

Dietary Strategies for Cancer Prevention

Dileep G. Bal, M.D., M.P.H., and Susan B. Foerster, M.P.H., R.D.

Background. Two-thirds of cancer cases are associated with two lifestyle practices: 35% with the typical American diet, and 30% with tobacco use. In contrast to the field of tobacco control, research and resources dedicated to the field of nutrition have been limited, in part because dietary change has been considered controversial and requires a more complex set of interventions.

Methods. This series of papers reviews the science base underlying diet as a cancer control strategy, including research about diet-cancer relationships, current nutrition policy recommendations, American dietary trends, models of dietary behavior change, and diet in health care delivery. The history of technology transfer of new knowledge into widespread application will be compared and contrasted with other cancer control measures.

Results. There is scientific and policy agreement about three priority dietary goals for the year 2000: increase fruit and vegetable consumption to 5 or more servings every day, increase breads, cereals, and legumes to 6 or more servings daily, and decrease fat to no more than 30% of total calories. Current data do not indicate that these goals will be reached. As yet there is no organized effort, with clearly identified steps, to translate research into practice. The parallel with delays in implementing other cancer control measures, including Papanicolaou testing, mammography, and tobacco intervention, is striking.

Conclusion. Without resources dedicated to dietary modification in the general population, it is not likely that the potential savings of more than 300,000 new cases, 160,000 deaths, and the \$25 billion in associated costs will be realized in the foreseeable future. *Cancer* 1993; 72:1005-10.

Key words: diet and cancer prevention, dietary strategies, cancer prevention and control, fruits and vegetables, fat, fiber.

The history of cancer prevention and control has been characterized by decades of delay between the acquisition of new knowledge and its widespread application.¹

Presented at the National Conference on Cancer Prevention and Early Detection, Chicago, Illinois, September 10-12, 1992.

From the Chronic Diseases Control Branch, California Department of Health Services, Sacramento, California.

Address for reprints: Dileep G. Bal, M.D., M.P.H., Chief, Chronic Diseases Control Branch, California Department of Health Services, P.O. Box 942732, Sacramento, CA 94234-7320.

Accepted for publication March 26, 1993.

Three important examples make this point. Perfected in 1943, the Papanicolaou test was not widely used in clinical practice until the early 1970s.¹ Mammography as a screening procedure became available in the late 1950s, but it was not widely promoted until 1985, when, through efforts by the Breast Cancer Detection Program of the American Cancer Society (ACS), its use among white women increased dramatically, from 48% in 1987 to 74% in 1990 (California data).² For tobacco, though the Surgeon General first warned about smoking and cancer in 1964, it was not until the late 1980s that contemporary, comprehensive approaches to smoking control employing multiple strategies drawn from every relevant sector of the environment were being used.³

The human cost of these delays is stunning. An estimated 7,000-10,000 lives were lost annually to cervical cancer between 1943 and the early 1970s.¹ Breast cancer is the second cancer killer for women, killing more than 42,000 in 1988,⁴ and incidence rates are rising.⁵ Lung cancer has become the number one cancer for both men and women, taking more than 45,000 lives in 1988,⁴ with the only intervention being the prevention programs so belatedly being adopted. In each case, active technology transfer was the missing strategy.

Regrettably, the same pattern of delay is observed today in diet and cancer prevention. It was in 1913 that the first study of a diet-cancer relationship appeared. By 1950, associations with alcohol, protective foods, obesity, dietary fat, nutritional status, and carcinogens in cooking had been reported. In the 1950s, the literature began to reflect site-specific relationships.⁶ The science base now numbers hundreds of studies, expert panels have called for dietary changes in the general population (as described below), and an array of strategies has been proposed.⁷ However, like the cancer control methods described above, a critical shortcoming is that no plan is in place to transfer diet-cancer prevention research to practice.

