Nutrition Education and the Role of Dosage

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Purpose and Background

Why Dosage Matters Nutrition education, in a public health context, is intended to influence large segments of the general population where they live, work and play. Educators face many challenges as they seek to engage people with varying degrees of interest and motivation in activities designed to change their eating habits. The intervention literature offers numerous examples of modest take-up rates and high levels of attrition. Such conditions argue for pursuing educational initiatives that are relatively brief and non-burdensome. At the same time, it is generally recognized that sufficient time and practice are needed for individuals to acquire the necessary information and skills, as well as to incorporate new behaviors into their life styles. Finding the optimal balance between these competing demands is at the core of the dosage question – how much nutrition education is enough for people to change dietary patterns? The purpose of this paper is to examine pertinent research for a credible answer or answers.

Key Definitions One of the first steps is to refine the question. It is clear that dosage has multiple dimensions. The term generally refers to the amount of exposure individuals have to an educational message or intervention. It may be defined operationally in terms of the number of educational contacts, such as lessons, activities or public service message plays. Dosage may also refer to the length of time associated with a complete intervention or individual components, such as a ten hour curriculum or 90 minute workshop.

Duration is another frequently cited aspect of dosage. It refers to the calendar length of an active intervention and is typically measured in weeks, months or years. A publication, for instance, may note that the nutrition education curriculum of interest was delivered over a semester or a full school year.

Dosage now encompasses the number of communication channels as well. For example, in a school-based setting, educational channels may include classroom lessons, activities to pursue at home with parents, posters in the cafeteria, and/or special events open to students, their families and the community.

Occasionally, research is focused on interventions delivered at the individual level versus small groups or even population segments. While some regard this as another dimension of dosage, a case may be made that these approaches vary with respect to more than intensity.

It is important to note that in the research reviewed, dosage is not always defined clearly or consistently. Instead, the terms dosage and intensity are used interchangeably and may refer to any or all of the dimensions described. When a study focused on a specific dimension of dosage, that definition is cited.

In addition, references to large, medium and small doses are generally study specific. Terms are defined operationally whenever possible. While there is no formal consensus, references to a small or modest dose often mean a single and/or brief face-to-face contact – though supplemented with other material or forms of contact. Large doses sometimes are defined as multiple contacts or components delivered over several weeks to several months, but frequently a dose is *relatively* large – that is, only in reference to the comparison or control group.

Interpreting the Research on Dosage An initial observation is that the four primary dimensions of dosage – number of contacts, length of exposure, duration, and number of communication channels – while distinct do not necessarily co-vary within an intervention. An intervention with many contact occasions, such as some social marketing campaigns, may provide limited total message exposure. Alternatively, nutrition education for students may be delivered over an entire school year but only through a single communication channel, such as classroom lessons.

If dimensions of dosage are not examined individually within the context of nutrition education research, it is impossible to interpret the results clearly. Let's say, we observe larger, but still relatively modest, behavior improvements among those receiving the intervention with more total exposure time. Is the outcome due only to variation in total exposure time or did dosage vary along other dimensions as well? Would the impact be even larger if participants experienced a greater number of contacts and communication channels, as well as more total exposure time? Definitive answers require systematically testing individual dimensions of dosage.

Approach to the Research Review

This paper reviews research that examines the effects of intervention dosage on changes in dietary behaviors. The focus is on research in which participants come from healthy, free-living populations rather than from those identified as having or being at-risk for specific health conditions. The initial plan was to look exclusively at research that used experimental designs and varied intensity as the independent variable. However, only three such studies were identified in the review of literature published from 1995 through 2004 (Carpenter et al., 2004; Havas et al., 1998; Sorensen et al., 1996).

The review, consequently, was expanded to include studies that assessed the impact of intervention intensity using dose-response analyses on a post-hoc basis. In addition, the summary includes research reviews that looked across nutrition education evaluations for patterns in the relationship between dosage and outcomes. The internal validity of non-experimental approaches is uncertain, however, because selection bias and/or other plausible explanations may account for the results observed.

Attention recently has been directed to research in which participants receive a modest or low-intensity exposure to nutrition education—frequently where the content is individually-tailored. When carried out in the context of an experimental design, such studies can contribute to our understanding of the minimum dose needed. A sample of these is included in the review.

