
A Series of Systematic Reviews on the Effects of Nutrition Education on Children's and Adolescents' Dietary Intake

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Chapter 1. Executive Summary

Consuming a healthy diet consistent with the *Dietary Guidelines for Americans, 2010*¹ can help individuals achieve and maintain a healthy weight, reduce the risk of developing chronic diseases, and promote good health. However, many children are consuming excess calories, while not meeting nutrient needs, and are overweight/obese and/or at increased risk for a variety of chronic diseases. The USDA supports and funds a wide range of nutrition education programs, delivered via different methods and channels, designed to help Americans consume healthier diets. The purpose of this project was to conduct a series of systematic reviews to better understand how to effectively deliver nutrition education to improve the dietary intake-related behaviors of children and adolescents, and promote consumption of a healthy diet consistent with the *Dietary Guidelines for Americans, 2010 (DGA 2010)*. The Food and Nutrition Service (FNS), USDA supported this research in order to answer targeted nutrition education-related questions to inform guidance, policy, and program development related to FNS-administered nutrition education programs.

Background and Methodology

USDA's Nutrition Evidence Library (NEL) conducted these systematic reviews. The NEL uses a rigorous, transparent, and reproducible methodology to conduct systematic reviews on food- and nutrition-related topics to support Federal nutrition policies and programs using a six-step process:

1. Develop systematic review questions
2. Create and implement literature search and sort plans
3. Develop evidence portfolios
4. Synthesize the bodies of evidence
5. Develop conclusion statements and grade the evidence
6. Describe research recommendations.

This NEL systematic review project was planned, organized, and guided by a NEL Systematic Review Management Team composed of Federal nutritionists trained in systematic review methodology. The NEL Systematic review team worked with a Technical Expert Collaborative (TEC), which consisted of eight leading nutrition education experts, whose expertise was needed to address specific issues related to the topic of nutrition education and to guide synthesis of the body of evidence to answer the systematic review questions posed. A Stakeholder Group, which included Federal employees who represented end-users of the review and possessed varying perspectives and expertise related to nutrition education, provided input throughout the process.

Systematic Review Questions

The systematic review questions addressed were identified and prioritized to focus the reviews on topics that would enhance current nutrition education practice and programs. A broad range of school- and community-based nutrition education interventions involving children in preschool, kindergarten, and elementary school and adolescents in middle and high school were considered in order to answer the following seven systematic review questions:

1. What is the effect of nutrition education delivered via digital media and/or technology on children's and adolescents' dietary intake-related behaviors?
2. What is the effect of nutrition education with parental involvement compared to no parental involvement on children's and adolescents' dietary intake-related behaviors?
3. Which type of educator who delivers nutrition education is most effective in changing children's and adolescents' dietary intake-related behaviors?

¹ U.S. Department of Agriculture & U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2010* (7th Ed). Washington, DC: U.S. Government Printing Office; 2010.

4. What are the effects of combining changes to the food environment and nutrition education compared to either of these strategies alone on children's and adolescents' dietary intake-related behaviors?
5. What are the effects of multi-component compared to single-component nutrition education interventions on children's and adolescents' dietary intake-related behaviors?
6. What factors mediate² the effects of nutrition education interventions on children's and adolescents' dietary-intake related behaviors?
7. What factors moderate³ the effects of nutrition education interventions on children's and adolescents' dietary-intake related behaviors?

Conclusion Statements

The evidence available to support each of the systematic review questions varied widely. More robust evidence was available to develop the following conclusion statements on the effects of combining nutrition education with changes to the school food environment and the effects of nutrition education delivered using digital media and/or technology.

Consistent evidence suggested that combining nutrition education with changes to the school food environment is more effective for improving children's and adolescents' dietary intake than making changes to the food environment alone (Grade I–Strong).

Moderate evidence showed that nutrition education delivered via digital media/technology (computer- and internet-based programs) may be effective for improving dietary intake-related behaviors among children and adolescents (Grade II–Moderate).

More limited bodies of evidence were available to determine the effects of nutrition education with and without parental involvement, and the effects of multi- versus single-component nutrition education interventions.

Limited and inconsistent evidence is available to assess the effects of involving parents in nutrition education on children's (ages 9 and older) dietary intake-related behaviors. Some evidence suggests that involving parents in a nutrition education intervention improves outcomes, while other evidence finds no added benefit of including parents. In children less than 9 years of age, there is no evidence to assess the effects of nutrition education with parental involvement on dietary intake-related behaviors (Grade III – Limited).

There is inconsistent evidence to suggest that multi-component nutrition education interventions may be more effective for improving children's and adolescents' dietary intake-related behaviors than single-component interventions. Limited evidence also suggests that multi-component nutrition education interventions that combine classroom nutrition education with a hands-on educational component may be particularly effective (Grade III – Limited).

For a few questions, the evidence was either not sufficient or too disparate to draw conclusions. For example, there was insufficient evidence to determine whether certain types of educators who deliver nutrition education are more effective for changing children's dietary intake-related behaviors, and this conclusion received a grade of V – Grade Not Assignable. Evidence regarding mediators and moderators of nutrition education interventions was also examined, and a number of studies were identified and reviewed. However, there was wide variation across these studies in terms of the variables tested as potential mediators or moderators, making it difficult to compare results and draw conclusions. Therefore, conclusions regarding mediators and moderators were not drawn.

Research Recommendations

² A mediator is a variable that explains the relationship between two variables.

³ A moderator is a variable that affects the strength of a relationship between two variables.

The systematic reviews highlighted a number of overarching limitations in the research on nutrition education, and research recommendations which apply globally to the field of nutrition education were identified. The following limitations were identified in the literature reviewed:

- Many studies were conducted in single school districts or individual schools, limiting the generalizability of the study findings.
- A number of studies were not designed or adequately powered to determine whether certain children are more responsive to nutrition education.
- In much of the existing nutrition education research, the dose, frequency, and intensity of the interventions tested were not well characterized.

More research is recommended to investigate:

- Whether subject characteristics, such as age, gender, ethnicity, or socioeconomic status, affect the outcomes of nutrition education, and how nutrition education can effectively be delivered to diverse populations
- Which dose of nutrition education is optimal in terms of changing children's and adolescents' dietary intake behavior
- If there are long-term impacts of these types of interventions on children's and adolescents' dietary intake behavior, as well as body weight and other health outcomes.

Chapter 2. Introduction

Consuming a healthy diet consistent with the *Dietary Guidelines for Americans, 2010* can help individuals achieve and maintain a healthy weight, reduce the risk of developing chronic diseases, and promote good health. However, many Americans do not consume healthy diets, and are overweight/obese and/or at increased risk for a variety of chronic diseases (e.g., cardiovascular disease, type 2 diabetes, and hypertension).

Eating behaviors established during childhood can track in adulthood, making it particularly important to ensure that children adopt healthy eating practices early in life. However, many children are consuming excess calories, while not meeting nutrient needs, and are facing the same health consequences as adults. The U.S. Department of Agriculture (USDA) supports a wide range of nutrition education policies and programs designed to help Americans, particularly children, consume healthier diets.

The purpose of this project was for the Evidence Analysis Library Division of the Center for Nutrition Policy and Promotion (CNPP), USDA, to conduct a series of systematic reviews for the Food and Nutrition Service (FNS), USDA to ascertain the most effective designs for delivering nutrition education that improves the dietary intake-related behaviors of children and adolescents.

Over the past few decades, systematic reviews have become the preferred foundation for developing public health guidelines, policies, and programs. Also, systematic reviews can aid compliance with the Consolidated Appropriations Act of 2001⁴ or *Data Quality Act*, which mandates Federal agencies ensure the quality, objectivity, utility, and integrity of the information used to form federal guidance. Therefore, conducting systematic reviews of nutrition education research can help FNS and other USDA agencies, such as the National Institute of Food and Agriculture (NIFA) to better understand how nutrition education can be used to promote adoption of dietary intake-related behaviors consistent with Dietary Guidelines for children and adolescents.