The American Cancer Society Role

The ACS advocates faster progress toward preventing and curing cancer. This panel has an action-oriented philosophy. We hope to provide concepts and informa-

Table 1. A Quick Reference for Diet–Cancer Relationships, Mechanisms, and Cancer Sites*

| Dietary component | Role | Hypothesized mechanisms | Sites |
|--|------|---|--|
| Fat | + | May affect cell membrane fluidity, prostaglandins, lipid peroxide radicals, hormone receptors, cell growth, or ultracellular substances Breakdown products may convert to tumor-promoting substances or damage colonic mucosa | Colon, breast, prostate, rectum, endometrium |
| Body weight and calories | + | Fatty tissue may store chemical carcinogens Excess energy may increase cell multiplication or shorten latent period Metabolism of hormones in adipose tissue may contribute to tumor formation and growth | Colon, breast, prostate, endometrium, kidney, cervix, thyroid |
| Fiber | – | Shortens bowel transit time and may dilute or modify bile and fecal acids May reduce colonic pH | Colon |
| Fruits and vegetables | – | Acting through various vitamins, minerals, or other plant substances, may promote growth of epithelial tissue Deactivate carcinogens, block formation, or neutralize oxygen radicals and lipid peroxides Inhibit initiation and promotion stages Reverse cancerous changes | Lung, colon, breast, prostate, bladder, oral cavity, cervix, stomach |
| Alcohol | + | Acts synergetically with smoking for cancers of the mouth, larynx, and esophagus Acts independently through alcohol or other chemicals in alcohol, has separate and multiple effects with poor nutrition Through poor nutrition, also may impair immune function | Lung (with smoking), breast, rectum, oral cavity, esophagus |
| Charred, smoked, salted, pickled foods | + | Carcinogens or precarcinogens in food, some associated with high temperature and open flames May be effects of salt on the gastric mucosa | Stomach, esophagus |

+: positive association, increased intake with increased cancer; -: negative association, increased intake with decreased cancer.

* Adapted from the Surgeon General's Report on Nutrition and Health, 1988: 191–224.

tion that can be used actively, in your roles as scientists and physicians in many different areas of cancer control, but especially application: in the medical care of patients, in ACS leadership, and in policy-making by legislatures, health maintenance organizations, insurance companies, and state health departments.

This seminar reports current knowledge about: diet–cancer policy recommendations; the science base underlying the diet–cancer relationship (Table 1); trends in domestic food consumption related to cancer incidence; a strategic framework for introducing dietary change at the community, state, and national levels; and techniques for supporting patients with making dietary change. Our speakers address each issue more fully, outlining how intervention strategies might be constructed, and emphasizing the role that the ACS might play.

Background of Diet–Cancer Policy and Strategies for Prevention

Analytic reviews of the diet–cancer science base began appearing as early as the mid 1960s. They predicted

that dramatic gains in cancer prevention may be possible through diet. Using lifestyle and environmental evidence, the World Health Organization in 1964 concluded that “the majority of human cancer is potentially preventable.” In the late 1970s, Wynder and Gori estimated the proportion of cancer deaths attributable to diet as 40% in men and 60% in women, and a few years later, Doll and Peto concluded that an average was 35% of deaths, varying by site from 10% to 70%.⁶ In 1982, the National Academy of Sciences (NAS) concluded that cancers of most major sites are related to diet.⁸ In 1989, a second NAS panel noted that, in Mediterranean countries with diets like those being recommended for Americans, rates for diet-related cancers are about half those of the United States.⁹

As the relationships between diet and cancer became clearer, numeric targets for dietary change and strategies for intervention began appearing in the scientific and policy literature. The U.S. Senate Select Committee on Nutrition and Human Needs spoke out early, recommending in 1977 that fat intake be reduced to 30% of calories, while carbohydrate should rise to 55%

or more,¹⁰ exactly the same conclusions reached 12 years later by the NAS, among others. In 1985, the National Cancer Institute (NCI) was the first to link specific diet changes prospectively with cancer incidence and mortality. It projected that 35% of all cancer could be prevented with a national diet of 30% or less of calories from fat, 20–30 g of dietary fiber, and more fruits and vegetables.¹¹ It stated that, in just 15 years, a drop of 8% in cancer mortality was realistic, if measures involving other federal agencies, voluntary and professional organizations, state and local health departments, schools, and the food industry were applied.¹¹