Results from each body of research are examined with respect to the methodological strength of the studies producing them and in terms of any patterns that emerge. The paper concludes with a discussion of outstanding questions for future research on nutrition education intensity.

Studies that Used Experimental Designs

The three studies that used experimental designs to assess dosage impacts vary in terms of population, targeted dietary behaviors, intervention features, and setting (Carpenter et al., 2004; Havas et al., 1998; Sorensen et al., 1996). They share, however, some pertinent methodological features. In each, the control group received a less intense intervention than the treatment group rather than no intervention at all. All three studies measured dietary change with self-reports of dietary consumption – although with different tools.

Havas et al. (1998) studied an intervention targeting increased fruit and vegetable consumption among women who were enrolled in the WIC Program or whose children were enrolled. Over a six month period, women in the treatment group were offered three small group sessions, each lasting about 45 minutes, and received four educational letters through the mail. Group discussions were facilitated by peer educators and used a *photonovella*, that is, an illustrated booklet with a story line, to actively engage participants in self-assessment, goal setting, and identification of strategies to overcome barriers. Letter content was tailored to each individual's readiness to change behavior and specific goal. Control group participants received the usual 10 minutes of dietary counseling during bimonthly clinic visits to pick up WIC vouchers. A small, but statistically significant difference was observed between the two groups. Treatment group members reported consuming about 0.4 more servings of fruits and vegetables per day than the control subjects at two and twelve months after the intervention.

In the Carpenter et al. (2004) study, subjects were healthy men and women who had previously expressed interest in participating in research sponsored by the Cooper Institute. The intervention focused on improving multiple aspects of diet quality, and only those whose initial screening showed room for improvement in at least two areas were included. Participants were randomly assigned to one of three intensity levels for a six month intervention. All three groups, including control group subjects, received the American Dietetic Association's (ADA) Complete Food and Nutrition Guide, along with instructions to contact project staff with any questions. In addition, the weekly meeting group (WMG) participated in twenty small group sessions, each lasting 75 minutes and scheduled over twenty-four weeks. Meetings emphasized the process of behavior change and incorporated interactive strategies. WMG participants were encouraged to keep food logs and check in with project staff. The correspondent group (CRG) received the same curriculum through the mail on a bi-weekly schedule, as well as weekly reminders to review the materials. CRG subjects were also provided access to an interactive web-site.

Carpenter et al. measured impacts on a modified version of the Healthy Eating Index. Small, statistically significant differences were observed between the WMG and each of the less intensive treatment conditions for overall diet quality and fruit consumption. The WMG also showed modest but statistically significant improvement in their saturated fat score compared to the control group. The net score changes with respect to overall diet quality were five to nine points higher for the WMG participants compared to the CRG and control group subjects, respectively. A higher score indicates a diet that corresponds more closely to recommendations of the Food Guide Pyramid.

The third experiment, the Working Well Trial, took place in more than 100 different businesses. Work sites were sorted into matched pairs and then randomly assigned to a treatment or control group (Sorensen et al., 1996). This was a cancer prevention study with attention to several aspects of diet quality and smoking cessation.

Intervention activities took place over two years, although duration varied somewhat across work sites. The core intervention consisted of employee self-assessments, small classes and self-help materials, as well as a number of campaigns, contests and other interactive activities. Employees at treatment group sites also experienced some environmental changes, such as the availability of more healthful foods in cafeterias, vending machines and at catered events. In the control sites, employees were offered a self-assessment survey and a variety of printed nutrition materials, including a summary of the survey results.

Again, small but statistically significant differences were found for some, but not all, measures of individual diet quality. Participants in the intervention sites reported an average 0.18 additional servings of fruits and vegetables per day and 0.37 percent reduction in the amount of calories from fat compared to control site employees.

General Observations from the Experimental Designs In these three studies, the more or most intensive intervention resulted in larger dietary improvements compared to the control group. Impacts occurred most consistently for self-reported fruit consumption. The interventions shared some key features. They all provided more face-to-face contact through small group meetings, included some initial self-assessment and goal setting, incorporated strategies for changing behavior, and involved more than a single communication channel.

