2005.
[218] Institute of Medicine, National Research Council. *Local government actions to prevent childhood obesity*. Washington, DC: National Academy Press; 2009.
[219] Shak L, Mikkelsen L, Chehimi S. Convergence Partnership. PolicyLink. Prevention Institute. *Recipes for Change: Healthy Food in Every Community*. Convergence Partnership; 2010.
[220] Frieden TR, Dietz W, Collins J. Reducing childhood obesity through policy change: Acting now to prevent obesity. *Health Affairs*. 2010; 29(3): 357-363.

[221] Cohen L, Chavez V, Chehimi S. Prevention Institute. *Prevention is primary: Strategies for community well-being. Second Ed*. San Francisco, CA: Jossey-Bass; 2010.
[222] Kahane CJ. An evaluation of child passenger safety: The effectiveness and benefits of safety seats. Washington, DC: National Highway Traffic Safety Administration, 2001.
[223] California Department of Public Health, California Tobacco Control Program. California Tobacco Control Update 2009: 20 Years of Tobacco Control in California: Sacramento, CA.
[224] Edwards K. California's leadership in tobacco control results in lower lung cancer rate. *UC San Diego News Center*. Available at: http://ucsdnews.ucsd.edu/newsrel/health/09-29californialeadership.asp. Accessed December 24, 2010
[225] Church T. Thousands of lives saved due to Tobacco Prevention and Control Program. *Washington State Dept. of Health*. Available at: http://www.doh.wa.gov/Publicat/2010_news/10-183.htm. Accessed December 24, 2010
[226] Prevention Institute. The California Association of Nutrition and Activity Providers. Updating nutrition education in the food stamp program: A farm bill opportunity. Sacramento, CA: The California Association of Nutrition and Activity Providers; 2007.
[227] Trust for America's Health. Prevention for a healthier America: Investments in disease prevention yield significant savings, stronger communities. Washington, DC: Trust for America's Health; 2008.
[228] Shak L, Mikkelsen L, Chehimi S. Convergence Partnership. PolicyLink. Prevention Institute. *Recipes for Change: Healthy Food in Every Community*. Convergence Partnership; 2010.
[229] Mikkelsen, Erickson, Nestle, Sims.
[230] Finkelstein, EA, Zuckerman L. The flattening of America: How the economy makes us fat, if it matters, and what to do about it. Hoboken, NJ: John Wiley & Sons, Inc.; 2008.
[231] Finkelstein, EA, Zuckerman L. The flattening of America: How the economy makes us fat, if it matters, and what to do about it. Hoboken, NJ: John Wiley & Sons, Inc.; 2008.
[232] Zhao M, Carretta H, Hurley R. Sole hospital commitment to health promotion and disease prevention (HPDP) services: does ownership matter? J Health Hum Serv Adm 2003 26(1):93-118.
[233] Ibid.
[234] the authors would like to note that while this paper addresses the food side of contributors to chronic disease, a similar argument could be made on the physical activity side. Increasing physical activity through land-use and transportation policies that make walking, bicycling, and public transit more viable transportation choices simultaneously reduces risk for chronic disease and the carbon emission from the transportation system.
[235] Harvie, J., Redefining Healthy Food: An Ecological Health Approach to Food Production, Distribution, and Procurement, Paper presented by The Center for Health Design and Health Care Without Harm at a conference sponsored by the Robert Wood Johnson Foundation, September 2006
[236] Kirschenmann F, Stevenson S, Buttel F, et al. Why worry about the agriculture of the middle? Available at: http://www.agofthemiddle.org/archives/2005/08/why_worry_about.html. Accessed July 4, 2010
[237] Hendrickson M, Heffernan W, Howard P, et al. *Consolidation in Food Retailing and Dairy: Implications for Farmers and Consumers in a Global Food System*, Washington, DC: National Farmers Union; 2001
[238] Harvie, J., Mikkelsen, L., Shak, L., A New Health Care Prevention Agenda: Sustainable Food Procurement and Agricultural Policy, Journal of Hunger & Environmental Nutrition, Volume 4, Issue 3 & 4 July 2009, pages 409 - 429.
[239] http://noharm.org/us_canada/issues/food/balanced_menus/challenge.php accessed January 30, 2011
[240] Balanced Menus: A Pilot Evaluation of Implementation in Four San Francisco Bay Area Hospitals Developed for San Francisco Physicians for Social Responsibility and Health Care without Harm Lisa Lagasse MHS and Roni Neff, PhD MS Johns Hopkins School of Public Health Center for a Livable Future April 20, 2010
[241] Harvie, Menu of J., Menu of Change, Healthcare Without Harm Report, 2008
[242] Estes, M., Fletcher Allen Health Care Keynote, September, 2009 Burlingtion VT.
[243] http://www.stonybrookphysicians.com/html_community/news_view.asp?item=251 accessed January 30, 2011
[244] http://www.stericycle.com/carbon-footprint-estimator.html) accessed January 30, 2011
[245] http://www.premierinc.com/quality-safety/tools-services/safety/topics/sphere/index.jsp accessed January 30, 2011
[246] http://www.cbo.gov/ftpdocs/87xx/doc8758/MainText.3.1.shtml accessed January 30, 2011
[247] Agriculture at a Crossroads: Synthesis Report of the International Assessment of Agricultural Knowledge, Science, and Technology for Development (IAASTD). Edited by B. D. McIntyre, H. R. Herren, J. Wakhungu and R. T. Watson. Washington, DC: Island Press (2008), Available at http://www.agassessment.org/reports/IAASTD/EN/Agriculture%20at%20a%20Crossroads_Synthesis%20Report%20(English).pdf Accessed Jan 30, 2011.

[248] "The United States of Diabetes: Challenges and Opportunities in the Decade Ahead" UnitedHealth; Center for Health Reform and Modernization. Available at http://www.unitedhealthgroup.com/hrm/UNH_WorkingPaper5.pdf Accessed Jan 30, 2011.

[249]US Department of Health and Human Services, Agency for Health Care Research and Quality Medical Expenditure Panel Survery 2007 http://meps.ahrq.gov/mepsweb/data_stats/tables_compendia_hh_interactive.jsp?_SERVICE=MEPSSocket0&_PROGRAM=MEPSPGM.TC.SAS&File=HCFY2008&Table=HCFY2008_CNDXP_C&_Debug= accessed January 30, 2011