The systematic review questions addressed were identified and prioritized to focus the reviews on topics that would enhance current nutrition education practice and programs. In particular, the reviews focus on nutrition education interventions designed for children in preschool, kindergarten, and elementary school and adolescents in middle and high school. In addition, attention was given to effective interventions that are appropriate for the Supplemental Nutrition Assistance Program Nutrition Education (SNAPed) population and other similar target audiences (e.g., the Expanded Food and Nutrition Education Program (EFNEP); Special Supplemental Nutrition Program for Women, Infants, and Children (WIC); Commodity Supplemental Food Program (CSFP)). Therefore, when available, research findings related to specific population sub-groups (e.g., cultural, racial and/or ethnic background, gender, age, and household income) was included.

The evidence reviews encompassed a broad range of child-focused, school-based nutrition education interventions, but also considered other types of interventions, such as those delivered in other community-based settings (e.g., healthcare settings, child care facilities, after-school and extracurricular programs) or directly to families, so long as the intervention targeted children's dietary intake behaviors. The outcomes of interest for this review were limited to dietary intake-related behaviors. Intermediate outcomes, such as knowledge and attitudes, and health outcomes, such as body weight, were not considered. Interventions that targeted children indirectly by educating their parents, teachers, child care providers, food service staff, and other nutritional gatekeepers were included, as long as there was assessment of behavioral change among children or adolescents. Full systematic reviews were conducted for the following systematic review questions:

- What is the effect of nutrition education delivered via digital media and/or technology on children's and adolescents' dietary intake-related behaviors?
- What is the effect of nutrition education with parental involvement compared to no parental involvement on children's and adolescents' dietary intake-related behaviors?

⁴ Consolidated Appropriations Act (2001) Pub.L. 106–554, 114 Stat. 2763 (2000).

- Which type of educator who delivers nutrition education is most effective in changing children's and adolescents' dietary intake-related behaviors?
- What are the effects of combining changes to the food environment and nutrition education compared to either of these strategies alone on children's and adolescents' dietary intake-related behaviors?
- What are the effects of multi-component compared to single-component nutrition education interventions on children's and adolescents' dietary intake-related behaviors?

In addition, systematic evidence scans were conducted for the following systematic review questions:

- What factors mediate⁵ the effects of nutrition education interventions on children's and adolescent's dietary-intake related behaviors?
- What factors moderate⁶ the effects of nutrition education interventions on children's and adolescent's dietary-intake related behaviors?

The results of this systematic review project can be used to inform the work of nutrition education practitioners, as well as Federal nutrition education policy and programs. It can also aid in the development of nutrition education guidance and communication strategies and effective nutrition education interventions targeting behavior change, and help identify areas where more research is needed.

⁵ A mediator is a variable that explains the relationship between two variables.

⁶ A moderator is a variable that affects the strength of a relationship between two variables.

Chapter 3. Methods

The Nutrition Evidence Library (NEL) was launched in July 2008 by the U.S. Department of Agriculture’s Center for Nutrition Policy and Promotion. The NEL uses a rigorous, transparent, and reproducible methodology to conduct systematic reviews on food- and nutrition-related topics to support Federal nutrition policies and programs. The following section describes the systematic review methodology used to conduct a series of systematic reviews on nutrition education.

Nutrition Education Systematic Review Project: Roles and Responsibilities

When conducting systematic reviews, NEL staff are assigned to a NEL Project Systematic Review Management Team, and work with a Technical Expert Collaborative (TEC), a Stakeholder Group, Abstractors, and Peer Reviewers. The roles and responsibilities of each of these groups and individuals are outlined below.

NEL Systematic Review Management Team

This NEL systematic review project was planned, organized, and guided by a NEL Systematic Review Management Team composed of Federal nutritionists trained in systematic review methodology. This team was led by the Director of the Evidence Analysis Library Division (EALD) and included a Project Manager, Lead Analysts, a Research Librarian, and additional staff from the EALD. The Project Manager was responsible for leading, planning, organizing, and facilitating the work necessary for timely execution of the systematic review within an allotted budget. The Lead Analysts reviewed individual research questions, and the NEL Research Librarian developed the systematic review search strategy for the scientific articles. Specific responsibilities of the NEL Systematic Review Management Team included the following:

- Facilitated the initial planning and led development of the systematic review project protocol.
- Directed the execution and quality control of the NEL systematic review project based on input from the TEC and Stakeholders in accordance with the principles and procedures outlined in the NEL systematic review methodology manual.
- Developed and disseminated products of the review, including website content, a systematic review report, CNPP NEL Insights, and peer reviewed publications.

The NEL Systematic Review Management Team met regularly throughout the systematic review project from conceptualization of the project through completion of the final products. They coordinated regular meetings with the TEC and Stakeholder Groups through conference call and webinar. They also served as the conduit between the TEC and the Stakeholder Group, Abstractors, and Peer Reviewers.

Technical Expert Collaborative

The Technical Expert Collaborative (TEC) consisted of eight leading nutrition education experts, including researchers, nutrition educators, methodologists, communicators, and end users of the reviews. A list of TEC members and their affiliations is found in the Acknowledgements section (on page 4). TEC members assisted the NEL Systematic Review Management Team by reviewing and providing expert feedback to refine systematic review materials. Their expertise was needed to address specific issues related to the topic of nutrition education and to guide synthesis of the body of evidence to answer the systematic review questions posed. TEC members guided the systematic review process in the following ways:

- Reviewed and refined materials drafted by the NEL Systematic Review Management Team, including:
 - Analytic framework and definitions of key terms to be used in the systematic reviews
 - Research questions
 - Including identifying outcomes, comparators, key confounders, or effect modifiers
 - Inclusion/exclusion criteria used to initially select articles used in the review, search strategy, and literature selection
 - Including guidance on potential search terms, databases, and literature search strategies

- Lists of included and excluded articles
- Data extraction plan
 - Including guidance on format and structure of evidence paragraphs and tables
- Summaries of the body of evidence, including evidence worksheets with quality ratings
- Conclusion statements and grades assigned based upon the body of evidence
- Additionally, the TEC:
 - Provided input on research recommendations
 - Served as co-authors of any manuscript(s) that are submitted for peer-review publication
 - Provided suggestions for communicating the findings of the review project.

NEL Project Stakeholder Group

Members of the Stakeholder Group included Federal employees who represent end-users of the review and possessed varying perspectives and expertise related to nutrition education. Specifically, the Stakeholder Group:

- Assisted in refining and prioritizing systematic review questions to ensure the questions were valuable for informing policy and programs
- Provided input on research recommendations and implications
- Identified strategies to communicate results.

NEL Abstractors

NEL Abstractors are National Service Volunteers from across the United States with advanced degrees in nutrition or a related field. They received training to review individual research articles included in the systematic reviews and rate the methodological rigor (quality) of each study. They extracted evidence from the research articles and posted this information to data fields in evidence worksheet templates in the NEL online portal. The methodological rigor of each individual study was assessed using the Research Design and Implementation Checklist. Worksheets prepared by the Abstractors were reviewed by the NEL Systematic Review Management Team and provided a templated presentation of each article to assist the TEC in their review of the evidence.

Peer Reviewers

Peer reviewers were individuals from USDA who reviewed and provided comment on the systematic review products. The peer reviewers provided written input after this draft report was produced. A variety of perspectives were sought to ensure that this report provides a transparent and comprehensive description of the review. The NEL Systematic Review Management Team, particularly the Project Leader, coordinated the peer-review and developed responses to comments.

Nutrition Education Systematic Reviews: Methodology

Research Protocol

The NEL uses a rigorous, transparent, and reproducible methodology that was informed by the Agency for Healthcare Research Quality (AHRQ), the Academy of Nutrition and Dietetics (AND) (formerly the American Dietetic Association), and the US Cochrane Collaboration process. The NEL utilizes a six-step systematic review process to conduct systematic reviews. The steps include:

1. Develop systematic review questions
2. Create and implement literature search and sort plans
3. Develop evidence portfolios
4. Synthesize the bodies of evidence
5. Develop conclusion statements and grade the evidence
6. Describe research recommendations

In addition, for this project, two systematic evidence scans were conducted. A systematic evidence scan includes the following steps:

1. Develop a systematic review question
2. Create and implement a literature search and sort plan
3. Develop an evidence portfolio
4. Prepare a preliminary description of the evidence and rationale for not completing a full systematic review
5. Describe future systematic review recommendations.

