**PHYTOCHEMICALS AS A MOTIVATIONAL TOOL
TO CHANGE FRUIT, VEGETABLE AND WHOLE GRAIN CONSUMPTION**

by
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ABSTRACT

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The purpose of this study was to learn whether phytochemical knowledge has motivated some people to change their eating behavior and to consume more fruits, vegetables and whole grains. The hypothesis tested a positive correlation between the seeking of nutrition information, food and health benefits, and a deliberate inclusion of plant-based foods into the diet. Population-based objectives included drawing a demographic profile, estimating the number who had increased consumption of plant foods, determining whether phytochemical awareness was the major intake change effecter, defining phytochemical understanding and expectations, and summarizing general health beliefs.

Results were collected via a survey mailed nationally to 1,600 adults. The surveys were mailed randomly to a subset of people who subscribe to or buy consumer health magazines from Rodale Inc.

Three hundred eighty individuals returned surveys; this population was largely female (82.6%), between 45-64 years of age (77.0%) and Caucasian (88.0%); had at least some post-secondary education (81.5%) and lived in households of two people or less (64.1%). The study population was older, more educated, and lived in smaller households than the full Rodale subscriber list.

The results indicated that 82.9% of the subjects had begun eating more of at least one plant food group, either recently or years earlier. These subjects form the “more phyto” subgroup. Plant foods which showed the largest consumption increases were fruits (40.5%, in past 12 months) and vegetables (39.1%, years earlier). Dry beans, lentils, nuts and seeds were noted for consumption increases at some point in time by nearly half of these respondents. In contrast, consumption of bread, cereal, rice and pasta declined, with 34.8% of the “more phyto” subgroup eating less in the past 12 months. Intake changes were positively and significantly ($p < .01$) related to each other. With the exception of nuts and seeds, intake changes were also significantly ($p < .01$) and positively related to belief in matching food guidelines (i.e. “eat plenty of fruits and vegetables”).

Of the “more phyto” subgroup, 20.2% reported increasing their plant food intake because of phyto-chemicals. These subjects form the “phyto motivated” subgroup. The results suggest that phyto-chemical motivation was positively and significantly ($p < .05$) correlated to increased intake of these foods.

Significant positive relationships regarding *information seeking* and eating more phytochemicals included reading magazines (80.0%, $p < .05$) and consulting with medical professionals (62.5%, $p < .01$) for nutritional advice and hearing much about 5-A-Day, a national fruit-and-vegetable campaign (38.9%, $p < .05$). “Phyto motivated” subjects shared preference for these sources but relied more upon their own reading and research (22.6%, positive correlation, $p < .01$) and less upon professional medical advice (43.5%, negative correlation, $p < .01$).

Significant positive relationships ($p < .05$) regarding *food and health beliefs* and eating more phyto-chemicals included placing importance on eating fruits/vegetables (81.3%) and fiber (81.3%) and on limiting meat intake (65.1%). A significant negative relationship was found with putting taste ahead of nutrition when selecting food (47.6% disagree, $p < .05$). “Phyto motivated” subjects also shared these beliefs plus placed importance on eating grain products (86.9%, $p < .05$), getting dietary fiber (93.1%,

$p < .01$), and preventing disease through diet (98.4%, $p < .01$). Despite the importance placed on eating grain products, however, this population was eating fewer of these foods (34.8% “more phyto,” 39.3% “phyto motivated”).

Applications of this study include making use of this population’s interest, vocabulary, and understanding of phytochemicals to effectively target public health or food industry messages. Nutrition educators and food industry professionals will need to overcome the plant food subgroups’ inclination to favor their own research over professional advice or public health campaigns. Other researchers could expand upon this project by (1) studying populations for belief/action discrepancies in whole grain intake, fiber intake, micronutrient intake, and diet/weight satisfaction and (2) tracking the marketing of nutraceuticals, especially during the current boom years.

Acknowledgements

I received assistance and support from many people during the two years it took to complete this project. First in line to receive thanks are the members of my thesis committee: thesis adviser Dr. Janice Coker, UW-Stout Food and Nutrition Department, for her long-term counseling, guidance and friendship; Dr. Louis Milanesi, UW-Stout Psychology Department, for his expertise in statistical analysis; and Dr. Mary Flynn, UW-Stout Psychology Department, for her timely and appropriate suggestions as the written thesis took shape.

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A final word of thanks to my friends and family. They folded letters, stuffed envelopes, or listened patiently (and sometimes endlessly) to my ramblings about phytochemicals. A special note of appreciation goes to the “Lucky 31” who pretested the survey and shared thoughts on how to improve it. Bruce Warren, in particular, helped sharpen mushy language and created questions which solicited the data I needed.

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Chapter 1.
Introduction

Phytochemicals are compounds found in plants which provide health benefits for humans beyond those attributed to macronutrients and micronutrients. Many of these benefits suggest a possible role for phytochemicals in the prevention and treatment of disease, following a shift away from food's historical role of merely maintaining health (Hasler and Blumberg 1999).

Humans receive the potential health benefits of phytochemicals by eating plant foods, namely fruits, vegetables, whole grains, seeds and nuts. A diet rich in plant-based foods, particularly plenty of vegetables and fruits, has been promoted by many major health organizations, including the American Institute for Cancer Research (Moorachian 2000), the American Cancer Society (Byers et al. 2002) and the U.S. Department of Agriculture (USDA and USDHHS 2000), as a guideline for optimizing health.

Research involving human subjects has begun to identify whether phytochemicals act alone or together with the macro and micronutrients. Despite the lack of concrete data confirming human health benefits, consumers are already interested in phytochemicals, presenting dietitians and other health professionals with the opportunity to promote healthy eating. Knowing the motivation behind this behavior is important, because consumption of fruit and vegetables in the U.S. falls below national recommended levels. Gibson, Wardel and Watts (1998) encourage greater cooperation between nutritional and behavioral scientists in the study of nutritional behavior for this reason.

Problem statement

Public interest in phytochemicals presents dietitians and other health professionals with the opportunity to promote healthy eating. The purpose of this study was to learn whether phytochemicals knowledge motivates some people to change their eating behavior and eat more fruits, vegetables and whole grains. While plant food intake studies have identified factors which either facilitate or hinder fruit, vegetable and whole-grain intake, no studies were found in the literature which focus on phytochemical knowledge as a factor. A better understanding of the motivational factors and health beliefs identified in this population could help health professionals affect successful behavioral changes in the public's fruit, vegetable and whole grain consumption. The study findings could also help the food industry understand how to reach and persuade a key target market: consumers who move from awareness of a product feature (phytochemicals) to a desired action (purchase and/or consumption of product).

Objectives

The objectives of this project are to:

1. Draw a demographic profile of this population;
2. Estimate from the subset the number of adults who have increased their consumption of fruits, vegetables and whole grains;
3. Determine whether the major change effecter was an awareness of phytochemicals;
4. Define this population's understanding and expectations of phytochemicals; and
5. Summarize this population's general health beliefs.

The hypothesis under study is that there is a positive correlation between the seeking of nutrition information, food and health beliefs, and a deliberate inclusion of additional plant-based foods into the daily diet. Information collected to test the hypothesis will include patterns of information seeking, belief in "healthful eating" statements and food guidelines, and awareness of nutritional campaigns.

Chapter 2.
Review of literature

Phytochemicals

Defined

Phytochemicals (from the Greek word *phyto,* meaning plant) are biologically active, naturally occurring chemical compounds found in plants. They protect plants from disease and damage and contribute to the plant's color, aroma and flavor. Based on data from animal and lab studies, ingested phytochemicals show potential for reducing the risk of cancer and cardiovascular disease in humans (Gibson, Wardel, and Watts 1998, Mathai 2000).

More than 4,000 phytochemicals have been cataloged (American Cancer Society 2002) and are classified by protective function, physical characteristics and chemical characteristics (Mathai 2000). Three major classes are the terpenes (including the subclasses carotenoids and limonoids); the phenols (including the subclasses flavonoids and isoflavones); and the thiols (including the subclasses the indoles, dithiolthiones and isothiocyanates) (Mathai 2000, Meagher and Thomson 1999). Within each subclass are individual phytochemicals (see Table 1). About 150 phytochemicals have been studied in detail (American Cancer Society 2002). Two well researched and publicized individual phytochemicals are the phytoestrogen genistein (found in soybeans) and the carotenoid beta carotene (found in green and yellow fruits and vegetables) (Mathai 2000).

In general, dietary phytochemicals are found in fruits, vegetables, legumes, whole grains, nuts, seeds, fungi, herbs and spices (Mathai 2000). Broccoli, cabbage, carrots, onions, garlic, whole wheat bread, tomatoes, grapes, cherries, strawberries, raspberries, beans, legumes, and soy foods are common sources (Moorachian 2000). Phytochemicals accumulate in different parts of the plants, such as in the roots, stems, leaves, flowers, fruits or seeds (Costa et al. 1999). Many phytochemicals, particularly the pigment molecules, are often concentrated in the outer layers of the various plant tissues. Levels vary from plant to plant depending upon the variety, processing, cooking and growing conditions (King and Young 1999).

Other phytochemicals form through metabolism. For example, the “mammalian” lignans enterodiol and enterolactone form when gastrointestinal flora act, respectively, on the plant lignans secoisolariciresinol and matairesinol. Plants with the highest concentrations of secoisolariciresinol and matairesinol include soybeans, lima beans, kidney beans, flax seeds and pumpkin seeds (Costa et al. 1999).

Phytochemicals are also available in supplementary forms, but evidence is lacking that they provide the same health benefits as dietary phytochemicals (American Cancer Society 2002).

Phytochemical functions

The physiologic properties of relatively few phytochemicals are well understood (Hahn 1998). Much research has focused on their possible role in preventing or treating cancer and heart disease (Mathai 2000).

- *Cancer:* Phytochemicals may detoxify substances that cause cancer. They appear to neutralize free radicals, inhibit enzymes that activate carcinogens, and activate enzymes that detoxify carcinogens. For example, according to data summarized by Meagher and Thomson (1999), genistein prevents the formation of new capillaries that are needed for tumor growth and metastasis.

- *Heart disease:* Study findings suggest that phytochemicals may reduce the risk of coronary heart disease by preventing the oxidation of low-density lipoprotein (LDL) cholesterol, reducing the synthesis or absorption of cholesterol, normalizing blood pressure and clotting, and improving arterial elasticity (Mathai 2000, Hahn 1998).

Phytochemicals have also been promoted for the prevention and treatment of diabetes, high blood pressure, and macular degeneration (American Cancer Society 2002).

While phytochemicals are classified by function, an individual compound may have more than one biological function (serving as both an antioxidant and antibacterial agent, for example) (Hahn 1998).

Most plants also have a mix of phytochemicals. An example is the carrot, which contains more than 100 phytochemicals (American Cancer Society 2002).

Possible mechanisms of action

Phytochemicals may protect against cancer by blocking or suppressing active carcinogens or tumor promoters from reaching target tissue. The blocking actions could include activating enzymes that detoxify carcinogens, trapping carcinogens, or inhibiting cellular events linked to tumor formation (Mathai 2000). Sulforaphane (found in broccoli and broccoli sprouts) is one of the phytochemicals that activate enzymes which detoxify carcinogens (DeSimone 1998). The suppressing actions could include interference with the malignant expression of cells that have been exposed to carcinogens (Mathai 2000).

Another related theory (De Simone 1998) supports phytochemicals' role in causing cancer cell death. The director of Cancer Prevention at the Medical University of South Carolina suggests that ellagic acid (found in raspberries) induces normal cell death, a process which is missing in rapidly-reproducing cancer cells.

Some phytochemicals, such as lignans and isoflavones, have a diphenolic structure similar to the hormone estrogen. Flax seed contains both lignans and isoflavones, while soybeans are a rich source of isoflavones (Slavin et al. 1999, Mathai 2000). Limited data from animal studies suggests a relationship between phytoestrogens and sex steroid action, but the exact effect (estrogenic or antiestrogenic) may depend on the amount of endogenous estrogens present.

This hormonal duality of phytoestrogens is thought to cause a range of health effects, including lowered cholesterol levels, better prostate health and, possibly, increased bone density and reduced risk of hormone-dependent cancers (Hahn 1998, Mathai 2000). Acting as a weak estrogen, a phytoestrogen could potentially reduce the risk of osteoporosis and cardiovascular disease. Acting as an antiestrogen, the same phytoestrogen could protect humans against breast cancer (Hahn 1998).

Table 1. Common phytochemicals, identified by class, source and function

CLASS	SUBCLASS	PHYTOCHEMICALS	SOURCE	POSSIBLE ROLES
Phenols	**Flavonoids** *Anthocyanins* (red, blue and purple pigments)	Cyanidin, delphinidin, malvidin, nasunin, pelargonidan, peonidin	Berries (esp. bilberries and blueberries), kale, wine, beans, red cabbage, eggplant	Antioxidant. May stimulate detoxification enzymes and protect liver. Strengthens capillaries. Blocks inflammation. May inhibit tumor formation.
	Anthoxanthins (colorless, or white-to-yellow pigments)	• *Flavonols:* Quercetin, kaempferol	Olives, onions, kale, lettuce, cherry tomato, broccoli, apples, yellow/green beans, turnip greens, endive tea, apple juice	Antioxidant. May stimulate detoxification enzymes and protect liver. Strengthens capillaries. Blocks inflammation. May inhibit tumor formation.
		• *Flavones:* Apigenin, luteolin	Celery, olives	
		• *Flavanols:* Catechin, epicatechin	Pears, red wine, green tea, white wine, apples	
		• *Isoflavones:* (phytoestrogens) Diadzein, genistein	Soybeans, lentils, dry peas, soy products	May inhibit estrogen-promoted cancers and lower serum cholesterol. May limit effects of menopause.
		• *Lignans:* (phytoestrogens) Coumestrol,enterolactone, enterodiol, zearalenone, zearalenol, sesamin, sesamolinol	Flaxseed, linseed, wheat, barley, beans, peas, whole grains, fungi, tea, pumpkin seeds, sesame seeds, peanuts, cranberries	Antioxidant. May protect against cancers. Antiviral, antibacterial, antifungal. May lower serum cholesterol.
	Phenolic acid	• *Hydroxycinnamic acids:* Caffeic, ferulic, chlorogenic, neochlorogenic acids	Blueberries, cherries, pears, apples, oranges, white potatoes, grapefruit, coffee beans	
		• *Hydroxybenzoic acids:* Ellagic, gallic acids	Raspberries, strawberries, green and black grape juice	
	Polyphenols (tannins)	Catechin, epicatechin polymers	Lentils, black-eyed peas, light and dark grapes, red and white wine, apple juice	
Terpenes	**Carotenoids**	Alpha carotene, beta carotene	Carrots, cantaloupe, butternut squash, pumpkins, sweet potatoes	Antioxidant. May protect against heart disease and stroke.
		Lycopene (red-orange pigments)	Tomatoes, red grapefruit, guava, dried apricots, watermelon	Antioxidant. May protect against cancers of the cervix, stomach, bladder, colon and prostate.
		Lutein, zeaxanthin (xanthophylls)	Dark green leafy vegetables, broccoli, kiwi	Antioxidant. May protect against heart disease and stroke.
	Limonoids (monoterpenes)	Limonene, sobrerol, perillyl alcohol	Citrus fruit, citrus oil, caraway seeds	May block action of carcinogens. May inhibit hormone-related cancers.
Thiols	**Diallylsulfides**	Diallyl disulfide, S-allyl cysteine, allicin	Garlic, onions, leeks, shallots, chives, broccoli, cabbage, cauliflower, Brussels sprouts, mustard, horseradish, watercress	May block carcinogens and suppress carcinogenic changes in cells. May stimulate detoxification enzymes.
	Indoles	Indole-3-carbidol (I3C)		May protect against breast cancer.
	Isothiocyanates	Sulforaphane		May protect against colon cancer, stimulate detoxification enzymes and protect against cigarette smoke.

Sources: Birt, Shull, and Yaktine 1999, Costa et al. 1999, King and Young 1999, Mathai 2000, Ronzio 1997.

Phytochemical research

Meagher and Thomson (1999) and Hahn (1998) note that while data from experimental, animal and epidemiologic studies suggests a role for phytochemicals in preventing cancer and heart disease, few well-designed clinical trials or intervention studies have been undertaken to confirm the same promising functions in humans. The number of phytochemicals and the complexity of their chemical processes also complicate research; a challenge is to determine which dietary phytochemicals are beneficial to health and which may be harmful (American Cancer Society 2002).

The studies have also tended to take the “magic bullet” approach, in which one dietary ingredient (a phytochemical, in this case), is isolated, fed to either animal or human subjects, and scrutinized for cause-and-effect phenomena. Potter, as reported by Slavin et al. (1999), sees this approach as problematic since it ignores the independent, overlapping and possibly interactive mechanisms of compounds other than phytochemicals, such as macronutrients (protein, fat and carbohydrates) and micronutrients (vitamins and minerals).

At the 1996 symposium “Phytochemicals: Biochemistry and Physiology” in Washington, Hasler and Blumberg urged researchers to evaluate not only the safety and efficacy of phytochemicals but also their absorption, distribution, metabolism, excretion and mechanisms of action.

Cancer

Phyto-estrogens. Recent research has cast doubt on the safety of one of the most long-studied phytochemicals. Genistein is an isoflavone found in soybeans. Hahn (1998) writes that when administered to animals in high doses either through diet or injection, genistein has been shown to decrease the number and size of tumors. The results are less clear when looking at epidemiologic study data involving human subjects who have ingested soy isoflavones, however. Genistein is the most estrogenic of isoflavones but binds weakly to estrogen receptors in breast cells. Therefore, it only partially blocks the binding of the body’s own estrogen to these receptors plus elicits an estrogenic response itself, possibly posing an increased cancer risk. Genistein can stimulate reproduction of cells with estrogen receptors, which could be dangerous for women with estrogen-receptor-positive breast cancer. Lampe, a cancer researcher quoted in Hahn (1998), says, “Until we learn more about the clinical implications of these findings, I would be cautious about recommending phytoestrogen supplements or high intakes of soy food to women with estrogen-responsive breast cancer." The American Cancer Society, in its 2002 *Guidelines on Nutrition and Physical Activity for Cancer Prevention*, advises breast cancer survivors to consume only moderate amounts of soy foods as part of a healthy plant-based diet and to avoid high levels of soy foods or concentrated soy products (Byers et al. 2002).

In June 2000, two U.S. Food and Drug Administration (FDA) scientists publicly criticized their agency's October 1999 health claim linking soy to lower cholesterol levels and the risk of heart disease (American Broadcast Corporation 2000). In a letter of protest written to the FDA, researchers Doerge and Sheehan say some research indicates a link between soy and fertility problems in certain animals. Other researchers, as reported in a news story about the Doerge and Sheehan protest, say other studies show that soy may increase reproduction of estrogen-dependent breast cancer cells and could participate in accelerating aging in the brain. The FDA, the soy industry, and the infant formula industry say the research noted in these criticisms is scientifically unjustified, fails to prove cause and effect, and conflicts with other research.

Cancer researcher Lampe (Hahn 1998) writes that we need more information about the long-term effects of a very high intake of phytoestrogens to be assured there are no toxicity risks with prolonged exposure to high doses of these compounds.

Beta carotene. Another much-studied phytochemical is the carotenoid beta carotene. In the 1970s and 1980s, observational and epidemiological studies indicated a lower risk of lung cancer in people eating foods high in beta carotene. Four large clinical trials in the 1980s and 1990s tested the validity of this protective role. Three of the studies involved well-nourished adults, two from populations at high risk for lung cancer – the Alpha-Tocopherol, Beta Carotene Cancer Prevention Study (ATBC) and the Beta Carotene and Retinol Efficacy Trial (CARET) – and the third from a lower-risk population (Physicians Health Study I). (The fourth trial, conducted in Linxian, China, will not be discussed here since it involved an undernourished population and did not report the incidence of lung cancer) (Omenn et al. 1996).

- The ATBC study was a randomized, double-blind, placebo-controlled primary-prevention trial to determine whether daily supplementation with alpha-tocopherol, beta carotene or both would reduce the incidence of lung and other cancers (ATBC Cancer Prevention Study Group 1994). Study subjects were 29,133 male smokers, 50-69 years of age, from southwestern Finland, who were recruited 1985 through 1988. The men were randomly assigned to one of four regimens: synthetic alpha-tocopherol (50mg/day), synthetic beta carotene (20mg/day), both, or the placebo. Dosing began in April 1985, and follow-up continued through April 1993.

Findings included an unexpected higher incidence of lung cancer (18% change in incidence) and total mortality (8% change in incidence) among the men who received beta carotene from those who did not. Researchers concluded that neither beta carotene nor alpha-tocopherol supplementation reduced the incidence of lung cancer in male smokers. They discounted bias or low dosing as being responsible for these results, but found it plausible that the intervention period (5 years) was too short to inhibit development of cancers resulting from a lifetime of exposure to cigarette smoke. They also believed their study raised the possibility that these supplements may actually have harmful as well as beneficial effects, particularly for smokers.

- The next trial involving beta carotene was the Physicians Health Study I (PHS I), which was a randomized, double-blind, placebo-controlled trial involving 22,071 male physicians, 40-84 years of age (Hennekens et al. 1996). At the beginning of the study (1982), half of the subjects had never smoked, 11% were current smokers, and 39% were former smokers. They alternatively received either aspirin, beta carotene, both supplements, or a placebo.

  The aspirin component of the study finished ahead of schedule (January 25, 1988) because of positive associations between the drug and myocardial infarction (MI) incidence (the aspirin group had a significant 44% reduction in the risk of a first MI). The beta carotene component continued through December 31, 1995. At the end of the follow-up period (12 years on average), the researchers found no statistically significant association, either beneficial or harmful, between beta carotene intake and relative risks of cancer, heart disease or death. The malignancies which did occur (996 in the beta carotene group; 1,027 in the placebo group) were diagnosed later in the study (years 6 to 14), leading the researchers to conclude that beta carotene was particularly ineffectual as an early preventive treatment tool. Later subgroup analysis, however, indicated that subsequent important vascular events decreased by 54% among 333 men who had prior angina or revascularization procedures (Christen, Gaziano, and Hennekens 2000).

- The CARET randomized pilot studies began in 1985 and expanded in 1988 and 1991 to include additional subjects (Omenn et al. 1996). A total of 4,060 male workers (45-74 years old) exposed to asbestos and 14,254 heavy smokers (current status or within past 6 years, 44% women, 50-69 years) were randomized. Eventually all received daily a supplement combination of 30mg beta carotene and 25,000 IU retinyl palmitate or a placebo.

  While the study was designed for active intervention until late 1997, it was terminated on January 11, 1996, due to results its researchers found "troubling." Compared to the placebo group, the subjects receiving supplements had a significant 28% higher relative risk of lung cancer and a significant 17% higher mortality rate. While the researchers couldn't specifically explain these possible adverse associations, they noted that the median serum beta carotene levels in the subjects who had received supplements were 12 times greater than those measured at baseline or from subjects in the placebo group. They hypothesized that ". . . such levels may be toxic or at least cause serious disequilibrium with other compounds important to redox relations or other cellular mechanisms." They also believed that continuing exposure to risk factors, such as smoking, is hard to reverse or overcome. The researchers stated that ". . . there can be little enthusiasm about the efficacy or safety of supple-mental beta carotene or vitamin A in efforts to reduce the burdens of cancer or heart disease in certain populations. However, we still recommend the dietary intake of fruits and vegetables."

These negative findings influenced other research. At the time of the CARET trial, the only other large-scale study involving beta carotene was the Women's Health Study, which tested the effects of various supplements and factors on the risk of getting cancer and heart disease (NIH, NCI 2002). When CARET was terminated, the Women's Health Study researchers dropped the beta carotene component (50 mg every other day) and continued dosing the subjects (40,000 healthy female health professionals, ≥45 years of age) with vitamin E, aspirin or placebos. Researchers of smaller or shorter-term studies including beta carotene were alerted and advised to consider the results of the ATBS, CARET and PHS I when designing their own research.

Since then, research has focused on other aspects of or diseases associated with beta carotene. One in vivo study studied the effect of cigarette smoke on plasma levels of carotenoids, tocopherols and retinol (Handelman, Packer, and Cross 1996). Plasma from five volunteer adults was exposed to cigarette smoke in a pattern and at a level mimicking exposure experienced by human cigarette smokers. Results indicated that cigarette smoke is capable of destroying antioxidants and lowering their concentration in human plasma. Most susceptible to destruction was lycopene, followed by alpha-tocopherol (70% loss after 9 hours exposure) and beta carotene (58% loss), then lutein + zeaxanthin, then cryptoxanthin, then γ-tocopherol, then retinol. The researchers cautioned against extrapolating these in vivo reactions to those that could occur in the human respiratory tract and also noted the multiple mechanisms (including phagocyte activation and smoke-catalyzed oxidant production) that could contribute to lower concentrations of antioxidants in smokers.

More recently, a small-scale clinical trial involving 20 nonsmoking females (21-39 years) living near Clermont-Ferrand, France, assessed whether interactions between vegetable-borne carotenoids affected their bioavailability or medium-term presence in plasma (Tyssandier et al. 2002). The subjects were randomly divided into 2 groups and followed a diet supplemented with varying amounts of lycopene, lutein, beta carotene and zeaxanthin for three 3-week periods. The carotenoids sources were either dietary (tomato puree or chopped spinach) or synthetic (supplement pills). Fasting blood samples were collected at baseline and the beginning of each supplement period or washout period to compare plasma carotenoids, triglycerides and cholesterol levels.

Based on post-prandial results, the researchers concluded that vegetable-borne lutein, lycopene and beta carotene compete for absorption into the intestine, incorporation into the chylomicron, or both. The medium-term results showed that this interaction doesn’t have an adverse effect on the medium-term plasma status of carotenoids and that, in fact, lutein and lycopene had mutually beneficial effects on their respective plasma concentrations (lutein supplementation increased lycopene levels 85-92%, and lycopene supplementation increased lutein levels 2.3-3.2 fold). The researchers believed their results supported the case for eating a diet rich in a variety of fruit and vegetables, rather focusing on a single carotenoid.

As these and other studies have been conducted, many researchers have formed the opinion that factors other than beta carotene or dietary components influenced the negative findings or that consuming high-dose beta carotene supplements may have vastly different results than consuming foods rich in beta carotene (Byers et al. 2002).

Current clinical trials involving beta carotene no longer solely focus on lung cancer and will be discussed in the following sections.

Heart disease

Cardiovascular disease (CVD) is the leading cause of death in the U.S. and most developed countries (Christen, Gaziano, and Hennekens 2000). Epidemiologic studies indicate that a decreased risk of heart disease is associated with diets rich in fruits, vegetables, vitamin C, vitamin E and carotenoids. However, prospective randomized trials involving supplemental antioxidants have not been consistent.

As mentioned above, beta carotene had either no effect (PHS I) or a possibly adverse effect (CARET) on CVD risk. In the CARET study, the subjects receiving beta carotene had a 26% great risk of death from heart disease, compared to the subjects receiving placebos (Omenn et al. 1996). The population studied was considered to be at high risk for cancer and heart disease because of their status as heavy smokers or exposure to asbestos. PHS I studied a population with less risk (50% never smokers, 11% current smokers) (Hennekens et al. 1996). The major significant finding from PHS I was a positive association between aspirin and MI incidence (the aspirin group had a significant 44% reduction in the risk of a first MI). No significant association, however, was found between beta carotene intake and relative risks of total MI; total stroke; death from cardio-vascular disease; or the combined endpoint of nonfatal MI, nonfatal stroke and total cardiovascular death (Christen, Gaziano, and Hennekens 2000). Later subgroup analysis by Gaziano, however, indicated that subsequent important vascular events decreased by 54% among 333 men who had prior angina or revascular-ization procedures.

A more recent study with similar findings to PHS I was the MRC/BHF Heart Protection Study (HPS) in the United Kingdom (HPS Collaborative Group 2002). This large randomized trial studied the effects of three antioxidant vitamins (20 mg beta carotene, 250 mg vitamin C, and 600 mg vitamin E) on vascular and non-vascular disease and death. Subjects included 20,536 adults, aged 40-80 years, who were considered to be at high risk of death from heart disease because of past medical history of CVD, occlusive arterial disease, diabetes mellitus or treated hypertension. Subjects were randomized between July 1994 and May 1997 and made visits to the study clinics for routine checks at 4, 8 and

12 months, and then at every 6-month interval until the final follow-up visits between May and October, 2001. Half of the subjects received the antioxidants, and half received placebos. Results at the end of the five-year trial showed no significant benefits or harm from daily supplementation of the antioxidants and risk of heart attacks, strokes, cancers or mother major adverse events. However, supplementation was linked to small increases in the plasma triglycerides and LDL cholesterol. The researchers came to two conclusions: that the lower risks of vascular disease and cancer found in observational studies must be due to factors, such as lifestyle changes; and that advice regarding antioxidant supplementation for cardiovascular disease prevention is hard to justify. They instead recommend prescribing aspirin and statin drugs (the latter also tested in another phase of this study) and making behavioral changes, such as smoking cessation.

In contrast, Tavani et al. (1997) found that the risk of nonfatal acute myocardial infarction (MI) in women was inversely related to consumption of foods containing beta carotene. Findings from this study were based on a test population of 433 women living in northern Italy between 1983-92, aged 18-74 years (median age 53 years), 43.7% never smokers and 48.7% current smokers. The control group of 869 women was matched for age but differed in smoking habits (71.5% never smokers, 22.5% current smokers) and disease status (the controls were not hospitalized for cardiovascular reasons and fewer had a history of hypertension (18.5% versus 46.8%) than the case subjects). The inverse relationship was apparently stronger for young, lean current smokers with no history of diabetes or hypertension. A limitation of the study was the restricted amount of dietary information collected, based on frequencies and consumption of only 14 selected indicator foods, with no information on portion size.

Current ongoing studies seek to shed more light on the possible link between carotenoid intake and heart disease.

- The Physicians' Health Study II (PHS II) is a randomized, double-blind, placebo-controlled primary prevention trial to test the preventive effects of alternate day beta carotene (50mg), alternate day vitamin E (400 IU), daily vitamin C (500 mg) and daily multivitamin (Centrum Silver) dosing on total and prostate cancer, CVD, and two age-related eye diseases (cataract and macular degeneration) (Christen, Gaziano, and Hennekens 2000). Subjects include 15,000 male physicians (≥55 years), half recruited from the PHS I cohort, and half recruited from the American

Medical Association membership list. Recruitment began in the summer of 1999. As in PHS I, data will be collected from yearly questionnaires and review of medical records, as needed. This prevention trial is scheduled to run for five years.

- The Women's Antioxidant Cardiovascular Study (WACS) is a randomized, doubled-masked, placebo-controlled secondary prevention trial to test antioxidant vitamins among women who are at high risk for getting or dying from CVD (NIH, NEI 2002b). The antioxidants to be tested include beta carotene (50mg on alternate days) plus vitamins B6, B12, C, E and folate. Subjects include 8,171 female health professionals (≥40 years), who were recruited between August 1993 and October 1996. The follow-up period is planned to end in February 2006 (NIH, NLM 2002). Study sponsor is the National Heart, Lung and Blood Institute.

- The "Supplementation en Vitamines et Minéraux AntioXidants" (SU.VI.MAX) Study is a random-ized double-blind, placebo-controlled primary prevention trial in France (Hercberg et al. 1998). The study is testing the effects of combination antioxidant supplementation (6 mg beta carotene, 120 mg vitamin C, and 30 mg vitamin E) and mineral supplementation (100 mcg selenium and 20 mg zinc) on CVD and cancer rates in healthy adults. The nutrient doses were set at these levels in order to be at or near daily recommended levels and in order to be lower than the doses used in the ATBC and CARET studies. Subjects were drawn from the general population between October 1994 and April 1995 and included 12,735 individuals (7,679 women, aged 35-60 years; 5,056 men, aged 45-60 years). The subjects will be followed for eight years. Data collection will consist of alternative years of blood sampling or sex-specific clinical examination, conducted at one of 65 clinics nationwide. Using the SU.VI.MAX computer network, subjects will also send 24-hour dietary records to researchers six times annually.

  In order to guard against the troubling effects associated with high beta carotene levels found in the ATBC and CARET studies, researchers have tested SU.VI.MAX subjects' antioxidant and vitamin serum levels after two years of supplementation (Malvy et al. 2001). Data drawn from a 1,000-subject subsample indicated that daily supplementation of the antioxidant-and-mineral combination had moderately increased serum concentrations of these nutrients, reaching levels consistent with positive health effects but lower than levels associated with increased risk of disease. For the subjects receiving supplements, median serum concentrations of beta carotene in men rose 168% (0.51 μmol/L at baseline, 0.86 μmol/L at 2 years) and in women rose 176% (0.71 μmol/L at baseline, 1.25 μmol/L at 2 years). In comparison, supplementation raised the median serum beta carotene levels an estimated 12 times over baseline levels (0.32 μmol/L at baseline, 3.91 μmol/L at 5 years) in CARET adult subjects (Omenn et al. 1996) and an estimated 18 times over baseline levels (0.32 μmol/L at baseline, 5.59 μmol/L at 3 years) in ATBC adult subjects (ATBC Cancer Prevention Study Group 1994).

Eye disease

The leading causes of visual impairment and blindness in the U.S. are age-related macular degeneration (AMD) and cataract formation. AMD is a degeneration of the macular area of the retina of the eyes. This macular area is a small pitted yellow spot in the center of retina; the pit contains closely packed cones, which function as the area of most acute vision. With a cataract formation, there is a clouding of the eye's lens or its capsule (Thomas 1993). Treatment for AMD is limited and applicable only for people with advanced stages of the disease; cataracts can be successfully removed surgically (NIH, NEI 2002c).

Estimates of incidence among the U.S. population are 1.7 million people having some form of AMD, with approximately 100,000 becoming blind from the disease, and 1.5 million surgeries performed annually for cataracts. Incidence rises sharply after 60 years of age (NIH, NEI 2002c).

Animal and epidemiological human research has centered on the carotenoids for their possible roles in diseases of the eye. The carotenoids most studied have been beta carotene, lutein and zeaxanthin. Lutein and zeaxanthin are the carotenoids most concentrated in the retinal pit (the macula) (Seddon et al. 1994, Taylor et al. 2002); when deposited in this region, they are referred to as macular pigment (MP) (Curran-Celentano et al. 2001). Beta carotene and lycopene, in comparison, are nearly absent in the macula (Seddon et al. 1994). MP optical density (MPOD) has been shown to vary between individuals by 10-17% (Berendschot et al. 2000). Increased MPOD has been linked directly to preserving function and visual sensitivity, possibly by absorbing short-wave visible blue light before it damages photoreceptor membranes or by deactivating reactive oxygen species generated within the retina (Seddon et al. 1994, Curran-Celentano et al. 2001). Oxidation of lens proteins plays a central role in the formation of age-related cataracts (Chasan-Taber et al. 1999).

When the methodology for these studies has measured fruit and vegetable intake, particularly of foods rich in lutein and zeaxanthin such as spinach, collard greens or other dark leafy greens (Seddon et al. 1994), results have shown a significantly decreased incidence of AMD in smokers and nonsmokers who have higher intakes of these foods. The results have been less consistent or reliable when the methodology has focused on isolated phytochemical or vitamin intake, however.

