

2010

# Obesity Prevention: A Review of the Interactions and Interventions, and some Policy Implications

Anura Amarasinghe

Gerard D'Souza  
*West Virginia University*

Follow this and additional works at: [https://researchrepository.wvu.edu/rri\\_pubs](https://researchrepository.wvu.edu/rri_pubs)



Part of the [Regional Economics Commons](#)

---

## Digital Commons Citation

Amarasinghe, Anura and D'Souza, Gerard, "Obesity Prevention: A Review of the Interactions and Interventions, and some Policy Implications" (2010). *Regional Research Institute Publications and Working Papers*. 88.  
[https://researchrepository.wvu.edu/rri\\_pubs/88](https://researchrepository.wvu.edu/rri_pubs/88)

This Working Paper is brought to you for free and open access by the Regional Research Institute at The Research Repository @ WVU. It has been accepted for inclusion in Regional Research Institute Publications and Working Papers by an authorized administrator of The Research Repository @ WVU. For more information, please contact [ian.harmon@mail.wvu.edu](mailto:ian.harmon@mail.wvu.edu).

# Obesity Prevention: A review of the interactions and interventions, and some policy implications

Anura Amarasinghe<sup>1</sup> and Gerard D'Souza<sup>2,\*</sup>

<sup>1</sup> Centre for the Built Environment and Health, School of Population Health, The University of Western Australia, 35 Stirling Highway, Crawley, Western Australia 6009;

E-Mail: [AAmarasinghe@meddent.uwa.edu.au](mailto:AAmarasinghe@meddent.uwa.edu.au)

<sup>2</sup> Division of Resource Management, West Virginia University, P.O. Box 6108, Morgantown, WV 26505-6108, USA; E-Mail: [gdsouza@wvu.edu](mailto:gdsouza@wvu.edu)

\* Author to whom correspondence should be addressed; E-Mail: [gdsouza@wvu.edu](mailto:gdsouza@wvu.edu);

Tel.: +1-304-293- 5490; Fax: +1-304-293-3752

---

**Abstract:** Obesity is reaching epidemic proportions especially in the developed and, more recently, in the developing world where the problem is compounded by myriad socio-economic, demographic, built and natural environmental factors. This review examines the possible causes, consequences and policy implications using a multilevel, multispectral framework. The causes of obesity clearly are multifaceted and involve numerous interactions. Together with economic incentives, allocation of physical and financial resources to community intervention strategies through educational programs as well as better land use planning would be helpful in promoting healthier and sustainable communities. Towards this goal, we proposed a dynamic and integrated Individual, Social, Economic and Environmental Model (ISEEM) for obesity prevention. The use of an ISEEM framework, involving a strategic combinations of strategies and targeted to the specific circumstances of individual communities and localities could be helpful for obesity prevention in the years to come.

**Keywords:** health promotion; obesity prevention; dynamic, integrated system, economic incentives

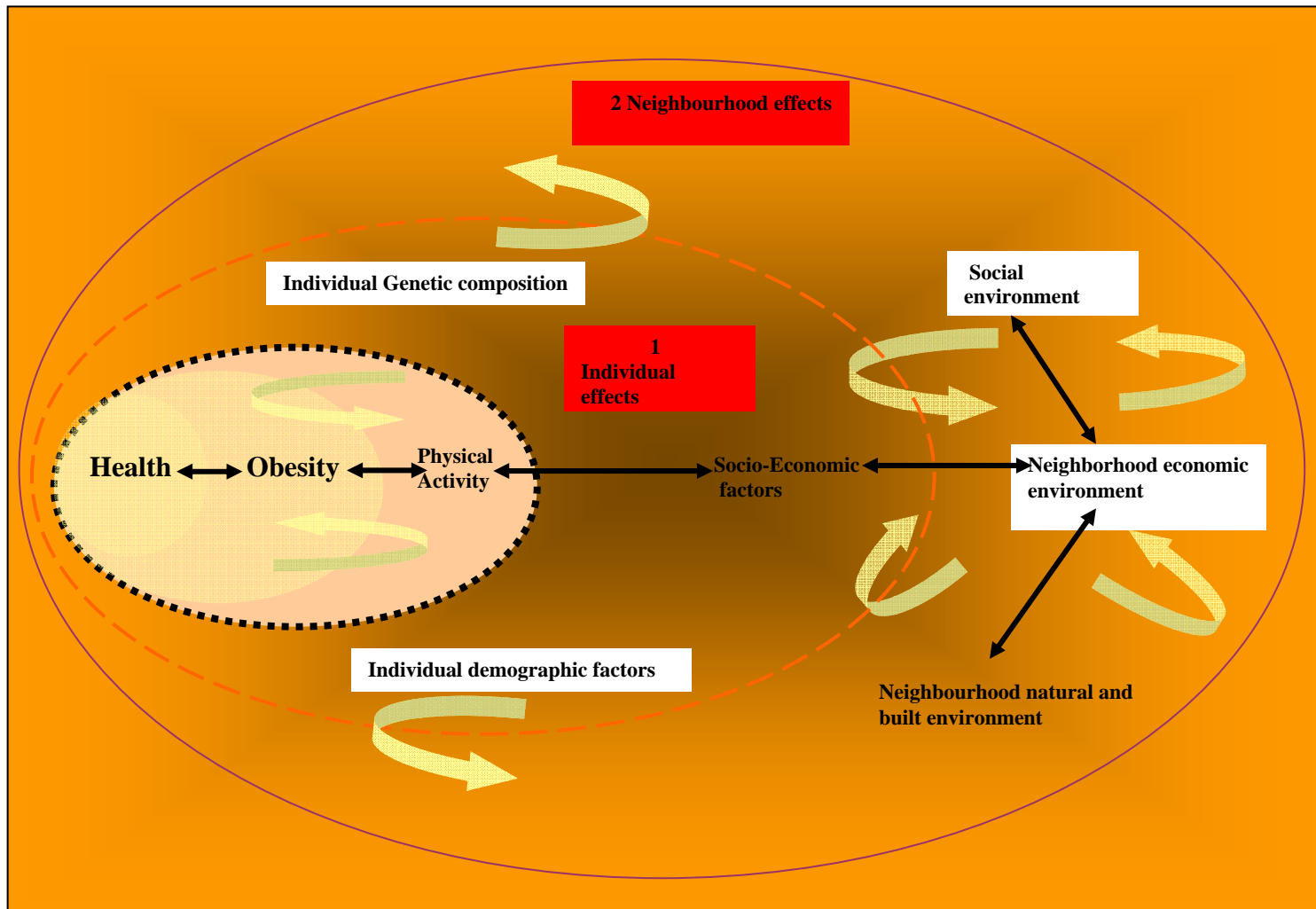
# **Obesity Prevention: A review of the interactions and interventions, and some policy implications**

Increasing prevalence of obesity in children, adolescents, and adults poses a major threat to any country's sustainable growth, health and social wellbeing. Obesity is reaching epidemic proportions especially in the developed and, more recently, in the developing world where the problem is compounded by myriad socio-economic, demographic, built and natural environmental factors. The possible socio-economic, demographic and contextual influences on obesity and health are illustrated in the conceptual model shown in Figure 1. Obesity is defined in terms of Body Mass Index (BMI), which is a measure of body fat content, and is a function of both height and weight. According to National Institute of Health (NIH) guidelines, individuals having a BMI  $\geq 30$  (kg/m<sup>2</sup>) are considered obese, and those with a BMI 25-29.9(kg/m<sup>2</sup>) are considered to be overweight. Overweight and obesity, in turn, increase the risk of having other prevailing diseases, including diabetes, cardiovascular diseases, and cancers. [1-3] Subsequently, obesity is an important public policy issue because it imposes external costs to society through increased health-care costs, productivity and other deadweight losses borne by taxpayers. Despite decades of research, policy makers are still debating the causes, consequences, and much needed policy interventions to combat obesity. Thus, the main objective of this review is to contribute to our understanding of the obesity problem and, in the process, to examine the socioeconomic and policy implications for health promotion. Most of the reviewed literature pertains to the US and other developed countries; however there are obvious implications for developing regions as well.