By 1989, the NAS had concluded that quantitative dietary recommendations also should be food-specific.⁹ Relative to cancer prevention, they urged: (1) lowering fat to 30% or less of total calories by using fish, skinless poultry, and lean meats; nonfat and low-fat milk products; and less fats and oils; and (2) eating five or more servings of vegetables and fruits, and six or more servings of breads, cereals, and legumes every day. In 1990, the cumulative weight of evidence^{6,9,12} resulted in these recommendations becoming national health goals for the year 2000.^{13,14}

The Science Base

There are two main bodies of evidence underlying current dietary guidelines: animal research and epidemiologic studies (ecologic comparisons, migration studies, and cohort case control). Several prospective clinical trials are in progress or under development.¹⁵ Various dietary constituents are believed to inhibit, initiate, and promote carcinogenesis.^{6,9} The mechanisms through which diet is hypothesized to protect or promote the leading diet-related cancers are highlighted in Figure 1. Our first speaker outlines the latest advances in basic research.

Dietary Trends

Though simple in concept, our national dietary goals nonetheless require significant changes for Americans, namely: a near-doubling of fruits and vegetables, a doubling of dietary fiber, and a reduction by one-quarter or more of fat intake. Food supply statistics and dietary surveys indicate that food consumption has changed slowly over the last two decades, if at all.^{9,12} Therefore, achieving these targets by the year 2000 will require unprecedented acceleration in the rate of dietary change.

Americans have never been better informed or expressed more interest in diet than they do today. However, the food industry is the nation's largest advertiser, spending \$8 billion in 1988, of which the vast majority

promotes foods inconsistent with cancer prevention guidelines.¹⁶ Further, incomplete and distorted messages in the media and in food advertising^{17–19} suggest that current health education strategies are insufficient to support behavior change. Our second speaker reviews the available evidence to tell us where the progress is occurring, and where more emphasis is warranted.

From Bench to Widespread Application

There is as yet no single unifying model of how dietary behavior can be modified in the population at large,²⁰ nor is it clear what combination of approaches works best, or why.²¹ It has been stated by the NAS that

A concerted effort will be needed to make changes in the food supply and in nutrition policy and programs to increase the availability of (healthier foods) in supermarkets and in public eating facilities such as school cafeterias and restaurants. Consideration may need to be given to the most effective means of achieving such modification: through technologic changes, massive public education efforts, legislative efforts such as food labeling, or a combination of such strategies.⁹

Figure 1 displays how one model of behavior change, the stages of change approach,²² can be applied to ACS nutrition activities. This illustrates that both independently and as part of larger national, state, and local coalitions, ACS activities may be effective in stimulating society-wide dietary improvement to reduce cancer risk.

A related initiative is the "5 a Day" program, which was launched by the NCI and the nation's fruit and vegetable industry in October 1991.²³ It builds on the growing research base showing strong associations between lower cancer rates and patterns of higher fruit and vegetable consumption.^{24–27} The program has one simple dietary message, eat five or more fruits and vegetables every day. Strongly supported by the ACS on the national level, many ACS divisions and units are participating. Our third speaker heads NCI's program, which is the first national cancer prevention campaign that attempts to change the way America eats. She describes NCI's approach to translating research to dietary behavior change in the general population.

Medical Practice

Patients are more satisfied when physicians give them guidance they feel they need²⁸; therefore, for some physicians, providing firm dietary intervention may be a practice builder. Although patients say that physician instruction is a powerful motivation to change,²⁹ many