The following section will summarize studies which examined trends in population and suggested links between these nutrients and decreased risk of eye disease.

MPOD. Several studies have tested the ability to measure MPOD, or levels of lutein and zeaxanthin in the retina. Mares-Perlman et al. (2002) writes that these measurements may someday become useful biomarkers of lutein availability; their validity now is unclear and being tested in various research.

One observational study which supported the use of MPOD as a biomarker of exposure to dietary carotenoids was conducted by Berendschot et al. (2000). The study had two goals: to determine the extent of changes in MPOD after oral supplementation with lutein, and to compare two objective measurement techniques. The subjects were 8 nonsmoking Dutch males, aged 18-50 years, who took 10mg lutein supplements daily for 12 weeks. Plasma lutein concentration and MPOD were measured at baseline, 4-week intervals, and 4 weeks after the end of the supplementation period. MPOD was measured in each subject using both techniques: MP maps from scanning laser ophthalmoscopy (SLO), and spectral analysis. After 4 weeks, mean blood level of lutein had increased from 0.18 to 0.90 μM; concentration remained elevated at this level through the supplementation period and stayed above baseline 4 weeks after supplementation ceased. Comparing the measurement techniques, SLO indicated a linear 4-week increase in MPOD of 5.3%, while spectral analysis indicated an increased of 4.1%. The within-subject variation of MPOD was 10% with SLO and 17% with spectral analysis. The researchers concluded that lutein supplementation significantly increased MPOD and that SLO provided the more reliable results. Berendschot et al. (2000) compared their results to other data from the literature, particularly studies using heterochromatic flicker photometry. The most comparable was a study conducted by Landrum et al. (1997), in which 2 males were supplemented for 20 weeks with 30 mg of lutein per day. Berendschot et al. (2000) noted that this greater supplementation level yielded a 4-week increase in MPOD (4.2%) similar to their own study and stated that a dose of 10mg per day is sufficient to provide the same effects.

One of several small studies which showed small and inconsistent relationships between dietary intake and MPOD was conducted by Ciulla et al. (2001). This study sought to assess the MPOD of a healthy sample more representative of the general population. The self-selected sample population included 280 healthy adult volunteers who lived in Indianapolis or bordering counties, aged 18-50 years. Healthy was defined as lacking known ocular disease; any major life-threatening disease; recent heart, pancreatic, liver or intestinal surgery; or acquired immune deficiency syndrome. MPOD was measured using flicker photometry; blood was drawn after a 6-hour fast to measure serum carotenoids levels; and dietary consumption of lutein, zeaxanthin and other nutrients were estimated from a one-year food frequency questionnaire. This data was collected during a single clinic visit. The main finding was that the average MPOD of the sample was low; specifically, it was 40% lower on the average than results reported in the literature. Ciulla et al. (2001) were not surprised by this finding, noting that the average lutein and zeaxanthin of the sample and the general population was fairly low (1.1 mg/day), equivalent to what could be obtained from one tablespoon of spinach. However, multi-variate analysis indicated significant positive relationships between MPOD and several diet factors (lutein and zeaxanthin intake, fruit intake and beta carotene intake), serum measures (lutein, zeaxan-thin and both) and physical factors (skin color and iris color). Subjects with blue-grey irises had 19% less MP than individuals with brown-black irises, and subjects who had the lowest intake of lutein and zeaxanthin had 33% lower MP compared with subjects who had the highest intake of these phyto-chemicals. No significant relationship was found between smoking and MPOD. One of the researchers, Curran-Celentano et al. (2001), writes in a separate article that this finding may be due to the small number of smokers in the study and their slightly less carotenoid-dense diet compared to nonsmokers.

Mares-Perlman et al. (2002) suggest that the differences in findings between such studies may reflect errors in measuring dietary lutein and retinal carotenoids levels.

Cataracts. Research in this area has attempted to relate nutrition to the odds of developing cataracts specific to the three lens zones: nuclear or core cells, found in the central and oldest zone; posterior subcapsular (PSC) cells, found in the outermost layers; and cortical cells, found in the inner and outer cortical tissue (Taylor et al. 2002). Study findings have indicated that opacities in these different zones may have different etiologies (Chasen-Taber et al. 1999).

Two prospective studies used a subgroup of the Nurses' Health Study (NHS) cohort. The cohort is formed by 121,700 female nurses aged 30-55 years in 1976 who lived in the U.S. and have been contacted every two years since for information on risk factors and disease status.

The first study examined the associations between dietary intakes of vitamin A, specific carotenoids, and food items with incident of cataract extraction (Chasen-Taber et al. 1999). The NHS cohort was followed for 12 years. After making exclusions (for low total energy intake, cancer diagnoses, and age incompatible with senile cataract diagnoses) and additions (subjects who became 45 years of age during follow up), the study subgroup cohort included 77,466 women by the end of the follow-up period (June 1, 1992). Nutrient intake was collected through semiquantitative food-frequency questionnaires in alternate years from 1980-86; and cataract extraction status was assessed in alternate years from 1984-92. By June 1992, 1,471 subjects were identified as having confirmed cases of cataract extraction and formed the analysis subgroup.

After controlling for age, smoking and other potential risk factors, subjects who had the highest intake of lutein and zeaxanthin had a significant 22% lower risk of cataract extraction than did those with the lowest intake. Increased frequency of spinach and kale intake was associated with a moderate decrease in cataract risk. Other carotenoids (alpha carotene, beta carotene, lycopene and beta cryptoxanthin), vitamin A and retinol were not associated with cataract. With regard to cataract formation in a specific zone, risks of PSC cataract were significantly 50% lower for those with the highest intake of vitamin A without supplements and significantly 31% lower for those with the highest intake of beta carotene, lutein and zeaxanthin, and carotene. Most of the cases had either nuclear (N=388) or PSC (N=314) cataracts; few cases of cortical cataract (N=56) were available.

The second study focused on the relationship between nutrient intake and cortical and PSC cataracts (Taylor et al. 2002). Earlier work by two of these researchers (Taylor and Jacques, in a study involving vitamin C and cataracts and later in the Nutrition and Vision Project) yielded results which suggested that higher intakes of vitamin C or lutein/zeaxanthin markedly diminished the prevalence of early nuclear cataracts. This study subgroup was based on 1,442 NHS cohort members aged 54-73 years in 1993; 492 nondiabetic women without previously formed cataracts eventually formed the study group. Nutrient intake was based on food-frequency questionnaires and supplement surveys collected over a 13-15 year period. Cataract status was determined through a detailed eye examination using standardized techniques. Data collection ended in August 1995.

The researchers found no associations between antioxidant nutrient intake and either cortical or PSC cataracts in the full sample of 492 subjects. However, significant relationships were seen in selected subgroups, including the observation that the odds of PSC cataracts were 74%, 71%, 72% and 81% lower in those subjects who had never smoked and who had the highest intakes of folate, alpha carotene, beta carotene and total carotenoids. After mutual adjustment for these nutrients, only total carotenoid intake remained associated with PSC cataracts among “never smokers.” Taylor et al. (2002) noted that carotenoids have roles in forming membrane components or maintaining membrane integrity. Since epithelial or outer cells, such as those found in the PSC, are metabolically more active, antioxidant stress (or relief of that stress) that results in membrane dysfunction may play a greater role in the etiology of PSC cataracts. The researchers pointed to the depressant effect of smoking on carotenoid and antioxidant concentrations and believed their findings underscored the weakened or adverse effects antioxidant intake can have for smokers.

Another prospective study which found a trend toward lower risk of cataract extraction with higher intakes of lutein and zeaxanthin, this time in men, was based on a subgroup of the Health Professionals Follow-up Study (HPFS) (Brown et al. 1999). The HPFS was a prospective investigation of dietary links to chronic disease in 51,529 U.S. male dentists, optometrists, osteopaths, podiatrists, pharmacists and veterinarians, aged 40-75 years in 1986. Subjects have been contacted every two years since for information on risk factors and disease status. After excluding subjects for similar reasons as described earlier (energy intake, age, cancer diagnosis), 36,644 men were included in the baseline population. Dietary intake was collected using a semi-quantitative food-frequency questionnaire. Health status, with an emphasis on cataract diagnosis, was determined through follow-up questionnaires sent in alternative years from 1988-1994 and medical record review, as needed. At the end of the 8-year follow-up period, 840 cases of confirmed cataract extraction formed the analysis subgroup.

After controlling for age, smoking and other risk factors, the researchers observed a modestly lower risk of cataract extraction in men with higher intakes of lutein and zeaxanthin but not of other carotenoids (alpha carotene, beta carotene, lycopene and beta cryptoxanthin) or vitamin A. The difference in cataract extraction risk between men with the highest and lowest intakes of lutein and zeaxanthin was 19%. The foods most consistently associated with a lower risk of cataract were broccoli and spinach. As occurred in the NHS subgroup analysis by Chasen-Taber et al. (1999), few cases were confirmed for cortical cataracts. In multivariate models, subjects with the highest intake of lycopene had a significantly reduced risk of nuclear cataract but not of PSC cataract. The researchers urged caution in interpreting this finding, because the cohort included a small number of nuclear-only cataract (N=208). Overall, the researchers believed their findings strengthened the evidence that dietary carotenoids, specifically lutein and zeaxanthin, may lower the incidence of cataracts severe enough to require extraction.

Macular degeneration. One study evaluated the relationship between dietary intake of carotenoids and vitamins A, C and E and the risk of AMD (Seddon et al. 1994). Case (N=356) and control (N=520) subjects were selected between May 1986 and December 1990 from patients attending five ophthalmology centers in the US. The case subjects had confirmed recent diagnoses (within 1 year of enrollment) of advanced AMD, while the control subjects had other ocular diseases. The two groups were matched for age (55-80 years) and sex. Dietary data was collected from a semiquantitative food-frequency questionnaire, which included questions about the use of multivitamins and supplements containing vitamins A, C, and E, selenium, iron, zinc and calcium. After adjusting for other risk factors, subjects consuming the highest levels of carotenoids had a statistically significant 43% lower risk for AMD than those subjects with the lowest intake. The combination of lutein and zeaxanthin was most strongly associated with AMD, and this beneficial effect was most apparent for intake of spinach or collard greens.

Two branches of the National Institutes of Health (NIH), the National Eye Institute (NEI) and the National Heart, Lung and Blood (NHLB), are sponsoring a re-examination of data from PHS I, this time assessing a possible link between beta carotene intake and the development of AMD (NIH, NEI 2002a). Researchers involved with this study, known as the Randomized Trial of Beta Carotene and Macular Degeneration, began evaluating PHS I data in 1990, and the team continues to collect medical records from subjects who have reported diagnoses of AMD.

Cataract and macular degeneration. Nutrient analyses based on the Beaver Dam Eye Study (BDES) have found no significant associations between the risk of cataracts (Lyle et al. 1999) and/or AMD (VandenLangenberg et al. 1998) and carotenoid intake. The BDES was a population-based study of adults living in the community of Beaver Dam, Wisconsin, regarding the prevalence of age-related eye diseases (Klein, Klein, and Lee 1998). The participants were aged 43-86 years in 1987-88; the group was 99% Caucasian. Baseline eye examinations for age-related eye disease and collection of dietary data through two food-frequency questionnaires (current intake and 10-years past intake) occurred from March 1, 1988, to August 31, 1990 (N=4926); a follow-up study was conducted between March 1, 1993, and June 14, 1995 (N=3684).

In the cataract analysis, 400 subjects, aged 56-86 years, were randomly selected from the BDES cohort (Lyle et al. 1999). After screening for absence of nuclear cataracts at baseline, presence of risk factors, and previous cataract surgery, 252 cases formed the final analysis subgroup. The results did not support an association between cataract and serum concentrations of alpha carotene, beta carotene, lutein, lycopene or cryptoxanthin, even though nonsignificant inverse associations were found for lutein and cryptoxanthin. The researchers noted that the sample may have been too small, as the statistical power needed to detect a 50% reduction in risk was 28% lower in this study than it needed to be.

The AMD analysis began with a 50% random sample of the BDES cohort (VandenLangenberg et al. 1998). After excluding for incomplete dietary records and exam participation, presence of late-stage AMD at baseline, and gradable retinal photographs, 1,586 subjects remained to form the study subgroup. The researchers found no significant inverse associations between antioxidant or zinc intake and overall AMD. However, they did find significant relationships between several dietary components and the formation of large drusen (deposits which form in the retinas of people who have AMD and may represent an accumulation of degradative end products). These dietary components were higher past intakes of fruits and vegetables, alpha carotene and vitamin E; past intakes of beta carotene; and higher past or current intakes of total pro-vitamin A carotenoids. Significant inverse associations were also found between pigment abnormalities and higher past intakes of total pro-vitamin A carotenoids and zinc. Because of the small sample size, the researchers could not evaluate the role of antioxidant intake in the progression of AMD from early stage to advanced stage. VandenLangenberg et al. (1998) concluded that dietary components were related to specific AMD lesions but were not related to overall AMD incidence. They believe these inconsistent findings imply roles of varying magnitude for antioxidant nutrients in the AMD pathophysiologic pathway.

A major clinical study sponsored by the NEI, the Age-Related Eye Disease Study (AREDS), focused on both AMD and cataracts and released its findings in October 2001 (NIH, NEI 2002c). Goals of the study were to assess the progression and risk factors of AMD and cataracts and to evaluate the effects of high doses of antioxidants and zinc on AMD, cataracts and vision loss related to either condition.

The subject pool included 4,757 adults (56% female), aged 55-80 years, enrolled at 11 clinics nationwide. The AMD portion of the trial included 3,640 subjects who had at least early AMD, while the cataract results were based on 4,629 subjects. Recruitment began in November 1992 and ended in January 1998; about 90% of all participants were followed for a minimum of 5 years. The remaining 10% were either in the study less than 5 years, lost to follow-up, or had died. Subjects were categorized by their stage of AMD (none, early, intermediate or advanced). Per category, subjects were randomly selected to receive daily oral tables of zinc (80 mg zinc oxide), antioxidants, a combination of antioxidants and zinc, or a placebo. The antioxidant formulation contained beta carotene (15 mg), vitamin C (500 mg) and vitamin E (400 IU). Copper (2 mg cupric oxide) was also given to the subjects receiving zinc, because copper deficiency is associated with zinc supplementation.

Regarding AMD, the most favorable significant findings were found in subjects with intermediate AMD or those with advanced AMD in one eye only; the treatment of antioxidants plus zinc reduced these subject’s risk of developing advanced stages of AMD by about 25 percent and reduced the risk of central vision loss by 19 percent. Treatment with zinc or antioxidants alone was also associated with lowered risks of disease progress and vision loss, but at lower rates. For subjects who had early AMD, none of the treatments slowed the disease’s progression to intermediate AMD.

Regarding cataracts, none of the treatments had a significant effect on the development or progress of the disease for any of the population categories.

Based on the AREDS research, the NEI endorses antioxidant and zinc therapy for people with intermediate AMD in one or both eyes and advanced AMD in one eye. The institute does not endorse this treatment for people with early AMD, but instead recommends that this group should track disease progression through annual dilated eye examinations (NIH, NEI 2002d).

While the findings have been received positively by retinal specialists (Charters 2001), a few physicians and researchers noted what the trial did not study, namely the effects of lutein supplements (not recognized or available at the study onset) or a clear picture of the role of diet in eye disease.

Market trends

Food industry journals (Broihier 1999a, Broihier 1999b, Falkman 2000, Ouellette 1995, Scimone 1997) have reported increasing consumer awareness of phytochemicals and their potential health value. Falkman (2000) sees the catalysts behind this interest as increased awareness and acceptance by consumer of natural herbal ingredients that affect health and mood and better shelf positioning in retail stores. Even general familiarity with concepts, such as soy products have beneficial health effects because of their isoflavone content, have created new marketing opportunities for the industry. Other health benefits of appeal to consumers in relation to dietary supplements are energy enhancement, illness protection, heart/cardiovascular health, anti-cancer properties, memory improvement, relaxation, and sexual enhancement (Falkman 2000, Theodore 2001). Broihier (1999b) believes that phytochemicals will be to the 21st century what vitamins were to the first half of the 20th century.

Phytochemicals can be added to food or packaged as dietary supplements. These enhanced products are often referred to as functional foods or nutraceuticals. Data from a 1999 Datamonitor Americas survey listed the nutraceutical market at $19.9 billion in 1998 and estimated an annual growth rate of 8.3% to $27.5 billion by 2003 (Falkman 2000). Datamonitor Americas also predicted that the fastest growing segment of the overall market expected to be dietary supplements (9.9% annual growth rate, reaching a value of $10.3 billion by 2003). Actual sales have topped that rate, as figures quoted from the 2001 *Nutrition Business Journal* put retail and nonretail sales of dietary supplment products across all distribution channels in the U.S. at $17 billion in 2000 (Consumer Healthcare Products Association 2002). Retail sales alone were approximately $11.3 billion in 2000.

Phytochemicals in food

The nutraceutical market encompasses standard grocery items, such as foods rich in naturally occurring phytochemicals (beta carotene-rich carrots and lutein-rich kiwi or oats with their soluble and insoluble fiber content) or foods fortified with vitamins and minerals (calcium-enriched juices and cereals, for example).

Food supply and utilization data, including total and per capita consumption estimates, and compiled and published annually by the USDA's Economic Research Service (ERS) (Putnam 2000). The data are collected directly from producers and distributors, not from individual consumers (Putnam, Kantor, and Allshouse 2000). Because the supplies are measured as they move through marketing channels, the data typically overstate the amount of food people actually ingest. For that reason, the data is used best as indicators of consumption trends over time (Putnam 2000).

In the last decade of the 20^{th} century, total food expenditures rose by 18%, from $578,313 in 1990 to $844,202 in 2001 (Table 2). By the end of the decade, Americans were spending more food money away from home ($400,259) than at home ($365,982). Based on current prices, total per capita food expenditures rose 28%, from $2,317 in 1990 to $2,964 in 2001.

Table 2. Total and per capita food expenditures in the US, 1990-2001

	1990	1993	1996	1999	2001
All food, total expenditures (millions) [a]	$578,313	$609,563	$681,608	$779,447	$844,202
Food at home, total expenditures (millions)	315,987	329,439	367,565	330,991	365,982
Food away, total expenditure (millions)	262,326	280,124	314,043	363,730	400,259
US per capita food expenditures [b]					
Total (current prices)	$ 2,317	$ 2,345	$ 2,530	$ 2,793	$ 2,964
U.S. resident population as of July 1 (millions)	249.623	259.919	269.394	279.041	284.797

[a] USDA, ERS 2002a; based on data from the USDA Economic Research Service
[b] USDA, ERS 2002b; based on data from the USDA Economic Research Service

The ERS also compiles and analyzes consumption data by commodity. Table 3 lists per capita annual averages for the plant food groups studied in this thesis project. Over the last three decades of the 20th century, Americans increased their consumption of total fruits (24%), total vegetables (26%) and total flour and cereal products (49%). The trends within categories include the following:

Table 3. Per capita food consumption in the U.S. for selected commodities, 1970-1999 [a]

ITEM	PER CAPITA ANNUAL AVERAGES							CHANGE
	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	1999	1970-79 to 1999
	Pound, edible weight							%
Total fruit	240.0	257.5	266.0	275.3	277.1	290.9	297.9	24%
Fresh fruit	97.6	101.2	107.6	118.6	120.7	129.6	132.5	36%
Processed fruit	142.3	156.3	158.4	156.7	156.4	161.3	165.3	16%
Total vegetables	335.5	340.1	339.0	364.3	399.0	418.0	421.2	26%
Fresh vegetables	148.1	145.7	148.7	162.7	173.6	185.9	192.1	30%
Processed vegetables	187.3	194.4	190.3	201.5	225.4	232.1	229.1	22%
Dry beans, peas, lentils	7.2	6.7	6.2	6.9	7.8	8.2	8.6	19%
Total flour and cereal products	135.1	141.2	147.0	167.9	186.8	198.6	201.9	49%
Total wheat flour	111.0	116.1	117.3	128.3	139.9	146.9	148.4	34%
Rye flour	1.2	0.8	0.7	0.6	0.6	0.6	0.5	-54%
Rice (milled)	7.2	7.4	10.1	12.6	16.7	18.7	19.4	170%
Total corn products	10.2	11.8	14.1	20.4	22.6	27.0	28.4	178%
Oat products	4.7	4.1	3.8	5.0	6.3	4.9	4.5	-5%
Barley products	0.9	1.0	1.0	0.9	0.7	0.7	0.7	-18%

[a] USDA, ERS 2002a; based on data from the USDA Economic Research Service

- *Fruits:* Since 1970, Americans have eaten more processed fruit than fresh fruit. However, the gap is closing, and a greater percentage are eating more fresh fruit (36% change) than processed fruit (16% change). ERS researchers pointed out that variety is missing from most consumers diets, since 6 foods, out of more than 60 fruit products, accounted for 55% of total fruit servings in 1999 (Putnam, Kantor, and Allshouse 2000). These six were orange juice (19%), bananas (11%), fresh apples (7%), apple juice (6%), watermelon (6%), and fresh grapes (6%).

- *Vegetables:* The story here is similar to that for fruits regarding fresh versus processed, with a greater percentage eating more fresh vegetables (30% change) than processed vegetables (22%) by 1999. Americans also eat a limited variety of vegetables, with five foods (iceberg lettuce, frozen potatoes, fresh potatoes, potato chips and canned tomatoes) making up 52% of total vegetable servings in 1999 (Putnam, Kantor, and Allshouse 2000). Consumption of fresh potatoes dropped by 11%, while consumption of frozen potatoes (mostly French fries) rose 88%.

- *Flour and cereal products:* Of the three commodities, flour and cereal products had the greatest increase in consumption (49%), due mainly to changes in milled rice (170%) and corn products (178%, used for some snack foods and tortillas). Offsetting these gains, however, were decreases in oat products (-5%), barley products (-18%) and rye flour (-54%). ERS researchers note that the food supply series fails to count many grain foods, particularly whole grain items (Putnam, Kantor, and Allshouse 2000). The ERS uses data from the U.S. Census of Manufactures series to estimate whole grain consumption. Using the most recent census data, ERS researchers would add 18 more pounds of grain foods per person to 1999 totals if including wheat germ, wheat bran, popcorn and whole field corn used in snack foods and tortillas.

Phytochemicals as food

The market for phytochemical food additives, while small compared to the herbal supplement market, is still sizeable: $21 million out of a total $4.8 billion market for nutritional additives in 1996, according to one industry consultant (Scimone 1997). This consultant also expected phytochemical food additives to outpace overall growth in nutritional additives up through 2001, depending upon their approval as a food additive and subsequent regulation by the U.S. Food and Drug Administration (FDA).

The FDA has approved 14 health claims for use on food labels (USFDA, CFSAN 2002a) that require prior approval from the Agency. Six of the 14 claims state that a plant food (fruits, vegetables, grain products, whole grains, soy protein or plant sterols) may reduce the risk of a disease (cancer or heart disease). A manufacturer can add the appropriate claim to a food additive product label as along as there are scientific studies to support it, and the claim is not intentionally misleading. The scientific studies must be clinical trails and must have isolated, identified and proven safe an active component of the manufacturer’s product. Sometimes federal scientific bodies conduct the research, but more often it falls on the shoulders of the manufacturer, who must then incur the expenditure of time and money (Scimone 1997).

In 2000, the FDA ruled that it would allow manufacturers to make dietary supplement label claims about a product's effect on a physiological structure or function without prior review by the agency (USFDA, CFSAN 2002b). The ruling went into effect on January 6, 2000, for newly marketed products and February 7, 2000, for new claims attached to existing products. Manufacturers are required to substantiate the truthfulness of the claim, notify the FDA of the claim within 30 days of initial marketing, and include a mandatory disclaimer statement on the product label. A lawyer specializing in food and drug law and packaging law (Greenberg 2000) believes the biggest challenge for regulators will be to maintain fairness among consumers, traditional drug manufacturers and nutritional aid companies.

One of the fastest growing segments of the functional food market belongs to beverages. Functional beverages include soy drinks and waters, juices and alcohol fortified with herbs, vitamins, electrolytes, and/or phytochemicals. Revenues generated from functional beverages total $47 billion in 2000, according to data from *U.S. Functional Beverage Market,* a study from Frost and Sullivan (Theodore 2001). Sales of bottled functional waters alone went from $20 million in 2000 to $85 million in 2001 (Focus on Beverages 2002). An analyst with the firm believes that between 2001-2006, functional beverage sales will grow at a rate above the food and beverage industry as a whole (Theodore 2001).

Product examples include the following:

- Healthy Solutions 100% Juices from Veryfine Products Inc. Contains fruit juice; vitamins (A, B3, B6, B12, C and E); minerals (zinc); and herbs (Siberian ginseng, guarana, gingko biloba and echinacea) (Theodore 2000).

- Fruit$_2$O lightly flavored spring waters from Veryfine Products Inc. Contains herbs and vitamins similar to the Healthy Solutions juice line (Theodore 2000).

- Aquéss fiber water from Essentia Water. Contains Fibersol 2, an indigestible form of maltodextrin, and some fruit juice; provides 5 grams of soluble fiber and 30 calories per 16.9-ounce bottle (Theodore 2000).

- Glaceau Wellness Waters from Energy Brands. Contains water; vitamins A, B3, B5, B6, B12, C and E; zinc, arabinogalactan, Siberian ginseng, astragalus, gotu kola, schiznadra, hibiscus and rosehips. Provides 75 calories per 20-ounce bottle (Theodore 2000).

- Smartwater, Fruitwater, Soywater and Vitaminwater from Energy Brands. Depending on the product line, contains electrolytes (calcium chloride, magnesium chloride and potassium bicarbonate), herbs similar to the Wellness Waters, and calories (Focus on Beverages 2002).

- Naked Juice Tidal Wave from California Day Fresh Foods. Contains a blend of fruits (strawberries, raspberries, blackberries, apples, bananas) and sea vegetables (spirulina, Nova Scotia dulse, chlorella, Atlantic kelp, blue green algae) and omega 3 and omega 6 fatty acids (Theodore 1999).

- Aquafina Essentials enhanced waters from Pepsi (at testing stage in 2002). Flavors under consideration include citrus blend with vitamin C, watermelon-flavored water with multiple vitamins, tangerine/pineapple-flavored water with calcium, and berry-flavored water with B vitamins; none will contain artificial sweeteners (Beverage Digest 2002).

- Dasani Nutriwater from Coke (at testing stage in 2002); an enhanced water (Beverage Digest 2002).

- Propel Fitness Water from Gatorade. Contains sucrose syrup, aspartame, four varieties of B vitamins, vitamins C and E, and fruit flavors; provides 30 calories per bottle (Focus on Beverages 2002).

- Reebok Fitness Water from Clearly Canadian. Contains vitamins, minerals, electrolytes and two substances (Citrimax and ChromeMate) purported to facilitate weight loss; provides 30 calories per 24-ounce bottle. The product line includes a "super-oxygenated" water; product claims state it has ten times water's normal concentration of oxygen (Focus on Beverages 2002).

- Pulse from Baxter International. Contains lightly flavored waters, green tea liposomes, lycopene liposomes or soy isoflavones, depending upon the product line (Men's Health Formula, Women's Health Formula); provides 45 calories per 16.9-ounce bottle (Day 2002).

The marketability of these functional beverages is now driven by a consumer perception of "good for you," according to a spokesperson from InterHealth Nutraceuticals, which makes CitriMax and ChromeMate (Theodore 2001). Perception may differ from reality, as beverage marketers admit the small quantities of herbal ingredients are used more to facilitate sales than health, according to the Frost and Sullivan analyst. Long-term success for functional beverages is keyed to companies providing science-based products backed by clinical studies regarding health benefits.

Functional waters have caused dissent on three fronts: marketing, nutrition and environmental concerns. Regarding marketing, the FDA and the International Bottle Water Association have defined bottled waters as containing water and a few select ingredients performing specific functions (anti-microbial, for instance) or contributing a minimal percent by weight to the final product. Many of the functional waters fall outside of these standards, and the FDA has warned several companies either to conduct ingredient tests needed to maintain marketing approval of the “bottle water” designation or to remove the ingredients from the products (Focus on Beverages 2002). Regarding nutrition, spokespeople from the American Dietetic Association, worry that consumers will underestimate the amount of calories provided by the waters and gain weight (Day 2002). Regarding environmental concerns, watchdog groups and smaller municipalties are concerned about the amount of water being pumped out of the ground (Hollingsworth 2002). Perrier, for example, draws more than 720,000 gallons per day from some of its 75 spring sites across the country, causing worries about depleting the water table and the supply of water for municipal use.

Phytochemicals as supplements

In supplement form, phytochemicals can be regulated by the FDA as either a drug or food additive. (Scimone 1997). Under the Dietary Supplement Health and Education Act of 1994 (DSHEA), a dietary supplement is defined as “a product intended to supplement the diet that contains one or more of the following ingredients—a vitamin, mineral, herb, or other botanical; an amino acid; or a concentrate, metabolite, constituent, extract or combination of any of these ingredients.” (Ouellette 1995). An example of a phytochemical supplement is Indole-3-Carbinol (I3C), a compound isolated from cruciferous vegetables and marketed by New York-based International Resource Management and Acquisitions. The company president claims one tablet supplies the same amount of I3C as a large helping of broccoli. Sales of I3C were $500,000 in 1996 and $2.5 million over the first half of 1997 (Scimone 1997). The regulations regarding health claims for dietary supplements as food, as described above, also apply to dietary supplements in pill, tablet, liquid, etc. forms.

Recommended intake of plant foods

Steinmetz and Potter, as reported by Hasler and Blumberg (1999), said that " . . . vegetables and fruit contain the anticarcinogenic cocktail to which we are adapted. We abandon it at our peril." So rather than focusing on one phytochemical or one phytochemical class, taking a broader approach to improving the quality of the human diet through plant food consumption would provide phytochemical benefits while dampening some of the risks suggested by recent research. (Hahn 1998)

Since phytochemicals are found in plants, diets high in fruits, vegetables and unprocessed whole grains will consequently be high in phytochemicals. Research data show repeatedly that diets high in plant foods help prevent many chronic diseases (Hahn 1998, Field et al. 1998). For example, Mathai (2000) writes that in 82% of 156 selected dietary studies, fruit and vegetable consumption cut cancer risk by more than 50%. The American Cancer Society (ACS), in its *2002 Guidelines on Nutrition and Physical Activity for Cancer Prevention*, notes that most of the epidemiological studies involving greater intake of fruits and/or vegetables also find a lower risk of lung, oral, esophageal, stomach and colon cancer (Byers et al. 2002). Evidence that consumption of these foods protects against cancers considered hormonal, such as breast and prostate cancer, is not as strong. Whole grains, according to the ACS, show an association with a lower risk for colon cancer, probably due to the plant's folate, vitamin E, and selenium content; the connection between fiber (also found in whole grains) and cancer risk is inconclusive. The *Guidelines* also include this passage:

> It is not presently clear how single nutrients, combination of nutrients, overnutrition and energy imbalance, or the amount of distribution of body fat at particular stages of life affect one's risk of specific cancers. However, epidemiological studies have shown that populations whose diets are high in vegetables and fruits and low in animal fat, meat, and/or calories have a reduced risk of some of the most common types of cancer. Until more is known about the specific components of a diet that influence cancer risk, the best advice is to emphasize whole foods and certain broad dietary patterns, as described within these guidelines. (Byers et al. 2002)

Mentions of fruit, vegetable and whole grain consumption dominate the first ACS guideline, which states, "Eat a variety of healthful foods, with an emphasis on plant sources." The bulleted points under this guideline include the following:

Eat five or more servings of a variety of vegetables and fruits each day.

- Include vegetables and fruits at every meal and for snacks.
- Eat a variety of vegetables and fruits.
- Limit French fries, snack chips, and other fried vegetable products.
- Choose 100% juice if you drink fruit or vegetable juices.

Choose whole grains in preference to processed (refined) grains and sugars.

- Choose whole grain rice, bread, pasta, and cereals.
- Limit consumption of refined carbohydrates, including pastries, sweetened cereals, soft drinks, and sugars.

Choose foods that help you maintain a healthful weight.

- Substitute vegetables, fruits, and other low-calorie foods for calorie-dense foods such as French fries, cheeseburgers, pizza, ice cream, doughnuts, and other sweets. (Byers et al. 2002)

Conversely, scientific evidence indicates that a diet low in fruit and vegetables is associated with an increased risk of developing at least 15 different types of cancers (Havas et al. 1998). The ACS attributes diet and physical activity habits to one third of the 500,000 cancer deaths that occur in the United States each year (Byers et al. 2002).

Based on scientific evidence, U.S. health organizations (such as the ACS) have recommended consumption of five or more daily servings of fruits and vegetables (Gibson, Wardel, and Watts 1998, Field et al. 1998). Outside this country, the United Kingdom Department of Health and the World Health Organization have recommended a minimum daily intake for adults of 400 g of fruit and vegetables (Gibson, Wardel, and Watts 1998). Regarding whole grains, many organizations follow the recommendation found in the U.S. federal government's 2000 *Dietary Guidelines for Americans* for 6 to 11 servings of grains per day (depending upon calorie needs), several of which are whole-grain foods (USDA and USDHHS 2000). Healthy People 2010, a national health promotion and disease prevention initiative, builds upon this recommendation by specifying three of the six servings should be whole-grain foods (National Center for Health Statistics 2001).

Consumption influences

Health beliefs

The U.S. Department of Agriculture (USDA) periodically conducts two consumer surveys: the Continuing Survey of Food Intakes by Individuals (CSFII) and the Diet and Health Knowledge Survey (DHKS). The CSFII gathers information about individuals' food and nutrient intakes, food sources and eating habits, while the DHKS, a telephone follow-up survey, records the perceptions of a sampling of the CSFII participants concerning intake, diet and health relationships, dietary guidelines, and food safety (Owen, Splett and Owen 1999). The most current surveys reflect 1994-1996 data.

Several questions from the DHKS are based on recommendations from the Dietary Guidelines for Americans; the data represent consumer beliefs which may influence dietary behavior. Responses to those questions for individuals $\geq$ 20 years (USDA Food Surveys Research Group 1994-96) are listed in Tables 4, 5 and 6. These questions were modified and added to this thesis project's research tool in order to gain similar insight into dietary behavior. Data to those questions will be discussed later in the "Results and Discussion" chapter.

Almost all of the guidelines were important to 80% - 95% of the DHKS respondents, with greater percentages finding them "very important" versus "somewhat important." The exception was the guideline encouraging a diet with plenty of breads, cereals, rice and pasta. While most respondents gave this guideline a high rating (74.4%), its importance was diminished with a higher percentage believe it was "somewhat important" (42.8%) in comparison to "very important" (31.6%).

Respondents were also asked to rate the importance of several factors which influenced their food buying habits. While a high percentage (roughly 95%) found nutrition and taste to be equally important, more people picked taste (83.0%) over nutrition (62.3%) as "very important."