### ***Perspectives on Health and Obesity***

Health, a form of human capital, can raise consumers' productivity in both market and non-market sectors of the economy.[4,5] Gross investments in health capital are produced by household production functions whose direct inputs include the time of the consumer along with market goods such as medical care, diet, exercise, recreation, and housing as well as exogenous socio-economic and demographic characteristics.[4-7] Health is a multi-attribute concept, which encompasses both physical and mental components.[8] Although, birth weight can be used as a good indicator of a healthy newborn, as people get older, an individual's health can be influenced by both observed (e.g., lifestyle choices such as smoking and drinking) and unobserved heterogeneous components (e.g., unobserved genetic, hormonal and biochemical environmental factors). [9-11] Furthermore, health can be affected by several lifestyle choices such as diet, smoking, exercise, alcohol consumption, sleep, weight (relative to height), and stress.[9, 10] However, education helps people choose healthier lifestyles by improving their knowledge of the relationship between health behaviors and health outcomes.[10] Empirical findings show that while schooling has a significant negative association with smoking and heavy drinking, it has a significant positive effect on exercise. [10] Realization of health outcomes become more complex when lifestyle behaviors enters into health production functions, and are correlated with unobserved heterogeneous factors affecting health. [11-13] Not accounting for unobserved heterogeneity and endogeneity can give biased estimates of optimal lifestyle choices and the socio-economic status–health relationship.[12] A multivariate analysis showed that discrete indicators of lifestyle choices such as sleeping well, exercising, and not smoking have a positive effect on the probability of reporting excellent or good health.[12]

**Figure 1: Conceptual model: Possible health, obesity, socio-economic and environmental interactions**



A lifestyle outcome of obesity is the increasingly significant effects on individual health and longevity, and, ultimately, on the economy as a whole [14] Significance of obesity is quite evident in a growing body of literature from various disciplines including public health, community planning, human nutrition, food science, and other social sciences including economics. Recent economic contributions have focused on consumer demand and behavior; the food supply chain; and the theoretical, conceptual, technological and spatial issues underlying obesity. [8, 13-24] Some of these studies focused primarily on demand for food consumption, consumer eating habits, risk factors and prevention.[13, 17, 19, 25-29] Other studies emphasize various theoretical issues and the implications of economic growth and technological change on obesity.[14, 22, 24] In addition, there are studies that are concerned primarily with the consequences of, and possible policy interventions to overcome, obesity. [21, 28, 30-36] More recently, urban sprawl characterized by a complex pattern of land use, transportation, and economic development has been found to significantly and negatively impact both quality of life and public health. [37-40] Advocates of this “new urbanism” suggest that, by inducing sedentary lifestyles urban sprawl may have an impact on obesity. In line with these propositions, studies also discussed the possible linkages among obesity, physical inactivity, and the built environment.[27, 37, 41-47] With this as an initial background to the interactions among health, lifestyle and the built environment in general, the next few sections explore some deeper insights into the causes and consequences of obesity.

### ***Food Security, Hunger, Food Away from Home and Obesity***

Fast food consumption is believed to be one of the major contributing factors to obesity. A substantial body of evidence from recent economic and health studies reveal that fast foods, which contain high levels of calories and saturated fats, have a positive impact on gaining body weight [15, 16, 27, 47, 48] Fast foods contain all the ingredients, such as saturated trans-fatty acids, high

glycemic index, high energy density and large portions, which give rise to unhealthy meals. [15, 47] It was found that from the late 1970s to the late 1990s, food eaten away from home (FEAFH) by children has increased from 17% to 30%.[47] During that period, the fast food contribution to total caloric intake of children rose from 2% to 10%.[47] Similarly, daily per capita soft drink consumption of children increased from 179 to 520 grams for boys and from 148 to 337 grams for girls between 1965 and 1996.[49] Although recommended energy intakes vary with age, the typical recommended daily caloric intake is fewer than 3000 calories; per capita nutrients available for consumption have increased from 3300 calories in 1978 to 3600 calories in 1988. [50] It has been predicted that consumer spending at full-service and fast food restaurants will continue to grow over the next few decade(s), expected to rise by 18% at full-service restaurants and by 6% at fast food restaurants between 2000 and 2020.[51]

A prime driver for fast food consumption is convenience. Both fast food restaurants and full-service restaurants can provide leisure for households, as households are freed from cooking, cleaning and shopping. Along with additional leisure, households with more income tend to buy more variety and other dining amenities. Thus, households with higher incomes tend to spend more on fast food and full-service meals and snacks [52, 53] Also, households that spend long hours working outside the home prefer consuming fast foods, if such meals are accessible within a reasonable location.[54] As household labor force participation increases, spending on fast foods appears to have increased. However, traveling to and from dining at full-service restaurants can take the same amount or less time as food preparing, eating and cleaning up after meals at home [52] Thus, there is no clear relationship between a household's demand for food at full-service restaurants and its time constraints.[52] In addition, household income, size, and increasing hours of labor force participation, the age, race and ethnicity, and educational level of the head of the household, along

with region of residence, are also factors contributing to the demand for food away from home.[53, 55, 56] Interestingly, given the different opportunities to socialize and to eat out, young and older adults choose different establishments for dining out. On average households with younger members tend to spend more money on fast food, while households with older people tend to spend more money on full-service dining.[52, 56] However, more frequent consumption of fast foods are found to positively correlate with overweight in women and higher serum cholesterol levels in children who ate weekly outside the home.[57-59]

Benefiting from these growing trends in household lifestyles, a wide array of food service firms, including full service restaurants, fast food establishments, hotels, retail stores, recreation places, bars and operators of vending machines are competing for consumers' food away from home (FAFH) expenditures. It was found that about 39% and 38% percent market shares, respectively, appeared to be captured by full service and fast food restaurants.[51] Full-service restaurants, defined as establishments with wait staff, tend to offer more varied menu and dining amenities. As the number of fast food restaurants proliferates in convenient locations, consumers have to travel less on average, thus boosting the demand for fast foods.[60] The proliferation of fast food restaurants can also be seen in a trend known as the "channel-blurring" effect whereby gas stations and retail stores, such as Wal-Mart and Target, are hosting outlets for fast food giants.[51] From the business point of view, the fast food industry appeared to monitor the changing lifestyles of consumers and intercept them at every turn to gain market share.

Interestingly, other studies suggest that non-alcoholic beverages that are complementary in nature to fast food consumption may also be a contributory factor to current obesity trends.[61-63] This is because consumers are offered a wide variation of choices among nonalcoholic beverages and,



simultaneously, there is a decreasing trend toward consumption of milk and increased consumption of other beverages, especially soft drinks. Besides, beverage choices may have important implications for intake of calories, and therefore for obesity risk, as well as for adequacy of important nutrients such as calcium. It has been found that, on average, for each 1-ounce reduction in milk consumption, a child's calcium consumption declines by 34 mg. It was revealed that soft drinks are the major source of added sugars in American diets, contributing approximately a third of the added-sugars intake of Americans 2 years of age and older.[63] Despite Americans' professed concern with losing weight, diet soft drink consumption has grown steadily from 4 gallons per capita in 1977 to 12 gallons per capita in 2001.[62]

Apparently, industrialized economies are becoming increasingly service-oriented, and, over the past several decades, foodservice industries that offer the highest levels of convenience have been rewarded with strong sales growth. In the face of rising incomes and increasingly hectic work schedules, a nearly insatiable demand for convenience will continue to drive fast food sales and associated complementary food products. Firms will strive to find ways to make their products even more accessible. However, these developments in the demand for foodservice meals and snacks could also reflect important changes in the diets and health of the industrialized populations.

Yet, body weight is greatly influenced by the difference between energy intake and its expense. The amount of calories consumed and expended daily are influenced by a myriad of factors, including the price of goods and services, disposable income, time constraints, cooking skills, level of education, gender, age, cultural background, and genetic endowment. [64] Each factor may play a multifaceted role, affecting an individual's knowledge about health and nutrition, his or her choice of what to eat, and how many calories he or she expends. One study reveals that individuals who exercise more

frequently, watch less television, drink fewer sugary beverages, and eat a higher quality diet are more likely to have a healthy body weight.[13] Attitudes about diet and health may also have an impact on health behaviors.[21, 65] Obese women are less likely to believe that they have control over their weight. Similarly, overweight and obese men are less likely to accurately assess their weight status. Nearly 60% of overweight and obese men consider themselves to have a healthy weight. [13] Differences in obesity rates across population subgroups indicate that socioeconomic factors significantly and systematically affect an individual's ability to achieve good health. Individuals with higher incomes tend to make greater investments in their own health. They watch less TV and eat a higher quality diet. Men with higher incomes are more accurate about their weight status, while women with higher incomes drink fewer sugary beverages, exercise more frequently, and are more confident that they can control their weight. Time constraints may limit personal investments in healthy behaviors. These time constraints seem to correlate with household composition. Compared with single parents, married parents have a higher quality diet, eat breakfast more often, and drink fewer sugary beverages.[13] Formal education also seems to motivate individuals to make greater investments in their own health. Individuals with a college education watch less TV, eat a higher quality diet, drink fewer soft drinks, and eat breakfast more often.[13, 66] Women with a college education have a greater feeling of control over their own weight and exercise more frequently. [13, 66] In addition, it was revealed that per-meal nutrient demand depends on food prices, an individual's wage rate, body weight, caloric expenditures, information about health and nutrition, per-meal situational factors that affect one's sensitivity to time delay, and the amount of time spent preparing the meal. Empirical investigation shows that situational factors influence food choices, and that the use of nutritional information changes as one becomes hungrier, busier, and eats more foods away from home. [13] On the other hand demand for food at home is influenced by a wide array of socio-demographic factors such as per capita household income, per capita at-home food

