IMPROVING FOOD ACESS IN SOUTH AND WEST BERKELEY: AN EVALUATION OF THE FARM FRESH CHOICE FARMERS MARKET PROGRAM

by

Matthew Thomas Messerschmidt

B.A. (Washington University, Saint Louis) 2002

A thesis submitted in partial satisfaction of the

requirements of the degree of

MASTER OF SCIENCE
in

Health and Medical Sciences

in the

GRADUATE DIVISION

of the

UNIVERSITY OF CALIFORNIA, BERKELEY

Committee in charge:

Professor William Satariano, Chair
Professor Linda Neuhauser
Professor Susan Ivey

Sping 2006

Table of Contents

TABLES AND FIGURES

PART I: REVIEW OF LITERATURE

1) THE EFFECTS OF DIET ON DISEASE

A) DIET HAS BEEN EXTENSIVELY LINKED TO CHRONIC DISEASE AND SPECIFIC DIETARY RISK FACTORS HAVE BEEN ESTABLISHED INCLUDING LOW INTAKE OF FRUITS AND VEGETABLES.

Introduction

Extensive research has led to consensus views that dietary habits are, among other lifestyle factors, major risk factors for a number of chronic diseases including certain cancers, cardiovascular disease (including hypertension, stroke, and coronary artery disease), type 2 diabetes, and obesity. A recent series of reviews in *Public Health Nutrition* (Nishida 2004b) highlights the role of diet in these diseases and is supported by other independent reviews (Glade 1999).

Generally, energy balance appears to be an important factor across many of these diet-related chronic diseases (DR-CDs). Dietary fats play a significant role as the most energy-dense macronutrient in the diet, and some dietary fats have been found to play more specific roles in specific diseases. While the role of dietary fat has been explored for more than 60 years now and has long been associated with DR-CDs, the role of fruits and vegetables in chronic disease prevention has only begun to emerge more recently. Although intake of these fruits and vegetables has strong epidemiologically links to chronic disease risk, the physiology of exactly which constituents (e.g. phytochemicals, fiber, energy density) confer which biological effects is the subject of much current research.

The Role of Diet in Obesity

The etiology and role of diet in many chronic diseases is complex and interrelated. For example, it is generally agreed that a positive balance in the number of calories consumed vs. the number of calories expended leads to weight gain. Overweight and obesity, in turn, are independent risk factors for certain cancers, cardiovascular disease (CVD), and type 2 diabetes (DM2). The common constellation of metabolic changes which include glucose intolerance, central obesity, hypertension, and dyslipidemia (decreased high-density lipoprotein cholesterol, elevated triglycerides) is termed the metabolic syndrome. This syndrome is associated with a three fold increase in DM2, and a two fold increase in CVD, and the term emphasizes the etiological interrelatedness of these diseases (Zimmet 2005).

It is generally agreed that regular physical activity, high-fiber diet, and high intake of dietary non-starch polysaccharides serve to protect against excess weight gain by increasing energy expenditure, decreasing caloric intake, and decreasing glycemic load of the diet respectively. Conversely, sedentary lifestyle and high intake of energy-dense, micronutrient-poor foods such as soft-drinks and sweetened fruit juice are established risk factors for excess weight gain because they oppose the metabolic mechanisms mentioned above. More recently, social factors such as supportive home and school environments, heavy marketing of energy-dense foods, and adverse social and economic conditions have been implicated as protective or risk factors for obesity (Swinburn 2004).

As plant-based diets have relatively low calorie density and high nutrient density, fruits and vegetables have the potential to play an important role in reducing energy intake while promoting satiety. Limited evidence of dietary interventions which specifically incorporate fruits and vegetables suggest that coupling advice to decrease total energy intake with advice to increase fruit and vegetable consumption is a particularly effective strategy for weight management (Rolls 2004).

The Role of Diet in Cancer:

Most major cancers are influenced by dietary habits (Go 2004). Over the past decade, the role for positive energy balance and obesity in the etiology of cancer have been strengthened and it has been suggested that consumption relative to expenditure may be the most important dietary factor for cancer in Western countries; however, a specific role for dietary fat or dietary fiber, beyond their roles in increasing and decreasing energy consumption, is no longer supported (McCullough 2004). Overweight and obesity increase the risk for cancers of the esophagus, colorectum, breast (postmenopausal), endometrium, and kidney.

Certain dietary components have been found to increase the risk of some cancers (see Table 1.1) (Key 2004). These include alcohol, aflotoxin, salted fish and other salt-preserved foods, preserved and red meats, and very hot food and drinks.

Table 1.1 Dietary components which increase the risk of site-specific cancers (Adapted from Key 2004).

Dietary Components	**Sites of Increased Cancer Risk**
Alcohol	Oral cavity, Pharynx, Esophagus, Liver, and Breast(small increase)
Aflotoxin	Liver
Chinese-style salted fish	Nasopharynx
Preserved meat and red meat	Colorectum, prostate (probable)
Salt preserved foods and high salt intake	Stomach (probable)
Very hot food and drinks	Oro-pharynx, esophagus (probable)

Fruits and vegetables, on the other hand, appear to decrease the risk for gastrointestinal cancers (mouth, pharynx, esophagus, stomach, colorectum, pancreas and possibly the larynx and kidney) as well as lung cancer (Key 2004) (Liang 2004) (Steinmetz 1996), though the effect size may be more moderate than first believed (McCullough 2004) (van't Veer 2000). More specifically, fruits appear to decrease the risk for bladder cancer and vegetables for ovarian cancer (IARC 2003) (Lock et al. 2005).

While it is suspected that particular micronutrients such as phytochemicals may be partially responsible for the cancer-protective effects of certain foods, especially fruits and vegetables, few micronutrients have been definitively shown to have significant effects (Heber 2004). However, folate deficiency, due to its role in DNA synthesis and methylation, has a strong causal effect in the development of colorectal, breast, uterine, and cervical cancers (McCullough 2004).

Role of Diet in Type 2 Diabetes

As in cancer, there is convincing evidence that positive energy balance increases the risk of developing type 2 diabetes mellitus (DM2) as body mass index (BMI) is associated with DM2 in a dose-dependent manner (Klein 2004), and overweight is the most important single risk factor for DM2 (Parillo 2004). Physical inactivity is also associated with an increased risk of DM2. Conversely, adults who are physically active and who maintain a normal BMI throughout adulthood have a decreased risk of DM2, and overweight adults with impaired glucose tolerance who lose weight voluntarily decrease their risk for DM2 (Steyn 2004),

It appears probable that a high intake of saturated fat and intrauterine growth retardation also increase this risk while non-starch polysaccharides are likely associated with a decreased risk. Though existing evidence is only suggestive, it is possible that omega-3 fatty acids, low glycemic index foods, and exclusive breastfeeding may be protective while total fat and trans-fat intake may contribute to the risk (Steyn 2004).

A role for fruits and vegetables in the prevention of DM2 has also recently emerged. A recent 20 year prospective cohort study found hazard ratios for development of DM2 in those consuming 5 or more fruits and vegetables a day to those consuming none was 0.79 (95% CI, 0.59–1.06) after adjustment for a host of physiologic and social variables (Ford 2001).

Role of Diet in Cardiovascular Disease

"Diet and nutrition have been extensively investigated as risk factors for major cardiovascular diseases (CVD) such as coronary heart disease (CHD) and stroke beginning in the late 1940's with the Twin Cities Study and the Framingham Study (Schneeman 2003).

The interrelation between diet and various chronic diseases is further elaborated when examining other DR-CDs as major risk factors for CVD. As described above, factors of the metabolic syndrome (obesity, high blood pressure and diabetes) are independent risk factors for CHD and are themselves partially determined by dietary habits. Further, there is sufficient evidence to link several nutrients, minerals, and food groups with risk of CVD. Beyond the role played in energy balance, some dietary fats (trans-fats and saturated fats) are associated with an increase in the risk of CHD, while others (polyunsaturated fats) are protective. Dietary sodium has long been associated with increased blood pressure which increases the risk of CVD while dietary potassium lowers the risk of hypertension and stroke (Reddy 2004). Simple carbohydrates with a high glycemic load have also been associated with increased risk of CHD (Liu 2000).

Frequent intake of fruits and vegetables appears protective against hypertension, CHD and stroke (Reddy 2004). Recent prospective cohort studies have shown that, even after adjusting for standard cardiovascular risk factors, persons in the highest quintile of fruit and vegetable intake have a 20% to 30% reduced risk of CVD compared to cohort members in the lowest quintile. (RR for CVD was 0.68 [95%CI 0.51, 0.92]; RR for CHD was .80 [95%CI .69-.93]; and RR for stroke of 0.69 [95%CI 0.52-0.92]) (Liu 2000; Joshipura 2001; Joshipura 1999). Each 1-serving per day increase in intake of fruits or vegetables was associated with a 4% lower risk for CHD and a 6% lower risk for stroke (Joshipura 2001; Joshipura 1999). Similar findings for peripheral vascular disease became insignificant after adjusting for common risk factors (Hung 2003). Green leafy vegetables, and vitamin C-rich fruits and vegetables contributed most to the apparent protective effect of total fruit and vegetable intake (Joshipura 2001).

Role of Mothers' Diet in Chronic Disease

Beyond the effects that a person's diet has on that individual, poor diet may have multi-generational effects on chronic disease and health status.

Mother's diets have been shown to be significant determinants of fetal birth-weight via both overall dietary quality and specific nutrient deficiencies such as folate deficiency and n-3 fatty acid deficiency. Low birth weight, in turn, is *independently* a risk factor for a variety of adult chronic diseases such as hypertension, diabetes, abdominal obesity, and coronary heart disease. When these children become mothers themselves, those with chronic diseases are more likely to bear low birth weight infants thus continuing the cycle (James 1997).

There has been significant exploratory research into the possibility of environmental imprinting "i.e. exposure in early life or even prenatally that predisposes individuals to later obesity" (Oken 2001, p285). Multiple studies in a number of western countries have examined infant birth weight and found clear associations between being born large for gestational age and the risk of becoming overweight later in life. Less intuitively, however, the smallest babies have also been found to have an increased risk for obesity, especially central obesity, in adolescence and later in life. Central obesity, in turn, has been shown to be a strong, independent risk factor for the development of metabolic syndrome (Oken 2001).

Role of Diet in Other Chronic Diseases

Beyond the established role of diet in the diseases described above, there is a possible role of low fruit and vegetable intake in the risk for COPD, cataract formation, diverticulosis, and hypertension (Van Duyn 2000). Functional declines associated with aging and all cause mortality have been associated with low fruit and vegetable intake as well (Heber 2004).

In many poor countries, two other nutritionally-related chronic disease states are particularly significant. The original Global Burden of Disease Project identified protein-calorie malnutrition as the single greatest contributor to overall disease burden (15%), and despite a decrease in

prevalence in most of the world, this form of malnutrition continues to contribute the greatest dietary burden of disease globally (Lock 2005). Relatedly, one-third of the world's population is affected by vitamin and mineral deficiencies and is thereby subject to infection, birth defects and impaired physical and psycho/intellectual development (WHO 2000).

Also significant in many poor countries, is the increased burden of dental carries caused by poor diet. Protein-calorie malnutrition can affect the teeth during development and may exacerbate periodontal and oral infectious diseases, but the most significant effect of diet on teeth is the local action of dietary sugars and acids (a major source of which is soft drinks) in the development of dental caries and enamel erosion (Moynihan 2004).

B) Nutrition-Related Chronic Disease Accounts for a Significant Burden of Disease in the US and in Low Income, Middle Income Countries

Introduction

Many of the nutritionally-related chronic diseases described above constitute the major chronic diseases of the United States and other developed countries. These diseases have been the major causes of morbidity and mortality in many western countries for the last century and are increasingly important in middle income and developing countries as they undergo similar, though often more rapid, demographic, epidemiologic and nutritional transitions. Worldwide, DR-CDs (cardiovascular disease, diabetes, stroke, and cancer) account for 38% of the 57 million annual deaths representing 19% of the total life-years lost (WHO 2002).

The Demographic, Epidemiologic, and Nutrition Transitions

As described by Omran (Omran 1977), the mortality decline in the US occurred during the latter 19th century and marked a shift from pandemics of infection to degenerative and man-made diseases. In 1900 the percentage of total deaths due to communicable diseases was 53%, but by

1970, this proportion had dropped to 6%. Little of this decline was due to medical progress, sanitation measures, or organized health services. More important determinants were improvements in living standards, personal hygiene, nutrition, housing, and ecologic recession of certain diseases. Certain infectious diseases may have lessened in virulence and occurrence through ecological means which are not entirely known.

However the proportion of deaths due to chronic disease increased over this time. "As the risk of dying from infectious diseases is reduced for a population, those saved from dying from such diseases survive into middle and older ages where they face the risk of dying from [chronic] diseases" (Olshansky 1986). For example, the proportion of deaths due to heart disease increased from 8.0% in 1900 to 39% in 1970 and for cancer, proportional mortality increased from 4% in 1900 to 17% in 1970 (Omran 1977).

The change from a pattern of high prevalence of infectious diseases associated with malnutrition, and periodic famine and poor environmental sanitation, to a pattern of high prevalence of chronic and degenerative diseases associated with urban–industrial lifestyles was first described by Omran (Omran 1977) and is termed the Epidemiologic Transition. A third pattern of delayed degenerative diseases has been observed more recently as some countries have had success at delaying the onset of chronic diseases in their populations (Olshansky 1986).

Accompanying this progression is a major shift in age-specific mortality patterns and a consequent increase in life expectancy. In some countries, a shift from a pattern of high fertility and high mortality to one of low fertility and low mortality (typical of modern industrialized countries) has taken place and is termed the demographic transition (Olshansky 1986).

Nutritional Transition theory has been developed to describe the changes in food consumption that accompany and are interrelated to these demographic and epidemiologic changes. While 5 patterns of nutrition across time and space have been described (collecting food, famine, receding famine, nutritionally-related non-communicable disease, and behavioral change) (Popkin 2002), current focus is usually on the latter three patterns as many low- and

moderate-income countries of the world move rapidly from the stage of receding famine to the stage of nutritionally-related non-communicable diseases, and many equate the term Nutrition Transition with this shift.

Recent Trends in Chronic Disease and Life Expectancy in the US

As noted in epidemiologic transition theory, as childhood infectious disease rates were reduced, chronic diseases came to dominate as causes of mortality during the second half of the 20th century in the United States. During this period, heart disease and stroke were the first and third leading causes of death respectively, and cancer was the second leading cause of death throughout the period (NCHS 2004).

Prevalence of these chronic diseases has continued to increase as the US population ages despite stagnation or reduction in the incidence of these diseases. In 2002 life expectancy at birth for the US population reached a record high of 77.4 years, up from 75.4 years in 1990. However, men and women in many other countries have longer life expectancies than in the US For example, in 1999 life expectancy at birth in Japan was more than 3 years longer for men and more than 4 years longer for women than in the United States (NCHS 2004).

The reduction in mortality over the last half of the 20th century was driven primarily by declines in mortality for such leading causes of death as heart-disease (59% decline 1950-2002), stroke (69% decline 1950-2002), and unintentional injury as well as in infant mortality (NCHS 2004). Factors which have contributed to the decline in heart disease and stroke mortality include better control of risk factors, improved access to early detection, and better treatment and care (NCHS 2004). Risk factor reduction includes a substantial decline in cigarette smoking, better lifestyle and pharmacological management of hypertension and dyslipidemia, and improvements in diet (MMWR1999).

Trends in cancer are more complex. Age adjusted mortality rates rose from 1960 to 1990 and have since reversed direction. While overall cancer incidence rates have been falling since 1990

(driven by a reduction in lung cancer incidence), incidence rates for individual cancers show mixed changes (NCHS 2004). It is unclear how these changes relate to changes in dietary habits on a national level.

Many authors have warned that while gains in the areas of heart disease, stroke and cancer are heartening, these areas may be off-set by a new epidemic of obesity. The percent overweight and obese changed little from 1960 to 1980, but data from 1988-2002 show substantial increases in overweight and obesity among adults. In 1999-2002, 65% of adults were overweight with 31% obese. The increases in obesity are closely paralleled by increases in the rates of type 2 diabetes. Data from the National Health Interview Survey show a four fold increase in the prevalence of diagnosed diabetes over the latter half of the 20th century, and the most recent data from the National Center for Health Statistics show that approximately 9.1% of the US population had type 2 diabetes during 1999-2002, up from 8.4% during 1988-1994 (NCHS 2005).

Recent Trends in Nutrition and Chronic Disease Worldwide

While DR-CDs were once referred to as diseases of affluence, for decades this has not been true in higher-income countries, and this is increasingly not the case in the lower- and middle-income countries. Overall, four-fifths of the world's burden of DR-CD comes from the low- and moderate-income countries, and many low- and middle-income countries have now attained rates of overweight and obesity greater than or equal to those of the US and Western Europe (Popkin 2002). Further, many households in developing countries are now experiencing both under- and overweight in the same home as urbanization and changes in income structure create complex changes in dietary and social behaviors (Popkin 2002).

Modern societies appear to be converging on a pattern of diet high in saturated fat, sugar and refined foods and low in fiber which is often termed the 'Western diet' (Popkin 2002). In Mexico, Brazil, Venezuela and other Latin American countries, diets have diversified and the proportion of animal protein in the diet has risen improving diets, especially for the poor.

However, these modern transitions have also introduced processed foods and sedentary lifestyles. Along with the changes in food patterns, changes in morbidity and mortality rates have taken place as well; for instance, the prevalence of diabetes has recently doubled. Similarly, as China undergoes its own nutritional transition, rates of hypertension, obesity, and stroke are increasing there as well. In contrast, the nutritional transitions of Japan and South Korea resulted in improved nutrition without causing severe increases in obesity or DR-CDs, probably because the traditional diet was essentially maintained as new food products were introduced (Bengoa 2001). Thus while much of the world is experiencing debilitating effects of modern nutritional changes, opportunities do exist to guide such changes in a healthy and productive direction.

C) SES AND RACE ARE IMPORTANT DETERMINANTS OF POOR HEALTH INCLUDING CHRONIC DISEASE.

Unequal Distribution of Poor Health

Despite increased lifespan and reduction in the incidence of both infectious and some chronic diseases in developed countries, these improvements have not been equally distributed by income, education, and race/ethnicity, and geography. Importantly, from a social justice standpoint, dietary-related chronic diseases have a greater impact in poor and minority groups throughout the life course.

While low income and poverty have long been associated with poor health status and increased mortality rates, Marmot was the first to demonstrate a graded relationship between socio-economic status and several chronic diseases. This gradient has now been observed in different countries and for almost all causes of morbidity and mortality as well as for important health risk factors such as tobacco, obesity, and blood cholesterol levels (Dubois 2001).

Mortality rates also vary by educational attainment. In 2002 the age-adjusted death rate for persons 25–64 years of age with fewer than 12 years of education was 2.7 times the rate for persons with 13 or more years of education (NCHS 2004).

In the US, race is intricately linked with poverty, education, and geography, and has also been a focus of health disparity research. In 2002 more than one-half of black and Hispanic children under 18 years or 65 years and over were either poor or near poor (NCHS 2004). Death rates for African Americans exceed those for whites of the same gender for each of the top causes of mortality and are especially severe for infant mortality. This has been true throughout US history, but the excess mortality experienced by black persons has exhibited marked fluctuation ranging between 45% and 75% over the 20th century. This disparity peaked in the late 1920s and early 1930s, then declined until the mid 1960s and has since been rising (Gaylen 1997). Similarly, disparities in mortality rates on the basis of income and education have also increased over the years 1960 to 1986 (Gaylen 1997).

In 2002 age-adjusted death rates for the black population exceeded those for the white population by 41% for stroke, 30% for heart disease, 25% for cancer, and more than 75% for HIV/AIDS. Similar disparities can be seen in breast cancer mortality, prostate, lung, and colorectal cancer incidence, diabetes, and obesity (NCHS 2004). It is generally believed that the differences in health status by race may be explained by several factors including socioeconomic status, health practices, psychosocial stress and resources, environmental exposures, discrimination, and access to health care (NCHS 2004).

Geographic areas have been found to exhibit racial mortality disparities in stark contrast. For example, a 1990 study found that African American males in Harlem were less likely to reach age 65 than males in Bangladesh, and the mortality rates in African Americans in Harlem were more than twice those of US whites (Gaylen 1997).

Nutrition Disparities Help to Explain Health Disparities

Among the many factors causing health disparities, diet has been implicated as one cause of the overall poorer health of those in lower socio-economic groups (Lynch 1997). The graded influence of social position on the quality of the diet indicates a possible intermediary role for nutrition in the distribution of social health inequalities in North America and Britain. Such a role has been supported by population surveys in Brittan, Canada, and the US which relate lower socioeconomic status with a number of indices of dietary quality.

For example, a British study found intake of nutrients as a percentage of the recommended intake to be lower in lower in low-income groups with intakes for many nutrients (iron, calcium, dietary fiber, folate, and vitamin C) below recommended levels (James 1997).

Likewise, an examination of national survey data from the US and Canada looked at variations in energy and 26 to 31 nutrients across four indicators of social position: relative education, income adequacy, working class, and a global socio-economic status scale. There was a graded association for nearly all of the measures of nutrition across all four of the socioeconomic indicators leading the authors to conclude that these indices of socioeconomic status tap a broader construct (Dubois 2001, p371).

Ethnic differences in eating patterns have also been reported. For example, a study by Neumark-Sztainer found American Indians were at highest risk for inadequate fruit consumption and African Americans were at greatest risk for inadequate vegetable consumption (Neumark-Sztainer 1996). A review of disparities in cancer mortality and etiological factors emphasized the importance of socioeconomic status in explaining Black-White differences in cancer risk and survival (Polednak 2005).

Food Insecurity has been Associated with Poor Dietary Behaviors

In the US, researchers have more traditionally looked at the relationship between diet and poverty as it relates to the concept of food security. "Food insecurity implies a limited access to

or availability of food or a limited or uncertain ability to acquire food in a socially acceptable way" (Holben 2004, p238). Food insecurity can result in suboptimal quality of life and health and its results can be especially severe in children (Holben 2004).

Examination of NHANESIII data indicate that 10.2 million persons living in the United States experience food insufficiency, a condition in which persons sometimes or often do not have enough food to eat, and households with children experienced food insecurity at rates greater than the national average (Dixon 2001). Other characteristics associated with being food insecure are: having an income below the official poverty line, being headed by a single woman, and living in a rural area (Holben 2004).

Other analysis of national nutrition data indicate lower intakes of energy, protein, many vitamins and minerals, and gram amounts of various food groups by children, women of child-bearing age, and elderly members of food-insufficient households compared to their food sufficient counterparts (Dixon 2001). Even when receiving combined aid from Food Stamps, Aid to Families with Dependent Children, and Supplemental Security Income, some poor people have not been able to meet their nutritional needs (Moorland 2002a).

Despite the wealth of studies describing nutritional disparities, and linking them with disparities in morbidity and mortality, no research was found explicitly examining trends in nutritional disparities over time.

Other Health Related Behaviors Also Help to Explain this Disparity

While there is convincing evidence that differences in dietary practices are one mechanism by which chronic disease rates are increased among persons of low SES, it is important to recognize other lifestyle factors that also play major roles in DR-CD rates, chief among these are smoking and physical activity.

As described above, the reduction in smoking prevalence is one of the main factors that has driven the reduction in heart disease over the latter half of the twentieth century. However, like

other factors, this reduction has not been equally distributed. In 2002, only 25% of US men and 20% of US women were smokers; however, adults with less than a high school education were three times as likely to smoke as were those with a bachelor's degree or more education in 2002 (NCHS 2004).

Also in 2002, the percent of US adults 18 years of age and over who were inactive during their leisure time increased sharply with age and was higher for women than men. Among adults 18–44 years of age, 30 percent of men and 35 % of women were inactive during leisure time. In 2003, one-third of high school students, about the same as in 2001, did not engage in the recommended amounts of moderate or vigorous physical activity (NCHS 2004). Likewise, in Britain, the likelihood of smoking more than 20 cigarettes a day, or being physical inactive were observed to increase in a step-wise fashion with decreases in social class (James 1997).

However, known biomedical and behavioral risk factors do not explain all of the inequalities between socioeconomic position and morbidity and mortality leaving the door open for theorizing about the social, psychological, and other effects of social status and neighborhood characteristics on health (Krieger 1997; Dubois 2001).

D) Population Attributable Risk (PAR) Quantifies the Portion of Risk due to Inadequate Diet and Fruit and Vegetable Intake

Overview of PAR

Estimates have been created to quantify the portion of chronic disease due to dietary factors. Most commonly, these estimates are expressed in the form of Population Attributable Risk (PAR) which is the incidence of a disease in a population that is associated with (i.e. attributable to) the risk factor of interest (Last 2001). These estimates show that changes in dietary habits could significantly reduce rates of DR-CDs. They also emphasize that, to be most effective, an

improved diet (high in fiber, vegetables, and fruit and low in meat and fat) should be accompanied by changes in other major lifestyle risk factors including avoiding smoking, alcohol use, and weight gain and engaging in sufficient exercise (James 1997, Cerhan 2004).

The total worldwide mortality associated with suboptimal consumption of fruits and vegetables was estimated to account for 1.8% of the GBD. By comparison, 1.3% of GBD is attributable to physical inactivity, 2.3% to overweight and obesity, and 4.1% for tobacco. In developed countries, the attributable mortality was about 7.5% (Lock et al. 2005).

Percent of Cancer Risk Attributable to Diet

In the 1980's Doll and Peto estimated that 35% (range 10% to 70%) of cancer in the US could be diet-related (i.e. preventable by practicable dietary means) (Doll 1981), and they later estimated nutritional factors to contribute to 20-60% of cancers worldwide (Doll 1992). Following the seminal work of Doll and Peto, a consensus soon emerged among epidemiologists that diet might be responsible for 30-60% of cancers in the developed world and that the principal dietary changes required to bring about reduction in cancer incidence were a reduction in the consumption of fat; an increase in the consumption of fruit, green and yellow vegetables, dietary fiber, and some micronutrients; and possibly an improvement in the methods of food preservation (Doll 1981; Doll 1992; Glade 1999; Key 2004).

The strongest evidence for effective dietary cancer prevention is found in studies showing benefits of eating a substantial amounts and variety of fruits and vegetables. (AICR 1997). Diets containing substantial and varied amounts of vegetables and fruits were estimated to prevent 20% or more of all cases of cancer and 11% (95%CI 5-24%) for cancer mortality (Glade 1999).

Estimates for specific cancers have also been made and have consistently shown stomach, colorectal, and esophageal cancers to have the highest PAR due to diet. The AIRC panel estimated that stomach and colorectal cancer incidence may be reduced by 66-75% and 50-75% of esophageal CA may be preventable through dietary means (AIRC 1997; La Vecchia 1996).

More recent estimates indicate that an increase in fruit and vegetable intake to recommended levels might reduce gastrointestinal tract cancer incidence by 15%-40% (La Vecchia 2004; Lock 2005).

A detailed review of PARs for each of the major cancers can be found in the 1997 AIRC report and some more recent studies have been published, but in general, cancers of the mouth and pharynx, nasopharynx, pancreas, gall bladder, breast, endometrium, and ovary have PARs due to diet of approximately 30-50%, and 10-20% of the incidence of cervical, prostate, and bladder cancers may be preventable by dietary means (AICR 1997). Fruit and vegetable intake specifically may prevent 10-20% of breast cancer and prostate cancer and 20-30% of lung cancers (AIRC 1997). These findings are supported by other analyses which have used betacarotine levels as a biomarker for fruit and vegetable intake. (Mezzetti 2000; Negri 1993; La Vecchia 1996)

Percent of CVD Risk Attributable to Diet

While there are a number of studies that quantify the percent of CHD due to cholesterol, diastolic blood pressure, cigarette smoking, and other risk factors modifiable by dietary and lifestyle means (cumulative PARs of these factors are approximately 80%), none gives a broader assessment of the PAR of CHD due to diet. Other CVD endpoints such as ischemic heart disease and congestive heart failure are similarly analyzed and have PARs for known modifiable risk factors of approximately 40-70% and 40-60% respectively (Chambless 2003).

A recent study investigating hypertension, a major risk factor for other cardiovascular events, compared the relative contributions of body weight (PAR 11-25%), physical inactivity (PAR 5-13%) and dietary factors such as high sodium (PAR 9-17%), low potassium (PAR 4-17%), low magnesium (4-8%) and low fish fatty acids (3-16%) to the prevalence of hypertension in a variety of western countries (Geleijnse 2004).

An evaluation of the Dutch population (van't Veer 2000) calculated that cardiovascular deaths (including stroke) could be reduced by 16% [range 6-22%] by increasing average fruit and vegetable intake from the current 250g/day to the recommended 400 g/day. Similarly, increasing fruit and vegetable intake to 600g/d was estimated to reduce worldwide burden of disease for ischemic heart disease by 31%, and ischemic stroke by 19% (Lock 2005).

Percent of Type 2 Diabetes Risk Attributable to Diet

As for cardiovascular disease, although dietary behaviors are risk factors for diabetes, PAR calculations have focused on more immediate risk factors such as overweight/obesity, lack of exercise, poor diet, smoking, and alcohol use. Ability to correct these behaviors in the population is estimated to reduce the incidence of diabetes by as much as 87% (Hu 2001).

Burden of Disease Attributable to Poverty

Given the disparities in health discussed above, it is interesting to look at the effect of income through the lens of PAR. If poverty had been listed as a cause of death in the United States in 1991, it would have ranked as the third leading cause of death among black men, fourth among black women, sixth among white women, and eighth among white men. Paralleling trends in increasing income and racial disparities, the PAR of death due to poverty increased between the early 1970's and early 1990's, especially among black men and women (Krieger 1997).

E) Dietary Risk Factors Have Been Used to Create Dietary Recommendations Including Increased Intake of Fruits and Vegetables

"Leave your drugs in the chemist's pot if you can heal the patient with food." ~ Hippocrates (Schneeman 2003)

Evolution of Dietary Recommendations

For the past 150 years dietary recommendations have been based on the sciences of public health and medicine. During the first half of the 20th century the focus of recommendations was on sanitation and the prevention of nutrient deficient diseases (Schneeman 2003). This was particularly applicable as the US was transitioning to an industrial economy and as nutrition deficiency was a problem for a large portion of the population during the Great Depression.

As evidence emerged linking diet to chronic disease in the second half of the 20th century, recommendations followed suit (Schneeman 2003). Behavioral risk factor identification has led to dietary recommendations by many non-governmental organizations focused on specific chronic diseases (e.g. AHA, NCI, NCEP, NIH, NHLBI, NHBPEP AICR/WCRF, ACS) as well as by divisions within the US government (e.g. USDA, DHHS). As evidence regarding the etiological interrelatedness of these diseases has emerged, these groups have joined together to release more unified recommendations

Recommendations are often categorized into quantitative and qualitative recommendations. Quantitative recommendations are technical guidelines which focus on determining the adequate amount of various nutrients (e.g. RDA, DRI) and are used to make population recommendations, to determine individuals with dietary deficiencies, and to validate food-based dietary guidelines. Qualitative recommendations express nutrition principles in terms of foods and dietary patterns and are more appropriate for education and communicating with the public (Schneeman 2003).

While a complete review of all the relevant dietary guidelines is beyond the scope of this paper, a brief overview of the USDA Dietary Guidelines will be given to demonstrate the changing nature of qualitative recommendations for Americans while focusing on the role of fruits and vegetables in these recommendations.

USDA Dietary Guidelines

USDA *Dietary Guidelines* have been published every five years beginning in 1980 (Krebs-Smith 2001). These recommendations represented a departure from previous "foundation diet" recommendations like the *Basic Four* or the *Four Food Groups* in that in addition to promoting nutritional adequacy, it attempted to provide recommendations about proportionality and moderation of all foods consumed – i.e. the "total diet concept" (Dixon 2001a).

Guidelines from the early 1980's emphasized food components such as fat and fiber stating "eat foods with adequate starch and fiber" with the intention of substituting calories from fats and sweets with complex carbohydrates. (Krebs-Smith 2001). Beginning in 1990, the dietary guidelines were changed to emphasize variety stating "Choose a diet with plenty of vegetables, fruits, and grain products." Also, for the first time, a minimum serving of fruits (2) and vegetables (3) were recommended based on a system also used to develop the food guide pyramid which was released in 1992. 1995 recommendations introduced the concept of serving ranges, and the 2000 recommendations further emphasized eating a variety of fruits and vegetables by making a separate recommendation apart from that for grains (Krebs-Smith 2001).

The most recent USDA dietary guidelines, released in 2005, continue to be based on the food pyramid and include the role of physical activity in weight control as well as the importance of food safety. They also go further in describing how to achieve a variety of fruits and vegetables stating, "In particular, select from all five vegetable subgroups (dark green, orange, legumes, starchy vegetables, and other vegetables) several times a week" (USDA 2005).

Throughout their history, USDA dietary guidelines have recommended getting required nutrients through foods rather then dietary supplements. This stance remains true of the most recent recommendations as few dietary supplements have been shown to be beneficial except in particular cases of nutrient deficiency.

Other Dietary Guidelines

Other broad-based dietary guidelines are essentially in accordance with the USDA guidelines. For example, USDA Dietary Guidelines for Americans, USDHHS Healthy People, and WHO all place dietary behavioral recommendations along side recommendations to achieve energy balance and healthy weight. Each has specific recommendations to increase fruit and vegetable intake and mentions the need for part of the vegetable intake to be from dark green or deep yellow vegetables. Table 1.2 summarizes recent dietary recommendations regarding fruit and vegetable consumption.

Similarly, dietary and lifestyle recommendations put out by non-profit agencies focusing on research and prevention of specific chronic diseases have begun to merge. In general, these organizations now recommend a diet low in fat and red meat and high in fruits, vegetables and grains. Beyond these basic dietary recommendations, more specific recommendations to increase or decrease particular nutrients are given for various diseases. For example low intake of trans-fats appear in the cardiac disease specific recommendations (NIH, NHLBI, NHBPEP 1997; NCEP 2001; AHA 2005), but not in the cancer-specific recommendations (NCI 2005a; NCI 2005b; ACS 1996; Glade 1999); however, the broader recommendation to reduce fat consumption is given in both. Similarly reduced consumption of salt is recommended for reducing risk of hypertension (NIH, NHLBI, NHBPEP 1997), but also for decreasing risk of colorectal and possibly other GI cancers (NCI 2005b).

In order to aid the public and researchers in operationalizing and implementing these recommendations, a number of composite diets have been created. Examples include the DASH

diet, Mediterranean diet, the American Heart Association's prudent diet, and the Ornish diet. These diets often emphasize the role of fruits and vegetables in maintaining a healthy diet (Chahoud 2004).