The size of positive impacts was uniformly modest despite differences across studies in number of contacts, length of contacts, duration, and number of different communication channels offered. One possible equalizer may be the intensity of education which treatment group participants actually received. We know from Havas et al. (1998) that even with an intervention including just three group meetings, close to 50 percent of participants attended none of them. Although the Sorensen et al. (1996) and Carpenter et al. (2004) interventions had more components, it is possible that the level of material use and activity participation was similarly low.

A second explanation for the small impacts is the rigorous analytic approach. All three studies used an intention-to treat analyses. This means that all subjects participating at the baseline measurement are part of the impact analysis, regardless of their level of treatment exposure or attrition. For subjects who do not provide post-intervention data, their baseline scores were used. As a result, intervention impacts were more accurate but were also likely to be smaller.

Research Reviews and What They Say about Dosage

There are a number of published nutrition education research reviews that track dosage as an intervention feature and compare impacts across studies. Typically, such reviews select individual studies with experimental and sometimes strong quasi-experimental designs, as well as a focus on behavioral impacts. They usually rely on the dimension of dosage reported in individual publications, although some reviewers apply their own conceptual approach to

classify intervention intensity as high, medium or low. Reviews vary in terms of publication time frame, intervention settings and population, targeted dietary outcomes, and method for standardizing impact size across studies.

Occasionally, reviewers report that efforts to compare impacts across different levels of intensity were unsuccessful. Either the number of studies meeting the standard for methodological rigor was too small (MacArthur, 1998) or study details on intensity were too limited to make quantitative comparisons (Ammerman et al., 2002; Hoelscher et al., 2002; and Department of Health and Human Services, 2001). There remain, however, a number of research reviews that provide some general observations on the relationship between dosage and changes in dietary behavior.

Early Reviews on Dosage Three early reviews fall outside the time frame for this paper but are included because they are cited frequently in the research literature as setting dosage benchmarks for behavior change. Connell et al. (1985) focused on general health education and Contento et al. (1992 and 1995) on nutrition education in school settings. The Connell et al. publication does not report results for nutrition outcomes specifically, but notes that small, statistically significant effects on overall health practices occur when classroom instruction hours reach at least 12-15 hours. Medium effect sizes[1] were not observed except when interventions provided at least 30 hours of instruction and were not consistently found across studies until health programs offered 50 or more classroom hours.

The Contento et al. (1992 and 1995) reviews are consistent with these findings. The typical intervention involved 10-15 hours of instruction over a one to four month period. Although there is no quantitative comparison of effect size, Contento et al. observed that impacts on behavior were minimal. In contrast, nutrition education programs lasting multiple years, sequential in nature and delivering weekly lessons throughout the school year produced positive effects on dietary intake. Some studies were designed to assess the incremental impact of involving parents in the intervention. The authors conclude that parent participation in programs targeted to younger children adds to effectiveness, but that involvement may need to go beyond sending materials home for parents to read.

More Recent Reviews A number of more recent reviews examine nutrition education targeted to individuals recruited through health care delivery or research settings. The reviews discussed next focus on studies in which participants were asymptomatic and considered healthy. Their emphasis on more general populations makes the results relevant for public health nutrition interventions.

Brunner et al. (1997) examined randomized control studies of interventions intended to reduce dietary fat among diverse populations. The interventions varied with respect to duration (3-6 months and 9-18 months) along with number of contacts (2-3, 5-9 and 10-32). Effects were measured in terms of self-reported diet and in some studies, serum cholesterol. Net changes in both outcomes were generally larger among intervention subjects who had more contacts over a

[1] Effect size is measured in terms of the proportion of a standard deviation associated with each study's impact measure. The definition of small effect sizes falls between 0.25 and 0.5 percent of the relevant standard deviation. Medium effects range between 0.51 and 0.8.

longer time period. The reviewers noted, however, that the more intense interventions were targeted more often to highly motivated, at risk participants. Equally important, however, is that all the shorter interventions reported at least small, statistically significant reductions in percent of calories from fat. This finding was independent of participant health risks.

Berg et al. (2003) and Pignone et al. (2003) report on nutrition interventions aimed at unselected adult patients in primary care practices or audiences similar to them. Low intensity initiatives typically involved a single face-to-face contact of less than 30 minutes that were sometimes supplemented by self-help materials or other interactive forms of communication. High intensity was defined in both reviews as six or more face- to-face contacts of at least 30 minutes each. Interventions included in the Berg review were a minimum of three months in duration, while trials in Pignone's review ranged from one week to a year.