Table 4. Perceived importance of dietary guidelines, for individuals 20 years of age and older, 1994-96 (N=5649) [a]

GUIDELINE	Not at all important	Not too important	Somewhat important	Very important	Don't know
Use salt or sodium only in moderation	5.7%	13.1%	29.1%	51.8%	0.4%
Choose a diet low in fat	2.1%	8.8%	31.0%	57.9%	0.3%
Choose a diet low in saturated fat	2.7%	10.4%	31.0%	53.8%	2.2%
Use sugars only in moderation	2.6%	10.7%	35.2%	51.1%	0.4%
Choose a diet with adequate fiber	2.0%	10.8%	35.0%	50.2%	2.0%
Eat a variety of foods	1.3%	6.9%	29.9%	61.6%	0.2%
Maintain a healthy weight	1.1%	4.0%	21.8%	72.9%	0.2%
Choose a diet low in cholesterol	2.6%	9.6%	30.0%	56.3%	1.4%
Choose a diet with plenty of fruits and vegetables	1.1%	6.5%	24.2%	68.0%	0.2%
Choose a diet with plenty of breads, cereals, rice and pasta	4.5%	20.5%	42.8%	31.6%	0.6%
Importance of these factors when buying food:					
Nutrition	0.9%	4.4%	31.7%	62.3%	0.7%
Taste	0.3%	1.4%	15.0%	83.0%	0.3%

[a] Represents data from 1994-96 Diet and Health Knowledge Survey Question 4, which read, "To you personally, is it very important, somewhat important, not too important or not at all important to (guideline)," and Question 15, which read, "Now think about buying food. When you buy food, how important is (Factor) – very important, somewhat important, not too important, or not at all important?"

The DHKS and CSFII are planned so that information about health beliefs can be linked to information about food choices and nutrient intakes. Table 5 presents the food and nutrient data relevant to the health beliefs discussed above. On one hand, the importance of eating fruits, vegetables and grain products does seem to translate into meeting target intake goals, albeit at the lower end of the recommended intake levels. On the other hand, the two sets of data suggest that consumer beliefs are inconsistent with their dietary actions. Discrepancies between beliefs and actions were found for the following guidelines:

- Three-quarters of adults (72.9%) indicated it was "very important" to maintain a healthy weight. Yet, their mean body mass index (BMI) of 26.0 (calculated on self-reported heights and weights) places them just over the normal weight range (BMI 18.5-24.99) into the overweight category. Mean BMI was progressively larger as importance on maintaining a healthy weight dropped.

- While more than half of adults found it "very important" to limit their intake of salt (51.8%), fat (57.9%) and saturated fat (53.8%), they and the other importance groups exceeded the recommended intake levels.

- More than half of adults found it “very important” to choose a diet with adequate fiber. However, their intake of 16.5 grams fell far short of the recommended 25-30 grams daily. In the other importance groups, dietary fiber intake dropped as the value placed on this recommendation fell.

- Almost two-thirds of adults found it “very important” to eat a variety of foods. Yet the index which accounts for variety and overall diet soundness is only average for this group (64.4) and only slightly better than the other importance groups.

Table 5. Mean intake values and body mass index by perceived importance of various health guidelines, for individuals 20 years of age and older, 1994-96 (N=5649) [a]

GUIDELINE	Target	Very important	Somewhat important	Not too important or not at all important
Use salt or sodium only in moderation [b]	≤2400 mg	3237 mg	3458 mg	3701 mg
Choose a diet low in fat [c]	≤30%	32.4% cal	34.0% cal	35.4% cal
Choose a diet low in saturated fat [c]	<10%	10.5% cal	11.5% cal	12.1% cal
Use sugars only in moderation [c]	Unspecified	13.4% cal	15.2% cal	16.6% cal
Choose a diet with adequate fiber [b]	25-30 g	16.5 g	15.6 g	15.2 g
Eat a variety of foods [d]	80	HEI 64.4	HEI 61.7	HEI 58.7
Maintain a healthy weight [e]	18.5 – 24.99	BMI 26.0	BMI 26.8	BMI 27.3%
Choose a diet low in cholesterol [b]	≤300 mg	254 mg	274 mg	316 mg
Choose a diet with plenty of fruits and vegetables [f]	5-9 servings	5.4 servings	4.7 servings	5.1 servings
Choose a diet with plenty of breads, cereals, rice and pasta [f]	6-11 servings	6.9 servings	6.9 servings	6.2 servings

[a] Represents data from 1994-96 Diet and Health Knowledge Survey Question 4, which read, “To you personally, is it very important, somewhat important, not too important or not at all important to (guideline).”

[b] Mean intake per day (g or mg) is based on a two-day average. Target intakes for sodium, cholesterol and fiber are Daily Values (DV).

[c] Mean percentage of calories per day is based on a two-day average. Target intakes are based on the 2000 *Dietary Guidelines for Americans*.

[d] Mean Healthy Eating Index (HEI) is based on two-day average intake data. ≥80 points is considered a good diet.

[e] Mean body mass index (BMI) is based on self-reported heights and weights. 18.5-24.99 is considered normal; other categories are underweight (<18.5), overweight (25-29.99) and obese (≥30).

[f] Mean number of servings per day is based on a two-day average. Target intakes are Food Guide Pyramid recommended servings.

The Healthy Eating Index (HEI) is the measure of overall diet quality. It represents 10 different aspects of a healthy diet. Each aspect can be measured from 0 (minimum) to 10 (maximum). Five aspects correspond to the degree to which a person’s diet conforms to the USDA Food Guide Pyramid serving recommendations for grains, vegetables, fruits, milk and meat. Individuals who eat no servings of a particular food get 0 points for the appropriate aspect, while individuals who meet or exceed the recommended servings get 10 points. Points are awarded proportionately for servings falling between these two levels. The other five aspects measure total fat and saturated fat as a percentage of total daily calories, total cholesterol and sodium intake, and variety. The maximum total HEI is 100; scores of 80 points and above indicate a “good” diet (US Census Bureau 2002a).

Another question tested participants’ level of agreement with several health beliefs (see Table 6). More people disagreed with “some people are born to be fat and some thin” (64.3% somewhat or strongly disagree) or “starchy foods, like potatoes and rice, make people fat” (62.3% somewhat or strongly disagree). More people agreed that too many health recommendations have led to confusion (80.8%), that food variety provides all needed vitamins and minerals (75.5%) and that diet can make a difference in disease prevention (90.9%).

Table 6. Beliefs with potential to influence dietary behavior, for individuals 20 years of age and older, 1994-96 (N=5649) [a]

STATEMENT	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree	Don’t know
Some people are born to be fat and some thin; there is not much you can do to change this.	26.6%	33.7%	26.6%	13.0%	0.2%
Starchy foods, like potatoes and rice, make people fat.	29.1%	33.2%	25.0%	12.2%	0.5%
There are so many recommendations about healthy ways to eat, it’s hard to know what to believe.	5.9%	13.2%	41.0%	39.8%	0.2%
Eating a variety of foods probably gives you all the vitamins and minerals you need.	5.9%	18.3%	41.9%	33.6%	0.2%
What you eat can make a big difference in your chance of getting a disease, like heart disease or cancer.	2.7%	6.2%	30.3%	60.6%	0.3%

[a] Represents data from 1994-96 Diet and Health Knowledge Survey Question 2, which read, “Now I am going to read some statements about what people eat. Please tell me if you strongly agree, somewhat agree, somewhat disagree, or strongly disagree with the statement.”

Fruit and vegetable intake studies

Gibson, Wardel and Watts (1998) identified at least 10 studies which analyzed whether sociodemographic and psychosocial factors were associated with levels of plant food consumption. Most applied qualitative methods, including focus group reports, or modified sociocognitive models and identified three important influences (beliefs and attitudes about diet-disease relationships, fruit and vegetable availability, and early habitual exposure to fruits and vegetables). Gibson, Wardel and Watts believe that most of the findings from these studies produced more questions than answers about psychosocial influences on healthy food choice.

Some of the studies mentioned by Gibson, Wardel and Watts found that nutritional knowledge predicted dietary quality in varying degrees. This factor was one of several tested in a survey of 3,122 female clients at 16 WIC sites in Maryland (Havas et al. 1998). The variables tested included sociodemographic information; self-efficacy (asking whether the respondent could carry out specific behaviors); perceived barriers (preparation complexity, time, availability, expense, perishability); attitudes; social support; meal responsibility; and nutrition knowledge. Within the sociodemographic category, education, breastfeeding and pregnancy were all positively associated with fruit and vegetable consumption. The association with the last two variables was not unexpected, the researchers noted, since women who are pregnant or breast feeding are generally predisposed to being more attentive to healthful eating. In the other categories, the strongest predictors of high intake were self efficacy, attitudes, and knowledge of the number of recommended daily servings, while the strongest predictor of low intake was perceived barriers. Survey findings indicated that social support and meal responsibility were unexpectedly weak predictors of intake. Havas et al. (1998) found other studies which supported a positive relationship between social support and fruit and vegetable consumption but concluded that many of these studies involved medically required diets which often involve a greater need for social support. Since the study group was homogenous and not randomly selected, Havas et al. (1998) encouraged surveying diverse populations and querying respondents about income, fruit and vegetable consumption habits since childhood, and social support specific to fruit and vegetable consumption. Other studies have implicated these factors as influencing fruit and vegetable intake.

Other studies have assessed the effectiveness of different instruments used to collect information about fruit and vegetable consumption. Field et al. (1998) compared the performance of four self-administered questionnaires with the mean of three 24-hour diet recalls in determining the produce intake of high school students. They reported that while multiple 24-hour recalls collected on nonconsecutive days gave the best measure of dietary intake, single recalls or food frequency questionnaires are usually used to conserve time and money. The researchers concluded that a six-question survey measuring fruit and vegetable intake over the past year was (a) as effective as the average of three 24-hour recalls in determining whether subjects met the five-a-day consumption goal and was (b) more effective than a single four-question 24-hour recall in obtaining the same information. They noted, however, that these brief intake assessments were better at ranking subjects in terms of their fruit and vegetable consumption rather than in estimating the prevalence of such consumption.

Kristal et al. (2001) did a prospective population-based study of demographic and psychosocial predictors for adopting a diet low in fat and high in fruits and vegetables. The research tool was adapted from the Washington State Cancer Risk Behavior Survey, in which Washington adults were interviewed by telephone. The survey was conducted in two phases: baseline, and follow-up cohort. The baseline survey was conducted between October 1995 and May 1996 and involved 1,382 adults. The cohort sample (randomly pulled from the baseline respondents) was conducted between October 1997 and May 1998 and involved 838 adults. Of this cohort sample, nearly 60% were female, 50% were 35-54 years old, and 31% had some college education (Kristal et al. 2001).

The survey examined three factors: demographics; attitudes and behaviors related to cancer risk; and psychosocial factors related to diet. Demographics included age, gender and education. Behaviors included intake of fat, fruit and vegetables over the past three months. The researchers used a modified Fat-Related Diet Habits Questionnaire to measure fat intake and a food frequency questionnaire similar to one used by the national 5-A-Day for Better Health program to measure fruit and vegetable intake. Psychosocial factors included stage of change for adopting a diet low in fat or high in fruit and vegetables; belief in a link between diet and cancer; and perceived barriers to healthful eating (Kristal et al. 2001).

When comparing baseline data to cohort follow-up data, results showed that respondents had significantly dropped fat intake and increased fruit and vegetable consumption.

Fat intake dropped in all demographic segments, but the largest decreases were seen by women, older people, the well educated, later stage of change, and people who read food labels. Kristal et al. (2001) concluded that women are more likely to buy and prepare food and be more motivated to respond to health messages, and that the better educated may find it easier to access and understand complex health information. Baseline respondents identified as being at the maintenance stage of change (low fat or high fruit and vegetable intake for 6 months or more) made the biggest change, supporting other results that show people who already have made one healthy change are likely to make more healthy changes. The food label link confirms earlier studies, which showed that the use of and satisfaction with food labels increased after the new FDA-mandated labels appeared in 1994. When controlled for other psychosocial factors, belief in a diet-cancer link and barriers to healthful eating were not significantly associated with lower fat intake (Kristal et al. 2001).

While fruit and vegetable intake increased significantly, this change was restricted to a smaller group: women, and respondents with 16 or more years of schooling. Trends for higher intakes in two other groups (respondents in later stages of change, and those with stronger beliefs in the diet-cancer link) looked promising, but the intake changes were small, and the trends were not statistically significant (Kristal et al. 2001).

Kristal et al. (2001) believes his study shows two things: that we need to better understand how to reach other groups (men, the less educated) with nutrition interventions, and that public health could be improved by targeting people in the action and maintenance stages of change. Study limitations included self-reported assessments of diet and psychosocial factors and nonresponse bias (participation may related to adoption of healthy habits).

Another study which examined fruit and vegetable intake in relation to a social-psychological variable was conducted as part of a larger research project, the Family Relationships and Nutrition Study (Schafer et al. 1999). Self-esteem was the tested variable, and the subject group was formed by 155 Caucasian married couples living in Iowa, randomly selected from a stratified random sample. Women had a mean age of 47.3 ± 14.1 years and mean education level of 13.3 ± 2.1 years, while men had a mean age of 49.7 ± 14.1 years and mean education level of 13.6 ± 2.9 years. Data was collected during one visit to the subjects' homes. During the visit, men and women were interviewed separately about dietary intake, height and weight (self-reported), and self-esteem (Rosenberg scale).

Women consumed significantly more servings of the following foods per week than men:

- Number of fruit servings per week (women, 14.3 ± 10.3; men 11.4 ± 8.4)
- Number of fruit choices per week, indicating greater variety (women 3.9 ± 1.9; men 3.4 ± 2.2)
- Number of vegetable choices per week (women, 7.3 ± 5.1, men 6.3 ± 2.9)
- Energy-adjusted daily intakes of dietary fiber (women 7.4g ± 2.9g, men 6.5g ± 2.5g)

Women also ate more servings of vegetables per week (20.4 ± 9.7) than men (18.8 ± 9.3), but this finding was not statistically significant. Greater percentages of women than men also met the various dietary standards of ≥2 daily fruit servings (women 41.5%, men 35.9%) and ≥3 daily vegetable servings (women 46.4%, men 31.9%). Combining and averaging the fruit-and-vegetable intake amounts indicates that women ate 4.96 servings of fruits and vegetables each day, while men ate 4.31 servings each day, both somewhat under the USDA-recommended 5 servings per day.

Self-esteem seemed to exert only a minor influence on intake (significant relationships were found with vitamin C for women and with folate for men and women). Age and education instead were most often positively correlated with quantity and variety of vegetable and fruit intake. The researchers reached three conclusions concerning these social-psychological variables: that self-esteem might be more important for avoiding negative behaviors than for choosing positive behaviors, that a sense of vulnerability may increase with age and trigger health-enhancing dietary changes, and that education may give people more tools for seeking out and adopting healthful behaviors. The researchers encouraged caution in interpreting the role of self-esteem in food behaviors and noted the narrow sample population as a major limiting factor.

Whole grain intake studies

Whole grains, as classified in the USDA's Pyramid Servings Database, include amaranth; pearled barley; barley flour; buckwheat; buckwheat groats; whole-groat buckwheat flour; bulgur; crude corn bran; whole-grain corn flour (white or yellow); whole-grain cornmeal (white or yellow); popcorn; nondigestible carbohydrate with dietary fiber; oats; oat cereals (regular, quick, instant); oat flour; raw oat bran; whole-wheat macaroni; psyllium seed husks; brown rice (medium or long grain); brown rice flour; wild rice; rye; rye flour (dark, medium and light); whole-wheat spaghetti; whole-grain triticale flour; wheat (hard red spring, hard red winter, soft red winter, soft white); crude wheat bran; whole-wheat cereals; and whole-wheat flour (Cleveland et al. 2000).

Research which differentiates whole grain from total grain intake and accurately quantifies whole grain intake began in the 1990s. Albertson and Tobelmann (1995) conducted one of the first studies, prompted by research which indicated Americans were eating less than half of the recommended 20-35 grams of dietary fiber per day. Their study collected data from homemakers in 4,000 households between July 1990 and June 1992. The data included all food and beverages eaten by each household member for 14 consecutive days. Intake quantities were not reported, so an “eating occasion” was not necessarily synonymous with a Food Guide Pyramid serving. Data was examined for all ages (2 years and up) plus the subgroups of 2-18 years and 19+ years.

Results indicated that most people (all ages 84.3%, 19+ years 82.7%) had less than one daily eating occasion of whole grains; the average number of eating occasions of whole-grain products by adults was 0.5 per day. Almost one quarter of adults (22.6%) ate no whole grains, and only 0.1% of adults had three or more eating occasions of whole grains daily.

Years later, Albertson teamed with other researchers (Cleveland et al. 2000) to quantify whole grain intake with more precision. These researchers examined the 1994-96 CSFII data and converted grain intake into Pyramid servings using a USDA-developed database. Their goals were to present national estimates of whole-grain intake, identify major dietary sources of whole grains, and compare food and nutrient intakes of whole-grain consumers to nonconsumers. Subjects included 9,323 individuals aged 20 years and older, and the overall response rate was 76%.

Results of this second study indicated that American adults ate an average of 6.7 grain servings per day; 1.0 serving (or 15%) was whole grain. Only 8% of adults met the recommendation of ≥ three servings per day.

Cleveland et al. (2000) reported that individuals who consumed some whole grain were more likely to be male, older, white, in a higher income category, more educated, non-smokers, exercisers, vitamin and/or mineral supplement users and not overweight. The authors attributed some of the gender difference to the fact that males eat more food than females. Regionally, those who didn’t eat any whole grains ranged from a low of 23% in the Midwest to a high of 34% in the South. Those who ate three or more servings a day ranged from a low of 6% in the Northeast to a high of 11% in the West.

The products which accounted for almost a third of the whole-grain servings were yeast breads and breakfast cereals. The authors noted, however, that most yeast breads were composed mostly of nonwhole grains, in contrast to the breakfast cereals, many of which are more than half whole grains.

Those adults who consumed some whole grains were significantly ($p \leq .01$) more likely (% about three-fold higher) to meet Pyramid recommendations for the grain, fruit and dairy groups. Whole-grain consumers had significantly better nutrient intakes (% of total energy, except as noted) than nonconsumers in these areas:

- Carbohydrates (nonconsumers 48%, >0 servings 51%, ≥3 servings 54%);
- Total fat (nonconsumers 34%, >0 servings 33%, ≥3 servings 31%);
- Saturated fat (nonconsumers 11%, >0 servings 11%, ≥3 servings 10%);
- Added sugars (nonconsumers 15%, >0 servings 14%, ≥3 servings 12%); and
- All nutrients studied (% of 1989 RDA higher for >0 and ≥3 servings than for nonconsumers).

Cleveland et al. (2000) stated several hurdles to increasing whole grain consumption. Topping the list, which included availability, variety, price and preparation, was consumer perception of whole-grain foods as being inferior in taste and texture. The authors saw these hurdles as challenges to the food industry to continue to explore new ways of making whole grain more acceptable to consumers.

Research on the link between dietary whole grains and disease prevention led the U.S. Food and Drug Administration (FDA) to approve a health claim in July 1999 concerning whole-grain products. The claim, which reads, “Diets rich in whole-grain foods and other plant foods and low in total fat, saturated fat, and cholesterol may reduce the risk of heart disease and some cancers,” can appear on the food labels of products that are ≥ 51% whole grain by weight, contain a specific minimal percentage of fiber (4.9% - 5.6%, depending on weight), and are low in fat (USFDA 2002a). The FDA approved this claim so that consumers can better identify whole-grain foods and become aware of the relationship between whole grain consumption and disease prevention.

Dietary intake patterns

One study (Tseng and DeVellis 2001) confirmed the presence of two fundamental dietary patterns (red meat-starch and vegetable-fruit) in the US, which cuts across sex and geographic location. The subjects were 5,788 white US-born subjects, aged 20-74 years, who had completed the third National Health and Nutrition Examination Survey of 1988-1994. The subject pool was formed through a four-stage probability sampling. Each subject/household received a 62-item food frequency questionnaire concerning the previous month’s intake and answered various demographic (age, education, family income, occupation) and lifestyle (smoking, alcohol consumption, dietary supplement use, breakfast frequency) questions.

The red meat-starch pattern involves consumption of red meats, potatoes, white bread, eggs and cheese. Study subjects following this pattern were generally male, poor (at or below the poverty level), working class, smokers, used salt at the table, and could be classified as heavy alcohol drinkers. This pattern is influenced by British culinary heritage.

The vegetable-fruit pattern involves high consumption of vegetables, fruit, dark bread, poultry and fish. Study subjects following this pattern were generally female, older, more educated, urban, had attempted weight loss in the past year, were more physically active, used dietary supplements, ate breakfast daily, and drank wine. This pattern is influenced by nutritional science, the food and advertising industries, and food conservation programs (Tseng and DeVillis 2001).

For example, in the beginning of the twentieth century nutritionists began to recommend simpler, lighter meals. The nutritionists were home economists, “a growing group of professional women,” who “exposed school-age girls to the new science of nutrition, to new ideas about the efficient organization of housework, and to new appliances.” Many of the home economists were employed by the U.S. Department of Agriculture’s national extension service, a program that continues today (Bowers 2000).

Tseng and DeVellis (2001) wrote that his results resembled patterns from similar studies in the US, Canada and Great Britain and reflect 20th-century use of messages targeted at middle-class women concerning diet and health. The messages were not as effective in influencing the habits of populations with a less secure food supply, such as the poor, thereby explaining the retention of the more traditional red meat-starch diet.

Tseng and DeVillis (2001) noted that most other studies have identified more than two patterns. These studies differed because they reflected some cultural differences and interpreted a set of different criteria. Tseng and DeVillis (2001) also wrote that more study was needed to determine whether measurement of food patterns is a good way to characterize intake when looking for a link between diet and disease.

Population shifts

America's eating patterns have been influenced by regional shifts in population. Within any geographic region, people make "distinctive food choices and cuisines, based on demographic composition, income levels, or the ethnic heritage of both older natives or more recent immigrants."

Regions

In the twentieth century, the greatest population gains occurred in the West and the South. In 1900, 4.3 million people lived in the West (all states containing or west of the Rocky Mountains, including Alaska and Hawaii). By 1998, that population had grown to 60 million, a fourteenfold increase. In 1950, one-third of the non-Western population lived in the South. In 1998, that population had grown to 45 percent, making it "far more populous than either the Northeast or the Midwest, which used to be its equals." Yet, the median center of the U.S. population remains at a point in southwestern Indiana, meaning that "half of the population still lives north of or east of this location," reflecting the earlier heavy concentration of people in the Northeast and Midwest (Beale 2000).

Ethnic heritage

At the beginning of the twentieth century, America was predominantly white. Much of this population had a background rooted in northern or western Europe, but the largest wave of new immigrants were coming from southern and eastern Europe. Laws were enacted twice to control the immigration flow and deal with illegal entry into the country. After the Immigration Reform Act of 1965, Latin America, China, the Philippines and India supplied the largest number of new immigrants. The result is a more diverse ethnic mix and larger proportion of foreign-born people (since 1990, 32% of our population growth has come from immigration). Each wave of immigration has stamped its imprint on food consumption by changes in farming, supermarket selections, and restaurants (Beale 2000).

Household size

The proportion of elderly people in the U.S. population continues to rise, due to a longer life expectancy and lower birth rates. Many elderly people live alone, so single-resident households are also on the rise. By 1998, 26.3 million people were living alone, and they represent one-fourth of all housing units. Two-fifths of the people living alone were 65 years or older. More small households affect both food preferences and purchasing habits. People who live alone have little incentive to spend time in the kitchen (Bowers 2000), and so spend a higher proportion of their food money on eating out (Beale 2000).

Age

Gerrior (1999) re-examined data from the U.S.Department of Agriculture's 1977-78 Nationwide Food Consumption Survey (NFCS) and 1994-96 Continuing Survey of Food Intake by Individuals (CSFII), with the purpose of assessing the dietary quality of Americans over age 65. Nutrient intakes were evaluated as percentages of the 1989 Recommended Energy Allowance (REA) or Recommended Dietary Allowance (RDA).

Results were mixed for changes in plant food consumption by older adults:

- *Fiber.* The subjects failed to meet the 25 grams per day recommendation. Intakes ranged from 54% to 74% of the recommendation.

- *Legumes, nuts and seeds.* Consumption (as measured by grams per day) increased: 50% for men, 63% for women.

- *Total grains.* Older adults ate more grain products, especially grain mixtures and snacks (pizzas and pretzels) in 1994-96 compared to 1977-78. They also ate more cereals and pastas, with about double the number of men (52%) eating more than women (29%). However, this study did not differentiate whole grain from total grain consumption, so whole grain intake was not known.

- *Total vegetables and total fruit.* Vegetable intake remained relatively constant: subjects ate fewer white potatoes (-8% men, -18% women) but more tomatoes (21% men, 3% women) and deep-green vegetables (45% men, 50% women). They ate more total fruit, too (27% men, 10% women).

Table 7. Intake levels summarized in this paper

SOURCE	SAMPLE POPULATION	FRUIT AND/OR VEGETABLE INTAKE	GRAIN AND/OR WHOLE GRAIN INTAKE
Healthy People 2000; CSFII 1994-96	Individuals ≥2 years excluding pregnant or lactating women	*Average daily intake, fruit & veg (1996):* 4.7 servings 35% met 5 srving/day goal	*Average daily intake, grain prods (1996):* 6.7 servings 52% met 6 srving/day goal
US Census Bureau, Statistical Abstract of the United States: 2001, Healthy Eating Index; CSFII 1994-96	Individuals ≥2 years excluding pregnant or lactating women	*Average daily score (10 pt. maximum):* • Fruits (3.8 pts) 17.1% pop had 2-4 srving/day • Veg (6.3 pts) 31.8% pop had 3-5 srving/day	*Average daily score (10 pt. maximum):* Grains (6.7 pts) 22.2% pop had 6-11 srving/day
Schafer et al. (1999); Family Relationships and Nutrition Study	155 married couples; Caucasian Women: 47.3 ± 14.1 years age 13.3 ± 2.1 years educ. Men: 49.7 ± 14.1 years age 13.6 ± 2.9 years educ.	*Mean daily servings fruit & veg:* Men 4.31 (1.62 fruit, 2.69 veg) Women 4.96 (2.04 fruit, 2.91 veg) *≥2 servings/day fruit:* 31.9% men 46.4% women *≥3 servings/day veg:* 35.9% men 41.5% women	
Cleveland et al. (2000); CSFII 1994-96	Individuals ≥20 years excluding pregnant or lactating women		*Average daily intake, whole grains:* 1.0 servings 8% adults had ≥3 srving/day
Albertson & Tobelmann (1994); Market Research Corp. of America 17th and 18th Menu Census Panel Surveys	Individuals ≥2 years		*Average daily intake:* 0.5 average eating occasions/day *<1.0 eating occasions:* All ages 84.3% 19+ years 82.7%

Nutrition campaigns

Despite the proven health benefits, consumption of fruit, vegetables and whole grains in the United States is lower than levels recommended by national health organizations (Byers et al. 2001, Cleveland et al. 2001, National Center for Health Statistics 2001). Nutrition campaigns have applied many marketing and motivational tools in trying to reverse this trend. The following text describes five campaigns which have been promoted nationally or regionally in the United States and have some chance of being recognized by consumers.

Five nutrition campaigns

Basic Four Food Groups

The U.S. Department of Agriculture (USDA) has issued food guides since 1916 to help consumers translate nutritional science into a healthful diet (Welsh 1994, Davis, Britten, and Myers 2001). One of the best known food guides, called the Basic Four Food Groups, served as the federal government's officially recognized food plan from 1956-1991. The four groups included (1) meat and meat alternatives (two servings); (2) milk and milk products (two servings); (3) breads and cereals (four servings); and (4) fruits and vegetables (four servings). The Basic Four specified a foundation diet of core foods that would provide most, but not all, of the needed calories and nutrients. While this food plan fulfilled its goal of teaching children about nutrition and adults about meal planning, it suffered several shortcomings (Whitney and Rolfes 1993). Chief among its disadvantages were the failure to define serving sizes, identification of only a minimum number of servings, overemphasis of foods containing animal fat, and underemphasis of the importance of dietary fiber (Ronzio 1997). This combination of shortcomings could have led consumers to either exceed adequate fat and energy levels or to fall below levels recommended for good health (Whitney and Rolfes 1993). In addition, diets based on the Basic Four Food Groups were shown to be low in many key trace nutrients (Ronzio 1997).

Food Guide Pyramid

This educational tool replaced the Basic Four Food Groups in 1992 as the U.S. government's official food guide and continues in that role today. It translates two federal nutritional recommendations – the recommended dietary allowances (nutrient-based) and *Dietary Guidelines for Americans* (food-based) – into food groups and serving sizes. Its three key messages are variety, moderation and proportionality. The Food Guide Pyramid differs from the Basic Four Food Groups in the following areas:

- Increased number of food groups (five instead of four);
- Amplification of some food group names ("meat and meat products" in the Basic Four, "meat, poultry, fish, dry beans, eggs and nuts" in the Pyramid);
- Separation of fruits from vegetables,
- Placement into its own food group of nutrient-spare foods high in fats or added sugars;
- Addition of food subgroups (such as whole-grain products and dark green or deep yellow vegetables) to emphasize certain nutrients;
- Definitions of serving sizes,
- Definitions of protein equivalents,
- Shift from a foundation diet to a total diet, and
- Replacement of the foundation food group (meat in the Basic Four, produce and grains in the Pyramid) (Achterberg, McDonnell, and Bagby 1994, Welsh 1994, Owen, Splett and Owen 1999).

While the information found in the Food Guide Pyramid was first published in 1984 (as part of a Red Cross-USDA food wheel), the now familiar pyramid graphic wasn't introduced until 1992 (Welsh 1994, Davis, Britten and Myers 2001). Extensive consumer research identified the pyramid shape as being both memorable and easy to understand (Achterberg, McDonnell, and Bagby 1994, Welsh 1994). The largest areas lie at the base of the pyramid and represent foods with the greatest number of recommended servings: grains (6-11 servings), fruits (2-4 servings) and vegetables (3-5 servings). The smallest area forms the peak of the Pyramid and represents foods recommended for occasional consumption: fat, oils, sweets, sugars, soft drinks and alcohol (Ronzio 1997).

The Food Guide Pyramid is heavily and widely promoted to consumers throughout the country and appears in many publications sponsored by the USDA, health agencies and organizations, and the food industry. By 1995, it had become highly recognized by consumers, as indicated by participants in the 1994 and 1995 USDA Diet and Health Knowledge Surveys (43% awareness) and the American Dietetic Association's (ADA) 1995 Nutrition Trends Survey (58% awareness) (Guthrie and Derby

1998). By 1997, that awareness had grown to 67% of all Americans, as shown in another ADA survey. By 2000, 75% of primary grocery shoppers responding to a Gallup survey said they were somewhat or very familiar with the Food Guide Pyramid (Davis, Britten, and Myers 2001).

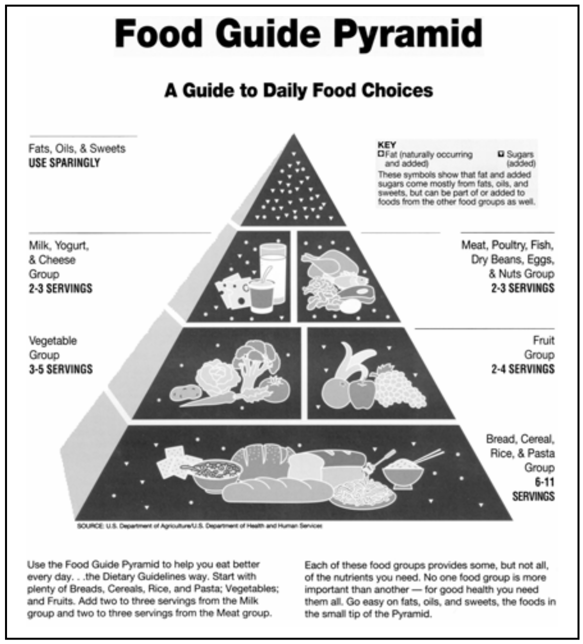

Figure 1. The USDA Food Guide Pyramid (USDA, NAL 2002)

Many variations have appeared to serve specific audiences—such as young children or different ethnic or cultural groups (Arabic, Chinese, Cuban, Indian, Italian, Japanese, Mediterranean, Mexican, Native American, Portuguese, Russian and Thai)—and specific diets (vegetarian, low glycemic, or weight loss) (Aronne, Edman and Willett 2001, USDA, NAL 2002).

Concerns leveled at diets based on the Food Guide Pyramid include inadequate iron intake for special populations with high needs (menstruating, pregnant or lactating women or those following low-calorie diets); serving sizes that don’t correspond to food label information or typical amounts consumed by most Americans (one-half of a bagel equals a serving size in the Pyramid, while a whole bagel is a typical serving); and imprecise language concerning serving sizes of fats and sweets ("use sparingly" is open to various interpretations) (Achterberg, McDonnell and Bagby 1994, Welsh 1994).

The USDA is currently reassessing the Food Guide Pyramid for its effectiveness in meeting nutritional goals and providing advice to consumers in the 21^{st} century. The assessment process will incorporate technical research, stakeholder input and consumer research (Davis, Britten, and Myers 2001).

Healthy People 2000/2010

The goals of this national health promotion and disease prevention initiative are to improve the health of all Americans, eliminate health disparities and improve the length and quality of life (USDHHS 2001). In its first release*, Healthy People 2000* expanded the national health objectives set in earlier documents by major U.S. health organizations and the Surgeon General (Owen, Splett and Owen 1999). The current version, *Healthy People 2010*, was announced by its coordinating agency (the U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion) on January 25, 2000, and outlines the national health agenda for this decade (USDHHS 2001).

The Healthy People initiatives set hundreds of objectives (319 unduplicated objectives for 2000, and 467 objectives for 2010), only some of which are related to nutrition (27 objectives in 2000, and 25 objectives in 2010). In either edition, increased fruit, vegetable and grain product intake were the focus of two or three objectives. Progress on meeting the objectives is tracked with 190 government-sponsored data sources, such as the National Health and Nutrition Examination Survey (NHANES) and National Health Interview Survey (NHIS). The main data source for tracking nutrition-related objectives is the Continuing Survey of Food Intake by Individuals (CSFII) (USDHHS 2002).

While the plans themselves are not marketed directly to the public, the plan's objectives (such as increasing the proportion of people who eat at least two daily fruit servings) make their way into many health promotions, strategic plans, publications and tools (such as the Food Guide Pyramid).

5 A Day for Better Health Campaign

A national survey sponsored by the National Cancer Institute (NCI) in Rockville, Maryland, showed that only 23% of the population consumed five or more fruits and/or vegetables daily (Havas et al. 1998, Gibson, Wardel, and Watts 1998). In response, the NCI, in cooperation with the Produce for Better Health Foundation, launched the “5 A Day for Better Health” campaign in 1991 to increase American consumption to the recommended level and to promote knowledge of health benefits provided by fruit and vegetables. The campaign now includes all 50 state health agencies, many national professional health or governmental agencies, and 700 industry partners (which represent more than 30,000 supermarkets nationwide) (Stables et al. 2002).

1% or Less

This health education intervention was developed by the Center for Science in the Public Interest (CSPI) in 1994 (Reger et al. 1998). Its aim is to help consumers meet two recommendations from the *Dietary Guidelines for Americans* (increased calcium intake and decreased saturated fat intake) by replacing high-fat milk (2% or whole) with low-fat milk (1% or skim). CSPI conducted the first campaign in 1995 in two West Virginia cities. Results included a 16% jump in overall milk sales (which remained high into the follow-up period) and replacement of low-fat milk for high-fat milk as reported by 38.2% of follow-up survey respondents. CSPI has developed an implementation guide to help communities and health professional replicate the campaign.