Table 1.2 Summary of Dietary Recommendations for Fruits and Vegetables

Organization Name	Year	Recommendation
USDA Dietary Guidelines for Americans	2005	1) Eat 2 cups fruit and 2.5 cups vegetables per day for a 2000 calorie diet. • Children ages 2 to 6 years, women, some older adults (about 1,600 calories) 3 servings of vegetables 2 servings of fruit. • Older children, teen girls, active women, most men (about 2,200 calories) 4 servings of vegetables 3 servings of fruit. • Teen boys, active men (about 2,800 calories) 5 servings of vegetables 4 servings of fruit. 2) Choose a variety of fruits and vegetables each day. In particular, select from all five vegetable subgroups (dark green, orange, legumes, starchy vegetables, and other vegetables) several times a week.
US Department of Health and Human Services, National Institutes of Health, National Cancer Institute	2005	1) Little kids (ages 2 to 6) should eat a minimum of 5 servings a day 2) Older kids, teen girls, and active women at least 7. 3) Teenage boys and active men at least 9. 4) Eat a variety of colorful fruits and vegetables — green, yellow-orange, red, blue-purple, and white.
USRDA	2004	Gives recommendations for micronutrients, macronutrients, and daily calorie intake but does not give recommendations by food type.
2002 Joint WHO/FAO Expert Consultation	2002	1) ≥400g/day fruits and vegetables
US DHHS Healthy People 2010 Goals	2000	1) increase the proportion of persons >2y old who consume at least 2 daily servings of fruit. 2) increase the proportion of persons >2 who consume at least 3 daily servings of vegetables with at least one third being dark green or deep yellow vegetables
American Heart Association Eating Plan for Healthy Americans	2000	Eat a variety of fruits and vegetables. Choose 5 or more servings per day.
WCRF/ACIR	1999/ 1997	1) Eat 400–800 g (15–30 oz), or at least five portions (servings) a day of a variety of vegetables and fruits (not including grains, legumes, roots, tubers, and plantains), all year round (calculated on the basis of 2000 Kcal daily energy intake and 80 g per portion; children's portions and goals should be proportionately smaller).
1989 WHO Study Group	1989	1) ≥400g/day fruits and vegetables 2) ≥30g/day pulses, nuts and seeds as part of 400g fruits and vegetables

Efficacy of Diet Related Recommendations

A number of studies have looked at diets as a whole but have found mixed results when examining the protective effects of dietary recommendations for reducing DR-CD risk. Studies of the Breast Cancer Detection Project (Kant 2000) and a Sweedish cohort (Michels 2002). found significantly decreased risk of total mortality (RR 0.69, n/a), cancer mortality (RR 0.64, 0.76), coronary heart disease mortality (RR 0.67, 0.47), and stroke mortality (RR 0.58, 0.40) when comparing highest and lowest quartiles of adherence to the USDHHS Recommended Food Score.

However, data from the Nurses Health Study found only weakly reduced risk of CVD incidence and mortality and no change in risk for cancer incidence or mortality for high vs. low adherence to the Recommended Food Score (McCullough 2000). Similarly, studies of the USDA's Healthy Eating Index, which is based on the food pyramid and the 1995 Dietary Guidelines for Americans, showed only weak associations with CVD risk and was not associated with cancer risk (USDHHS 1995). A follow up analysis of highest vs. lowest quartiles of a modified Healthy Eating Index, showed that healthy diet was inversely associated with CVD risk (RR 0.72) but not cancer risk (RR 0.97) (McCullough 2002).

The 1997 AIRC panel estimated that their recommendations, if widely adopted, could reduce the incidence of new cancers by 30% to 40%. (AICR 1997) Cerhan et al. (Cerhan 2004) operationalized these recommendations, which included dietary recommendations for daily consumption of fruits and vegetables, complex carbohydrates, red meat, fat, sodium, and alcohol as well as recommendations for limiting weight gain and maintaining physical activity. Using the Iowa Women's Health Study (IWHS) cohort, PARs for both cancer and cardiovascular disease incidence and mortality were produced. "Irrespective of smoking status, if all women had followed six to nine versus less than six recommendations, 22% of cancer incidence and 11% of cancer mortality could have been delayed or prevented but only 4% of CVD mortality and 9% of the total mortality. If all of these women had never smoked cigarettes and had followed six to

nine recommendations, 31% (95% CI 19-37) of the cancer incidence, 30% of the cancer mortality (95% CI 15-40) and 22% (95% CI 4-36) of the CVD mortality could have been delayed or prevented . However, when BMI, weight gain, and physical activity were excluded, there was no association between the number of dietary recommendations followed and cancer incidence or mortality, CVD mortality, or total mortality. A similar effect was found in this cohort when adherence to the 2000 Dietary Guidelines for Americans was analyzed (Harnack 2002).

While the fact that controlling for BMI and weight gain reduced the effect size of the dietary recommendations, it is important to keep in mind that these two factors also represent primary mechanisms by which improved diet is thought to work. That is, healthy diets are generally low in calories but relatively high in micronutrients. If, as would be expected in these cohorts, substantial micronutrient deficiencies are less common than high calorie diets, then dietary improvements such as increases in fruits and vegetables would be more likely to show effects via improved caloric balance than through other factors. As described above, further research on the biochemical effects of dietary subcomponents in whole foods and supplements will help elucidate the extent of their effect.

F) DIETARY TRENDS AND PRACTICES IN THE US SHOW MINIMAL CHANGE AND COMPLIANCE WITH DIETARY GUIDELINES FOR FRUITS AND VEGETABLES

Introduction

Thus there is substantial evidence that dietary factors are important mediators of NR-CD risk and that a diet high in fruits and vegetables, and complex carbohydrates and low in saturated and trans fats, and red meat, along with other major lifestyle factors such as weight maintenance, physical activity, and not smoking, can play an important role in reducing the burden of NR-CDs in both wealthy and poor nations. Despite the risk of disease and the scientifically based

recommendations, US dietary practices show only moderate changes toward compliance with dietary guidelines. This review will focus on dietary trends in fruit and vegetable intake.

Fruit and Vegetable Food Supply Data

There are three main ways to measure dietary trends: food supply, foods acquired, and foods consumed. Food supply data, recorded by the Economic Research Service of the USDA, has the advantage of a long history of data collection (from 1909 for most commodities) and thus it offers the only source of lengthy time series data on food use in the US. While per capita food supply data substantially overestimates servings of food per person (due to inedible portions, waste, and other losses) ERS has created adjustment methods that are relatively robust allowing for comparison with *Pyramid servings per day* (Krebs-Smith 2001). These calculations may underestimate actual consumption of dark green and leafy vegetables, some berries, squashes, and many "exotic" fruits and vegetables, but consumption of these products appears quite low by other measures so the errors probably have little effect on the overall estimates.

Generally, food supply data show that vegetable servings are within 10% of minimum recommended levels, but that fruit servings are more than 50% below recommended levels (French 2001). The 1998 food supply data showed 5.3 servings of fruits and vegetables per person per day representing a 24% increase from 1970. Most of this increase occurred after the 1980 release of the *Dietary Guidelines*. More specifically, per capita fruit consumption increased from 1.1 servings/day in 1970 to 1.4 servings in 1998 but still falls far short of the recommended 3 servings/day. Vegetable consumption increased from 3.1 servings/day in 1970 to 4 servings in 1998 thus meeting the recommendation for vegetable servings (French 2001, Krebs-Smith 2001). However, starchy vegetables made up more than 40% of vegetable servings and this category was dominated by fresh and frozen potatoes which made up over 50% of servings. Dark green and leafy vegetables accounted for less than 10% of vegetable servings up only slightly since the

pyramid was introduced in 1992, and other vegetables – over half from iceberg lettuce and tomatoes - made up a disproportionate 48% of total vegetable servings (Krebs-Smith 2001).

Fruit and Vegetable Foods Acquired Data

Data on food expenditure patterns by households of different socioeconomic and demographic characteristics are collected by the Bureau of Labor Statistics of the US Department of Labor through the Consumer Expenditure Survey. This survey uses both two week diary and interview data to capture small regular purchases and larger irregular purchases respectively. Data collection began in 1980 and the most recent available data is for 2003 (US Department of Labor 2003). Data available online show an increase in spending of 12.3% from 1997 to 2003 but whether this represents a real increase in quantity purchased needs further investigation and correction for inflation (US Department of Labor 2003).

Fruit and Vegetable Individual Intake Trends

Individual dietary surveys are conducted at both the national and local levels and income, demographic, and lifestyle information is typically collected along with food intake data. Because studies have differing methodologies of data collection and operationalize fruit and vegetable consumption differently, they are not directly comparable; however each give a different view into dietary trends and calibration studies have been done to aid in comparison. (Krebs-Smith 2001).

The two most common methods of dietary assessment at the individual level are 24 hour recall and food frequency questionnaires. While 24 hour recall may give a more accurate representation of intake on a population level, estimates of portions of the population consuming the recommended amount of a commodity vary widely depending on the number of 24 hour recalls used (fewer recalls result in significant underestimates) and food frequency questionnaires

may give a better estimate of regular intake. Each of these types of surveys is generally tested by comparing results to those of the gold-standard multi-day dietary diaries (Krebs-Smith 2001).

There are three primary sources of national 24 hour recall nutrition data; each has its own strengths and weaknesses. The Nationwide Food Consumption Survey (NFCS) collects one week household and three day individual food consumption information and has been performed for over 25 years allowing comparability over time. The Continuing Survey of Food Intakes by Individuals (CSFII) reports in terms of mean intake and prevalences of high and low intakes. The National Health and Nutrition Examination Survey (NHANES) reports nutrient intake rather than numbers of servings. Data from four surveys over 30 years is available. NHANES data is the most recent dietary data available and is the only national survey planned to continue into the future (Krebs-Smith 2001).

In general, individual dietary surveys also show that fruit and vegetable consumption appears to be rising, but only slightly, and this increase may be an artifact of shifts in population demographics (Krebs-Smith 2001). These data suggest that, on average, Americans are consuming fruits and vegetables at a level near the minimum recommendations. Of course, given the wide variation in individual fruit and vegetable consumption, an average intake near minimum recommendations indicates a significant portion of the population is consuming less than recommended. As found in other measures, dark green and deep yellow vegetables account for a disproportionately small share of the total vegetable intake (Krebs-Smith 2001).

Data from the NFCS shows decreases in the consumption of high fat foods and percentage of energy from fat, but did not report fruit and vegetable consumption changes (NFCS 2005).

Krebs-Smith (Krebs-Smith 2001) adjusted for changes in collection methods between 1989-1991 and 1994-1996 CSFII surveys to allow for analysis of dietary trends. They found that total fruit and vegetable intake for all persons over two years of age increased from 4.5 servings in 1989-1991 to 4.9 in 1994-1996 ($p<0.0001$) reflecting only a fraction of a serving increase in both fruits and vegetables over that time. (Krebs-Smith 2001) NHANES data from 1988 to 1994 were

coded using CSFII codes and have been linked to the Pyramid Servings Database allowing for analysis of serving sizes and rough comparison with other surveys. This method found mean total vegetables intakes of 3.4 servings and mean total fruit intakes of 1.5 servings in 1994 (Krebs-Smith 2001).

As with food supply data, although these surveys show intakes near recommended standards, potatoes dominated vegetable intake accounting for about a third of vegetable intake in each survey. In 1994–96, only 8% of the population met the recommendation that at least one third of vegetable servings be dark green or deep yellow orange vegetables (Briefel 2004). Fruit intake was well below recommended standards in all surveys, with about half of the population not consuming any fruit on a given day (Briefel 2004).

Two other national surveys use food frequency questionnaires. The Behavioral Risk Factor Surveillance System (BRFSS) and 5-A-Day Surveys use a longer reference periods 0and may actually provide a better indication of the propensity to consume a particular food or group of foods than surveys that use 24 hour recall (Krebs-Smith 2001).

The National Cancer Institute's 5-A-Day for Better Health Program conducted a baseline survey in 1991 and a follow-up survey in 1997 using a 7 item fruit and vegetable screener. Fried potatoes, and miscellaneous or high-fat fruits and vegetables were excluded (Krebs-Smith 2001). The follow up survey showed a statistically significant increase of about a quarter serving per day for adults; (3.75 in 1991 to 3.98 in 1997) this represents an increase from 23.1% to 26.8% of respondents who ate 5 or more fruits and vegetables a day (Stables 2002). However, when the data were adjusted for demographic shifts, the increase was no longer significant. However, the increase in percentage of people eating at least 5 a day remained significant as did the decrease in blacks eating 5 a day (Krebs-Smith 2001; Stables 2002).

BRFSS is conducted by the Centers for Disease Control and Prevention. It is an ongoing telephone survey of adults that includes six food frequency questions that ask about the number of times a food is eaten per day. Formal serving sizes of one-half cup have been shown to have

good correlation with normal portion sizes; thus data on number of times eaten per day are roughly comparable to data on servings-per day. Trend analysis among adults in 16 states showed an increase in the prevalence of adults consuming fruits and vegetables more than 5 times per day from 19% in 1990 to 22% in 1994 and 23% in 1996 (Krebs-Smith 2001). 1996 BRFSS data shows levels of fruit and vegetable intake at 3.4 times per day for men and 3.6 for women with 22.7% reporting eating FV 5 or more times per day (Bensley 2003). When stratified by activity level and weight status, intake trends showed increases among normal weight active persons, no change among normal-weight, inactive persons, and decreases among the obese. This analysis points to declines in dietary quality among certain subgroups even as measures of central tendency improve.

Energy from Macronutrients

Increases and decreases in fruits and vegetables do not occur in isolation in the diet. So in attempting to understand the health effects of changes in fruit and vegetable consumption, it is worth briefly reviewing other food trends.

As noted above, dietary fat recommendations have been in existence for the greater part of the last century, but both food supply data and individual data show that despite decreases in the percentage of energy from fat, Americans generally still do not meet the dietary guidelines of 30% or less of calories from fat, and less than 10% from saturated fat. Further, total calorie intake and absolute fat intake have actually continued to rise (Tippet 1999, Dubois 2001, French 2001, Briefel 2004). Factors contributing to increases in energy intake include increases in the percentage of meals eaten away from home (particularly at fast-food restaurants), larger portion sizes of foods and beverages, increased consumption of sweetened beverages, changes in snacking habits, and improved dietary methodology (Briefel 2004). For example, consumption of added fat doubled between 1909 and 1998 from 32 to 63 per-capita pounds per year (French 2001).

Mean dietary cholesterol levels declined among all age groups from the 1970s to the early 1990s and have since leveled off at 341 mg for adult men and 242 mg for adult women. Factors contributing to the decline are a decrease in the consumption of whole eggs and improved measurement of the cholesterol content of foods (Briefel 2004).

One of the more important trends concerning recent increases in the prevalence of obesity is the increase in calories from simple carbohydrates. The percentage of calories from carbohydrate increased from 44% to 50% of calories from 1970 to 1990 largely due to the increase in soft drink consumption. In 1994, soft drinks comprised about one third of added sugar intake which, in turn accounted for 16% of energy intake (20% for adolescents) (French 2001). Milk consumption has declined as soft drink intake has risen (French 2001), and underconsumption of milk has been associated with inadequate intake of vitamin A, folate, calcium, phosphorus, and magnesium. (Briefel 2004).

A study of the intake of low-nutrient-dense foods by children which used NHANES III data found that consumption of soft drinks and snack foods accounted for more than 30% of daily calories. Frequent consumption of these foods was associated with higher energy intake, lower intake of certain vitamins (A, B6, folate, calcium, magnesium, iron, zinc), and lower intake of the major food groups (fruits, vegetables, grains, dairy, and meat). However, consumption of low-nutrient-dense foods was not strongly associated with BMI in this age group (Briefel 2004).

Overall Dietary Trends

In an attempt to begin to look at nutritional intakes within a whole-diet framework, the Healthy Eating Index (HEI) was developed as a summary measure of the population's dietary quality and adherence to the Food Guide Pyramid. The HEI includes ten components that assess adherence to the dietary guidelines (servings of grains, fruits, vegetables, milk and dairy products, and meats; the percentage of calories from fat and saturated fat; intake of cholesterol and sodium; and variety of food group selections). Out of a maximum score of 100, an HEI score above 80

reflects a "good diet"; a score between 51 and 80, a "diet that needs improvement"; and a score of 50 or less, a "poor diet" (Briefel 2004).

Based on the HEI, the overall diets of Americans age 2 and older improved slightly between the 1989 CSFII (mean 61.4) and the 1994–96 CSFII (mean 63.6), but did not improve further in the NHANES 1999–2000 (mean of 63.8). Mean scores improved slightly for grains, saturated fat, total fat, and variety, while mean scores declined for sodium, meat, and milk. The highest mean component scores in 1999–2000 were 7.7 (out of 10) for variety and cholesterol. The lowest mean score was 3.8 for fruit, the food component most in need of improvement in Americans' diets. HEI scores from NHANES 1999–2000 indicate that 10% of Americans have "good" diets, 74% "need improvement," and 16% have "poor" diets. (Briefel 2004)

2) INDIVIDUAL DIETARY BEHAVIOR CHANGE THEORY

All models are wrong. Some models are useful. ~ George Box

A) NUTRITION KNOWLEDGE & MOTIVATIONAL MODELS OF HEALTH BEHAVIOR

Introduction - Reviews of Nutritional Behavior Change Interventions

As dietary health researchers discovered links between diet and disease outcomes, they became interested in sharing this knowledge with the public in the hopes of improving public health. Nutrition education was accomplished through a variety of national dietary guidelines that have been disseminated through media campaigns, various intervention programs, and through individual health care provider-patient counseling.

Nutrition education has been variously defined over the years, but one more-or-less standard definition is given by Contento: "Nutrition education is any set of learning experiences designed to facilitate the voluntary adoption of eating and other nutrition-related behaviors conducive to health and well-being" (Contento 1995). This definition suggests that behavior change is the ultimate goal of nutrition education, and the use of the word "voluntary" emphasizes the importance of personal choice in this model. The importance of individual choice was not explicitly constructed in early efforts of nutrition education but appears to be a natural outcome of its foundation in the medical model which frames health problems at the individual level. Because health problems were conceptualized as problems of the individual, solutions - both treatment and prevention - were often limited to creating changes within the individual.

While the mechanisms by which these solutions would work were generally not spelled out theoretically, implicit models of individual behavior change seem to have rested on the assumption that increasing people's knowledge of appropriate dietary practices would motivate and enable them to take action to improve their own health. The extent to which an individual

decided to take advantage of this new information by making dietary changes would be considered a matter of personal choice. Other psychological, social, and environmental barriers to action were not initially identified in traditional behavioral models.

Though dietary behavior change has always been, at least implicitly, the goal of nutrition education efforts, many early intervention programs did not focus on these outcomes and were consequently not successful at changing dietary behavior despite effectively improving dietary knowledge (Contento 1995). Programs that did set dietary behavior change as an explicit goal were found to be more successful at promoting dietary change; however, it was not until Johnson and Johnson's 1985 review of the knowledge, attitude and behavior impacts of nutrition education programs that behavior change theory became more explicit and mediating variables began to be assessed in the nutrition education literature (Contento 1995; Ammerman 2001).

Over the following decade, theory-based research became more common and theories about behavior change became increasingly complex expanding from the individual to include increasingly the social and physical environment (Contento 1995). Early theoretical work sought to understand the motivational determinants of health (including dietary) behaviors, and theories such as social psychological and expectancy-value models began this process by explicitly laying out earlier assumptions about individual choice and the rational, cognitive routs of decision-making. These models posit that people will be likely to take action if they perceive that the action will lead to expected outcomes or anticipated consequences they value or desire.

Among the earliest of these models, the health belief model (HBM) was developed in the 1970s by Rosenstock 1974 and posited six determinants of health behavior. Though the theory did not explicitly describe interactions between these variables, there appeared an implicit concept that perceived severity and susceptibility combined to produce a perceived threat, and that perceived benefits determined the preferred course of action but was moderated by barriers, personal motivation, and cues to action. In general, evaluations showed that this model suffered from weak predictive value due to poor construct definition and lack of combinatorial rules. That

is definitions of constructs such as "threat" and "perceived severity" were not standardized, and without an explicit theoretical model, predictions regarding the interrelatedness of factors could not be made (Contento 1995; Armitage 2000).

Building on this work, Roger's protection motivation theory (Rogers 1987) was quite similar to the HBM, but was more explicit in its modeling of the relationships between key variables. Like the HBM, perceived vulnerability to and severity of a threat are posited to increase "protection motivation;" however, Rogers also concedes that advantages to performing what he terms the "maladaptive" behavior would decrease protection motivation. An individual's appraisal of a "coping" response (Roger's term for a more desirable response) is modeled as a dependent on the perceived efficacy of the response, and one's own self-efficacy (confidence in one's ability to perform the behavior). While many of these variables have been shown to operate in health interventions, average correlations with behavior were small to medium indicating that even effective interventions which seek to act via these variables would likely exert only minimal impact on behavior (Armitage 2000).

Social cognitive theory (SCT) was developed by Bandura and states that self-efficacy and outcome expectancy are central determinants of behavior. However, the concept of self-efficacy itself appears have greater predictive value than other elements of SCT (Armitage 2000).

The theory of reasoned action (TRA) expands the health belief model to stress "attitudes" – the personal beliefs about expectations and the values placed on these outcomes – and "perceived social norms" or perceived group pressure. These factors are thought to interact to influence behavior intention which is, in turn, postulated to be the major predictor of behavior. While the theory of reasoned action was developed to deal with purely volitional behaviors, the theory of planned behavior (TPB) was designed to extend this theory to include situations of incomplete control by adding the variable of "perceived behavioral control" or "self-efficacy" as a determinant of both behavior intention and behavior itself. Meta-analyses of the TPB have shown this theory to explain a substantial amount of the variance in behavioral intentions (41%;

R=0.64) and behaviors (34% R=0.58) across a range of health behaviors. Two other variables – self-identity and moral norms – have since been shown to further contribute to prediction of behavior intention indicating room for extension of the TPB (Armitage 2000).

Studies of Nutritional Education and Knowledge Attitudes and Beliefs (KAB)

Under these social psychological and expectancy value models, education regarding the relationships between diet and disease could play a major role in shifting expected outcomes, leading people to take action to avoid harmful dietary effects, or take advantage of positive dietary effects on health, especially if good health is a widely held value.

Despite the centrality of nutrition knowledge to many early behavioral theories, in the 1980s and 1990s, a series of studies failed to find strong associations between nutrition knowledge and dietary habits leading to a critical questioning of the importance of nutrition knowledge as an influence on dietary behavior (Baker 2003; Wardle et al., 2000). Studies of fat and fiber intake have shown only modest associations between nutrition knowledge and dietary quality (Baker 2003) and even the most successful educational dietary interventions to increase fruit and vegetable consumption rarely observed effects of more than half a serving of fruits and vegetables (Satia 2002).

In the mid nineties, at the height of the focus on education as a means for dietary behavior change, Contento (Contento 1995) released a review of nutritional education interventions most of which were individual and small group interventions. Of the 303 nutrition education intervention studies reviewed, 34% reported no effect, 47% reported an improvement in knowledge or attitudes, and only 19% reported changes in diet.

Contento found that many studies had been based on a "dissemination of information and teaching of skills" model and were not very effective in bringing about behavioral change. These were often "misapplications" of the knowledge-attitude-behavior model in that the knowledge was "instrumental knowledge" (*e.g.* food groups, balanced diets, label reading, food shopping,

and food preparation) rather than "motivational knowledge" (*e.g.* diet-disease relations) aimed at changing attitudes and behavior. In cases where "instrumental knowledge was effective, audiences were self selected and already motivated (Contento 1995). Contento's conclusion that "knowledge can be motivating when it is about the potential positive or negative consequences of behavior, particularly when these are of personal relevance or when they tap into other motivators of and reinforcers of change," supports attitude change theory, various expectancy-value theories, and social learning theory (Contento 1995).

Contento further identified that information on specific items or brands is more effective than general information, and that information on ingredients to avoid is more relevant than info about nutrients to include. She also supports stage change models (see below) stating that "addressing issues of relevance to individual's stage of readiness to change is more effective than general nutrition issues" (Contento 1995).

These conclusions point to an idea proposed earlier in the nutrition education literature, that the concept of "nutritional knowledge" is probably too broad to be practically useful. Rogers identified three types of dietary and nutrition knowledge: (1) *awareness* (e.g. of diet-disease relationships), (2) *knowledge of principles* (e.g. cholesterol is found in animal foods only), and (3) *how-to* or *instrumental knowledge* (e.g. how to select foods with less fat or how to read a food label accurately) (Rogers 1987). These categories are useful in creating more precise constructs of nutrition knowledge which enable more sophisticated models of dietary behavior and can be more tightly related to dietary behaviors.

Despite the lack of strong evidence that improving nutrition knowledge leads to improved dietary behaviors, there are reasons to question an outright rejection of the importance of nutrition education in dietary behavior modification. First, there is an intuitive validity to the argument that, if people knew better how to avoid illness, they would make changes to do so. Though the importance of this factor may have been overstated early on, it seems likely that it plays some roll. Second, much of this research on nutrition knowledge used ad hoc measures of knowledge

that were rarely psychometrically validated, and studies were typically powered to detect clinically significant effects whereas more modest effect sizes may have a significant public health effect at a population level. Further, most of the research on the effects of dietary knowledge is based on dietary fat research. Since most western populations have now been exposed to decades of education campaigns, it is unlikely that there are many people for whom lack of knowledge is the most significant obstacle to eating a low-fat diet. However, improving knowledge of other dietary factors such as fruit and vegetable consumption may continue to reap significant rewards (Wardle 2000b).

More recently, a number of better-designed studies have found substantial evidence of a significant association between nutritional knowledge and dietary behaviors. Some cross sectional studies have used better measures of nutritional knowledge to find significant associations between knowledge and fruit and dietary habits.

For example, Neill recruited a convenience sample of British coffeehouse goers and asked about their frequency of compliance with seven dietary recommendations as well as open questions about the expected health benefits of each recommendation and reasons for noncompliance. Dietary knowledge scores were constructed to differentiate knowledge of the primary health benefit from knowledge of other health benefits and lack of knowledge of health benefits for a given recommendation. An overall correlation coefficient of 0.57 was found between knowledge scores and frequency of compliance with dietary recommendations. Interestingly, the recommendation to eat at least five servings of fruits and vegetables a day was both the least known about and least complied with recommendation, and the within category correlation coefficient (0.62) was the strongest in the study (Neill 2000).

A study of British GP patients by Wardle et al. measured nutrition knowledge using a validated questionnaire which included experts' recommendations, knowledge about the nutrient content of 69 items, nutrition effect of everyday food choices, and links between diet and disease (Wardle 2000a). Scores for this index were related to scores for a simple food frequency

questionnaire, and the investigators found substantial associations between nutritional knowledge and fruit (r=0.27), vegetable(r=0.32), and fat (r=0.16) intake independent of demographic factors. In logistic regression analysis, with all variables modeled, people in the highest quintile of nutrition knowledge were almost 25 times as likely as those in the lowest quintile to be eating a healthy diet with graded effects for intermediate levels of knowledge.

In further analysis of this study, nutritional knowledge was shown to mediate some of the variation in intake associated with SES. After including knowledge in multivariate regression, education, and occupational class effects on fruit and vegetable intake became non-significant though effects on fat persisted. The stronger associations between nutrition knowledge and fruit and vegetable intake than fat intake may reflect knowledge saturation since, unlike the situation for fat intake, overall levels of public awareness of fruit and vegetable recommendations were low (Wardle 2000a).

Theory of Planned Behavior and Reasoned Action Include KAB

Cross sectional studies based on theory of planned behavior and the theory of reasoned action have explored attitudes and beliefs about health and nutrition along with knowledge in order to model dietary health behaviors. Research into these theories has resulted in mixed evidence concerning the relative importance of attitudes, beliefs, and knowledge.

Some studies have shown important roles for nutrition knowledge in explaining the variation among people's fruit and vegetable consumption. In regression analysis using data from the 5-A-Day Baseline Survey, a telephone survey of US adults, Krebs-Smith et al. found that beliefs regarding the number of servings of fruit and vegetables a person should consume was significantly associated with reported consumption of fruits and vegetables (b=2.61)[1]. Other less important, but still significant factors were liking the taste of fruits (b=0.65) and vegetables

[1] b-values here refer to the slope of the line in linear regression and represent a measure of the magnitude of and direction of the relationship between variables in the regression model.

(b=0.68) and having been in the habit of eating many fruits and vegetables since childhood (b=0.61). These factors accounted for 15% more of the variation in fruit and vegetable consumption than did demographic variables alone (8%). Other factors studied such as perceived health benefits, encouragement from friends and family, and feeling there was a lot of confusing advice about healthy ways to eat did not explain variation beyond demographic variables (Krebs Smith 1995).

Another British study looked at the relationships between fruit and vegetable intake and factors such as nutrition knowledge, taste preferences, attitudes to fruit and vegetable intake, and dieting status. These results demonstrated overall low levels of nutritional knowledge regarding fruit and vegetables with men having poorer knowledge about current dietary recommendations, and fewer men being aware of links between diet and disease. Multivariate analysis showed that the gender difference in intake was substantially attenuated by controlling for nutrition knowledge, but preferences, attitudes and dieting status had no such effects. These results indicate that men's poorer nutrition knowledge explains about half of the disparity between male and female fruit and vegetable intake giving strong support for some role of nutritional knowledge in dietary behavior (Baker 2003).

However, in a population survey of England, Thompson found that after adjusting for demographic factors including age, sex, & smoking status, attitudinal statements like "I don't really care what I eat" or "healthy foods are enjoyable" were *more* important predictors of low fruit or vegetable consumption than dietary knowledge about health benefits of a healthy diet and knowledge of the role of fruits and vegetables in a healthy diet (Thompson 1993).

Another British study looked at the roles of attitudes and beliefs of both mothers and their children across a variety of the children's dietary intakes. Mother's nutritional knowledge was an independent predictor only of children's fruit, not vegetable or confectionary intake. Conviction that increasing fruit and vegetable consumption would prevent disease, and belief in the importance of disease prevention predicted fruit and vegetable consumption respectively.

Mother's frequency of fruit consumption, and mother's liking for confectionary predicted children's intake of these items but not of vegetables which were better predicted by children's liking for vegetables. Only confectionery consumption was predicted by children's concern for health in what to eat (Gibson 1998).

The conflicting nature of the evidence regarding the relative importance of attitudes, beliefs, and knowledge in determining dietary behavior may have a number of causes. First, though they have been theoretically defined, the terms "attitude," "belief," and "knowledge" are often difficult to separate and may lack consistent construct validity. For example, though a surveyor may be careful to word a question "how many servings of fruits & vegetables do you *believe* a person should eat..." vs. " how many servings of fruits and vegetables do *experts recommend*..." it is not always clear whether these questions reliably measure different constructs of "belief" and "knowledge" as few questionnaires have been psychometrically validated.

Further, while ranking these factors may seem important for policy makers who must somehow prioritize the types of interventions that are used, their relative importance is likely to vary among populations and individuals. Therefore, it is at least as important to validate and refine the theoretical frameworks in which these factors are situated. The framework itself can only be validated by looking *prospectively* at the *interactions* between theoretical factors in the production of a behavior (Brug 2005).

As none of the studies above are prospective, they cannot answer the epistemologically important question of whether dietary knowledge actually precedes changes in beliefs, attitudes, and behavior or whether it is acquired concurrently or even after dietary behavior change. These studies only show associations between theoretical constructs and the variation in dietary behaviors. While these descriptions are a necessary first step, it cannot be assumed that factors that are significantly associated with dietary behaviors will also be significant determinants of dietary behavior *change* (Brug 2005).

B) Behavioral Enaction Models

Whereas models such as theory of planned behavior provide clear guidance as to what motivates people, (behavioral intentions), they are less clear about how motivation is translated into action. Thus a number of models have been developed to bridge this "intention-behavior gap."

The most prominent of these is Gollwitzer's theory which distinguishes between goal intentions (intentions to perform a behavior) and implementation intentions (plans as to when, where, and how a goal intention will be translated into action). A number of studies involving various health behaviors (cervical cancer screening, vitamin supplementation intake, breast self exam, vigorous physical activity, and functional ability after surgery) have shown the potential for implementation intention interventions to promote health prevention behaviors to be independent of prior goal intentions. Generally, these interventions involve asking participants to create a detailed plan as to how they will enact a given goal intention (Armitage 2000).

Subsequent laboratory research in this area has shown that the efficacy of implementation intentions in producing behavior change is dependent upon the strength and activation of people's prior goal intentions (Sheeran 2005). This type of research has also shown that people often construe behaviors in moral terms and that, when they do, the alignment of their goal intentions with these moral norms appears more important than their personal attitudes in predicting a variety of preventive health behaviors (Godin 2005).

Bagozzi's theory of goal pursuit has built upon the motivational models outlined above by outlining the way in which motivational variables may be translated into action. Though it offers more concrete ideas about the mechanisms through which motivational variables exert their influence, this theory is quite complicated and has yet to be significantly investigated in the area of preventive health behavior (Armitage 2000).

In an intriguing example of the utility of the implementation intention approach, men and women from a British company were given a mail-in questionnaire which included a validated food frequency instrument and scales for measuring attitude, subjective norms, and perceived behavioral control, and behavioral intention regarding eating a low-fat diet (Armitage 2004). Participants were randomized to an extremely simple intervention consisting of written instructions to plan to eat a low-fat diet during the following month and to formulate plans in detail regarding how this would be achieved. Behavior was followed up at one month, and the authors found that fat intake significantly decreased among the experimental group ($F(3,135) = 2.86$, $p<.05$) but not among the comparison group ($F(3,123) = 1.41$, $p>0.24$).

Despite these promising results, there is not sufficient evidence to prove this effect was not due to reporting bias (since all information was self reported and the intervention group was explicitly told of the researchers intentions). A more thorough analysis of the behavioral intentions (e.g. ranking the plans as more or less specific, or more or less effective, and correlating this to reported behavior change) and/or an additional objective marker of behavior (such as blood vitamin C or K levels) would add considerable validity to the implementation intention concept.

C) STAGES-OF-CHANGE MODELS OF HEALTH BEHAVIOR

Introduction to Stages-of-Change Research

A third wave of health behavior theory research conceptualizes people as passing through discrete stages in their transition from uninterested or unaware non-actors to motivated actors. Kuhl was actually the first theorist to clearly distinguish motivational and action stages, and while his work provides some additional insight into what factors might be relevant in the volitional stage, few measures of these constructs have been developed (Wagner 2004).