expenditures, away-from-home share of the food budget, education, race, urbanization, regional differences, and composition and size of the household.[67] The results also indicate that larger households allocate more of their food expenditures to beef and pork, and less to bread and juice. Households headed by those who attended college allocate more of their food budgets to poultry, fruits, and vegetables, and less to beef, pork, other meat, and eggs. In terms of differences by race, black households allocated more of their food budgets to pork, poultry, other meat, fish, eggs, and juice than white households, but less to dairy, bread, and fruits. City and suburban households allocate less of their food budgets to pork and fats, and more to fruits and juice than rural households.[67] Families with children aged 2-5 tend to spend more of their food budgets on dairy products.

### ***Relationship between Poverty and Obesity***

Poverty, hunger, and poor health tend to occur jointly.[50] Many health disparities in the United States are linked to inequalities in education and income, thus wealth and poverty have profound effects on diet structure, nutrition and health.[68, 69] Apparently, income and the macronutrient composition of diets are linked at the aggregate and most likely at the individual level. In line with Engel's law, the percentage of personal consumption of at-home foods appears to diminish as per capita gross domestic product rises. U.S. residents spent the lowest amount (less than 8%) of disposable income on at-home food followed by Canada and the United Kingdom.[68, 69] However, in higher income nations, cost per unit of food energy is low such that those nations are associated with high-energy intakes. Accordingly, people in higher income nations consume more added sugars and fats than those in low-income nations. In addition, low-income consumers within rich nations consume lower quality diets than do higher income consumers.[68, 69] Thus, there is evidence to support occurrence of the highest rates of obesity among population groups with the highest poverty

rates and the least education.[46] Moreover, there is an inverse relationship between energy density, mega joule per kilogram (MJ/kg) and energy cost (\$/MJ), such that energy-dense foods composed of refined grains, added sugars, or fats are a low-cost option for the consumer.[68, 69] Therefore, the selection of energy dense foods by food insecure, low-income consumers may represent a deliberate strategy to save money. Also, poverty and food insecurity are associated with lower food expenditures, low fruit and vegetable consumption, and lower-quality diets[46, 69]. Food insecurity, which is defined as limited or uncertain availability of nutritionally acceptable safe foods, appears to be linked with obesity.[70, 71] The evidence of the third National Health and Nutrition Examination Survey (NHANES III) showed that women, but not men, in food-insufficient households were more likely to be overweight than food-sufficient women. [70] The corollary of Engel's law is that low-income households spend a higher proportion of disposable income on food relative to what they earn. While U.S. households with incomes greater than \$70,000 per year spent 7% of disposable income on food, low-income families (\$10,000 - 15,000 per year) spent approximately 25%.[69] This implies that consumption of energy dense diets is an important strategy for low-income people to extend their food budget which, in turn, results in higher rates of obesity and type 2 diabetes.[69] It was noted that other factors such as food stamp participation, homeowner occupancy, level of education, and age and ethnicity of household members also have an impact on food insecurity. However, important policy concerns are the nutrition and health consequences of food insecurity and hunger.[72]

### ***Technological Change and Obesity***

Even though the market price reflects the major component of the cost of the product, its full cost is comprised of other components such as time cost and information cost. For example, the full cost of a home-prepared meal includes not only the cost of ingredients bought at the store, but also the travel

cost to the store and back, the cost of time spent preparing the food and information costs related to nutrition knowledge and cooking techniques. A change in any component of these costs will change the incentive for consuming that product, as well as its closely related alternatives.[73] Prices change over time due to a variety of reasons, including availability of resources, but the prime mover of prices is technology. Better production and distribution technologies generate more and better goods, driving prices down. Foods prices, whether at the store or at a restaurant, have been declining relative to prices of all other items between 1952 and 2003. The ratio of food prices to the price of all other goods has fallen by 12% [73] It has also been suggested that the increase in food consumption prompted by the falling time cost of food is the major cause behind the surge in obesity since 1980. In addition, technological innovations—including vacuum packing, improved preservatives, deep freezing, artificial flavors, and microwaves—have enabled food manufacturers to cook food centrally and ship it to consumers for rapid consumption. In 1965, a married woman who didn't work spent over two hours per day cooking and cleaning up from meals. In 1995, the same tasks took less than half the time. Although greater convenience, growing portion sizes, and increased accessibility of restaurant meals have been blamed for contributing to the rise in obesity, in economic terms, these are quality attributes that are valued by consumers.[8]

Obesity is also believed to be accompanied by innovations that economize on time previously allocated to the non-market or household sector. [8, 14] New innovations have reduced the time spent on food preparation at home through the introduction of convenience foods at low cost for home consumption and also through the increased number of fast food and full-service food outlets. It was reported that the number of fast food outlets has doubled from 1972 to 1997.[17] In the same period the number of full-service restaurants has risen by 35%, according to the Census of Retail Trade.[17] An increasing trend of fast food consumption in favor of labor intensive preparation of food at home

can be partly attributed to labor market developments since 1970. The real income of single earner households has declined from 1970 to 1993, and it was only 1% higher in 1998 than 1970. Increases in hours of work and labor force participation, reduction in wage rates, and decline or modest increase in real incomes has stimulated the demand for inexpensive, convenient, fast foods which are also high in caloric content. At the same time, the reduction in time available for active leisure has reduced the calories expended.[17]

Researchers also argue that in an agricultural or industrial society, work tends to be strenuous, and, in turn, the worker is paid to exercise. [14] In most post-industrial and redistributive societies, such as the U.S., most work entails little exercise, and not working does not lead to starvation or cause reduction in weight, because of food stamps and other welfare programs. As a result, people must pay for undertaking, rather than being paid to undertake, physical activity. Payment is mostly in terms of forgone leisure, because leisure weight control must be substituted for weight control by physical exertion at work.[14] The jogging and gym ‘revolution’ and the limiting of calorie consumption as a result of deliberate dieting can thus be interpreted as substitutions brought about by technological changes in market and household work. Despite these off-the-job substitutions, overall obesity can still rise as the result of technological changes that cause fewer calories to be expended in market and non-market work.[14]

### ***Time Use, Leisure, Physical Inactivity and Obesity***

The seminal theory of time allocation, has paved the way for economists to analyze the tradeoffs of time use decisions that affect an individual’s daily life. [4, 74] People divide their time between five categories of activities—sleep, leisure, occupation (paid work), transportation, and home production

(unpaid work)—collectively referred to by the acronym SLOTH. Wages and unearned income are the most important economic determinants of labor supply of married women, in the short run, thus an increase in the market wage is expected to reduce work at home, while its effect on leisure and work in the market is indeterminate.[74] However, an increase in income may increase leisure, reduce work in the market and leave work at home unchanged. At the same time, the wage penalty or the opportunity cost of time, time use decisions, and health of a family have become important issues today as more and more women participate in the labor force. The labor force participation rate of women with young children (under 6 years of age) increased from 39% in 1975 to 62% in 1996.[19] Increased participation of women in the labor force has reduced time available for non-market household activities and motivated people to consume relatively cheap high-caloric foods.[17] A substantial change, in terms of expenditures and time allocation, has been observed in the area of leisure time and travel/transportation. Since 1965, overall leisure time has increased by greater than 4 hours per week, time spent at paid work and on productive activities at home (cooking, cleaning, repairing things, childcare) has diminished, transportation time has increased and time for personal care (taking showers, getting dressed or eating) remained the same. Along with these developments, many individuals tend to spend more of their leisure time engaged in sedentary activities at the expense of physical activities, such that increasing weight is accompanied by increased leisure time. [75] There is evidence to suggest that children who engage in less vigorous physical activity, mostly television viewing, tend to be more overweight[15, 76] Overweight children spent 6-12 fewer hours per week in sports, particularly in team sports. Overweight children spent more time than their normal weight counterparts in marginally active and sedentary activities such as shopping, studying, visiting, and time on the computer. There were no significant differences between overweight and normal-weight children in time spent playing or viewing television. It appears that normal weight

children are not just more likely to participate in active leisure pursuits, but are more likely to be involved in team sports in their leisure time than overweight children.[76]