Effectiveness of nutrition campaigns

Research indicates that public health campaigns and other nutrition intervention programs have had modest positive effects on healthy eating for U.S. adults. At best, these programs have resulted in not more than a 1% decrease in fat energy and an additional ½ serving per day of fruit and vegetables (Kristal et al. 2001, Greene and Rossi 1998).

In order to evaluate the effectiveness of the “5-A-Day” program, the NCI has funded nine randomized community intervention research trials and cross-sectional baseline and follow-up surveys. The baseline survey (N=2,837) was conducted in 1991 before the program began, and the follow-up survey (N=2,602) was conducted in 1997. Results, summarized by Stables et al. (2002), show that a significantly greater percentage of people were aware of the campaign in 1997 (19.2%) than they were in 1991 (7.2%). Women were more aware of the campaign than men, and Caucasians were more aware than either African-Americans or Hispanics. Message awareness was associated significantly with a higher total daily intake of vegetables and fruit: mean intake for those aware of the campaign was 5.8 daily servings in 1991 and 5.2 daily servings in 1997, while mean intake for those unaware of the campaign either year was 3.6 daily servings. Over the six campaign years, two daily intake measures significantly rose: the weighted mean daily intake of fruits and vegetables for the whole population (3.75 servings in 1991, 3.98 servings in 1997) and the weighted percentage of respondents eating five or more servings (23.1% in 1991, 26.8% in 1997). The demographic profile of the 1997 follow-up survey population showed a group almost evenly split between genders (male 48%, female 52%), predominantly Caucasian (76%), fairly young (65% between ages 18-49 years) and educated (57% more than high school). While the campaign has helped the public become more aware of the link between diet and disease, actual consumption of fruit and vegetables does not appear to have increased significantly (Gibson, Wardel, and Watts 1998); most of the modest 0.23-daily-serving-increase revealed in the follow-up survey can be attributed to demographic changes in the U.S. (Stables et al. 2002).

Healthy People 2000 released its final report in 2001 and noted modest gains in fruit and vegetable consumption which fell short of target goals. (Average number of daily servings was 4.1 in 1991 and 4.7 in 1996 with a target of 5 servings; proportion of the population eating five servings a day was 29% in 1991 and 35% in 1996, with a target of 50%) (National Center for Health Statistics 2001).

The final report also noted that while it appears people heard the word about increasing grain products (6.7 servings in 1996, exceeding the target goal of 6 servings, and 52% of the population eating at least 6 servings, exceeding the 50% target goal), they didn’t make the distinction between whole-grain products and refined-grain products. According to the 1994-96 CSFII, only 1.0 of those 6.7 servings came from whole grains, 36% of the respondents ate less than one whole-grain serving per day (on average), and only 8% ate at least three servings per day (Cleveland et al. 2000). To place better emphasis on nutrient-dense grain products, Healthy People 2010 specifies that at least three of the six recommended daily servings of grain products should come from whole grains (National Center for Health Statistics 2001).

Kristal et al. (2001) wrote that research data consistently shows self-initiated dietary change to be as effective as intervention. Little is known about what motivates this self-initiated change, and most studies show relationships between demographic and psychosocial factors and diet.

Greene and Rossi (1998) backed up Kristal's assertion about failed interventions, particularly the large, intensive worksite programs that lead to relatively small decreases in fat intake. Effective programs, such as the Women's Health Trial, provide individual feedback and counseling. Brug et al. (1998) demonstrated the positive effect of computer-tailored feedback and iterative feedback on fat reduction and fruit and vegetable intake. But individualization is expensive and, therefore, inappropriate for reaching broad audiences.

Cleveland et al. (2000) believed that new health messages about whole grains which go beyond fiber content, such as the 1999 FDA health claim, could heighten interest in eating more whole grains. Contrary to other researchers, they believed consumers are responsive to positive diet and health messages that are clear, actionable and sustained. The campaigns they cited as examples focused on fruit and vegetable intake and cancer (as reported in *Health Education Behavior* in 2000 about the 5-A-Day projects), fiber intake and cancer (as reported by Ippolito and Mathios in 1990), and fat reduction and blood cholesterol (as reported by the U.S. Department of Health and Human Service in its "National Cholesterol Education Program Report" in 1990).

Gerrior (1999) concluded that older Americans (> 65 years) appear to be incorporating nutrition education messages into healthful eating behaviors. However, this population's average intake of food energy, dietary fiber, vitamins B6 and 3, calcium, magnesium and zinc was lower than recommendations. While intake of dietary fiber may be due to the low food energy intakes characteristic of older Americans, these intakes are considerably below intakes expected of people consuming the recommended servings of fruits, vegetables and whole-grain foods, based on the Food Guide Pyramid.

In the end, the benefit of public nutrition campaigns may be subtle and hard to directly measure. As one consumer noted, while participating in a USDA-sponsored focus group on the *Dietary Guidelines for Americans,* "The food pyramid is part of the way I was trained growing up. It's in the back of my head when I make choices." (Davis, Britten, and Myers 2001).

Chapter 3.
Methodology

The data collection tool was an 18-question question survey (Appendix 4) mailed to adults nationwide who subscribe to and buy books from Rodale Inc*.,* publishers of mass-market consumer health magazines and books. This list was selected as being most likely to include people who have increased their fruit, vegetable and whole grain consumption and who are aware of phytochemicals.

Subjects

The researcher needed to find a sizeable group of people who knew about phytochemicals or had an above-average interest and knowledge in personal health care and nutrition. The best audience included adults who actively sought health care and nutritional information, such as subscribers to a health care magazine.

A well known and heavily circulated health care magazine is *Prevention*, published by Rodale Inc., headquartered in Emmaus, Pennsylvania. Rodale bills *Prevention* as “America's Leading Health Magazine” (Rodale 2001b). Started in 1950, *Prevention* “… informs nearly 12 million readers each month on new developments in nutrition, fitness, weight control, food preparation and body care; and it motivates them to take charge of their health” (Rodale 2001b). This mission of awareness, motivation and activity fit the characteristics of the audience the researcher was seeking.

Rodale agreed to share the mailing list, free of charge, in the interests of academic research. Between January and March 2001, a consumer marketing representative helped the researcher to understand the composition of the full Rodale database and to select a sample that would fit the purpose of this thesis project. Active subscribers to *Prevention* magazine total 3.3 million. Some of these people also subscribe to other Rodale publications or buy Rodale books (Appendix 7). Sampling a database of this size was beyond the scope of this thesis project, so the researcher narrowed the selection by stratifying subscribers based on two variables:

- Recent subscribing and buying activity,
- Sales source.

Regarding activity, two subsets exist within Rodale's active subscriber database: people who have subscribed to or bought a publication in the past 13 months, and those who have not. Regarding sales source, subscriptions come through direct mail solicitations, blow-out cards, subscription agencies, and gift certificates. The subscribers most likely to renew are those who originally subscribed through a direct mail solicitation or blow-out card.

The sample was drawn from the part of the database that included people who subscribed through direct mail pieces or blow-out cards, renewed their subscriptions, and bought books, because these subscribers actively sought out health care and nutrition information. Therefore, they were most likely to have heard or read about phytochemicals. The subgroup was now small enough (estimated 400,000-450,000 names) (DeLash 2001a, DeLash 2001b) to yield a sample within the financial reach of the researcher, a factor important enough to override the subgroup's chief limitation: that analysis of data could not be projected onto the general U.S. adult population.

Using a sampling table based on information from Krejcie and Morgan (1970), it was determined that 385 respondents were needed to yield a 5% margin of error for an "N" of 400,000. Drawing on previous personal experience with mail surveys, the researcher determined the number mailed by quadrupling the sample size. Therefore, to obtain 385 completed surveys, surveys were mailed to 1,600 people randomly selected from the subgroup. The random sample included individuals aged 35-64 years or of "unidentified" age; male or female; and from all zip codes in the 50 U.S. states.

Research Tool

Survey Questions

The survey questions were based on the research objectives (as described in the Introduction), research hypotheses (Appendix 1), focus-of-inquiry questions (Appendix 2) and a review of literature. The questions were then refined through committee discussion and pretesting. The survey as it appeared to subjects is in Appendix 4.

The research objectives were specifically met with these survey questions:

Objective 1: Draw a demographic profile of this population.

The final five questions were directed at all subjects and asked them to identify their gender (Question 13), birth year (Question 14), household size (Question 15), schooling (Question 16) and ethnicity (Question 17).

Objective 2: Estimate from the subset the number of adults who have increased their consumption of fruits, vegetables and whole grains.

Question 6 asked all subjects to indicate whether their consumption of fruits; vegetables; breads, cereal, rice and pasta; lentils and dry beans; or nuts and seeds had changed in the last 12 months.

Objective 3: Determine whether the major change effecter was an awareness of phytochemicals.

Questions 7 and 8 were directed to subjects who self-reported eating more of the foods named in Question 6. The subjects were offered a list of 13 reasons (including "other") for increasing consumption and directed to (a) select all the reasons that applied to their decision and (b) single out the most important reason.

Objective 4: Define this population's understanding and expectations of phytochemicals.

Questions 9 and 10 were directed at all subjects. Question 9 gave a list of ten nutrition-related words and asked subjects to select any they had heard of or read about. These ten words had appeared in *Prevention* articles or advertisements during the past 12 months. In Question 10, the subjects were told that these words were related to phytochemicals and were asked to pick one of six statements that tested their understanding of phytochemicals. The statements were worded to indicate whether the subjects had no, some or much knowledge of phytochemicals.

Questions 11 and 12 were directed only at the subjects who self-reported some or much knowledge of phytochemicals from Question 10 and were included to more sharply delineate the subjects' knowledge. Question 11 named three broad food categories (meat, dairy, plants) and asked subjects to pick which food category they believed contained phytochemicals ("all" and "don't know" were also included as choices). Question 12 asked subjects to identify the source of phytochemicals (endogenous or exogenous) in food ("don't know" was also included as a choice).

Objective 5: Summarize this population's general health beliefs.

Questions 1 and 5 listed a series of statements regarding food guidelines/practices and dietary beliefs, adapted from the USDA Diet and Health Knowledge Survey (DHKS) and refined during this project's pretesting phase. Subjects were directed to indicate the importance of 15 food guidelines to their personal diets (Question 1) and their degree of agreement with eight health statements (Question 5). Each question was set up using a five-point Lichert scale which included "don't know" as a choice.

Hypothesis: There is a positive correlation between the seeking of nutrition information, food and health beliefs, and a deliberate inclusion of additional plant-based foods into the daily diet.

Three questions were included to test the hypothesis. These questions focused on the subjects' sources of information about nutrition (Questions 2 and 3) and awareness of public health messages (Question 4). In addition, data from Question 1 (food guidelines) and Question 5 (health statements) were re-examined by isolating responses from subjects who have increased their intake of plant foods.

Procedures

The project involved three mailings:

- *Survey pretest.* An 18-question survey, cover letter and postage-paid return envelope were mailed to 31 adults. The recipients were acquaintances of the researcher, all older than 30 years, most living in Wisconsin, and all interested either in nutrition or surveys/research. A brief note, explaining the project and asking for feedback, was included in the survey package. The survey package was mailed first-class on April 12, 2001; deadline for returning the surveys was April 24. Twenty four surveys were returned.

- *Final survey.* A revised 18-question survey (Appendix 3), cover letter (Appendix 4) and postage-paid return envelope were mailed to 1,600 adults who subscribed to and had purchased books from Rodale. The survey package was mailed at the standard mail/nonprofit basic rate on May 14, 2001; deadline for returning the surveys was June 8. Three-hundred-eighty-one surveys were returned, with one survey discarded for being incomplete. The overall survey return rate was 23.7%.

- *Postcard reminder.* A postcard (Appendix 5) reminding people to return the survey was mailed to 1,200 subjects first-class on June 1, 2001. The mailing labels had not been coded and the mailings were not tracked, so some subjects who had already returned their surveys received the postcard.

Statistical Analysis

The survey data were entered into the software program SPSS Version 10.0. Analysis included appropriate descriptive statistics and tests of association based on the level of measurement of the variables. Descriptive statistics included frequencies, percentages, means, medians, standard deviations and ranges. Tests of association were conducted using chi square and Spearman's rho correlation coefficiency tests.

Chapter 4.
Results and Discussion

Limitations of the Study

The researcher acknowledges that the population tested is a segment of the general U.S. adult population. Therefore, conclusions made from analysis of data taken from this group cannot be projected onto the general U.S. adult population.

Data is colored in two aspects because of the nature of a mailed survey instrument: demographic information was self-reported, and subjects were asked to recall and compare behavior spanning 12 months. Their responses may differ from actual information and, therefore, limit interpretation.

Objective 1:
Draw a demographic profile of this population.

Data from five questions was used to draw a demographic profile of the respondents (see Table 8). Question 13 asked, “Please tell me whether you are male or female”; Question 14 asked, “What year were you born?”; Question 15 asked, “How many people live in your household (include yourself as 1)?”; Question 16 asked, “Which one statement (from a list of six choices) best describes your formal schooling?”; and Question 17 asked, “Please tell me your ethnic background.”

Most respondents were female (82.6%), between 45-64 years of age (77.0%) and Caucasian (88.0%); had at least some post-secondary education (81.5%), and lived in households of four people or less (93.6%). Slightly less than half (48.6%) were born during the Baby Boom years of 1946-1964 (making these subjects 37-55 years of age at the time of the survey) (Mitchell 1998). Nearly half (47.8%) had earned at least one degree from a university or technical college. Other ethnic groups with which respondents identified themselves were black (5.7%), Asian (1.7%), Hispanic (1.4%), multi-racial (2.3%) and “other” (0.6%).

Table 8. Demographic characteristics of the respondents

CHARACTERISTIC	N	Frequency	% of N
Gender	380		
Male		66	17.4%
Female		314	82.6%
Age	370		
< 25		0	0.0%
25-34		6	1.6%
35-44		37	10.0%
45-54		128	34.6%
55-64		157	42.4%
65-74		26	7.0%
≥ 75		16	4.3%
Median age = 55			
Range = 27 to 88			
Household size	376		
1 person		48	12.8%
2		193	51.3%
3		73	19.4%
4		38	10.1%
5 or more		24	6.4%
Median size = 2			
Range = 1 to 11			
Education	377		
Elementary school		1	0.3%
Some high school		7	1.9%
High school diploma		62	16.4%
Some post-secondary		127	33.7%
Tech college/univ degree		119	31.6%
More than one degree		61	16.2%
Ethnic background	349		
Caucasian		307	88.0%
African American/Black		20	5.7%
Multi-racial		8	2.3%
Asian		6	1.7%
Hispanic		5	1.4%
Other*		2	0.6%
Native American		1	0.3%

* "Other" ethnic background = Syrian or West Indian.

These demographics were compared to information collected about subscribers in the full *Prevention* circulation list (Rodale 2001a), as shown in Table 9. The only solid similarity was the gender of both groups, which was predominantly female. Otherwise, the thesis survey respondents were significantly older (median age of 55 years versus 50.1 years for the full list), lived in smaller households (two people/household, 51.3% survey versus 42.7% full list), and had received more post-secondary education (attended/graduated college, 81.5% survey versus 57.8% full list).

Table 9. Comparison of respondents' demographics to full Rodale subscribers' list (1999 Fall MRI)

CHARACTERISTIC	PREVENTION	RESPONDENTS
Gender		
Male	21.2%	17.4%
Female	78.8%	82.6%
Age		
18-49	49.7%	25.95%
25-54	59.6%	46.22%
35-54	49.2%	44.59%
35-64	66.6%	87.03%
35+	86.7%	98.38%
Median	50.1 years	55 years
Household size		
Two	42.7%	51.3%
Three +	44.6%	35.9%
Education		
Attended/graduated college	57.8%	81.5%
Graduated college	25.9%	48.8%

Note: 1999 Fall MRI based on 3,000,000 circulation rate base (Rodale 2001a)

Residence was also examined. To determine geographical representation, the mailing list and return envelope zip codes were counted by state, and the state totals were combined and resorted by two regional systems.

- The four U.S. Census Bureau regions (U.S. Census Bureau 2002b). This section will discuss and present results based on the Census Bureau system. Results are summarized in Figures 2 and 3.
- The seven Rodale advertising and subscribing regions (Rodale 2001a). See Appendix 3 for a discussion of results based on this regional system.

The Census Bureau regions are composed of these states:

- *Midwest region:* Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin. (Mailed N = 415, returned N = 105, return rate 25.9%)

- *Northeast region:* Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont. (Mailed N = 313, returned N = 60, return rate 19.2%)
- *South region:* Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia. (Mailed N = 574, returned N = 129, return rate 22.5%)
- *West region:* Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming. (Mailed N = 298, returned N = 61, return rate 20.5%)

Each of the four Census regions is split into two or three subregions (Figure 2). The composition of the Census subdivisions in the Midwest and Northeast are similar to the composition of four Rodale regions (East Central, West Central, Mid Atlantic and New England). The two systems differ in where they categorize some of the states along the East Coast (particularly the southeast) and along the West Coast. (See Appendix 3 for a similar graphical representation of the Rodale regions.)

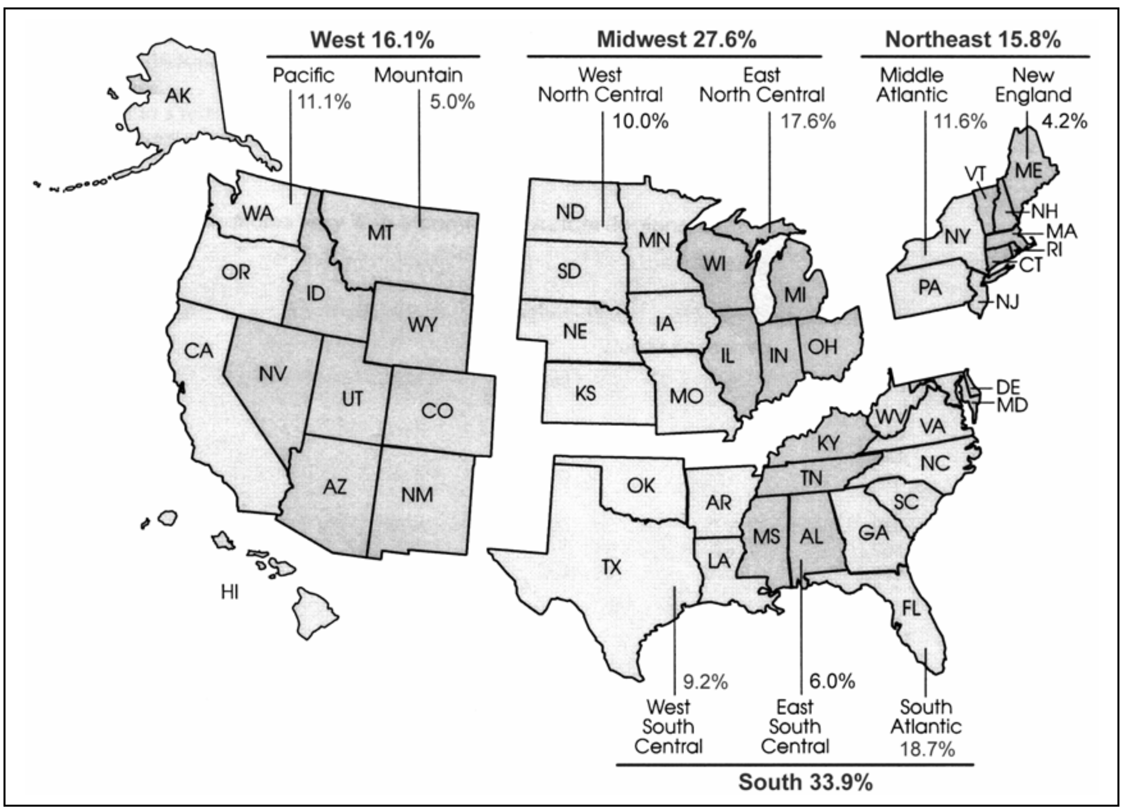

Figure 2. Surveys returned from individuals living in Census Bureau regions and subregions
Graphic source: USDA ERS (Jekanowski and Binkley 2000)

Census regional data is represented graphically in Figure 3. Mailed percentages are based on mailed N by region and the number of names (1,600) randomly selected from the part of the Rodale database. Returned percentages are based on returned N by region and the number of returned usable surveys (380). In addition, some returned surveys (25 or 6.6%) could not be identified by region, as their envelopes did not bear a postmark or zip code.

Nearly half (49.6%) of the surveys were mailed to people living in the central portion of the U.S. (Midwest 25.9%, East South Central 6.1%, West South Central 11.2%, Mountain 6.4%). Of the remaining mailed surveys, more (38.2%) were sent to people living on the East Coast (Northeast 19.6%, South Atlantic 18.6%) than living on the West Coast (Pacific 12.2%).

Returns from the South and West roughly matched surveys mailed. Deviations occurred in the Midwest, where the regional return rate (25.9%) was greater than the overall survey return rate (23.7%), and in the Northeast, where the regional return rate (19.2%) was lower than the overall survey return rate (23.7%).

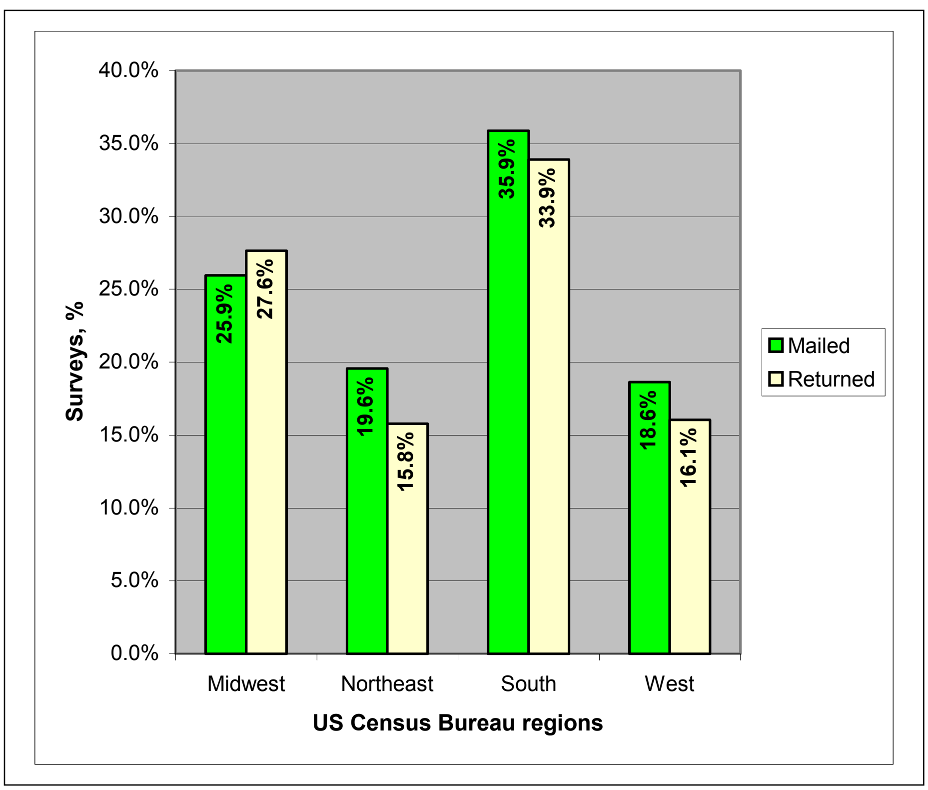

Figure 3. Surveys mailed to and returned from individuals living in Census Bureau regions (U.S. Census Bureau 2002).

Objective 2:
Estimate from the subset the number of adults who have increased their consumption of fruits, vegetables and whole grains.

This objective was met by examining data from Question 6, which asked "In the last 12 months, have you changed the amount you're eating of the following foods? (fruits; vegetables; bread, cereal, rice, pasta; lentils and dry beans; nuts and seeds)." The data were studied for these populations:

- All respondents.

- Subgroups of all respondents, based on change in plant food intake. The "more phyto" subgroup includes respondents who had indicated an increase, either in the last 12 months or years earlier, in consumption of *any* of the plant food groups. The "not more phyto" subgroup includes respondents who had indicated a decrease, either in the last 12 months or years earlier, or no change in consumption of *all* plant food groups.

- The portion of the "more phyto" subgroup which was motivated by phytochemical benefits to increase their plant food intake. These subjects selected "Heard they contain phytochemicals" (often along with other choices offered) in answer to Question 7, which asked, "Why are you eating more of these foods?" This smaller group is referred to as the "phyto motivated" subgroup.

All respondents

The greatest percentage change occurred with increased fruit intake in the past 12 months (40.7%), followed by 39.1% who had increased their vegetable intake years earlier. In each instance, combining "eat more now than 12 months ago" and "began eating more years earlier" showed that nearly 70% of all respondents had increased their consumption of these two food groups. The same combination indicates that almost half of all respondents had increased intake of dry beans/lentils (48.7%) and nuts/seeds (48.8%). While some respondents reported eating more grain products (34.1% cumulative), more reported eating less (37.8% cumulative). This data is summarized in Table 10 and presented graphically in Figure 4.

Table 10. Respondents' reported intake of individual phytochemical food groups (frequencies and percentages)

FOOD GROUP	N	Eat more now than 12 months ago		Began eating more years earlier		Eat less now than 12 months ago		Began eating less years earlier		No change		Don't know	
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Fruits	378	154	40.7%	109	28.8%	21	5.6%	2	0.5%	92	24.3%	0	0%
Vegetables	376	115	30.6%	147	39.1%	15	4.0%	2	0.5%	97	25.8%	0	0%
Bread, cereal, rice, pasta	376	45	12.0%	83	22.1%	121	32.2%	21	5.6%	106	28.2%	0	0%
Beans, lentils	372	104	28.0%	77	20.7%	35	9.4%	11	3.0%	135	36.3%	10	2.7%
Nuts, seeds	375	102	27.2%	81	21.6%	43	11.5%	9	2.4%	135	36.0%	5	1.3%

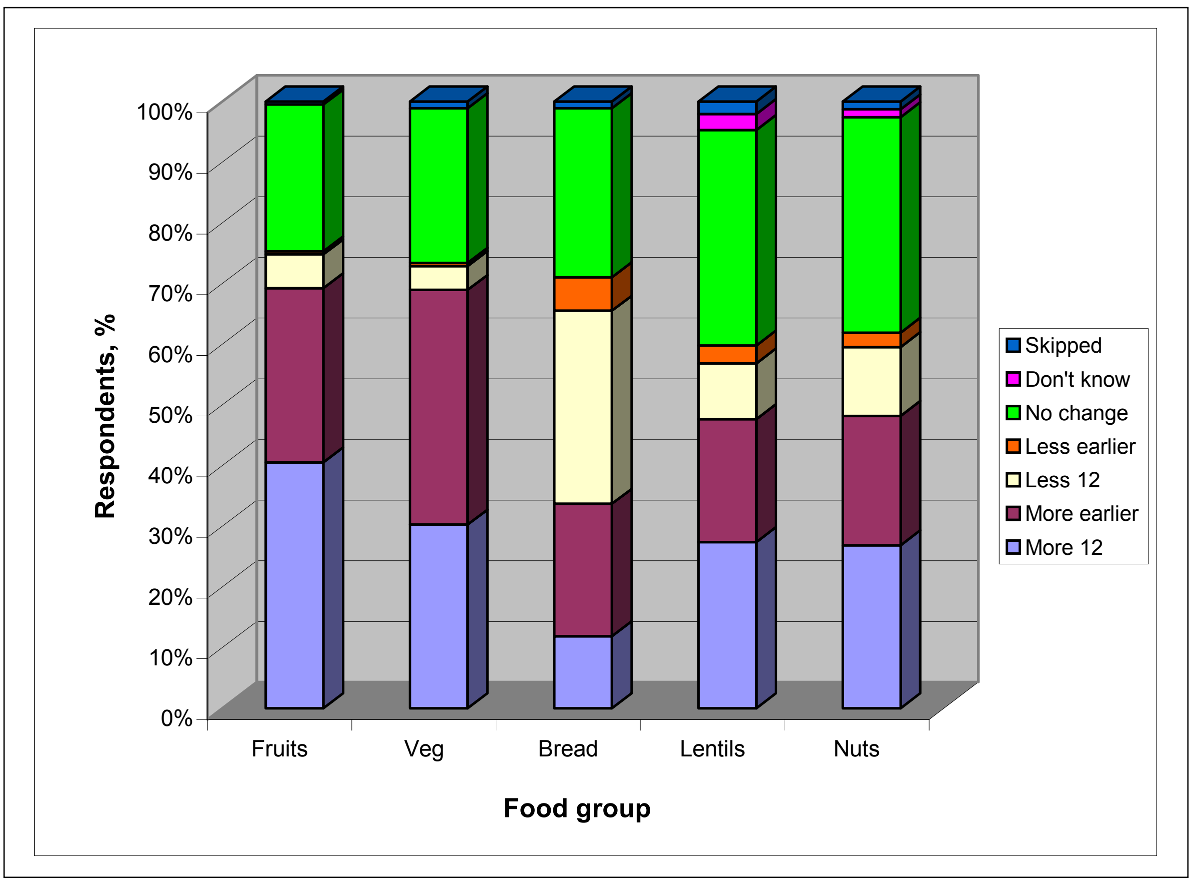

Figure 4. Intake changes (percentages) for individual plant food groups. Based on data presented in Table 10.

A Spearman's rho correlation coefficient test was run to detect correlational patterns of change in plant food intake (Table 11). All ten relationships are significant and positive; two are weak, and eight are moderate. Therefore, a change of intake in any one of the food groups increased the likelihood of a change in intake for any other food group.

Table 11. Correlational patterns of plant food intake (Spearman's rho)

FOOD GROUP	Vegetables	Bread, cereal, Rice, pasta	Beans, lentils	Nuts, seeds
Fruits	.679**	.406**	.262**	.262**
Vegetables		.455**	.345**	.319**
Bread, cereal, rice, pasta			.336**	.321**
Beans, lentils				.442**

** $p < .01$

Another Spearman's rho correlation coefficiency test was run to detect any relationship between plant food intake and importance of the food guidelines (Table 12). The food guideline data was generated by responses to Question 1, in which participants were asked, "How important to your personal diet are these (15) food guidelines?" (Descriptive data for Question 1 for can be found in Table 32 on page 87.) The agreement scales were recoded so that logical pairings ("more" intake and "very important" or "less" intake and "not at all important") would form positive relationships and aid assessment.

Nearly three-quarters of respondents (73.9%) found the guideline "eating lots of fruits and vegetables" to be very important. The correlation between this guideline and fruit and/or vegetable intake is significant, positive and weak: fruit intake (rho(375) = .219, $p < .01$), and vegetable intake (rho(373) = .165, $p < .01$). Coefficents of determination, following the formula of $r^2 \times 100$, are 4.80% and 2.73%, respectively. Importance and intake appear to be weakly and positively dependent on each other, in that increased intake changes can be partially explained (4.80% for fruit, and 2.73% for vegetables) by the high importance placed on eating fruits and vegetables.

Table 12. Correlations between plant food intake (all respondents) and importance of food guidelines (Spearman's rho)

FOOD GUIDELINE [a]	N	FOOD GROUP: INTAKE CHANGE [b]				
		Fruits	Vegetables	Bread, cereal, rice, pasta	Beans, lentils	Nuts, seeds
Avoid too much salt or sodium	369-375	.107*	.136**	.110*	.104*	.051
Avoid too much fat	369-375	.143**	.149**	.004	.100	.004
Avoid too much saturated fat	369-375	.147**	.154**	.031	.113*	.101
Avoid too much sugar	367-373	.134**	.145**	.051	.077	-.012
Eat foods with adequate fiber	371-377	.093	.127*	.111*	.061	.030
Eat a variety of foods	368-374	.110*	.061	.084	.031	.026
Maintain a desirable weight	370-376	.058	.038	.067	.056	.008
Avoid too much cholesterol	371-377	.088	.106*	.043	.072	-.002
Limit meat consumption	368-374	.085	.147**	.178**	.196**	.044
Eat plenty of fruits and vegetables	371-377	.219**	.165**	.076	.135*	.047
Eat plenty of breads, cereals, rice and pasta	364-370	.040	.049	.290**	.078	-.030
Eat in moderation	370-376	.130*	.101	-.011	.064	.045
Eat a balanced diet (Food Guide Pyramid)	367-373	.113*	.097	.122*	.095	.010
Eat unprocessed foods	357-363	.096	.075	.016	.140**	.098
Eat organic foods	352-358	-.099	-.121*	-.049	-.190**	-.154**

[a] Q1 asked, "How important to your personal diet are these food guidelines?" The agreement scale: 0=very important, 1=not too important and somewhat important, 2=not at all important, system missing=don't know.

[b] Q6 asked, "In the last 12 months, have you changed the amount you're eating of the following foods?" Answers: 0=less (12 months and earlier), 1=no change, 2=more (12 months and earlier), system missing=don't know.

* $p < .05$

** $p < .01$

Significant correlations that were positive and weak were also found between the fruit and vegetable guideline and intake changes in dry beans/lentils (rho(369) = .135, $p < .05$). Therefore, intake changes in these foods (nearly 50% increasing intake) can be partially explained (1.82%) by the high importance placed on eating fruits and vegetables.

Regarding consumption of grain products (bread, cereal, rice and pasta), equal percentages of respondents indicated that they either increased (33.6%) or decreased (37.3%) their intake of these foods at some point in time. The biggest shift occurred in the past 12 months, where 11.8% increased intake, and 31.5% decreased intake. This data may reflect the recent popularity of low-carbohydrate, high-protein diets, such as the Atkins Diet or Sugar Busters (Aronne et al. 2001, Gabel and Lund 2002). This conflict can be seen in the importance subjects placed on the guideline "eating plenty of bread, cereal, rice and pasta" from Question 1 (Table 30). More respondents found it somewhat important (157 individuals or 41.3%) as opposed to very important (148 individual or 38.9%). The

Spearman's rho correlation coefficents test between change in and importance of bread intake was found to be significant, positive and weak (rho(366) = .290, p < .01). Therefore, the declining intake changes in bread, cereal, rice and pasta can be partially explained (8.41%) by the moderate importance placed on eating these foods.

Overall, of the 75 relationships formed between plant food intake and food guideline importance, 29 relationships were significant and 46 were not significant. Of the significant relationships, 26 were positive (such as the relationships discussed above) and 3 were negative; all were weak (rho -.299 to .299). The three negative relationships were found forming between the importance of eating organic foods and the intake of vegetables (rho(376) = -.121, p < .05), dry beans/lentils (rho(372) = -.190, p < .01), and nuts/seeds (rho(375) = -.154, p < .01). The organic foods guideline had less importance placed on it (52.8% combined "not at all important" and "not too important") than any of the other guidelines. The relationship indicates that as the importance of eating organic foods declines, it weakly influences the intake of vegetables, dry beans/lentils and nuts/seeds to increase.