In the health action process approach (HAPA), the motivational phase is roughly described by the motivational models described above, and the volitional phase is broken into three overlapping stages of planning, action, and maintenance. However, the model is vague about the ways in which social-cognitive variables interact in the volitional stages (Wagner 2004).

The Transtheoretical Stages of Change model, developed by Prochaska and DiClimente in the early 1980s was originally developed and validated as a psychological model to describe quitting addictive behaviors such as cigarette and drug addiction. It was developed to unite a number of the motivational theories described above (hence its name) and has since been applied to a wide variety of fields involving behavioral change including dietary improvement and increasing fruit and vegetable intake. This model states that, for most people, a change in behavior occurs gradually as a person moves from being uninterested, unaware or unwilling to make a change (precontemplation), to considering a change (contemplation), to deciding and preparing to make a change (preparation). Genuine, determined action is taken in the action stage and, over time, attempts to maintain the new behavior occur (maintenance). Although the model is a linear one, relapses are extremely common and become part of the process of working toward life-long change (Brug 1997; Wagner 2004).

The Precaution Adoption Process Model (PAPM) uses stages that are similar to those in the Transtheoretical model but which differ in certain respects. First, the PAPM model distinguishes between people in two types of precontemplative stages: those who are unaware of an issue (stage 1), and those who know something about the issue but have never actively thought about it (stage 2). Secondly, those what have decided not to adopt the precaution (stage 4) are differentiated from those in stages 1 and 2 who have not even considered taking action. The PAPM also goes a step further in identifying some of the variables that might influence whether people proceed through stages (Weinstein 1998).

Stage-of-change models generally offer an overarching framework into which theories of behavior motivation and theories of behavioral enaction may be laid. While these models suggest

that different social-cognitive variables will carry different levels of importance at different stages and will vary in their ability to predict change from one stage to the next, theory is not currently clear about the nature of these differences. Thus a rather large body of exploratory literature seeks to examine the correlations of variables from motivational behavior theories with TTM and PAPM stages. Likewise, it is not yet clear whether such unifications of social-cognitive constructs are indeed best modeled as discrete stages or as continuum models. Given that these studies combine constructs from many of the models described above in attempts to validate these theories and give guidance to behavioral change interventionists, a brief review of the empirical literature will follow.

Cross-sectional Research on Stages of Change

Although clear guidelines for evaluating the validity of these models and their usefulness over the simpler "continuum theories" described above have been set out for at least eight years (Weinstein 1998), few studies have been conducted that are set up to rigorously test the validity of stage change theories. The vast majority of research on stage change theory for dietary and other preventive behaviors has been cross sectional research using the Transtheoretical Model. These studies would be predicted to show that social-cognitive variables increase non-linearly between stages. While linearity does not disprove stage theory, it does point to the possibility that simpler continuum models might better, and more simply, explain these changes in social-cognitive variables.

A review of Stages-of-Change models applied to dietary behavior was presented by Mhurchu et al. (1997). Most of the studies cited attempted to categorize the sample into stages of dietary change based on participants' reports of their engagement in or intentions to engage in healthy dietary habits. Given the variation in operationalization of the stage definitions, and the variety of cohorts selected, Mhurchu did not find convincing patterns in the proportions of participants in the various stages even within a given food group. Many of these studies also attempted to

correlate indices of healthy dietary habits with stages. As stage theory would predict, many of these studies found relatively small differences among the pre-action stages and among the post-action stages but found larger differences in diet between these two stage groups (i.e. between pre-contemplators and actors).

Mhurchu et al. (1997) also highlight a number of limitations of stage of change theory. First, dietary behaviors are more complex than behaviors such as smoking for which the model was originally developed. In fact, given the multiplicity of behaviors involved in one's diet, it is possible for an individual to be in more than one stage of change at a given point in time. However disaggregating a "healthy diet" into each of its component behaviors may be an overly reductionistic approach. A second, and related finding is that many of the studies asked very general questions about participant's intentions and behaviors regarding a healthy diet. More recent research (Brug 1997) supports the concern that many people who are classified into action or maintenance stages actually have diets that are substantially poorer than recommendations. This disconnect between self-categorization and more objective methods of categorization calls into question the validity of using self-categorization as a measure of stage of change constructs. This finding also supports the PAPM distinction between people who are unaware of their need to change behavior and those who are aware but have decided against action.

Prospective Research on Stages-of-Change

Cross sectional research is a weak test of stage of change given that similar results could be explained with continuum processes models as well (Weinstein 1998). A slightly more robust test occurs with longitudinal observational data which can assess whether people actually pass through the stages of change in the proposed order. When combined with motivational and volitional constructs, prospective studies can also be used to test predictions about which causal factors are most important at various stages and which factors predict transitions from one stage to the next.

In one of the first longitudinal observational studies examining nutrition knowledge, attitude, beliefs and nutritional behavior on a population basis, Patterson found that belief in a connection between diet and cancer, and knowledge of dietary recommendations, preceded healthful dietary changes while knowledge of food composition (i.e. which foods were high in fat or fiber) and perceived social pressure to improve diet did not. (Patterson 1996)

These results reinforce research on TPB and the stages of change construct by establishing the predicted temporal nature of events (i.e. belief in diet-cancer relation and knowledge of dietary recommendations precedes dietary change). This research also suggests that information about diet-health relationships and dietary recommendations may be more appropriately targeted toward those who have not yet made dietary changes (i.e. precontemplative or contemplative stages) while information about food composition may be better targeted to those who want to make or have begun making changes (i.e. preparation or action stages) (Patterson 1996).

A paper by De Nooijer et al. (De Nooijer 2005) describes the stability of the stages of change concept of the Transtheoretical Model for three different nutrition behaviors (fat, fruit, and vegetable intake) among adult individuals who are unexposed to planned interventions. While pre-contemplation and maintenance stages appeared to be the most stable stages, many forward as well as backward stage transitions occurred between baseline and follow-up among respondents in all stages. These results indicate that many stage transitions may occur in individuals, even when they are not exposed to planned interventions. Thus shorter measurement intervals or better constructed or operationalized stage definitions may be needed in order to make full use of TTM stages in dietary behavior.

Intervention Studies and Stages-of-Change

By far, the strongest test of stage theories would be experimental studies of matched and mis-matched interventions. Weinstein et al. conducted such a study on home radon testing in which they created a "high risk" treatment intended to convince people who were undecided to test, and

a "low-effort" treatment intended to make it easier for those who intended to test to carry this out. The treatments were combined factorially into four conditions and were assigned at random to people in the undecided and decided-to-test stages. As predicted the high-risk treatment was effective at getting undecided people to decide to test but not at getting them to order the tests. The low effort treatment was effective at getting those who had decided to test to act on these intentions but did not cause those who were undecided to order tests. Further, as predicted, the combined treatments were no more effective than the low-effort treatment for getting those who had already decided to test. The presence of these predicted interactions between treatment types and stages gives extremely strong support for a staged theory of behavior change in this situation (Weinstein 1998).

Unfortunately, perhaps because of the added cost and difficulty of creating such an experiment with lifestyle factors, this kind of experiment has yet to be performed for more complex, ongoing behaviors such as diet selection or physical activity. Instead, several studies have compared stage-tailored interventions with standardized interventions to promote preventive lifestyle behaviors. However, it is not always clear that stage-tailoring *per se* is responsible for the observed effects, and there is no way for these studies to examine those interactions described above which would truly give robust support to the use of stage change theory in preventive lifestyle behavior change. Nevertheless, these studies give moderate support to the utility of stage change theory in behavioral change interventions.

A study by Armitage et al. (Armitage 2004) used both self-identification and dietary intake instruments to classify participants into the TTM stages regarding eating a low-fat diet. Demographic characteristics as well as validated indices of constructs from theory of planned behavior (attitude, subjective norm, perceived behavioral control, and behavioral intention) were used to predict progress and regression from baseline stage after an attitude-change and self-efficacy promoting intervention presented in a mailed leaflet or tailored feedback about their current dietary fat intake as assessed by a food frequency questionnaire.

The attitude change intervention consisted of brief statements to persuade people that eating a low-fat diet would maintain fitness, control weight, and enhance feelings of health while the self-efficacy promoting intervention provided participants with low-fat options they could easily incorporate into their existing lifestyle, recipes for low-fat meals that were quick, cheap, and easy to prepare, and a message intended to persuade participants that eating a low-fat diet was not expensive, that information was freely available, and that a great amount of willpower is not necessary.

Armitage et al. found that the measured TPB indices increased linearly with successive stages of change in cross-sectional analysis of both baseline and follow-up data. Longitudinal analysis showed that, overall, 61.52% of individuals remained in the same stage at both time points, 24.25% "progressed" and 14.23% "regressed." As in a study involving physical activity (Courneya 2001), transitions between most stages, both advancement and regression, could be predicted by the TPB and demographic variables. However, progression from the preparation stage to action/maintenance stages was not predicted by the model. This transition is crucial given that it involves the transition from intention to actual performance of the behavior and while the TPB may not account for this transition, it is possible that integration of theories such as behavior enaction models (see above) into the TTM may aid in bridging this gap. Further, age predicted both regressions and progressions indicating that there are important variables that are not currently assessed in the TPB which mediate stage transition. Also, though TPB variables were predictive, a substantial portion of stage transitions were not explained by the model.

D) INDIVIDUAL-LEVEL FACTORS IMPORTANT IN FOOD CHOICE

Relative importance of taste and nutrition

Research from Western countries has generally found that people consistently identify certain factors as the most important determinants of food choices. For example, a population survey by

Glanz (1998) explored the relative importance of reasons why people choose the foods they eat. This survey found that, overall, taste was the primary factor determining consumption with nutrition, cost, convenience, and weight control following in that order of importance. The individual-level factors of taste, nutrition, and weight control as well as potential psychological factors will be discussed here while the contextual factors of cost and convenience are discussed below.

In numerous studies, taste has been found to be the number one priority in food selection (Cotugna 1992; Glanz 1998). Since 1989, the number of shoppers rating nutrition as "very important has remained near or above 75%; however nutrition remains the most important factor cited by consumers (Guthrie 1999). This fact poses a considerable barrier for behavior change strategies since many people also believe that eating healthy necessitates a reduction in taste. For example, about 30% of consumers, responding to a 1994 poll conducted by the American Dietetic Association and the International Food Information Council, asserted that healthy foods do not taste good. Similarly, the *1995 Nutrition Trends Survey* found that 38% of consumers believed that to improve their diets they would have to give up their favorite foods. (Guthrie 1999) Moreover, a random digit dial survey in Washington State showed that more than a quarter of participants agreed with the statement that eating low-fat foods takes the pleasure out of eating (Patterson 2001).

Similarly, data from the National Health Interview Survey, a US population survey, investigated prominent reasons for making dietary changes and, for the 65% of respondents who had never made any dietary changes for health reasons, asked a series of attitudinal statements to ascertain why no changes had been made. The three most common reasons given for not making dietary changes were that people enjoyed the foods they were eating (76.3%), people thought that their diets were already healthy (69.3%), and that there were so many different recommendations, it was hard to know which ones to follow (48.0%) (Cotugna 1992).

One exception to this general attitudinal trend is fruits which have generally been found to be rated rather highly in terms of taste compared to vegetables which are often disliked by both children and adults. Because of the importance of taste, many authors have proposed emphasizing the tastefulness of healthy dietary choices. While this may be a "hard sell" for some foods, fruits are generally well-liked and present an opportunity to take advantage of this attitude.

Recently, researchers have become interested in the biology of taste determination have found that high energy density tends to be associated with high palatability and that in general, energy-dense foods are palatable but not satiating, whereas foods with low energy density are more satiating but less palatable (Drewnowski 1998). Further, consumption of these highly preferred foods, which are often high in sugars and fats, produces neurochemical changes in brain sites involved in feeding and reward, some of which are also affected by drugs of abuse (Levine 2003).

Other researchers have looked at the sociocultural meanings behind taste. The French philosopher, Bordieu defined "taste" as a vehicle for the display by various social classes of their non-material capital (Murcott 2002), and some researchers have supported the idea that food carries these social meanings as social gradients are found in food preferences (Warde 1997).

At least one group of researchers has focused on the life-course development of habits and food preferences (Devine 1999). This perspective highlights patterns of dietary behavior over time and in historical context. In qualitative investigation of fruit and vegetable choice, life course events and experiences that emerged as influences included: food upbringing, social roles, skills and resources, acquiring and preparing food, health transitions, ethnic identity, changing context of the food system and changing nutrition advice over time. Quantitative evaluation of these factors showed that life course experiences with fruits and vegetables differed among three ethnic groups: white, black, and Hispanic

Weight Control

Besides taste and nutrition, weight control is another factor often cited as an interpersonal determinant of food choice. In a population survey conducted in the UK, Wardle et al. found that approximately equal proportions of the sample were 'not bothered about weight' (30%), 'watching their weight' (36%), or 'trying to lose weight' (28%) (Wardle 2000a). People who were trying to lose or were watching their weight were more likely to report restricting fats, sugars, snacks, and the amount eaten at meals, than those who were not bothered; however, there were no differences between weight watchers and weight losers, and the overall level of restriction among weight losers was modest. There were no group differences in eating breakfast, fruits or vegetables, skipping meals or fasting.

Personal Psychological Barriers to Dietary Change

Two personal psychological factors, underestimation of personal risk and discounting the future, are of potential importance but were not widely discussed in the dietary change literature. In general people tend to underestimate their own risk using psychological defense mechanisms to "protect" themselves from risks (Sandman 1998). Two strategies that are particularly common are an initial denial that one is personally likely to be affected by the disease, or even when confronted with evidence about one's risk, rationalization that the described risks do not apply to oneself.

It is also well known in the fields of economics and psychology that people tend to discount the future. Thus a tasty, filling meal today may seem more important than avoiding heart disease in 20 years. Though no literature was found assessing this point, it is quite possible that long-term preventive behaviors are less salient for people who have more immediate necessities. The extent to which this may account for socioeconomic differences in attitudes toward preventive health behaviors is uncertain.

E) INTERVENTION STUDIES IN NUTRITIONAL BEHAVIOR CHANGE

Introduction - Reviews of Nutritional Behavior Change Interventions

Since Contento's (1995) review of nutrition education interventions, nutrition behavior change theory has broadened, and while most nutritional behavior interventions still center on an education component, many have begun to use ideas from multiple theories in combination. Two recent reviews offer some insight into the efficacy of nutritional behavior interventions over the past twenty or so years. Both of these reviews looked at dietary behavior change interventions involving reducing fat and improving fruit and vegetable intake. These reviews were limited, however because details about specific intervention components were typically not included in articles, making comparisons across features quite difficult.

The review by Ammerman (2002) used three analysis tiers: meta-analysis, standardized quantitative analysis of the reported changes (differences in deltas) between intervention and control groups, and semiquantitative analysis which summarized the proportion of interventions which reported significant improvements in intake. This allowed systematic review of the large literature on dietary fat as well as the smaller set of interventions to improve fruit and vegetable intake. In general, most studies reported some positive effect, and usually this was significant. Ammerman found that about 86% of studies found a significant effect in reducing total and saturated fats intake and that 77% of studies found significant increases in fruit and vegetable intake.

While there were insufficient studies to compare efficacy of theories, it was clear that for both fat intake and fruit and vegetable intake, explicit declaration of a theoretical basis for the intervention program was associated with finding statistically significant improvements in intake. Other factors such as the use of goal setting and food-related activities were also consistently associated with study efficacy for both fat reduction and fruit and vegetable consumption

interventions. Age of participants, study, quality, cultural specificity, social support and family components were also related to intervention efficacy in at least two of the analyses conducted.

Comparing standardized effect sizes from these studies, Ammerman found that intervention groups increased their intake of fruit and vegetables about 17% more than control groups representing an average increase of 0.6 servings of fruits and vegetables per day. Analysis of those interventions which reported follow-up effects showed much more modest effects of about 7% improvement over baseline remaining at the second follow up. This falloff of effect points toward a need for maintenance of these interventions to sustain the intervention effects.

Bowen and Beresford (2002) reviewed eighty intervention studies to decrease fat or increase fiber or fruit and vegetables. These authors performed a summary review rather than a quantitative analysis, and categorized interventions into individual-level intervention studies, studies focused on family, providers, and community organizations, worksite and point-of-purchase interventions, and interventions on entire communities, but they did not distinguish between primary outcome variable. They were also unable to make comparisons among intervention components and their results parallel those of Ammerman.

Individual and Small Group Nutrition Interventions

Individual and small group interventions are most directly related to the medical model of health care and prevention. These interventions are often carried out with cohorts selected from a health care setting and are most likely to be implemented as hospital or clinic prevention programs. These interventions are the most intensive as far as resources go, and the most successful in their ability to improve diet.

While these intensive studies support the idea that changing dietary behaviors in free-living populations is possible, participants were often highly selected, motivated, and fully resourced limiting applicability to broader populations. The largest effect size was found in a very intensive study by Ornish which showed a twenty-four percentage point improvement in percent of energy

from fat in a healthcare setting study among patients diagnosed with CVD. This can be compared with worksite/community interventions which showed at best a seven percent improvement and school-based interventions which showed up to a three percent improvement (Ammerman 2002). Other studies such as the Women's Health Trial, and MRFIT also produced large changes in selected groups through intense interventions (Bowen 2002).

Both reviews found that interventions conducted among higher disease-risk populations were more likely to be effective whether the outcome was fat, fiber, or fruit and vegetable intake. It is unclear, however, to what extent this is due to increased individual motivation and to what extent these studies were more intensive and therefore more successful.

Face-to-face instruction appears to create better results than material-based instruction whether that material is print, video, or computer. Further, individual or group counseling delivered by health professionals tended to result in greater levels of change than population-based strategies delivered through channels such as communities and work sites (Bowen 2002).

Also, the use of social support components was associated with more favorable increases in fruit and vegetable intake. Studies that employed goal setting and interactive activities involving food were more likely to report statistically significant increases in fruit and vegetable intake, although the magnitude of the increases was not notably higher than that in studies not employing such techniques (Ammerman 2001).

Tailoring interventions to individuals by giving personal feedback appears to be effective whether it is given in person, through print, or electronically (Brug 2003) although some studies reported no extra effect of tailoring over standardized interventions. Likewise, tailoring interventions to specific ethnic groups appears to be a useful method of improving intervention effectiveness. All five of the interventions reviewed by Ammerman (2002) designed to be culturally or ethnically specific reported significant decreases in both total and saturated fat intake, compared with 84% of other studies.

Because of the resource-intensive nature of individual and small group interventions, and the special populations that they involve, these interventions do not offer realistic models for improving dietary behavior on a population basis. Thus a number of studies have attempted to alter nutrition behavior at broader levels that are more relevant to public health goals of reducing rates of chronic disease.

Community-level Interventions

While there is a large literature about promoting dietary behavior change in the clinical setting, the literature on public/community dietary behavior promotion is less developed. Given the broader level of focus, it is not surprising that community-level interventions are more likely to involve environmental components along with ideas from social cognitive theory. However few of these interventions explicitly describe their theoretical framework and interventions are rarely described in enough detail to determine how this framework is "mapped" onto the intervention. Thus Bowen and Beresford (2002) have reviewed community interventions based on site rather than theoretical framework or intervention components.

Worksites were the most commonly used public channel. These interventions showed consistent improvements in fruit and vegetable intake confirming the promise of this site but effects were often small and long term follow up was rare. Three examples of community-level worksite interventions follow.

The Seattle 5-A-Day program tested a one-year community based worksite intervention which used environmental components such as cafeteria changes and worksite events as well as self-help materials. This intervention was guided by the Transtheoretical Model and found increases in overage serving frequency of about one third at two year followup (Beresford 2001).

In another worksite intervention among low socioeconomic status, multi-cultural employees, naturally occurring groups of employees (cliques) were randomized and key members of each intervention group were trained as peer educators who delivered messages about increasing fruit

and vegetable intake. At 18-month followup, intervention group members were consuming about half a serving more of fruits and vegetables daily compared to comparison group members, and there was some evidence of continued effect at 2-year followup (Buller 1999).

The Treatwell 5-A-Day study further evaluated a randomized worksite intervention that included multilevel components (guidelines, classes, food demonstrations, point of choice labeling, employee advisory board) to determine the added effect of a family intervention and found half serving increases in fruit and vegetable consumption only in the worksite-family intervention (Sorenson 1999).

Grocery stores have also been the site of dietary behavior interventions. Interventions which were essentially individual-level interventions which recruited from grocery stores found significant improvements in fruit and vegetable consumption, however public service announcements, flyers, point-of-purchase information, and storewide activities were not effective at improving dietary practices (Bowen 2002).

Community-wide, State, and National Interventions

Entire communities have also been the subject of nutrition behavior interventions. While many of these studies show improvement over time, the lack of a control group prevents certainty as to the effects of the intervention since secular trends cannot be taken into account. This is significant considering one consistent finding from community based randomized trials of interventions to increase vegetables intakes is that secular trends in the control group, or dietary self-change, are almost as large as changes attributed to the intervention (Satia 2002).

For example, the Bootheel Heart Health Project provided community-based interventions such as classes, screenings, cooking demonstrations, and other education programs (Brownson 1996). This study did not find significantly greater increases of fruit and vegetable consumption in intervention vs. control counties. However blood pressure and cholesterol screening increased and weight decreased compared to state data. The Minnesota Heart Health Program compared

three intervention and three control communities (Luepker 1994). Community organization strategies, mass media, and other models were used to design a multi-pronged intervention. Significant gains were reported in the intervention communities though the change in serum cholesterol was small and within chance findings. The North Karelia Project was a multicomponent community intervention to reduce high cardiovascular disease rates in part of Finland (Pietinen 1988). Individual, worksite, point-of-purchase, school-based, and community-wide strategies were combined to produce moderate changes in indicators of diet in this study. However no differences were found between intervention and control areas in the reduction of heart disease or stroke.

Nutrition Behavior Interventions at the state and national level have almost always been limited to mass media health campaigns which have tended to focus on nutrition education messages. Given the proven ability of education interventions to improve awareness of diet-disease relations, but the limited relationship found between dietary knowledge and behavior change in the smaller scale studies reviewed above, it should not be surprising that broader level national and regional interventions have met with similar difficulties in changing population behavior.

Some of these nutrition education campaigns, like the USDA food pyramid, and the Nutrition Labeling and Education Act have been widely implemented, but direct evaluation data on their effectiveness in increasing awareness or changing eating behaviors is not available (French 2001).

Given the interest in tracking population level changes in nutrition knowledge, a number of longitudinal surveys have been conducted beginning in the 1980's. These have had to balance continuity of information with changes in research focus as the emphasis of dietary guidelines has changed leading to a somewhat disjointed longitudinal picture. Using data from a variety of public and private sources, the United States Department of Agriculture Economic Research Service published a review examining the level of nutrition knowledge among American

consumers and trends in nutrition knowledge levels over time (Guthrie 1999). This review used the Food and Drug Administration's (FDA) Health and Diet Survey (HDS) (1982-1995), the US Department of Agriculture's (USDA) Diet and Health Knowledge Survey (DHKS) (1989-1996), the Food Marketing Institute's (FMI) Trends Survey (YEARS) , and the American Dietetic Association's (ADA) 1995 Nutrition Trends Survey.

The HDS shows that during the 1980s and 1990s, Americans had fairly high levels of awareness of the relationship between their diets and serious chronic diseases such as heart disease and cancer. Increased levels of awareness have been shown to follow major public health campaigns (sodium and hypertension; cholesterol, saturated fat, total fat and heart disease; and dietary fiber and cancer) and have been shown to change along with the nutrition information and dietary recommendations promulgated by these campaigns (Guthrie 1999).

There is evidence, however, the salience of the diet-disease relationship may be quite low compared with other lifestyle factors. In a population survey, respondents were asked a general question about what things they believed increase a person's chances of getting cancer (Cotugna 1992). Of the 19 responses read by the interviewer, poor eating practices were chosen by 40% of the sample as compared with 88% for cigarettes, 75% for sun exposure, 55% for heredity, 40% for excessive alcohol consumption, and 33% for stress. Further, there was a substantial minority (44%) who believed there was nothing a person could do to reduce the risk of getting cancer or who didn't know what could be done.

While popular knowledge about recommendations for lowering intake of fat and saturated fat appear quite widespread several North American studies have indicated that the majority of the population are unaware of the recommended intakes of fruit and vegetables or of the links between fruit and vegetable consumption and cancer (Baker 2003). There have been similar findings in the UK, with less than one third of adults knowing that experts recommend eating five servings of fruits and vegetables a day, and even fewer aware of the protective effects against cancer and heart disease (Parmenter 2000; Baker 2003).

The most recent data on levels of nutrition knowledge in the US come from the 2002-2003 Health Information National Trends Survey (NCI 2005c). US population-adjusted data from this survey show that a sizeable minority (about one quarter) of the US population considers dietary factors important in cancer prevention. When asked to provide specific recommendations for eating habits, the top three recommendations were to eat less fat (20.67%) to eat more vegetables (19.62%) and to eat more fruits (11.89%). It is noteworthy that for each of the dietary factors surveyed (inadequate consumption of fruits and vegetables, inadequate fiber, or high fat diet, or high alcohol intake) a similar substantial minority (about 25 to 35%) either believed that these factors did not increase the risk of cancer at all, or had no opinion about their effects on risk.

Unlike many previous national nutritional education campaigns, the national 5-A-Day for Better Health campaign was regularly evaluated, first as it was piloted in California in the mid 1990's, and later as it was expanded. The national intervention included both media releases and point-of-purchase information and was evaluated using a random digit dial survey of US adult which measured fruit and vegetable consumption as well as awareness, knowledge, beliefs, and attitudes about cancer (Stables 2002).

This intervention appears to have been quite successful at improving people's knowledge of dietary recommendations as a significantly greater percentage of the population was aware of the 5-A-Day message in 1997 (19%) than in 1991 (7%). Intake of fruits and vegetables also appears to have increased during this time period. However, while population-weighted mean intakes showed a statistically significant increase from 3.75 servings a day in 1991 to 3.98 by 1997, these differences became non-significant ($p=0.12$) after adjustment for changes in the national demographic structure. Many of these demographic changes (e.g. older age) are known to be associated with higher levels of fruit and vegetable consumption. Assessment of the percent of respondents eating five or more servings of fruits and vegetables per day showed similar trends with increases from 23.1% to 26.8% (a non-significant difference) for the population-weighted and 23.4% to 25.8% (a significant difference) for the model-adjusted figures.

While there were general increases in awareness and fruit and vegetable consumption, these data are not reflective of all sub-groups. For example, African Americans actually showed a non-significant trend toward consuming fewer servings of fruits and vegetables and a non-significant decrease in the percent eating five servings a day. Also, in 1997, women were more aware of the message than men (21.1% vs. 14.9%) and were more likely to consume recommended servings (30.94% vs. 19.65%); similar trends were found comparing those with more than a high school education to those with less (22.0% vs. 16.7% were aware of the message; 29.3% vs. 20.7% ate five or more servings). Paradoxically, although Hispanics showed no significant increase in awareness, they were the only racial subgroup to show significant increases in consumption highlighting the large role of other factors in determining national dietary trends.

When American shoppers were asked directly about what types of information had led them to make changes in food purchases, 61% reported having made changes because of nutrition label information, 27% changed purchases because of the *Food Guide Pyramid,* and 23% changed purchases because of the 5-A-Day campaign (Guthrie 1999). However, other research indicates that most consumers are unaware of quantitative recommendations for the nutrients on the food label perhaps indicating a lack of instrumental knowledge of how to implement more general recommendations.

F) PROBLEMS WITH LIMITING DIETARY BEHAVIOR THEORY TO THE INDIVIDUAL

Limits of Knowledge and Belief Mediated Interventions

Although the research reviewed above shows that well-conceived and well-executed interventions can improve nutritional conditions though knowledge and belief mediated pathways, this research also reveals the limits to this approach as even the most successful interventions fall far short of the full potential for dietary change. Even when substantial

numbers of people believe in a diet disease connection, the public appears generally unwilling to make the changes they believe necessary to reduce their risk of cancer.

Despite the facts that at least a quarter of the population is aware of the utility of eating more fruits and vegetables, and over two thirds worry about getting cancer sometimes or often, only about 14% said they would like to improve the way they eat in order to prevent cancer, and over 54% said they did not want to change any lifestyle factors to avoid cancer (NCI 2005c). Thus, while there appears to be substantial room for improvement in dietary knowledge of Americans as it relates to DR-CD risk, and therefore substantial improvement in dietary and other risk factor behavior, even if dietary knowledge were nearly perfect, one would reasonably expect a large proportion of Americans to continue their current dietary and other lifestyle behaviors (NCI 2005c).

Blaming the Victim

Besides the modest efficacy of the individual approach, in changing dietary behavior, this paradigm can lead to "blaming the victim" as it neglects the contextual factors that causally influence decision making and behavior. Emphasis on human volition has emphasized risk factor approach and responsibility of the knowledgeable individual to improving his or her own health. "While individuals make choices about how to act, these choices are situated within economic, historical, family, cultural, and political contexts. Decontextualizing behavior from this real world setting obscures it socioeconomic production and encourages blaming the victims of inequality for their unhealthy lifestyles" (Lynch 1997, p810). Lynch et al. show evidence that adult behaviors are patterned by childhood socioeconomic status and thus do not support the "free choice" conception of adult behavior. "SES status at birth is not chosen, so it seems difficult to argue that the subsequent normative level of education for any particular childhood SES group is freely "chosen" or in fact that people then choose their subsequent occupation" (Lynch 1997, p810).

Necessity of Protracted Interventions

Further, a focus on altering behavior in the current population neglects the fact that structural determinants of nutritional behaviors will remain unchanged resulting in a continuous supply of new generations of people with poor dietary habits leading to significant health outcomes. (Lynch 1997) While we may expect some natural dissemination of information through social networks and from one generation to the next, it seems foolish to rely only on these indirect avenues while ignoring more direct structural routes to behavior change. This understanding has led to calls by many researchers to broaden the scope of behavior change and to integrate efforts to change preventive health behaviors at the individual level with broader environmental and societal level policy influences (Ammerman 2002; Moorland 2002a).

3) CONTEXTUAL AND POWER-RELATED EFFECTS ON HEALTH

A) DEVELOPMENT OF RENEWED INTEREST IN CONTEXTUAL FACTORS

Introduction

From the 1940's to the early 1990's, there was little direct research on the impact of the local social or physical environment on human health. Individualism conceptually dominated theoretical and public discourse in many industrialized countries during this time period. This paralleled the epidemiologic transition which emphasized individual lifestyle choices rather than structural and environmental conditions which had been understood to shape patterns of infectious disease and diseases of extreme want (Macintyre 2002).

Though emphasis of environmental and contextual factors actually harks back to the earliest days of public health research, the movement redirect the attention of public health theorists and practitioners back towards the structural and environmental influences on health and health behaviors has been called "the new public health." Researchers working in this paradigm have made calls to look upstream at the causes of poor health and health inequalities rather than solely looking downstream a their expression in individual behaviors or ill-health (Macintyre 2002).

Because of the apparent limits to interventions grounded in individual behavior change theory, researchers have indeed begun to look outside of the individual for other important determinants of dietary practices. As nutrition-behavior research expands outward from the individual, theories and intervention approaches based on nutrition education and individual behavior change have been supplemented by research focusing on the ways in which the social, economic, and physical environments constrain and foster certain dietary behaviors (Drenowski 2005).

These two methods of examining nutrition behavior have been dichotomized into "individual behavior theory" or "belief-related research," and "contextual behavior theory" or "power-related

research" (Pelto2003). Individual, belief-based behavior theory has largely been discussed above, and includes biological, psychological, and belief-related variables. Contextual, or power-related, behavior theory looks at a number of factors that largely sit outside of the individual. In this paradigm, food choices are seen to have sociocultural determinants such as the cultural meaning of foods, economic determinants such as prices, income, and expenses, as well as situationally related determinants of food consumption such as food availability, time availability, and infrastructure (e.g. transportation, storage, cooking wares) (Gedrich 2003).

The Ecological Fallacy

One of the primary reasons for the emphasis on the individual was an equation of using ecological data with engagement in the ecological fallacy. Robinson first described the ecological fallacy in the 1950s as inferring individual level relationships from relationships observed at the aggregate level.

In her paper, "The Fallacy of the Ecological Fallacy," Schwartz (1994) critiques the idea that all health determinants are best conceptualized as individual level attributes. She uses a framework of internal and construct validity to make three main points about ecological data. First, while it is true that using ecological data to "fill in" for missing individual data can lead to errors of both magnitude and direction of an effect, if one is dealing with a circumstance where the ecological data is likely to be better specified than individual data, as might occur with certain sensitive issues, then this form of analysis may have better internal validity and be worthwhile. Secondly, she draws a clear distinction between variables which are derived or aggregated from individual-level variables (e.g. mean household income) and integral or global variables which describe features not reducible to characteristics of individuals (e.g. neighborhood pollution). These concepts are important as one assesses the construct validity of a descriptive variable. While aggregate variables have often been viewed simply as poor estimates of individual-level constructs, they, like integral variables, may actually represent properties of groups and areas at

the ecological-level. Finally, Schwartz highlights a third assumption associated with the ecological fallacy, that only characteristics of the individual cause disease. However, any level of analysis can be further broken down or expanded. For example, the individual can be looked at as an ecological interaction of organs and cells or can be placed in a social context. A given level of analysis gains importance from the underlying analytical purpose and its utility in predicting and modifying the system toward that purpose.

Methodological Individualism

A second reason for the focus on individual level variables was the development of methodologies in statistics, computing, and surveying which enabled the use of large volumes of individual data. While these methods have proven extremely valuable in determining many causal factors for diseases, individual models also have their limits as is apparent from the nutritional intervention literature described above.

These methodological frameworks maintained their prominence in early work on ecological and contextual variables. Contextual effects were often essentially conceptualized as what was "left over" after all known individual level attributes had been controlled for. This type of analysis is limiting in that it does not give a sound theoretical framework for how specific ecological variables interact with each other and with individual level variables to cause specific health outcomes of interest. Instead, the variability attributed to ecological factors, such as living in a deprived neighborhood, has been called "social miasma" and, as with similar work on SES, researchers are left wondering how such factors "get under the skin."

In attempting to carve out a new space in the public health literature, these sorts of studies tended to dichotomize individual and contextual properties. These were often seen as mutually exclusive causal explanations for health outcomes and significant effort was made attempting to determine their relative importance. As in most such arguments, however, this dichotomy

appears somewhat artificial as properties of individuals are themselves shaped by the properties of the locality and their society (Macintyre 2002).