In 2001, fewer than half of U.S. adults achieved recommended levels of physical activity, and most of those who walked for exercise did not walk long enough, often enough, or briskly enough to obtain health benefits [77] The determinants of time allocation for leisure, home cooking, and other activities could also be influenced by socioeconomic and demographic factors such as education, household income, and ethnicity. Individuals with higher incomes or education were more likely to engage in healthy behaviors including eating a healthier, reducing television viewing and increased participation of active sports. [13, 75]

### **Built Environment and Obesity**

In recent times, there is a growing concern that urban sprawl and the structure of the built environment have an impact on the escalation of non-contagious health disorders. While sprawl is a somewhat imprecise and difficult to measure phenomenon, it is often characterized by low-density urban development that consumes land faster than the growth of the population. More specifically sprawl environments are characterized by: (1) a population widely dispersed in low-density residential development; (2) rigid separation of homes, shops, and workplaces; (3) a lack of distinct, thriving activity centers, such as strong downtowns or suburban town centers; and (4) a network of roads marked by large block size and poor access from one place to another.[40, 44] Simply put, it is poor accessibility. As such, nothing is within easy walking distance of anything else. This redistribution of the nation's population to suburbs and away from central cities and rural areas has given rise to undesirable impacts on metropolitan residents and communities.[78] These impacts include the destruction of open space and farmland, increased automobile congestion and pollution,



the geographic isolation of low-income and minority residents, and a mismatch between the location of jobs and the residences of workers, especially, low-skilled, low-income workers. These developments are important, because, transportation, which is a key factor of our everyday life, could also be a decisive factor of changes in physical activity as small shifts in travel modes noticeably alter energy expenditure. It was found that while time spent on transportation has increased, suburbanization, street design, and land use patterns reduce the amount of physical activity that can be achieved through transportation.[37, 38, 40, 44, 75, 79] The influence of transportation on energy expenditure is mainly affected through the built environment in which the cities and transportation corridors are planned and developed.[77]

Evidence also suggests that residents of sprawling neighbourhoods were also more likely to walk less during leisure time, weigh more, and have a greater prevalence of hypertension than residents of compact counties. In addition, urban sprawl is highly correlated with other undesirable social outcomes including overall traffic fatality rate, as well as with an array of transportation outcomes (e.g., percentage of residents walking or taking public transit to work, average vehicle ownership, and vehicle miles traveled per capita) and environmental outcomes. (e.g., ground-level ozone levels). The most compact counties (i.e., those with the highest population density and street accessibility and, therefore, the higher index value) had lower traffic fatality rates and for every 1% increase in the index, the traffic fatality rate decreased by 1.49%. These adverse outcome may also lead to increased reliance on automobile transportation and decreased ability to walk to destinations, decreased neighborhood cohesion, and environmental degradation (e.g., greenhouse gas emissions and destruction of open space) [40, 80]

One study showed that, after controlling for socioeconomic and demographic factors, for each one point rise in the urban sprawl index (0-100 scale), the risk of being overweight increased by 0.2% and the risk of being obese increased by 0.5%.[41] Urban sprawl may reduce the time available for physical activity because parks or fitness facilities are more distant. It may also affect diets by increasing the distance to supermarkets or by the increased cost of nutritious foods caused by the conversion of farmland to urban areas.[40] Moreover, there is increasing consensus that the built environment may play a major role in controlling weight by shaping food access and availability.[81] Research also suggests that supermarkets are more likely to be located in wealthier and predominantly white areas, and that fruit and vegetable intake is positively associated with the presence of a supermarket, even after controlling for personal economic factors.[82] Though the relationship between different types of eating-places and dietary consumption has not been well examined, availability, type and distribution of restaurants and the diffusion of food advertising represent other means by which the environment affects weight imbalances.[81, 82] It showed that establishment of “supercenter” retail grocery stores tends to create food deserts for the rural population. When a supercenter is opened in non-metropolitan areas, it draws customers from a wide radius such that existing small retailers in these areas go out of business due to loss of customers. This places low-income earners at a disadvantage when it comes to finding low cost grocery stores. [42, 81] On other hand, there is a geographic correlation between exposure low-income neighborhoods to fast food restaurants. It reveals that predominantly black neighborhoods in the U.S have 2.4 fast food restaurants per square mile compared to 1.5 restaurants in predominantly white neighborhoods. [43] A study from Australia showed that residents of low income neighborhoods have 2.5 times more exposure to fast food restaurants than those living in affluent neighborhoods .[83]

In contrast to Urban sprawl, mixed-used urban environments featuring better access to pedestrian-friendly street networks, shops and services, compact higher density housing and high quality parks are believed to promote non motorized form of transport such as walking and cycling. In fact, there is increasing evidence that mixed-use environments are meant to create more active, healthier and livable communities [79, 84] One study pointed out that the likelihood of obesity apparently declines with an increase in mixed land use, but rises with time spent per day in a car. While each 25% increase in mixed land use has declined the risk of being obese by 12%, each additional hour spent in a car raises the likelihood of obesity by 6%. [37] Also, each additional kilometer walked per day is associated with a 5 % reduction in the likelihood of obesity.[37] It was also found that increasing recreation opportunities have the potential to decrease health care expenditures and rates of obesity through increasing rates of physical activity.[85]

On the other hand, there are studies that claimed that lower-population densities encourage physical activity, hence, lowering the risk of being obese. These studies hypothesized that a shortcoming of the urban planning and public health literature on sprawl and obesity is that it treats land use (or more broadly the built environment) as exogenous.[86] From this perspective, weight gain is caused by land use patterns that discourage physical activity. However, in these empirical approaches, there is no room for consumers to express preferences for land use patterns, for individuals to undertake averting behaviors to avoid health risks and for prices to ration housing in desirable (e.g., healthy) locations.[86] In fact income, weight, location and land development densities are endogenous choices such that there is a tradeoff between time allocated to work and leisure and between the consumption of food and other goods. If weight outcomes and development densities (i.e. sprawl) are endogenous, single equation empirical estimation seems to be invalid.[86, 87] In particular, low-

density developments should not be viewed as a cause of high obesity rates any more than they should be considered as a cause of higher commuting costs.[86]

### **Obesity: A Result of Market Failure?**

Despite these growing environmental and socio demographic causes of obesity, some believe that obesity is a result of market failure.[21, 46] Like environmental pollution, it imposes an external cost to society so that public intervention to control obesity is justified. In order to reduce the consumption of unhealthy foods, it has been suggested that foods high in calories, fat or sugar be taxed, and that healthy foods such as fruits and vegetables be subsidized.[28, 46] A steep tax would probably reduce consumption of taxed foods and could be used to generate funding to subsidize healthful foods [28] Although, it was found that fruit and vegetable subsidies are more likely to increase sales, there are mixed opinions on the feasibility and desirability of a steep 'junk food' tax.[28] A small tax may be more politically feasible and still could generate significant revenues to support health measures. [28] A study of pricing effects on food choices shows that price reduction strategies promote the choice of targeted foods by lowering their cost relative to alternate food choices. [57] Two community-based intervention studies showed that price reductions resulted in a four-fold increase in fresh fruit sales and a two-fold increase in baby carrot sales. [57] This study also concluded that price reductions are an effective strategy to increase the purchase of more healthful foods in community-based settings such as work sites and schools.[57] Previous studies suggest that economic instruments such as taxes are a means of changing the lifestyle behaviors such as alcohol and tobacco consumption. [88-92]

Studies have also dealt with the implications of taxes on energy dense snack foods and soft drinks [28, 33, 93, 94] There are about 19 U.S. states and cities that levy taxes on soft drinks, candy,

chewing gum or snack foods (potato chips, pretzels, and others).[28] These taxes could be levied at the wholesale or retail level in terms of a fixed tax per volume of product (i.e., excise tax), or as a percentage of sales price (sales tax).[33] However, a relatively small ad valorem tax would not immediately change a consumer's diet, thus having little effect on diet quality or health outcomes. But substantial revenue generated from smalls taxes can be used in educational programs.[28] Even though taxing snack and fast food have been advocated frequently, it is difficult to confirm economic efficacy of such taxes without clear understanding tax influences on weight issues.[33]