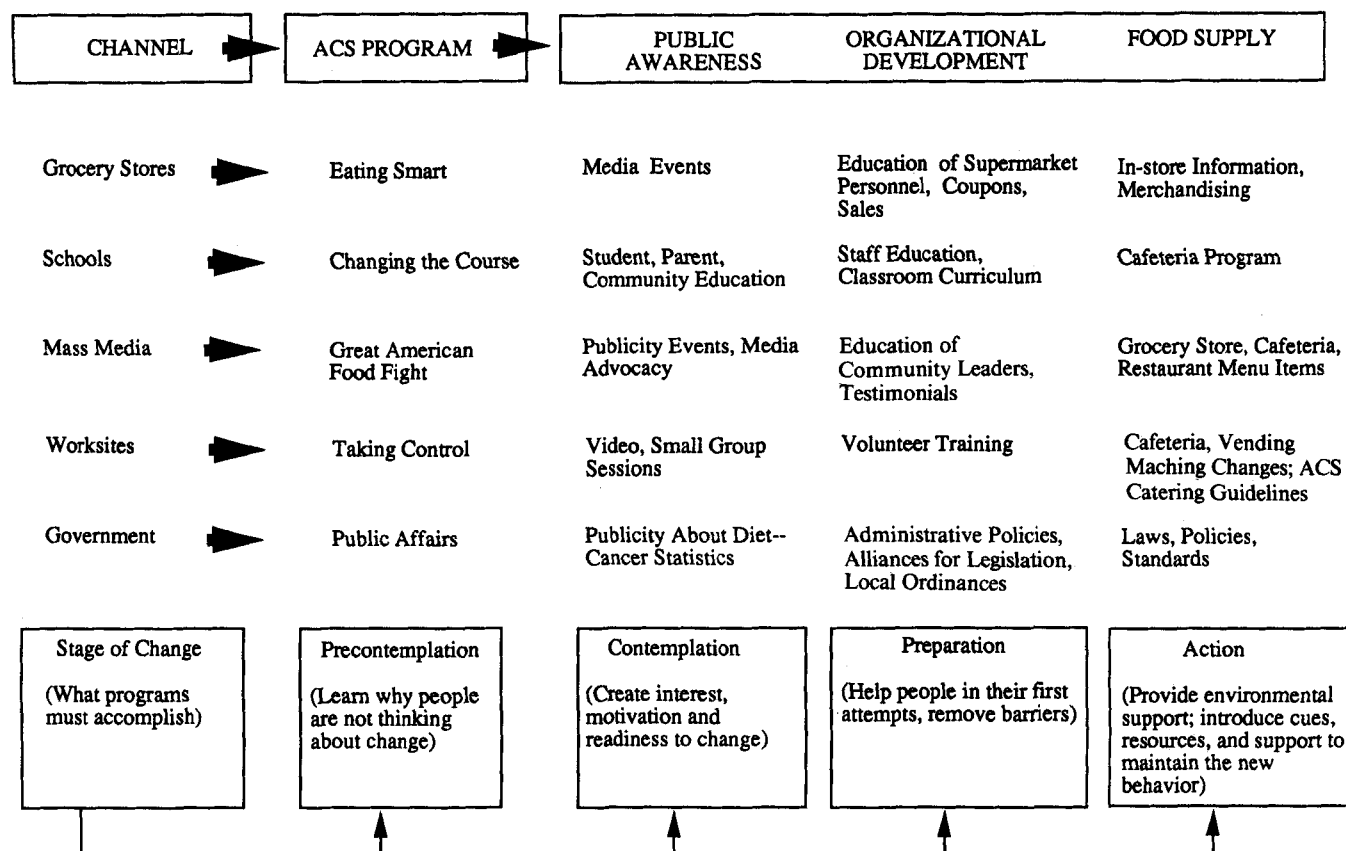


Fig. 1. A framework for cancer prevention through diet, with existing American Cancer Society programs as examples.

practitioners say that dietary guidance is difficult, time-consuming, and largely unsuccessful with patients.³⁰ It could be otherwise. Recent studies have demonstrated that among motivated women, relatively simple group approaches were successful in lowering fat intake not only among the women, but also among their husbands.^{31,32} There were two important results: Women achieved and maintained for 1 year what many consider to be the ideal level of fat for cancer risk reduction.³¹ The husbands, incidental to their wives' more rigorous changes, dropped their fat intake enough to be within two points of the 30% goal set for the year 2000.³² This is all the more remarkable because, for the U.S. adult population at large, there has been no change in fat intake for the last 20 years.⁹ Even more simply, in any practice situation, physicians could easily prescribe five servings of fruits and vegetables every day, at the same time that they advise patients to quit smoking or start a walking program. Our last speaker describes how clinicians can motivate and guide patients to apply cancer prevention dietary guidelines on a daily basis.