More recently, researchers have made advances both in the methodology and theoretical framing of ecological variables. Interest in examining the interplay between individual and ecological variables has pushed the emergence of multilevel modeling. By simultaneously including both ecological and individual level predictors in regression equations with individuals as the units of analysis these strategies allow both controlling for individual level factors and, more importantly, they also permit examination of individual level characteristics as modifiers of the ecological variables (and vice versa). That is, additive and multiplicative interactions between individual and ecological variables can be explored (Diez Roux 2001). Likewise, Raudenbush made a significant contribution to the methodology of studying area effects on health by developing and validating indicators of neighborhood characteristics that are distinct from aggregated individual characteristics (Raudenbush 1997).

Theories to Guide Contextual Research on Place and Health

Macintyre and others (Macintyre 2002) suggest a number of theoretical frameworks for examining the relationship between place and health. First, they propose three general explanations for how geographic variables might impact health. Composition describes characteristics of individuals concentrated in certain areas. Examples of compositional resource-based explanations of poor fruit and vegetable consumption might be that few households in an area have vegetable gardens or that few have cars or private transportation to shop at stores selling affordable produce. Contextual explanations draw attention to opportunity structures in the physical and social environment. For example, low fruit and vegetable consumption in a neighborhood may also be related to a paucity of grocers providing sufficient variety and quality of produce at affordable prices in that area. Further, public transportation routes may not conveniently link community members to produce vendors. Collective explanations may be seen

as a subset of contextual factors which highlight the sociocultural and historical features of communities. For example, years of living in areas without access to produce may have resulted in cultural norms that do not include preparing and eating these foods or fruits and vegetables may not be considered "tasty" in this local culture.

Implicit in many of these proposed examples are interactions between the various types of explanations. Access to private transportation may only be important in the context of few local grocers, and the historical causes of cultural norms may be based in characteristics of earlier physical environments. Compositional factors such as low demand for fruits and vegetables may perpetuate the lack of local produce vendors which, in turn, may preclude familiarity with these products and thus future demand.

These authors also suggest a framework of five features of local areas which may influence health. The first of these is the physical environment shared by all and includes such physical features as air, water, and climate. The second is the availability of healthy environments at home work and play which includes factors such as provision of adequate housing, non-hazardous employment, healthy food vendors, and places for physical activity. Thirdly, services provided publicly or privately to support people in their daily lives include education, transport, and health and welfare services. Socio-cultural features of a neighborhood include the social history of a community, its norms and values, levels of crime, and the degree of community integration and social networks. Finally, the reputation of an area may influence how planners and business providers approach and interact with a community, the political power of community relative to other communities, and who moves into and out of the area.

Lastly, the researchers propose a framework of universal human needs as a basis for thinking about how places may influence health. They identify these needs as air, water, food, shelter, security, hygiene, education, healing, housekeeping, work, means of exchange, information, transport, personal relationships, religious, group involvement, and play, and they suggest that investigators ask how the resources available to meet these needs are distributed geographically

(and socially I might add) within a given society. They also stress that, rather than attempting to study every measure of the physical and social context, that researchers should attempt to create and test hypotheses regarding specific pathways through which area might influence health.

With these suggestions in mind, the rest of this paper will review the research on the effects of the economic context and physical environment on dietary behavior.

B) ECONOMIC FACTORS: PRODUCTION, DISTRIBUTION, PURCHASING

While economic determinants of food consumption have generally been looked at from the point of the consumer, factors affecting costs occur at the levels of production, distribution, and consumer purchasing.

Production

Research by La France (La France 1999, Beatty 2003) and others suggests that major, broad trends in food consumption have been driven by production-side price regulations/subsidies. Analysis of consumption trends in food products such as milk, cheese, poultry, and cereals shows that consumption patterns follow major changes in farm policy that result in increases or decreases in the costs of these products.

As shown above, trends in the consumption of macronutrients are related to increases in body weight, and these consumption trends can also be related to changes in farm policy. Energy intake increased dramatically since 1972 due to low farm prices for corn and food grains, in part due to farm policy. Consumption of carbohydrates decreased from 1934 to 1970 due to tight import quotas which caused high sugar prices, but this trend reversed from 1972 to 1996 as new farm policy caused very low grain prices. Fat consumption follows a linear trend upward throughout the 20th century (Beatty 2003).

Similar research shows that many of the federal farm programs work in direct opposition to federal welfare programs in terms of their effects on nutrient consumption patterns. For example, the current food stamp program works as an income transfer mechanism to increase the nutritional status of the poor. However, price discrimination in federal milk marketing orders increases the retail price of fresh milk and lowers the prices of manufactured dairy products creating incentives for production of less healthy processed foods.

Likewise, target prices for feed corn increase prices received by farmers, thereby increasing the supply of corn. To clear these additional supplies from the market, prices paid by hog and cattle feedlot operators are lower than they otherwise would be. The resulting decreases in input costs to the livestock sector has the effect of increasing supplies of livestock to slaughterhouses, thereby reducing the market prices for red meat and increasing consumption – an effect contrary to sound nutrition or health policy (LaFrance 1999). A similar effect is found for high fructose corn syrup. The high fructose corn syrup technology which was developed in the 1970s is now used in over 50% of the sweetener market driving recent four-fold increases in sweetener consumption (Beatty 2003).

Thus price supports and other commodity programs create consumer incentives that directly oppose those created by food subsidy programs. It is not clear whether consumers would not be better off without any government intervention, and taxpayers that are neither farmers nor food aid recipients end up with less disposable income.

Distribution

Produce is distributed to consumers through three different channels: retail stores (38%), foodservice establishments (39%), and direct markets (e.g. farmer markets, roadside stands, U-pick operations) (1%). The actual volume reaching consumers is greatest in the retail channel because of the higher levels of waste in the foodservice industry (McLaughlin 2004).

Fresh produce prices are among the most volatile of any food product with swings of 100% to 200% common throughout the year. However, three quarters of consumer spending goes to covering marketing costs (packaging, transport, risk-taking, storage, handling, promotion, profit) with roughly one quarter returning to the grower and shipper. Thus supply price can change significantly with only muted effects on consumer price, and retailers further mute this volatility by using a variety of pricing techniques.

There is little research on exactly what the effects of price change are on produce consumption. For example, there is an average 75% increase in sales with a major retail promotion but it is unclear what portion of this is due to price reduction and it is even less apparent to what extent such promotions result in absolute increases in consumption of produce versus substitution from another type of produce or produce bought at another store (McLaughlin 2004).

Nevertheless, there is evidence of unprecedented expansion of the produce sector over the past 20 years. Produce departments are increasing both their percentage of supermarket sales and their profitability relative to other departments. Produce departments now account for 16% of store profitability while averaging only 10% of sales (McLaughlin 2004). Between 1982 and 1997, fruits and vegetables led all other food categories in retail price increases with increases for fresh fruits and vegetables more than double those for processed products (Krebs-Smith 2001). However, studies in both the US and Britain conclude that recent grocer consolidation has not lead to price manipulation (ERS 2005).

Purchasing

While it is apparent that food price does influence consumption at the population level, the immediate effects of price changes on produce sales have generally been found to be relatively limited. In other words, there is low price elasticity of demand for produce due to the ability to substitute foods (McLaughlin 2004) (Beatty 2003).

A series of studies conducted by French (2005), however, showed substantial effects of price changes in a school and cafeteria environment. These studies examined the effects of price changes on the consumption of healthier snacks and lower-fat foods.

In the first of these, vending machines in 12 worksites and 12 schools were stocked with lower fat snacks and prices were reduced 10%, 25%, or 50% compared to higher fat snacks. These rates of price reduction were associated with increases in the sales of lower-fat snack foods by 9%, 39%, and 93% respectively and Promotion of the lower-fat snacks at these sites had a small but significant effect independent of the effects of price reductions. Overall snack sales volumes increased during the intervention for the 25% and 50% price reduction cases and average monthly profits per machine did not significantly differ by price reduction condition.

A second study examined the effect of a 50% price reduction on fruit and vegetable sales in two secondary school cafeterias. This study showed four-fold increases in fruit sales and two-fold increases in vegetable (baby carrot) sales during the intervention with return to baseline sales with the return of usual prices

Given concerns about financing such price reductions, another study in a single high school piloted a strategy to subsidize 25% price reductions in four lower fat foods (fresh fruit, low-fat cookies, low-fat chips, and cereal bars) with price increases of 10% in three popular higher-fat foods (French fries, cookies, and cheese sauce). Sales data for the year long intervention indicated that pooled revenues for the seven food items were within 5% of those estimated under usual-price conditions.

Despite the limited *price* elasticity of demand, there is a relatively high *income* elasticity associated with demand for meats, fruits, and vegetables so that nutrient consumption responds strongly to variations in income (Darmon2002). Household survey research has shown that while the poor spend less money on food overall, a greater proportion of their income is spent on this necessity. Households in the bottom tenth of income distribution spend an average of 29% of

their disposable income on food (after allowance for housing costs) while those in the top tenth spend 18% (James 1997).

In order to limit the amount of income spend on food, the poor utilize a number of buying strategies many of which are counterproductive to healthy eating. While income is not associated with total quantity of food consumed, it is associated with the types of food consumed (French 2001). In a study comparing food taken home with demographic factors, Leibtag (2003) found that the poor stretch their food dollars through three primary methods: 1) shopping in discount food stores 2) purchasing and consuming less food and 3) purchasing low-priced, and possibly lower quality, food products. A dose-response was found between household income and purchase of discounted products. Poorer households were found to purchase more discounted products both by proportion of expenditure and weight for a variety of products including cheese, fruit, vegetables, and meat. Lower income households were also found to purchase more private-label (generic) products.

Interestingly, low income households were found to have the lowest proportion of large-package purchases whereas middle income households were most likely to take advantage of these discounts. This may be due to a number of factors including lack of transportation and access to stores that sell in large quantities, a lack of immediate income to stock up, and household storage constraints.

Thirdly, data show that households allocate their at-home food budgets differently both across and within food groups, depending on their income. In general, low income households have been found to buy more efficiently in terms of energy per unit price. While this results in far less spending on alcohol and sweets, these efficiencies also lead to the purchase of foods richer in energy rather than foods richer in protective nutrients which are more expensive per unit of energy (Leibtag 2003). The purchase of healthy options within mainstream eating patterns appears to increase the food bill by 6-13% (James 1997).

While low income households appeared to purchase more meat and poultry - perhaps because of unmeasured out-of-home purchases of other groups – their purchases were cheaper per unit weight denoting poorer quality cuts. Low income households were also found to purchase 3.3% less fruits and vegetables by weight, and to pay 13% less for these products in total. They accomplished this by buying cheaper fruits like bananas versus more expensive ones like berries (Leibtag 2003). These sorts of differences may be significant from a health perspective as berries have been found to be a rich source of antioxidants, potentially protective against both cancer and atherosclerosis, whereas there have been calls from nutrition researchers to discontinue counting bananas and potatoes as fruits and vegetables respectively. Whatever the specific effects on fruit and vegetable consumption, restricting purchases to the cheapest fruits and vegetables is likely to limit variety thereby reducing compliance with the primary recommendation of the USDA dietary guidelines.

Another study looked at the difference in cost associated with selection of a healthy or unhealthy diet as assessed by a global dietary index (Cade 1999). This study found that a healthy diet was indeed more expensive with expenditure on fruit and vegetables being the main items accounting for this effect. Forty nine percent of the food budget was spent on fruit and vegetables in the group with the highest healthy eating index score compared to 29% in the group with the lowest score. Interestingly, 52% of those scoring at the extremes of the dietary index groups did not think that it was difficult to eat healthily. Other research in France has shown similar results showing that for both computer modeled diets (chosen to reduce cost while staying as close as possible to national average consumption) and freely chosen diets, lower costs were associated with higher amounts of fats and sugars and lower amounts of fruits and vegetables (Darmon2002; Drewnowski 2004).

Further, there is mixed evidence to suggest that the poor actually face higher prices further exacerbating this phenomenon. The 1997 USDA study concluded that, in general, the poor face about 1% higher prices nationally due to their greater representation in urban and rural locations.

Suburban grocery stores appear more likely to be supermarkets which offer lower prices (about 10% less than smaller stores on average) due to larger economies of scale. Further, inner city stores may have greater operating costs due to higher land taxes and higher security costs.

Similarly, Frankel and Gould (in Leibtag 2003) found that low income households face higher prices depending on their proximity to low and middle income neighborhoods; however, Hays (in Leibtag 2003) found prices were 6% lower in poor neighborhoods. Thus, while it is unresolved whether the poor actually pay higher prices for food, there is substantial evidence indicating that there are direct economic pressures, especially for those with limited budgets, to purchase and consume less healthy diets. Further, the US income distribution has become wider over the past 50 years indicating a greater disparity between rich and poor which may further exacerbate these economic pressures (Beatty 2003).

C) SITUATIONAL: TIME, PORTION SIZES

Time

Like economic constraints, time constraints are often cited by consumers as obstacles to healthy dietary behavior. In a 1995 US population survey, 21 % of consumers said that lack of time prevented them from making healthful dietary changes (Guthrie 1999). Some researchers have corroborated this assertion, finding that time constraints had a negative effect on an individual's performance of recommended dietary practices (Guthrie 1999). However, for individuals who had more nutrition knowledge, the negative effect of time constraints neared zero. This led the authors to hypothesize that nutrition knowledge may mitigate the effects of time constraints by enabling consumers through improved planning and preparation skills or greater information on their options for planning a healthful diet. (Guthrie 1999)

One way food prep time is decreased is through the consumption of "value added" products. Value is defined as the benefits received from the product or service divided by its price – in other words, what you get for what you pay. Common ways that value is added to food products include increased convenience, quality, information, taste, safety, nutrition, and fun (McLaughlin 2004). Value added products have been particularly effective in increasing the consumption of fresh produce. The introduction of prepackaged, precut, and other value-added products helped boost average consumption of fresh broccoli by 76% between 1993 and 1999 and of carrots by 25% (Krebs-Smith 2001). Given their popularity, these products may offer a useful mechanism for promoting consumption of other fruits and vegetables.

A second mechanism people use to reduce food preparation time is eating out. Eating away from home has been found by several researchers to be associated with differences in diet quality (Guthrie 1999). Possible reasons for this may include a more limited choice in away-from-home eating establishments, especially for lower income consumers, and the fact that consumers have less information about the nutrient content of foods served in restaurants and other eating establishments. Also, consumers may view eating away from home as an exception to their normal dietary habits and an opportunity to "splurge" (Guthrie 1999).

Portion Sizes:

Further, the portion sizes found in both away-from home eating establishments and many pre-packaged grocery store foods has steadily risen over the past half century. For example, in the 1950's soft drinks were marketed in 6.5oz bottles whereas by the 1970's the 12oz bottle was standard and by 2000, the 20oz bottle was the typical single serving size representing a 250% increase from 1950 (French 2005). Likewise fast food restaurants now market supersized hamburgers, fries, and soft-drinks, and candy bars and potato chips that were once sold in one ounce packages are now sold in two to three ounce packages. During the two decade period following 1978, average portion size increased from 3.1 to 3.6 ounces for french fries (a 68-kcal

increase), from 5.8 to 7.3 ounces for a cheeseburger (a 136-kcal increase), and from 6.3 to 8.0 ounces for Mexican food (a 133-kcal increase) (Briefel 2004).

These portion increases may represent a recognition by marketers that the marginal increase in cost associated with larger serving size is more than offset by the ability to charge more for a product based on the apparent increase in value from the consumer standpoint. This method works well for foods which have extremely low production costs, since the vast proportion of the cost is in packaging, transporting, and marketing, but is not a viable strategy for foods with tighter profit margins.

Many well-controlled, laboratory-based studies have shown that increasing portion sizes leads to increased intakes of energy-dense foods which can lead to excess energy intakes, and this influence intake has been supported by data collected in naturalistic settings (Ledikwe 2005). Given the effect of portion size on food consumption, one proposed strategy is to reduce the energy density of foods, while maintaining food weight or volume, so that consumers can eat satisfying portions while reducing their energy intakes. Thus encouraging the consumption of those foods with a low energy density, such as fruits and vegetables, may be a particularly effective method to limit calories.

While some researchers have recommended removing price incentives for "supersize" portions on high-fat, energy-dense foods as a way to limit the purchase and consumption of low nutrient-density foods by the consumer (French 2005), this sort of recommendation is in direct opposition to the industry and there may be no clear rout toward legislating this.

One major contextual trend that appears to have driven trends in increased calorie intake is the increase in the number of meals eaten away from home, especially the number of fast food meals. This is reflected in increases in both percent of income spent on away from home food as well as in number of meals eaten away from home. For example, on any given day in 1994–96, about 57% of Americans ate away from home, an increase of one third since 1977–78 (Briefel

2004). One intriguing explanation for this shift is the increase in the number of women in the workforce and the resultant reduction in time spent preparing food (French 2001).

Compared with foods eaten at home, away-from-home foods are higher in fat and energy, and while both away-from and in-home foods have declined somewhat in fat content, at home foods have declined more (French 2001). In 1995, "away from home" foods provided 34% of total caloric intake and 38% of total fat intake compared to 18% for both categories in 1977-1978 (Lin 1999).

Further, there has been a disproportionate increase in the use of fast food restaurants. The number of fast food restaurants (defined as self-service or carry-out eating places without waiter service) grew nearly 150% from 1972 to 1995, and the of meals and snacks eaten there increased 200% during this time period while other restaurant use increased 150% (French 2001). Fast food meals compose a particularly large portion of the diets of adolescents – especially adolescent boys – and have been associated with significantly higher intake of energy, fat, saturated fat, sodium, and carbonated soft drinks, and significantly lower intake of vitamins A and C, fruits, vegetables, and milk (Briefel 2004; French 2001).

D) AVAILABILITY WITHIN FOOD SOURCES – GROCERY, RESTAURANT, CAFETERIA

Groceries

In broadening research from the individual to the physical environment, the within-store food environment is a logical place to begin given that consumers directly interact with this environment as they are making food choices.

In general availability of fruits and vegetables within grocery stores has increased 19% between 1970 and 1995, with today's supermarkets carrying over 400 produce items compared with 250 in late 1980's and 150 in mid-1970s (French 2001). Off-season imports have improved

year-round access to fruits and vegetables (Krebs-Smith 2001). However, this increase in average produce variety may mask increased disparities between various store types (see below).

In one early study altering the physical environment within a grocery, Curhan (in Glanz 2004a) modified the positioning of foods according to marketing principles often used for snack foods. He did this by providing bonus space and improving quality of locations and found significantly increased sales of hard fruit and cooking vegetables.

Restaurants

Other authors have suggested restaurant-based environmental changes including offering more types of fruits and vegetables, more fruits and vegetables in their mixed dishes, and healthier preparation of fruits and vegetables in menu options. A recent review by Glanz (2004b) describes a number of such interventions, but few have implemented sufficient evaluation procedures to draw conclusions about program efficacy.

Project LEAN (Lower Fat Eating for America Now) included a training program for chefs to improve healthy menu choices by focusing on improved taste and empowerment of chefs, however no out comes were reported. Another intervention in the United Kingdom found that increasing the number of reduced-fat menu items increased the proportion of healthy menu choices, but that there was no effect of nutritional information alone on diets.

A multi-component program in Virginia, "Dine to Your Heart's Content" included interventions to prepare foods with lower fat, cholesterol, and sodium content, to make healthy menu items easier to identify, and to promote such menu items to restaurant patrons. While such low-fat menu items have been shown to enhance restaurants' images and both patrons and managers showed interest, there was no evaluation of the program's impact on food choices.

Another tactic that appears promising, but has not yet been thoroughly evaluated, are community-driven health promotion and award schemes. The Heartbeat Award Scheme requires that at least one third of menu items be "healthy choices," and that a more than a third of staff be

trained in food safety. The use of audit systems showed that more healthy menu items were offered in the award locations, but there are no data on consumer habits. Similarly, a program in Australia child care centers was modeled off of these audit systems and found more healthy choices available in the registered centers.

Workplaces

Perhaps because of the high level of management control over workplace, school, and community cafeterias, these sites have been popular in intervention trials which attempt to improve the availability of healthy foods. A recent review of worksite interventions to increase fruit and vegetable consumption (Sorenson 2004) cited a number of interventions with environmental components.

In one of these, Jeffery et al. (1994) increased the variety and reduced prices of fruits and salads in a university worksite cafeteria. Frit choices were increased from three to six and three additional vegetable choices were added to the salad bar. The prices of fruit and salad were decreased by 50% to $0.25 per piece of fruit and $2.00 per pound of salad. While the number of customers remained stable over the study period, both fruit and salad purchases increased three-fold during the intervention period. Sales levels decreased again during follow-up but remained slightly above baseline (significant only for salad). These effect sizes were substantially larger than those found in point of purchase interventions which relied exclusively on education, but because of the study design, the individual and interactive effects of the increases in variety could not be determined.

Catering policies that require minimum amounts of fruits and vegetables among menu choices, or which result in serving fruit and vegetable side dishes more consistently have also been suggested; although no outcome studies have been performed to date (Glanz 2004b; Sorenson 2004)

Conclusions from other studies of worksite interventions which target the physical and information environment have been limited by small sample size, non-randomized design, and lack of effective measures of environmental policies (Sorenson 2004).

Schools

Similarly, characteristics of the school food environment may have a significant effect on adolescents' food choices because a large proportion of total daily energy is consumed at school. Recognizing this, the USDA has created the National School Lunch Program (NSLP) as well as school Breakfast and Food Stamp Programs. These programs have not only served to improve food security for low income students, but have also been shown to offer substantially healthier food choices than students would otherwise face. Studies have shown that participants consume 29% less calories from fat, and that NSLP lunches have three times as many dairy products, twice as much fruit and seven times the vegetable amounts as lunches brought from home (Rainville 2001). Participants of the NSLP have also been found to be at reduced odds of being overweight (Jones 2003), and participation in a school breakfast program resulted in significant increases in math grades, decreases in student absences and tardiness and decreases in ratings of psychosocial problems (Murphy 1998).

However, foods sold outside the National School Lunch Program, known as "competitive foods," make up an increasing share of students' purchases at school especially at the secondary level, and available data indicate that these foods are higher in fat compared to the NSLP. Additionally, vending machines selling soft drinks are now available in 98% of US high schools, 74% of middle schools, and 43% of elementary schools (GAO 2004). While school meals are required to meet federal nutrition standards outlined by the Dietary Guidelines for Americans, these policies do not apply to competitive foods, and state and district policies are also generally limited with few specifically addressing fruit and vegetable availability (French 2005).

Most early school-based interventions have been mixed approaches with educational and sometimes physical or economic environmental components and have shown positive effects. While the literature is less established, changes to the physical environment have produced some promising results.

In a study by French (2005) 20 secondary schools were randomly assigned to either an environmental intervention or a control group for a 2-y period. The intervention increased the availability of lower-fat foods and implemented student-based peer promotions. Intervention schools showed a steeper increase in sales of lower fat foods in year one and higher % of lower fat foods in year two but no change in self-reported food choices.

An interesting pair of studies was conducted in a university student cafeteria to assess the effect of manipulating the effort to purchase high-fat foods (Meiselman 1994). In the first of these studies, candy was moved from the four cash registers to a small snack bar located at a single cash register, and meal selections from a portion of the students was measured. Compared to baseline, the sales of candy decreased significantly during the intervention week while selection of desserts, fruits, and accessory foods increased (this difference approached significance when these three categories were grouped). In the second study, students who reported that they regularly used the cafeteria and regularly bought potato chips were selected to participate during a similar manipulation of the location of potato chips. Selection of potato chips was found to decrease significantly during the intervention, with increases in other starchy foods.

One strength of this study was its ability to assess replacement and substitution of the "unhealthy" foods. It is important to note that the decreases in candy and potato chips in these experiments were associated with increases in other foods, only some of which were healthy. This effect is nevertheless promising given that increasing the effort to purchase unhealthy foods apparently opens a door to dietary behavior change which might be exploited by concurrently improving the accessibility of healthy choices as was done in the grocery store intervention by

Curhan described above. It also highlights the importance of making novel healthy food choices easily accessible and associated with little effort compared to less healthy alternatives.

Several new approaches which focus more explicitly on physical environment are currently being piloted, but results are not yet published. These include school gardening programs, salad bars using fresh produce from local Farmer's Markets, and in-school free fruit and vegetable distribution.

Community Organizations

As in schools and workplaces, community group interventions have often been multi-component interventions. The North Carolina Black Churches United for Better Health project used both individual and environmental strategies including serving fv and church functions and partnerships with community grocers. This intervention showed a relatively large effect size with a 0.85 servings per day increase in fruits and vegetables. Interestingly, the program component with highest perceived impact was serving more fruits and vegetables at church functions while the grocery store promotions, educational sessions and cooking classes did not appear effective or well received (Glanz 2004a; Resnicow 2004).

The Eat for Life Trial randomized 14 Georgia churches to two intervention arms and a control arm. The intervention arms consisted of individual-level interventions which included a self help education program including a recipe book and a cue phone call, or the education component plus cue call and motivational interviewing. Taste testing in second and third arms could be considered environmental components but their effects were not studied separately. Results showed an increase of 1.2 servings of fruits and vegetables in the motivational interviewing group over the control group and about 1.0 servings greater effect in the motivational interviewing group over the self-help only group (Glanz 2004a, Resnicow 2004).

A third intervention, "Body and Soul" was created from these two "parent" interventions and was designed to for larger scale diffusion (Resnicow 2004). The research team viewed two

components as particularly central to the effects of the previous interventions and thus included a program to serve fruits and vegetables at church events as well as a motivational interviewing component that was carried out by community volunteers. A 17 item fruit and vegetable scale found significantly higher levels of fruit and vegetable consumption in the intervention group (6.6 servings per day) compared to the control group (5.2 servings per day) which represents an effect size of 0.18. As in other studies, the effect appeared slightly greater for fruit than vegetable consumption. While these effect sizes were somewhat muted compared to the original interventions, all intervention components were carried out by community members with only minimal training making the potential for distribution of this program much greater than the previous university-led programs.

E) AVAILABILITY OF FOOD SOURCES – GROCERY, FARMER'S MARKETS, URBAN GARDENS, FAST FOOD

Grocer Location

As ideas about the importance of the built environment gained further prominence, researchers began investigating the role of the physical location of food sources in relation to where people live. Thus far, most of these efforts have focused on grocer location, however researchers have also begun to look into the roles of restaurant type and location.

Despite the growth in away-from-home food consumption, grocery stores continue to distribute the largest volume of food to consumers. Average per-capita weekly grocery store expenses in the US are near forty dollars, and supermarkets now accounts for a fifth of all take out foods (Glanz 2004a).

Despite this increase in within-store variety and availability described above, there is evidence that the recent consolidation of grocery distributors has led to fewer grocer locations and

thus decreased availability of healthy food vendors. The grocery retail sector has undergone unprecedented consolidation over the past decade. While the market share of US food sales held by the top eight supermarket chains was 26-28% during the entire period from 1929-1994, this figure suddenly rose to nearly 50% between 1995 and 2000 (McLaughlin 2004). While this consolidation has lead to improved purchasing power and improved variety and prices for consumers with access to these supermarkets, there is also evidence that grocer consolidation has had negative social and environmental effects due to a reduction in the number of available grocer outlets.

Some authors have suggested that large grocery retailers have systematically avoided low-income inner city areas because of the lower profit margins associated with increased cost of business and decreased consumer buying power in these areas (Troutt 1993). However, a recent report by the British Competition Commission found "no systematic link between the locational strategies of supermarket operators and restricted access to groceries." Thus, although the commission found some areas of relatively low access to grocers, it states, "it can nevertheless be concluded that supermarkets are not systematically avoiding low-income urban areas, nor do they appear to be exacerbating any isolated problems of grocery access that may exist by withdrawing from those areas" (Competition Commission 2000, paragraph 13.123.).

Definitions and Existence of Food Deserts

In Britain, the retail store consolidation has resulted in a 35% decline in the total number of retail stores since 1980 (James 1997). Further, there is evidence for a trend of larger superstores being constructed at the periphery of cities resulting in the subsequent closure of smaller independent food stores located nearer the center of the city, and similar trends have been observed in the US (Wrigley 2002).

There is evidence that the current distribution of grocers may have adverse effects on the local availability of retail food stores for low-income residents of inner cities. For example, a

number of ecologic studies have found correlations between the income of area residents and the provision of retail food stores (Moorland 2002b).

In Brittan, the term "food desert" was first used by the Low Income Project Team of the Nutrition Taskforce (Beaumont 1995) to describe apparent areas of relatively poor retail food provision that were located in neighborhoods of relative social and economic deprivation. While this term quickly invaded the public discourse on the issue, there was initially little systematic evidence of such "food deserts." Indeed, the first substantial examination of this issue in an economically deprived area of a British city found that even when retail food outlets were limited to those selling over 50% of 71 healthy staple foods at prices similar to the national average for such products, the median distance to the nearest shop was 323 meters (Donkin 2000).

However, a second study examining 66 wards in London found that in 29 of the 66 wards, over 50% of the population was further than 500 meters from a "green grocer" selling fresh fruits and vegetables at a reasonable price and in 13 of these, over 75% were further than 500 meters away from such a grocer (ELCHA 1999). More detailed examination of two of the most materially deprived wards showed that even when smaller grocers, which were not in the broader analysis, were included, there remained substantial areas without access to healthy, affordable foods.

Identification of Food Deserts

More recently, a series of studies has been performed specifically to test the construct of "food deserts." The first step in these studies was the creation of a more precise and valid definition of "food deserts." In order to quantify spatial variation in access to goods and services, "performance indicators" have been developed. These measure ether the effectiveness of provision to households, or the efficiency of provision by organizations and their facilities.

Clarke (2002) compared three types of such performance indicators for determining the existence of food deserts in Cardiff England: simple provision indicators, accessibility indicators, and model-based indicators.

The simplest of these measure geographic provision as square feet of retail grocery per household and was calculated at the level of postal sectors. This indicator appears to show that urban, inner-city areas are the best provided for by grocery retailers with provision declining rapidly as one moves outward.

Two types of accessibility indicators were also examined. One of these was an indicator based on that developed by Hansen to analyze spatial variations in employment opportunities and by Guy to assess local shopping facilities. This indicator models accessibility as direct function of the scale of provision of a retail store and an exponentially decaying function of distance to a store. This indicator also calculates that central urban areas have the best provision, but this may be misleading since it relates an area to all possible retail destinations thus central areas would remain apparently well provisioned, even if area access was low, since they are at the heart of the spatial zoning system.

In a second accessibility indicator, a GIS–based local mapping approach similar to that used in the studies cited above was used. All "multiple/co-operative" food shops in the study area, representing stores likely to sell a full range of food products, were mapped. A circle of 500 meter radius was drawn around each food retailer representing a maximum reasonable walking distance. Areas outside of these buffers represent potential food deserts. These areas of potential desert were further restricted to areas characterized by high Carstrairs indices of multiple deprivation given the belief that areas with poor accessibility to food shops are of policy concern only if their inhabitants are likely to have low levels of car ownership and other indices of deprivation. Finally, the characteristics of independent food shops within these remaining areas were considered although systematic field survey was not performed. This method identified 7 potential areas of food desert within Cardiff.

All of the above models are limited in that they look only at the opportunities available to residents of a given area. While these limits may actually be in line with the concept of food deserts, which describe a lack of opportunity rather than a lack of actual use, they do not take into account the interaction that occurs between residence zones and retail locations and are thus not sufficient for modeling effects of proposed introductions of new retailers into the system.

To address these concerns, model-based indicators were created which allowed use of smaller zones of study. These were indicators of aggregate level of provision which, unlike models above, took into account the proximity of zones to a retail outlet in an adjacent zone as well as the size of the store in relation to the number of households near that store. These models found eight areas in Leeds/Bradford and five areas in Cardiff that had poor provision relative to the rest of each city. Again these areas of low provision were limited to those with limited car ownership which would thus have many residents more reliant on local grocery stores. These areas tended to occur at the edges of "conurbations" between town centers and far from city-edge superstores, and they appear to match up with areas identified as food deserts using the local mapping approach described above. This method is limited, however, in that these are areas of relative access as even the worst areas of provision in Cardiff are better provided than most areas of Leeds/Bradford.

This data was then used to further investigate the concern that large grocery providers might systematically avoid areas of deprivation. This analysis found that, indeed, the areas identified as food deserts were poorly served by the large chain retailers. Thus people in these areas would be more reliant on independent stores (which tend to have higher prices) and on outlet stores (which tend to have fewer product lines and fresh produce).

Finally, Clarke assessed the addition of a new superstore to an area identified as a food desert using these performance indicators. The model showed a "large and widespread improvement in provision across the whole area thus eliminating the previous food desert. However, there was concern that added competition from such a single large store might result in reduced revenues

and closure of other nearby smaller stores resulting in creation of multiple new small food deserts and this was supported by analysis in which the model was run assuming closure of the most susceptible stores. Analysis of a similar area was performed to assess the effects of opening multiple moderate-sized stores found that this method resulted in less severe deflections in provision versus opening a single superstore.

A similar analysis was performed for a recent introduction of a superstore in an area of Cardiff that was not previously identified as a food desert. This introduction was not found to have significant effects on provision to previously identified nearby food deserts.

Association Between Food Desert and Poor Dietary Behavior

Even if areas of relatively poor access to healthy and nutritious foods can be accurately identified, the question remains whether a causal link exists between such poor access and poor dietary behaviors that would likely lead to poor health outcomes. Investigating the relationship between local food store provision and dietary patterns has been the focus of a number of studies from the US.

For example, early studies by Cheadle (in Morland 2002a) reported that availability of healthy food choices in grocery stores was linked to the diet of residents in the nearby areas at both the community and census tract level. Correlations between changes in grocery store product availability and changes in reported consumption remained positive but were weaker and not statistically significant.

Morland et al. (2002a) used food frequency questionnaire data from the Atherosclerosis Risk in Communities Study and geocoded supermarkets, grocery stores, and full service fast-food restaurants to investigate associations between the local food environment and residents' dietary intakes. They found that greater numbers of supermarkets in each census tract was associated with higher levels of fruit and vegetable intake, as well as lower levels of total and saturated fat. This increase was more dramatic for Black Americans than for White Americans and was

independent of educational attainment and ability to afford healthy foods. In fact, the study found that black Americans consume one third more fruits and vegetables for every additional supermarket found in their census tract. While blacks and whites were sampled from different states raising doubts about data comparability, limiting data within states resulted in similar results. Further, white Americans in the study had three times greater access to private transport suggesting a specific mechanism for this disparity.