At least one quarter of all respondents reported no change in their consumption. Percentages ranged from 24.3% reporting no change in fruit consumption up to 36.3% reporting no change in dry beans/lentils and 36.0% in nuts/seeds. This survey did not ask questions regarding level of intake, so no assumptions can be made equating "no change" (or "more" or "less") to either high intake or low intake. To get a better idea of how these "no change" respondents regard plant foods, data for intake levels was cross tabulated with three Question 1 guidelines: the two concerning the importance of eating fruits, vegetables and grain products, and a third about the importance of limiting meat intake. Dry beans, lentils and nuts are good sources of protein and are often substituted for meat. Cross tabulation data are presented in Table 13.

- *Fruits and vegetables.* The "no change" fruit and vegetable respondents placed high importance on eating these foods. 63.7% of the fruit "no change" respondents and 62.9% of the vegetable "no change" respondents found it very important to eat plenty of fruits and vegetables, and most of the rest found it somewhat important. Percentages are similar for the other "no change" respondents. As reported above, the correlations between intake and value of these food groups are significant, weak and positive: fruit intake (rho(375) = .219, p < .01), and vegetable intake (rho(373) = .165, p < .01).

Table 13. Importance placed on specific food guidelines by respondents reporting no change of intake (frequencies and percentages)

GUIDELINE and FOOD GROUP	No change N	IMPORTANCE OF GUIDELINE							
		Not at all important		Not too important		Somewhat Important		Very important	
		Freq	%	Freq	%	Freq	%	Freq	%
Eat plenty of fruits, vegetables									
Fruit	91	1	1.1%	8	8.8%	24	26.4%	58	63.7%
Vegetables	97	1	1.0%	6	6.2%	29	29.9%	61	62.9%
Bread, cereal, rice, pasta	105	1	1.0%	5	4.8%	29	27.6%	70	66.7%
Dry beans, lentils	135	1	0.7%	8	5.9%	41	30.4%	85	63.0%
Nuts, seeds	134	1	0.7%	7	5.2%	33	24.6%	93	69.4%
Eat plenty of bread, cereal, rice and pasta									
Fruit	90	4	4.4%	18	20.0%	36	40.0%	32	35.6%
Vegetables	96	4	4.2%	18	18.8%	40	41.7%	34	35.4%
Bread, cereal, rice, pasta	104	3	2.9%	15	14.4%	47	45.2%	39	37.5%
Dry beans, lentils	132	8	6.1%	20	15.2%	56	42.4%	48	36.4%
Nuts, seeds	131	6	4.6%	21	16.0%	57	43.5%	47	35.9%
Limit meat consumption									
Fruit	91	5	5.5%	19	20.9%	41	45.1%	26	28.6%
Vegetables	96	5	5.2%	23	24.0%	47	49.0%	21	21.9%
Bread, cereal, rice, pasta	104	7	6.7%	20	19.2%	51	49.0%	26	25.0%
Dry beans, lentils	134	10	7.5%	33	24.6%	68	50.7%	23	17.2%
Nuts, seeds	134	9	6.7%	27	20.1%	68	50.7%	30	22.4%

- *Bread, cereal, rice and pasta.* The "no change" bread/cereal/rice/pasta respondents placed average-to-high importance on eating these foods. More than one third (37.5%) of these "no change" respondents found it very important to eat plenty of bread, cereal, rice and pasta, but a greater percentage (45.2%) found it somewhat important, and 19.2% found it not too important. As reported above, the correlation between intake and value for the grain food group is significant, weak and positive (rho(366) = .290, $p < .01$).

- *Meat.* "No change" respondents for dry bean, lentil, nut and seed intake (sources of vegetable protein) placed average importance on limiting their intake of meat (source of animal protein). Half (50.7%) of these "no change" respondents found it somewhat important to limit meat consumption. "Very important" percentages are smaller than for other guidelines (22.4% from nut/seed "no change" respondents, 17.2% from dry bean/lentil "no change" respondents), and "not too important" percentages are greater (20.1% nuts/seeds, 24.6% dry beans/lentils). The correlation between dry bean/lentil intake and the value of limiting meat intake is significant, weak and positive (rho(366) = .196, p < .01). However, the relationship between nut/seed intake and the value of limiting meat intake was found to be very weak, positive and not signficiant (rho(369) = .044, p > .05). Therefore, 3.84% of the average importance placed on limiting meat intake can be explained by the moderate intake of dry beans/lentils; intake of nuts/seeds is independent of the value placed on limiting meat intake.

"More phyto" and "not more phyto" respondents

To identify respondents who had increased consumption of at least one food group at some point in time, a variable was added to the SPSS syntax. This variable assigned a value of "1" to respondents who had indicated a consumption increase in at least one of the food groups and a value of "2" to respondents who had not indicated a consumption increase in any of the food groups. When looked at from this second perspective, most of the respondents (82.9% or 315 individuals) indicated that they have increased consumption of at least one food group, either in the last 12 months or years earlier. *These respondents form the "more phyto" subgroup.*

Table 14. Respondents' reported intake of any phytochemical food group (N = 380)

AMOUNT CHANGED	Frequency	% of N
Eating more phytochemical foods	315	82.9%
Eating less phytochemical foods/no change	65	17.1%

Table 10, which presents intake change data for all respondents, can also be read for the "more phyto" subgroup. Data in the "eat more now than 12 months ago" and "began eating more years earlier" columns itemizes this subgroups' intake increases for each food group.

It's important to remember that an increase of any one food type – not all food types – placed respondents in the "more phyto" subgroup. To test the possibility that "more phyto" respondents may have also decreased or experienced no change of intake in a food group, the subgroup variable was cross tabulated with the food intake data from Question 6. Results are summarized in Table 15.

Table 15. "More phyto" respondents who decreased intake of a plant food (frequencies, percentages, Spearman's rho)

FOOD GROUP	N	INTAKE CHANGE								rho
		Less in last 12 mo		Less years earlier		No change		Don't know		
		Freq	%	Freq	%	Freq	%	Freq	%	
Fruits	315	15	4.8%	0	0%	37	11.7%	0	0%	.589**
Vegetables	313	9	2.9%	1	0.3%	41	13.1%	0	0%	.582**
Bread, cereal, rice, pasta	313	109	34.8%	19	6.1%	57	18.2%	0	0%	.460**
Beans and lentils	311	28	9.0%	10	3.2%	85	27.3%	7	2.3%	.429**
Nuts and seeds	313	35	11.2%	9	2.9%	83	26.5%	3	1.0%	.448**

** $p < .01$

Among the "more phyto" subgroup, 34.8% have recently (within the last 12 months) decreased their intake of bread, cereal, rice and pasta. This finding is consistent with intake data from all respondents (32.2% of who ate less now than 12 months ago). The Spearman's rho correlation coefficient test for this relationship, as in all of the correlations between the "more phyto" subgroup and plant food intake, was found to be significant, positive and moderate (rho(311) = .460, $p < .01$).

In the other food groups, most of the decreases involved ≤ 6.1% of "more phyto" respondents. Exceptions were the recent 11.2% decrease in nut/seed intake (rho(311) = .448, $p <0.01$) and the recent 9.0% decrease in dry bean/lentil intake (rho(309) = .429, $p < .01$). These two food groups also had the largest percentages of "no change" respondents in the "more phyto" subgroup: 27.3% for dry beans/lentils, and 26.5% for nuts/seeds.

Therefore, a significant finding was that respondents who consumed more of some plant foods also ate less of other plant foods. This behavior was especially true regarding intake of bread, cereal, rice and pasta, as 34.8% of the "more phyto" respondents said they ate less of these foods than they had 12 months earlier.

Objective 3:
Determine whether the major change effecter was an awareness of phytochemicals.

The 315 respondents who reported eating more phytochemical-containing foods in Question 6 were given the opportunity to identify the reasons for this change in Question 7, which asked, “Why are you eating more of these foods?,” and then listed 13 possible reasons. Most of the eligible respondents (307 individuals) answered Question 7. Fewer eligible respondents (281 individuals) answered the follow-up question (Question 8), which asked them to single out the most important reason from the list in Question 7.

Table 16 summarizes the respondents’ reasons for increasing intake of phytochemical foods, ranking data in ascending order of percentage value based on responses to Question 7. Table 17 presents correlational patterns of motivation for eating more of these foods.

Table 16. Respondents’ reasons for increasing intake of phytochemical food groups (frequencies and percentages)

REASON	Q7: Why are you eating more of these foods?		Q8: In Q7, which is the most important reason for eating more of these foods?	
	No. selected	*% (N=307)*	*No. selected*	*% (N=281)*
Believe eating these foods can make me healthier	289	94.1%	210	74.7%
Watching my fat intake	243	79.2%	24	8.5%
Enjoy eating these foods	196	63.8%	15	5.3%
Believe eating these foods can make me stronger	155	50.5%	0	0
Am replacing these foods for all or some of my meat consumption	135	44.0%	7	2.5%
Believe eating these foods can make me look better	132	43.0%	4	1.1%
Can buy from an easily accessible and affordable source	79	20.8%	1	0.4%
Heard they contain phytochemicals	62	20.2%	0	0
Grow these foods in my garden	59	19.2%	1	0.4
Following doctor’s orders	59	19.2%	10	3.6%
Other	25	8.1%	9	3.2%
Eating more ethnic meals which emphasize these foods	21	5.5%	0	0
Following example of others in my household	14	4.6%	1	0.4%

Note: 315 respondents were eligible to answer Question 7 (N = 307) and Question 8 (N = 281)

Table 17. Correlational patterns of motivation for increased plant food intake (Spearman's rho)

REASON [a]	2	3	4	5	6	7	8	9	10	11	12	13
1	.217**	.224**	.126*	.087	.052	.109	-.145*	.068	.145*	.016	.072	-.078
2		.557**	.104	.011	.226**	.039	-.001	.077	.106	-.090	.065	.006
3			.141*	.053	.136*	.142*	-.033	.139*	.133*	-.063	.082	-.015
4				.187**	.131*	.225**	-.071	.024	.078	-.060	.091	-.001
5					.186**	.068	-.027	-.001	.047	.056	.178**	.066
6						.109	.014	.224**	.082	.053	.272**	.043
7							.027	.098	.083	.134*	.052	.072
8								.064	-.080	.012	.002	.049
9									.076	.032	.096	.061
10										.128*	-.002	-.199**
11											-.132*	.097
12												.001

[a] **1= To make me healthier;** 2=to make me look better; **3=to make me stronger; 4=contains phytochemicals;** 5=grow these foods in my garden; **6=have accessible, affordable source;** 7=replacement for all/most meat; 8=following others in household; 9=eating more ethnic meals; 10=watching fat intake; 11=following doctor's orders; 12=enjoy eating these foods; 13=other.

* $p < .05$

** $p < .01$

Major change effectors for these respondents were health enhancement (289 individuals), dietary fat reduction (243 individuals) and enjoyment (196 individuals). Respondents also identified these change effectors, in the same order, as their main reason for increased consumption.

Phytochemical awareness was a change effecter for 62 people, but none identified it as most important. *These respondents form the "phyto motivated" subgroup.* Of nearly equal importance to phytochemical awareness as a change effecter were source (79 individuals), home gardening (59 individuals), and doctor's orders (59 individuals).

Of more importance than phytochemical awareness were strength enhancement (155 individuals), meat replacement (135 individuals) and appearance enhancement (132 individuals).

Of less importance than phytochemical awareness were ethnic meal emphasis (21 individuals), household pattern (14 individuals), and "other" (25 individuals). Most of the "other" reasons given were related to a medical condition ("Trying to lower my borderline high blood pressure," "Watch diet for diabetes type 2," and eight other similar responses) or weight loss ("Am a Weight Watchers member and try to eat healthy," "On a low-carbohydrate diet," and three other similar responses).

A Spearman's rho test was calculated to detect correlational patterns of motivation for eating more plant foods (Table 17). Of the 78 relationships, 23 were found to be significant, and 55 were found to be not significant. Of the significant correlations, 22 are weak (-.299 to .299) and one is moderate (.300 to .599), and 20 are positive, while 3 are negative. The strongest is the positive, moderate correlation between "to make me look better" and "to make me stronger" (rho(305) = .557, $p < .01$). The weakest is the positive, weak correlation between "to make me healthier" and "contains phytochemicals" (rho(305) = .126, $p < .05$). Applying the formula (r^2 x 100), the coefficients of determination for the better/strong relationship is 31.0% and for the healthier/phytochemical relationship is 1.6%. Every reason for eating more plant foods forms at least one significant correlation with another reason. The greatest number of significant relationships involve "to make me stronger" (seven); "have an accessible, affordable source" (six); "to make me healthier" (five); and "contains phytochemicals" (five). Therefore, many of these variables are dependent upon each other, particularly those involving strength or health enhancement, affordable source, and phytochemical benefit. The data overlap by 1.6% to 31.0%, depending upon the reason for increased plant food intake.

Many respondents gave more than one reason for eating more plant foods (Table 18): 53.7% of the "more phyto" subgroup and 83.9% of the "phyto motivated" subgroup selected five or more reasons. The fewest number of motivations identified was three by the "phyto motivated" subgroup and zero by the "more phyto" respondents. The greatest number of motivations identified was nine by the "phyto motivated" subgroup and 11 by the "more phyto" subjects. The correlations between number of motivations and each subgroup is significant, positive and moderate: "more phyto" (rho(313) = .600, $p < .01$, coefficient of determination 36.0%); and "phyto motivated" (rho(60) = .417, $p < .01$, coefficient of determination 17.4%). Therefore, subjects who have increased their intake of plant foods tend to do so for multiple reasons (mean, SD of 4.66 ± 2.10), particularly if one of the motivations is to gain phytochemical benefits (mean, SD of 6.45 ± 1.66 reasons). The shared variance for these relationships ranges from 17.4% ("phyto motivated") to 36.0% ("more phyto").

Table 18. Number of reasons for respondents' increased plant food intake (frequencies and percentages)

NUMBER OF REASONS [a]	MORE PHYTO [b]		PHYTO MOTIVATED [b]	
	Freq	% (N=315)	Freq	% (N=62)
0	8	2.5%	0	0.0%
1	9	2.9%	0	0.0%
2	34	10.8%	0	0.0%
3	44	14.0%	2	3.2%
4	51	16.2%	4	6.5%
5	58	18.4%	13	21.0%
6	55	17.5%	14	22.6%
7	28	8.9%	13	21.0%
8	17	5.4%	9	14.5%
9	7	2.2%	3	4.8%
10	3	1.0%	0	0.0%
11	1	0.3%	0	0.0%
12	0	0.0%	0	0.0%
13	0	0.0%	0	0.0%

[a] Mean ± SD: "more phyto" = 4.66 ± 2.10; "phyto motivated" = 6.45 ± 1.66.

[b] Spearman rho correlation coefficients: "more phyto" is rho(313)= .600, $p < .01$; "phyto motivated" is rho(60) = .417, $p < .01$.

In order to compare food intake data among the subgroups, the "phyto motivated" subgroup variable was cross tabulated with the data from Question 6. Results are summarized in Table 19.

Table 19. "Phyto motivated" respondents who decreased intake of a plant food (frequencies, percentages, Spearman's rho)

FOOD GROUP	N	INTAKE CHANGE										rho
		More in 12 mo		More years earlier		Less in last 12 mo		Less years earlier		No change		
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	
Fruits	62	23	37.1%	29	46.8%	0	0%	2	3.2%	8	12.9%	-.099
Vegetables	62	17	27.4%	37	59.7%	0	0%	0	0%	8	12.9%	-.066
Bread, cereal, rice, pasta	61	3	4.9%	18	29.5%	24	39.3%	3	4.9%	13	21.3%	-.087
Beans and lentils	61	26	42.6%	19	31.1%	1	1.6%	2	3.3%	13	21.3%	.127*
Nuts and seeds	61	25	41.0%	22	36.1%	3	4.9%	0	0%	11	18.0%	.157**

* $p < .05$ ** $p < .01$

When comparing the data in Table 19 to the data in Table 10, the subgroups shared these intake patterns:

- Among the “phyto motivated” subgroup, 39.3% had recently (within the last 12 months) decreased their intake of bread, cereal, rice and pasta. This finding is consistent with intake data from all respondents (32.2% of who ate less now than 12 months ago) and “more phyto” respondents (34.8%). The Spearman’s rho correlation coefficient test for this relationship was found to be very weak, negative and not significant (rho(59) = -.087, $p > .05$). Therefore, another variable outside of phytochemical motivation must explain the intake pattern of grain products.

- Regarding vegetable intake, the largest percentages of both “more phyto” (39.1%) and “phyto motivated” respondents (59.7%) had increased intake years earlier. The correlation between vegetable intake and phytochemical motivation is not significant.

- The same approximate percentage of respondents (± 6.0%) indicated no intake change of any food group.

The subgroups differed with intake in these areas:

- All of the “phyto motivated” subjects indicated awareness of intake changes for all food groups (no “don’t know” responses).

- Regarding fruit intake, a greater percentage of “phyto motivated” subjects (46.8%) began eating more years earlier than had “more phyto” subjects (28.8%). The correlation between fruit intake and phytochemical motivation is not significant.

- Regarding dry bean/lentil and nut/seed intake, the “phyto motivated” subjects were eating more of these foods, especially recently (42.6% dry beans/lentils, 41.0% nuts/seeds), than were the “more phyto” subjects (28.0% dry beans/lentils, 27.2% nuts/seeds). The correlation between intake of these foods and phytochemical motivation is significant, weak and positive (dry beans/lentils, rho(61) = .127, $p < .05$; nuts/seeds, rho(61) = .157, $p < .01$).

Objective 4:
Define this population's understanding and expectations of phytochemicals.

Phytochemical research involving human subjects, so far, has mostly touted health enhancement (Hasler and Blumberg 1999, Scimone 1997, Slavin et al. 1999). Some research is surfacing regarding harmful aspects of phytochemical intake (American Broadcasting Corp. 2000, Byers et al. 2002), but its reporting is recent and outweighed in number by favorable research. The beneficial aspects of phytochemicals fit the opinions of these respondents, as reflected by their answers to Question 9 ("Have you heard of or read about any of these nutrition-related words?), Question 10 ("Which one statement best matches your understanding of phytochemicals?"), Question 11 ("Which types of food you believe to contain phytochemicals") and Question 12 ("Which one of the following statements [concerning phytochemicals as naturally occurring or added to foods] do you agree with most?").

Discussion of Question 9 data will be presented for all respondents and two plant food intake subgroups: "more phyto" (respondents who reported eating more plant foods) and "phyto motivated" (respondents who reported eating more in order to gain phytochemical health benefits).

Discussion of Question 10 will introduce a new subgroup, the "phyto aware" respondents. This subgroup is composed of subjects who indicated understanding phytochemical function to some degree (including uncertainty) in their answers to Question 10. Only this subgroup was directed to answer Questions 11 and 12, so discussion of these questions will focus on the "phyto aware" subgroup alone. Question 9 will also be re-analyzed for this subgroup.

All respondents, "more phyto" respondents, "phyto motivated" respondents

Question 9 tested all respondents' recognition of several phytochemical words. About 90% of all respondents (Table 20) reported having heard of *antioxidants* and *carotenoids/beta carotene*, words which are commonly brought up in medical news reports in the popular press. About two-thirds indicated they'd heard of *flavonoids/isoflavones* (67.2%) and *lutein* (61.6%). The latter phytochemical has received much attention recently from researchers and supplement manufacturers in connection with reversal of age-related macular degeneration (Mares-Perlman 2002, McCord 2000). Of the word itself, 43.2% reported having heard of *phytochemical*.

Table 20. Respondents' awareness of specific phytochemical-related words (frequencies and percentages, N = 375)

PHYTOCHEMICAL WORD	Q9: Have you heard of or read about any of these nutrition-related words?	
	"Yes" freq	*% of N*
Antioxidants	354	94.4%
Carotenoids, beta carotene	331	88.3%
Flavonoids, isoflavones	252	67.2%
Lutein	231	61.6%
Phytochemicals	162	43.2%
Pigments	132	35.2%
Anti-estrogens	118	31.5%
Phytoestrogens	116	30.9%
Lycopene	111	29.6%
Genistein	25	6.7%

A Spearman's rho test was run to detect correlational patterns of awareness with these words. Four relationships were found not to be significant; they were extremely weak (-.028 to .090), with one negative and three positive (Table 21). The majority of relationships (41), however, were significant and positive. Of the significant correlations, 27 were weak (≤ .299) and 14 were moderate (.300 to .699). The strongest relationships were the moderate positive correlations between recognition of *phytochemicals* and *phytoestrogens* (rho(373) = .511, $p < .01$, coefficient of determination 26.1%); between *phytochemicals* and *flavonoids/isoflavones* (rho(373) = .449, $p < .01$, coefficient of determination 20.2%); and between *flavonoids/isolfavones* and *lutein* (rho(373) = .418, $p < .01$, coefficient of determination 17.5%). The weakest relationship was between *anti-estrogens* and *carotenoids/beta carotene* (rho(373) = .104, $p < .05$, coefficient of determination 1.1%). Two deductions can be made from this correlational data. First, knowledge of one word increased the likelihood of recognizing any any word. Second, this degree of likelihood ranges from 1.1% up to 26.1%.

Table 21. Correlational patterns of awareness with phytochemical words (Spearman's rho)

PHYTOCHEMICAL WORD [a]	2	3	4	5	6	7	8	9	10
1	.090	.138**	-.028	.299**	.344**	.261**	.133*	.155**	.212**
2		.329**	.072	.143**	.104*	.110*	.215**	.246**	.221**
3			.214**	.308**	.154**	.244**	.312**	.232**	.511**
4				.141**	.064	.145**	.272**	.206**	.220**
5					.345**	.418**	.304**	.313**	.449**
6						.223**	.200**	.182**	.218**
7							.332**	.180**	.334**
8								.244**	.354**
9									.327**

[a] 1=Antioxidants; 2=anti-estrogens; 3=phytoestrogens; 4=genistein; 5=flavonoids, isoflavones; 6=carotenoids, beta carotene; 7=lutein; 8=lycopene; 9=pigments; 10=phytochemicals.

* $p < .05$

** $p < .01$

To distinguish how many words were recognized by the "more phyto" and "phyto motivated" subgroups, Question 9 data was cross tabulated with the "eat more phyto foods" variable and Question 7 data. Results are summarized in Table 22. Spearman's rho correlation coefficency tests were also calculated to detect significance and strength of any relationships (Table 23).

Table 22. Plant food subgroups' awareness of specific phytochemical-related words (frequencies and percentages)

PHYTOCHEMICAL WORD	MORE PHYTO			NOT MORE PHYTO			PHYTO MOTIVATED		
	Freq	% (N=375)	% of subgroup (N=313)	Freq	% (N=375)	% of subgroup (N=62)	Freq	% (N=306)	% of subgroup (N=62)
Antioxidants	296	78.9%	94.6%	58	15.5%	93.5%	62	20.3%	100.0%
Carotenoids, beta carotene	277	73.9%	88.5%	54	14.4%	87.1%	58	19.0%	93.5%
Flavonoids, isoflavones	215	57.3%	68.7%	37	9.9%	59.7%	57	18.6%	91.9%
Lutein	194	51.7%	62.0%	37	9.9%	59.7%	53	17.3%	85.5%
Phytochemicals	142	37.9%	45.4%	20	5.3%	32.3%	59	19.3%	95.2%
Pigments	109	29.1%	34.8%	23	6.1%	37.1%	36	11.8%	58.1%
Anti-estrogens	96	25.6%	30.7%	22	5.9%	35.5%	31	10.1%	50.0%
Phytoestrogens	98	26.1%	31.3%	18	4.8%	29.0%	44	14.4%	71.0%
Lycopene	93	24.8%	29.7%	18	4.8%	29.0%	37	12.1%	59.7%
Genistein	22	5.9%	7.0%	3	0.8%	4.8%	11	3.6%	17.7%

Table 23. Correlations between awareness of phytochemical words and plant food intake (Spearman's rho)

PHYTOCHEMICAL WORD	EAT MORE PHYTO		PHYTO MOTIVATED	
	N	rho	N	rho
Antioxidants	375	.016	306	.122*
Anti-estrogens	375	-.039	306	.207**
Phytoestrogens	375	.018	306	.430**
Genistein	375	.033	306	.206**
Flavonoids, isoflavones	375	.071	306	.253**
Carotenoids, beta carotene	375	.016	306	.079
Lutein	375	.018	306	.240**
Lycopene	375	.006	306	.340**
Pigments	375	-.018	306	.244**
Phytochemicals	375	.098	306	.507**
Number of words recognized	380	-.068	307	.488**

* $p < .05$ ** $p < .01$

The word *antioxidants* was recognized by nearly all members of each subgroup (including the "not more phyto" respondents). In fact, 100% of the "phyto motivated" subjects had heard of the word, which most likely reflects their more specific understanding of nutrition. Correlational data is significant, supporting this deduction, but extremely weak and positive (rho(59) = .122, $p < .05$, coefficient of determination 1.5%). It is one of the weakest correlations between the "phyto motivated" subjects and the list of words. Therefore, factors outside of phytochemical motivation explain most (98.5%) of this group's high recognition of the word *antioxidant*.

There was greater recognition of most words by "more phyto" respondents than "not more phyto" respondents but not by a great degree (< 14% difference). Two words (*anti-estrogens* and *pigments*) were selected by a greater percentage of "not more phyto" respondents (35.5% *anti-estrogens*, 37.1% *pigments*) than "more phyto" respondents (30.7% *anti-estrogens*, 34.8% *pigments*). These relationships are extremely weak, negative and not significant, however: *anti-estrogens* (rho(373) = -.039, $p < .05$), and *pigments* (rho(373) = -.018, $p < .05$). In fact, all correlations between "eat more phyto foods" and awareness of phytochemical words were found to be not significant.

The differences between "more phyto" and "phyto motivated" respondents were more striking. Both demonstrated great awareness of *antioxidants,* as discussed above, and *carotenoids/beta carotene* (88.5% "more phyto" and 93.5% "phyto motivated"). The Spearman's rho correlation for this last relationship was found to be not significant for either subgroup (p < .05). Seven of the words, though, were recognized by a substantially greater percentage (> 20.0%) of "phyto motivated" subjects than "more phyto" and were significantly, moderately and positively correlated. Examples include awareness of the words *phytochemical* ("more phyto" 45.4%, "phyto motivated" 95.2%, rho(60) = .507, p < .01), *phytoestrogens* ("more phyto" 31.3%, "phyto motivated" 71.0%, rho(60) = .430, p < .01) and *lycopene* ("more phyto" 29.7%, "phyto motivated" 59.7%, rho(60) = .340, p < .01). A smaller gap occurred between the subgroups' awareness of *genistein* ("more phyto" 7.0%, "phyto motivated" 17.7%, rho(60) = .206, p < .01). A good summary statement might be that no relationship was demonstrated between intake of plant foods and recognition of phytochemical words until motivation for increased intake was factored in. Therefore, motivation/intake can explain 1.5% to 25.7% of the variance in data with word recognition, depending on the specific word.

Table 24. Respondents' awareness of multiple phytochemical words (frequencies and percentages)

NUMBER OF WORDS	ALL RESPONDENTS		MORE PHYTO		NOT MORE PHYTO		PHYTO MOTIVATED	
	Freq	% (N=380)	Freq	% (N=315)	Freq	% (N=65)	Freq	% (N=62)
0	14	3.7%	8	2.5%	6	9.2%	0	0%
1	17	4.5%	15	4.8%	2	3.1%	0	0%
2	38	10.0%	32	10.2%	6	9.2%	0	0%
3	48	12.6%	38	12.1%	10	15.4%	0	0%
4	62	16.3%	52	16.5%	10	15.4%	4	6.5%
5	54	14.2%	44	14.0%	10	15.4%	8	12.9%
6	48	12.6%	40	12.7%	8	12.3%	7	11.3%
7	40	10.5%	34	10.8%	6	9.2%	13	21.0%
8	31	8.2%	31	9.3%	0	0%	14	22.6%
9	19	5.0%	15	4.8%	4	6.2%	13	21.0%
10	9	2.4%	6	1.9%	3	4.6%	3	4.8%
Mean ± SD	4.82 ± 2.42		4.90 ± 2.38		4.46 ± 2.62		7.23 ± 1.64	

Note: See Table22 or 23 for the ten phytochemical terms listed in Q9.

Most respondents recognized more than one phytochemical word: 91.8% all respondents, 92.7% of "more phyto" respondents, and 100% of "phyto motivated" respondents (Table 24). Few respondents either had not heard of any of the terms (3.7% all respondents, 2.5% "more phyto," 0.0% "phyto motivated") or had heard of all of the terms (2.4% all respondents, 1.9% "more phyto," 4.8% "phyto motivated"). "Phyto motivated" subjects were aware of a greater number of words (88.8% recognized

5-9 words; mean, SD of 7.23 ± 1.64) than the other groups. About the same percentages of subjects (85.6% "more phyto," 84.4% all respondents) recognized the same number of words (2-8). For comparison's sake, 76.9% of the "not more phyto" subgroup recognized 2-7 words. The correlation between motivation/intake and number of words recognized is significant, moderate and positive (rho(60) = .488, $p < .01$, coefficient of determination 23.8%), while the correlation between intake alone and number of words recognized was found to be not significant. Therefore, no relationship was demonstrated between intake of plant foods and the number of phytochemical words recognized until motivation for increased intake was factored in. Then, motivation/intake can explain 23.8% of the variance in data.

"Phyto aware" subgroup

Question 10 attempted to assess respondents' awareness of phytochemical function. A little less than half of all respondents (45.5%) indicated that they knew nothing about phytochemicals (see Table 25). A little more than half (51.8% or 197 respondents) indicated some degree of understanding of function, including uncertainty (25.8%). *These 197 individuals will be referred to as the "phyto aware" subgroup.* Of the individuals who commented, a typical response was a desire for more information. As one respondent put it, "I am now forced to go to the library and learn about phytochemicals."

Table 25. Respondents' awareness and understanding of phytochemical functions (frequencies and percentages, N = 380)

AWARENESS LEVEL	Q10: All of the words in Q9 are related to phytochemicals. Please tell me which one statement best matches your understanding of phytochemicals.	
	Frequency	% of N
Know nothing*		
Know nothing	173	45.5%
Skip	10	2.6%
Subtotal	183	48.2%
Know something**		
Heard something but not sure of function	98	25.8%
Know it specifically helps prevent disease	62	16.3%
Know it somehow improves health	36	9.5%
Know it somehow harms health	1	0.3%
Know it specifically leads to disease	0	0.0%
Subtotal	197	51.8%

* Respondents who selected "know nothing about phytochemicals" were directed to skip to Question 13. Respondents who did not answer Question 10 were also categorized as "know nothing about phytochemicals."

** These respondents were eligible to answer Questions 11 and 12.

The “phyto aware” subgroup can be further subdivided based on Question 10 data (Table 26):

- The data can be grouped by respondents’ understanding of phytochemical function as affecting health either positively or negatively. These judgment levels include “not sure of function,” “positive (helps)” and “negative (harms).” “Not sure of function” (49.75%) corresponds to the respondents who selected “I’ve heard about phytochemicals but am not quite sure what they do.” “Helps” (49.75%) represents merged data and corresponds to respondents who selected “I know that phytochemicals can somehow improve my health” and “I know that phytochemicals can specifically help to prevent cancer, heart disease and osteoporosis.” “Harms” (0.51%) also represents merged data and corresponds to respondents who selected “I know that phytochemicals can somehow harm my health” and “I know that phytochemicals can specifically lead to cancer, heart disease and osteoporosis.” This data indicates that “phyto aware” respondents’ opinions reflect the mostly favorable press phytochemicals have received.

- The data can also be grouped by respondents’ certainty in their understanding of phytochemical function. Besides “not sure of function,” these levels include “somehow changes” and “specifically changes.” “Not sure of function” (49.75%) is defined as it is above. “Somehow changes” (18.78%) represents the merging of data from respondents who chose “I know that phytochemicals can somehow improve my health” and “I know … somehow harm my health.” “Specifically changes” (31.47%) also represents the merging of data from respondents who chose “I know that phytochemicals can specifically help to prevent cancer, heart disease and osteoporosis” and “I know … specifically lead to cancer, heart disease and osteoporosis.”

Table 26. “Phyto aware” subgroup: their judgment and certainty of phytochemical function (frequencies and percentages, N = 197)

FUNCTION	FREQUENCY	% of N
Not sure of function	98	49.75%
Judgment of function		
Positive(helps)	98	49.75%
Negative (harms)	1	0.51%
Certainty of function		
Somehow changes	37	18.78%
Specifically changes	62	31.47%

Word recognition

Discussion of this new subgroup will begin by re-examining the data for Question 9. This data was cross tabulated with data from Question 10 to isolate responses from the "phyto aware" subgroup, and a Spearman's rho correlation coefficiency test was calculated to determine significance and strength of relationships (Table 27).

Table 27. Recognition of phytochemical words by "phyto aware" subjects (frequencies and Spearman's rho, N=370)

	UNDERSTANDING OF PHYTOCHEMICAL FUNCTION				Total
Judgment of function	Know nothing	Heard something but not sure of function	Helps somehow/specifically	Harms somehow/specifically	
0 words	10	3	0	0	13
1	15	2	0	0	17
2	29	4	2	0	35
3	39	7	2	0	48
4	37	11	11	0	59
5	21	16	17	0	54
6	16	18	12	0	46
7	4	20	14	1	39
8	1	15	15	0	31
9	1	1	17	0	19
10	0	1	8	0	9
Total	*173*	*98*	*98*	*1*	*370*
Mean, SD	*3.38 ± 2.22*	*5.53 ± 2.10*	*6.76 ± 2.06*	*7.00 ± 0.00*	
Certainty of function	Know nothing	Heard something but not sure of function	Changes Somehow	Changes specifically	
0 words	10	3	0	0	13
1	15	2	1	0	17
2	29	4	1	1	35
3	39	7	6	1	48
4	37	11	11	5	59
5	21	16	5	6	54
6	16	18	5	7	46
7	4	20	5	10	39
8	1	15	2	10	31
9	1	1	1	15	19
10	0	1	0	7	9
Total	*173*	98	37	*62*	
Mean, SD	*3.38 ± 2.22*	*5.53 ± 2.10*	5.86 ± *1.81*	*7.29 ± 2.00*	

Mean ± SD: all respondents 4.82 ± 2.42, and "phyto aware" respondents 6.15 ± 2.16.

Spearman's rho: judment of function rho 368(): .605, p < .01; certainty of function rho (368): .616, p < .01.

"Phyto aware" subjects overall recognized 6.15 ± 2.16 mean words, or nearly twice the number of words that were recognized by subjects who answered "don't know" to Question 10 (3.38 ± 2.22 mean words). When the data was recoded for perspective, means dropped for respondents who indicated any degree of uncertainty. "Phyto aware" subjects who were unsure of function recognized 5.53 ± 2.10 words, while "phyto aware" subjects who knew that phytochemicals somehow change health recognized 5.86 ± 1.81 words. This awareness is still greater than that shown by all survey respondents, who recognized 4.82 ± 2.42 mean words. Respondents with a more certain or positive understanding of function recognized more words than the "phyto aware" subgroup overall: "changes specifically" 7.29 ± 2.00 mean words, and "helps health" 6.76 ± 2.06 mean words.

The correlation between word recognition and function understanding was significant, positive and moderate (judgment rho(368) = .605, $p < .01$, coefficient of determination 36.6%; certainty rho(368) = .616, $p < .01$, coefficient of determination 37.9%). Therefore, these variables were dependent upon each other, and their shared variance was 36.6% - 37.9%. Subjects who recognized more words tended to have a more specific and/or positive understanding of phytochemical function.