Discussion

As has happened with other cancer control measures,¹ it appears that, in the case of diet, "the means of control

has been discovered before the pathogenic mechanisms or precise etiology have been identified." Returning to the opening subject, delays in widespread application, we can use analogies with smoking—in itself a difficult field—to see clearly the many parallels that diet has with other cancer prevention advances.

Etiology

Physiologic and behavioral complexity, as well as social forces, make diet technically difficult to investigate. Food contains many more chemicals than tobacco does, resulting in more possible combinations of physiologic interactions. Since food constituents both protect and promote carcinogenesis, clear relationships are hard to identify. With interstate shipping of agricultural commodities and standardized processed foods, large variations in the types of foods eaten within any one population group are increasingly rare. At the same time, dietary patterns are becoming more varied,³³ and diets are being made up of smaller amounts of more different foods.³⁴ This contrasts with the field of smoking, where exposure is fairly clear: who smokes, how much, what brand, and for how long. In sum, lifelong dietary behaviors are difficult to characterize, in contrast to the easier

task of counting the number of years of smoking and the number of cigarettes smoked per day.

It is interesting to recall that, as was the case with both Papanicolaou tests and mammography, the lack of clinical trials, considered the gold standard in medical research, has been used as a reason that more emphasis has not been given to diet. In the case of mammography, the clinical trial actually delayed implementation of the measure, and it is unlikely that the ultimate outcome following trials was modified.¹

Professional Responsibility

The health impact of diet occurs broadly, across many anatomic sites and in multiple practice specialties; therefore, unlike other cancers in which surgeons or gynecologists have taken the lead,¹ no single, powerful discipline directly experiences the brunt of the impact. Perhaps more to the point, for the great majority of people, the remedies are not medical in nature. Even for high-risk patients, the health care system is not organized or financed to deliver preventive services,¹ such as dietary modification, that in research settings, have proved effective in changing lifestyle behavior. Pharmaceutical and medical equipment companies, traditionally effective in introducing new technologies,¹ do not have a role in promoting healthful foods. A related example is the rapid acceptance of lipid-lowering drugs for heart disease, following heavy promotion by the drug industry, as compared with the measure that is recommended first, namely dietary change without medication.

Profit and Loss

Compared to smoking, the "costs" of modifying diet are more subtle. Indeed, while many advertisers are taking advantage of promotional opportunities made possible by new nutrition labeling regulations, others are taking an opposite tack, by promoting the idea that healthy food is unpleasant, bad tasting, or no fun to eat. These trends are becoming more blatant in television food advertising, such as with ostensibly humorous ads decrying "healthy" cereals, promotion of high-fat snack items and fast food instead of healthier school lunches, and even the abandonment of lean beef promotion in favor of the campaign, "Beef, the way America eats." As with smoking, some segments of the food industry selectively promote unhealthy foods to minority audiences, including advertising, event sponsorships, and scholarships.³⁵ Clearly, to the degree that fats and oils are low-cost fillers in food processing, reducing the fat content of food means that some sectors of the industry could lose profits. Finally, from frozen dinners to frozen dairy desserts to fast food salads,

many of the more healthful foods command premium prices, thereby creating a barrier for much of the American public.

Diversions

Competing for attention and resources are apparently respectable scientific initiatives. Within NCI for a time, the use of biotechnology was supported to develop "designer foods." This involved identifying produce items with high proportions of cancer-inhibiting plant substances and selectively breeding new strains for the mass market, despite the fact that ordinary produce is associated with lower cancer risk.³⁶ The pharmaceutical industry, under the auspices of the New York Academy of Sciences, has promoted vitamin supplements as preventives, although they are not proven to be such.³⁷ Meanwhile, the National Dairy Board's initiative, "Resetting the American Table," seeks to enlist leading culinary and dietetic professionals in an "alliance of taste and health," with which no one would disagree, but which avoids the hard issue of quantitative standards for fat lowering.³⁸