One explanation for these findings is that restaurants and stores adapt their selection to the food preferences of individuals living nearby. Therefore, they may not offer healthy food options in black and low-income neighborhoods because their market research indicates that demand for such products is weak in those communities. However, the opposite might also be true. Food preferences could partly be dictated by available selection in a neighborhood. This mechanism may be particularly relevant in primarily minority and low-income neighborhoods because of the lower levels of car ownership and often higher levels of disability in these communities.

Thus lack of physical food availability *may* be implicated as a structural cause of poor dietary patterns in these poor areas. Most likely, retail availability of healthy foods and social preference (i.e. market demand) interact reciprocally creating a "vicious cycle" of price-demand relation in poor areas (Forsyth 1994). However, longitudinal data exploring the temporal nature of changes in food preferences with respect to changes in food availability are needed to more definitively determine the presence and direction of a causal relationship between grocer provision and dietary practices of nearby residents.

More recently, Wrigley et al. (Wrigley 2002) have reported preliminary results of the first before and after assessment of the effect of the addition of a food retail center on the food consumption patterns of residents of an area previously identified as having poor food retail access in the studies described above. The researchers used a seven day dietary questionnaire to assess dietary intake and supplemented this with a questionnaire regarding various socioeconomic factors.

A number of pre-intervention cross-sectional analyses were performed. Analysis of baseline fruit and vegetable consumption showed extremely low levels of intake, and corroborated previous research demonstrating associations between extreme material deprivation based on the Townsend index and low levels of fruit and vegetable consumption. Prior to the introduction of the superstore, the median level of fruit and vegetable consumption was 2.43 portions per day and only 10% of respondents met the recommendations of at least 5 portions per day.

Final regression analysis found many typical factors were associated with low fruit and vegetable intake. These included young age, heavy smoking status, having children under 16, low educational attainment, material deprivation, and expressing negative attitudes toward the importance of eating a healthy diet attainment. However, contrary to prior hypotheses, there was no evidence relating household car access to fruit and vegetable intake and no simple relationship was found between distance to main food store and fruit and vegetable intake. Wrigley et al. hypothesize that the lack of association in these cases may be due to the complex coping mechanisms utilized by residents. For example, 10% were found to get a ride to the grocery store from someone outside their household. Of the 12% whose primary mode to store was walking, only half of these typically walked back home burdened with shopping. Rather, they typically rode home in a taxi as did some of those who arrived by bus.

Importantly, those residents who reported primarily using limited range and budget stores had lower levels of fruit and vegetable consumption, and these residents tended to be poor, young , heavy smokers, and those with children under 16. Further, use of limited-range and budget stores was associated with walking home from the store revealing a limited, combined effect of physical and economic access.

A second survey wave was conducted following the introduction of a large superstore to this area. Comparison of baseline and follow-up data reveal a number of interesting findings. While overall increase in mean vegetable intake was only 1% (from 2.88 to 2.92 portions per day), this statistic masks improvements in the diets of those with the lowest baseline consumption. For

those who consumed less than one portion per day at baseline, vegetable consumption more than doubled from 4.13 portions per week to 9.83 portions week and fruit consumption increased five fold from 0.77 to 3.92 portions per week. Likewise, of those who had consumed two or less portions per day at baseline, 60% increased their fruit and vegetable consumption with mean fruit and vegetable consumption increasing by a third.

Further, there is evidence that this improvement in fruit and vegetable consumption is due to use of the new store. Use of limited range and budget stores near the study area as a primary fruit and vegetable source showed a 60% decline overall and an 80% decline for those consuming 2 or less portions per day at baseline. At follow-up, an average of 35% of respondents reported the new store as their primary fruit and vegetable source, while 42% of those switching from limited range and budget stores and 70% of those consuming less than 1 portion per day at baseline reported using the new store for fruit and vegetable purchases at follow-up. These effects occurred without reducing the use of local green grocers and market stalls.

The differential switching from limited range and budget stores by those with the poorest baseline diets and the differential improvement in fruit and vegetable consumption in this group is substantial evidence that these respondents were constrained by physical and economic access to this type of store at baseline and that introduction of the supermarket resulted in substantial healthful dietary changes in these groups (Wrigley 2002).

Most recently, a second study has been published investigating the effects of the introduction of a "Hypermarket" in a deprived Scottish community (Cummins 2005). This study was set up as a "natural experiment" comparing before and after levels of fruit and vegetable consumption, as well as self-reported health and psychological health in both the intervention community and in a similar control community.

Like the previous study, this investigation found little evidence of a population-level impact due to the introduction of the hypermarket. Unadjusted analysis showed that the intervention community improved fruit and vegetable consumption by less than a third of a serving while the

control community improved consumption by 0.44 servings. In fact, ANCOVA models adjusted for baseline consumption, sex, age, employment, and education found a slightly negative effect on daily servings of fruits and vegetables (-0.10, 95% CI: -0.59 to 0.40).

In line with the previous study, limiting analysis to those who reported switching their main food shopping location to the new hypermarket resulted in larger effect sizes for fruit and vegetable consumption, however these remained small and confidence intervals included zero. Analysis showed increases in fruit and vegetable consumption of just under a third of a serving in the unadjusted model which increased slightly and in the adjusted model (0.35, 95% CI: -0.33 to 1.03). Further, comparison of ANCOVA regression lines between switchers and non-switchers showed no evidence against the null hypothesis of parallel lines, an effect quite different from the marked differential effect of switching observed in the study by Wrigley et al.

Cummins et al. conclude that because the unadjusted population effect sizes were similar in these two studies, and because this effect size decreased when changes in the matched control community were taken into account, that "This suggests that attributing change to superstore development in uncontrolled studies is problematic."

There may be a number of problems with this conclusion, however. Firstly, the study by Cummins et al. may have had increased levels of measurement error due to the use of a much simpler measure of dietary intake. In this study, two questions asked respondents to estimate their consumption of fruits and of vegetables compared to a 7 day food diary used in the study by Wrigley et al. This is important considering the non-significant trends found in the Cummins study.

Much more importantly, these two studies may have tested two quite different situations. The study by Wrigley et al. focused on an area which had been extensively researched and previously identified as a food desert. While the Cummins et al. study did focus on an area of substantial socio-economic deprivation, there was no further assessment of actual grocer availability in this area. Further, the data they did collect may indicate that this area was not a

food desert. First, the baseline levels of fruit and vegetable intake were higher than expected with 37% of the cohort reporting eating five or more fruits and vegetables daily. This is in contrast to figures of 29% as found in a national survey and 10% in the Wrigley et al. study. Secondly, though differential switching based on prior store type used was not thoroughly explored in the Cummins study, about half of all switchers changed from alternative superstores located outside of the area.

Indeed, the most convincing evidence from the Wrigley study comes from the observation of differential switching by those using limited range and budget stores and relatively large changes in fruit and vegetable intake in this subset of the study cohort. This evidence is convincing because it is in line with predictions based on the specific mechanisms by which the introduction of a retail grocer would be expected to influence consumer behavior. Namely, that the largest effect of such a change would be limited to those for whom physical *and* economic access to healthy foods was most limited before the introduction. Thus, taken together, these papers point to a more nuanced effect of improved food retail access. They suggest that, for people who are economically and physically limited to shopping at stores with poor availability of fruits and vegetables, the introduction of a nearby store that does carry these goods at an affordable price is likely to improve consumption of these products significantly. While some improvements in dietary consumption may occur in less constrained populations, these are likely to be muted in comparison.

The Cummins study also attempted to look one step past dietary consumption to assess the health effects of the retail intervention. Unexpectedly, odds of reporting fair or poor health were actually increased among intervention community respondents in both unadjusted and adjusted (OR 1.52 95%CI 0.77 to 2.99). Conversely, the odds of having poor psychological heath were reduced, but not significantly so (OR 0.57 95%CI 0.29 to 1.11). Limiting these analyses to switchers reversed the effect of the intervention so that adjusted analysis showed reduced odds of reporting fair to poor health though this effect remained non-significant. Similar analysis of the

reporting of poor psychological health found a significant protective effect associated with switching to the new store (OR 0.24, 95%CI: 0.09 to 0.66).

While self-reported health has been related to all cause mortality and self report of psychological well-being may be an important health outcome in itself, Cummins et al. did not explicitly lay out the mechanisms by which they believed that these factors might be related to changes in the food retail environment. Most directly, one would expect that, if improved retail access resulted in improved diet, these dietary improvements would result in improvements in health via the apparently protective effects of these foods for nutritionally related chronic diseases. The Cummins et al. study followed participants for only 10 months. While this was probably a sufficiently long period of time to expect to observe dietary changes, it is unlikely that many DR-CDs are substantially modified over this time period, and any changes that might have occurred would likely be diluted by the generality of the measurement variable "self reported health." To the extent that improved diet may result in improvements in psychological well-being, the results of Cummins are intriguing since there is very little research on the effects of healthful foods on psychological wellbeing. Perhaps more likely, however, the increase in psychological well-being may be related to the retail intervention due to the reduction in stress associated with reduced effort to obtain food and/or an improved view of the neighborhood as "urban redevelopment" occurs. All of these hypotheses must remain preliminary until more detailed research into these proposed mechanistic pathways is pursued.

Restaurant/Fast Food Location

While grocery store sales account for the largest proportion of the food consumed by Americans, restaurant sales volumes have been growing over the past decades and are now nearly equivalent to those of grocers (Glanz 2004a). Thus the physical location of restaurants has also begun to be examined as a structural factor contributing to high levels of DR-CDs and the recent increases in obesity.

Three studies have examined geographic associations between neighborhood composition and density of fast food restaurants. One of these was an ancillary examination which used median home value as a proxy for area wealth. This study did not find associations between fast-food restaurant density and either median home value or percent white/non-white (Morland 2002b).

However, two other studies did find a relationship between low neighborhood wealth and high density of fast-food restaurants (Reidpath 2002; Block 2004). Significantly, both of these studies were specifically designed to investigate this relationship and used median household income, rather than median home value, as a marker of wealth. Further, one of these studies (Block 2004) investigated, and found, a positive association between predominantly black neighborhoods and increased density of fast food restaurants.

Evidence also suggests that low-income and nonwhite individuals do consume more fast food and unhealthy food. French et al. (2000) noted that low income and nonwhite ethnicity were associated with increased fast food consumption, but the interactions between geographic location of fast food stores, socioeconomic, and racial groups has not yet been studied.

Thus it remains to be seen whether there is a causal relationship between increased density of fast food restaurants and higher levels of consumption of fast food by nearby residents, and to what extent this hypothesized relationship might account for socioeconomic and racial differences in dietary consumption patterns. Given the evidence seen in grocery store research, effects may be expected to be limited to certain subpopulations and should be explored with specific mechanisms in mind.

Community-Based Approaches: Farmer's Markets & Urban Gardens

Besides the more mainstream food vendors like grocers and restaurants, advocates of improving access to fresh fruits and vegetables have begun to explore the potential for a number of other options to improve healthy food access in areas of need.

In general, the number of farmer's markets has grown dramatically from 1,755 in 1993 to 2,746 in 1998 (French 2001). A number of farmer's market programs have been developed to target low income groups, but evaluation of these have generally been limited to price reduction or coupon programs. No peer-reviewed research was found regarding the location of farmer's market programs in areas of limited food availability.

Likewise, urban gardens have been suggested as a way to alleviate food insecurity, improve access to fruits and vegetables, and improve community cohesion. However, peer-reviewed evaluations of such programs have not yet been published.

Other Important Physical Environment Factors

Though this paper focuses on the diet and related health effects, it is worth noting that, as mentioned above, many of the nutritionally related chronic diseases are related to energy balance and thus considerable improvements in health may be made with increases in physical activity. Thus a growing literature on the effects of the physical environment on physical activity complements the research presented above which focuses on dietary behaviors.

As with the location of supermarkets on the edges of cities, some studies have found that modern land-use practices may result in barriers to physical activity. As with grocer location, the common use of cars has allowed land-use patterns which are actually prohibitive for walking and biking (Frank 2001). Authors are currently researching the effects of neighborhood walkability, neighborhood safety, park availability, and other environmental factors which may inhibit or promote physical activity.

F) IMPLICATIONS

Introduction

Because of the importance of healthful nutrition to large populations, population-based interventions to improve nutrition are necessary. Nutrition behavior is now viewed as a complex phenomenon influenced by individual, social, and environmental variables. Given that the focus of population interventions has previously been on nutrition education and these interventions have proven limited in their effectiveness, it makes sense to explore other avenues to promote healthy dietary practices. The physical and economic environments are logical "lever arms" in this system because many of the decisions to create our built environment can be consciously made and altered by policy makers and community members and have the potential to impact large segments of the population. These conclusions have implications for government, communities and academics.

Government

Given its role as a regulator of many social and environmental factors, government is in a position to play a central role in improving health via contextual interventions. One proposal for insuring government's continued role in and awareness of the health effects of structural decisions is the creation of health impact assessments. Analogous to environmental impact statements, these assessments ensure that health impacts of government policies, such as zoning laws, which may not be carried out primarily for health purposes, but which may have significant health impacts nonetheless, are taken into account.

As described by Ashe (2003) and Frank (2001), modern zoning laws have resulted in greater travel distances between where we live, work, shop, and play, and may in some ways work counter to the original health intent of the zoning act. However, zoning laws have more recently

been used to regulate the location and density of alcohol, tobacco, firearms and fast food retail outlets offering a promising tool for public health advocacy.

While economists have made strong arguments from many sides for agricultural policy reform, strong interests make political action difficult. Nevertheless, highlighting the adverse effects of economic farm policy on our nation's health offers another strong reason for considering such policy reform. While some authors have gone so far as to suggest taxes on unhealthy foods, this also seems like a difficult political move, and seems to make little economic sense given the likely inefficiencies introduced from multiple market subsidizations and corrections.

Communities

Communities have already taken the lead in a number of ways to improve the health of residents by supporting healthy nutritional behaviors. Initiatives to reduce access to harmful foods by banning vending machines in schools as well as increasing access to healthy foods by creating farmer's markets and urban gardens are occurring across the country. One tool that has been used to determine local needs is the Community Food Assessment (Pothukuchi 2002). These are assessments carried out by community members themselves to determine the sufficiency of the local food supply and to pressure local government to react to local needs.

Academia

As discussed by Macintyre (2000), the scientific assessment of government and community-based social programs is essential for a number of reasons. First, despite the best of intentions, social and public health interventions do have the capacity to do harm. Thus serious consideration and exploration of possible negative effects of an intervention (as modeled by Clarke et al. above) is an important step in responsible research.

Secondly, even if an intervention is found to be "good in general" there is a need to know how good, at what cost, via what mechanisms, and for which population subgroups as policy makers need this information to intelligently assess the relative desirability and of various social interventions for which there are always finite resources. Further, interactive models will be particularly useful in determining what mixture of programs may be useful in a given situation.

Finally, it is important to keep in mind that experimental evaluation of interventions may underestimate benefits if they are too narrowly defined, but may also show benefits that would otherwise go unnoticed. The first concern is particularly important as interventions become based on complex ecological models of causation and is also important to keep in mind given the relatively short time-scale of most intervention research and the often much longer timescale that are generally applicable to chronic diseases.

Thus academics can play an important role in cooperation with governmental and non-governmental organizations by engaging in research which adds to the evidence base behind social and environmental programs. In fact, cooperation with these groups as well as industry is likely the only way to test large-scale environmental interventions such as those described above. With this structure in mind, the following paper describes an evaluation of a novel farmer's market intervention which seeks to improve access to fruits and vegetables in a low income minority neighborhood of Berkeley, California.

Part II: Evaluation of an Intervention to Improve Access to Healthy Foods in South West Berkeley.

A) Background

Background: Statement of the Problem

As discussed in part I, poor dietary habits are established contributors to high rates of chronic disease in the US and around the world. There is now a large body of literature on the substantial link between diet and many chronic diseases including cancer, cardiovascular disease (which includes hypertension, stroke, & coronary artery disease), diabetes, and obesity.

These diseases represent the leading causes of death across the US for most of the last century (NCHS 2004), and poor lifestyle factors, including diet, have been estimated to account for large proportions of these diseases (15%-90% depending on the disease) (AICR 1997; Chang 2001; Lloyd-Jones 2001; Hu 2001; Key 2004). There is also a growing literature indicating that fruit and vegetable consumption may play an independent and important role in protecting against these diseases. For example, low fruit and vegetable intake alone has recently been estimated to account for 20% of all cancers (Glade 1999), and 16% of all cardiovascular deaths in the US (Van't Veer 2000).

Further, a large literature on health disparities has shown that poor & minority populations are disproportionately affected by chronic diseases. For example, there is a strong association between lower socioeconomic status and higher rates of nearly all chronic diseases, and death rates for Blacks exceed those for Whites of the same gender for each of the top causes of mortality over the past century (NCHS 2004).

So far, the efforts aimed at improving public nutrition have centered on nutritional education and have met with limited success. For example, while the California 5-A-Day for Better Health! Campaign was successful at increasing awareness of the need to eat at least 5 servings of fruit and

vegetables a day, it had little or no effect on improving fruit and vegetable consumption across the state (Foerster 1994; Krebs-Smith 1995).

The lack of improvement in fruit and vegetable consumption via traditional health communication interventions has fed into a renewed interest in the role environmental factors play in health. This has led to calls for structural changes in the built, social, and economic environments in hopes they will act as more effective means of improving dietary behaviors.

Background: Built Environment and Nutrition

Improving physical and economic access to nutritious foods like fruits and vegetables is one example of such a structural change that has been proposed. In the US, researchers have focused on the variation in neighborhood availability of grocery stores and stores carrying affordable healthy foods. An early study by Cheadle et al, found that availability of healthy products in stores is associated with the reported healthfulness of the diets of near-by residents. (Cheadle 1991)

A more recent study identified grocers by census tract and found three times as many supermarkets in wealthy versus poor areas and four times as many in white versus black neighborhoods. Only 8% of black Americans lived in a census tract with at least one supermarket, and those who did live in such a neighborhood were more likely to meet dietary recommendations. This effect was independent of both education and income (Morland 2002).

In the UK, research and policy debate has centered around the phenomena of "Food Deserts." These are described as populated urban areas where residents have relatively poor access to healthy dietary choices (Cummins 2002). In this field, the notion of "access" subsumes physical availability, affordability and variety; thus food deserts are areas where people have poor physical access to a sufficient variety of affordable produce and other healthy foods.

While physical lack of food availability has been associated with poor dietary patterns in a number of studies, their cross-sectional nature prevented determination of the causal nature of the

findings. In the first prospective study regarding food deserts, Wrigley and others (Wrigley 2002) looked at the effect of the introduction of a large grocer to an area that had previously been identified as being socioeconomically deprived and as having poor food access. Although there was no clear association between distance to grocer or car access and FV intake, significant improvements in fruit and vegetable consumption were found amongst those who had the poorest diets pre-intervention.

A second study was recently published by Cummins et al. which evaluated the effects of the introduction of a similar type of superstore in an area of socioeconomic deprivation which had not been identified as a food desert (Cummins 2005). As in the first study this investigation did not find significant population improvements in fruit and vegetable consumption post-intervention, but found some evidence of improvement among those who reported switching to the new store. Unlike the Wrigley study, however, this study used a comparison neighborhood to assess for secular changes in fruit and vegetable consumption and controlled for demographic factors in the analysis. These controls rendered improvements non-significant.

Taken together, these studies highlight a likely mechanism whereby *combined* economic and physical limits to accessing fruits and vegetables may drive consumers to shop at stores selling fewer of these products. When a viable alternative which provides fruits and vegetables is introduced, consumers are able to take advantage of this improvement in access and diets appear to improve accordingly. The fact that effects appear to be greatest for those with the poorest diets is of significant importance given the general difficulty of effectively targeting this group through nutritional education interventions. (see Part I for more complete discussion)

Background: Status of Berkeley

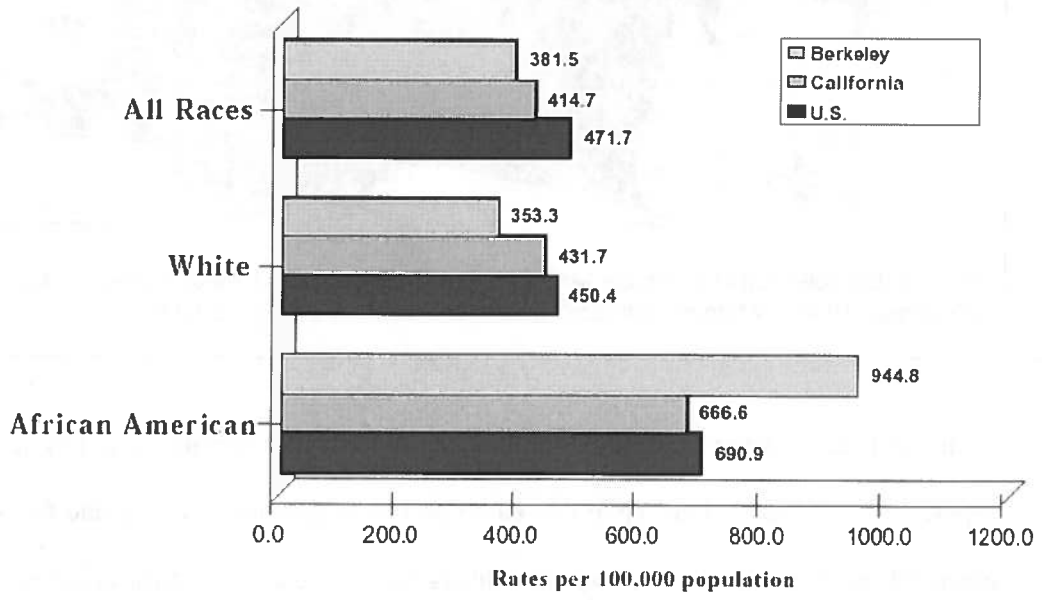
In 2000 the City of Berkeley released a Health Status Report (City of Berkeley2001) which found that, as in the rest of the US, diet-related chronic diseases (DR-CDs) were the most

common causes of death in this area. Specifically, the top three causes of death - heart disease, cancer, and stroke - account for about 60% of all deaths in Berkeley.

The report also highlighted significant disparities in socio-economic status in Berkeley. For example, per capita income of whites was found to be at least twice that of people of color, and at least four times as many families of African American, Latino, Asian, and other races live in poverty compared to white families. Further, significant disparities in proportional mortality were found paralleling these socio-economic disparities. African Americans were found to account for 48% of deaths from stroke, 36% from coronary heart disease and hypertension in 1998 while making up only 19% of the Berkeley Population. In fact, racial disparities in health appear to be greater in Berkeley than in the rest of California or the US (Figure 2.1).

Figure 2.1

Age Adjusted Mortality Rates by Race/Ethnicity
City of Berkeley, 1998

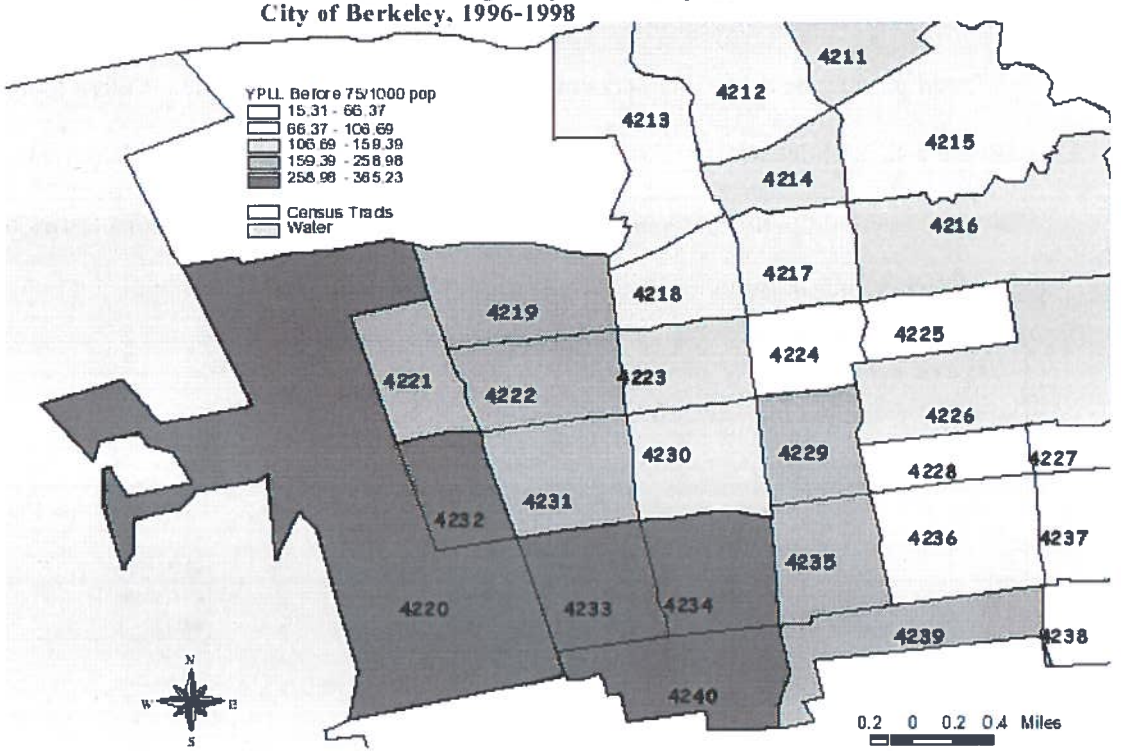


Source: Berkeley City Health Department, Epidemiology and Health Statistics, Mortality Database, 1998, National Statistics Report, NCHS, July 24, 2000, CDHS

Finally, these disparities were also found to play out geographically. South and West areas of Berkeley represent a concentration of Berkeley's poverty, (Map 1.2) and they also represent a concentration of the burden of disease. (Figure 2.2)

Figure 2.2

Years of Potential Life Lost Before Age 75 per 1000 Population
City of Berkeley, 1996-1998



Source: Berkeley City Health Department, Epidemiology and Health Statistics, Mortality Database, 1998, National Statistics Report, NCHS, July 24, 2000, CDHS

In 2001 the Berkeley Department of Public Health issued a Nutrition and Physical Activity Report (Clayton 2000). This report was based on a non-randomized survey and focus groups of area residents and examined, among other things, barriers to eating nutritious foods identified by the residents. The report found that 41% of African American and Latinos surveyed cited lack of money as an important barrier compared to 34% surveyed whites. Other prominent reasons cited included not enough quick and easy recipes, not enough time, and a lack of access to quality nearby grocers. The report also found that most people believed that they needed to improve

their diets, and that Latinos were more likely to want to do this by eating more fruits and vegetables.

The report also produced a wide range of recommendations on how the city might start to improve the dietary and physical activity habits of residents of predominantly poor and minority neighborhoods in hopes of reducing health disparities. Recommendations centered on outreach and education, skill building, physical environmental changes, economic strategies, and social strategies. Proposed changes to the physical environment included promotion of urban agriculture and community gardens, limits to the number of fast food restaurants, improved affordability and distribution of produce in South and West Berkeley, improved availability of free & low cost exercise venues, and promotion of safe aesthetic exercise locations.

Background: Farm Fresh Choice

In response to this perceived need for improved access to fruits and vegetables in South and West Berkeley, a novel farmer's market program, Farm Fresh Choice (FFC), was created. This program has a two-part mission statement: 1) to improve health and nutrition by increasing access and consumption of fresh, nutritious and affordable fresh fruits and vegetables to communities with limited access to produce outlets; and 2) to support small scale, independent sustainable farmers in the Northern California region (FFC 2004). The program is supported by funding from the California Nutrition Network and other governmental and private donors and is run by the Ecology Center, a well-established local non-governmental organization which seeks to "promote environmentally and socially responsible practices through programs that educate, demonstrate, and provide direct services." Prior to the initiation of FFC, the Ecology Center ran two weekly farmer's markets in Berkeley near the center of town and a third market in the northeast of Berkeley.

FFC now runs four farmer's market stalls which are located in community and childcare centers in South and West Berkeley. These sites are open weekly and offer a variety of fresh,

organic, and pesticide-free produce. A typical market stall consists of a tent with two tables (about 30 square feet of sale space) and 20 to 30 types of fruits and vegetables depending on the site and season. As an arm of the Ecology center, the FFC program contracts with farmers who sell at the larger Ecology Center farmer's market, and resells this produce at cost.

Beyond running these market stalls, FFC is involved in a number of food promotional activities such as cooking demonstrations, taste-testings, local farm field trips, community health fairs, and other education and outreach activities. These programs are less consistent than the markets and are developed and implemented as need is perceived and opportunities allow. FFC also seeks to serve as a mechanism for youth training and employment. FFC interns are generally youth from southwest Berkeley or adjacent areas of Oakland.

In a self assessment performed in 2004, FFC was found to have served approximately 500 families and 2,300 children, and 1,400 local residents had been contacted through outreach. The program generated one hundred thousand dollars in additional sales for local farmers, and had provided employment and training to 19 youth interns.

Background: Study Objectives

Broadly, this project seeks to add to the growing body of literature which investigates the effect of the built environment on food access. It is designed to evaluate the effectiveness of FFC farmer's markets as a built environment intervention to improve food access in areas which have previously been shown to have substandard food access as well as poor dietary norms and heightened rates of chronic disease.

It is hoped that research into the effectiveness of this intervention will guide FFC in its ability to better meet its goals and will serve to verify the extent to which FFC is successful, thus aiding funders and policymakers in their decisions whether to fund this and other similar projects.

This project had 6 primary aims addressing these issues as well as three secondary aims. The study's primary aims were:

1) To determine if a food desert existed in the area of southwest Berkeley/ North Oakland using GIS methods;
2) To determine if the addition of FFC decreases the number or severity of these putative food deserts;
3) To determine if FFC is successfully reaching its target audience;
4) To determine which members of the local community are most affected by FFC and which community members are not affected by the intervention;
5) To explore reasons why some community members not utilizing FFC;
6) To explore ways in which the intervention could be changed to positively affect a greater portion of the local community

Secondary aims of the study were:

7) To create an opportunity for training, education, and employment of local community members through community member participation in research investigation;
8) To enhance collaboration between the university and a community organization (FFC) and to find methods which promote this relationship; and
9) To create research that will be of direct benefit to the community.

B) METHODS

Methods: GIS Data

Base map

The first two objectives concern the geographical distribution of food stores in the City of Berkeley, thus ArcMap was used as the GIS platform for spatial data entry and analysis. Shapefiles for streets, political boundaries, and landmarks for Alameda and Contra Costa counties were downloaded from the US Census 2000 TIGER files made available through ERIS. These

shapefiles were united to create a base-layer map which included the study area. The border of the City of Berkeley was drawn based on the most recent City of Berkeley Districting maps (City of Berkely 2002) and borders of South and West Berkeley were drawn based on those used by Gardener (Gardner 2003). These defined South Berkeley as areas of Berkeley south of Derby Street and West of Fulton Street and defined West Berkeley as all areas of Berkeley west of Sacramento Street. The term "southwest Berkeley" will be used to describe the union of these areas (i.e. areas within the boarders of *either* South or West Berkeley).

Demographic Data

Demographic data on age, sex, race, and household relationship were available with block-level unique geographic identifiers and these data were joined to the base-layer Shapefile. Demographic data on counts of the number of residents living at various percentages of the federal poverty line, and number of households without a car were available at the block-group level. These were downloaded into Microsoft Access, converted into percentage data, and unique geographic identifiers were constructed to enable joining these data to the base-layer map as well.

Using these data, maps were created showing the percentages of block-group residents below 150% of the Federal Poverty Line (see Map 1.2). Maps were also created showing the percentage of block-group homes without automobile access (see Map 1.1). For both of these variables, natural breaks were used within the ArcMap software to define categories of proportions of block groups below the poverty line or without an automobile.

Food Store Data

It was originally planned that these data would be added to a recently created map of food stores from a previous master's thesis (Gardner 2003). However digital data from this project was no longer available; thus a list of Berkeley grocers was created from a hardcopy list and was supplemented by data on grocers from Yahoo maps, MapQuest, and survey data. Grocers within

500 meters of the Berkeley Border were also included to take into account the effects of stores outside of the study boundary which might nevertheless affect results within the study area. Grocers were defined as all potential non-restaurant retail food sources and included warehouse stores, large chain supermarkets, large local non-chain supermarkets, local natural-food grocers, local ethnic grocers, local markets, delis, liquor stores, and convenience stores. Each of these was plotted on the base-map with a unique identifier and a code for the store type.

Food Deserts

Given the resource limitations of the study and the lack of availability of data evaluating food availability within specific stores, a sensitivity analysis was performed and "best-case" and "worst-case" scenarios were created using two schemes of determining which stores sold an adequate variety of fruits and vegetables at reasonable prices (see results for definitions).

Following the methodology of Donkin et al. (Donkin 2000), 500 meter buffers were drawn around each of these grocer locations representing the furthest distance that people would reasonably walk to a store. The area between these buffers represents a first estimation of potential food deserts.

Because of the apparent mechanisms by which physical limits to food access might impair dietary consumption, and because of the explicit use of "walkability" as theoretical parameter, only those inter-buffer areas which overlap areas of low car ownership represent likely food deserts. Since car access correlates well with poverty indices, this measure also serves as a marker of area deprivation.

Methods: Survey Development

Prior to the initiation of this research project, FFC, in collaboration with the University of California, Berkeley Center for Weight and Health, had performed a baseline survey during a membership drive over the summer of 2004. New members completed a seven-item fruit and

vegetable screener developed and validated by Block et al. (Block 2000) which also included participant age and sex. This survey was administered by two FFC employees. Participants were given 10 dollars for participating, and although there was some concern over some participants attempting to take the survey multiple times under different names, the small number of staff and their awareness of this possibility are believed to have limited this problem. Power calculations concluded that approximately 300 base-line surveys should be completed, however only 139 baseline surveys were completed. Data were entered via an optical scanner, and data were tied to participant's names through ID numbers to maintain confidentiality and allow follow-up.

Planning for this project was begun in fall of 2004, and a questionnaire (see appendix II) was developed which included the Block fruit and vegetable screener to allow follow-up of baseline data. Because of concern over small sample size and uncertainty about the ability to followup participants, a second measure of self-reported change in fruit consumption and self-reported change in vegetable consumption was created using a five-point scale centered on "no change." Demographic variables were based off of 2000 census question to the extent possible to improve comparability with these data. The questionnaire also included questions regarding frequency and reasons for and against use of the FFC markets, frequency of use of other grocers, modes of transport for grocery shopping, and attitudes regarding the FFC membership fee. In order to geographically tie these data to the GIS data, residential cross streets were also asked.