Each step of these NEL processes and how it was applied to the Nutrition Education Systematic Evidence-Based Review Project is described below.

Develop Systematic Review Questions and Analytical Frameworks

The first step of the evidence analysis process was the development of systematic review questions. In order to identify which questions would be addressed, NEL staff gathered input from both the TEC and the Project Stakeholder Group to identify topic areas of interest. The Stakeholder group and TEC members were asked to identify topic areas and/or questions that they felt needed to be reviewed in order to enhance current nutrition education practice.

Once key topic areas were identified, the PICO (**P**opulation, **I**ntervention, **C**omparator, and **O**utcomes) method was used in order to focus each of the systematic review questions. In addition, an analytical framework was created to provide a visual map of key variables, such as the population, interventions, comparators, outcomes, and potential confounders, to be addressed within each review (Appendix A). The TEC also agreed to define “nutrition education” as “any set of learning experiences designed to facilitate the voluntary adoption of eating and other nutrition-related behaviors conducive to good health.”⁷ For each systematic review question developed, the following PICO components were used:

- **Population:** Children and adolescents in preschool through high school
- **Intervention:** A nutrition education intervention
- **Comparator:** No nutrition education intervention (control) or a different nutrition education intervention (comparison)
- **Outcomes:** Dietary intake-related outcomes

After prioritization, the TEC agreed upon the following seven systematic review questions:

1. What is the effect of nutrition education delivered via digital media and/or technology on children’s dietary intake-related behaviors? (“Digital media and technology”)
2. What is the effect of nutrition education with parental involvement compared to no parental involvement on children’s dietary intake-related behaviors? (“Parental involvement”)
3. Which type of educator who delivers nutrition education is most effective in changing children’s dietary intake-related behaviors? (“Type of educator”)
4. What are the effects of combining changes to the food environment and nutrition education compared to either of these strategies alone on children’s and adolescent’s dietary intake-related behaviors? (“Food environment”)
5. What are the effects of multi-component compared to single-component nutrition education interventions on children’s and adolescents’ dietary intake-related behaviors? (“Multi- vs. single-component interventions”)

⁷ Contento IR, Senior author. The effectiveness of nutrition education and implications for nutrition education policy, programs and research. A Review of research. *J Nutr Educ.* 1995;27:279-418.

6. What factors mediate the effects of nutrition education interventions on children and adolescent's dietary-intake related behaviors? ("Mediators")
7. What factors moderate the effects of nutrition education interventions on children and adolescent's dietary-intake related behaviors? ("Moderators")

Create and Implement Literature Search and Sort Plans

After the systematic review questions were developed, the NEL Project Management Team developed the literature search and sort plan used to identify scientific articles analyzed to answer each systematic review question. The search and sort plan includes the development of inclusion and exclusion criteria, identification of databases and search terms used to identify relevant articles, implementation of the search strategy, and selection of studies to include in each systematic review. The TEC reviewed and provided feedback on inclusion and exclusion criteria, the literature search strategy, and the list of articles included and excluded for each review.

Inclusion and Exclusion Criteria

Inclusion criteria for the nutrition education systematic reviews include studies conducted using:

- Human subjects
- Subject populations from countries with high or very high human development, according to the Human Development Index
- Children and adolescents aged 0–18 years
- Subjects who were healthy or at elevated chronic disease risk
- Randomized controlled trial, non-randomized controlled trial, quasi-experimental study designs
- School, home, and community settings

In addition, articles were included if they were published in English in a peer-reviewed journal between January 1995 and December 2010 (or were available via on-line prepublication prior to December 31, 2010). If an author is included on more than one review article or primary research article that is similar in content, the paper with the most pertinent data/endpoints was included. If data/endpoints from both papers are appropriate, it was made clear that results are from the same intervention.

Exclusion criteria for the nutrition education systematic reviews include studies conducted using:

- Animals and in vitro models
- Subject populations from countries with medium or low human development, according to the Human Development Index
- Adults over the age of 18 years
- Subjects who were hospitalized, diagnosed with disease, and/or receiving medical treatment
- Studies with no control or comparison group
- Systematic review, meta-analysis, narrative review, prospective cohort, cross-sectional, or case-control designs

Articles were excluded if they were not published in English, or were published before January 1995 or after December 2010. Articles, abstracts, and presentations not published in peer-reviewed journals (e.g., websites, magazine articles, Federal reports) were also excluded. Finally, if an author was included on more than one review article or primary research article that is similar in content, the paper with the most pertinent data/endpoints was included, and others were excluded.

Databases and Search Terms

Several databases were searched using a wide variety of search terms and key words, including subject headings such as MeSH and thesauri terms. The following is a list of databases and corresponding search terms that were used:

- PubMed:** “child nutrition sciences/education”[mh] OR “nutritional sciences/ education”[mh] OR (nutrition* AND (“Health Knowledge, Attitudes, Practice”[mh] OR “health education/methods”[mh] OR “Health Behavior”[mh] OR “Health Promotion/methods”[mh])) Limits: Humans, English, All Child: 0-18 years, Publication Date from 1995; Teacher* AND (nutritionist* OR dietitian*) AND education*; (“nutrition education” OR “nutrition instruction”) AND (((parent* OR teacher*) AND (dietician* OR nutritionist*)) OR fruit* OR vegetable* OR garden*); school* AND environment* AND food[mh] AND nutrition* AND education* ; (“School Health Services”[majr] OR “Schools”[majr]) AND (“Health Knowledge, Attitudes, Practice”[majr] OR “child nutrition sciences/education”[mh] OR “Health Promotion/methods”[majr] OR “nutritional sciences/education”[mh] OR fruit[mh] OR vegetables[mh] OR food[majr])
- Embase:** 'nutrition education'/exp AND ([article]/lim OR [article in press]/lim) AND ([newborn]/lim OR [infant]/lim OR [preschool]/lim OR [school]/lim OR [child]/lim OR [adolescent]/lim) AND [humans]/lim AND [english]/lim AND [embase]/lim AND [1995-2010]/py; nutrition OR diet OR food AND education AND mediat* AND ([preschool]/lim OR [school]/lim OR [child]/lim OR [adolescent]/lim) AND [embase]/lim NOT [medline]/lim
- EBSCOhost (CINAHL; ERIC; PsycINFO; PsycARTICLES; SocINDEX with Full Text; Education Research Complete):** SU nutrition* n2 education* and behavior*; SU nutrition* n2 education* and (meat or (whole w1 grain*) or fruit* or vegetable* or eggs or dairy or milk or yogurt or snack* or fish* or seafood* or nuts or environment*); (“nutrition education” OR “nutrition instruction”) AND (((parent* OR teacher*) AND (dietitian* OR nutritionist*)) OR fruit* OR vegetable* OR garden*)

Additional databases and search terms were used to search for studies related to the systematic review question on the use of digital media or technology to deliver nutrition education. The following is a list of the additional databases and corresponding search terms that were used for this question:

- PubMed:** (Video Game* OR (“virtual reality” AND gaming) OR Computer game* OR Youtube OR Facebook OR Twitter OR Aps OR Wii OR DDR OR Advergam* OR Social media* OR Television[majr] OR Mobile phone* OR cell phone* OR Web-based learning* OR internet[majr] OR computers[majr] OR “Computer-Assisted Instruction”[mesh]) AND ((nutrition AND education) OR “child nutrition sciences/education”[mh] OR “nutritional sciences/ education”[mh] OR obesity OR overweight OR fruit* OR vegetables OR “Health Knowledge, Attitudes, Practice”[mh] OR “health education/methods”[mh] OR “Behavior Control/methods”[mh] OR “Health Behavior”[majr] OR “Health Promotion/methods”[mh]) Limits: Humans, English, All Child: 0-18
- EBSCOhost (CINAHL; ERIC; PsycINFO; PsycARTICLES; SocINDEX with Full Text; Education Research Complete):** (((Video OR “virtual reality” OR computer*) AND gaming OR games) OR Advergam* OR (Mobile w1 phone*) OR (cell w1 phone*) OR "Web-based learning" OR internet) and (obesity OR overweight OR fruit* OR vegetables) (((Video OR “virtual reality” OR computer*) AND gaming OR games) OR Advergam* OR (Mobile w1 phone*) OR (cell w1 phone*) OR "Web-based learning" OR internet) and ((nutrition* w8 education*) OR (nutrition* w8 behavior*)) ("social media" OR twitter OR facebook OR "virtual reality" OR youtube) and (obesity OR overweight OR fruit* OR vegetables) (((Video or (virtual adj reality) or computer* or online) and (gaming or games)) or Advergam* or (Mobile near1 phone*) or (cell near1 phone*) or internet) and ((nutrition* near8 education*) or (nutrition* near8 behavior*))
- Education Fulltext (Wilson):** (("Games" OR "Video game machines" OR "Virtual reality games" OR "Electronic games") Or ("Wireless communication systems" OR "Cellular telephones")) <in> Subject(s) AND (nutrition OR diet OR food OR "Behavior" OR "Family" OR "Parents") <in> Subject(s) AND Limited to: PEER_REVIEWED ("Computers/Nutritional use" OR "Nutrition/Computer software") <in> Subject(s) (“digital media” OR internet) <in> Subject(s) AND (nutrition education)

- **Global Health:** (((Video OR virtual adj reality OR computer* OR online) AND (gaming OR games)) OR Advergam* OR (Mobile near1 phone*) OR (cell near1 phone*) OR internet) and ((nutrition* near8 education*) OR (nutrition* near8 behavior*)) (social adj media OR twitter OR facebook OR virtual adj reality OR youtube)) AND ((nutrition* near8 education*) or (nutrition* near8 behavior*))

Search Strategy and Study Selection

The NEL librarian conducted all database searches and performed initial title sorts to exclude articles that clearly did not address the question. NEL staff sorted abstracts and full text articles based upon approved criteria and developed a list of included and excluded articles (citing rationale for exclusion). Additionally, reference lists from review and primary articles were hand searched. TEC members reviewed and provided feedback on the sort lists. If TEC members identified relevant articles that were not on the sort list, or if results were too expansive or too limited, the subcommittee refined the search strategy and the search was rerun. NEL staff continued to monitor the literature for new articles through December 2010.

Develop Evidence Portfolios for Each Systematic Review Question

Relevant information from all included articles in each systematic review was assembled into evidence portfolios. For each study in a systematic review, the evidence portfolio includes an evidence worksheet with a study quality rating that reflects the assessment of methodological rigor of the study, as well as an evidence paragraph and overview table entry that summarizes the study methodology and results as it relates to the systematic review question being addressed. The components of the evidence portfolio are described in more detail below.

Each article included in a review was assigned to a NEL Abstractor to analyze and extract key data into an evidence worksheet template. The quality, or methodological rigor, of each article was assessed using the Research Design and Implementation (RDI) Checklist, developed and validated by the Academy of Nutrition and Dietetics. The RDI checklist is based on criteria outlined in the Agency for Healthcare Research and Quality (AHRQ) report on *Systems to Rate the Strength of Scientific Evidence* (West et al., 2002⁸). The RDI checklist for primary research articles includes four relevancy questions and ten scientific validity questions (ADA, 2009)⁹ (Appendix B). Based on responses to the checklist, each article was assigned a quality rating, positive, neutral, or negative, that reflects the methodological rigor with which the research was designed and executed. NEL staff reviewed the accuracy and quality of each evidence worksheet and RDI checklist, and the TEC was provided the worksheets as a component of the evidence portfolio.

The NEL staff worked with the TEC to define the content of evidence paragraphs and overview tables for each systematic review question. Using the evidence worksheets, RDI checklists, and full text articles, NEL staff drafted evidence paragraphs and overview tables to summarize the evidence in a uniform way for study-to-study evaluation and comparison. The evidence paragraphs briefly summarized each included study and reported relevant data including: authors, year, rating; population, location, sample size and subject age; description of the intervention and comparison/control condition; methods used to assess dietary intake-related outcomes; results related to dietary intake-related outcomes. The overview tables provided information parallel to the evidence paragraphs, as well as additional information about study subjects (gender, race/ethnicity, and socioeconomic status) and key limitations of each included study.

Synthesize the Body of Evidence

TEC members and the NEL Systematic Review Management Team reviewed the portfolio of evidence and defined an approach to analyzing the body of evidence, based on:

⁸ West S, King V, Carey TS, Lohr KN, McKoy N, Sutton SF, Lux L. *Systems to Rate the Strength of Scientific Evidence. Evidence Report/Technology Assessment No. 47*. Prepared by the Research Triangle Institute-University of North Carolina Evidence-based Practice Center under Contract No. 290-97-0011. AHRQ Publication No. 02-E016. Rockville, MD: Agency for Healthcare Research and Quality; April 2002.

⁹ American Dietetic Association, Research and Strategic Business Development. *Evidence Analysis Manual Adapted for the USDA Nutrition Evidence Library*. Chicago, IL: American Dietetic Association; 2009.

- Intervention characteristics (e.g., methods used to deliver nutrition education, dose and/or duration)
- Comparators (e.g., whether the nutrition education intervention was compared to a control group that received no nutrition education, or a group that received a different kind of intervention)
- Subject characteristics (e.g., age, gender, race/ethnicity)
- Study location (e.g., whether the study was conducted in the United States or not)
- Study outcomes (e.g., fruit and vegetable intake, sugar-sweetened beverage intake, fat intake)

The NEL Systematic Review Management Team worked to develop evidence summary overviews that enumerated the number, type, and quality of included studies, key definitions, statements about methodology and strengths and limitations of the body of evidence, key findings or trends, potential rationale for variations observed, and a discussion of findings. TEC members provided input throughout the development of the evidence summary overviews.

Develop and Grade the Conclusion Statement

TEC members and the NEL Systematic Review Management Team reviewed the body of evidence and a conclusion statement was developed to answer each research question. Conclusion statements focused on areas of general agreement among the studies and when evidence addressed only one gender, age group, ethnicity, or level of health risk, this was reflected in the conclusion statement.

The NEL Systematic Review Management Team then facilitated an evaluation by the TEC members of the strength of the body of evidence supporting each conclusion using a pre-established set of criteria. These criteria were adapted and validated by the American Dietetic Association (now the Academy of Nutrition and Dietetics) based upon the original work by Greer and colleagues (Greer et al., 2000¹⁰). Grading criteria included: quality, quantity, consistency, generalizability, and magnitude of effect. The following grades were used to describe the strength of the evidence supporting their conclusion statements: I – Strong, II – Moderate, III – Limited, IV – Expert Opinion, and V – Grade Not Assignable. Appendix C provides more detail on the grading criteria.

Define Research Recommendations

Once TEC members and the NEL Systematic Review Management Team developed a graded conclusion statement for a research question, they identified research recommendations related to the question or topic area. The Stakeholder group also reviewed and provided feedback on the research recommendations.

Nutrition Education Systematic Evidence Scans: Methodology

Systematic evidence scans are done for a number of reasons:

- The independent and/or dependent variables included in the systematic review question need further refinement
- The evidence identified via the literature search is too disparate to synthesize, or does not directly address the systematic review question
- A more in-depth analysis/synthesis plan may be required.

A systematic evidence scan includes five steps:

1. Develop a systematic review question
2. Create and implement a literature search and sort plan
3. Develop an evidence portfolio
4. Prepare a preliminary description of the evidence and rationale for not completing a full systematic review

¹⁰ Greer N, Mosser G, Logan G, Halaas GW. A practical approach to evidence grading. *The Joint Commission Journal on Quality Improvement*. 2000;26:700-712.