Source identification

Data from Question 11 ("Please tell me which types of food you believe to contain phytochemicals") were analyzed only for the phytochemically aware subgroup. Nearly two-thirds (62.8%) of the subgroup correctly identified "plants" and nearly one-third (30.1%) didn't know which foods contain phytochemicals (see Table 28). A small percent selected the incorrect sources of "meat" (1.5%) or "all food" (5.6%). None of the phytochemically aware respondents selected the other incorrect choice ("dairy") as a source of phytochemicals.

Table 28. Respondents' awareness of foods that contain phytochemicals (frequencies and percentages, N=196)

FOOD	Q11: Please tell me which types of food you believe to contain phytochemicals	
	Frequency	% of N
Plants	123	62.8%
Don't know	59	30.1%
All	11	5.6%
Meat	3	1.5%
Dairy	0	0%

As summarized in Table 29, the correlation between the variables was significant, positive and moderate (judgment of function rho(194) = .504, $p < .01$, coefficient of determination 25.4%; certainty of function rho(194) = .477, $p < .01$, coefficient of determination 22.8%). Therefore, understanding phytochemical function, from both the perspective of judgment and certainty, and identification of phytochemical food source were dependent upon each other, and their shared variance was 22.8 – 25.4%. "Phyto aware" subjects who correctly identified the food source of phytochemicals tended to view function positively (43.4%) and to be more specific about function (27.6%). Those who incorrectly identified the foods' source were inclined to not be sure of function (30.6%).

Table 29. Identification of phytochemical food source by "phyto aware" subjects (frequencies and Spearman's rho, N=196)

SUBGROUP LEVELS	IDENTIFICATION OF PHYTO FOOD SOURCE				rho
	Correct [a]		Incorrect [b]		
	Freq	%	Freq	%	
Judgment of function					.504**
Not sure	37	18.9%	60	30.6%	
Positive (helps)	85	43.4%	13	6.6%	
Negative (harms)	1	0.5%	0	0.0%	
Certainty of function					.477**
Not sure	37	18.9%	60	30.6%	
Somehow changes	32	16.3%	5	2.6%	
Specifically changes	54	27.6%	8	4.1%	

[a] Correct answer to Q11 was "plants."
[b] Incorrect answers to Q11 were "meat," "all" and "don't know."
* $p < .05$
** $p < .01$

Occurrence identification

Data from Question 12 ("Which one of the following statements [regarding occurrence] do you agree with most?") were also analyzed only for the phytochemically aware subgroup. Again, about two-thirds of the subgroup selected the correct choice of "occurs naturally," while nearly one-third didn't know (29.6%). A small percent (3.1%) selected the incorrect choice of "added to food." Table 30 summarizes this data.

Table 30. Respondents' awareness of how phytochemicals occur in food (frequencies and percentages, N=196)

OCCURRENCE	Q12: Which one of the following statements do you agree with most?	
	Frequency	% of N
Occurs naturally	132	67.3%
Don't know	58	29.6%
Added to food	6	3.1%

As summarized in Table 31, the correlation between the variables was significant, positive and moderate (judgment of function rho(194) = .594, $p < .01$, coefficient of determination 35.3%; certainty of function rho(194) = .584, $p < .01$, coefficient of determination 34.1%). Therefore, understanding how phytochemicals occur in food, from both the perspective of judgment and certainty, and identification of phytochemical occurrence were dependent upon each other, and their shared variance was 34.1% – 35.3%. "Phyto aware" subjects who correctly identified the occurrence of phytochemicals in food tended to view function positively (47.4%) and be more specific about function (31.1%). Those who incorrectly identified the foods' source were also not sure of function (30.1%).

Table 31. Identification of phytochemical occurrence by "phyto aware" subjects (frequencies and Spearman's rho, N=196)

SUBGROUP LEVELS	IDENTIFICATION OF PHYTO OCCURRENCE				rho
	Correct [a]		Incorrect [b]		
	Freq	%	Freq	%	
Judgment of function					.594**
Not sure	38	19.4%	59	30.1%	
Positive (helps)	93	47.4%	5	2.6%	
Negative (harms)	1	0.5%	0	0.0%	
Certainty of function					.584**
Not sure	38	19.4%	59	30.1%	
Somehow changes	33	16.8%	4	2.0%	
Specifically changes	61	31.1%	1	0.5%	

[a] Correct answer to Q12 was "occurs naturally."

[b] Incorrect answers to Q12 were "added to food" and "don't know."

* $p < .05$

** $p < .01$

Objective 5:
Summarize this population's general health beliefs.

Two questions tested the respondents' reaction to a set of food guidelines and a set of health statements. Question 1 listed 15 guidelines and asked, "How important are these food guidelines to your personal diet?" Question 5 listed 10 statements and asked, "How much do you agree or disagree with the following statements?" Responses for both questions were set on a five-point scale.

Food guidelines

Data for Question 1 (importance of food guidelines) are presented in two tables. Frequencies, percentages and means for the five-point agreement scale are found in Table 32. Spearman's rho correlation coefficients for all respondent's agreement with the guidelines are found in Table 33.

Table 32. Importance of various food guidelines to respondents' personal diets (frequencies and means)

GUIDELINE	N	Q1: How important to your personal diet are these food guidelines? (frequency)										MEAN ± SD
		Not at all important		Not too important		Somewhat important		Very important		Don't know		
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	
Salt/sodium*	378	6	1.6%	45	11.8%	123	32.4%	203	53.4%	1	0.3%	3.39 ± 0.76
Fat*	377	3	0.8%	14	3.7%	99	26.1%	261	68.7%	0	0.0%	3.64 ± 0.59
Saturated fat*	378	2	0.5%	8	2.1%	76	20.0%	291	76.6%	1	0.3%	3.74 ± 0.52
Sugar*	375	3	0.8%	31	8.2%	159	41.8%	182	47.9%	0	0.0%	3.39 ± 0.67
Fiber**	379	4	1.1%	9	2.4%	120	31.6%	246	64.7%	0	0.0%	3.60 ± 0.59
Variety**	376	2	0.5%	14	3.7%	101	26.6%	259	68.2%	0	0.0%	3.64 ± 0.58
Desirable weight**	378	2	0.5%	9	2.4%	89	23.4%	278	73.2%	0	0.0%	3.70 ± 0.54
Cholesterol*	379	4	1.1%	28	7.4%	118	31.1%	229	60.3%	0	0.0%	3.51 ± 0.68
Meat*	377	18	4.7%	68	17.9%	171	45.0%	119	31.3%	1	0.3%	3.04 ± 0.83
Fruits, vegetables**	379	1	0.3%	12	3.2%	85	22.4%	281	73.9%	0	0.0%	3.70 ± 0.54
Breads**	373	12	3.2%	55	14.5%	157	41.3%	148	38.9%	1	0.3%	3.19 ± 0.80
Moderation**	378	2	0.5%	16	4.2%	132	34.7%	228	60.0%	0	0.0%	3.55 ± 0.60
Balance**	376	7	1.8%	37	9.7%	131	34.5%	200	52.6%	1	0.3%	3.40 ± 0.74
Unprocessed foods**	373	26	6.8%	66	17.4%	160	42.1%	113	29.7%	8	2.1%	2.99 ± 0.88
Organic foods**	375	63	16.8%	135	36.0%	109	29.1%	53	14.1%	15	4.0%	2.42 ± 0.94

Agreement scale: 1 = Not at all important, 2 = Not too important, 3 = Somewhat important, 4 = Very important

* Language on survey indicated avoidance or limiting of these items

** Language on survey indicated eating plenty of these items or achieving this guideline

On the five-point scale (Table 32), avoiding too much saturated fat (3.74 ± 0.52), eating plenty of fruits and vegetables (3.70 ± 0.54), and maintaining a desirable weight (3.70 ± 0.54) were most important to the respondents. The noteworthy result was the high level of importance most respondents gave to the full list of guidelines. Only two guidelines had means falling below the "somewhat important" value: eating unprocessed foods (2.99 ± 0.88) and eating organic foods (2.42 ± 0.94).

Some of these food guidelines have also been assessed by participants of the USDA Diet and Health Knowledge Survey (DHKS) (USDA Food Surveys Research Group, 1994-96). Overall, the same guidelines were important to each set of participants and in roughly the same percentages (80-95% of DHKS subjects, 86%-97% of thesis project subjects). Eating fruits and vegetables (92.2% DHKS, 96.3% thesis) and maintaining a healthy (DHKS) or desirable (thesis) weight (94.7 DHKS, 96.6% thesis) were almost equally important to both groups. However, choosing a diet low in saturated fat (84.8% DHKS, 96.6% thesis), low in total fat (88.9 % DHKS, 94.8% thesis), and with adequate fiber (85.2% DHKS, 96.3% thesis) were important to greater percentages of the thesis respondents. Data from both sets of subjects show the same pattern for choosing a diet with plenty of breads, cereals, rice and pasta: important to at least three-quarters of adults (74.4% DHKS, 80.2% thesis) but more moderately when compared to the other guidelines because of the split between "somewhat important" (42.8% DHKS, 41.3% thesis) and "very important" (31.6% DHKS, 38.9% thesis).

In the Spearman's rho correlation coefficient test (Table 33), almost all food guidelines proved to be positively and significantly related, either weakly or moderately. (The only correlation which did not prove to be significant was the relationship between eating a variety of foods and avoiding too much fat; rho(375) = .094, $p > .05$). The strongest relationships were moderate positive correlations between eating organic foods and eating unprocessed foods (rho(363) = .613, $p < .01$) and avoiding too much fat and avoiding too much saturated fat (rho(375) = .538, $p < .01$). This level of significance, both in number of relationships and degree of relationships (most $p < .01$), indicates that respondents' beliefs in the importance of any one guideline favored them believing in the importance of all of the guidelines.

Table 33. Correlational patterns of food guideline importance (Spearman's rho)

VARIABLE [a]	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	.377**	.270**	.366**	.261**	.167**	.135**	.430**	.347**	.191**	.237**	.154**	.235**	.237**	.305**
2		.538**	.382**	.271**	.094	.279**	.438**	.330**	.216*	.256**	.244**	.295**	.171**	.140**
3			.384**	.311**	.168**	.229**	.346**	.289**	.268**	.253**	.233**	.302**	.357**	.264**
4				.382**	.146**	.204**	.349**	.333**	.265**	.187**	.324**	.278**	.395**	.384**
5					.397**	.306**	.384**	.388**	.457**	.314**	.375**	.425**	.471**	.390**
6						.312**	.214**	.182**	.466**	.343**	.311**	.420**	.304**	.236**
7							.324**	.218**	.310**	.244**	.432**	.334**	.161**	.196**
8								.411**	.249**	.259**	.225**	.294**	.200**	.304**
9									.443**	.367**	.362**	.329**	.411**	.443**
10										.394**	.391**	.492**	.437**	.375**
11											.321**	.437**	.304**	.312**
12												.479**	.381**	.272**
13													.353**	.292**
14														.613**

[a] 1=Avoid too much salt; 2=avoid too much fat; 3 = avoid too much saturated fat; 4=avoid too much sugar; 5= eat foods with adequate fiber; 6=eat a variety of foods; 7=maintain a desirable weight; 8=avoid too much cholesterol; 9=limit meat consumption; 10=eat plenty of fruits and vegetables; 11=eat plenty of breads, cereals, rice, pasta; 12=eat in moderation; 13=eat a balanced diet (Food Guide Pyramid); 14=eat unprocessed foods; 15=eat organic foods.

* $p < .05$

** $p < .01$

Health statements

Data for Question 5 (agreement with health statements) are also presented in two tables. Frequencies, percentages and means for the five-point agreement scale are found in Table 34. Spearman's rho correlation coefficients for all respondents' agreements with the statements are found in Table 35.

Overall, most of the means (8 out of 10) are in the middle of the scale (2.07 – 3.07), values which are associated with "somewhat disagree" or "somewhat agree." This pattern suggests uncertainty or ambivalence on the part of the respondents toward the bulk of the guidelines. Strong feelings (of agreement, in this case) were shown only for the link between diet and disease (3.62 ± 0.56) and the varying health benefits of different fiber types (3.31 ± 0.65). Some respondents backed up this finding with comments such as “I believe improved diet will help stave off age-related diseases such as heart disease and diabetes” or “Eating fuels our bodies, keeps U.S. healthy and give U.S. energy. Please tell U.S. more!” Other respondents, speaking more retrospectively, commented “I am a three-time survivor of breast cancer. My life has been full of good food, exercise and positive thinking. . . .” or “I have eaten healthy all of my life and still developed breast cancer. . . .” And one respondent commented, “6’2”, 222 lbs. Eat as much as I want of whatever I want and am healthy as a horse.”

Table 34. Respondents’ level of agreement with various health statements (frequencies and means)

STATEMENT	N	Q5: How much do you agree or disagree with the following statements? (frequency)										MEAN ± SD
		Strongly disagree		Somewhat disagree		Somewhat Agree		Strongly Agree		Don’t know		
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	
Some people are born to be fat and some thin.	370	68	17.9%	66	17.4%	202	53.4%	34	8.9%	7	1.8%	2.55 ± 0.90
Different kinds of fiber in food have different health benefits.	334	4	1.1%	23	6.1%	174	45.8%	133	35.0%	41	10.8 %	3.31 ± 0.65
Starchy foods, like potatoes and rice, make people fat.	367	108	28.4%	135	35.5%	91	23.9%	33	8.7%	7	1.8%	2.13 ± 0.94
So many recommendations about healthy ways to eat, hard to know what to believe.	377	32	8.4%	32	8.4%	191	50.3%	122	32.1%	2	0.5%	3.07 ± 0.86
There is too much fuss about food and health aspects in the media.	363	104	27.4%	107	28.2%	115	30.3%	37	9.7%	11	2.9%	2.23 ± 0.98
Eating a variety of foods probably gives you all the vitamins and minerals you need.	376	58	15.3%	88	23.2%	169	44.5%	61	16.1%	2	0.5%	2.62 ± 0.93
What you eat can make a big difference in preventing a disease, like heart disease or cancer.	376	3	0.8%	5	1.3%	125	32.9%	243	63.9%	3	0.8%	3.62 ± 0.56
When selecting foods to eat, taste is more important to me than nutritional value.	378	93	24.5%	117	30.8%	143	37.6%	25	6.6%	1	0.3%	2.26 ± 0.91
Overall, I believe my current diet is healthy.	373	7	1.8%	60	15.8%	225	59.2%	81	21.3%	5	0.5%	3.02 ± 0.67
I am pleased with my current weight.	377	153	40.3%	94	24.7%	82	21.6%	48	12.6%	0	0.0%	2.07 ± 1.06

Agreement scale: 1 = Strongly disagree, 2 = Somewhat disagree, 3 = Somewhat agree, 4 = Strongly agree

Some of these health beliefs have also been assessed by participants of the USDA Diet and Health Knowledge Survey (DHKS) (USDA Food Surveys Research Group, 1994-96). Comparisons between the data from that survey and this thesis project indicate the following:

- Great percentages of each set of subjects agree with statements about the link between diet and disease (90.9% DHKS, 96.8% thesis) and confusion due to too many health recommendations (80.8% DHKS, 82.4% thesis). The difference in the diet-disease question may be due to the language used in each survey; the DHKS survey talked of diet influencing the chance of “getting” a disease, while the thesis survey modified the statement to read “ . . . chance of preventing a disease. . . .” The language was changed to clarify the nature of diet as preventive; pretest survey respondents noted that the DHKS language could be interpreted as diet either preventing or causing disease.

- More DHKS respondents (75.5%) than thesis subjects (60.6%) agreed that a varied diet probably provides all needed vitamins and minerals. Follow-up research is needed to identify the reasons for this difference, which may included greater reliance upon vitamin/mineral supplements or distrust of food supply, preparation techniques or storage.

- Similar percentages of each set of subjects disagreed with the statement which read, “Starchy foods, like potatoes and rice, make people fat” (62.3% DHKS, 63.9% thesis).

- In each survey, agreement with the statement “Some people are born to be fat and some thin” followed a 3:2 ratio. However, the majority percentage changed per survey. In DHKS, 60.3% somewhat or strongly *agreed* with the statement. In the thesis project survey, 62.3% somewhat or strongly *disagreed* with the statement. This discrepancy could again be explained by language. The DHKS language reads, “Some people are born to be fat and some thin; there is not much you can do to change this.” Pretest survey respondents commented on the “double-barrelled” nature of the language, in that the question asked for agreement with two statements: that genetics can influence weight, and that attempts to change genetically-preset weight won’t work. To clarify the question’s intent, the thesis project statement deleted the language “there is not much you can do to change this.”

A separate DHKS question asked respondents to rate the importance of nutrition and taste when buying food. This question corresponds to one of the health beliefs listed in the thesis project survey. Nearly all of the DHKS respondents (≥94%) found both factors to be important, with taste having a decided edge (83.0%) over nutrition (62.3%) for "very important." This data is contrary to responses from the thesis project subjects, who were more ambivalent and gave a slight edge to nutrition (55.3%) over taste (44.2%). Percentages were also smaller for people who "strongly" favored one factor (taste 6.6%, nutrition 24.5%) over the other.

In the Spearman's rho correlation coefficient test (Table 35), 31 of the 45 health statement correlations proved to be significant: 20 positively and 11 negatively, 2 moderately and 29 weakly. The strongest relationships were moderate positive correlations between satisfaction with current diet and current weight (rho(375) = .530, $p < .01$) and between excessive coverage of nutrition news and taste-versus-nutrition as selection criteria (rho(376) = .321, $p < .01$).

Table 35. Correlational patterns of health statement agreement (Spearman's rho)

VARIABLE a	2	3	4	5	6	7	8	9	10
1	.006	.215**	.274**	.224**	.136**	-.044	.253**	-.097	-.181**
2		.011	-.124*	-.114*	-.118*	.146**	-.133*	.229**	.192**
3			.230**	.134*	.099	.039	.143**	-.067	-.107*
4				.298**	.155**	-.079	.258**	-.143**	-.176**
5					.289**	-.137**	.321**	-.078	-.022
6						-.016	.195**	-.044	.016
7							-.294**	.168**	.108*
8								-.281**	-.195**
9									.530**

[a] 1=Some people are born to be thin or fat, 2=different types of fiber have different benefits, 3=starchy foods make people fat, 4=it's hard to know what to believe, 5=there's too much fuss about nutrition in the media, 6=variety of food provides all needed vitamins and minerals, 7=what you eat can help prevent disease, 8=taste is more important than nutrition in selecting food, 9=current diet is healthy, 10=pleased with current weight.

* $p < .05$

** $p < .01$

Regarding diet and weight, two-thirds of respondents (cumulative for "strongly disagree" and "somewhat disagree") indicated displeasure with their current weight (2.07 ± 1.06). Comments included "I am always struggling to lose weight . . . lose 10-20 lbs and then gain back 30"; "I gain weight easily";

or “My body has changed since I turned 40. I have to eat less and exercise more, and I’m still overweight by 15 pounds. . . .” However, most respondents (225 individuals or 60.3%) somewhat agree (3.02 $\pm$ 0.67) that their current diets are healthy. The correlation coefficient would indicate that satisfaction with diet and weight would both be high or both would be low. Data from Question 1 (food guidelines) would tend to support the correlation, as nearly all respondents (278 individuals or 73.5%) reported that they highly value a diet that supports a desirable weight. A third variable and/or further questioning of the respondents may account for this discrepancy.

Regarding the correlation between media coverage and selection critiera, almost as many respondents agreed as disagreed to statements concerning excessive coverage of nutrition news (2.23 $\pm$ 0.98) and taste-versus-nutrition as selection criteria (2.26 $\pm$ 0.91; rho(376) = .321, $p < .01$). This positive moderate correlation indicates that respondents who like the level of media coverage given to health and food also tend to consider nutrition before taste when selecting food.

The strongest negative relationship was the weak correlation between the dietary link to disease (3.62 $\pm$ 0.56) and taste-versus-nutrition as a selection criteria (2.26 $\pm$ 0.91) (rho(376) = -.294, $p < .01$). Therefore, subjects who subscribe to the link between diet and disease don’t discount taste as a factor when selecting food but give slightly more importance to nutritional value.

Hypothesis:
There is a positive correlation between the seeking of nutrition information, food and health beliefs, and a deliberate inclusion of additional plant-based foods into the daily diet.

To measure their seeking of nutrition information, respondents were asked to identify their sources of accurate information (Questions 2 and 3) and to indicate their awareness of five public health messages (Question 4).

Previous sections of this thesis have reported the results concerning food and health beliefs of all respondents (Objective 4: “Summarize this population’s general health beliefs”) and inclusion of additional plant-based foods into the daily diet (Objective 2: “Estimate from the subset the number of adults who have increased their consumption of fruits, vegetables and whole grains”). This section will narrow the discussion of results to food and health beliefs held by the “more phyto” and the “phyto motivated” subgroups. The discussion concerning nutritional information will focus on responses from all subjects as well as from these same two subgroups.

Information sources

Question 2 asked, “Which media do you use for accurate information about nutrition?,” and respondents could check as many of the six choices (including “other”) as appropriate. Question 3 asked, “Who do you go to for accurate information about nutrition?,” and respondents could check as many of the five choices (including “other”) as appropriate. Each question provided space for respondents to identify specific magazines, books or other sources.

Questions 2 and 3 were combined into one during data entry, due to the large number of repeat answers, refinements, or common new options written into “other.”

Examples of repeating include the respondent who checked “Books” in Question 2 and wrote it in as an “Other” choice in Question 3, or the respondent who wrote “Doctor” in Question 2’s “Other” and checked “Medical professional” in Question 3.

The most common refinement was attached to the “Medical professional” or “Friend/family member” choices. For example, one respondent checked “Medical professional” and wrote “R.D.” next to this choice.

The “other” category was also recoded. Before the data was combined, 106 respondents reported use of specific information sources beyond the five media types and six personal contacts listed in Questions 2 and 3. Many indicated reliance upon themselves (37 respondents), by answering “me,” “my personal research” or “reading on my own,” or upon various newsletters (44 respondents). These responses were recoded and removed from the “other” classification. (Table 36 reflects the recoded data.) After the data was combined, 32 respondents remained in the “other” category. The unique sources of information used by these respondents included trainer, natural health care or alternative health care provider, chiropractor, massage therapist, health program at local church, or flyer from health food store.

In the first step toward testing the hypothesis, the combined Questions 2 and 3 data were cross-tabulated with the “more phyto” and “not more phyto” subgroups in order to isolate information-seeking behavior of people who reported consuming more plant-based foods. Results are summarized in Table 36. Correlational data between plant food intake/motivation and information seeking is summarized in Table 37.

Magazines and medical professionals were cited as the more popular sources of accurate nutritional information by all respondents (77.9% and 58.9%, respectively) and by subjects in the “more phyto” subgroup (80.0% and 62.5% respectively). This finding is not surprising: in general, because the population is based on magazine subscribers and, specifically, because “more phyto” subjects make up at least 75% of the users of each type of information source. Significant positive and weak relationships were found with magazines (“more phyto” rho(378) = .112, $p < .05$, and “phyto motivated” rho(305) = .132, $p < .05$). Significant and weak relationships were also found involving use of medical professionals, but the relationship is positive for the “more phyto” respondents (rho(378) = .161, $p < .01$) and negative for the “phyto motivated” subgroup (rho(305) = -.197, $p < .01$).

Table 36. Respondents' use of nutritional information sources (frequencies and percentages)

INFO SOURCE	ALL RESPONDENTS		NOT MORE PHYTO			MORE PHYTO			PHYTO MOTIVATED		
	Freq	% (N=380)	Freq	% using media type (N=65)	% within media type	Freq	% using media type (N=315)	% within media type	Freq	% using media type (N=62)	% within media type
Magazines	296	77.9%	44	67.7%	14.9%	252	80.0%	85.1%	56	90.3%	18.9%
Medical professional	224	58.9%	27	41.5%	12.1%	197	62.5%	87.9%	27	43.5%	12.1%
TV	173	45.5%	34	52.3%	19.7%	139	44.1%	80.3%	22	35.5%	12.7%
Newspapers	162	42.6%	31	47.7%	19.1%	131	41.6%	80.9%	31	50.0%	19.1%
Books	149	39.2%	23	35.4%	15.4%	126	40.0%	84.6%	30	48.4%	20.1%
Internet	111	29.2%	13	20.0%	11.7%	98	31.1%	88.3%	22	35.5%	19.8%
Health store	94	24.7%	10	15.4%	10.6%	84	26.7%	89.4%	20	32.3%	21.3%
Friend/family	93	24.5%	22	33.8%	23.7%	71	22.5%	76.3%	14	22.6%	15.0%
Other	32	8.4%	8	12.3%	25.0%	24	7.6%	75.0%	5	8.1%	18.7%
Weight-loss program	58	15.3%	5	7.7%	8.6%	53	16.8%	91.4%	7	11.3%	12.1%
Radio	47	12.4%	6	9.2%	12.8%	41	13.0%	87.2%	12	19.4%	25.5%
Newsletters	44	11.6%	4	6.2%	9.1%	40	12.7%	90.9%	12	19.4%	27.3%
Educator/teacher	43	11.3%	8	12.3%	18.6%	35	11.1%	81.4%	5	8.1%	11.6%
Me/my research/reading	37	9.7%	6	9.2%	16.2%	31	9.8%	83.8%	14	22.6%	37.8%
Dietitian/nutritionist	10	2.6%	0	0.0%	0.0%	10	3.2%	100.0%	2	3.2%	20.0%
Friend/family & med pro	6	1.6%	1	1.5%	16.7%	5	1.6%	83.3%	1	1.6%	16.7%
Friend/family & dietitian	4	1.1%	0	0.0%	0.0%	4	1.3%	100.0%	2	3.2%	50.0%
Med pro & dietitian	2	0.5%	0	0.0%	0.0%	2	0.6%	100.0%	1	1.6%	50.0%

Table 37. Correlations between plant food intake and use of information sources (Spearman's rho)

VARIABLE	EAT MORE PHYTO FOODS		PHYTO MOTIVATED	
	N	rho	N	rho
Magazines	380	.112*	307	.132*
Medical professional	380	.161**	307	-.197**
TV	380	-.062	307	-.086
Newspapers	380	-.046	307	.081
Books	380	.036	307	.089
Internet	380	.092	307	.049
Health store	380	.098	307	.067
Friend/family	380	-.099	307	-.007
Other	380	-.064	307	.005
Weight-loss program	380	.096	307	-.076
Radio	380	.043	307	.089
Newsletters	380	.077	307	.095
Educator/teacher	380	-.014	307	-.048
Me/my research/reading	380	.008	307	.217**
Dietitian/nutritionist	380	.075	307	-.001
Friend/family & med pro	380	.001	307	-.001
Friend/family & dietitian	380	.047	307	.085
Med pro & dietitian	380	.033	307	.060

* $p < .05$ ** $p < .01$

While the smaller "not more phyto" subgroup also preferred magazines (67.7%) as their top nutritional information source, their second most popular choice was television (52.3%). Newspapers (41.6% "more phyto," 47.7% "not more phyto") and books (40.0% "more phyto," 35.4% "not more phyto") were also indicated frequently as sources by both subgroups. None of these relationships were found to be significant.

Within the "phyto motivated" subgroup, an additional relationship (positive) was found with "my research" (rho(313) = .217, $p < .01$). Therefore, increased plant food intake is associated with getting nutritional information from magazines (80.0%) or medical professionals (62.5%). But when phytochemicals are one of the motivations for eating more plant foods, fewer subjects (43.5%) turn to medical professionals. These "phyto motivated" subjects instead rely more upon their own reading and research (22.6%) than do other subjects with different motivations (9.8%).

Few respondents (16 individuals or 4.2% of all respondents) indicated consulting with a dietitian, a medical professional "whose training and experiences is in the area of nutrition, and who has the ability to apply that information to the dietary needs of the healthy and sick" (Thomas 1993). All of the 16 were part of the "more phyto" subgroup. None of the relationships involving the four "dietitian" variables and information seeking were found to be significant.

Many respondents named specific titles of books (51 titles, 15 general types); magazines (54 titles; 9 general types); newsletters (21 titles, 2 general types) and other sources (32) they turned to for accurate nutrition information (see Appendix 8). The respondents who used television (45.5%) or the Internet (29.2%) were not as forthcoming. The few specific sources cited in these media were television news programs (2 respondents), the "Discovery Channel" on cable television (1 respondent) and Dr. Andrew Weil's Web site (1 respondent).

Because the sample was drawn from a list of magazine subscribers and/or book purchasers, the assumption was made that most of the respondents would actively seek nutrition information. The data (Table 38) verifies this assumption, as only 2 of the 380 respondents checked none of the choices. Virtually all respondents used more than one type of source, with two-to-five types of

Table 38. Respondents' use of multiple sources for information about nutrition (frequencies and percentages)

NUMBER OF SOURCES	Q2 & Q3: Which media do you use / who do you go to for accurate information about nutrition?							
	All respondents (N=380)		Not more phyto [a] (N=65)		More phyto [b] (N=315)		Phyto motivated [c] (N=62)	
	Freq	% of N	Freq	% of N	Freq	% of N	Freq	% of N
0	2	0.5%	1	1.5%	1	0.3%	1	1.6%
1	15	3.9%	4	6.2%	11	3.5%	2	3.2%
2	47	12.4%	8	12.3%	39	12.4%	3	4.8%
3	91	23.9%	20	30.8%	71	22.5%	10	16.1%
4	83	21.8%	12	18.5%	71	22.5%	22	35.5%
5	61	16.1%	10	15.4%	51	16.2%	7	11.3%
6	37	9.7%	7	10.8%	30	9.5%	8	12.9%
7	25	6.6%	2	3.1%	23	7.3%	4	6.5%
8	11	2.9%	1	1.5%	10	32.%	2	3.2%
9	6	1.6%	0	0.0%	6	1.9%	2	3.2%
10	2	0.5%	0	0.0%	2	0.6%	1	1.6%

[a] Spearman's rho(378) = .095, $p > .05$; mean, SD of 3.72 ± 1.64
[b] Spearman's rho(378) = .095, $p > .05$; mean, SD of 4.24 ± 1.86
c Spearman's rho(305) = .083, $p > .05$; mean, SD of 4.53 ± 1.95

sources (73.9%) being typical. Only 15 respondents (3.9% of N) used a single type of information source. The means would suggest that plant food intake and phytochemical motivation are somewhat associated with using the most sources ("not more phyto" 3.72 ± 1.64, "more phyto" 4.24 ± 1.86, and "phyto motivated 4.53 ± 1.95), but Spearman's rho correlation coefficiency tests found this relationship to be extremely weak, positive and not significant ("eat more phyto foods" rho(378) = .095, p > .05; "phyto motivated" rho(305) = 0.83, p > .05). Plant food intake/phytochemical motivation and use of multiple information sources, therefore, are independent variables.

A Spearman's rho correlation was also calculated to detect correlational patterns of information seeking (Table 39). Weak correlations, both positive and negative, were found, with 26 of the correlations being significant and 143 not significant. The strongest of the significant relationships was a positive correlation between use of newspapers and television (rho(378) = 0.291, p < .01) and

Table 39. Correlational patterns of information seeking (Spearman's rho)

VARIABLE[a]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	-.032	.003	.075	.051	-.006	.129*	.023	-.021	-.038	.008	.054	.090	.089	.048	.017	.055	.039
2		.118*	.038	.035	.077	.119*	-.035	-.094	.072	.037	-.016	.095	-.249**	-.063	-.066	-.019	-.087
3			.291**	.034	.029	.076	.094	-.049	.023	.170**	-.083	.074	-.104*	.015	.011	-.043	-.066
4				.005	.020	-.050	.103*	-.089	.004	.210**	.021	.112*	.022	.024	-.067	.068	.011
5					.006	.177**	.032	.145**	.034	.058	.114*	.138**	.063	.003	-.015	-.030	.016
6						.128*	-.083	-.007	.033	.163**	-.070	.008	-.016	.039	-.081	.047	.033
7							.128*	-.086	.062	.100	.098	.123*	-.065	.020	-.024	-.059	-.042
8								-.040	.014	-.065	-.015	.125*	-.146**	-.017	-.072	-.059	-.041
9									.029	.001	.068	.131*	-.068	.069	-.038	-.031	-.022
10										.018	-.016	.126*	-.139**	-.070	-.054	-.044	-.031
11											.139**	.042	-.043	-.012	.017	-.039	-.027
12												.027	.075	.146**	-.046	-.037	-.026
13													-.089	-.007	-.045	-.037	-.026
14														.001	.030	-.034	.099
15															.111*	-.017	-.012
16																-.013	-.009
17																	-.008

[a] 1=Magazines, 2=medical professional, 3=TV, 4=newspapers, 5=books, 6-internet, 7=health store, 8=friend/family, 9=other, 10=weight-loss program, 11=radio, 12=newsletters, 13=educator/teacher, 14=me/my research/reading, 15=dietitian/nutritionist, 16=friend/family & med pro, 17=friend/family & dietitian, 18=med pro & dietitian

* p < .05

** p < .01

a negative relationship between use of a medical professional and use of own research (rho(378) = -0.249, $p < .01$). Therefore, respondents who learn about nutrition from newspapers are slightly inclined to also turn to television for this information. Respondents who rely on their own research tend to not make as much use of medical professionals for nutritional information, except for those in the “more phyto” subgroup, who showed a slight tendency to use both medical professionals and their own research.

The greatest number of significant relationships involved use of health store personnel (six) and use of educator/teacher (six); these 12 relationships were all weak and positive. The only information sources which were not found to be significant to use of any other source were “friend/family and dietitian” and “medical professional and dietitan.” As noted earlier, few respondents (16 individuals or 4.2% of all respondents) indicated consulting with a dietitian.

Public health messages

Question 4 asked, “To what degree have you heard about these public health messages?” Five messages were listed, and respondents selected one of three ordinal choices (heard much, heard something, heard nothing) to indicate their level of awareness.

The data is presented in five tables. Frequencies and means for the three-point scale are found in Table 40. Note that this table presents data for all respondents answering Question 4. Frequencies and percentages, isolated for the “more phyto” and “not more phyto” subgroups, are found in Table 41. Frequencies and percentages, isolated for the “phyto motivated” subgroup, are found in Table 42. Correlational patterns between awareness of the different campaigns and relationships between awareness and plant food intake are presented in Tables 43 and 44.

Data in Table 40 indicates that respondents had heard much about the two oldest and most nationally publicized campaigns, the Food Guide Pyramid (1.27 $\pm$ 0.544) and the Basic Four Food Groups (1.25 $\pm$ 0.50). This data is similar to other research concerning the Food Guide Pyramid, which indicates that more than two-thirds of American adults are aware of the campaign (Davis, Britten, and Mayers 2001). The Basic Four Food Groups was the USDA’s official food plan for 35 years. The survey respondents had heard something about the newer national campaign (5-A-Day, 2.02 $\pm$ 0.87) and nearly nothing about the two campaigns marketed to specific groups (Healthy People, 2.02 ± 0.87; and 1% or Less, 2.87 ± 0.40). Awareness seems to track with length of time and scope of publicity.