On the other hand, the change in consumption of fruit and vegetables could be induced by modest subsidies in retail prices.[31] Empirical simulations showed that, on average, the present value of the cost per statistical life saved for a 1% fruit and vegetable subsidy is \$1.29 million. Since fat taxes are regressive, tax incidence would be felt hardest by low income families. In contrast to fat taxes, subsidy programs would likely be progressive as the largest benefits would go to low income earners. But, these subsidy programs have to be funded by taxpayers so it is necessary to further investigate the societal welfare impacts in general, and whether or not such policies would be cost-effective in achieving health improvement, in particular.[31] Developing economies resort to discriminatory excise taxes as stopgap measures to solve short term problems. Since more advanced economies do not have such short term problems, justification for a discriminatory excise tax on soft drinks is weak. Thus, the use of discriminatory excise taxes other than on "sin" products have little justification in modern tax systems. [93]

The evidence between drinking alcoholic beverages and body weight has been inconsistent. However, recent evidence suggests that infrequent alcohol-related overeating could lead to weight gain over time.[95] In addition to weight issues, increased medical expenses, lost income, increased

health and automobile premiums and pain, discomfort, emotional and physical stress are some of the internal costs associated with alcohol consumption. External costs take the form of injury to others and property damage. [96] However, taxing alcoholic beverages to reduce the social cost of alcohol consumption has been a debated public policy issue. It has been argued that public health costs and other external costs associated with alcoholic beverages are so significant that imposing a substantial excise tax on those beverages is justified.[96] It was identified that higher rates are needed for alcoholics to lose their utility gain from alcohol consumption, if alcoholism is accepted as a disease.[96] The evidence from National Longitudinal Survey of Youth (NLSY97) suggests that a complete ban on all alcohol could reduce adolescent monthly alcohol participation by about 24% and binge participation by 42%. In fact both price and advertising policies have a substantial impact on reducing alcohol consumption. Like alcohol consumption, the impact of smoking on obesity has been inconsistent however.[18] Externalities including rising health insurance premiums and lower labor productivity are some of the market failures that warrant government intervention in tobacco products. Studies suggest that higher cigarette prices, irrespective of the way they are measured, reduce the probability of youth cigarette smoking. [97]

Event though “sin” taxes, such as taxes on cigarettes and alcohol consumption, produce economic benefits by reducing various external costs, these taxes can also create an economic cost, for example, by tempting people to consume less of the desired commodity and more of other commodities than they otherwise would. The marginal excess burden (MEB) of a tax refers to the welfare loss (or gain), net of any external benefits caused by the increase in the tax necessary to raise an extra dollar of revenue for the government. [98] Information on the MEB of different taxes would help to determine the economic case for tax reforms such as the effect of cutting one tax at the expense of raising another tax, holding total tax revenue constant. The economic costs of any public

spending (defense, aid for the needy, health, education) include not only the monetary outlays but also the additional excess burden from the higher taxes necessary to finance the required amount of revenue. Even though the usage of economic incentives to correct externalities of such health disorders are economically justifiable, in reality, their applicability depends on the tradeoff between the marginal excess burden of economic incentives (e.g., taxes) in controlling such health issues and the marginal external cost of such health issues to society. If marginal external costs of obesity are greater than the marginal excess burden of taxes to control it, the use of taxes would create a Pareto improvement in society. Therefore, the use of economic incentives such as taxes to control obesity is an important researchable question.

### ***Implications for Health Promotion***

From this review, it is quite apparent that a growing trend of obesity has been attributed to combination of economic, social, cultural, environmental and political factors in addition to genetic endowment factors. Although unobserved genetic influences are difficult to manage, multi-factorial obesity problem on health requires a system intervention approach involving changes in attitudes, increasing in role of and value of local food systems, fostering economic development through less caloric value added products and providing built and natural environments for recreational opportunities. A possible conceptual framework for multi-dimensional system intervention is illustrated in Figure 2. This framework suggests that a dynamic and integrated individual, social, economic and environmental model (ISEEM) could work well for obesity prevention. Interventions at each segment have its own merits/demerits which are directly or indirectly interrelated to each other. However, a combination of ISEEM strategies is essential to address obesity, which some consider to create an externality to society through increased health care costs which are borne largely by taxpayers. Thus, a concerted effort from the governments for obesity prevention is

essential and justified. However, like many other public policy programs, any policy for obesity prevention needs to be economically efficient, socially acceptable, easy to implement, provide flexibility for unforeseeable events, be politically feasible and yield dynamic incentives.

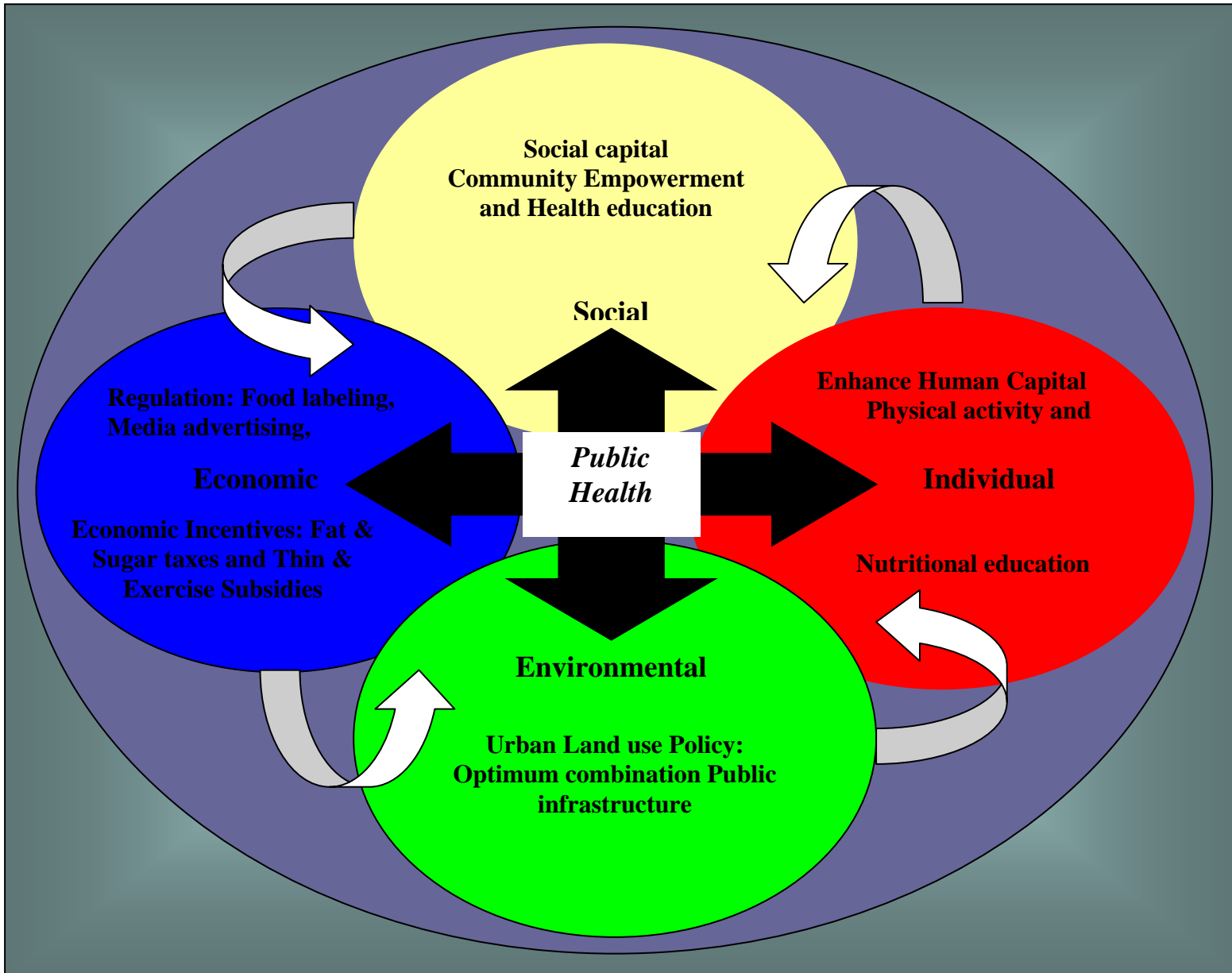
In light of this, use of command and control approaches to correct inadvertent behavioral problems may not be acceptable morally and socially. Taxing the individual directly may not be practical and may also be unjustifiable, as obesity is not only associated with hereditary issues, but is partly the unintended consequence of current economic activities. However, it seems that such regulatory mechanisms are imperative and could be easily in place to control economic activities that may promote obesity issue. In lieu of regulatory approaches, the use of economic instruments (i.e. tax and subsidies) may be more efficient, flexible and equitable than command and control approaches. However, in terms of political feasibility, a tax could be the least amenable policy intervention. Given the complexity of the present obesity issue, it may urgently need a combination of regulatory and economic instruments to control behavioral health problems. Similar to taxes on tobacco and alcohol, imposing taxes on fast foods, food away from home, snacks, and promotional food advertisements would be timely. However, it should also be noted that implementing taxes may create other market distortions including an excess burden or deadweight loss on the economy in the long run. If the external cost of obesity is greater than the excess burden of imposed taxes, a tax on fatty foods may be justifiable. On the other hand in kind subsidies for healthy foods such as fruit vegetables, tax credits for weight management, and subsidies for exercise equipments are some other fiscal policy instruments available for obesity control. Even though the use of economic instruments for obesity prevention needs further research, they seem to be the most flexible policy measures available for unforeseeable economic and political downturns. In fact, the effect on regulatory measures and economic instruments in turn reflect on the social as well as natural and built