5. Describe future systematic review recommendations.

Steps 1-3 are identical to those described above for the full systematic review. Steps 4 and 5 differ, and are described in more detail below.

Prepare a Preliminary Description of the Evidence and Provide Rationale for Completing a Systematic Evidence Scan

The NEL Systematic Review Management Team worked to develop evidence summary overviews that describe the evidence, including the number, type, and quality of studies identified, key definitions, statements about methodology and strengths and limitations of the identified studies, and a description of key findings from each study. TEC members provided input on the development of the evidence summary overviews. In addition, a rationale is provided that describes the reasons for conducting a systematic evidence scan, as opposed to a full systematic review. This rationale provides an explanation as to why development of a conclusion statement and grade is not possible given the nature of the evidence identified during the literature search.

Describe Systematic Evidence Scan Research Recommendations

Once TEC members and the NEL Systematic Review Management Team described the studies identified and provided rationale for conducting a systematic evidence scan, they identified research recommendations related to the question or topic area. The Stakeholder group also reviewed and provided feedback on the systematic evidence scan and research recommendations.

Chapter 4-A. The Effects of Nutrition Education Delivered via Digital Media and/or Technology on Children's Dietary Intake-Related Behaviors

TECHNICAL ABSTRACT

Background

The use of digital media and/or technology, such as computers or Internet, for delivering education is increasing. The objective of this systematic review was to determine the effect of nutrition education delivered via digital media and/or technology on children's and adolescents' dietary intake-related behavior.

Conclusion Statement

Moderate evidence shows that nutrition education delivered via digital media/technology (computer- and Internet-based programs) may be effective for improving dietary intake-related behaviors among children and adolescents (Grade: Moderate).

Methods

Literature searches were conducted using PubMed, EBSCOhost, Education Fulltext, and Global Health to identify studies that tested the effects of nutrition education delivered using some type of digital media/technology (e.g., computer, internet) on dietary-intake related outcomes.

- Inclusion criteria: published between January 1995 and December 2010; conducted in subjects aged 0–18 years; randomized controlled trials, non-randomized controlled trials, or quasi-experimental studies; subjects from countries with high or very high human development (based on the Human Development Index); subjects who were healthy or at elevated chronic disease risk; published in English in a peer-reviewed journal
- Exclusion criteria: systematic reviews, meta-analyses, narrative reviews, or prospective cohort, cross-sectional, or case-control designs; studies with no control group; subjects hospitalized, diagnosed with disease, and/or receiving medical treatment

The results of each included study were summarized in evidence worksheets (including a study quality rating), an evidence paragraph, and evidence table. A group of subject matter experts were involved in a qualitative synthesis of the body of evidence, development of a conclusion statement, and assessment of the strength of the evidence (grade) using pre-established criteria including evaluation of the quality, quantity, consistency, magnitude of effect and generalizability of available evidence.

Findings

- Twenty-four articles were included in this systematic review. Nineteen studies were randomized controlled trials and five were non-randomized controlled trials. Twelve studies received a positive quality rating (12 RCTs), and 12 studies received a neutral quality rating (7 RCTs, 5 non-RCTs).
- Twenty-one studies found that nutrition education delivered via digital media/technology significantly improved dietary intake-related behaviors.
 - Fifteen studies found that nutrition education delivered via digital media/technology was more effective than the no-intervention control or a comparison intervention with another type of nutrition education method.
 - Two studies found delivering nutrition education using digital media/technology or traditional

- methods were equally effective
- One study found that nutrition education delivered via digital media/technology improved dietary intake, but not more than the control/comparison.
- Two studies found that nutrition education delivered via digital media/technology improved dietary intake in girls, but not in boys.
- One study found that nutrition education delivered via digital media/technology was effective immediately following the intervention, but not six months post-intervention.
- Three studies found no significant differences in dietary intake following nutrition education delivered via digital media/technology compared to a control or comparison intervention.

Discussion

The ability to draw strong conclusions was limited due to the following issues:

- The large degree of variation in intervention design and study characteristics
- The field of digital media/technology is rapidly evolving
- The use of digital media/technology in the field of nutrition is novel

In general, use of digital media/technology can ensure that interventions are delivered to a wide range of children in a variety of settings with high fidelity. In addition, using a theoretical framework that targets specific behaviors, and providing frequent doses of education over longer periods of time can help ensure that the intervention is successful. However, keeping students engaged is a challenge, and more research is needed to better understand the utility and effectiveness of using digital media/technology to deliver nutrition education.

PLAIN LANGUAGE SUMMARY

The effects of delivering nutrition education using the computer or Internet on what children eat

The use of digital media and/or technology, such as computers or Internet, as an educational tool is growing. This summary of a NEL review presents what we know from research about the effects of using the computer or Internet to teach nutrition education on what children eat.

Conclusion

Moderate evidence shows that nutrition education delivered via digital media/technology may be effective for improving dietary intake-related behaviors among children and adolescents

What the Research Says

- Twenty-one of twenty-four studies in this review found that using computer or Internet for nutrition education improved what children ate.
- Three studies did not find big differences in what children ate after using the computer or Internet to get nutrition education compared to other types of education.
- Using the computer or Internet for nutrition education has a number of benefits, especially when the education is based on theory and is given more often over longer periods of time:
 - A wide range of children can be reached by using the computer or Internet.
 - The education provided using the computer or Internet is high quality and consistent.
- This review raised some key issues that make it harder to make stronger recommendations:
 - There were many differences in how the studies were done.
 - Technology is rapidly changing.

- Using technology for nutrition education is a new concept, so more research is needed to look at long-term impacts.
- Keeping students interested can be hard.

EVIDENCE PORTFOLIO

Conclusion Statement

Moderate evidence shows that nutrition education delivered via digital media/technology (computer- and internet-based programs) may be effective for improving dietary intake-related behaviors among children and adolescents.

Grade

II – Moderate

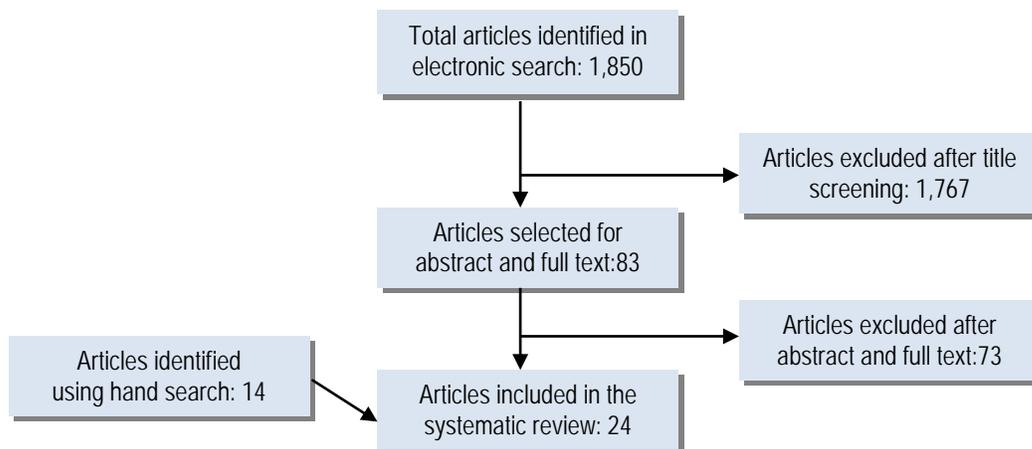
Evidence Summary Overview

Overall, the ability to draw strong conclusions as to the effect of nutrition education delivered via digital media/technology on children’s dietary intake-related behaviors is limited by the small number of relevant studies and large degree of variation in intervention design and study characteristics, and by the fact that digital media/technology is not only rapidly evolving, but its use as an educational tool in the field of nutrition is novel. In general, use of digital media/technology can ensure that interventions are delivered to a wide range of children in a variety of settings with high fidelity. In addition, using a theoretical framework that targets specific behaviors, and providing frequent doses of education over longer periods of time can help ensure that the intervention is successful. However, keeping students engaged is a challenge, and therefore, more research is needed to better understand the utility and effectiveness of these types of programs.