Two other reviews took a more general look at dietary change interventions with the goal of identifying features that are consistently associated with positive impacts. Bowen and Beresford (2002) examined interventions by delivery channel, e.g., those that are individually-focused or delivered through work-sites, religious organizations, grocery stores or community-wide venues. All participants were adults; target behaviors included fat, fiber, fruit and/or vegetable consumption. Ciliska et al. (2000) reported on community-based interventions to increase fruit and vegetable consumption among children and adults. These studies reported only on the general direction of dosage impacts.

Nevertheless, all the reviews draw similar conclusions. Dosage was positively associated with the size of impacts. Studies involving large dose interventions were different, however, in other ways – more often including highly trained nutrition educators and motivated participants who were at risk for some disease. The co-variation between intervention intensity, educator qualifications and participant interest made it impossible to isolate the effects of dosage alone.

A second important finding is that less intense interventions, targeted to individuals or small groups, can produce dietary improvements – although of smaller magnitude. Berg et al. (2003) reported comparable impacts for interventions consisting of a few face-to-face sessions and for single brief contacts. In the Pignone et al. review (2003), the amount of dietary improvement increased with intensity, but small effects (net differences between treatment and control group participants) were consistently observed even with low dose interventions. Specifically, low-dose initiatives most often resulted in net reductions of less than 1.3 percent of calories from saturated fat or five percent of calories from total fat. When interventions targeting fiber, fruits and vegetables were examined, low intensity initiatives typically resulted in increases of less than two grams of fiber/day and 0.3 servings of fruits or vegetables per day.

Orleans et al. (1999) also reported that individual-level interventions involving minimal contact show promise for producing meaningful dietary and other changes at a population level. This conclusion came from prominent health promotion researchers who were asked to identify noteworthy trends in their respective fields.

Dose Response Analyses

Other studies have investigated the influence of dosage by examining variation in exposure among participants within an intervention group. Recent research on dose response captures

intensity differences that occur naturally because of the voluntary nature of participating in nutrition education activities.
The strongest positive relationship between dose and dietary change was observed in the Havas et al. (1998) study of WIC mothers. The intervention consisted of three interactive discussions and four personally tailored letters delivered over a six month period. Self-reported fruit and vegetable consumption went up with each additional nutrition session attended. Women attending all three sessions increased daily consumption by 1.25 servings, while those participating in no sessions increased consumption by 0.15 servings per day. Others report an inconsistent (Koblinsky et al., 1992) or more modest relationship (Dollahite and Scott-Pierce, 2003) between dose and response.

Relying on natural variation in educational intensity unfortunately introduces some confounding factors. One of the most serious is the matter of selection bias. It is quite possible that those who choose to participate more extensively are different from those who do not, and this difference may account for larger impacts among the former.

Controlling for the influence of multiple factors is another challenge to interpreting the results of natural experiments. While not a dose-response analysis, the Dollahite and Scott-Pierce (2003) study offers a good example. Changes in nutrition related behaviors among EFNEP graduates who received their education in small groups were compared to those who participated in individual sessions. Both groups showed statistically significant improvements, although the magnitude was greater for those receiving a one-on-one education. One might hypothesize that individual delivery engages participants to a greater degree and leads to more improvement in diet quality, food resource management and food safety practices. However, the two groups also varied in terms of some demographic characteristics, as well as the number of lessons completed. The research design makes it impossible to definitively untangle the relationships between and relative influence of personal characteristics, delivery mode and number of lessons. Results from dose-response analyses are difficult to interpret for similar reasons.

Can Low-intensity Interventions Make a Difference?

A Rationale for Low Dose Interventions The evidence indicates that higher doses of nutrition education generally lead to larger dietary improvements. It is, clear, however, that educators cannot guarantee the intended dose will be the one delivered or received (Baranowski et al., 2003; Glasgow et al., 2003 and Sharpe et al., 1996).

Gaps in delivery may be due, in part, to the fact that many interventions are delivered in existing organizational settings, such as schools, work sites, community centers or food stores. All of these impose their own competing priorities and constraints.