Methods: Sampling

In order to assess characteristics of the current membership of FFC, a random sample of 150 members was drawn from the membership lists of FFC. While this sample included some of those who had signed up via the 2004 membership drive, follow-up was also attempted with all of those who had completed the baseline survey but were not randomly selected. As FFC records included only name and phone number for most members, a reverse telephone book was used to identify potential addresses to allow door-to-door interviewing. When addresses and names did

not exactly match, multiple addresses were included so that the appropriate address could be determined during door-to-door interviewing. All addresses were entered into an online mapping program to facilitate location. Finally, point-samples were taken over a single day at each market to validate FFC management impressions that the vast majority of market users were members.

The original project protocol specified a comparison group that would be selected by systematic sampling of members' neighbors. However, the wider-than-expected geographic distribution of members, lack of project team transportation resources, and the general expense of door-to-door sampling made collecting this comparison sample impossible.

Methods: Interviewing

Farm Fresh Choice interns who were interested in working on this project were trained in survey methodology and project protocol. This training included practice in administering the survey, and two actual study surveys were observed for each intern. For safety, interns conducted door-to-door interviews in pairs and stopped interviewing at nightfall. Because of a change in FFC management during the summer of 2005, interviews were conducted from September 2005 through January 2006. Thus the possibility of seasonality bias does exist though this would be expected to decrease the level of fruit and vegetable consumption at followup and thus reduce any positive effect of the market. The fact that the survey asks participants to estimate their consumption over the past year may help to reduce this effect.

Interviewees provided written consent when interviewed in person, and verbal consent when interviewed by phone. After the interview, they were also asked to provide consent to further follow up and were given a choice of a FFC gift certificate worth ten dollars or a calling card of the same value as a thank-you gift for participating.

A number of methods of contacting members were tried. First, surveyors contacted participants at their homes and conducted in-person interviews according to the original protocol.

Each home was visited once; however, it was soon clear that this method was not feasible given the limited resources of the survey team.

Thus members were contacted at the FFC markets and over the phone and appointments were made to conduct interviews in person. While response was better with this method, it remained quite low. The questionnaire was then piloted over the phone and while this method took somewhat longer, respondents did not appear to have any extra difficulty answering questions. Thus two of the interns were trained in phone interviewing and interviews were conducted via this method.

Each selected member was called ten times or until they completed the survey or refused to participate. For those without working numbers, homes were visited up to five times. Thus, despite the randomized selection of FFC members and the frequency of calls, the variety of contact methods and low response rates may have affected the validity of this randomization.

Methods: CPHS

Project protocol and data collection materials, as well as changes to protocol, were approved by the University of California Berkeley, Committee for the Protection of Human Subjects under CPHS protocol number **#2005-6-7.**

Methods: Survey Data Entry & Analysis

Two FFC interns were trained in data entry and they and the author entered all survey data into Excel spreadsheets. All data entries were double checked by the author before analysis was performed. Participants' geographic data (i.e. cross streets) were plotted in ArcMap and x, y geographic coordinates for each participant and each grocer were exported to Excel. Straight line (Euclidian) distance was calculated for each participant's main grocer, secondary grocer, primary fruit and vegetable grocer and each FFC market site. These data were joined to the rest of the survey data in excel and imported into STATA for statistical analysis. Additional spatial

variables including residence in South or West Berkeley, and residence within the proposed food desert were likewise entered into Excel and imported into STATA.

Data from the baseline and follow-up surveys was joined based on the ID numbers from the membership list labeled "survey ID." However, age and sex for these ID numbers did not match between surveys. Thus FFC computers were searched for other possible baseline survey ID keys. One was found that appeared to match based on age and sex, however, because of the errors in selection caused by the invalid ID code, the number of successful follow-ups was extremely low.

All statistical analyses were conducted in STATA (version 7.0 intercooled). Categorical variables were analyzed using cross tables and Fischer's exact tests for significance given that cell values were often low. Means of continuous variables were analyzed using T-tests and ANOVA as appropriate.

C) RESULTS

Results: Food Deserts

Maps 2.1-2.4 represent the results of the sensitivity analysis of potential Berkeley food deserts. The blue outline represents the boundary of the City of Berkeley, the inner blue lines are the borders of South and West Berkeley, and the large green area to the east represents the UC Berkeley campus. As described above, these maps are placed on a background of household car ownership where darker areas represent block-groups in which higher proportions of households do not own a car.

Map 2.3 shows the "best case scenario." In this map, local markets, delis, and convenience stores which replied that they did carry fruits and vegetables in Gardener's 2002 phone survey are combined with warehouse grocers, supermarkets, and natural grocers as locations selling fruits and vegetables. However, this was a binary measure which did not take into account the quality, variety, or price of these goods and thus likely overestimates true availability.

Map 2.1 shows the "worst-case scenario" in which all local markets, delis, liquor stores, and convenience stores were coded as not selling adequate quality and variety of fruits and vegetables at affordable prices. These stores are shown in black. Warehouse grocers, supermarkets, and natural grocers are coded in various shades of green and with 500 meter buffers surrounding them. This method likely overestimates the presence of food deserts given that some of these markets may well carry a variety of canned fruits and vegetables as well as some produce. However, based on personal experience in these stores it is felt that this overestimation is mild given that the working definition of fruit and vegetable access includes quality, variety, and price.

Comparison of these two maps shows considerable variation in the areas considered potential food deserts depending on the analysis methods. In the best-case scenario, only a one square kilometer area in south-central Berkeley and the relatively unpopulated far-west of Berkeley appear as likely food deserts. In contrast, the worst-case scenario shows a much different picture. In this map, much of the area of south and west Berkeley, especially the central area along the South Berkeley-Oakland border and the southern half of the area within 1.5 kilometers either side of the eastern border of West Berkeley, appear to be areas of low levels of car ownership, high levels of poverty, high rates of life-years-lost, and little access to fruits and vegetables. Thus the areas of likely food deserts appear much larger.

In these maps, the block-groups with the largest proportion of households without car access are located adjacent to the UC campus. This may represent a special population given that these are likely to be the areas with the greatest student populations. Although these areas are also the poorest by FPL (Map 1.2), because students generally earn little income, this index probably obscures considerable wealth in the form of economic capital of students and their parents as well as the social capital that accompanies a college education.

Despite lack of local retail access to fruits and vegetables, college students may have the economic opportunity to purchase relatively healthy prepared foods from restaurants and college cafeterias. However, these college students may also be susceptible to the effects of food deserts

despite this economic power, depending on the quality of the available prepared foods. Data from this study are not suitable to answer the question of whether people in this area are truly affected by the apparent lack of fruit and vegetable outlets on the south side of campus. It is noteworthy that, whatever the balance between economic and physical environmental factors, people in most areas adjacent to the UC campus are among the healthiest in Berkeley (Figure 2.2).

Results: Effect of FFC

Maps 2.2 and 2.4 show the effect of FFC markets (yellow stars) as well as other farmer's markets (yellow hexagons) on the apparent food deserts shown in maps 2.1 and 2.3. Non-FFC farmer's markets were not included in previous maps because of their temporal (un)availability and the relatively high prices at non-FFC farmer's markets. Comparison of "best case maps" (Maps 2.2 and 2.4) shows relatively little change in the area of likely food deserts whereas comparison of "worst-case maps" (Maps 2.1 and 2.3) shows a substantial decrease in areas of likely food desert.

Results: Survey Response Rates

Completion and refusal rates were calculated for the survey samples. There were no data available to assess whether those who completed the survey were demographically similar to those who did not. Fifty-seven percent (86/150) of randomly sampled individuals were successfully contacted. Of those contacted, 13% (11/86) refused to participate resulting in an overall completion rate of 50% for this group. For those who were followed up from the baseline 2004 survey, 63% (20/32) were successfully contacted. Fifteen percent (3/20) of those contacted refused to participate resulting in a completion rate of 53% (17/32). For those point sampled at the markets, 69% (22/32) completed the survey and 31% (10/32) refused to participate.

Results: Demographic Characteristics of FFC Members

To determine which members of the community were reached by FFC, demographic data from the randomly selected survey participants were compared with similar data from the 2000 US census. Results of this comparison can be seen in Table 2.1 and Table 2.2. Any conclusions drawn from this comparison should take account of the fact that these data are temporally separated by six years and demographic shifts may have occurred during that time.

From this comparison, it appears that the demographic structure of the FFC membership varies in some significant ways from what would be expected from a random sample of either Berkeley or South and West Berkeley.

The age distribution of FFC members appears different from both that of Berkeley and that of southwest Berkeley. FFC members are more likely to be middle-aged (30-44) or later-middle-aged (45-59) and less likely to be either over 60 or under 30 years old. This may be related to the relatively high proportion of FFC members who have children in the home (58%). The predominance of females in the FFC membership is not surprising given findings of other studies which show that women continue to do more of the food shopping for a family.

Differences in the racial distribution of FFC members shows that FFC is successful in disproportionately reaching African Americans, but also that it reaches similar numbers of Latinos as would be expected by chance in Berkeley. Considering the similarity between the racial makeup of FFC and that of southwest Berkeley, it initially appears that this effect could be driven by the location of the markets in southwest Berkeley. However, fully one third of FFC members do not live within South or West Berkeley. Thus the concordance between the racial profile of FFC membership and that of surrounding neighborhoods may be due to unmeasured social factors which cause physical segregation of racial groups via distinct social routes.

Interestingly, relatively few FFC members have less than a high school education. FFC members appear relatively more likely to have had some college or more than a college degree

Table 2.1: Comparison of FFC and Berkeley Demographic Data (US Census 2000)			
Category	**Berkeley**	**SWBerk**	**FFC**
Age			
18-29	37%	26%	17%
30-44	26%	34%	36%
45-60	22%	23%	39%
60+	16%	17%	8%
Sex			
Male 18+	49%	47%	17%
Fem 18+	51%	53%	83%
Race (exclusive)			
White	57%	36%	31%
Black	12%	32%	33%
Latino	9%	16%	14%
AIAN	1%	0%	1%
Asian	18%	9%	4%
Other	0%	0%	9%
2+ races	4%	5%	7%
Educational Attainment for those 25+			
Less than High School	8%	16%	4%
High School Grad	9%	15%	3%
Some Col	19%	26%	35%
Col Grad	30%	25%	24%
Grad +	34%	18%	33%
Employment (16+ yrs)			
Employed	71%	75%	81%
Work Full	51%	48%	55%
Work Part	21%	27%	26%
Unemployed	4%	5%	4%
Not in Labor Market	24%	20%	15%
Keep House	-	-	5%
Student	-	-	3%
Retired	-	-	4%
Disabled (employment disability)	21%	11%	3%
Household Income			
Less than $25,000/year	32%	35%	32%
Less than $35,000/year (80% Median)	42%	46%	42%
$35,000 to $75,000/year	28%	34%	39%
More than $75,000/year	30%	20%	18%
Median	$39,610	-	$42,500

Table 2.2: Comparison of Other Demographic Factors (US Census 2000)

Characteristic	Berkeley	SW Berk	FFC
FPL			
<100%FPL	20%	17%	15%
<150%FPL	27%	27%	23%
<200%FPL	33%	35%	31%
Living situation			
Households with Children	17%	18%	58%
Households without Children	83%	82%	41%
Vehicle Ownership			
Households with no vehicle	17%	18%	12%
Less than daily access	-	-	17%
Buy for others			
Buy for someone else	n/a	n/a	84%
Buy for kids	n/a	n/a	64%
Food assistance			
Use food assistance in past yr	-	-	15%
Location			
Non-Berkeley	-	-	20%
Berkeley	67%	-	13%
SW Berkeley	33%	-	67%

compared to other Berkeley residents. FFC members also appear somewhat more likely to be employed than others in Berkeley.

The relatively low portion of FFC members who are on employment disability may be of concern if the people missing represent a subset of the population who are not physically able to access the market even when it is located within a short walk.

Interestingly, despite FFC's emphasis on providing affordable produce to low income residents, FFC members do not appear any more likely than other Berkeley or southwest Berkeley residents to earn less than the median Berkeley income. Likewise, the proportions of FFC members below 100%, 150%, and 200% of the Federal Poverty Line are slightly less than those for other Berkeley and southwest Berkeley residents. However, very few FFC members have yearly household incomes above 75,000 dollars. This indicates that FFC is not effectively

reaching low income residents, but rather, is mostly serving the middle-income segment of the surrounding population.

FFC members appear somewhat less likely to own a car than others in Berkeley, and although no comparison data are available, a substantial minority of FFC members have used some type of food assistance in the past year.

Results: Target Audience

One important question to FFC was whether they are indeed serving the groups which they intend to target via location and outreach efforts. Thus demographic data were used to dichotomize the sample into "target" and "non-target" groups based on a definition developed independently by FFC management. The target group was defined as African Americans & Latinos with children, living below 80% of Berkeley median income or 200% FPL, who are resident of South or West Berkeley. While FFC management was quick to state that others were welcome to take part in the program, they believed this group represented the community members the program most strongly seeks to target.

FFC targets these groups by strategically placing markets at youth and childcare centers in South and West Berkeley. Two of the markets are located at youth centers which serve predominantly African American youth of South and West Berkeley, a third center is at a community center located at a park, and the fourth is a Latino daycare center. FFC also seeks to engage its target audience by hiring youth interns and management from these areas. Likewise, staff and management at some sites are bilingual in Spanish and English.

Using the above definition, the target group was found to comprise 9% (95%CI: 2%-15%) of the participants randomly selected from the FFC membership lists, and 4% (95%CI: -4%-13%) of participants from the point samples.

Results: Fruit and Vegetable Knowledge and Consumption

Knowledge

Given the centrality of knowledge to many theories of dietary consumption and behavior change, and previous research demonstrating relatively low levels of knowledge regarding fruit and vegetable consumption, knowledge of current dietary recommendations was assessed with a single, open-ended question. FFC members appear relatively knowledgeable about these recommendations with 65% (95%CI: 54%-77%) reporting that experts recommend eating 5 or more servings of fruits and vegetables a day.

Five servings was by far the most common response to this question (53% of answers) probably indicating an educational effect of the California 5-A-Day for Better Health campaign either directly, or indirectly through information received via FFC.

FFC programs seek to educate their members and the public about the recommendations and benefits of fruits and vegetables and FFC members may have benefited from this. FFC members may represent a self-selected group who are more interested in eating fruits and vegetables because they are more knowledgeable about recommendations to do so. Alternatively, demographic factors such as relatively higher education and income levels may account for this finding.

Consumption

Using the algorithm described in Block (Block 2000), average daily fruit and vegetable consumption was calculated from a raw fruit and vegetable score derived from the Block fruit and vegetable screener. This calculation showed that fruit and vegetable intake among randomly selected FFC members was 4.9 servings/day (95%CI: 4.6-5.2) with 49% eating 5 or more fruits and vegetables daily.

Though not directly comparable to broader national and state surveys due to differences in the dietary instruments, this level of fruit and vegetable consumption appears quite similar to that

found in the 2001 California Health Information Survey (CHIS) (CHIS 2001). The CHIS survey found that 51% of both California and Alameda County adults eat 5 or more servings of fruits and vegetables daily.

Knowledge-Consumption Association

As in other studies, fruit and vegetable knowledge was not associated with daily servings of fruits and vegetables though the study was not powered to detect such an association and only a raw logistic regression was performed ($F(1,106) = 0.61$; $P=0.43$). \

Change in Fruit and Vegetable Consumption

The ultimate test of effectiveness of a dietary behavior intervention is its ability to improve diets and thereby improve health. Given the long timeframe for most relevant health outcomes, and the large literature indicating a causal influence of fruit and vegetable consumption on health, it is reasonable to use improvements in dietary consumption as a marker for health improvements and as a measure of program effectiveness.

While this study did include a longitudinal component assessing fruit and vegetable consumption, no comparison group was used thus secular trends in fruit and vegetable consumption cannot be distinguished from program-related trends. Further, logistical problems with follow-up and small sample size may limit the soundness of findings. Because the potential for these problems was a concern at the outset of the study, two questions were included regarding self-reported change in fruit and vegetable intake since beginning shopping at FFC.

Overall, 47% (95%CI: 35%-59%) of randomly selected FFC members reported change in fruit consumption and 37% (95%CI: 26%-58%) reported a change in vegetable consumption. This is in line with other research showing that interventions are more likely to improve fruit rather than vegetable consumption (Resnicow 2004).

Fruit and vegetable consumption calculated using the Block fruit and vegetable screener demonstrated a mean increase of 0.28 (.95%CI: -0.33 to 0.91) servings/day though the study was not powered to detect changes of this magnitude.

Stratification by Income

When data were stratified by poverty status, an interesting pattern emerged (see Table 2.3). For both fruits and vegetables, members living below 135% FPL appeared more likely to report increases in consumption since joining FFC. This difference was larger for fruits than for vegetables, and appears to be due to greater reporting of eating "very much more" fruits and vegetables by those below 135% FPL – an effect that was significant for fruits and neared significance for vegetables using all data. Limiting data to randomly selected members brought p-values further from significance, but this appears largely the result of larger standard errors (noted by 95% CI) due to smaller sample size rather than an true shift in proportions. Further, this effect appears limited to those closer to the poverty line as a similar analysis comparing those above and below 200% FPL gave values even further from significance but trending in the same direction (data not shown).

Further, patterns of calculated fruit and vegetable consumption, from the subset of longitudinally followed members, followed a similar pattern showing an average increase of 0.92 (95%CI: -.67-2.52) servings per day for those under 135% FPL but essentially no improvement (0.02; 95%CI: -0.65-0.69) for those above 135% FPL. While small sample size limits the power of this study to detect this level of improvement, this effect size is relatively large, and similar trends are observed in self-reported data. In comparison, even the most successful educational interventions rarely observed effects of more than half a serving of fruits and vegetables (Satia 2002), and the study by Wrigley (2002) cited above observed an increase from 0.59 to 1.4 servings per day among those who consumed less than one serving a day at baseline.

However, those under 135% FPL also trended toward higher fruit and vegetable intakes in general at follow-up. Although this difference was not significant (p=0.21), similar analysis comparing those above and below 200% FPL did find significant differences (p=0.04). There is no good theoretical reason why one would expect these groups to have higher consumption than the higher income groups.

Table 2.3: Fruit and vegetable consumption: reported and measured change.

	FFC Members (95% CI)	<135%FPL (95% CI)	>135%FPL (95% CI)	P value
Fruit and Vegetable Intake (servings/day)	4.9 (4.6-5.2)	4.8 (4.5-5.2)	5.3(4.6-5.9)	0.21
% reporting increase in Fruit Consumption	**47% (35%-59%)**	**43 (32-54)**	**63 (42-83)**	**0.108**
"Some more"	31% (20%-43%)			1
"Very much more"	16% (7%-24%)	10 (4-17)	33 (13-54)	0.022
% reporting increase in Vegetable Consumption	**37% (26%-49%)**	**35 (24-45)**	**50 (28-72)**	**0.129**
"Some more"	23% (13%-33%)			1
"Very much more"	14% (6%-23%)	10 (3-16)	25 (6-44)	0.078
Measured Change in Fruit and Vegetable servings per day	0.29 (-.33 - .91)	0.92 (-0.67-2.52)	0.02 (-0.65-0.69)	0.25

Results: Reasons for using and reasons for not using FFC

To explore reasons why community members are and are not affected by FFC and ways in which the program might reach a greater audience, a series of attitudinal questions were asked of participants (objectives 5 and 6). These questions sought to determine the primary reasons members had for using and not using the market.

Twelve reasons for using and not using the market were based on primary reasons for food choices cited in the literature (Glanz 1998; Gardener 2003; Tsai 2003) as well as some factors that may be more specific to farmer's markets. Participants were asked which of these were "major reasons" for their use of the FFC market(s). Participants could also add other reasons, and these were subsequently coded into existing or new constructs. A summary of members' main

reasons for using and not using the FFC markets, grouped by frequency of selection, is given in Table 2.4.

Table 2.4: Major Reasons Cited for Using and Not Using the FFC Markets

Reasons Use	Reasons Don't Use
Most Commonly Cited Reasons	Most Commonly Cited Reasons
• Produce is organic or pesticide free (76%)$++ • Produce comes from local farmers and farmers of color $$ (69%) • Able to walk/bike to FFC (57%) • Prices are lower than other places (57%)$++ • Quality is better than other places (51%) +	• Lack of time (47%) • Not enough variety of fruits and vegetables (36%)$+
Often Cited Reasons	Often Cited Reasons
• I feel safe around the market (45%) • FFC is open at a convenient time (44%)++ • Good variety of fruits and vegetables (23%)	• Not enough variety of other products (18%) • Sometimes not in the area (13%) • Restricted market hours (11%) • Forget about the market (10%) • Price is higher than other places (8%) **$$+ • Poor/inconsistent quality of fruits and vegetables (7%) • Can not walk/bike (5%)
Other reasons mentioned	
• Cooking demonstrations/recipes • Variety of other products • General convenience • Good public transportation • Friendly workers from the community • Community feel/ support community	Other reasons mentioned • Not all organic • Poor public transport • Not enough demos • No money at the time

+ non-significant but suggestive difference between high and low use groups (0.2>p>0.05)
++ significant difference between high and low use groups (p<0.05)
**target group significance
$non-significant but suggestive difference between households above and below 135% FPL (0.2>p>0.05)
$$ significant difference between households above and below 135% FPL (p<0.05)

Without a comparison group, it is impossible to know the attitudes of people not using the market, however a number of analyses can be performed with the current data to explore the questions of who uses FFC and why.

One analysis compared those who use the market often (about weekly) with those who rarely use the market (less than 3-4 times a year). Given the low counts in some cells, Fisher's exact test was used to compute significance. Those who use the market more often were significantly

more likely to report the availability of organic produce, low market prices, and convenient market times as major reasons for using the market. They also appeared more likely to cite the quality of the produce as a major reason for using the market (p=0.18) Unexpectedly, those participants who use the market the most also appeared more likely to report lack of produce variety and relatively high prices at the market as reasons for not using the market and these relationships neared statistical significance (p=0.064).

Similarly, in attempting to pull in a relatively larger number of target group members, determining what features of the market are important to this group could be useful. However, on examination, the only attitudinal factor cited significantly more often by target group members was relatively high prices at the market (p=0.003). While thousands of other comparisons could be made with these data, rather than check every combination in "fishing expedition" style, it is better to hypothesize about specific mechanisms by which attitudinal factors might vary by group. While this analysis was limited to randomly selected members, similar results occurred when the analysis was expanded to all members.

Hypothesis 1: *For the poor, price may be relatively more important given their constrained purchasing power.*

Indeed, when compared to those above 135% FPL, those below this line were significantly more likely (26% vs. 2%) to cite relatively higher prices at the market as a reason for not using FFC (p=0.006). Likewise, those below 135% FPL also appeared less likely (40% vs. 62%) to cite relatively lower prices at the market as a major reason for using FFC (p=0.151). Thus it appears that the poorest FFC members experience relatively higher prices at the market and perceive these as an obstacle to market use.

Hypothesis 2: *For those relatively well-off, factors that are associated with a farmer's market (e.g. organic produce from local farmers) may be relatively more important as these "luxuries of social responsibility" assume more importance after basic needs have been met.*

This hypothesis is also supported by the data. Although these factors remained among the most important for both groups, relatively more members above 135% FPL reported "organic produce" (82%vs 60% p=0.091) and "produce from local farmers and farmers of color" (78% vs. 40% p=0.009)

Hypothesis 3: *For those limited by economics and/or mobility, quality may be more important if these factors indeed limit access to quality produce.*

These data do not support such a hypothesis. Neither poverty status nor car access was associated with citing quality of produce when each variable was used alone. Likewise, when these factors were combined into a new variable, no interaction effects were observed.

Hypothesis 4: *For those without a car, ability to walk or bike to the market will be more important.*

Surprisingly, those who had less than daily access to a car were no more likely to cite the ability to walk or ride a bike to the market than those with regular car access (p=0.353) although data did trend in this direction (67% vs. 50%).

Results: Membership Donation

Farm Fresh Choice asks buyers to become members by giving a donation on a sliding scale from $0 to $35. Members receive a membership card and a discount so that fruits and vegetables generally cost about 25¢ less per pound with the membership. FFC management views the membership donation as a way for community members to "buy into" the organization, and believes that the sliding scale should effectively reduce financial barriers to membership.

To test these hypotheses, two attitudinal statements regarding the membership donation were presented to participants who rated their level of agreement or disagreement on a 5 point bipolar scale. Again, answers were compared between target and non-target groups and between those above and below 135% FPL.

Most participants (74%) disagreed somewhat (30%) or strongly (44%) with the first statement, "I see the membership donation as an obstacle – a reason not to join FFC." Only 4% agreed with this statement, and 6% were neutral. Conversely, the vast majority of members (89%) agreed somewhat (35%) or strongly (54%) with the statement, "I see the membership donation as a way to buy into or support FFC." There were not major differences between target groups or poverty groups in these variables.

Although the membership donation does appear to hold the desired significance for nearly all members, a minority (15%) did apparently see the donation as an obstacle to joining FFC. It is not apparent from these data whether the membership donation serves as a true economic obstacle or as more of a social obstacle for this minority.

Results: Location of FFC Members

Besides attitudinal reasons for use of the FFC market, physical environmental reasons for use were also examined. ANOVA and linear regression analysis were performed to determine whether a relationship existed between frequency of FFC use and distance to the FFC market used by a member. These showed very slight and non significant inverse relationships between distance to a FFC market and use of the market. Relationships between distance to the market and target-group status were not explored given the inclusion of physical location in the target group definition.

Mean Euclidian distance to FFC was 1.4 kilometers while the median distance was considerably less (0.5 kilometers) showing that most people live near the market, though members were widely distributed geographically. These findings can be seen graphically in Map

1.3 which shows the full extent of the study area and the distribution of survey participants and the grocers they reported using. From this map, it is obvious that most of the participants live within southwest Berkeley, but that there is also considerable geographic variation in residences. It is also obvious that the distribution of grocers generally parallels that of participants.

As in previous studies by Wrigley and Cummins (Wrigley 2002; Cummins 2005), no relationship was found between distance to the FFC market and frequency of use of the market (P=0.76).

D) DISCUSSION

Discussion: Food Desert & Effect of FFC

Given the disparity between the two analyses of Berkeley food stores, strong conclusions regarding the existence of food deserts prior to FFC markets are premature. Nevertheless, the considerable areas of combined poor access to fruits and vegetables, low levels of car access, high levels of poverty and high levels of potential life years lost seen in the "worst-case scenario" support community concerns that poor access to healthy foods in these areas may have adverse effects on diet and health.

Further, assuming this "worst-case scenario," the location of FFC markets appears to generally make sense in terms of ameliorating areas of poor food access in the pre-existing physical environment. From a perspective focused solely on the physical environment, better locations (i.e. locations that resulted in less overlap with pre-existing buffers surrounding food sources) may have been possible; however this criticism should be balanced with a recognition of the importance of the social functions of the chosen community centers in bringing people to the market and an understanding of the limitations of land-use policy.

Discussion: Effectiveness of the FFC Intervention

While levels of knowledge and consumption of dietary recommendations appeared relatively good, these figures still leave substantial room for improvement. Because the FFC markets act as an economic, physical, and social intervention, knowledge gained by community members may be more easily put to use than in an education-only intervention. Nevertheless, no significant relationship was found between knowledge of recommendations and dietary patterns in this study. While no data were collected on other types of dietary knowledge (for example diet-disease relationships or instrumental knowledge of how to prepare a variety of fruits and vegetables), FFC management is keenly aware of the potential utility of distributing these types of information and makes a point of educating interns on these issues and engaging in various other activities such as cooking demonstrations, and informal conversation about the benefits of and ways to prepare a healthy diet.

As in other studies involving changes to the built environment, no significant overall change was found in fruit and vegetable consumption calculated from the Block fruit and vegetable screener at follow-up. However, there were significant problems with data management that resulted in an extremely low sample size with far less power than would be necessary to detect a change.

Given these limitations, self reports of changes in fruit and vegetable intake may be valuable. While these measures are likely susceptible to reporting bias, and are not suitable for precisely determining an effect magnitude, a number of factors point to their validity as an indicator of program benefit. Firstly, the results of the self-reported data show the same directionality as measured fruit and vegetable consumption. Secondly, self reports of increases in fruit consumption are significantly higher than those for increases in vegetable consumption (47% vs. 37% $p=0.034$) and this effect is consistent with that found in other studies (Resnicow 2004). Finally, the data are consistent with an effect whereby those who were most likely to have had the

lowest pre-intervention access to fruits and vegetables (those who live below 135% FPL) reported the greatest change in consumption.

This effect could be further explored by comparing analysis of those poor who lived in food deserts and were without car access prior to the introduction of FFC to those who were relatively wealthier, had nearby grocers, and had access to a car. Persistence of this effect would point to a mechanism by which the introduction of FFC markets into areas of need resulted in the increase in fruit and vegetable consumption for those who were most economically and physically limited prior to the intervention.

Discussion: Community Members Affected & Target Audience

In limited respects, FFC appears to be doing well at reaching its target audience and those at risk of low fruit and vegetable consumption. However there are also causes for concern regarding the demographic patterns of market users. Overall, only 10% of members fit the criteria of those most targeted by FFC. However this definition is quite strict and given the way in which US census data are presented, it is impossible to determine the proportion of the Berkeley population which fits these criteria. Therefore, it is probably more useful to break this target definition down to examine its components along with other demographic factors of the FFC membership.

Race

From the data presented above, FFC appears to be particularly successful at recruiting African Americans, those with less than a college degree, and families with children as proportions of these individuals appear substantially higher among the FFC membership than the general Berkeley population. Thus two factors of the target group definition, African American race and parents with children are particularly descriptive of the membership.

As described above, despite the similarity between the racial makeup of FFC and that of southwest Berkeley, the fact that a large proportion of FFC members do not live within South or

West Berkeley points to additional explanations beyond use of the markets by a random group of southwest Berkeley residents. One explanation is that unmeasured social factors cause physical segregation of racial groups via distinct social routes which are intersected by these markets. For example, for a variety of social and economic reasons, African Americans may be more likely to utilize or work at or near community centers that are predominantly frequented by other African Americans.

While there are few data to describe why FFC is so popular among parents, some obvious characteristics about the market sites and anecdotal accounts collected during the course of interviewing point to likely explanations. First, three of the market sites are located at childcare centers or community centers oriented specifically toward youth. Secondly, during questions about how people found out about the market and why people use the market, a substantial number of participants volunteered information that they engage with the market when picking up or dropping off their children or grandchildren. Since these answers were volunteered, they were not compared statistically to those that were provided. This information highlights a social component to market use which, although not the focus of this research, is likely an important factor in determining both geographic and demographic patterns of market use.

However, FFC appears to have had more trouble recruiting certain other targeted groups. For example, Latinos make up a similar proportion as would be expected by chance alone. While little data analysis was performed to investigate possible reasons for moderate proportions of Latino membership, field work at the market sites makes it obvious that only one of the four FFC sites is located at a predominantly Latino-based community center and in a neighborhood with a large Latino population. Further analysis could be performed evaluating the racial makeup of members at this site relative to those of the surrounding neighborhood and similarly, reasons for using and not using the market could be stratified by this variable. This is currently one of the more popular markets, and it seems likely that the addition of another market at a similar Latino-

based community center would have the effect of increasing the proportion of Latinos served above that of the background Berkeley Latino population.

Education and Income

Perhaps more troubling are the findings that proportions of the undereducated and the very poor are equal or below those in the general Berkeley population. Relatively few FFC members have less than a high school education, and the proportion earning less than 80% of the median Berkeley income is similar to that of the population of Berkeley as a whole. This is congruent with diffusion of innovations theory which states that new programs tend to be utilized first by those who are more educated and better-linked to community systems with more vulnerable groups becoming users at later stages. Later reassessment of the demographic makeup of the FFC membership could determine if this case is likely.

It is also possible, however, that the limited numbers of the very poor and those with very limited education represents an economic limitation of the market. Although the market is subsidized, the fact that exclusively organic and pesticide-free produce is sold makes prices roughly comparable to conventional produce elsewhere. It is possible that those who earn relatively less may still find prices at the markets a barrier to access.

This hypothesis is supported by the attitudinal analysis which shows that a substantial proportion of the poorest FFC members (26% of those below 135% FPL), cited relatively high prices at the market as a major reason for not using the market. Further, these members were significantly more likely than wealthier members to cite this as a major factor for not using the market and they also appeared to be less likely to cite relatively good prices at the market as a reason for use. This effect appears to be limited to the very poor as significance is lost when the analysis compares those above and below 200% FPL ($p=0.128$). The finding that a significant proportion of the poorest FFC members experience market prices as relatively high and cite this as a barrier to use is of some concern considering FFC's focus on this population.

Given FFC's focus on providing organic and pesticide-free produce from small local farmers and farmers of color, it is interesting to note that the poorest members tended to be less likely to cite these factors as main reasons for using the market. Nevertheless, these factors remain among the most important reasons for use of the market by all FFC members. However, as stated above, the attitudes of those who do not use the markets are unknown. It is possible that this trend would be exaggerated in this group which may include those who know about the market but are not particularly attracted by organic, local produce.

Importantly, FFC has already taken some steps to reduce economic barriers. Apart from generally subsidizing the price of produce, FFC accepts food stamps and EBT (Electronic Benefit Transfer[2]) payment at all sites. They also allow members to "keep a tab" so that if a member is short on cash one week, they are not limited in their ability to purchase produce. Despite these efforts some members reported lack of cash as a reason they sometimes did not shop at FFC. Since no open air advertising is done, it is uncertain if there is wide knowledge of these benefits. It should also be noted, however, that advertising the market as a "benefit to the poor" might lead to stigmatization of the market creating a social barrier to use.

While FFC seeks to target lower income members of the community, it is unclear what kinds of effects significant proportions of higher income users may have on the market. For example, higher income members may be more likely to make larger donations thereby helping to defray the operation costs that FFC seeks to cover via external donors. Also, the presence of these members may act as a support to the market in that larger sales volumes of produce may make better variety more practical by decreasing marginal weekly variability in produce sales.

In order to further assess the effect that produce prices might have on the market clientele, a direct comparison of FFC prices with those in other stores, especially those used by the poorest

[2] Electronic Benefit Transfer (EBT) "is an electronic system that allows a recipient to authorize transfer of their government benefits from a Federal account to a retailer account to pay for products received. EBT is currently being used in many States to issue food stamp and other benefits. Nearly 85 percent of food stamp benefits are currently being issued by EBT" (USDA 2006).

members, would be useful. Given the fluctuation in produce prices multiple comparisons through time would be needed to compare produce prices, and it would also be wise to compare both conventional and organic/pesticide-free produce. While this analysis was not performed for this study, a form was created to enable such a comparison in the future by FFC management.