environments and in turn at individuals. Together with economic incentives, careful planning of mixed natural and built environment that have close access to recreational facilities and destination may have profound effects on improving physical activity such as walking and cycling and thereby reducing obesity. Even though new urbanist planning policy has led to a growing number of studies to suggest social-ecological approaches to understand health-lifestyle issues, one of the major challenges of such policy is residential “self selection”. Residential self-selection implies that residents who value recreational benefits such as walking gravitate to predetermined residential environments or vice versa.

Regardless of the validity of such hypotheses, it may help in the improvement of physical activity and subsequent reductions in obesity at least in that part of the population who likes walking. However, in addition to these favorable health outcomes, ecological interventions are believed to be a remedy for other public policy goals including reduced crimes, reduced air pollution, and increased social cohesion. In any case, it is worthwhile to further investigate the efficacy and efficiency of such interventions for health gains before implementing large scale urban design intervention projects for obesity prevention. It must be pointed out that urban design interventions may not be easy to implement and are not easily irreversible given dynamic political environments and ever changing climate and weather patterns.

**Figure 2: Individual Socio-Economic and Ecological Model (ISEEM) for obesity prevention and health promotion**

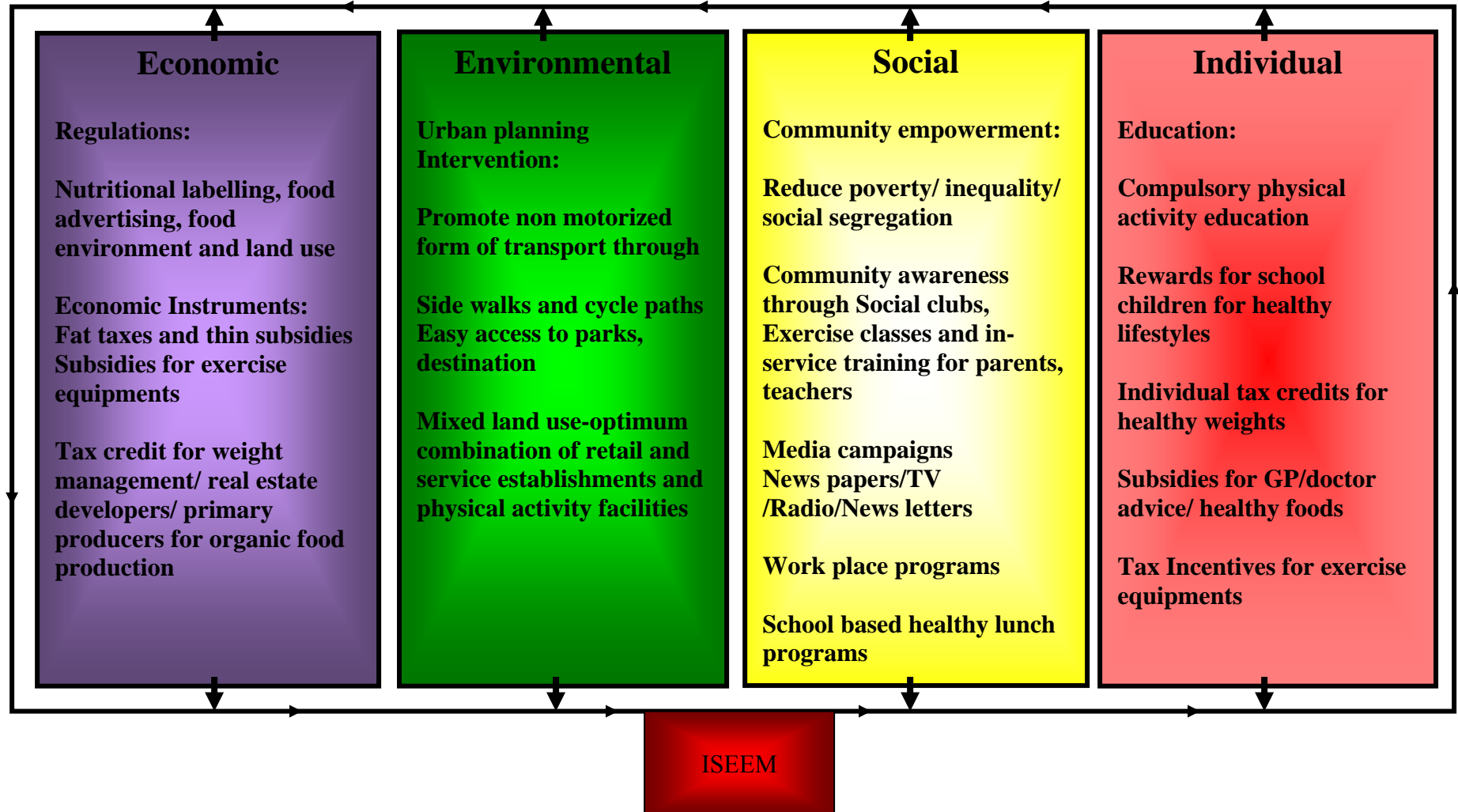


However, changes in economic and neighborhood built and environments have profound effects on both society and individuals. Because poverty and food insecurity are also possible contributory factors, undoubtedly, community empowerment programs especially for disadvantaged communities should be in place without further delay. Previous studies consistently indicate that community outreach educational programs, indeed, have a powerful impact on socioeconomic lifestyles (e.g., dietary patterns, recreational activities) as well as on health. At the same time, formal and informal education can be a remedy for other pressing socioeconomic problems such as poverty and unemployment. Education is one of the key determinants of human capital, not only providing an economic return, but also increasing employment rates and earnings, and improving health, well-being, parenting and in general social cohesion (OECD, 2001). Therefore, interventions which enhance educational attainment could play a vital role in addressing obesity especially in vulnerable, low income populations. Unfortunately, childhood overweight and obesity is also a poignant part of current obesity epidemic. An intervention tailored to young individuals is important and timely. In addition, establishment of a reward system for young school children for maintaining healthier weight limits, tax credits to households for maintaining healthier weight limits, tax credits for schools, healthy school lunch menus and reward systems in the work place for maintaining healthier lifestyles could be other community intervention strategies to control obesity. As youngsters represent the future of communities, allocation of resources tailored at school based physical activity and educational programs will ensure that such interventions are sustainable.

## *Conclusions*

The causes of obesity clearly are multifaceted and involve numerous interactions. Together with economic incentives, allocation of physical and financial resources to community intervention strategies through educational programs as well as better land use planning would be helpful in promoting healthier and sustainable communities. A single intervention alone may not be viable and economically efficient for modern day health promotion. Even though politically unpalatable, use of economic instruments and regulation may be important elements in a portfolio of effective strategies (see Figure 3) to reverse the global obesity epidemic in the short run without harming or disadvantaging communities. Since interventions in each segment tend to be synergistic, the use of an ISEEM framework involving strategic combinations of strategies, targeted to the specific circumstances of individual communities and localities could be helpful for obesity prevention in the years to come.