Even when an organization commits to delivering nutrition education, the voluntary nature of participation means the level of actual exposure may lag or, at least, vary across participants (Havas et al., 1998; Koblinsky et al., 1992 and Kristal et al., 2000). The potential for such gaps depends on the setting. For school-based interventions, most students will receive the dosage that is *delivered* although this may not be all that is intended. At work sites and other community settings, participants typically have considerable discretion in determining their level of involvement and exposure. And, in all settings, nutrition educators may vary in their adherence to implementation guidelines.

Research on Low-intensity Interventions Given the challenges associated with delivering and engaging participants in multi-component interventions, the interest in less intensive education is understandable. In addition, some posit that even small improvements in diet quality can produce health benefits if they occur across a large population (Orleans et al., 1999; and Rose, 1990 and cited in Beresford et al., 1997).

In the research reviewed here, low-intensity interventions are those that limit the total amount of face-to-face contact between educator and participant. This occurs by relying on other forms of communication, such as self-help materials or interactive software. Depending on the setting, individuals may have more flexibility in terms of when and how much they participate. Implementation quality and fidelity are less dependent on individual educators, such as classroom teachers or peer counselors – although competing priorities in community settings will still influence access to such interventions.

A number of low dose interventions have focused on adults who are not at specific risk for a diet-related disease but who are recruited and participate in health-related contexts – e.g., primary care facilities and health information phone lines (Beresford, et al., 1992; Beresford et al. 1997; Campbell et al., 1994; Delichatsios et al, 2001; Kristal et al., 2000; and Marcus et al., 2001). These interventions shared several characteristics; they:

- were preventive in nature;
- had multiple dietary goals;
- sought changes among many persons; and
- had multiple components, but limited face-to-face contact.

Their intervention structures were also similar. They typically provided individual assessment, brief initial contact to set goals, and self-help materials that were or were not tailored to the individual. Follow-up varied in terms of the number of contacts, type(s) of communication channels, and duration. Usually, follow-up occurred through the mail, computers and/or telephone over a period of 3-4 months.

Each study reported small but statistically significant changes in one or more goals. Improvements were around a 0.5 serving increase for fruits and vegetables per day and a daily reduction of a few grams or one percent in calories from fat. Two of the studies tested for net differences between treatment and control group participants twelve months after the intervention and reported positive, though smaller, impacts. All studies incorporated experimental design and some reported analyses based on an intention-to-treat.

It is worth noting that even among these relatively low-intensity interventions, participation suffered. Beresford et al. (1997), Kristal et al. (2000) and Delichatsios et al. (2001) reported that 40-67 percent of those who met the study eligibility requirements volunteered to participate. Some studies (Beresford et al., 1997; and Campbell et al., 1994) also reported large scale attrition among volunteers during the intervention period. Kristal et al. monitored use of and

participation in different components of the intervention. With the exception of follow-up phone calls, no more than 49 percent of the treatment group reported using any one of the other intervention components.

Two recent studies examined the impacts of nutrition education in community settings that consisted of interactive software on personal computers. In the Baranowski et al. (2003) study, the five week intervention was a computer game that delivered tailored messages to fourth graders over ten sessions of 25 minutes each. Students were scheduled for these sessions, but individual availability and competing school priorities affected participation somewhat. The percent of students completing all ten sessions in each of two series (that involved different schools and time of year) was 87 and 59 percent.

Irvine et al. (2004) provided access to interactive computer software in relatively private work settings. Participants could navigate through a variety of tailored paths that offered tips, strategies, encouragement and other information. Intervention participants were scheduled for their first use and then provided multiple occasions over a one month period to use the software. Average time for the first use was about 30 minutes, but only 15 and 10 percent of participants used the software a second and third time, respectively.

Both studies reported positive changes in behavior, although to different degrees. Irvine et al. reported small (0.33 to 0.5 percent of a standard deviation), but statistically significant effects for consumption of fat, fruits and vegetables. The Baranowski et al. study (2003) reported larger impacts with intervention participants consuming an additional 0.91 combined servings of fruit, juice and vegetables per day compared to control group students.

So What Do We Know and Where Do We Go?