Table 40. Respondents' awareness of public health messages (frequencies and means)

MESSAGE	N	Q4: To what degree have you heard about these public health messages?			MEAN ± SD
		Heard much about	Heard somehing about	Heard nothing about	
Food Guide Pyramid	376	291	67	18	1.27 ± 0.54
Basic Four Food Groups	376	292	73	11	1.25 ± 0.50
5-A-Day	373	138	88	147	2.02 ± 0.87
Healthy People	369	7	38	324	2.86 ± 0.40
1% or Less	361	8	30	323	2.87 ± 0.39

Awareness scale: 1 = Heard much about, 2 = Heard something about, 3 = Heard nothing about

Tables 41 and 42 compare the awareness indicated by the plant food intake subgroups ("more phyto," "not more phyto" and "phyto motivated") to the public health messages. In all subgroups, more than 75% of respondents had heard much about the Food Guide Pyramid and the Basic Four Food Groups, while more than 86% of respondents had heard nothing about the Healthy People or 1% or Less campaigns. The difference between the subgroups appears in their awareness of the 5-A-Day campaign. A greater percentage of "not more phyto" respondents (51.6%) than "more phyto" respondents (37.0%) or "phyto motivated" subjects (35.5%) had heard nothing about the campaign.

Table 41. Respondents' awareness of public health messages, based on plant food intake (frequencies and percentages)

MESSAGE	MORE PHYTO							NOT MORE PHYTO						
	N	Heard much		Heard something		Heard nothing		N	Heard much		Heard something		Heard nothing	
		Freq	%	Freq	%	Freq	%		Freq	%	Freq	%	Freq	%
Food Guide Pyramid	314	243	77.4%	58	18.5%	13	4.2%	62	48	77.4%	9	14.5%	5	8.1%
Basic Four Food Groups	313	243	77.6%	62	19.8%	8	2.5%	63	49	77.8%	11	17.5%	3	4.8%
5-A-Day	311	121	38.9%	75	24.1%	115	37.0%	62	17	27.4%	13	21.0%	32	51.6%
Healthy People	308	7	2.3%	33	10.7%	268	87.0%	61	0	0%	5	8.2%	56	91.8%
1% or Less	301	8	2.7%	25	8.3%	268	89.0%	60	0	0%	5	8.3%	55	91.7%

Table 42. Respondents' awareness of public health messages, based on motivation for plant food intake (frequencies and percentages)

MESSAGE	PHYTO MOTIVATED									
	N	Heard much			Heard something			Heard nothing		
		Freq	%	% of subgroup	Freq	%	% of subgroup	Freq	%	% of subgroup
Food Guide Pyramid	306	51	16.7%	82.3%	10	3.3%	16.1%	1	0.3%	1.6%
Basic Four Food Groups	305	48	15.7%	77.4%	12	3.9%	19.4%	2	0.7%	3.2%
5-A-Day	303	32	10.6%	51.6%	8	2.6%	12.9%	22	7.3%	35.5%
Healthy People	300	2	0.7%	3.3%	6	2.0%	10.0%	52	17.3%	86.7%
1% or Less	294	2	0.7%	3.3%	3	1.0%	5.0%	55	18.7%	91.7%

Note: "Phyto motivated" subgroup N=62.

This result makes sense, since the 5-A-Day campaign focuses on increasing intake of fruits and vegetables. Nearly 70.0% of the "more phyto" respondents (Table 10) and 84.0-87.0% of "phyto motivated" subjects (Table 15) indicated that they had increased their intake of fruit, vegetables, whole grains, bean or nut/seeds, while "not more phyto" respondents indicated a drop or no change in their intake of these foods.

Spearman's rho correlation cofficiency tests were run to detect correlational patterns between awareness of public health messages (Table 43) and to test relationships between awareness and plant food intake (Table 44).

Table 43. Correlational patterns between awareness of public health messages (Spearman's rho)

MESSAGE	Basic Four Food Groups	5-A-Day	Healthy People	1% or Less
Food Guide Pyramid	.548**	.279**	.020	.063
Basic Four Food Groups		.246**	.106*	.122*
5-A-Day			.210**	.173**
Healthy People				.482**

* $p < 0.05$ level ** $p < .01$ level

Table 44. Correlations between plant food intake and awareness of public health messages (Spearman's rho)

MESSAGE	EAT MORE PHYTO FOODS		PHYTO MOTIVATED	
	N	rho	N	rho
Food Guide Pyramid	376	.008	306	.065
Basic Four Food Groups	376	.003	305	-.002
5-A-Day	373	.112*	303	.094
Healthy People	369	.056	300	.028
1 % or Less	361	.035	294	-.024

* p < .05

The Spearman's rho test identified 9 significant relationships (out of 15), all positive, between the health campaigns. The strongest was a moderate positive correlation found between awareness of the Food Guide Pyramid and the Basic Four Food Groups (rho(374) = 0.548, p < .01). A weak positive correlation was found between plant food intake and awareness of the 5-A-Day campaign (rho(373) = 0.112, p < .05). The other seven significant relationships were positive and weak.

A Spearman's rho test was also calculated for the relationships between public health messages and the "phyto motivated" subgroup. Extremely weak correlations that were not significant were found (rho(294-306) = -.024 to .094, p > .05). Therefore, awareness of public health messages and phytochemical awareness as a specific motivator of increased plant food intake were not related.

The descriptive frequencies and Spearman's rho correlations suggest two tendencies. First, a weak but significant and positive relationship existed between plant food intake and awareness of the 5-A Day campaign, a national campaign which promotes fruit and vegetable consumption. Awareness of any of the five campaigns, however, was not related to subjects' selection of plant foods for phyto-chemical health benefits. Therefore, people who had heard at least something about the 5-A-Day campaign tended to eat more plant foods but not because of phytochemicals. Second, weak-to-moderate positive, significant relationships existed between awareness of most of the public health messages within the full group of respondents. Therefore, being aware of one campaign increased the likelihood of the respondents being aware of other campaigns.

Food guidelines

The data will be examined first for patterns, regardless of significance. The means (found in Tables 45 and 46) indicate that all subgroups ("more phyto," "not more phyto" and "phyto motivated") place considerable importance (between "somewhat important" and "very important") on most of the guidelines. The pattern follows as such:

"Not more phyto" means < "More phyto" means < "Phyto motivated" means

This pattern is logical, as the progressively higher values are consistent with habits and beliefs belonging to people who make deliberate food choices (in this case, plant foods).

Each subgroup indicated slightly less importance (between "not too important" and "somewhat important") for the guideline regarding organic food intake. For example, in the "more phyto" sub-group, as many respondents found it "not at all important" (46 individuals) as "very important" (46 individuals), and more respondents overall found it "not important" (55.0%) than "important" (45.0%). Of all the guidelines, "eat organic food" had the greatest number of "don't knows" (15 total, 11 "more phyto," 4 "not more phyto").

The "not more phyto" subgroup was also less interested in two other guidelines: limit meat consumption (2.82 ± 0.88) and eat unprocessed food (2.74 ± 0.95).

Highest means per subgroup were found for avoid too much saturated fat (3.79 ± 0.45) for the "more phyto" respondents, maintain a desirable weight (3.63 ± 0.60) for the "not more phyto" subgroup, and eat plenty of fruits and vegetables for the "phyto motivated" subgroup (3.87 ± 0.38). This last guideline had the second highest mean for the "more phyto" subgroup (3.74 ± 0.48) and "not more phyto" subgroup (3.52 ± 0.73).

Table 45. Importance of various food guidelines to respondents, specific to plant food intake (frequencies and means)

GUIDELINE	N	Q1: How important to your personal diet are these food guidelines?										MEAN ± SD	
		Not at all Important		Not too Important		Somewhat Important		Very Important		Don't know		More phyto	Not more phyto
		More phyto	Not more phyto	More phyto	Not more phyto	More phyto	Not more phyto	More phyto	Not more phyto	More phyto	Not more phyto		
Avoid too much salt or sodium	377	4	2	33	12	103	20	172	31	1	0	3.42 ± .73	3.23 ± 0.86
Avoid too much fat	377	1	2	9	5	78	21	226	35	0	0	3.68 ± .54	3.41 ± 0.78
Avoid too much saturated fat	377	1	1	3	5	57	19	252	39	1	0	3.79 ± .45	3.50 ± 0.71
Avoid too much sugar	375	2	1	19	12	141	18	149	33	0	0	3.41 ± .63	3.30 ± 0.83
Eat foods with adequate fiber	379	1	3	6	3	97	23	211	35	0	0	3.64 ± .54	3.41 ± 0.79
Eat a variety of foods	376	11	2	84	3	217	17	312	42	0	0	3.66 ± .54	3.55 ± 0.73
Maintain a desirable weight	378	1	1	8	1	70	19	234	44	0	0	3.72 ± .52	3.63 ± 0.60
Avoid too much cholesterol	379	2	2	21	7	97	21	194	35	0	0	3.54 ± .65	3.37 ± 0.80
Limit meat consumption	376	12	6	54	14	140	31	105	14	1	0	3.09 ± .81	2.82 ± 0.88
Eat plenty of fruits and vegetables	379	0	1	6	6	69	16	239	42	0	0	3.74 ± .48	3.52 ± 0.73
Eat plenty of breads, cereals, rice and pasta	372	8	4	44	11	130	27	126	22	1	0	3.21 ± .78	3.05 ± 0.88
Eat in moderation	378	1	1	10	6	108	24	194	34	0	0	3.58 ± .57	3.40 ± 0.72
Eat a balanced diet (Food Guide Pyramid)	375	4	3	29	8	107	24	171	29	1	0	3.43 ± .71	3.23 ± 0.85
Eat unprocessed foods	365	19	7	50	16	136	24	99	14	5	3	3.04 ± .86	2.74 ± 0.95
Eat organic foods	360	46	17	110	25	98	11	46	7	11	4	2.48 ± .93	2.13 ± 0.96

Agreement scale: 1 = Not at all important, 2 = Not too important, 3 = Somewhat important, 4 = Very important

Table 46. Importance of various food guidelines to "phyto motivated" subgroup (frequencies and means)

GUIDELINE	N	Q1: How important to your personal diet are these food guidelines?					MEAN ± SD
		Not at all Important	Not too Important	Somewhat Important	Very Important	Don't know	
Avoid too much salt or sodium	61	0	9	15	37	0	3.46 ± 0.74
Avoid too much fat	62	0	2	13	47	0	3.73 ± 0.52
Avoid too much saturated fat	62	0	1	9	52	0	3.82 ± 0.43
Avoid too much sugar	61	0	4	24	33	0	3.48 ± 0.62
Eat foods with adequate fiber	62	0	1	10	51	0	3.81 ± 0.44
Eat a variety of foods	62	0	1	13	48	0	3.76 ± 0.47
Maintain a desirable weight	62	0	1	13	48	0	3.76 ± 0.47
Avoid too much cholesterol	61	1	2	18	40	0	3.59 ± 0.64
Limit meat consumption	61	0	7	27	27	0	3.33 ± 0.68
Eat plenty of fruits and vegetables	62	0	1	6	55	0	3.87 ± 0.38
Eat plenty of breads, cereals, rice and pasta	61	1	7	19	34	0	3.41 ± 0.76
Eat in moderation	61	0	1	16	44	0	3.70 ± 0.49
Eat a balanced diet (Food Guide Pyramid)	60	1	7	14	38	0	3.48 ± 0.77
Eat unprocessed foods	60	0	4	21	35	1	3.52 ± 0.62
Eat organic foods	60	2	21	24	13	1	2.80 ± 0.82

Agreement scale: 1 = Not at all important, 2 = Not too important, 3 = Somewhat important, 4 = Very important

The data will now be examined for correlation (Table 47).

Table 47. Correlations between plant food intake and importance of food guidelines (Spearman's rho)

GUIDELINE	EAT MORE PHYTO FOODS		PHYTO MOTIVATED	
	N	rho	N	rho
Avoid too much salt or sodium	377	.080	309	.039
Avoid too much fat	377	.146**	310	.042
Avoid too much saturated fat	377	.186**	309	.047
Avoid too much sugar	375	.026	307	.071
Eat foods with adequate fiber	379	.113*	311	.163**
Eat a variety of foods	376	.042	307	.087
Maintain a desirable weight	378	.059	309	.037
Avoid too much cholesterol	379	.075	310	.042
Limit meat consumption	376	.118*	307	.143*
Eat plenty of fruits and vegetables	379	.115*	310	.146*
Eat plenty of breads, cereals, rice and pasta	372	.069	303	.138*
Eat in moderation	378	.092	309	.110*
Eat a balanced diet (Food Guide Pyramid)	375	.086	306	.060
Eat unprocessed foods	365	.123*	299	.298**
Eat organic foods	360	.142**	295	.175**

* $p < .05$ ** $p < .01$

Significant guidelines

Weak and positive correlations were found for five guidelines in each of the subgroups:

Guideline	*Eat more phyto foods*	*Phyto motivated*
Eat fruits and vegetables	rho(377) = .115, p < .05	rho(304) = .146, p < .05
Eat adequate fiber	rho(377) = .113, p < .05	rho(305) = .163, p < .01
Limit meat consumption	rho(374) = .118, p < .05	rho(301) = .143, p < .05
Eat unprocessed foods	rho(363) = .123, p < .05	rho(296) = .298, p < .01
Eat organic foods	rho(358) = .142, p < .05	rho(292) = .175, p < .01

Eat fruits and vegetables. Of the subjects who placed importance on eating fruits and vegetables, it was five times more likely that they had increased their plant food intake (308 “more phyto” individuals) than decreased or made no change to intake (58 “not more phyto” individuals). Within the “phyto motivated” subgroup, most respondents found it important (61 individuals) to eat these foods as not (1 individual). Therefore, respondents who had increased plant food intake (3.74 ± 0.48), particularly those motivated by phytochemicals (3.87 ± 0.38), placed high importance on eating fruits and vegetables.

Eat foods with adequate fiber. Of the subjects who found dietary fiber important, it was five times more likely that they had increased their plant food intake (308 “more phyto” individuals) than decreased or made no change to intake (58 “not more phyto” individuals). Within the “phyto motivated” subgroup, most respondents again found it important (61 individuals) to eat these foods as not (1 individual). Therefore, respondents who had increased plant food intake (3.64 ± 0.54), particularly those motivated by phytochemicals (3.81 ± 0.44), placed high importance on getting adequate fiber through their diets.

Limit meat consumption. Of the subjects who placed importance on limiting meat intake, it was five times more likely that they had increased their plant food intake (245 “more phyto” individuals) than decreased or made no change to intake (45 “not more phyto” individuals). Within the “phyto motivated” subgroup, respondents were seven times more likely to place importance (54 individuals) on limiting meat intake as not (7 individuals). Therefore, following a diet which emphasizes plant foods and liking a diet that de-emphasizes meat (3.09 ± 0.81) appear to be weakly dependent on each other, particularly for those plant food eaters who are motivated by phytochemical benefits (3.33 ± 0.68).

Eat organic foods. Of the subjects who placed importance on organic food, it was eight times more likely that they had increased their plant food intake (144 “more phyto” individuals) than decreased or made no change to intake (18 “not more phyto” individuals). Within the “phyto motivated” subgroup, organic foods’ importance is less pronounced, as 37 individuals assigned some importance to eating these foods, while 23 individuals did not. However, this significance is blunted somewhat by ambivalence, as demonstrated by the low means within each subgroup (2.82 ± 0.83 “phyto motivated,” 2.48 ± 0.93 “more phyto” and 2.13 ± 0.96 “not more phyto).

Eat unprocessed foods. Of the subjects who placed importance on unprocessed food, it was six times more likely that they had increased their plant food intake (235 “more phyto” individuals) than decreased or made no change to intake (38 “not more phyto” individuals). Within the “phyto motivated” subgroup, respondents were 14 times more likely to place importance (56 individuals) on eating unprocessed food as not (4 individuals). Therefore, eating unprocessed foods and eating more plant foods (3.04 ± 0.86) appear to be weakly dependent on each other, especially for those plant food eaters who are motivated by phytochemical benefits (3.52 ± 0.62).

Weak and positive correlations were found for three guidelines in one of the subgroups:

Guideline	Eat more phyto foods	Phyto motivated
Avoid too much saturated fat	rho(375) = .186, p < .01	---
Avoid too much fat	rho(375) = .146, p < .01	---
Eat bread, cereal, rice, pasta	---	rho(298) = .138, p < .05

Avoid too much saturated fat. A weak and positive significant relationship was found between changing plant food intake and avoiding excess saturated fat. Of the subjects who placed importance on a diet low in saturated fat, it was five times more likely that they had increased their plant food intake (309 “more phyto” individuals) than decreased or made no change to intake (58 “not more phyto” individuals). An extremely weak and positive relationship that was not significant was found between the “phyto motivated” subjects and avoiding too much saturated fat (rho(302) = .047, p > .05). Therefore, respondents who had increased plant food intake (3.79 ± .45) placed high importance on avoiding excess saturated fat in their diets; phytochemicals as a motivation for this change appears to be an independent variable.

Avoid too much fat. A weak and positive significant relationship was found between changing plant food intake and avoiding excess total fat. Of the subjects who placed importance on lowering dietary fat, it was five times more likely that they had increased their plant food intake (304 “more phyto” individuals) than decreased or made no change to intake (56 “not more phyto” individuals). An extremely weak and positive relationship that was not significant was found between the “phyto motivated” subjects and avoiding too much saturated fat ($rho(303) = .042$, $p > .05$). Therefore, respondents who had increased plant food intake (3.68 ± 0.54) placed high importance on avoiding excess fat in their diets; phytochemicals as a motivation for this change appears to be an independent variable.

Eat plenty of breads, cereals, rice and pasta. An extremely weak and positive relationship that was not significant was found between changing plant food intake and eating more bread, cereal, rice and pasta ($rho(370) = .069$, $p > .05$). However, within the “phyto motivated” subgroup, a significant relationship was found, and respondents were seven times more likely to place importance (53 individuals) on eating bread, cereal, rice and pasta as not (7 individuals). Therefore, valuing grain product consumption and eating more plant foods appear to be independent of each other, except for the plant food eaters who are motivated by phytochemical benefits. This smaller subgroup of plant food eaters tend to value the importance of eating breads, cereals, rice and pasta.

Not significant guidelines

Correlation data for the remaining seven guidelines indicated relationships which were not significant ($p > .05$). These guidelines are avoiding too much salt or sodium, avoiding sugar, eating a variety of foods, maintaining a desirable weight, avoiding too much cholesterol, eating in moderation, and eating a balance diet. Therefore, these activities appear to be independent of changing plant food intake.

Health statements

The data will be examined first for patterns, regardless of significance. Compared to this data for all respondents, the “more phyto” respondents, and particularly those who are motivated by phyto-chemical benefits, showed greater agreement or disagreement toward the health statements. The means (found in Tables 48 and 49) reflect this change, as a few are high (indicating agreement) and a few are low (indicating disagreement). Many mean values still fall in the middle (2.07 – 2.84), and many of the standard deviations are wide (1.05, 1.07, 1.12), indicating some ambivalency to several guidelines, particularly when the data is grouped into the “more phyto” and “not more phyto” subgroups. Within the “phyto motivated” subgroup, however, only four means fall in the middle (2.18 – 2.79), while others are either closer to strongly disagree (1.71 – 1.97) or strongly agree (3.26 – 3.79). Also, Ns for the individual statements varied widely (334-378), meaning that many respondents offered no opinions on some health statements, which could also be attributed to disinterest or uncertainty.

Table 48. “Phyto motivated” respondents’ agreement with health statements (frequencies and means)

STATEMENT	N	Q5: How much do you agree or disagree with the following statements?					MEAN ± SD
		Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree	Don’t know	
Some people born to be fat and some thin.	61	12	9	36	4	0	2.53 ± 0.88
Different fiber types have different health benefits.	58	0	4	18	36	0	3.56 ± 0.62
Starchy foods make people fat.	62	25	19	14	4	0	1.97 ± 0.95
Hard to know what to believe about healthy food.	62	9	8	32	13	0	2.79 ± 0.94
Too much media fuss about food and health.	59	31	17	8	3	0	1.70 ± 0.89
Variety of foods provides all needed vitamins, minerals.	62	18	19	21	4	0	2.19 ± 0.93
Diet makes a big difference in preventing disease.	62	1	0	10	51	0	3.79 ± 0.51
Taste more important than nutrition.	61	20	24	16	1	0	1.95 ± 0.82
Overall, I believe my current diet is healthy.	60	0	7	30	23	0	3.26 ± 0.66
I am pleased with my current weight.	62	20	15	18	9	0	2.24 ± 1.07

Agreement scale: 1 = Strongly disagree, 2 = Somewhat disagree, 3 = Somewhat agree, 4 = Strongly agree

In four statements, “not more phyto” had the higher means (agreement), and “phyto motivated” had the lowest means (disagreement): hard to know what to believe about healthy food (3.13 ± 0.88

Table 49. Respondents' agreement with health statements, specific to plant food intake (frequencies and means)

GUIDELINE	N	Q5: How much do you agree or disagree with the following statements?										MEAN ± SD	
		Strongly disagree		Somewhat disagree		Somewhat agree		Strongly agree		Don't know		More phyto	Not more phyto
		More phyto	Not more phyto	More phyto	Not more phyto	More phyto	Not more phyto	More phyto	Not more phyto	More phyto	Not more phyto		
Some people born to be fat and some thin.	370	56	12	54	12	169	33	29	5	0	0	2.56 ± .90	2.50 ± .90
Different fiber types have different health benefits.	334	3	1	21	2	136	38	116	17	0	0	3.32 ± .66	3.22 ± .59
Starchy foods make people fat.	367	86	22	116	19	81	10	25	8	0	0	2.15 ± .92	2.07 ± 1.05
Hard to know what to believe about healthy food.	377	27	5	27	5	162	29	99	23	0	0	3.06 ± .86	3.13 ± .88
Too much media fuss about food and health.	363	93	11	86	21	98	17	29	8	0	0	2.21 ± .98	2.39 ± .96
Variety of foods provides all needed vitamins and minerals.	376	51	7	74	14	143	26	45	16	0	0	2.58 ± .93	2.81 ± .95
Diet makes a big difference in preventing disease.	376	3	0	4	1	100	25	206	37	0	0	3.63 ± .56	3.57 ± .53
Taste more important than nutrition when selecting food.	378	81	12	99	18	118	25	16	9	0	0	2.22 ± .89	2.48 ± .96
Overall, I believe my current diet is healthy.	373	3	4	47	13	191	34	70	11	0	0	3.05 ± .64	2.84 ± .79
I am pleased with my current weight.	377	130	23	78	16	69	13	37	11	0	0	2.04 ± 1.05	2.19 ± 1.12

Agreement scale: 1 = Strongly disagree, 2 = Somewhat disagree, 3 = Somewhat agree, 4 = Strongly agree versus 2.79 ± 0.94), variety of foods provides all needed vitamins and minerals (2.81 ± 0.94 versus 2.19 ± 0.93), taste more important than nutrition when selecting food (2.48 ± 0.96 versus 1.95 ± 0.82), and too much media fuss about food and health (2.39 ± 0.96 versus 1.70 ± 0.89).

In three statements, “phyto motivated” had the higher means (agreement), and “not more phyto” had the lowest means (disagreement): diet makes a big difference in preventing disease (3.79 ± 0.51 versus 3.57 ± 0.53), different fiber types have different health benefits (3.56 ± 0.62 versus 3.22 ± 0.59), and believe current diet is healthy (3.26 ± 0.66 versus 2.84 ± 0.79).

All subgroups somewhat agreed/disagreed almost equally with “some people are born to be fat and some to be thin” (2.56 ± 0.90 “more phyto,” 2.53 ± 0.88 “phyto motivated,” 2.50 ± 0.90 “not more phyto”).

Two statements in which all subgroups somewhat disagreed almost equally were “I am pleased with current weight” (2.24 ± 1.07 “phyto motivated,” 2.19 ± 1.12 “not more phyto,” 2.04 ± 1.05 “more phyto”), and “starchy foods make people fat” (2.15 ± 0.92 “more phyto,” 2.07 ± 1.05 “not more phyto,” 1.97 ± 0.95 “phyto motivated”).

The data will now be examined for correlation (Table 50).

Table 50. Correlations between plant food intake and agreement with health statements (Spearman’s rho)

STATEMENT	EAT MORE PHYTO FOODS		PHYTO MOTIVATED	
	N	rho	N	rho
Some people born to be fat and some thin.	370	.025	300	-.023
Different fiber types have different health benefits.	334	.071	268	.200**
Starchy foods make people fat.	367	.045	300	-.102
Hard to know what to believe about healthy food.	377	-.038	307	-.150**
Too much media fuss about food and health.	363	-.064	299	-.254**
Variety of foods provides all needed vitamins and minerals.	376	-.091	305	-.223**
Diet makes a big difference in preventing disease.	376	.052	305	.172**
Taste more important than nutrition when selecting food.	378	-.103*	306	-.139**
Overall, I believe my current diet is healthy.	373	.100	304	.174**
I am pleased with my current weight.	377	-.049	306	.115*

* $p < .05$ ** $p < .01$

Significant statements

Taste more important than nutrition. This statement was the only one of the 10 to have a significant interaction with all of the subgroups. Within the “more phyto” and “not more phyto” subgroups, the correlation is weak and negative (rho(376) = -.103, $p < .05$). Of the subjects who disagreed with the statement (indicating that nutrition was more important than taste), it was six times more likely that they had increased their plant food intake (180 “more phyto” individuals) than decreased or made no change in intake (30 “not more phyto” individuals). Within the “phyto motivated” subgroup, the correlation is also weak and negative (rho(304) = -.139, $p < .01$), and respondents were twice as likely to disagree (44 individuals) as agree (17 individuals). Therefore, respondents who had increased plant food intake (2.22 ± .89), particularly those who were motivated by phytochemicals (1.97 ± .82), tended to favor nutrition over taste when selecting foods.

Weak and positive correlations were found for seven statements in the “phyto motivated” subgroup:

Guideline	*Phyto motivated*
Diet helps prevent disease	rho(305) = .172, p < .01
Different fiber, different benefits	rho(266) = .200, p < .01
Current diet is healthy	rho(302) = .174, p < .01
Hard to know what to believe	rho(305) = -.150, p < .01
Pleased with current weight	rho (304) = .115, p < .05
Variety provides vitamins, minerals	rho (303) = -.223, p < .01
Too much media fuss	rho (297) = -.254, p < .01

However, extremely weak correlations (both positive and negative) that were not significant were found between the statements and the broader plant food intake subgroups (“more phyto” and “not more phyto”). Therefore, changing plant food intake, per se, and agreeing with these seven health statements appear to be independent of each other.

Diet helps prevent disease. Most “phyto motivated” respondents (61 individuals) agreed with this statement (1 individual strongly disagreed). The correlation is weak and positive. Plant food eaters who were motivated by phytochemical benefits (3.79 ± 0.52) believe that diet can help prevent diseases, like cancer or heart disease. This finding is similar to the research by Kristal et al. (2001), in that the researchers also found a trend for small fruit-and-vegetable intake increases in people holding strong beliefs in the diet-cancer link; the trend in the Kristal research, however, was not statistically significant.

Different fiber has different health benefits. Most “phyto motivated” respondents agreed (54 individuals) with this statement (4 individuals somewhat disagreed). The correlation is weak and positive. Plant food eaters who were motivated by phytochemical benefits (3.55 ± 0.63) believed that foods with different kinds of fiber have different health benefits.

I believe my current diet is healthy. Within the “phyto motivated” subgroup, respondents were seven times more likely to agree (53 individuals) with this statement as disagree (7 individuals). The correlation is weak and positive. Plant food eaters who are motivated by phytochemical benefits (3.27 ± 0.66) believe that their current diets are healthy.

Hard to know what to believe about healthy food. Within the “phyto motivated” subgroup, respondents were three times more likely to agree (45 individuals) with this statement as disagree (17 individuals). The correlation is weak and negative. Plant food eaters who were motivated by phytochemical benefits (2.79 ± 0.94) agreed that the volume of recommendations make it hard to know what to believe about health.

I am pleased with my current weight. Within the “phyto motivated” subgroup, more respondents disagreed with this statement (35 individuals) as agreed (27 individuals). The correlation is weak and positive. Plant food eaters who were motivated by phytochemical benefits (2.26 ± 1.07) tended to be somewhat pleased with their current weight

Variety of foods provides all needed vitamins, minerals. Within the “phyto motivated” subgroup, more respondents disagreed with this statement (37 individuals) as agreed (25 individuals). The correlation is weak and negative. Plant food eaters who were motivated by phytochemical benefits (2.26 ± 1.07) were pleased with their current weight

Too much media fuss about food and health. Within the “phyto motivated” subgroup, respondents were four times more likely to disagree (48 individuals) with this statement as agree (11 individuals).

The correlation is weak and negative. Plant food eaters who were motivated by phytochemical benefits (1.95 ± 0.95) liked the level of media coverage given to food and health.

Not significant statements

Correlation data for the remaining two statements (“some people are born to be fat and some to be thin” and “starchy foods make people fat”) indicated relationships which were not significant ($p > .05$). Therefore, these activities appear to be independent of changing plant food intake.

Chapter 5.
Summary and Conclusion

The purpose of this study was to learn whether an awareness of phytochemicals motivates some people to change their eating behavior and to eat more fruits, vegetables and whole grains. The results suggest that phytochemical awareness and motivation was weakly correlated to greater intake of these foods, perhaps reflecting the subjects' interest but low confidence in their understanding of phytochemicals.

Objective 1:
Draw a demographic profile of this population.

The subjects were predominantly female (82.6%), Caucasian (88.0%), and middle-aged (45-64 years, 77.0%) or older (>65 years, 11.3%). Compared to the full *Prevention* subscriber list, the study subjects lived in smaller households (1-2 member households, 64.1%) and had received more post-secondary education (81.5%). Looking at geography, the survey data strongly reflected opinions of people living in the central portions, especially the east central portion, of the U.S. (61.6%), due to the composition of the mailing list and the strong response of returned surveys from these states. Therefore, the demographic profile of respondents matched the profile of the larger subscriber base in several characteristics (sex, geography) but varied for several other characteristics (age, household size, education). This comparison verifies the selective subgroup nature of the subjects and limits generalizing these results to other populations.

Objective 2:
Estimate from the subset the number of adults who have increased their consumption of fruits, vegetables and whole grains.

Many of the respondents (82.9%) had increased their consumption of phytochemical-containing foods. *They form the "more phyto" subgroup.* Recent increases occurred mostly with fruits (40.5%), and earlier increases occurred with vegetables (39.1%). Intake of both fruits and vegetables was significantly ($p < .01$) and positively correlated with the high importance placed on eating these foods. The respondents were less inclined to increase their intake of breads, cereal, rice and pasta (12.0%

eat more now than 12 months ago, 22.1% began eating more years earlier), with a sizeable group (32.2% all respondents, 34.8% “more phyto” subjects, 39.3% “phyto motivated” subjects) decreasing their intake recently. This pattern correlated significantly ($p < .01$) and positively with moderate importance placed on eating these foods. The respondents were holding steady on their consumption of lentils/dry beans and nuts/seeds (about 36.0% report no change in intake of either food group), with the more noticeable change tending toward increased intake (27.0% ate more now than 12 months ago, 21.0% began eating more years earlier). A moderate importance placed on limiting meat intake was significantly ($p < .01$) and positively correlated with lentil/dry bean intake but not with nut/seed intake. All relationships between intake changes were significant ($p < .01$) and positive, meaning that a change in any one food group increased the likelihood of a change for another food group.

Objective 3:
Determine whether the major change effecter was an awareness of phytochemicals.

Respondents increased their intake of fruit, vegetables and whole grains mostly to enhance health (94.1% as a reason, 74.4% as the most important reason); to reduce dietary fat intake (79.2% as a reason, 8.5% as the most important reason); and to increase eating enjoyment (63.8% as a reason, 5.3% as the most important reason). Phytochemical motivation was a minor change effecter for this behavior, being included as a reason by 20.2% of the eligible respondents but never as the single most important reason. *These respondents form the “phyto motivated” subgroup.* The relationships between the motivations were weakly and positively significant. Every reason for eating more plant foods formed at least one significant correlation with another reason. The greatest number of significant relationships (five to seven, $p < .05$) involved enhancing health and strength, having a good source, and adding phytochemicals to the diet. Subjects who had increased their intake of plant foods tended to do so for multiple reasons (mean, SD of 4.66 ± 2.10, $p < .01$), particularly if one of the motivations was to gain phytochemical benefits (mean, SD of 6.45 ± 1.66, $p < .01$).

Objective 4:
Define this population's understanding and expectations of phytochemicals.

A little less than half of all respondents knew nothing about phytochemicals, while a little more than half had heard of the term "phytochemical." Yet a high percent (62.0%-95.0%) had heard of specific phytochemicals when they were identified by another name. Knowledge of any one word significantly ($p < .05$) increased the likelihood of recognizing any of the words. Most respondents recognized more than one phytochemical word: 91.8% all respondents, 92.7% of "more phyto" respondents, and 100% of "phyto motivated" respondents. No significant relationship was demonstrated between intake of plant foods and recognition of phytochemical words (as individual words or multiple words) until motivation for increased intake ($p < .05$) was factored in. In that case, motivation/intake could explain 1.5% to 25.7% of individual word recognition data, depending upon the specific word, and 23.8% of multiple word recognition.

A new subgroup *("phyto aware")* was introduced to help identify and understand this population's expectations of phytochemicals. These subjects reported understanding phytochemical function to some degree, from uncertainty to specific knowledge of health effects. Nearly half (49.8%) of the "phyto aware" subgroup was unsure of function. Of the unsure "phyto aware" subjects, most (60.2%) also did not correctly identify phytochemicals' food source or occurrence in food. A sizeable percentage of the full subgroup, however, correctly identified phytochemicals as occurring naturally (67.3%) in plants (62.8%). A significant finding ($p < .01$) was that these correct identifiers tended to view function positively and to be more specific about function. "Phyto aware" respondents recognized a significantly greater number of phytochemical words (6.15 ± 2.16 mean words) than survey respondents overall (4.82 ± 2.42); having a positive (6.76 ± 2.06) or specific (7.29 ± 2.00) understanding of function increased recognition even more.

Objective 5:
Summarize this population's general health beliefs.

All respondents placed a high level of importance on common food guidelines, particularly those concerning a diet that is low in fat (94.8% cumulative for "somewhat agree" and "strongly agree"), high in fruits and vegetables (96.3% cumulative), and supports a desirable weight (96.6% cumulative). Correlation data ($p < .05$) supported the observation that belief in any one guideline favors belief in nearly all of the guidelines. Subjects were more uncertain or ambivalent regarding the bulk of the health statements, however. Most respondents agreed that diet can help prevent disease (96.8% cumulative) and that different types of fiber have different health benefits (80.8% cumulative). Correlation ($p < .01$) and descriptive data were consistent in indicating that two segments of subjects (those who subscribed to the link between diet and disease, and those who liked the level of media coverage) tended to select food for its nutritional value rather than for taste. The data was less consistent but still significant ($p < .01$) regarding the subjects' related beliefs concerning weight and diet. Other variables need to be explored to clarify this last relationship.

Hypothesis:
There is a positive correlation between the seeking of nutrition information, food and health beliefs, and a deliberate inclusion of additional plant-based foods into the daily diet.

Several significant relationships supported the hypothesis that there is a positive correlation between the seeking of nutrition information, food and health beliefs, and a deliberate inclusion of additional plant-based foods into the daily diet.