Description of the Evidence

The literature search for studies that tested the effects of nutrition education delivered to children and adolescents using digital media and/or technology identified 1,850 articles, 83 of which were selected for review (Fig. 4-A.1). Of these 83 articles, 10 were selected for inclusion. An additional 14 articles were identified via hand search. Therefore, a total of 24 articles were included in this systematic review. A detailed description of literature search results, including the databases searched and the number of articles identified using each database, articles identified using hand search, a list of citations for all included articles, and a table that lists excluded studies with rationale for exclusion can be found in Appendix D.

Figure 4-A.1. Flow chart of literature search results for studies examining the effects of nutrition education delivered to children and adolescents using digital media and/or technology



Kindergarten–Grade 5

This evidence review includes 11 studies that examined the effects of nutrition education delivered via digital media/technology on dietary intake-related behaviors in children in kindergarten through grade 5. Ten studies were randomized controlled trials [Bannon, 2006 (Neutral Quality); Baranowski, 2003a (Positive Quality); Baranowski, 2003b (Neutral Quality); Cullen, 2005 (Positive Quality); Haire-Joshu, 2010 (Neutral Quality); Horne, 2004 (Positive Quality); Mangunkusumo, 2007 (Positive Quality); Pempek, 2009 (Neutral Quality); Thompson, 2008 (Neutral Quality); Turnin, 2001 (Positive Quality)] and one study was a non-randomized controlled trial [Moore, 2009 (Neutral Quality)]. Five studies received a positive quality rating, and six studies received a neutral quality rating. Eight of the studies were conducted in the United States, one in the United Kingdom, one in the Netherlands, and one in France. Sample sizes of these studies ranged from 30 to 1,876 (four studies had <100 subjects, three studies had 100–500 subjects, one study had 500–1,000 subjects, and three studies had >1,000 subjects). Nine of the studies included both boys and girls, while two studies included only girls. Subjects in these studies ranged in age from 5 years to 12 years. Four studies included only African American subjects, and seven studies included a predominantly white or mixed ethnicity subject population. Few of the studies provided information regarding the socio-economic status of subjects.

The digital media/technology programs used were either computer- or internet-based. Seven studies used a multimedia computer game, three used an interactive website that provided nutrition information, goal-setting opportunities, and individually-tailored feedback, and two used educational videos.

All eleven studies targeted children’s dietary intake, with a primary focus on behaviors that would improve compliance with the Dietary Guidelines for Americans. While most of the studies aimed to increase fruit and vegetable intake, some also focused on increasing the following: 100% fruit juice, fiber, water, protein, dairy products, breakfast, and snacks. Several studies also aimed to decrease the following: fat, calories, soft drinks, fruit drinks (not 100%), sodium, snacks, sweets, and sugar.

Overall, 9 of the 11 studies found that nutrition education delivered via digital media/technology led to improved dietary intake-related behaviors (Bannon, 2006; Baranowski, 2003a; Cullen, 2005; Haire-Joshu, 2010; Horne, 2004; Moore, 2009; Pempek, 2009; Thompson, 2008; Turnin, 2001). Of these, six studies found that nutrition education delivered via digital media/technology was more effective than the no-intervention control (Baranowski, 2003a; Cullen, 2005; Horne, 2004; Thompson, 2008) or a comparison intervention with another type of nutrition education method (Pempek, 2009; Turnin, 2001), while two studies found that two different strategies for delivering nutrition education using digital media/technology were both effective (Bannon, 2006; Moore, 2009). Two of the twelve studies found no significant differences in dietary intake following nutrition education delivered via digital

media/technology compared to a control or comparison intervention (Baranowski, 2003b; Mangunkusumo, 2007). However, Baranowski et al. (2003b) did report “clinically significant” changes in dietary intake following a digital intervention, but the differences were not statistically significant, and it is likely the study was not adequately powered. In addition, Mangunkusumo et al. (2007) measured outcomes 3 months after the completion of the intervention, and may have missed any short-term changes in dietary intake that occurred immediately subsequent to the intervention.

Table 4-A.1. Summary of the results from studies examining the effects of nutrition education delivered to children in kindergarten–grade 5 using digital media and/or technology

Study	Outcomes	Type of Digital Media/Technology
Bannon, 2006 N = 50	(+) The nutrition message videos led more children to choose apples as a snack (56%) than those who saw the control condition (33%; p<0.01). (Ø) Snack choice did not differ between the gain-framed compared to the loss-framed videos	Video with either gain-framed (i.e., stated benefits of doing the behavior) or loss-framed (i.e., stated benefits that will be missed if behavior is not done) message compared to non-nutrition video
Baranowski, 2003a N = 1,489	(+) Intervention compared to control → increased fruit, 100% juice, and vegetable intake (1 serving/d, mainly from f/v; p=0.002)	Computer game (Squire's Quest) vs. no intervention control
Baranowski, 2003b N = 35	Ø Intervention compared to comparison → decreased calories (-231 kcal), percent calories from fat (-1.6%), sweetened beverages (-0.8 servings/d); increased water (1.4 servings/d), increased fruit/ 100% juice/vegetables intake (1.2 servings/d) (NS)	Interactive, tailored website vs. basic website
Cullen, 2005 N = 1,578	(+) Intervention compared to control → increased fruit (+0.26 servings; p<0.001) and 100% fruit juice (+0.06 servings, p<0.05) at snacks and regular vegetables at lunch (+0.16 servings; p<0.01)	Computer game (Squire's Quest) vs. no intervention control
Haire-Joshu, 2010 N = 451	(+) Overweight/Obese children: Intervention compared to control → decreased calories from high fat foods (p<0.05)	Computer storybooks vs. usual care
Horne PJ, 2004 N = 435	(+) Intervention compared to control → lunchtime fruit and vegetable intake was higher at intervention and follow-up than baseline (P<0.001), while snack intake was higher at intervention than baseline (P<0.001). There were also significant increases in fruit/veg intake at home (P<0.05).	Videos vs. No intervention control
Mangunkusumo, 2007 N = 486	Ø Intervention compared to control → no difference in fruit and vegetable intake (did not report change in intake from pre- to post-intervention)	Interactive, tailored website vs. no intervention control
Moore, 2009 N = 126	(+)/Ø Intervention compared to comparison → all improved nutrition self-care practices (p<0.05) with no difference between groups	Website/game (MyPyramid Blast-Off): small group vs. larger group
Pempek, 2009 N = 30	(+) Healthier advergame compared to the less healthy advergame → increased healthy snacks intake (1.4 servings vs. 0.20 servings; p=0.007); the control group fell in between (0.90 servings)	Advergames: healthier advergame vs. less healthy advergame
Thompson, 2008 N = 73	(+) Intervention compared to control → increased fruit, 100% juice, and vegetable intake (1 serving/d; p=0.002)	Interactive, tailored website vs. no intervention control (delayed group)
Turnin, 2001 N = 1,876	(+) Intervention compared to comparison → better dietary intake post-intervention: more carb (46.4% vs. 45%; p<0.05), less fat (37.1% vs. 37.6%; p<0.05), less protein (16.5% vs. 16.7%; p<0.05), less sugar (11.5% vs. 12.2%; p<0.001), more calcium (p<0.001), and more fiber (p<0.05)	Computer game vs. conventional teaching
(+): indicates a positive association. (-): indicates an inverse association. Ø: indicates a non-significant difference.		