Large dietary changes have been reported when nutrition education takes place in clinical settings, where repeated face-to-face contact on an individual level occurs between professionals and motivated, at-risk persons (Bowen et al., 2004 and Kristal et al., 2000). The clinical model for nutrition education is more difficult, and some would say not feasible, to apply to a public health nutrition challenge. High costs, limited availability of committed organizations and skilled educators, along with uneven motivation among the broad target audience make it essential to examine the cost-effectiveness of alternative, less intensive approaches to nutrition education.

We are still at the threshold of understanding the relationship between dose and response for community-based interventions with general populations. Very few studies have experimentally manipulated intensity, and none have examined a wide range of levels. Much of the research pertinent to dosage is post hoc in nature with all of the expected constraints on drawing cause and effect conclusions. Like nutrition education evaluation in general, dosage assessments typically rely on self-reported changes in food choices; thus, raising the additional concern that different levels of reported improvement may be responses to the demand features of more intense intervention. Finally, dosage has multiple dimensions—e.g., amount of contact, duration, number and type of communication channels – we know very little about the relative influence of each or about the interaction between them.

What can we conclude? There appears to be a generally positive association between intervention dose and dietary improvement. Early reviews of school-based interventions conclude that 10-15 hours of classroom education produce only minimal behavior changes, while stable medium effects (between 0.5 and 0.8 percent of a standard deviation) on behavior aren't observed until intervention contact reaches 50 hours. More recent research has not added significantly to our ability to specify a more precise relationship. However, it does demonstrate that small dietary effects (between 0.25 and 0.5 percent of a standard deviation) are the norm regardless of intervention intensity. A key factor may be the difference between the intended dosage of an intervention and what is actually delivered or received. Research shows that sizable portions of an intervention may not be delivered (Baranowski et al., 2003; Davis et al., 2000; Glasgow et al., 2003; and Sharpe et al., 1996). Even when there is strong fidelity between plans and implementation, participants, perhaps other than students, vary substantially in the degree to which they involve themselves. Where reported, that discretion is often associated with high levels of attrition or modest engagement in educational activities.

This landscape compels us to examine lower intensity alternatives as cost-effective alternatives. Available research consistently indicates that nutrition education with modest exposure time yields small but positive effects on diet quality. A few of these studies even demonstrate that some of the gain is retained up to six months after the intervention ends.

Low-intensity interventions that focus on communication channels other than repeated face-to face contact are a current focus of investigation. Communication channels in such initiatives may include hard copy self-help material, telephone, mail, computer-based activities or any combination of these. In addition, some of these intervention packages include participant assessments. This information is used to individually tailor subsequent messages in order to make them more salient to participants. Berkel et al. (2005) suggest that such direct delivery channels more easily reach participants in settings, like work and home, where many nutrition-related choices are made. Systematic investigation to determine the optimal features of such methods and their cost-effectiveness compared to interventions that emphasize face-to face contact is in order.

Virtually all of the nutrition education research related to dosage effects has focused on individual rather than institutional or environmental components. We might begin defining intensity in the context of environmental interventions. For example, to what extent do institutional changes alter opportunities to engage in health enhancing or compromising behavior?

The nutrition education research agenda is wide open for more systematic and controlled examination of the influence of dosage on behavior change. While definitive answers will require substantial work, everyone can help make progress. The starting place is to document routinely and precisely the multiple components of intensity associated with every intervention introduced. Leaving such information out may, in the short term, save a few pages in a journal issue, but extends the time and effort required to answer an important question.

Strong research designs are essential to untangling the impact of intervention dosage. At a minimum, this means pursuing random assignment of participants to different dosage conditions. Adding before and after measures and analytically controlling for differential attrition contribute

further to producing unbiased results. While there is an up-front cost associated with such rigor, the pay-off is making more effective and efficient intervention choices in the future.

Bibliography

Ammerman, A.S., Lindquist, C.H, Lohr, K.N., Hersey, J. 2002. "The Efficacy of Behavioral Interventions to Modify Dietary Fat and Fruit and Vegetable Intake: A Review of the Evidence." In *Preventive Medicine.* Vol. 35(1):25-41.