**Figure 3. A Portfolio of Choices for Obesity Prevention**



## Acknowledgements

The financial support from USDA Hatch funds and a Canaan Valley Institute (CVI) grant is gratefully acknowledged. We also acknowledge helpful comments and suggestions from, Tim Phipps of the Davis College of Agriculture, Forestry and Consumer Sciences, and Tatiana Borisova, Food and Resource Economics Department, University of Florida and the anonymous reviewers on earlier versions. The first author was supported by a National Health and Medical Research Council (NHMRC) Eco-Reside Grant (# 458768). Also special thanks to Billie Giles-Corti, Director, the Centre for the Built Environment and Health of the School of Population Health at the University of Western Australia for the assistance provided in preparing this manuscript. The views opinions and conclusions expressed in this article are solely the responsibility of the author and do not necessarily represent the official view of the institutes.

## References

1. Bianchini F, Kaaks R, Vainio H. Weight Control and Physical Activity in Cancer Prevention. *Obes. Rev.* 2002;3(1):5-8.
2. Egede L, Zheng D. Modifiable cardiovascular risk factors in adults diabetes: prevalence and missed opportunities for physician counseling. *Arch. Intern. Med.* 2002;162(4):427-433.
3. Wang G, Zheng Z, Heath G, Macera C, Pratt M, Buchner D. Economic Burden of Cardiovascular Disease Associated With Excess Body Weight in U.S. Adults. *Am. J. Prev. Med.* 2002; 23(1):1-6.
4. Becker G. A Theory of the Allocation of Time. *The Economic Journal* 1965;75(299):493-517.
5. Grossman M. On the Concept of Health Capital and the Demand for Health. *The Journal of Political Economy* 1972;80:223-253.
6. Lancaster K. A New Approach to Consumer Theory. *The Journal of Political Economy* 1966;74(2):132-157.

7. Muth RF. Household Production and Consumer Demand Functions: *Econometrica* 1966;34(3):699-708.
8. Cutler D, Glaeser E, Shapiro J. Why have Americans become more obese? *J. Econ. Perspect.* 2003;17:93-118.
9. Belloc N, Breslow L. Relationship of Physical Health Status and Health Practices. *Prev. Med.* 1972;1:409-421.
10. Kenkel D. Should you eat breakfast? Estimates from health production functions. *Health Econ.* 1995;6(189-210).
11. Rosenzweig M, Schultz T. Estimating a Household Production Function: Heterogeneity, the Demand for Health Inputs, and their Effects on Birth Weight. *J. Polit. Economy* 1983;91:723-46.
12. Contoyannis P, Jones A. Socio-Economic Status, Health and lifestyle. *J. Health Econ.* 2004;23(5):965-995.
13. Mancino L, Lin B, Ballinger N. The role of economics in eating choices and weight outcomes. USDA Economic Research Service Agriculture Information Bulletin Number 2004.
14. Philipson T. The World-wide Growth in Obesity: An Economic Research Agenda. *Health Econ.* 2001; 10:1-7.
15. Anderson P, Butcher K, Levine P. Economic Perspectives of Childhood Obesity *Economic Perspective* 2003;3Q.
16. Binkley J, Eales J, Jekanowski M. The Relation Between Dietary Change and Rising U.S. Obesity. *International Journal of Obesity* 2000;24:1032-1039.
17. Chou S, Grossman M, Saffer H. An economic analysis of adult obesity: Results from the behavioral risk factor surveillance system. *J. Health Econ.* 2004;23:565-587.

18. Gruber J, Frakes M. Does Falling Smoking Lead to Rising Obesity. *J. Health Econ.* 2005;30:1-15.
19. Guthrie J, Lin B, Frazao E. Role of Food Prepared Away From Home in the American diet 1977-78 Versus 1994-96: Changes and consequences. *J. Nutr. Educ. Behav.* 2002;34:140-150.
20. Kan K, Tasi W. Obesity and Risk knowledge. *J. Health Econ.* 2004;23:907-934.
21. Kuchler F, Ballenger N. Social Cost of Obesity: How Can We Assess When Federal Interventions Pay? *Food Review* 2002;25(3):33-37.
22. Ruhm C. Are recessions good for your health. *Quart. J. Econ.* 2000;115(2):616-650.
23. Saez M, Saurina C, Coenders G, Gonzalez-Raya S. Use of Health Care Services According to the Different Degrees of Obesity in the Girona Health Region, Spain  
*Health Economics* 2006;15:173-193.
24. Smith TG. Obesity and Nature's Thumbprint: How Modern Waistlines can Inform Economic Theory In: Dept of Economics, University of California, Santa Barbara; 2002. p. 68 pp.
25. Kenkel D, editor. Prevention *Handbook of Health Economics* 1B:1539-1627 ; 2000.
26. Kip V. Value of Risks to Life and Health *Journal of Economic Literature* 1993;31:1912-46.
27. Lin B, Frazao E, editors. *Away-From-Home Foods Increasingly Important to Quality of American Diet.* USDA, Economic Research Service; 1999.
28. Jacobson M, Brownell K. Small Taxes on Soft Drinks and Snack Foods to Promote Health. *American Journal of Public Health* 2000;90(6):854-857.
29. Stinson S, Weightier Issues than Diet Challenge 21st Century. *Healthy Weight Journal* 2000:pp. 46-47.



30. Johanson R, Mancino L, Cooper J. The Big Picture: Production and Environmental Impacts of Reduced US Obesity. In: Annual Meetings of the American Agricultural Economics Association; 2004; Denver, Colorado; 2004.
31. Cash S, Sunding D, Zilberman D. Fat taxes and Thing Subsidies: Prices, Diet and Health Outcomes. In: Annual Meeting of the American Agricultural Economics Association; 2004; Denver, Colorado; 2004.
32. Miller J, Coble K. Cheap Food Policy: Fact or Rhetoric? In: American Agricultural Economics Association Annual Meeting; 2005; Rhode Island; 2005.
33. Kuchler F, Tegene A, Harris M, . Taxing Snack Foods: What to Expect for Diet and Tax Revenues: Economic Research Service, USDA; 2004.
34. Baum C, Ford W. The Wage Effects of Obesity: A Longitudinal Study. *Health Economics* 2004;13:885-899.
35. Cawley J. An Economic Framework for Understanding Physical Activity and Eating Behaviors. *American Journal of Preventive Medicine* 2004;27((3s)).
36. Bhattacharya J, Sood N. Health Insurance and Obesity Externality. In: National Bureau of Economic Research; 2005.
37. Frank L, Anderson M, Schmid T. Obesity Relationships with Community Design, Physical Activity, and Time Spent In cars. *Am. J. Prev. Med.* 2004;27(2):87-96.
38. Frank L, Pivo G. Impacts of mixed use and density on utilization of three modes of travel: single-occupant vehicle, transit, and walking. *Transportation Res Rec* 1995;1466:44-52.
39. Freudenberg N, Galea S, Vlahov D. Beyond urban penalty and urban sprawl: Back to living conditions as the focus of public health. *Journal of Community Health* 2005;30(5):1-10.
40. Frumkin H. Urban sprawl and public health. *Public Health Rep.* 2002;117:201-217.

41. Lopez R. Urban Sprawl and Risk for Being Overweight or Obese. *American Journal of Public Health*, 2004;94(9):1574-1579.
42. Blanchard T, Lyson T. Access to Low Cost Groceries in Nonmetropolitan Counties: Large Retailers and the Creation of Food Deserts: Social Science Research Centre, Mississippi State University 2003.
43. Block J, Scribner R, DeSalvo K. Fast food, Race/Ethnicity, and Income, Geographic Analysis. *Am. J. Prev. Med.* 2004;27(3):211-217.
44. Ewing R, Schmid T, Killingsworth R, Zlot A, Raudenbush S. Relationship between urban sprawl and physical activity, obesity, and morbidity. *Am. J. Health Promot.* 2003;18(47-57).
45. Papas M, Alberg A, R E, Helzlsouer K, Gary T, Klassen A. The Built Environment and Obesity. *Epidemiologic Reviews* 2007;29:129-143.
46. Amarasinghe A, D'Souza G, Brown C, Oh H, Borisova T. The Influence of Socioeconomic and Environmental Determinants of Health and Obesity: A West Virginia Case Study. *International Journal of Environmental Research and Public Health* 2009;6(8):2271-2287.
47. Ebbeling C, Dorota B, David S L. Childhood Obesity: Public-health crisis, Common Sense Cure. *The Lancet* 2002;360(9331):473-482.
48. French S, Harnack L, Jeffery R. Fast Food Restaurant Use Among Women in the Pound of Prevention Study: Dietary behavioral and demographic Correlates. *International Journal of Obesity* 2000;24:1353-1359.
49. Cavadini C, Siega-Riz A, Popkin B. U.S. Adolescent Food Intake Trends from 1965 to 1966. *Archives of Diseases in Childhood* 2000;83:18-24.
50. Knutson R, Penn J, Boehm W. *Agricultural and Food Policy*. Prentice Hall, New Jersey; 1995.