Older than Grade 5

The literature search identified 13 studies that examined the effects of nutrition education delivered via digital media/technology on dietary intake-related behaviors in children in grade 5 and older. Nine studies were randomized controlled trials [Baranowski, 2011 (Positive Quality); DeBar, 2006 (Positive Quality); DeBar, 2009 (Neutral Quality); Di Noia, 2008 (Positive Quality); Haerens, 2006 (Positive Quality); Haerens, 2007b (Positive Quality); Haerens, 2007a (Neutral Quality); Thompson, 2009 (Positive Quality); Williamson, 2005 (Positive Quality)]; and four studies were non-randomized controlled trials [Casazza, 2007 (Neutral Quality); Frenn, 2003 (Neutral Quality); Long, 2004 (Neutral Quality); Winett, 1999 (Neutral Quality)]. Seven studies received a positive quality rating, and six studies received a neutral quality rating. Ten of the studies were conducted in the United States and three in Belgium. Sample size of these studies ranged from 50–2,840 (two studies had <100 subjects, eight studies had 100–500 subjects, one study had 500–1,000 subjects, and two studies had >1,000 subjects). Ten of the studies included both boys and girls, one study included only boys, and two studies included only girls. Subjects in these studies had a mean age ranging from 10 years to 16 years. Eight studies included predominantly white subjects, three studies had a mixed ethnicity subject population, and one study included only African American subjects. Few of the studies provided information regarding the socio-economic status of subjects.

The digital media/technology programs used were either computer- or internet-based. Six studies used a multimedia computer game, and five used an interactive internet website. One study combined the use of an internet website with videos.

All twelve studies targeted children's dietary intake, with a primary focus on behaviors that would improve compliance with the Dietary Guidelines for Americans. While most of the studies aimed to increase fruit and vegetable intake, some also focused on increasing the following: water, 100% fruit juice, fiber, and regular meal consumption. Several studies also aimed to decrease the following: fat, calories, soft drinks, high fat snacks, high fat dairy products, and fast food consumption.

Overall, 12 of the 13 studies showed some improvement in dietary intake following a nutrition education intervention delivered using digital media/technology. Nine studies found that nutrition education delivered via digital media/technology led to improved dietary intake more effectively than a no-intervention control (DeBar, 2006; DeBar, 2009; Haerens, 2006; Haerens, 2007a; Haerens, 2007b) or a comparison intervention with another type of nutrition education method (Baranowski, 2011; Di Noia, 2008; Williamson, 2005; Winett, 1999). One study found that digital media/technology nutrition education improved dietary intake, but not more than control/comparison (Casazza, 2007). Two studies found that nutrition education delivered via digital media/technology to girls led to improved dietary intake (lower fat intake), but not in boys (Frenn, 2003; Haerens, 2007a), and another found that nutrition education delivered via digital media/technology was effective in changing dietary intake immediately following the intervention, but that the behavior change did not persist 6 months post-intervention (Thompson, 2009). One study found no significant differences in dietary intake following nutrition education delivered via digital media/technology (Long, 2004). However, the studies varied widely in design and methodology, and it is possible that a number of factors that varied between the studies could have influenced the impact of nutrition education delivered via digital media/technology. Some of these factors are discussed in further detail below.

Table 4-A.2. Summary of the results from studies examining the effects of nutrition education delivered to children in grade 6–grade 12 using digital media and/or technology

Study	Outcomes	Type of Digital Media/Technology
Baranowski, 2011 N = 133	(+) Intervention compared to comparison → increased fruit and vegetable intake (0.67 servings/d; $p < 0.05$)	Computer games vs. nutrition games on public websites
Casazza, 2007 N = 275	(+)/∅ Intervention groups compared to control → both had significant decreases in total energy intake ($p < 0.01$) with no difference between the groups. ∅ Intervention groups compared to control → no differences in any other dietary intake measure (fiber, fruits, and vegetables).	Computer-based education vs. traditional education vs. no intervention control
DeBar, 2006 N = 82	(+) Intervention compared to control → increased intake of calcium in both study years ($p < 0.001$), vitamin D in the first year ($p < 0.02$), and fruits and vegetables (0.74 and 0.79 servings, $p < 0.01$) in both years.	Multicomponent intervention with a website component vs. No intervention control
DeBar, 2009 N = 209	(+) Website usage was associated with increased calcium intake ($p < 0.01$)	Multicomponent intervention with a website component vs. No intervention control
Di Noia, 2008 N = 507	(+) Intervention compared to comparison → increased fruit and vegetable consumption (3.3 vs. 2.5 servings/d, $P < 0.001$) and more maintained recommended intake levels ($P < 0.05$).	Computer-based education vs. traditional education
Frenn, 2003 N = 130	(+) Girls: Intervention compared to control → decreased fat intake ($P < 0.05$) ∅ Boys: Intervention compared to control → no differences in dietary intake	Internet + video vs. No intervention control
Haerens, 2006 N = 2,287	(+) Girls: Interventions with and without parental support compared to control → decreased fat intake (g and % energy) ($P < 0.05$) ∅ Boys: intervention groups compared to control → no differences in fat intake ∅ Boys and Girls: intervention groups compared to control → no differences in fruit, soft drinks and water consumption.	Computer-based intervention + environmental changes with parental support vs. Computer-based intervention + environmental changes without parental support vs. no intervention control
Haerens, 2007a N = 2,840	(+) Girls: Intervention with parental support compared to intervention alone and control → decreased fat intake (g and % energy) ($P < 0.05$) ∅ Boys: intervention groups compared to control → no differences in fat intake ∅ Boys and Girls: intervention groups compared to control → no differences in fruit, soft drinks and water consumption.	Computer-based intervention + environmental changes with parental support vs. Computer-based intervention + environmental changes without parental support vs. no intervention control;
Haerens, 2007b N = 304	(+) Girls in technical-vocational schools significantly decreased fat intake ($p < 0.05$), as did boys and girls undertaking general education who reported to have read the intervention messages ($p < 0.05$)	Computer-tailored intervention vs. No intervention control
Long, 2004 N = 121	∅ Intervention groups compared to comparison → no differences in consumption of fat, fruits, or vegetables	Internet-based education vs. traditional education

Table 4-A.2. Summary of the results from studies examining the effects of nutrition education delivered to children in grade 6–grade 12 using digital media and/or technology—continued

Study	Outcomes	Type of Digital Media/Technology
Thompson, 2009 N = 473	(+) Immediately following intervention, Intervention compared to comparison → increased fruit and fruit juice compared to control subjects (0.94 vs. 0.56 servings/d; $p < 0.003$). This difference was no longer significant 6-month post-intervention. (+) 6-month post-intervention, intervention group compared to comparison → increased vegetable intake (~1 serving; $p < 0.05$)	Internet-based nutrition education vs. Internet-based physical education
Williamson, 2005 N = 50	(+) Intervention compared to comparison → decreased fat intake ($p < 0.05$).	Internet-based, tailored education vs. Internet-based non-tailored education
Winett, 1999 N = 180	(+) Intervention → increased fruits and vegetables, breads/cereals (+ 1 serving/d, $p < 0.001$), and decreased consumption of regular soft drinks and fast foods ($p < 0.05$). The comparison group had no changes in dietary intake.	Computer-based education (Eat4Life) vs. Traditional education
(+): indicates a positive association (-): indicates an inverse association Ø: indicates a non-significant difference		

Factors that may impact the efficacy of nutrition education delivered via digital media/technology across age groups

Dose of Nutrition Education

One variable that may impact the efficacy of nutrition education delivered via digital media/technology is the dose of education subjects receive. Dose can be characterized by the duration of the educational intervention, the total number of education sessions, or the frequency with which education sessions are held. The doses tested in these studies tended to be shorter in length, with little follow-up to examine long term effects. Therefore, more research is needed to determine whether longer term or more intensive interventions results in further improved outcomes, and whether the effects of these types of interventions can be sustained over longer periods of time, ultimately impacting health outcomes such as body weight. The doses of nutrition education delivered in the studies reviewed are described in more detail below:

Kindergarten–Grade 5

Among the studies that included subjects in kindergarten through grade 5, the length of the interventions lasted from 1 day to up to 11 months, and the number of education sessions ranged from 1 to 10 (three studies were 1 day long (1 session each), one study was 16 days long (16 sessions), one study was 5 weeks long (5 sessions), two studies were 5 weeks long (10 sessions each), one study was 8 weeks long (subject logged-in weekly), one study was 3 months long (6 sessions), one study was 20 weeks long (subjects logged-in weekly), and one study was 5 months long (8 sessions)). In terms of frequency, the studies ranged from one session to two sessions per week (three studies had a single session, one study had sessions every other week, two studies had sessions once a week, and five studies had two or more sessions per week). Overall, the studies that had longer intervention periods with a greater number and frequency of education sessions had a greater impact on dietary intake change in children (Baranowski, 2003a; Baranowski, 2003b; Cullen, 2005; Horne, 2004; Thompson, 2008; Turnin, 2001; Moore, 2009) compared to interventions that were shorter, and had fewer education sessions less frequently (Mangunkusumo, 2007). However, additional research is needed to determine whether longer term or more intensive interventions results in further improved outcomes, and whether the effects of these types of interventions can be sustained over longer periods of time, ultimately impacting health outcomes, such as body weight.