Conclusion

Cancer control history shows that progress has come when the evidence accumulated through research is applied systematically in medical practice and/or public health. For example, with adequate resources for prevention and control activities, smoking rates in California have declined 17% in the last 3 years.³⁹ For a substance whose active principal, nicotine, is as addictive as cocaine or heroin, this is remarkable. (Even now, well funded lobbies defend the public's right to smoke.) By way of contrast, for fruits and vegetables, the annual rate of increase nationally appears to be no better than 1.5%.^{9,40} Clearly, without resources dedicated to its accomplishment, even the modest goal of five fruits and vegetables a day is likely to be met not by the year 2000, but in the year 2015, a decade and a half late.

The value of history is that it helps us understand where we have been, where we are, and the direction we are going. In the field of cancer, control has been a chronically missing link. Control is defined as deliberate, discrete, and organized effort, with steps identified clearly, through which research is translated to practice.¹ Using 1985 statistics,^{6b} a plan that leads to achieving the nation's dietary goals for cancer prevention would yield tremendous gains: 315,000 fewer new cases of cancer, 166,000 avoided cancer deaths, and \$25 billion saved every year. That is what the 35% of diet-attributable cancer cases means in human and economic terms. What also is clear is that significant leadership will be required if cancer control through diet is to realize its potential soon.