Baranowski, T., Baranowski, J., Cullen, K.W., Marsh, T., Islam, N., Zakeri, I., Honess-Morreale, L., deMoor, C. 2003. "Squire's Quest! Dietary Outcome Evaluation of a Multimedia Game." In *American Journal of Preventive Medicine*. Vol. 24(1): 52-61.

Beresford, S.A., Curry, S.J., Kristal, A.R., Lazovich, D., Feng, Z., Wagner, E.H. 1997. "A Dietary Intervention in Primary Care Practice: The Eating Patterns Study." In *American Journal of Public Health*. Vol. 87(4): 610–616.

Beresford, S.A., Farmer, E.M., Feingold, L., Graves, K.L., Sumner, S.K., Baker, R.M. 1992. "Evaluation of a Self-help Dietary Intervention in a Primary Care Setting." In *American Journal of Public Health.* Vol. 82(1):79–84.

Berg, A.O. 2003. "Behavioral Counseling in Primary Care to Promote a Healthy Diet: Recommendations and Rationale." In *American Journal of Nursing*. Vol. 103 (8):81-92.

Berkel, L.A., Poston, W.S.C., Reeves, R.S., Foreyt, J.P. 2005. "Behavioral Interventions for Obesity." In *Journal of the American Dietetic Association. Vol.105:S35-S43.*

Bowen, D.J. and Beresford, S.A.A. 2002. "Dietary Interventions to Prevent Disease." In *Annual Review of Public Health.* Vol. 23:255-286.

Bowen, D.J, Beresford, S.A., Vu, T., Feng, Z., Tinker, L., Hart, A. Jr., Christensen, C.L., McLerran, D., Satia-Abouta, J., Campbell, M. 2004. "Baseline Data and Design for a Randomized Intervention Study of Dietary Change in Religious Organizations." In *Preventive Medicine*. Vol. 39(3):602-11.

Brunner, E.R., White, I., Thorogood, M., Bristow, S., Curle, D., Marmot, M. 1997. "Can dietary interventions change diet and cardiovascular risk factors? A meta-analysis of randomized controlled trials." In *American Journal of Public Health.* Vol. 87(9):1415-1422.

Campbell, M.K., DeVellis, B.M., Strecher, V.J., Ammerman, A.S., DeVellis, R.F., Sandler, R.S. 1994. "Improving Dietary Behavior: The Effectiveness of Tailored Messages in Primary Care Settings." In *American Journal of Public Health*. Vol. 84(5):783-787.

Carpenter, R.A., Finley, C., Barlow, C.E. 2004 "Pilot Test of a Behavioral Skill Building Intervention to Improve Overall Diet Quality." In *Journal of Nutrition Education and Behavior*. Vol. 36(1):20-4.

Ciliska, D., Miles, E. O'Brien, M.A., Turl, C., Tomasik, H.H., Donovan, U. and Beyers, J. 2000. "Effectiveness of Community-Based Interventions to Increase Fruit and Vegetable Consumption." In *Journal of Nutrition Education.* Vol. 32 (6): 341-352.

Connell, D.B., Turner, R.R., Mason, E.F. 1985. “Summary of Findings of the School Health Education Evaluation: Health Promotion Effectiveness, Implementation, and Costs.” In *Journal of School Health*. Vol.55 (8):316-21.

Contento, I.R., Manning, A.D., Shannon, B. 1992. “Research perspective on school-based nutrition education.” In *Journal for the Society of Nutrition Education*. Vol. 24,247-260.

Contento, I., Balch, G.I., Bronner, Y.L., Lytle, L.A., Maloney, S.K., Olson, C.M., and Swadener, S.S. 1995. “The effectiveness of nutrition education and implications for nutrition education policy, programs and research: a review of the research.” In *Journal of Nutrition Education*. Vol. 27(6): 277–422.

Davis, M., Baranowski, T., Resnicow, K., Baranowski, J., Doyle, C., Smith, M., Dongquing, W., Yaroch, A., Hebert, D. 2000. **“**Gimme 5 Fruit and Vegetables for Fun and Health: Process Evaluation.” In *Health Education &Behavior*. Vol. 27(2):167-176.

Delichatsios, H.K., Friedman, R.H., Glanz, K., Tennstedt, S., Smigelski, C., Pinto, B.M. 2001. “Randomized trial of a "talking computer" to improve adults’ eating habits.” In *American Journal of Health Promotion*. Vol. 15(4):215-224.