Location

FFC also appears to be relatively successful at reaching those who live in southwest Berkeley with over two thirds of those surveyed living in this area. Given this obvious geographic concentration, it is somewhat surprising that other analyses comparing distance to and use of the market did not find any associations between these factors. However, it should also be recalled that other researchers did not find simple relationships between food outlet use and distance from the home. Given the wide distribution of residences, and the lack of association between distance to a FFC market and frequency of use of that market, other factors must also be responsible for drawing people from the far north of Richmond and the middle of Oakland in to the center of Berkeley.

Two factors seem likely explanatory candidates. The first of these, alluded to above, is the apparent importance of social networks to the physical routes that people travel and thus the physical environment which they experience. This survey recorded only the location of member's residences, however, many people described picking up their children or working at or near the community centers where the markets are located. The questionnaire was not focused enough on these issues to effectively assess the extent to which these factors are important. Thus future research should consider routes to regular activities such as work and school as factors in evaluating impacts of physical environment interventions.

Discussion: Important Factors in Effectiveness and Possible Improvements

Despite the variation in relative importance of attitudinal factors between those above and below 135% FPL, there was general consistency in the ranked order of the factors. Factors that were most or least frequently cited as important factors overall were similarly ranked among stratified groups.

For example, characteristics generally associated with a farmer's market (organic, small local farmers, quality produce) along with availability in terms of price and location were cited as the most important reasons for using the market in both groups. Without a comparison group, it is difficult to determine whether these attitudes extend to others in the community or represent self-selection by those interested in farmer's markets.

Lack of personal time and lack of produce variety at the market were the most important reasons for not using the market. FFC may be able to do little to ameliorate strains on personal time outside of extending hours or days of operation. Likewise, the variety of produce available is, to some extent, determined by what will likely sell at the market on a given day and whether a shopper goes to the market at the beginning or the end of the market. FFC uses a number of methods to counter this obstacle. Interns take orders for produce from one week to the next and will set aside a bag of pre-ordered produce for a customer to pick up at the end of market hours. Likewise, interns and management are generally receptive and even encouraging of requests for further variety at the market within the limits of seasonal availability. The limits of seasonal availability are inherent in a farmer's market. From a health perspective, it may be worthwhile to bolster low variety of winter produce with imported produce. However, it is not clear whether a local grocer would be willing to participate in such an arrangement, and given the Ecology Center's focus on community support of local agriculture, this change seems unlikely.

Most members agreed that the membership donation was a way to buy into the organization and disagreed that it was an obstacle. The fact that targeted groups and the poor were not more likely to feel that the membership donation was an obstacle is reassuring considering concerns

that the donation may have acted as a financial barrier for some. Further qualitative work may elucidate reasons why the sliding scale donation is perceived as a barrier for a small minority of participants.

Discussion: Strengths & Limitations

Multiple Methods

This study used an ecological framework to examine multiple endpoints of effectiveness of an intervention to improve fruit and vegetable access in a low-income, predominantly minority neighborhood of Berkeley California. Analysis focused on the physical environmental impacts of the intervention, measures of improvement of fruit and vegetable consumption, and attitudes regarding market characteristics. This type of analysis allowed a fuller exploration of the ways in which this intervention was and was not effective.

However the broad scope and limited resources also limited strong conclusions regarding many variables. For example, more focus on the physical environment including surveys of local grocers in potential food desert areas would have allowed more precision in the estimation of food deserts. Likewise, greater focus on the follow-up of members may have led to somewhat better response rates leading to more precise results and better confidence in their accuracy. Focusing the study on the survey may also have allowed collection of data from a comparison group. The limitations associated with lack of a comparison group generally involve not knowing the reasons why the market is not affecting those who have not joined and have been discussed in more detail above.

On the other hand, potentially important factors such as the relationship between FFC market prices and those of other grocers and the interaction of social routes with the physical environment were not substantially explored. Future research in these areas would continue to round out the picture of how such an ecological intervention functions.

Blend theory and immediate application

This study also sought to strike a balance between theory-driven research and immediate application of the study results. Working in conjunction with a local community organization made cooperation a top priority and resulted in greater sharing of study project management than might be the case in a researcher-driven intervention. While there were tensions regarding the management of project timelines, survey data, and survey interns, these difficulties were balanced by the expansion of capability afforded by the cooperation. For example, the work of FFC allowed exploration of an intervention much larger than would be possible to develop as part of a master's thesis alone. Likewise, the theory-backed research provided by a university student served as a way to ground and broaden FFC management concepts of the ways in which their program was affecting the community. Similarly, the community participatory nature of the project served as a mechanism to integrate the university into the community and as a way for the FFC interns and management to gain familiarity with research design and implementation.

Discussion: Further research

Given that the FFC program is likely to continue long after the end of this master's thesis, this project was conducted with the possibility of future research in mind. Consent for later follow-up was obtained from participants when possible, opening the door to further longitudinal evaluation of the program. For example, future qualitative work could further expand upon the mechanisms behind the apparent differences in attitudes or the differences in reported changes in fruit and vegetable consumption between those above and below 135% FPL.

Other expansions of this project are also possible and include filling in some of the limitations of this study by investigating non-users, the importance of economic factors and social networks, or by creating a better assessment of the price and variety carried by each local grocer.

Discussion: Conclusions

In summary, this study finds evidence that areas of southwest Berkeley are likely limited in the availability of fruit and vegetables. A novel farmer's market-based intervention, Farm Fresh Choice, appears appropriately located to improve access to produce in these areas.

Examination of demographic characteristics of Farm Fresh Choice users show that the program has been successful in reaching African Americans and families with children, but raises some concerns about the ability of the intervention to be accessed by the poor.

Self reported data give some evidence that the intervention has a positive effect on fruit and vegetable consumption and this is supported by longitudinal data which show trends toward improved fruit and vegetable consumption though this study was not powered to detect significance. Further, this effect appears greatest in those who are relatively poor maintaining the possibility that the market has a particularly large impact in this group.

Characteristics of the market which are unique to farmer's markets and FFC in particular (i.e. organic produce from local farmers and farmers of color which is sold at affordable prices) are most commonly cited as important reasons for use of the market.

A membership donation does not appear to be a barrier to use of the market and does appear to act as a way for participants to "buy into" the program.

Finally, proximity to the FFC markets is not clearly associated with use of the market indicating the importance of other factors, perhaps social networks, in determining usage patterns of the markets.

Acknowledgements

I would like to extend a special thanks to the management and interns of Farm Fresh Choice for their continued cooperation and support on this project. Also, I would like to thank Susan Ivey for her role as a liaison in initiating my relationship with Farm Fresh Choice and in supporting the development of this project. Special thanks to Marcela Smid and Suzanne Lee for help in editing.

For questions regarding this project, please contact the author at: mmessers@gmail.com

Or write to the address below.

Matthew Messerschmidt

4313 Dannywood Rd

Louisville, KY 40220

Bibliography

Agricultural Research Service. (2005) **The 1987-88 Nationwide Food Consumption Survey.** United States Department of Agriculture. (http://www.ars.usda.gov/Services/docs.htm?docid=7804) [accessed March 28, 2006].

American Cancer Society (1996) Advisory Committee on Diet NACP. **Guidelines on diet, nutrition, and cancer prevention: reducing the risk of cancer with healthy food choices and physical activity.** *CA Cancer Journal of Clinicians* . 25:325–41.

American Heart Association (2005). American **Heart Association: Dietary Recommendations for Healthy Americans. http://www.americanheart.org/presenter.jhtml?identifier=1330** [Accessed July 22, 2005]

American Institute Cancer Research. (1997). **Food, Nutrition and the Prevention of Cancer: a global perspective. http://www.aicr.org/research/report.lasso** [Accessed on March 28, 2006]

Ammerman AS, Lindquist CH, Lohr KN, Hersey J. (2002). **The Efficacy of Behavioral Interventions to Modify Dietary Fat and Fruit and Vegetable Intake: A Review of the Evidence.** *Preventive Medicine* 35: 25-41.

Armitage CJ, Conner M. (2000). **Social Cognition Models and Health Behaviour: A Structured Review**. *Psychology and Health*, 15: 173-189.

Armitage CJ, Sheeran P, Conner M, Arden MA, (2004) **Stages of Change or Changes of Stage? Predicting Transitions in Transtheoretical Model Stages in Relation to Healthy Food Choice.** *Journal of Consulting and Clinical Psychology* 72;3: 491-499

Ashe M. (2003) **Land Use planning and the control of alchohol tobacco firearms and fast food restaurants.** *American Journal of Public Health.* 93:1404-1408.

Baker AH, Wardle J.(2003) **Sex differences in fruit and vegetable intake in older adults.** *Appetite.* 40(3):269-75.

Beatty T, LaFrance, J (1995). *Food and nutrition consumption in 20th Century United States.* Presented at UC –Berkeley.

Bengoa JM. (2001) **Food Transitions in the 20th -21st Century.** *Public Health Nutrition* 4(6A), 1425-1427.

Bensley L, Van Eenwyk J, Bruemmer BA. (2003) **Measuring Fruit and Vegetable Consumption: Providing Serving Size Information Doubles Estimated Percent Eating Five Per Day.** *Journal of American Diet Associations.* 103:1530-1532.

Beresford SA, Thompson B, Feng Z, Christianson A, McLerran D, et al. (2001). **Seattle 5 a Day worksite program to increase fruit and vegetable consumption.** *Preventative. Medicine..* 32:230–38

Block B, Gillespie C, Rosenbaum EH, Jenson C. (2000) **A Rapid Food Screener to Assess Fat and Fruit and Vegetable Intake.** *American Journal of Preventative Medicine.* 18(4): 284-288.

Block JP, Scribner RA, DeSalvo KB. (2004) **Fast Food, Race/Ethnicity, and Income: A Geographic Analysis.** *American J Prev Med* 27(3): 211-217.

Bowen D, Beresford SAA. (2002) **Dietary Interventions to Prevent Disease.** *Annual Review of. Public Health.* 23:255-86.

Briefel RR, Johnson CL. (2004) **Secular Trends in Dietary Intake in the United States.** *Annual. Reiew of Nutrition.* 24:401-31.

Brownson RC, Smith CA, Pratt M, Mack NE, Jackson-Thompson J, Dean CG, Dabney S,Wilkerson JC. (1996) **Preventing cardiovascular disease through community-based risk reduction: the Bootheel Heart Health Project.** *American Journal of Public Health.* Feb;86(2):206-13.

Brug J, Glanz K, Kok G. (1997) **The relationship between self-efficacy, attitudes, intake compared to others, consumption, and stages of change related to fruit and vegetables.** *American Journal of Health Promotion.* 12(1):25-30.

Brug J, Oenema A, Campbell M. (2003) **Past, present, and future of computer-tailored nutrition education.** *American Journal of Clinical Nutrition.* 77(4 Suppl):1028S-1034S.

Brug J, Ruiter RA, van Assema P. (2003) **The (ir)relevance of framing nutrition education messages.** *Nutrition and Health.* 17(1):9-20.

Brug J, Oenema A, Ferreira I. (2005) **Theory, evidence and Intervention Mapping to improve behavior nutrition and physical activity interventions.** *International Journal of Behavioral and Nutritional Physicals Act.* 4;2(1):2.

Buller DB, Morrill C, Taren D, Aickin M, Sennott-Miller L. (1999) **Randomized trial testing the effect of peer education at increasing fruit and vegetable intake.** *Journal of. National. Cancer Insitute..* 91:1491–500

Cade, J., Upmeier, H., Calvert, C. & Greenwood, D. (1999) **Costs of a healthy diet: analysis from the UK Women's Cohort Study.** *Public Health and Nutrition. 2*: 505–512.

California Health Interview Survey (2001) http://www.chis.ucla.edu [Accessed on March 28, 2005].

Cerhan JR, Potter JD, Gilmore JM, Janney CA, Kushi LH, Lazovich D, Anderson KE, Sellers TA, Folsom AR. (2004) **Adherence to the AICR Cancer Prevention Recommendations and Subsequent Morbidity and Mortality in the Iowa Women's Health Study Cohort.** *Cancer Epidemiological, Biomarkers Prevention.* 13(7):1114-20.

Chahoud G, Aude Y W, Mehta JL. **Dietary Recommendation in the Prevention and Treatment of Coronary Heart Disease: Do We Have the Ideal Diet Yet?** *The American Journal of Cardiology.* (2004) 94(15): 1260-1267.

Chambless LE, Folsom AR, Sharrett AR, Sorlie P, Couper D, Szklo M, Nieto FJ. (2003). **Coronary heart disease risk prediction in the Atherosclerosis Risk in Communities (ARIC) study.** *Journal of Clinical Epidemiology*. 56(9):880-90.

City of Berkeley (2002). **Maps: City Council District Boundaries. Redistricting Ordinance No. 6,679-N.S.** G:\ELECTIONS\Maps\Booklet\Map Packet Cover.doc

City of Berkeley, Public Health Division. (2001). **Health Status Report, 2001 Mortality and Hospitalizations.** Vital Statistics Division

Clarke G, Eyre H, Guy C. (2002) **Deriving Indicators of Access to Food Retail Provision in British Cities: Studies of Cardiff, Leeds and Bradford.** *Urban Studies* 39;11: 2041-2060.

Clayton, K. Adams J(2000). **Berkeley Nutrition and Physical Activity Report and Recommendations.** *Berkeley Public Health Services.*

Competition Commission/ (2000) **Supermarkets: A Report on the Supply of Groceries from Multiple Stores in the United Kingdom**, 3 vols. Cm 4842. London: The Stationary Office.

Contento I, Balch GI, Bronner YL, (1995) **Theoretical frameworks of models for nutrition education**. J Nutr Educ. 27:287-290

Cotugna N et al. **Nutrition and Cancer Prevention Knowledge, Beliefs, Attitudes, and Practices: the 1987 National Health Interview Survey**. *Journal of the American Dietetic Association*. (1992) 92(8): 963-7.

Courneya, K. S., Plotnikoff, R. C., Hotz, S. B., & Birkett, N. J. (2001). **Predicting exercise stage transitions over two consecutive 6-month periods: A test of the theory of planned behaviour in a population-based sample.** *British Journal of Health Psychology,* 6: 135–150.

Cummins S, Petticrew M, Higgins C, et al. **Large scale food retailing as an intervention for diet and health: quasi-experimental evaluation of a natural experiment.** *Journal of Epidemiology and. Community Health* (2005) 59: 1035-1040.

Darmon N, Ferguson EL, Briend A. **A Cost Constraint Alone Has Adverse Effects on Food Selection and Nutrient Density: An Analysis of Human Diets by Linear Programming.** (2002) *J Nutr.* 132:3764-3771.

De Nooijer J, Van Assema P, De Vet E, Brug J. **How stable are stages of change for nutrition behaviors in the Netherlands?** *Health Promot Int*. 2005 Mar;20(1):27-32. abstract

Devine CM et al. **Life-course events and experiences: Association with fruit and vegetable consumption in 3 ethnic groups.** *J Am Diet Assoc* (1999) 99(3)L 309-314

Diez Roux. (2001) **Investigating Neighborhood and Area Effects on Health** *American Journal of Public Health*. 91:1783-1789

Dixon LB, Cronin FJ, Krebs-Smith SM. (2001a) . **Let the pyramid guide your food choices: capturing the total diet concept.** *J Nutri* 2001; 131(2S-1):461S-472S.

Dixon LB, Winkleby MA, and Radimer KL. (2001b) **Dietary Intakes and Serum Nutrients Differ between Adults from Food-Insufficient and Food-Sufficient Families: Third National Health an dNutrition Examination Survey, 1988-1994.** *Journal of Nutrition* 131: 1232-1246.

Doll R, Peto R. (1981) **The causes of cancer: quantitative estimates of avoidable risks of cancer in the United States today**. *Journal of National Cancer Institute.* 66: 1191–308.

Doll R. (1992) **The lessons of life: keynote address to the nutrition and cancer conference**. *Cancer Research.* 1;52(7 Suppl):2024s-2029s.

Donkin AJ, Dowler EA, Stevenson SJ, Turner SA. (2000) **Mapping access to food in a deprived area: the development of price and availability indices**. *Public Health and Nutrition.* 3(1):31-8.

Drewnowski A. (1998) **Energy density, palatahility and satiety: implications for weight control**. *Nutritional Review*: 56:347-353.

Drewnowski A. Darmon N. Briend A. (2004) **Replacing Fats and Sweets With Vegetables and Fruits--A Question of Cost** *American Journal of Public Health.* 94(9): 1555 - 1559.

Drewnowski A. (2005). **Concept of a nutritious food: toward a nutrient density score**. *American Journal of Clinical Nutrition.* 82(4): 721-32.

Dubois L, Girard M. **Social Position and Nutrition: a gradient relationship in Canada and the USA.** *European Journal of Clinical Nutrition* (2001) 55:366-373.

East London & City Health Authority (1999) **Health in the East End - Annual Public Health Report 1999/2000**, ELCHA, June, 1999.

Economic Research Service. Briefing Rooms: **Food Market Structures: Food Retailing** http://www.ers.usda.gov/Briefing/FoodMarketStructures/foodretailing.htm [Accessed on August, 21 2005]

Farm Fresh Choice (2004). http://www.ecologycenter.org/ffc/index.html [Accessed on March 29, 2005].

Ford ES and AH Mokdad (2001) **Fruit and vegetable consumption and diabetes mellitus incidence U.S. adults** *Preventative Medicine* 32(1): 33-9.

Forsyth A, Macintyre S, Anderson A. (1994) **Diets for Disease? Intraurban Variation in Reported Food Consumption in Glasgow.** *Appetite* 22: 259-274.

Frank LD, Engelke PO. (2001) **The Built Environment and Human Activity Patterns: Exploring the Impacts of Urban Form on Public Health.** *Journal of Planning Literature.* 16(2) 202-218

French S, Harnack L, Jeffery R. (2000) **Fast food restaurant use among women in the Pound of Prevention study: dietary, behavioral and demographic correlates**. *International Journal of Obesity*. 24:1353–9.

French A, Story M, Jeffery R. (2001) **Environmental Influences on Eating and Physical Activity.** *Annual Review of Public Health* 22: 309-35.

French SA. (2005) **Public Health Strategies for Dietary Change: Schools and Workplaces.** *Journal of Nutrition.* 135: 910-912.

General Accounting Office. (2004) **School Meal Programs: Competitive Foods are available; Actions Taken to Restrict Them Differ by State and Locality.** *Report to Congressional Requesters.* GA-04-673.

Gardner T. (2002). **Berkeley Food Security Asset Map: Examining Availability and Accessability of Fresh Food.** University of California, Berkeley; School of Public Health, Nutrition; Thesis Project.

Gaylen DS, Kates J. (1997) **Refocusing the Lens: Epidemiologic Transition Theory, Mortality Differentials, and the AIDS Pandemic.** *Social Science and. Medicine.* 44(5):609-621.

Geleijnse JM, Kok FJ, Grobbee DE. (2004) **Impact of dietary and lifestyle factors on the prevalence of hypertension in Western populations.** *European Journal of Public Health.* 14(3):235-9.

Gedrich K (2003) **Determinants of Nutritional behavior: a multitude of levers for successful intervention?** ***Appetite*** 41(3): 231-8.

Gibson, E.L., Wardle, J. & Watts, C.J. (1998). **Fruit and vegetable consumption, nutritional knowledge and beliefs in mothers and children.** *Appetite.* 31: 205-228

Glade MJ. (1999). **Food Nutrition and the Prevention of Cancer: A Global Perspective.** *Nutrition.* 15(6): 523-526.

Glanz K, Basil M. Maibach E, Goldberg J, Snyder D. (1998) **Why Americans Eat what they do: Taste, Nutrition, Cost, Convenience, and Weight control.** *Journal of American Diet Association.* 98:1118-1126.

Glanz K, Yaroch AL. **Strategies for increasing fruit and vegetable intake in grocery stores and communities: policy, pricing, and environmental change.** *Preventive Medicine* (2004) 39:S75-S80.

Glanz K, Hoelscher D. **Increasing Fruit and Vegetable Intake by Changing Environments, policy and Pricing: restaurant-based research, strategies, and recommendations.** *Preventive Medicine* (2004) 39:S88-S93.

Go VLW. (2004). **International Research Council on Food, Nutrition, and Cancer: Diet and Cancer Prevention: Evidence-based Medicine to Genomic Medicine.** *The Journal of Nutrition Supplement*: 3513S-3516S

Godin G, Conner M, Sheeran P. (2005) **Bridging the intention – behavior 'gap': the role of moral norm**. *British Journal of Psychology* 44(4) 497-512.

Gungdgaard J et al. **Increased intake of fruit and vegetables: estimation of impact in terms of life expectancy and healthcare costs.** (2003) *Public Health Nutrition* 6(1) 25-30.

Guthrie JF, BM Derby and AS Levy. (1999) **Chapter 13: What People Know and Do Not Know About Nutrition.** *What People Know* AIB-750. USDA/ERS. pp. 243-280.

Hahn RA, Eaker E, Barker ND, Teutsch SM, Sosniak W, et al. 1996. **Poverty and death in the United States**–1973 and 1991. *Inter. J. Health Service*. 26:673–90

Harnack L, Nicodemus K, Jacobs DR Jr, Folsom AR. (2002) **An evaluation of the Dietary Guidelines for Americans in relation to cancer occurrence.** *American Journal of Clinical Nutrition;*76:889-96.

Heber D. (2004) **Vegetables, fruits and phytoestrogens in the prevention of diseases.** *Journal of Postgraduate Medicine.* 50(2):145-9.

Holben D, McClincy M, Hollcomb J, Dean K, Walker C. (2004) **Food Security Status of Households in Appalachian Ohio with Children in Head Start.** *Journal of American Dietetics Association*; 104:238-241

Hung HC, Joshipura KJ, Jiang R, Hu FB, Hunter D, Smith-Warner SA, Colditz GA, Rosner B, Spiegelman D, Willett WC. (2004) **Fruit and vegetable intake and risk of major chronic disease.**
Journal of National Cancer Institute. 96(21):1577-84.

Hu FB, Manson JE, Stampfer MJ, Colditz G, Liu S, Solomon CG & Willett WC (2001) **Diet, lifestyle, and the risk of type 2 diabetes mellitus in women.** *New England Journal of Medicine* 345: 790–797.

IARC (2003). *IARC Handbooks of Cancer Prevention*. Volume 8.

James WPT et al. (1997) **The Contribution of Nutrition to Inequalities in Health.** *British Medical Journal.* 314: 1545-1549.

Jeffery R, French S, Raether C, Baxter J. (1994) **An enviromental intervention to increase fruit and salad purchases in a cafeteria.** *Preventative Medicine.* 23:788–92.

Jones et al. (2003). **Lower Risk of Overweight in School-aged Food Insecure Girls Who Participate in Food Assistance,** *Archives of Pediatric and Adolescent Medicine*, August.

Joshipura KJ, Ascherio A, Manson JE, Stampfer MJ, Rimm EB, Speizer FE, Hennekens CH, Spiegelman D, Willett WC. (1999) **Fruit and vegetable intake in relation to risk of ischemic stroke.** *Journal of the American Medical Association.* 6;282(13):1233-9.

Joshipura KJ, Hu FB, Manson JE, Stampfer MJ, Rimm EB, Speizer FE, Colditz G, Ascherio A, Rosner B, Spiegelman D, Willett WC. (2001) **The effect of fruit and vegetable intake on risk for coronary heart disease.** *Annals of Internal Medicine*. 19;134(12):1106-14.

Kant AK, Schatzkin A, Graubard BI, Schairer C. (2000) **A prospective study of diet quality and mortality in women**. *Journal of American Medical Association*. 283:2109-15.

Key TJ et al. (2004). **Diet, nutrition and the prevention of cancer.** *Public Health Nutrition* 7(1A): 187-200.

Klein S et.al. (2004). **Weight Management Through Lifestyle Modification for the Prevention and Management of Type 2 Diabetes: Rationale and Strategies. A Statement of the American Diabetes Association, the North American Association for the Study of Obesity, and the American Society for Clinical Nutrition.** *American Journal of Clinical Nutrition.* 80:257-63.

Krebs-Smith SM, Heimendinger J, Patterson BH, Subar AF, Kessler R, Pivonka E. (1995) **Psychosocial factors associated with fruit and vegetable consumption.** *Am J Health Promot.* 10(2):98-104.

Krebs-Smith S, Kantor LS. (2001) **Choose a Variety of Fruits and Vegetables Daily: Understanding the Complexities.** *J Nutr.* 131: 487S-501S.

Krieger N, Williams DR, Moss NE. (1997) **Measuring Social Class in Public Health Research.** *Annu. Rev. Public Health.* 18:341-78.

LaFrance JT. (1999) **U.S. Food and Nutrient Demand and the Effects of Agricultural Policies** Working Paper No. 864 New Economic Approaches to Consumer Welfare and Nutrition A Food and Agricultural Marketing Consortium Conference Sponsored by the USDA Economic Research Service.

La Vecchia C. (2004) **Mediterranean diet and cancer.** *Public Health Nutr.* 7(7):965-8.

La Vecchia C, Ferraroni M, Mezzetti M, Enard L, Negri E, Franceschi S, Decarli A. (1996) **Attributable risks for colorectal cancer in northern Italy.** *Int J Cancer.* 66(1):60-4.

Last JM. (2001) **A Dictionary of Epidemiology. 4th ed.** Oxford University Press; NY, NY.

Ledikwe JH, Ello-Martin JA, Rolls BJ. (2005) **Portion sizes and the obesity epidemic.** *J. Nutr.* 135: 905–909.

Leibtag ES, Kaufman PR. (2003) **Exploring Food Purchase Behavior of Low-Income Households: How do they economize?** Economic Research Service USDA Current Issues in Economics of Food Markets. *Agriculture Information Bulletin* No. 747-07 www.ers.usda.gov.

Levine AS, Kot-Catherine M, Gosnell BA. (2003) **Sugars and fats: the neurobiology of preference.** *J Nutr* 133:831S-834S.

Luepker RV, Rastam L, Hannan PJ, Murray DM, Gray C, Baker WL, Crow R, Jacobs DR Jr, Pirie PL, Mascioli SR, Mittelmark MB, Blackburn H. (1996) **Community education for cardiovascular disease prevention. Morbidity and mortality results from the Minnesota Heart Health Program.** *Am J Epidemiol.* 144(4):351-62.

Lin B, Frazao E. (1999) **Away-from-home foods increasingly important to quality of American diet.** *Agriculture Information Bulletin 749.* Washington DC: U.S. Department of Agriculture.

Liu S, Willett WC, Stampfer MJ, Hu FB, Franz M, SampsonL, Hennekens CH, Manson JE. (2000). **A prospective study of dietary glycemic load, carbohydrate intake, and risk of coronary heart disease in US women.** *Am. J. Clin. Nutr.* 71, 1455–1461.

Lock K, et al. (2005) **The global burden of disease attributable to low consumption of fruit and vegetables: implications for the global strategy on diet.** *Bulletin of the World Health Organization* 83:100-108.

Lynch JW, Kaplan GA, Salonen JT. (1997) **Why do Poor People Behave Poorly? Variation in Adult Health Behaviours and Psychosocial Characteristics by Stages of the Socioeconomic Lifecourse.** *Social Science and Medicine* 44(6) 809-819.

Macintyre S. (2000) **Good Intentions and Received Wisdom Are Not Enough.** *J Epidemiol Community Health* 54:802-803.

Macintyre S, Ellaway A, Cummins S. (2002) **Place Effects on Health: How can we conceptualize, operationalize, and measure them?** *Social Science and Medicine* 55;125-139.

McCullough ML, Giovannucci EL. (2004) **Diet and cancer prevention.** *Oncogene* 23: 6349-6364

McCullough ML, Feskanich D, Stampfer MJ. (2000) **Adherence to the Dietary Guidelines for Americans and risk of major chronic disease in women.** *Am J Clin Nutr* 72:1214-22.

McLaughlin EW. (2004) **The Dynamics of Fresh Fruit and Vegetable Pricing in the Supermarket Channel.** *Preventive Medicine* 39:S81-S87.
Meiselman HL, Hedderley D, Staddon SL, Pierson BJ, Symonds CR. (1994) **Effect of effort on meal selection and meal acceptability in a student cafeteria.** *Appetite* 23:43–55.

Mezzetti M, La Vecchia C, Decarli A, Boyle P, Talamini R, Franceschi S. (1998) **Population attributable risk for breast cancer: diet, nutrition, and physical exercise.** *J National Cancer Inst.* 90(5):389-94. Erratum in: *J Nationall Cancer Inst* 2000 May 17;92(10):845.

Mhurchu NC Margetts BM, Speller VM. (1997) **Applying the stages-of-change model to dietary change.** *Nutrional Review.* 55:10-6.

Michels KB, Wolk A. (2002) **A prospective study of variety of healthy foods and mortality in women.** *International Journal of Epidemiology* 31:847-54.

Morbidity and Mortality Weekly Report (1999). **Achievements in Public Health, 1900–1999: Decline in deaths from heart disease and stroke—United States.** *MMWR* 48(30):649–56. 1999.

Morland K, Wing S, Diez Roux A. (2002a) **The Contextual Effect of the Local Food Environment on Residents' Diets: The Atherosclerosis Risk in Community Study.** *American Journal of Public Health* 92;11: 1761-1767.

Morland K, Wing S, Diez Roux A, Poole C. (2002b) **Neighborhood Characteristics Associated with location of Food Stores and Food Service Places.** *American Journal Preventative Med.* 22(1): 23-29.

Murcott A. (2002) **Nutrition and Inequalities: a note on sociological approaches.** *European Journal of Public Health* 12: 203-207.

Murphy J. (1998) **The Relationship of School Breakfast to Psychosocial and Academic Functioning**. *Archives of Pediatric and Adolescent Medicine* 142(9).

Moynihan P, Petersen PE. (2004) **Diet, nutrition and the prevention of dental diseases.** *Public Health Nutr.* 7(1A):201-26.

National Cancer Institute. (2005a) U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute. **Fruits and Vegetables: Eat 5 to 9 a Day for Better Health**. http://www.5aday.gov/homepage/index_content.html [accessed July 22, 2005].

National Cancer Institute. (2005b) **PDQ Cancer Information Summaries: Prevention**. http://cancer.gov/cancerinfo/pdq/prevention/ [accessed July 22, 2005].

National Cancer Institute (2005c). **HINTS** National Cancer Institute Division of Cancer Control and Population Sciences http://hints.cancer.gov [accessed August 01, 2005]

National Cholesterol Education Program Adult Program Panel III. (2001) **Executive summary of the**
third report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (adult treatment panel III). *JAMA* 285:2486–97.

National Center for Health Statistics. (2004) **Health, United States, 2004 With Chartbook on Trends in the Health of Americans.** Hyattsville, Maryland.

National Center for Health Statistics. (2005) **Health, United States, 2005 With Chartbook on Trends in the Health of Americans.** Hyattsville, Maryland.

Negri E, La Vecchia C, Franceschi S, Tavani A. (1993) **Attributable risk for oral cancer in northern Italy.** *Cancer Epidemiol Biomarkers Prev.* 2(3):189-93.

Neill EC, Wise A, McLeish A. (2000) **Relationship between knowledge of reasons underlying nutritional messages and reported compliance**. *Int J Food Sci Nutr.* 51:73-77.

National Institutes of Health, National Heart, Lung, and Blood Institute, National High Blood Pressure Education Program. (1997) **The sixth report of the Joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure.** NIH Publication.

Neumark-Sztainer D, Story M, Resnick MD, Blum RW. (1996) **Correlates of Inadequate Fruit and Vegetable Consumption among Adolescents.** *Preventive Medicine* 25:497-505.

Nishida C, et al. (2004b) **The Joint WHO/FAO Expert Consultation on diet, nutrition and the prevention of chronic diseases: process, product and policy implications**. *Public Health Nutrition* 7(1A): 245-250.

Oken E, Lightdale JR. (2001) **Updates in pediatric nutrition.** *Current Opinion in Pediatrics* 13:280–288.

Olshansky SJ, Ault AB. (1986) **The fourth stage of the epidemiologic transition: the age of delayed degenerative diseases.** *Milbank Q.* 64(3):355-91.

Omran AR. (1977) **Forum: Population Planning - A century of Epidemiologic Transition in the United States.** *Preventive Medicine* 6: 30-51.

Parmenter K, Waller J, Wardle J. (2000) **Demographic variation in nutrition knowledge in England.** *Health Educ Res.* 15(2):163-74.

Parillo M, Riccardi G. (2004) **Diet Composition and the Risk of Type 2 Diabetes: Epidemiological and Clinical Evidence.** *British Journal of Nutrition* 92: 7-19.

Patterson RE, Kristal AR, White E. (1996) **Do beliefs, knowledge, and perceived norms about diet and cancer predict dietary change?** *Am Public Health* 86:1394-1400.

Patterson RE, Satia JA, Kristal AR, Neuhouser ML, Drewnowski A. (2001) **Is there a consumer backlash against the diet and health message?** *J Am Diet Assoc.* 101(1):37-41.

Pelto GH, Backstrand JR. (2003) **Interrelationships between Power-related and Belief-Related Factors Determine Nutrition in Populations.** *Journal of Nutrition* 133:297S-300S.

Pietinen P, Nissinen A, Vartiainen E, Tuomilehto A, Uusitalo U, et al. (1988) **Dietary changes in the North Karelia Project (1972–1982).** *Prev. Med.* 17:183–93.

Popkin B. (2002) **The Bellagio Conference on the Nutrition Transition and its Implications for Health in the Developing World, Bellagio, Italy, August 20-24 2001**. *Public Health and Nutrition* 5:93-280.

Polednak AP. (2005) **Revisiting the 1973 report, "Alarming increase of the cancer mortality in the US Black population (1950-1967)"**. *Ethn Dis.* 15(4):779-85.

Pothukuchi K, Joseph H, Burton H, Fisher A. (2002) **What's Cooking in Your Food System? A Guide to Community Food Assessment.** Community Food Security Coalition, Venice, CA. (http://www.foodsecurity.org/CFAguide-whatscookin.pdf)

Rainville A. (2001) **Nutritional Quality of Reimbursable School Lunches Compared to Lunches Brought From Home**. *The Journal of Child Nutrition & Management*. American School Food Service Association.