Positive significant relationships for subjects who had begun eating more plant foods ("more phyto" subjects) included reading magazines (80.0%, $p < .05$) and consulting with medical professionals (62.5%, $p < .01$) for nutritional advice; hearing much about 5-A-Day, a national campaign which promotes fruit-and-vegetable intake (38.9%, $p < .05$); and placing great importance on eating plenty of fruits/vegetables (81.3%, $p < .05$) and fiber (81.3%, $p < .05$) and on limiting meat intake (65.1%, $p < .05$). A significant negative relationship was found between changing plant food intake and putting taste ahead of nutrition when selecting food (47.6%, $p < .05$). These relationships were weak and shared no more than 4.0% of their variances.

Some of the people who had increased their plant food intake had been motivated to do so for phytochemical benefits (and often other reasons). Significant relationships for this smaller "phyto motivated" subgroup involved the same information sources as above – magazines (90.3%, $p < .05$) and medical professionals (43.5%, $p < .01$) – but with a difference: in comparison to "more phyto" subjects with other motivations, more of the "phyto motivated" subgroup (22.6% versus 9.8%) relied upon their own reading and research (positive correlation, $p < .01$) and less upon professional medical advice (negative correlation, $p < .01$). Awareness of public health campaigns was not significant for this group. Significant relationships involved the same food guidelines and health statements as above – positive for fruits/vegetables (98.4%, $p < .05$), fiber (98.4%, $p < .01$) and meat (88.5%, $p < .05$), and negative for nutrition/taste (72.1%, $p < .01$) – plus positive correlations with grain products (86.9%, $p < .05$), dietary fiber benefits (93.1%, $p < .01$) and disease prevention through diet (98.4%, $p < .01$). Again, these relationships were weak and shared no more than 3.9% of their variances.

The part of the hypothesis that proved least significant was the seeking of information. Few sources formed correlations, either with each other or with plant food intake/motivation. Ironically, consulting with health store personnel was positively correlated ($p < .05$) to six other sources, while consulting with dietitians, the nutrition professionals, was independent of using other information sources or to plant food intake subgroups.

Conclusion

The results of this study support the conclusion that phytochemical knowledge motivates some people to eat more fruits, vegetables and whole grains. These individuals tend to view phytochemicals as having positive health benefits and a function specific to disease prevention. Phytochemicals are not the sole or even most important reason for taking this dietary action, however. Nutrition educators, public health officials, and food industry professions will need to understand the complex mix of motivations which lead people to increasing their consumption of fruits, vegetables and whole grains.

A surprising finding was the sizeable percentage of people (30.0% - 40.0%) who had recently decreased their intake of bread, cereal, rice and pasta. On the one hand, this trend makes sense in light of the popularity of the low-carbohydrate, high-protein diets. It also supports data from one of the USDA national consumer surveys, the Diet and Health Knowledge Survey. On the other hand, this percentage grew as plant food intake increased (a significant relationship) or phytochemical motivation was included (not a significant relationship). These intake subgroups also held conflicting significant beliefs about the importance of eating bread, cereal, rice and pasta and getting adequate dietary fiber. This area is ripe for further study, particularly over time, as consumer interest in the low-carbohydrate, high-protein diet rides its curve and as researchers begin comparative studies of popular diets.

Also surprising was the limited number of information sources that were significant to the plant food subgroups. Their use of magazines, professional medical advice and/or self research was significant and strong enough to support the hypothesis of information seeking being correlated to deliberate intake of plant foods, however. Not surprising, from the information seeking perspective, was this population's low recognition of public nutrition campaigns. The only significant relationship (positive) was found between the "more phyto" subjects and recognition of the 5-A-Day campaign; no significant relationships were found between "phyto motivated" subjects and any of the five public nutrition campaigns. This finding is similar to other research (Gibson, Wardel, and Watts 1998, Greene and Rossi 1998, Kristal et al. 2001).

The opportunity exists for nutrition educators, public health officials and food industry professionals to reach this population with messages framed by phytochemical information. This population demonstrated interest, had a phytochemical vocabulary, and understood more about phytochemical function and source than they thought. The challenge for educators and officials will be to overcome the plant food subgroups' inclination to favor their own research over professional advice or public campaigns.

Recommendations for further study

Additional research could be directed to the following areas:

- Populations which have decreased their consumption of bread, cereal, rice and pasta. Future studies could examine the relationship with intake changes in other plant foods, distinction between wholegrain and non-whole grain consumption, meat consumption, or dietary fiber and motivations (including influence of popular diets).

- Populations which actively seek to increase dietary fiber. Of interest would be studying the discrepancy between placing importance on fiber and its benefits and decreasing intake of a chief source of fiber. Future studies could contrast the gap between thinking and doing, misindentifying fiber source, or getting fiber from dietary supplements rather than from foods.

- Populations which believe they eat healthfully but which are not pleased with their weight. The study population fits this conflicting profile. Future studies could make a nutritional analysis of the subjects' actual intake and compare it to their definition of healthful eating and/or probe for reasons behind the dissatisfaction with weight.

- Populations which believe a varied diet doesn't supply all the needed vitamins and minerals. In this study, the belief was held most strongly by respondents who had decreased intake of plant foods. Future studies, therefore, could make a nutritional analysis of the subjects' actual intake and compare it to their perceptions of nutrient deficiency, reasons for this perception, and source of nutrients (such as dietary supplements or fortified foods) used to correct deficiency.

- Marketing of nutraceuticals, especially during the anticipated boom years (1995-2007). Topics could include product development, point-of-sale retailing, and measurement of consumer awareness and acceptance.

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Appendices

Appendix 1. Research Hypotheses

1. Some U.S. adults are including more plant foods (fruits, grains, vegetables, nuts, seeds) in their diets.

2. In this population, there is a positive correlation between the seeking of nutrition information, food and health beliefs, and a deliberate inclusion of additional plant-based foods into the daily diet.

3. One piece of information (awareness of phytochemicals) is the main (but not always the sole) trigger leading to this dietary change.

4. This trigger works despite the population's incomplete or inconsistent understanding of phytochemicals.

Appendix 2. Focus of Inquiry

1. How does this population define “healthful eating”?

2. Have nutritional campaigns made an impression (positive or negative) on this population?

3. What link does this population make between diet and health, and how strong is that link?

4. What does this population know about phytochemicals?

5. What qualities (beneficial, harmful or neutral) does this population attribute to phytochemicals?

6. If awareness of phytochemicals triggered an inclusion of more plant foods into their diets, why?

7. If some other change effectors triggered the dietary change, what are they, and why?

8. What does this population expect to achieve/improve by making this dietary change?

9. How does the major change effecter shape this expectation?

10. Before the dietary change, which foods, beverages and supplements are these people eating?

11. After the dietary change, which foods, beverages and supplements are these people eating?

12. After the change, are these people eating more, the same or less (in terms of calories)?

13. Does this population perceive its diet (both before and after) as healthy?

14. Which stages of change are seen in this population?

15. What characteristics (demographic, lifestyle, psychological) do individuals in this population share?

16. Which sources does this population trust for credible information about nutrition and health?

Appendix 3. Subjects by region of residence

To determine geographical representation, the mailing list and return envelop zip codes were counted by state, and the state totals were combined and resorted by two regional systems.

- The seven Rodale advertising and subscribing regions (Rodale 2001b). This appendix will discuss and present results based on the Rodale system. Results are presented graphically in Figures 3-1 and 3-2.

- The four U.S. Census Bureau regions (US Census Bureau 2002b). See discussion of "Objective 1" for results based on this regional system.

The Rodale advertising and subscribing regions (Rodale 2001a) are composed of these states:

- *East Central states:* Illinois, Indiana, Kentucky, Michigan, Ohio, West Virginia, Wisconsin. (Mailed N = 319, returned N = 74, return rate 23.2%)

- *Mid Atlantic states:* Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania. (Mailed N = 274, returned N = 52, return rate 19.0%)

- *New England states:* Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont. (Mailed N = 80, returned N = 16, return rate 20.0%)

- *Pacific states:* Alaska, Arizona, California, Hawaii, Idaho, Nevada, Oregon, Utah, Washington. (Mailed N = 264, returned N = 56, return rate 21.2%)

- *Southeast states:* Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, Tennessee, Virginia. (Mailed N = 318, returned N = 75, return rate 23.9%)

- *Southwest states:* Arkansas, Louisiana, New Mexico, Oklahoma, Texas. (Mailed N = 189, returned N = 37, return rate 19.6%)

- *West Central states:* Colorado, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota, Wyoming. (Mailed N = 156, returned N = 41, return rate 26.3%)

Regional data is represented graphically in Figure 3-1. Circulation percentages reflect January 2001 data. Mailed percentages are based on mailed N by region (listed above) and the number of names (1,600) randomly selected from the part of the Rodale database. Returned percentages are based on returned N by region (listed above) and the number of returned usable surveys (380). In addition, some returned surveys (25 or 6.6%) could not be identified by region, as their envelopes did not bear a postmark or zip code.

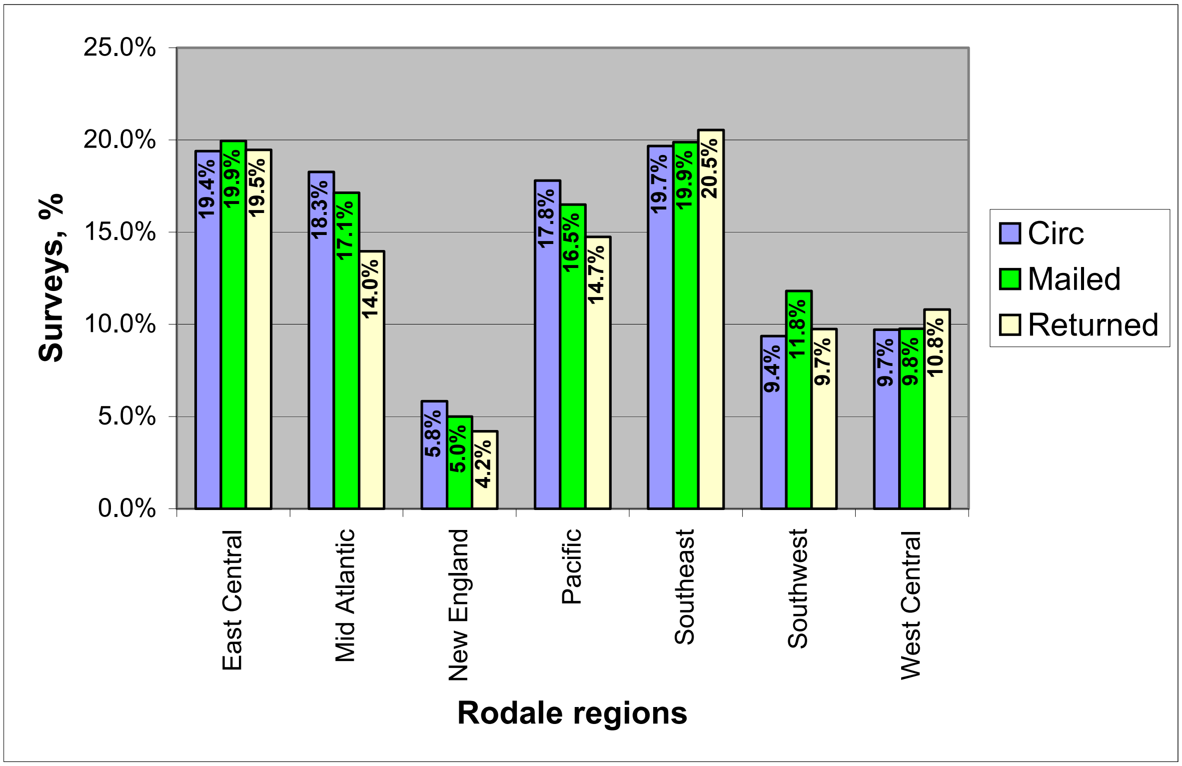

Figure 3-1. Surveys mailed to and returned from individuals living in Rodale's advertising/subscribing regions

Surveys were mailed in proportions roughly equal (± 2.5%) to the regional representation of *Prevention* circulation (see Figure 3-1). Nearly 60% of the surveys were mailed to people living in the central portion of the U.S. (Southeast 19.9%, Southwest 11.8%; East Central 19.9%, West Central 9.8%). The remaining mailed surveys were split fairly equally between people living on the East Coast (Mid Atlantic 17.5%, Northeast 5.0%) and West Coast (Pacific 16.5%).

Returns by region match surveys mailed by ± 3.5% and match those regions' representation in the *Prevention* circulation by ± 5.1% (see Figure 1). The biggest gaps are seen along the East Coast, where return percentages are down compared to circulation percentages. In the Mid Atlantic, circulation is 18.3%, and return is 14.0%. In New England, circulation is 5.0%, and return is 4.2%. Returns were also proportionally down on the West Coast, where Pacific circulation is 17.8%, and return is 14.7%.

Figure 3-2 graphically presents the surveys returned from each of the Rodale regions.

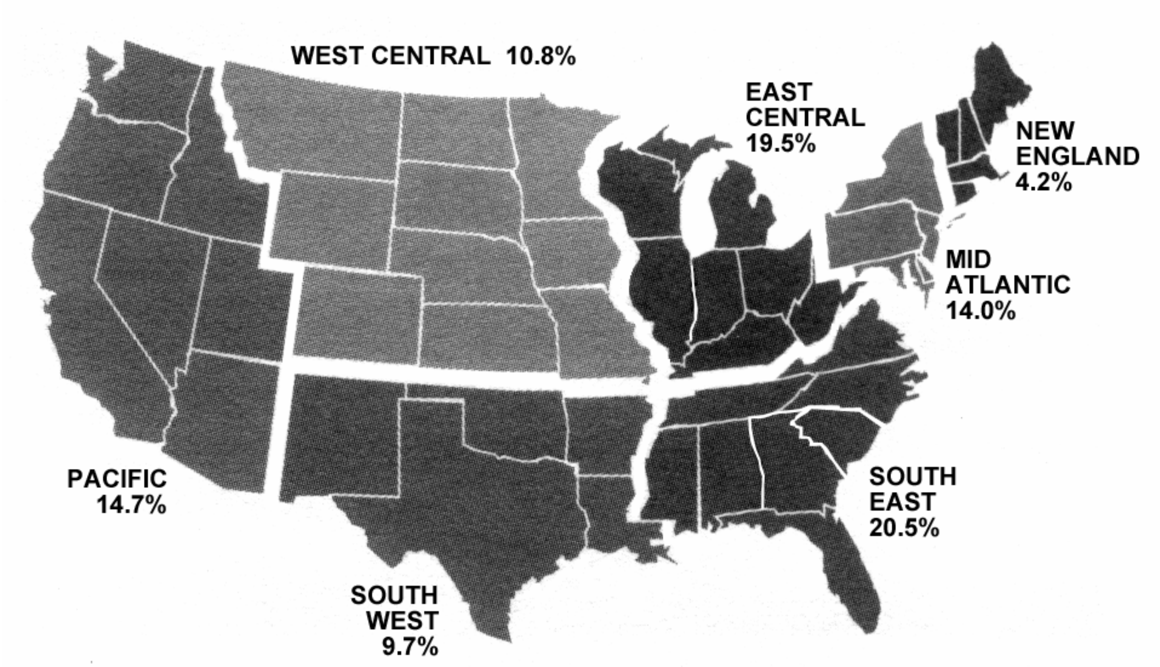

Figure 3-2. Surveys returned from individuals living in Rodale's advertising/subscribing regions Graphic source: Rodale 2001a

In conclusion, the survey data strongly reflects opinions of people living in the central, especially the east central, portions of the U.S. (60.53%), due to the composition of the mailing list and the strong response of returned surveys from these states. When compared to overall *Prevention* circulation, a smaller percentage of surveys were returned from the Mid Atlantic (difference –4.3%) and Pacific (difference –3.1%) regions than were mailed, but other regions were heard from in roughly equal proportions. Overall, the demographic profile of respondents matches the profile of the larger subscriber base in several characteristics (sex, geography) but varies for several other characteristics (age, household size, education). See the discussion of "Objective 1" for more information about these other characteristics.

Appendix 4. Survey

Nutritional beliefs & behaviors survey

Part of a research project conducted by Lori Miller, Master's Degree Candidate,
Food and Nutritional Sciences, University of Wisconsin-Stout, Menomonie, Wisconsin 54751.

1. How important are these food guidelines to your personal diet?
(For each item, please check the box that best expresses your opinion)

GUIDELINE	**Very important**	**Somewhat important**	**Not too important**	**Not at all important**	**Don't know**
Avoid too much salt or sodium					
Avoid too much fat					
Avoid too much saturated fat					
Avoid too much sugar					
Eat foods with adequate fiber					
Eat a variety of foods					
Maintain a desirable weight					
Avoid too much cholesterol					
Limit meat consumption					
Eat plenty of fruits and vegetables					
Eat plenty of breads, cereals, rice and pasta					
Eat in moderation					
Eat a balanced diet (Food Guide Pyramid)					
Eat unprocessed foods					
Eat organic foods					

2. Which media do you use for accurate information about nutrition? *(Check all that apply)*

- ❑ Magazines (which?) ______________________________
- ❑ Newspapers
- ❑ Radio
- ❑ Television
- ❑ Books (which?) ______________________________
- ❑ Internet
- ❑ Other: ______________________________

3. Who do you go to for accurate information about nutrition? *(Check all that apply)*

- ❑ Medical professional
- ❑ Weight-loss program leader
- ❑ Health store personnel
- ❑ Educator/teacher
- ❑ Friend or family member
- ❑ Other: ______________________________

4. To what degree have you heard about these public health messages?
(For each item, please check the appropriate box)

MESSAGE	**Heard much about**	**Heard something about**	**Heard nothing about**
Food Guide Pyramid			
Basic Four Food Groups			
5-A-Day			
Healthy People 2000 or 2010			
1% or Less			

5. How much do you agree or disagree with the following statements?
(For each statement, please check the box that best expresses your opinion)

STATEMENT	**Strongly agree**	**Somewhat agree**	**Somewhat disagree**	**Strongly disagree**	**Don't know**
Some people are born to be fat and some thin.					
Different kinds of fiber in food have different health benefits.					
Starchy foods, like potatoes and rice, make people fat.					
There are so many recommendations about healthy ways to eat, it's hard to know what to believe.					
There is too much fuss about food and health aspects in the media.					
Eating a variety of foods probably gives you all the vitamins and minerals you need.					
What you eat can make a big difference in your chance of preventing a disease, like heart disease or cancer.					
When selecting foods to eat, taste is more important to me than nutritional value.					
Overall, I believe my current diet is healthy.					
I am pleased with my current weight.					

6. **Now please think about your overall diet. In the last 12 months, have you changed the amount you're eating of the following foods?** *(For each food group, please check the appropriate box)*

FOOD GROUP	**Eat more now than 12 months ago**	**Began eating more years ago**	**Eat less now than 12 months ago**	**Began eating less years earlier**	**No change**	**Don't know**
Fruits						
Vegetables						
Bread, cereal, rice, pasta						
Lentils and dry beans (including soy products)						
Nuts and seeds						

If **ALL** of your answers are in the last 4 columns, please go on to question #9.

7. Why are you eating more of these foods? *(Check all that apply)*

- ❑ Believe eating these foods can make me healthier.
- ❑ Believe eating these foods can make me look better.
- ❑ Believe eating these foods can make me stronger.
- ❑ Heard they contain phytochemicals.
- ❑ Grow these foods in my garden.
- ❑ Can buy from an easily accessible and affordable source.
- ❑ Am replacing these foods for all or some of my meat consumption.
- ❑ Following example of others in my household.
- ❑ Eating more ethnic meals which emphasize these foods.
- ❑ Watching my fat intake.
- ❑ Following doctor's orders.
- ❑ Enjoy eating these foods.
- ❑ Other: ______________________________

8. In question #7, which is the MOST important reason for eating more of these foods?
PLEASE CIRCLE ONE LETTER ONLY: A B C D E F G H I J K L M

9. Have you heard of or read about any of these nutrition-related words? *(Check all that apply.)*

- ❑ Antioxidants
- ❑ Anti-estrogens
- ❑ Phytoestrogens
- ❑ Genistein
- ❑ Flavonoids, flavones, flavonodls or isoflavones
- ❑ Carotenoids or beta carotene
- ❑ Lutein
- ❑ Lycopene
- ❑ Pigments
- ❑ Phytochemicals

10. All of the words in question #9 are related to phytochemicals (substances found in some foods). Please tell me which ONE statement best matches your understanding of phytochemicals. *(Check one only)*

- ❑ I know nothing about phytochemicals. (IF "KNOW NOTHING," PLEASE GO ON TO QUESTION #13)
- ❑ I've heard about phytochemicals but am not quite sure what they are.
- ❑ I know that phytochemicals can somehow improve my health.
- ❑ I know that phytochemicals can somehow harm my health.
- ❑ I know that phytochemicals can specifically help to prevent cancer, heart disease and osteoporosis.
- ❑ I know that phytochemicals can specifically lead to cancer, heart disease and osteoporosis.

11. Please tell me which types of food you believe to contain phytochemicals. *(Check one only)*

- ❑ Meat
- ❑ Dairy
- ❑ Plants
- ❑ All
- ❑ I don't know

12. Which ONE of the following statements do you agree with most? *(Check one only)*

Phytochemicals occur naturally in food.
Phytochemicals are added to food.
I don't know.

13. Please tell me whether you are: ❑ Male or ❑ Female

14. What year were you born? ______________________________

15. How many people live in your household? ____ persons (include yourself as "1")

16. Which ONE statement best describes your formal schooling? (Check one only)

- ❑ Some elementary school
- ❑ Some high school
- ❑ Have a high school diploma
- ❑ High school degree with some technical college or university courses
- ❑ Have a technical college or university degree
- ❑ Have (or will have) more than one technical college or university degree

17. Please tell me your ethnic background: ____

18. Comments?

Thank you for your time and participation in my research project. Please return your survey to me in the enclosed postage-paid **envelope by June 8, 2001.**

Appendix 5. Cover Letter

May 21, 2001

Dear «Title» «First» «Last»:

News about food and nutrition appears almost daily in the media. Please take this opportunity to share your opinion on the clarity of these health messages and their importance to your personal diet. Your participation will help advance master's-level research and could help improve health education in the future.

I am a graduate student, pursuing a master's degree in food and nutritional sciences at the University of Wisconsin-Stout in Menomonie, Wisconsin. My thesis project focuses on health-conscious American adults and their nutritional beliefs and motivators for behavioral change. To collect this information, I have mailed a survey to you and to 1,600 other adults across the country.

Will you participate in my research project by completing this brief survey, please? It should take no more than 10 minutes of your time. I'll keep your individual responses confidential and won't identify you specifically in any way.

When finished, please return your survey to me in the enclosed pre-addressed, postage-paid envelope so that I may receive it by June 8, 2001.

If you have a question, concern or complaint about participating in this research, please contact me or my advisor first. Subsequently, you may also contact Chair, UW-Stout Institutional Review Board (IRB) for the Protection of Human Subjects in Research, 11 Harvey Hall, UW-Stout, Menomonie, WI 54751 (715-232-1126).

Please read this consent statement:
I understand that by returning this survey, I am giving my informed consent as a participating volunteer in this study. I understand the basic nature of the study and agree that any potential risks are exceedingly small. I also understand the potential benefits which might be realized from the successful completion of this study. I am aware that my confidentiality is guaranteed. I realize that I can refuse to participate or to withdraw from participation at any time during this study without coercion or prejudice.

Your opinions may give dietitians and other medical professionals deeper insights into promoting healthy eating. Thank you very much!

Lori B. Miller, *researcher*
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Home Economics 202
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millerl@post.uwstout.edu

Dr. Janice M. Coker, *research adviser*
Chair, Food & Nutrition Department
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cokerj@uwstout.edu or 715-232-2239

Appendix 6. Reminder Postcard

As part of my graduate research project, I recently mailed you a survey concerning your nutritional beliefs and habits. If you've already completed the survey and mailed it to me, thank you! If not, would you take a few minutes to do so now? The survey is brief, confidentiality is guaranteed, and return postage is prepaid. I would appreciate receiving your completed survey **by June 8, 2001.**

Please contact me if you need another copy of the survey and/or return envelope or if you have questions. I value your opinions and believe your answers can ultimately help dietitians and other medical professionals to promote healthy eating. Thank you!

Lori B. Miller, researcher
Graduate student, Food and Nutrition Department
University of Wisconsin-Stout, Home Economics 202
Menomonie, WI 54751
millerl@post.uwstout.edu

Food and Nutrition Department
Home Economics 202
University of Wisconsin-Stout
Menomonie, WI 54751
ATTN: Lori Miller, graduate student

Appendix 7. Rodale Publications

Table 7-1. Rodale magazines (Rodale 2001b)

MAGAZINE	CIRCULATION	ANNUAL PUBLICATION SCHEDULE	WEB PAGE
Backpacker	280,000	9 times	www.backpacker.com
Bicycling	280,000	11 times	www.bicycling.com
Men's Health	1.7 million	10 times	www.menshealth.com
Mountain Bike	150,000	---	www.mountainbike.com
OG (Organic Gardening)	350,000	6 times	www.organicgardening.com
Organic Style	500,000	---	www.rodaleorganicstyle.com
Prevention	3 million	12 times	www.prevention.com
Rodale's Scuba Diving	185,000	11 times	www.scubadiving.com
Runner's World	500,000	12 times	www.runnersworld.com

Table 7-2. Rodale special interest publications

These magazines serve as single-focused, hot-topic supplements to *Prevention* magazine. Highly targeted to slightly younger readers who shop at supermarkets, discount/drug chains and mass merchandisers/others. 40% of *Prevention* readers also read these publications (Rodale 1999).

Cats & Dogs

Fit & Firm at 40 Plus

Healing Herbs I

Healing Herbs II

Healing with Vitamins

Super Healing Foods

Walking Fit I

Walking Fit II

Weight Loss I

Weight Loss II

Weight Loss III

Table 7-3. Rodale books

Rodale publishes 100 new titles annually and maintains a backlist of more than 500 titles on subjects such as cooking, health, fitness, gardening, nature and spirituality (Rodale 2001b). Sold through the following six channels:

One-Shot Books
Backbone of the Rodale Book Division. Sold individually through direct mail, television commercials, and print ads.Titles include *The Doctors Book of Home Remedies, Win the Fat War, The Wrinkle Cure, The Doctors Book of Home Remedies for Dogs and Cats, New Choices in Natural Healing, Great Shortcuts* and *Dr. Shapiro's Picture Perfect Weight Loss.*

Continuity Series
Offers a complete library of books on individual subjects. Titles include the *Men's Health Life Improvement Guides, Women's Edge Health Enhancement Guides, Successful Organic Gardening, Rodale's Essential Herb Handbooks,* and the *Dog Care Companion Guides.*

Annual programs
Annual titles include *Women's Health Today, Men's Health Today, Report 2000: A Man's Guide to Women, Prevention's Natural Healing Guide, Gardener to Gardener,* and the *Runner's World Calendar.*

Book club
The Prevention Book Club spots new trends in the marketplace and offers books from a variety of publishers.

Trade sales
The trade outlet for Rodale titles; distributed by New York publisher St. Martin's Press. Titles include *Square Foot Gardening, Rodale's Illustrated Encyclopedia of Herbs, The Doctors Book of Home Remedies, Jacques Pipin's Simple and Health Cooking, Healthy Homestyle Cooking, Joan Benoit Samuelson's Running for Women, New Choices in Natural Healing,* and *The Doctors Book of Home Rememdies for Dogs and Cats.*

On-line bookstore
Available at www.rodalestore.com. General categories include "Cooking," "Health," "Women's Health," "Men's Health," "Sports" and "Home Arts." Many of the above titles available for purchase. Additional titles include *5-A-Day: The Better Health Cookbook, Hormone Connection, Cholesterol Cures, Low-Fat Living, Meals that Heal, Outwit Your Weight,* and *Green Pharmacy Herbal Handbook.* Many written by *Prevention* editors (Rodale 2002).

Appendix 8. Sources of Nutritional Information

Table 8-1. Magazines identified by title

Magazine	*Frequency*	*Magazine*	*Frequency*
AARP	2	Men's Health	3
Alternative Health	1	Men's Journal	1
Better Homes and Gardens	2	Muscle Media	1
Consumer Reports	6	Natural Health	2
Consumers Digest	1	Newsweek	4
Cooking Light	3	Nursing	1
Diabetes Cooking	1	Nutrition	3
Diabetes Forecast	3	Prevention	206
Diabetes Interview	1	Reader's Digest	12
Diabetes Self-Management	1	Redbook	1
Energy Times	1	Remedy	1
Family Circle	7	RN	1
Farm and Home Magazine	1	Runner's World	1
First	3	Self	4
Fitness	8	Shape	1
Food & Nutrition	1	Taste of Home	1
Good Housekeeping	5	Time	4
Guideposts	1	US News & World Report	1
Health	25	Vegetarian Times	7
JAMA	1	Veggie	1
Journal of Longevity	1	Walking	7
Ladies Home Journal	3	Weight Watchers	4
Let's Live	1	Woman's World	7
Life Extensions	1	Women's Day	5
Light 'n Tasty	1	Women's Journal	1
Macrobiotic	1	Your Health	1
McCall's	3		

Table 8-2. Newsletters identified by title

Newsletter title	*Frequency*	*Newsletter title*	*Frequency*
AIM Company	1	Health Sciences Institute	3
Baptist Health Systems	1	Johns Hopkins	2
Bottom Line Health	4	Lahey Clinic	1
Dr. Andrew Weil's Self Healing Newsletter	6	Lark Letter	2
Dr. Christinae Northrup Health Wisdom for Women	1	Mayo Clinic	6
Dr. David Williams Alternatives	3	Nutrition Action	10
Dr. James Balch Prescriptions for Healthy Living	1	Shaklee	2
Dr. Julian Whittaker	3	Sinatra Health Report	1
Dr. Milton Ted Morter	1	UC Berkeley Wellness Letter	4
Environmental Nutrition	1	United HealthCare Truly Yours	1
Harvard newsletters	5		

Table 8-3. Books identified by title and/or author

BOOK TITLE/AUTHOR	FREQ
Allergies: Disease in Disguise (C. Battson-Koch)	1
An Apple a Day: Is it Enough? (M.T. Morter)	1
Back to Eden (J. Kloss)	1
Business Plan for the Body (J. Karas)	1
Complete Self-Care Guide to Holistic Medicine (R. Iivker et al.)	1
Diet for a Small Planet (Moore-Lappe)	1
Dr. Atkins Diet Revolution (R.C. Atkins) [a]	5
Dr. Dean Ornish books [b]	5
Dr. Howard Shapiro books [e]	2
Dr. Andrew Weil books [d]	12
Doctor's Book of Home Remedies [e]	1
Don't Eat Your Heart Out (J.C. Piscatella)	1
Foods that Harm, Foods that Heal (Reader's Digest)	3
Glucose Revolution (J. Brand-Miller et al.)	1
Healing Foods (P. Hausman, J. Benn Hurley)	1
Healing Herbs (M. Castleman) [e]	1
Healing Power of Vitamins, Minerals and Herbs (Reader's Digest)	1
Healthy Homestyle Cooking [e]	1
Juicing for Life (C. Calbom, M. Keane)	1
Low-Fat Living (R.H. Cooper) [c]	2
Mad Cowboy: Plain Truth from Cattle Rancher Who Won't Eat Meat (H. Lyman)	1
McDougall Books (J.A. and/or M. McDougall) [e]	3
Nature's Cures (M. Castleman) [e]	1
New Choices in Natural Healing [e]	1
People's Pharmacy: Guide to Home & Herbal Remedies (J. & T. Graedon) [e]	1
Protein Power (M. Eades)	1
Reversing Diabetes (/Dr. J. Whittaker)	1
Barry Sears books [f]	3
Sugar Busters (H. Leighton Stewart et al.)	1
Thin is Just a Four-Letter Word (D. Hakala)	1
Vitamin Book (R. Wentzler)	1
Other no title given [g]	1

[a] Respondents' indicated title as "Dr. Atkins"; could be any of several books.

[b] *Includes Dr. Dean Ornish's Program for Reversing Heart Disease* (1 resp.), *Eat More, Weight Less* (2 resp.), and no title (2 resp.)

[c] Published by Rodale; no titles given for Dr. Howard Shapiro books.

[d] Includes *Eating Well for Optimal Health* (4 resp.), *Health and Healing* (1 resp.), *Holistic Approach* (1 resp.), *Spontaneous Healing* (1 resp.), *Vitamins and Minerals* (1 resp.), and no title (3 resp.).

[e] Includes *McDougall Program for Healthy Heart* (1 resp.) and no title (2 resp.)

[f] Includes *The Zone* (1 resp.), *Soy Zone* (1 resp.) and no title (1 resp.).

[g] Authors/publishers include American Heart Association, Linda Clark, Coop Clinic, Adelle Davis, H&M Diamond, Johns Hopkins, Mayo Clinic, Earl Mindell, University of California-Berkeley, Weight Watchers.

Table 8-4. Publications not identified by title and/or author

Publication type	*Frequency*	*Publication type*	*Frequency*
Alternative medicine books	1	Macrobiotic books	1
Any that look good at bookstore	1	Medical journals	3
Cookbooks	4	Natural supplements	1
Diabetes books	1	Newsletter, no title	1
Doctor's research books	2	Nutritional journals	1
Exercise books	2	Professional magazines	1
Health books [a]	16	Rodale books , no titles [b]	28
Health food/nutrition books	13	Running books	1
Health food store magazines	1	Various/assorted books	12
Health magazines	1	Various/many other magazines	2
Health newsletters	3	Vegetarian books	1
Herb books	2	Weekly tabloids	1
Herb magazines	1	Whatever my wife has	1
Light cookbooks	1	Women's magazines	2

[a] Includes books published by Reader's Digest (2 resp.) and by Rodale (3 resp.).

[b] Includes Prevention/Rodale books (26 resp.), Prevention Book Club selections (1 resp.) and Prevention recommended books (1 resp.)

Table 8-5. Other information sources used by respondents

INFORMATION SOURCE	FREQ
Alternative health care provider [a]	3
Chiropractor/chirpractic nutritionist	2
County extension work or home ec teacher; will probably give best information with least bias	1
Herbalife	1
Massage therapist	1
Dr. George Malcamus (Hallaluh Acres, NC)	1
Programs [b]	2
Publications [c]	6
Recognized health sources: American Medical Association, American Health Association, etc.	1
Trainer	1
Videos by Dr. Lorraine Day, John Robbins, McDougalls	1
Word of mouth	1
Work, fellow employees [d]	5
Not named [e]	6

[a] Includes alternative doctor, natural health care provider, naturopathic physician (1 resp. each)

[b] Includes health program at local church and hospital seminars (1 resp. each)

[C] Includes publications (no titles); ads by mail; God's Garden natural nutritional information from Tulsa, OK; college wellness letters; flyer from health food store; and U.S. Department of Agriculture publications (1 resp. each).

[d] Includes work - dietary department at nursing home, fellow employees at county nursing service, work – wellness department at hospital, "I am an RN: I teach all above daily in my job," and workplace (1 resp. each).

[e] Includes "other" checked with no extra information provided (5 resp.), and "other" checked but extra information unreadable (1 resp.).