Dollahite J., Scott-Pierce, M. 2003. “Outcomes of Individual vs. Group Instruction in EFNEP.” In *Journal of Extension.* Vol. 41(2). Available at [http://www.joe.org/joe/2003april/a4.shtml]. Accessed December 6, 2006.

Glasgow, R.E., Lichtenstein, E., Marcus, A.C. 2003. “Why Don’t We See More Translation of Health Promotion Research to Practice? Rethinking the Efficacy-to-Effectiveness Transition.” In *American Journal of Public Health.* Vol. 93(8):1261-1267.

Havas, S., Anliker, J., Damron, D., Langenberg, P., Ballesteros, M., Feldman, R. 1998. “Final Results of the Maryland WIC 5-A-Day Promotion Program.” In *American Journal of Public Health*. Vol. 88(8):1161-1167.

Hoelscher, D.M., Evans, A., Parcel, G.S., Kelder, S.H. 2002. “Designing effective Nutrition Interventions for Adolescents.” In *Journal of the American Dietetic Association*. Vol. 102(3 Suppl):S52-63

Irvine, A.B., Ary D.V., Grove, D.A., and Gilfillan-Morton, L. 2004. “The effectiveness of an interactive multimedia program to influence eating habits.” In *Health Education Research*. Vol. 19(3):290-305.

Koblinsky, S.A., Guthrie, J.F., Lynch, L. 1992. “Evaluation of a nutrition education program for Head Start parents.” In *Journal of Nutrition Education*. Vol. 24(1):4-13.

Kristal, A.R., Curry, S.J., Shattuck, A.L, Feng, Z., Li, S. 2000. “A Randomized Trial of a Tailored, Self-Help Dietary Intervention: The Puget Sound Eating Patterns Study.” In *Preventive Medicine*. Vol. 31(4): 380-389.

MacArthur, D.B. 1998. “Heart Healthy Eating Behaviors of Children Following a School-based Intervention: A Meta-Analysis.” In *Issues in Comprehensive Pediatric Nursing*. Vol. 21(1):35-48.

Marcus, A.C., Heimendinger, J., Wolfe, P., Fairclough, D., Rimer, B.K, Morra, M., Warnecke, R., Himes, J.H., Darrow, S.L., Davis, S.W., Julesberg, K., Slevin-Perocchia, R., Steelman, M., Wooldridge, J. 2001. "A Randomized Trial of a Brief Intervention to Increase Fruit and Vegetable Intake: A Replication Study among Callers to the CIS." In *Preventive Medicine.* Vol. 33(3): 204-216.

Orleans, C.T., Gruman, J., Ulmer, C., and Emont, S.L. 1999. "Rating Our Progress in Population Health Promotion: Report Card on Six Behaviors." In *American Journal of Health Promotion*. Vol. 14 (2):75-82.

Pignone, M.P., Ammerman, A., Fernandez, L. Orleans, C.T., Pender, N., Woolf, S., Lohr, K.N., Sutton, S. 2003. "Counseling to Promote a Healthy Diet in Adults." In *American Journal of Preventive Medicine*. Vol. 24(1):75-92

Rose, G. 1990. "British perspective on the U.S. Preventive Services Task Force guidelines." In *Journal of General Internal Medicine*. Vol. 5(5 Suppl):S128-32.

Sharpe, P.A., Vaca, V.L., Sargent, R.G., White, C., Gu, J., Corwin, S.J. 1996. "A Nutrition Education Program for Older Adults at Congregate Nutrition Sites." In *Journal of Nutrition for the Elderly.* Vol. 16(2): 19-31.

Sorensen, G., Thompson B, Glanz, K., Feng, Z., Kinne, S., DiClemente, C., Emmons, K., Heimendinger, J., Probart, C., Lichtenstein, E. 1996. "Work Site-Based Cancer Prevention: Primary Results from the Working Well Trial." In *American Journal of Public Health*. Vol. 86(7):939-947.

U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality 2001. "The Efficacy of Interventions to Modify Dietary Behavior Related to Cancer Risk." Available at [www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=hstat1.chapter.35668]. Accessed December 6, 2006.