References

- Breslow L, Agran L, Breslow DM, Morganstern M, Ellwin L. Cancer control: implications from its history. *J Natl Cancer Inst* 1977;59(2 Suppl):671-86.
- California cancer facts and figures. Oakland: American Cancer Society, 1992.
- National Cancer Institute. Strategies to control tobacco use in the United States: a blueprint for public health action in the 1990s. Smoking and tobacco control monograph 1. Bethesda: US Department of Health and Human Services, 1991; NIH publication no. 92-3316: 33.
- Cancer facts and figures—1992. Atlanta: American Cancer Society, 1992.
- Miller BA, Ries LAG, Hankey BF, Kosary CL, Edwards BK, editors. Cancer statistics review 1973-1989. Bethesda: National Cancer Institute, NIH publication no. 29-2789, 1992.
- US Department of Health and Human Services. The Surgeon General's report on nutrition and health. Washington, DC: US Government Printing Office, 1988; DHHS (PHS) publication no. 88-520210: 4-6, 177-247.
- Thomas PR, editor. Institute of Medicine (US), Committee on Dietary Guidelines Implementation, Food and Nutrition Board: improving America's diet and health—from recommendations to action. Washington, DC: National Academy Press, 1991.
- National Research Council, Committee on Diet, Nutrition, and Cancer, Assembly of Life Sciences. Diet, nutrition, and cancer. Washington, DC: National Academy Press, 1982.
- National Research Council, Committee on Diet and Health, Food and Nutrition Board, Commission on Life Sciences. Diet and health: implications for reducing chronic disease risk. Washington, DC: National Academy Press, 1989: 12-8, 54-62, 593-613, 669-90, 701-3.
- Senate Select Committee on Nutrition and Human Needs. Dietary goals for the United States. Washington, DC: US Government Printing Office, 1977.
- Cancer control objectives for the nation: 1985-2000. NCI monograph 2. Bethesda: US Department of Health and Human Services, 1986: 4-5, 9, 20-22.
- Bal DG, Foerster SB. Changing the American diet. *Cancer* 1991;67:2671-80.
- US Department of Agriculture, US Department of Health and Human Services. Nutrition and your health: dietary guidelines for Americans. Washington, DC: US Government Printing Office, 1990: Home and garden bulletin no. 232.
- US Department of Health and Human Services. Healthy people 2000: national health promotion and disease prevention objectives. Washington, DC: US Government Printing Office, 1990; DHHS (PHS) publication no. 91-50213: 93-5.
- National Cancer Institute. Fact book, 1990. Bethesda: US Department of Health and Human Services, Public Health Services, National Institutes of Health, 1990: 7-8.
- Economic Research Service. Food marketing review, 1989-90. Agricultural economic report no. 639. Washington, DC: US Department of Agriculture, Nov 1990; 13-7.
- Barr SI. Nutrition in food advertising: content analysis of a Canadian woman's magazine, 1928-1986. *J Nutr Educ* 1986;21:64-71.
- Story M, Faulkner P. The prime time diet: a content analysis of eating behavior and food messages in television program content and commercials. *Am J Public Health* 1990;80:738-40.
- Wallack L, Dorfman L. Health messages on television commercials. *American Journal of Health Promotion* 1992;6:190-6.
- Cancer Prevention Research Program. Proceedings of the conference, promoting dietary change in communities: applying existing models of dietary change to population-based interventions. Seattle: Fred Hutchinson Cancer Research Center, 1992.
- McLeroy K. Health education research: theory and practice—future directions (editorial). *Health Education Research* 1992; 7:1-8.
- Prochaska JO. A transtheoretical model of behavior change: implications for diet interventions. In: Proceedings of the conference, promoting dietary change in communities: applying existing models of dietary change to population-based interventions. Seattle: Fred Hutchinson Cancer Research Center, 1992: 37-52.
- 5 a day is underway: President Bush's principal advisor on consumer affairs helps launch 5 a day. NCI commits \$27 million to mobilize public health community. *The 5 a Day News* 1991;Dec:1.
- Block G, Menkes M. Ascorbic acid in cancer prevention. In: Nutrition and cancer prevention: investigating the role of micronutrients. Moon TE, Micozzi MS, editors. New York: Marcel Dekker, 1989: 341-88.
- Steinmetz KA, Potter JD. Vegetables, fruit, and cancer: I. epidemiology. *Cancer Causes and Control* 1991;2:325-57.
- Steinmetz KA, Potter JD. Vegetables, fruit, and cancer: II. mechanisms. *Cancer Causes and Control* 1991;2:427-41.
- Gey KF. On the antioxidant hypothesis with regard to arteriosclerosis. *Bibl Nutr Dieta* 1986;37:53-91.
- Brody DS, Miller SM, Lerman CE, Smith DG, et al. The relationship between patients' satisfaction with their physicians and perceptions about interventions they desired and received. *Med Care* 1989;27:1027-35.
- Greenberg JS, Hale JF. The receptivity to and feasibility of patient education for patients of private practice, primary care physicians. *American Journal of Health Promotion* 1988;3:36-43.
- Valente CM, Sobal J, Muncie HI, Levine DM, et al. Health promotion: physicians' beliefs, attitudes, and practices. *Am J Prev Med* 1986;2:82-8.
- Kristal AR, White E, Shattuck AL, Curry S, Anderson GL, Fowler A, Urban N. Long-term maintenance of a low-fat diet: Durability of fat-related habits in the women's health trial. *J Am Diet Assoc* 1992;92:553-9.
- Shattuck AL, White E, Kristal AR. How women's adopted low-fat diets affect their husbands. *Am J Public Health* 1992; 82:1244-50.
- Senauer B, Asp E, Kinsey J. Food trends and the changing consumer. St. Paul: Eagan, 1991: 115-32.
- Popkin BM, Haines PS, Reidy KC. Food consumption trends of U.S. women: patterns and determinants between 1977 and 1985. *Am J Clin Nutr* 1989;49:1307-19.
- Maxwell B, Jacobson M. Marketing disease to Hispanics. Washington, DC: Center for Science in the Public Interest, 1989: 42-6.
- Designer foods. *Nutrition Action Health Letter* Apr 1991;18:1, 5-7.
- Wilde P. Media coverage spurs fad for vitamin pills, after year-long industry effort. *Community Nutrition Institute Nutrition Week* May 22, 1992;22:1-6.
- American Institute of Wine and Food. Resetting the American table—creating an alliance of taste and health. In: Standards for food and diet quality. San Diego: Nuffer, Smith, Tucker Public Relations, 1991.
- Burns D, Pierce JP. Tobacco use in California, 1990-1991. Sacramento: California Department of Health Services, 1992: 31.
- Pearl RC. Trends in consumption and processing of fruits and vegetables in the United States. *Food Technology* 1990;Feb: 102-4.