Raudenbush SW, Sampson RJ. (1999) **Ecometrics: Toward a Science of Assessing Ecological Settings, with Application to the Systematic Social Observation of Neighborhoods.** *Sociological methodology* 29(1):1.

Reddy KS, Katan MB. (2004) **Diet, nutrition and the prevention of hypertension and cardiovascular disease.** *Public Health Nutrtion* 7(1A): 167-186.

Reidpath D, Burns C, Garrand J, Mahoney M, Townsend M. (2002) **An ecological study of the relationship between social and environmental determinants of obesity.** *Health Place* 8:141–5.

Resnicow K, Jackson A, Braithwaite R, DiIorio C, Blisset D, Rahotep S, Periasamy S. (2002) **Healthy Body/Healthy Spirit: a church-based nutrition and physical activity intervention.** *Health Educ Res.* 17(5):562-73.

Rippetoe PA, Rogers RW. (1987) **Effects of components of protection-motivation theory on adaptive and maladaptive coping with a health threat.** *Journal of Personal and Social Psychology.* 52(3):596-604.

Rolls BJ, Ello-Martin JA and BC Tohill (2004) **What can intervention studies tell us about the relationship between fruit and vegetable consumption and weight management?** *Nutritional Review.* 62(1):1-17.

Sandman PM, Weinstein ND, Hallman WK. (1998) **Communications to Reduce Risk Underestimation and Overestimation.** *Risk Decision and Policy* 3(2):93–108.

Satia JA, Kristal AR, Patterson RE, Neuhouser ML, Trudeau E. (2002) **Psychosocial factors and dietary habits associated with vegetable consumption.** *Nutrition.* 18(3):247-54.

Schneeman BO (2003) **Evolution of dietary guidelines.** *Journal of American Dietetics Association.*103(12 Suppl 2):S5-9.

Schwartz S. (1994) **The Fallacy of the Ecological Fallacy: The potential misuse of a concept and the consequences.** *American Journal of Public Health* 84(5): 819-824.

Sheeran P, Webb TL, Gollwitzer PM. (2005) **The interplay between goal intentions and implementation intentions.** *Pers Soc Psychol Bull.* 31(1):87-98.

Sorensen G, Stoddard A, Peterson K, Cohen N, Hunt MK, et al. (1999) **Increasing fruit and vegetable consumption through worksites and families in the Treatwell 5-a-day study.** *Am. J. Public Health* 89:54–60.

Sorensen G, Linnan L, Hunt MK. (2004) **Worksite-based Research and Initiatives to Increase Fruit and Vegetable Consumption.** *Preventive Medicine* 39:S94-S100.

Stables GJ, Subar AF, Patterson BH, et al. (2002) **Changes in vegetable and fruit consumption and awareness among US adults: Results of the 1991 and 1997 5 A Day for Better Health Program surveys.** *J Am Diet Assoc.* 102:809-817.

Steyn NP, et al. (2004) **Diet, nutrition and the prevention of type 2 diabetes.** *Public Health Nutrition* 7(1A): 147-165.

Steinmetz KA,. Potter JD (1996). **Vegetables, fruit and cancer prevention: a review.** *Journal of American Dietetics Association.* 96(10):1027-39.

Swinburn BA, et al. (2004) **Diet, nutrition and the prevention of excess weight gain and obesity.** *Public Health Nutrition* 7(1A): 18123-146.

Thompson RL, Margetts BM, Speller VM, McVey D. (1999) **The Health Education Authority's health and lifestyle survey 1993: who are the low fruit and vegetable consumers?** *Journal of Epidemiology and Community Health* 53:294-299.

Tippett K, Cleveland L. (1999) **How current diets stack up—comparison with dietary guidelines.** In: Frazao E (ed.) America's eating habits: changes and consequences. Washington DC: U.S. Department of Agriculture 59–63 (Information Bulletin A1B-750).

Troutt DD. **The Thin Red Line: How The Poor Still Pay More,.** Consumers Union of U.S., Inc. West Coast Regional Office. June, 1993.

Tsai S. (2003) **Needs Assessment: Access to Nutritious Food in East Oakland and South Hayward.** Interdisciplinary Program, UC Berkeley School of Public Health, Alameda County Public Health Department. May 12, 2003.

US Department of Agriculture, Food and Nutrition Service: **Food Stamp Program** (2006) http://www.fns.usda.gov/fsp/ebt/ [Accessed April 22, 2006]

U.S. Department of Agriculture and the U.S. Department of Health and Human Services. (2005) **Nutrition and your health. Dietary Guidelines for Americans, 1st ed.**, U.S. Government Printing Office Washington, DC .http://www.health.gov/dietaryguidelines/dga2000/document/frontcover.htm [Accessed July 22, 2005]

U.S. Department of Labor, Bureau of Labor Statistics. ***Consumer Expenditure Surveys*** (2003) http://www.bls.gov/cex/. [Accessed on March 28, 2005].

U.S. Department of Health and Human Services (2000). **Healthy People**. http://www.healthypeople.gov. [Accessed on March 28 2005].

Van Duyn MA, Pivonka E. (2000) **Overview of the health benefits of fruit and vegetable consumption for the dietetics professional: selected literature.** *Journal of American Dietetics Association*. 100(12):1511-21.

van't Veer P, et al. (2000) **Fruits and Vegetables in the Prevention of Cancer and Cardiovascular Disease.** *Public Health Nutrition* 3(1): 103-107.

Wagner TH, Goldstein MK. (2004). **Behavioral interventions and cost-effectiveness analysis.** *Preventive Medicine* 39: 1208– 1214.

Wahrendorf J. (1987). **An estimate of the proportion of colo-rectal and stomach cancers which might be prevented by certain changes in dietary habits**. *International Journal of Cancer*. 40(5):625-8.

Wang MC. **The Influence of Neighborhood Environment on Obesity Risk.** *Preliminary Findings presented 03/31/05*

Warde A. **Consumption, food & taste.** London: Sage, 1997.

Wardle J, Griffith J, Johnson F, Rapoport L (2000).. **Intentional weight control and food choice habits in a national representative sample of adults in the UK.** *International Journal of Obesity and Related Metabolic Disorder*. 24(5):534-40.

Wardle J, Paramenter K, Waller J. (2000) **Nutrition Knowledge and Food Intake.** *Appetite*. 34: 269-175.

Wardle J (2000) **Intentional weight control and food choice habits in a national representative sample of adults in the UK.** *International Journal of Obesity.* 24: 534-540.

Wardle J, Steptoe A. (2003). **Socioeconomic differences in attitudes and beliefs about healthy lifestyles.** *Journal of Epidemiology and Community Health.* 57(6):440-3.

Weinstein ND, Rothman AJ, Sutton SR. (1998). **Stage theories of health behavior: Conceptual and methodological issues.** *Health Psychology* 17:290-299.

World Health Organization. (2002) **Global Burden of Disease 2002 Estimates. World Health Reports**. http://www.who.int/healthinfo/bodgbd2002/en/index.html [Accessed March 28th, 2005]

World Health Organization. (2002). **World Health Organization and the Millennium Development Goals** http://www.who.int/mdg/en/index.html [Accessed March 28th, 2006]

Wrigley N. (2002). **Assessing the impact of improved retail access on diet in a food desert.** *Urban Studies*. 39:2061-82.

Zimmet P Magliano D, Matsuzawa Y, Albnerti G and J Shaw. (2005). **The metabolic syndrome: a global public health problem and a new definition.** *Journal of Atherosclerosis and Thrombosis.* 12(6): 295-300.

Appendix I: Maps

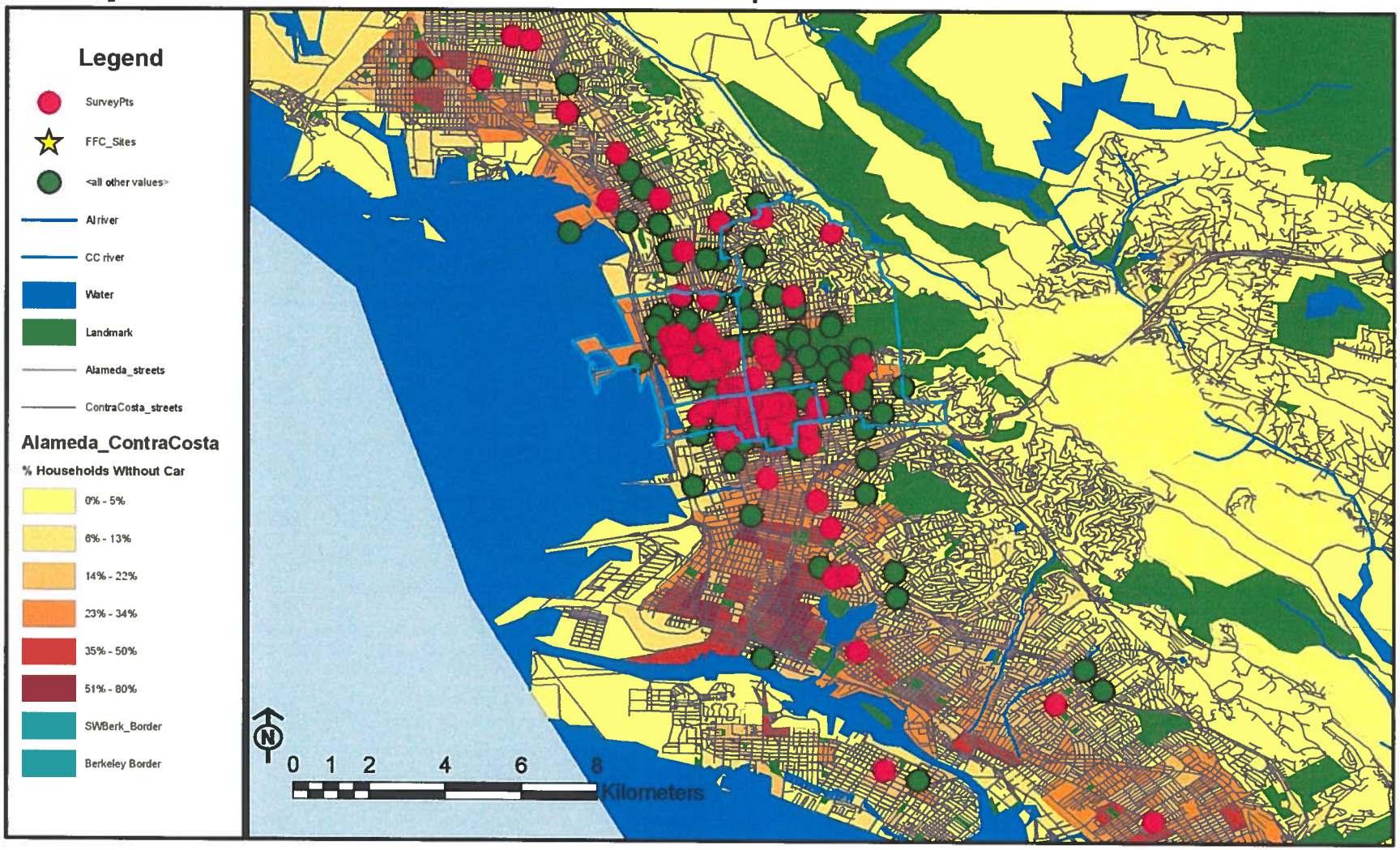
Map 1.1

Household Car Ownership in Berkeley

Map 1.2 Percent of Households Under 150% of Federal Poverty Line

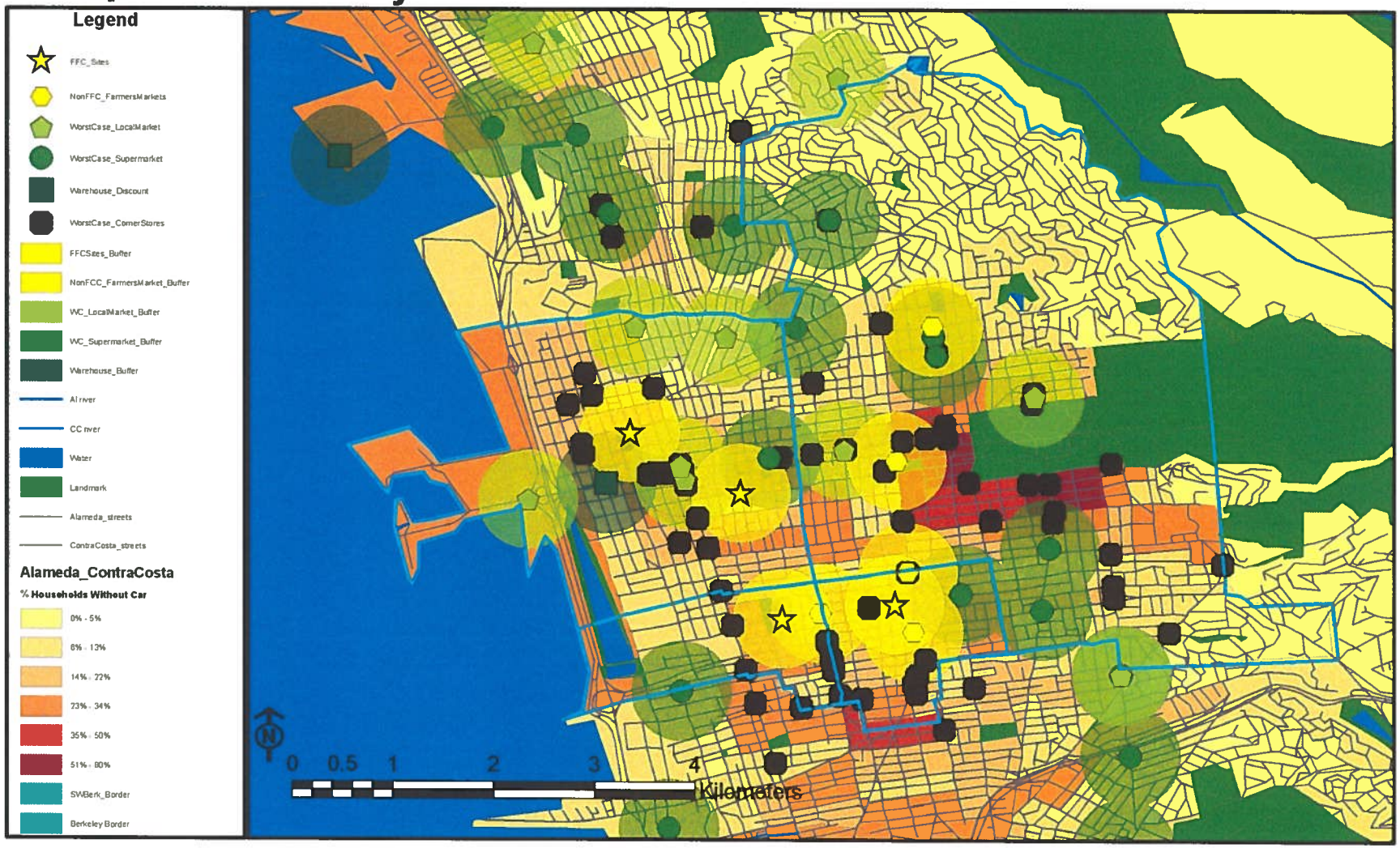
Map 1.3

Distribution of Participants and Grocers



Map 2.1 Berkeley Food Deserts: Worst Case Scenario

Map 2.2 Berkeley Food Deserts: Worst Case + Farmers Markets



Map 2.3 Berkeley Food Deserts: Best Case Scenario

Map 2.4 Berkeley Food Deserts: Best Case + Farmers Markets

Appendix II: Questionnaire – English version

FFC Questionnaire 20 In Person:

START TIME:

Participant ID:

Before we start:

- This is **not a test**.
- Your answers are **confidential**.
- It is important for us to hear **what you really think**, not what you think we want to hear.
- **Please give correct information.** You can refuse to answer any question.

---

1) What is your age today?

__ __ Age in years

❑99 No Response

---

2) How many adults do you usually buy food or groceries for? Include yourself.

__ __ Number of adults

❑99 No Response

---

3) How many children do you usually buy food or groceries for?

__ __ Number of children

❑99 No Response

IF THE PERSON IS 18 YEARS OR OLDER TODAY AND USUALLY BUYS FOOD FOR THEMSELVES OR OTHERS, THEN CONTINUE WITH THE SURVEY.

OTHERWISE THANK THEM: "THANKS FOR OFFERING TO HELP US OUT, BUT YOU DON'T FIT THE CRITERIA FOR THE SURVEY."

4) Think about your eating habits over the past year or so. About how often do you eat each of the following foods? Remember breakfast, lunch, dinner, snacks and eating out.

FILL IN ONE BUBBLE FOR EACH QUESTION

	How often do you have....	(0) Less than 1/WEEK	(1) Once a WEEK	(2) 2-3 times a WEEK	(3) 4-6 times a WEEK	(4) Once a DAY	(5) 2 + a DAY
4.1)	Fruit juice, like orange, apple, grape, fresh, frozen or canned. (Not sodas or other drinks)	○	○	○	○	○	○
4.2)	How often do you eat any fruit, fresh or canned (not counting juice)	○	○	○	○	○	○
4.3)	Vegetable juice, like tomato juice, V-8, carrot	○	○	○	○	○	○
4.4)	Green salad	○	○	○	○	○	○
4.5)	Potatoes, any kind, including baked, mashed or french fried	○	○	○	○	○	○
4.6)	Vegetable soup or stew with vegetables	○	○	○	○	○	○
4.7)	Beans such as baked beans, pinto, kidney, or lentils (not green beans)	○	○	○	○	○	○
4.8)	Any other vegetables, including string beans, peas, corn, broccoli or any other kind	○	○	○	○	○	○

5) How many servings of fruit and vegetables do health experts recommend adults should eat each day. (Count an average piece of fruit or a half cup of vegetables as one serving.)

GIVE A SINGLE NUMBER (NOT A RANGE)

ONE NUMBER FOR FRUITS AND VEGETABLES COMBINED

__ __ Number of fruits and vegetables adults should eat each day.

❑$_{98}$ Don't Know (probe first for best guess)

❑$_{99}$ No Response

6) How often do you buy food or groceries?

CHECK THE ONE BEST ANSWER

❑$_{1}$ Less than once a week

❑$_{2}$ 1-2 times a week

❑$_{3}$ 3 times a week

❑$_{4}$ 4 or more times a week

❑$_{9}$ No Response

7.1) Where do you buy most of your food or groceries? *ONE STORE ONLY* *STORE NAME* *STREET* ❑9 No Response	8.1) Is there another store where you buy food or groceries at least once a month? *NEXT MOST USED STORE* *STORE NAME* *STREET* ❑9 No Response ❑8 Not Applicable	9.1) Where do you usually buy fruits and vegetables? *ONE STORE ONLY* *STORE NAME* *STREET* ❑9 No Response ❑8 Not Applicable
7.2) How do you usually get there? *CHECK ALL THAT APPLY* ❑1 Walk ❑2 Bicycle ❑3 Bus ❑4 Taxi ❑5 Ride from friend, family member, or neighbor ❑6 My own car ❑7 Other: _____ ❑9 No Response	8.2) How do you usually get there? *CHECK ALL THAT APPLY* ❑1 Walk ❑2 Bicycle ❑3 Bus ❑4 Taxi ❑5 Ride from friend, family member, or neighbor ❑6 My own car ❑7 Other: _____ ❑9 No Response ❑8 Not Applicable	9.2) How do you usually get there? *CHECK ALL THAT APPLY* ❑1 Walk ❑2 Bicycle ❑3 Bus ❑4 Taxi ❑5 Ride from friend, family member, or neighbor ❑6 My own car ❑7 Other: _____ ❑9 No Response ❑8 Not Applicable
7.3) How long does it take you to get there? ___ ___ minutes from home to store ❑99 No Response	8.3) How long does it take you to get there? ___ ___ minutes from home to store ❑99 No Response ❑88 Not Applicable	9.3) How long does it take you to get there? ___ ___ minutes from home to store ❑99 No Response ❑88 Not Applicable

FFC Questionnaire 20 In Person:

10) In the past year, how often have you purchased food from any farmer's market?
CHECK THE ONE BEST ANSWER

- ❑ 1 Never
- ❑ 2 Once or twice
- ❑ 3 A few (3-4) times a year
- ❑ 4 About once a month
- ❑ 5 About once a week
- ❑ 6 No Response

11) Have you or anyone in your household used any form of food assistance in the past year? Which kind?
READ ALL CHOICES
CHECK ALL THAT APPLY

- ❑ 1 **WIC** (Special Supplemental Food Program for Women, Infants, and Children)
- ❑ 2 **Food Stamps** (Food Stamp Program)
- ❑ 3 **National School Lunch Program**
- ❑ 4 **A food pantry**
- ❑ 5 **Free or low-cost meals**
- ❑ 6 **Another type of food assistance** _____
- ❑ 7 **None of the above**
- ❑ 8 No Response

12) Do you know about the farmer's markets at any of these places? Do you use any of them?
FILL IN ONE BUBBLE FOR EACH QUESTION

	Market	1 Yes I use this market.	2 I know about it, but I do not use it.	3 I do not know about it.
12.1)	**Young Adult Project** (Oregon and Grant - Tuesdays from 3:30-6:30pm)	○	○	○
12.2)	**Berkeley Youth Alternatives** (Allston and Bonar - Tuesdays from 3:30-6:30pm)	○	○	○
12.3)	**BAHIA Child Care Center** (8th and Virginia - Tuesdays from 3:30-6pm)	○	○	○
12.4)	**San Pablo Park** (Oregon and Park - Wednesdays from 3:30-6pm)	○	○	○

GO TO PAGE 5 *IF THEY DO KNOW ABOUT FFC*

GO TO PAGE 7 *IF THEY DO NOT KNOW ABOUT FFC*

IF THEY DO KNOW ABOUT FFC (ANSWERED YES TO ANY OF 11.1 - 11.4) CONTINUE ON PAGE 5
EVEN IF THEY HAVE NEVER SHOPPED AT FFC

IF THEY DO NOT KNOW ABOUT FFC (ANSWERED NO TO ALL OF 11.1 - 11.4) CONTINUE ON PAGE 7

FFC Questionnaire 20 In Person:

*IF THEY **DO** KNOW ABOUT FFC CONTINUE HERE*

13) How did you find out about Farm Fresh Choice market(s)?

CHECK ALL THAT APPLY

- ❑1 I was **going there for other reasons**. (eg childcare, or other services at the site)
- ❑2 I was **passing by** there. (eg walking or driving by)
- ❑3 I saw or heard an **advertisement** for the market
- ❑4 **Someone told me** about the market.
- ❑5 **I looked for information** on farmers markets in my area.
- ❑6 Other_____

❑9 No Response

14) How often have you purchased food from a Farm Fresh Choice market?

CHECK THE ONE BEST ANSWER

- ❑1 Never
- ❑2 Once or twice
- ❑3 A few (3-4) times a year
- ❑4 About once a month
- ❑5 About once a week

❑9 No Response

15) How do you usually get to Farm Fresh Choice?

CHECK ALL THAT APPLY

- ❑1 Walk
- ❑2 Bicycle
- ❑3 Bus
- ❑4 Taxi
- ❑5 Ride from friend, family member, or neighbor
- ❑6 My own car
- ❑7 Other: _____

❑9 No Response

❑8 Not Applicable

16) How long does it take you to get to Farm Fresh Choice?

___ ___ minutes from home to FFC

❑99 No Response

❑88 Not Applicable

CONTINUE ON PAGE 6

FFC Questionnaire 20 In Person:

CONTINUE FROM PAGE 5 FOR THOSE WHO DO KNOW ABOUT FFC

17) Think about the main reasons that you sometimes do and do not shop at Farm Fresh Choice.
READ ALL ANSWERS

17.1) What are the main reasons you sometimes do use Farm Fresh Choice? *CHECK ALL IMPORTANT REASONS*	**17.2) What are the main reasons you sometimes do not use Farm Fresh Choice?** *CHECK ALL IMPORTANT REASONS*
☐1 **Cooking demonstrations and recipes**	☐1 **Not enough cooking demonstrations and recipes**
☐2 Produce comes from **local small farmers and farmers of color**	☐2 Farmers are not at the market
☐3 Produce **is organic or pesticide free**	☐3 Some produce **is not organic** (but all is pesticide free)
☐4 **Quality of produce** is better than other places	☐4 **Quality of produce** is not as good as other places
☐5 **Large variety of fruits and vegetables**	☐5 **Not enough variety of fruits and vegetables**
☐6 **Good variety of other products**	☐6 **Not enough variety of other products**
☐7 **Do feel safe** around the market	☐7 **Don't feel safe** around the market
☐8 Open at a **convenient time** for me	☐8 Only open **Tuesday or Wednesday afternoons**
☐9 **Convenient public transportation**	☐9 **No convenient public transportation**
☐10 Within **walking/biking distance**	☐10 Further than **walking/biking distance**
☐11 **Prices** are lower than other places	☐11 **Prices** are higher than other places
☐12 Other_____	☐12 Other _____
☐13 None of the above	☐13 None of the above
☐R1 No Response	☐R1 No Response

18) Think about the number of fruits and vegetables you ate each day before you began using Farm Fresh Choice. Think of how many you eat now.
FILL IN ONE BUBELE FOR EACH QUESTION

		1 I eat **A LOT LESS** than before	2 I eat **SOMEWHAT LESS** than before	3 **NO CHANGE**	4 I eat **SOMEWHAT MORE** than before	5 I eat **A LOT MORE** than before
18.1	**Has the number of fruits you eat each day changed since you started using Farm Fresh Choice?**	○	○	○	○	○
18.2	**Has the number of vegetables you eat each day changed since you started using Farm Fresh Choice?**	○	○	○	○	○

SKIP PAGE 7. GO TO PAGE 8

FFC Questionnaire 20 In Person:

*IF THEY **DO NOT** KNOW ABOUT FFC CONTINUE HERE*

Farm Fresh Choice is a farmer's market in South and West Berkeley.

17) Think about the main reasons that you sometimes would and would not shop at a farmer's market. *READ ALL ANSWERS*

17.3) What are the main reasons you sometimes would use a farmer's market? *CHECK ALL IMPORTANT REASONS*	**17.4) What are the main reasons you sometimes would not use a farmer's market:** *CHECK ALL IMPORTANT REASONS*
☐1 If there are **cooking demonstrations** and **recipes**	☐1 If there are no **cooking demonstrations** and **recipes**
☐2 If the produce comes from **local small farmers** and **farmers of color**	☐2 If farmers are not at the market
☐3 If the produce is **organic or pesticide free**	☐3 If some produce is not **organic** (but all is pesticide free)
☐4 If the **quality of produce** is better than other places	☐4 If the **quality of produce** is not as good as other places
☐5 If there is a large **variety of fruits and vegetables**	☐5 If there is not enough **variety of fruits and vegetables**
☐6 If there is good **variety of other products**	☐6 If there is not enough **variety of other products**
☐7 If I do **feel safe** around the market	☐7 If I don't **feel safe** around the market
☐8 If it is open at a **convenient time** for me	☐8 If it is only open **Tuesday afternoons**
☐9 If there is convenient **public transportation**	☐9 If there is no convenient **public transportation**
☐10 If it is within **walking distance**	☐10 If it is further than **walking distance**
☐11 If **prices** are lower than other places	☐11 If **prices** are higher than other places
☐12 Other_____	☐12 Other_____
☐13 None of the above	☐13 None of the above
☐99 No Response	☐99 No Response

18)Think about the number of fruits and vegetables you ate each day one year ago. Think of how many you eat now.

FILL IN ONE BUBBLE FOR EACH QUESTION

		1	2	3	4	5
		I eat **A LOT LESS** than before	I eat **SOMEWHAT LESS** than before	**NO CHANGE**	I eat **SOMEWHAT MORE** than before	I eat **A LOT MORE** than before
18.3	**Has the number of fruits you eat each day changed since one year ago?**	○	○	○	○	○
18.4	**Has the number of vegetables you eat each day changed since one year ago?**	○	○	○	○	○

CONTINUE ON PAGE 8

FFC Questionnaire 20 In Person:

Farm Fresh Choice asks buyers to become members by giving a donation on a sliding scale from $0 to $35. You get a membership card and a discount. Fruits and vegetables usually cost about 25¢ less per pound with membership.

19) Below are some statements about the membership donation. How much would you agree or disagree with each statement?

		1	2	3	4	5
		Disagree Strongly	**Disagree Somewhat**	**Neutral**	**Agree Somewhat**	**Agree Strongly**
19.1)	I see the donation as an **obstacle** – a **reason not to join** Farm Fresh Choice?	○	○	○	○	○
19.2)	I see the donation as a way to **"buy into" or support the organization.**	○	○	○	○	○

20) Which ethnic or racial group (or groups) do you most identify with (or belong to)?

CHECK ALL THAT APPLY

- ❑ 1 Asian / Pacific Islander
- ❑ 2 Latino / Hispanic
- ❑ 3 African American / Black
- ❑ 4 White / Caucasian
- ❑ 5 Native American
- ❑ 6 Other: _____

❑ 99 No Response

21) What is the highest grade (or year) of regular school you have completed?

CHECK THE ONE BEST ANSWER

DO NOT COUNT TRADE SCHOOL IN THIS ANSWER

- ❑ 1 Never attended school or only attended kindergarten
- ❑ 2 Elementary (Grades 1 through 8)
- ❑ 3 Some high school (Grades 9 through 11)
- ❑ 4 High school graduate (Grade 12 of high school or got a GED) *(PROBE FOR GRADUATE)*
- ❑ 5 Some college, Technical school, or Associate's degree (1 to 3 years of college)
- ❑ 6 Bachelors degree (4 years of college) *(PROBE FOR 4 YEAR COLLEGE GRADUATE)*
- ❑ 7 Some graduate or professional school or more
- ❑ 8 Other (Specify)_____

❑ 99 No Response

22) Which of these best describes your current main daily activities or responsibilities?
CHECK ALL THAT APPLY

- ❑1 Working full time
- ❑2 Working part-time
- ❑3 Out of work for more than 1 year
- ❑4 Out of work for less than 1 year
- ❑5 Keeping house or raising children full-time
- ❑6 Student
- ❑7 Retired
- ❑8 Other_____
- ❑99 No Response

23) Which of these best describes your total combined household income for the past 12 months? Include income (before taxes) from all sources and all house-members.
TOTAL HOUSEHOLD INCOME IS THE TOTAL AMOUNT OF INCOME FOR EACH HOUSEHOLD MEMBER ADDED TOGETHER
IF THE INCOME OF SOME HOUSEHOLD MEMBERS IS NOT KNOWN, PLEASE MAKE A BEST GUESS.
CHECK THE ONE BEST ANSWER

	Yearly	or	Monthly
❑1	Less than $10,000		(less than $850)
❑2	$10,000 to $15,000		($850 to $1,20)
❑3	$15,000 to $25,000		($1,250 to $2,100)
❑4	$25,000 to $35,000		($2,100 to $3,000)
❑5	$35,000 to $50,000		($3,000 to $4,200)
❑6	$50,000 to $75,000		($4,200 to $6,250)
❑7	$75,000 or more		($6,250 or more)

❑9 No Response

24) How many people are currently living or staying in your home.

24.1) ___ ___Number of people

24.2) ___ ___**Of these people, how many are children less than 18 years old?**

❑99 No Response

25) What street do you live on? **What is the closest street that crosses it?**

_____ and _____
MAIN STREET *CROSS STREET*

Which city do you live in?

_____
CITY

❑9 No Response

26.1) Do you have access to a car to get groceries and run errands?
CHECK THE ONE BEST ANSWER

- ❑₁ Yes
- ❑₂ No
- ❑₉ No Response

If Yes
26.2) How often do you have access to this car?
CHECK THE ONE BEST ANSWER

- ❑₁ Every Day
- ❑₂ 4 to 6 days a week
- ❑₃ 2-3 days a week
- ❑₄ Once a week or less
- ❑₉ No Response

RECORD BUT DO NOT ASK
27) What is this person's sex?
CHECK THE ONE BEST ANSWER

- ❑₁ Male
- ❑₂ Female

RECORD BUT DO NOT ASK
28) Is this person a member?
CHECK THE ONE BEST ANSWER

- ❑₁ Yes $ ___
- ❑₂ No

FINISH TIME:

- ❑₁ FFC Gift Card
- ❑₂ Phone Card
- ❑₃ No Gift

For Office Staff only

Data Entry by (initials) _____
Date Entered ___/___/___

Data Entry by (initials) _____
Date Entered. ___/___/___

Fill out at completion of interview:

Interviewer:
Date of Interview: ___/___/___
Location of Interview: ❑₁ Home, ❑₂ Phone
❑₃ BYA, ❑₄ BAHIA, ❑₅ YAP, ❑₆ SPP,
❑₉ Other
Comments:

UNIVERSITY OF CALIFORNIA, BERKELEY

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO

SANTA BARBARA • SANTA CRUZ

OFFICE FOR THE PROTECTION
OF HUMAN SUBJECTS
101 WHEELER HALL, MC: #1340
BERKELEY, CA 94720-1340

(510) 642-7461 FAX: (510) 643-6272

Web Site: http://cphs.berkeley.edu
FWA#00006252

8/1/2005

MATTHEW MESSERSCHMIDT (matthew.messerschmidt@ucsf.edu)
1809 Short Street
Berkeley, CA 94702

RE: **Exemption of CPHS Protocol #2005-6-7**
"Improving Food Acess in South and West Berkeley: an Evaluation of the Farm Fresh Choice Farmers Market Program" - Graduate Research, UCB Joint Medical Program,UCB Division of Health And Medical Sciences, Health and Medical Sciences

Dear Mr. MESSERSCHMIDT:

Thank you for the statement and request for exemption that you submitted to the Committee for the above-referenced project. As described in the statement, your research satisfies the Committee's requirements under Exemption #3, page 4, of CPHS Guidelines of January 1998 (45 CFR 46.101(b)(#2)).

Accordingly, the project is exempt from full Committee review provided that there are no changes in the use of human subjects.

Please note that although your research has been deemed exempt from full committee and subcommittee review, you still have a responsibility to protect your subjects, and the research should be conducted in accordance with the principles of the Belmont Report. Download the Belmont Report at this link:
http://www.hhs.gov/ohrp/humansubjects/guidance/belmont.htm

If you have any questions about this matter, please contact the OPHS staff at 642-7461; FAX 643-6272; E-Mail cphs@berkeley.edu.

Sincerely,

Malcolm Potts, M.B., BChir, Ph.D.
Chair, Committee for the Protection of Human Subjects
Bixby Professor, School of Public Health

MP:BM

Cc: SUSAN L. IVEY (sivey@berkeley.edu)
Graduate Division: SID #171055574 – (degrees@berkeley.edu)
Graduate Assistant