51. Stewart H, Blisard N, Bhuyan S, Nayga R, . The Demand for Food Away From Home Full-Service or Fast Food?; 2004.
52. Byrne P, Capps O, Saha A. Analysis of Quick-serve, Mid-scale, and Up-scale Food Away from Home Expenditures. *The International Food and Agribusiness Management Review* 1998; 1:51- 72.
53. McCracken V, Brandt J. Household Consumption of Food Away from Home: Total Expenditure and by Type of Food Facility. *American Journal of Agricultural Economics* 1987;69:274-84.
54. Mancino L, Kinsey J. Diet Quality and Calories Consumed: The impact of being Hungrier, Busier, and Eating out.” Working Paper, 04-02, The Food Industry Center, University of Minnesota. In: *The Food Industry Center, University of Minnesota* 2004.
55. Hiemstra S, Kim W. Factors Affecting Expenditures for Food Away From Home in Commercial Establishment by Type of Eating Place and Meal Occasion. *Hospitality Research Journal* 1995;19:15-31.
56. Friddle C, Mangraj S, Kinsey J. The Food Service Industry: Trends and Changing Structure in the New Millennium. In: *The Retail Food Industry Centre, University of Minnesota*; 2001.
57. French S, Harnack L, Jeffery R. Fast Food Restaurant Use Among Women in the Pound of Prevention Study: Dietary behavioral and demographic Correlates. *International Journal of Obesity* 2000;24:1353-1359.
58. McCrory M, Fuss P, Hays N, Vinken A, Greenberg A, Roerts S. Overeating in America: Association between Restaurant Food Consumption and Body Fatness in Healthy Adult Men and Women ages 19 to 80. *Obesity Research* 1999; 7:564-571.

59. Purath J, Lansinger T, Ragheb C. Cardiac Risk Evaluation for Elementary School Children. *Public Health Nurs* 1995 12:189-195.
60. Jekanowski M, Binkley J, Eales J. Convenience, Accessibility and the Demand for Fast food *Journal of Agricultural and Resource Economics* 2001;26:58-74.
61. Yen S, Biing-Hwan L. Beverage Consumption Among U.S. Children and Adolescents: Full-Information and Quasi Maximum-Likelihood Estimation of a Censored System *European Review of Agricultural Economics* 2002;29(1):85-103.
62. Capps O, Clauson A, Guthrie J, Pittman G, Stockton M. Contributions of Nonalcoholic Beverages to the U.S. Diet, : U.S. Department of Agriculture, Economic Research Service; 2005.
63. Guthrie J, Morton J. Food Sources of Added Sweeteners in the Diets of Americans. *J Am Diet Assoc* 2000;100:43-48.
64. Frazao E. The American Diet: A Costly Health Problem. *Food Review* 1996;19(1):1-6.
65. Lin B, Huang C, French S. Factors Associated with Women's and Children's Body Mass Indices by Income Status. *International Journal of Obesity* 2004;28:536-542.
66. Kenkel D. Health behavior, health knowledge, and schooling, *Journal of Political Economy* 1991;99:287-305.
67. Huang K, Lin B. Estimation of Food Demand and Nutrient Elasticities from Household Survey Data: Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture; 2000.
68. Drewnowski A. Fat and Sugar: An Economic Analysis. *J. Nutr.* 2003;133::83S-840S.
69. Drewnowski A, Specter S. Poverty and Obesity: The Role of Energy density and Energy costs. *Am. J. Clin. Nutr.* 2004;79(6):6-16.

70. Basiotis P, Lino M. Food Insufficiency and Prevalence of Overweight Among Adult Women. *Nutrition Insights* 2002;26:1–2.
71. Mokdad A, Ford E, Bowman B. Prevalence of obesity, Diabetes, and Obesity-Related Health Risk Factors. *Journal of American Medical Association* 2003;289:76–9.
72. Rose D. Economic Determinants and Dietary Consequences of food insecurity in the United States. *Journal of Nutrition* 1999;129:517-20.
73. Variyam J. Economics and Rising Obesity. . *Amber Waves* 2005.
74. Gronau. Leisure, Home Production, and Work – The Theory of the Allocation of Time Revisited. *The Journal of Political Economy* 1977;85(6):1099-1124.
75. Sturm R. The Economics of Physical Activity: Societal Trends and Rationales for Intervention. . *American Journal of Preventive Medicine* 2004; 27(3S):126-135.
76. Curtin S, Hofferth S. Leisure activities and child overweight." Working Paper, Department of Family Studies. In: College of Health and Human Performance, University of Maryland; 2004.
77. Pratt M, Macera C, Sallis J, O'Donnell M, Frank L. Economic Interventions to Promote Physical Activity: Application of the SLOTH model. *American Journal of Preventive Medicine* 2004;27(3S):136-145.
78. Foster-Bey J. Sprawl, Smart Growth and Economic Opportunity: The Urban Institute, Metropolitan Housing Communities Policy Center, Program on Regional Economic Opportunities, Washington, DC; 2002.
79. Handy S, Boarnet M, Ewing R, Killingsworth R. How the built Environment Affects Physical Activity. Views form Urban Planning. *American Journal of Preventive Medicine* 2002;23(2):64-73.

80. Freeman L. The Effects of Sprawl on Neighborhood Social Ties. An explanatory Analysis. *Journal of American Planning Association* 2001; 67(1):69-77.
81. Derry A. Impacts of Our Built environment on Public Health. *Environmental Health Perspective* 2004;112(11):A600-601.
82. Morland K, Wing S, Roux A. The Contextual Effect of the Local Food Environment on Residents Diets: The Atherosclerosis Risk in Communities Study. *American Journal of Public Health* 2002 92:1761-1768.
83. Reidpath D, Burns C, Garrand J, Townsend M. An Ecological Study of the Relationship between Social and Environmental Determinants of Obesity. *Health and Place* 2002;8(141-5).
84. Salens B, Sellis J, Black J, Chen D. Neighborhood-based Differences in Physical Activity: An Environment Scale Evaluation. *American Journal of public Health* 2003;93:1552-1558.
85. Rosenberger R, Sneh Y, Phipps T. A Spatial Analysis of Linkage between Health Care Expenditures, Physical Inactivity, Obesity and Recreation Supply. *Journal of Leisure Research* 2002;37(2):216-235.
86. Plantinga A, Bernell S. A Spatial Economic Analysis of Urban Land Use and Obesity. *Journal of Regional Science* 2005;45(3):473-492.
87. Eid J, Overman H, Puga D, Turner M. Fat city: Questioning the relationship between urban sprawl and obesity *Journal of Urban Economics* 2008;63(385-404).
88. Coate D, M G. Effects of Alcoholic Beverage Prices and Legal Drinking Ages on Youth Alcohol Use. *Journal of Law and Economics* 1988; 31(1):145-171.
89. Grossman M. Health benefits of Increase in Alcohol and Cigarette Taxes. In: *National Bureau of Economic Research*; 1989.

90. Harris J. Increasing the Federal Excise Tax on Cigarettes. *Journal of Health Economics* 1982; 1:117-120.
91. Lewit E, Coate D. The Potential for Using Excise Taxes to Reduce Smoking. *Journal of Health Economics* 1981;1(2):121-54.
92. Ohsfeldt R, Boyele R, Capilouto E. Tobacco Taxes, Smoking Restrictions, And Tobacco Use. In: NBER 1998.
93. Bahl R. Why Levy Discriminatory Excises on Soft Drinks. In: School of International Studies Program, Policy Studies, Georgia State University; 1998.
94. Leicester A, Windmeijer F. The Fat Tax: Economic Incentives to Reduce Obesity. In: The Institute of Fiscal Studies; 2004.
95. Suter P. Is Alcohol consumption a risk factor for weight gain and obesity. *Critical Reviews in Clinical Laboratory Sciences* 2005;42(3):197-227.
96. Pogue F, Sgontz L. Taxing to Control Social Costs: The Case of Alcohol. *The American Economic Review* 1989;79(1):235-243.
97. Saffer H, Dave D. Alcohol Advertising and Alcohol consumption by Adolescents. In: NBER, Cambridge, MA 02138; 2003.
98. Parry I. Comparing the Marginal Excess Burden of Labor, Petrol, Cigarette, and Alcohol Taxes: An Application to the United Kingdom. In: Resource for the Future Washington D.C.; 2001.