Log-on rate is another aspect of studies using digital media/technology that may impact not only dose and intensity, but also the effect of the intervention on nutrition-related behaviors. The degree to which free-

living subjects log-on to a computer- or internet-based program affects the dose of nutrition education they receive. Only two of the studies included in this review measured log-on rates (Baranowski, 2003b; Thompson, 2008). Baranowski et al. (2003b) found that 48 percent of intervention girls logged-on weekly, and 25 percent of control girls logged-on monthly, while Thompson et al. (2008) found that 75 percent of subjects logged-on weekly. Neither study analyzed whether log-on rate affected outcomes; however, Thompson et al. (2008) showed that subjects significantly improved their dietary intake. While Baranowski et al. (2003b) reported some improvements in dietary intake behaviors, they did not reach statistical significance, likely due to a small sample size and lack of statistical power.

Older than Grade 5

In the studies that examined children older than grade 5, intervention duration lasted from a single session to 2 years with varied session frequency and session length (one study was a single day (1 session), one study had 2 sessions (length not reported), two studies were 4 weeks long (one study had 4 sessions; one study did not provide information on number of sessions), one study was 9 weeks long (subjects logged-in weekly), three studies were 12 weeks long (4 sessions, 6 sessions; one study did not provide information on number of sessions), one study was 16 weeks long (5 sessions), two studies were 9 months long (neither provided information on number of sessions), and two studies were 24 months long (subjects logged-in weekly)). Overall, most of the studies in this review had a fairly long duration of intervention, with multiple, frequent sessions. Therefore, it is likely that these studies provided subjects an adequate dose of nutrition education to affect dietary intake, as thirteen of the fourteen studies showed significant improvements. More research is needed to determine whether longer term or more intensive interventions results in further improved outcomes, and whether there are the effects of these types of interventions can be sustained over longer periods of time, ultimately impacting health outcomes, such as body weight.

Study Setting

Another factor that may impact the efficacy of nutrition education delivered via digital media/technology is the setting in which the education is provided. For example, it is possible the nutrition education delivered via digital media/technology may be less effective at home compared to in a classroom setting due to competing forms of technology and other forms of entertainment. The study setting used in the studies reviewed is described in more detail below. In this body of literature, there do not appear to be any emerging patterns related to the setting, indicating that nutrition education delivered via digital media/technology has the potential to be used effectively in a variety of settings. However, this set of studies did not systematically test the effects of setting on outcomes, and therefore additional research is needed to determine whether nutrition education delivered via digital media/technology is more effective when delivered in a particular setting. In addition, parental involvement was not addressed across the board in the body of literature reviewed, and therefore, determining whether parental involvement affects outcomes is also of interest. The study settings in the studies reviewed are described in more detail below:

Kindergarten–Grade 5

In this body of literature, eight studies took place in a school (Bannon, 2006; Cullen, 2005; Baranowski, 2003a; Haire-Joshu, 2010; Horne, 2004; Mangunkusumo, 2007; Moore, 2009; Turnin, 2001), one study was delivered at a day camp (Baranowski, 2003b), one study was delivered in a research laboratory (Pempek, 2009), and one study was done at home (Thompson, 2008).

Older than Grade 5

In this body of literature, four studies took place in a school (Casazza, 2007; Frenn, 2003; Haerens, 2006; Haerens, 2007a; Haerens, 2007b; Long, 2004; Winett, 1999), one study was done in a youth service agency (Di Noia, 2008), one was delivered in a health care clinic (DeBar, 2006; DeBar, 2009), one was done during Boy Scout troop meetings and at home (Thompson, 2009), one was delivered in a research laboratory (Baranowski, 2011), and one was done in a research laboratory and at home (Williamson, 2005).

Theoretical Frameworks

Whether an intervention is developed using some theoretical basis may also play a role in how effective the intervention is. Using a theoretical framework when developing nutrition education interventions may improve outcomes, and previous reviews have indicated that the use of theoretical models to develop nutrition education interventions has become more common over time, and that use of theoretical models allow the researchers to better account for variables that may explain how nutrition education interventions impact children's behavioral outcomes.¹¹ The theoretical frameworks used in the studies reviewed are described in more detail below:

Kindergarten–Grade 5

In this set of studies, 8 of the 11 studies reported use of a theoretical framework, with 4 using the Social-Cognitive Theory (Baranowski, 2003a; Baranowski, 2003b; Cullen, 2005; Thompson, 2008), 1 used Behavioral-Change Theory (Mangunkusumo, 2007), 1 used the Self-Care Deficit Nursing Theory (Moore, 2009), 1 used Decision Making Theory (Bannon, 2006), and 1 used the Social-Ecological Model (Haire-Joshu, 2010). Three studies did not report using a theoretical framework to develop the nutrition education intervention (Horne, 2004; Pempek, 2009; Turnin, 2001). In particular, the studies that used a theoretical framework when developing the educational intervention, particularly the Social-Cognitive Theory or the Self-Care Deficit Nursing Theory, showed significant improvements in nutrition-related behaviors.

Older than Grade 5

In this review, 8 of the 13 studies used a theory when developing the intervention (Baranowski, 2011; Di Noia, 2008; Frenn, 2003; Haerens, 2006; Haerens, 2007a; Haerens, 2007b; Thompson, 2009; Winett, 1999), and 5 studies did not report any theoretical framework (Casazza, 2007; De Bar, 2006; De Bar, 2009; Long, 2004; Williamson, 2005). Of those studies that used a theory when designing the intervention, four used the Transtheoretical Model (Di Noia, 2008; Haerens, 2006; Haerens, 2007a; Haerens, 2007b), two used the Social-Cognitive Theory (Thompson, 2009; Winett, 1999), one used the Social Cognitive, Self-Determination, and Persuasion Theories (Baranowski, 2011), and one used both the Transtheoretical Model and the Health Promotion Model (Frenn, 2003). Of those studies that used a theory, seven out of eight showed that nutrition education improved children's dietary intake. Of those studies that did not use a theory, three out of five showed that nutrition education improved children's dietary intake. Therefore, it appears that in this set of studies, interventions that were explicitly grounded in theory may be more effective for improving children's dietary intake behaviors.

Other Issues to Consider

There are several additional issues that are important to consider when reviewing and interpreting this body of literature. One study found that when children are presented with messages about less healthy foods, this can have a more negative impact on food choices than no message at all (Pempek, 2009). Therefore, when possible, it is important to consider the impact on children's behavior of competing unhealthy messages that are widely available in the digital environment. In addition, the speed with which technological advances are occurring in our society makes it difficult to know what the impact of the digital media/technology tested in previously published studies would be in the current technological environment. Another consideration relates to subject characteristics, and whether these types of interventions are more effective in certain groups of children, based on race/ethnicity, socioeconomic status, or prior experience with digital media/technology. Also, none of the studies included in this review assessed whether the digital media/technology program used was engaging to students, and whether the degree to which students liked the program affected study outcomes.

Finally, it is important to consider potential unintended consequences that may not have been captured in the literature. Strong and consistent evidence in children shows that screen time is directly associated with increased overweight and obesity. However, the strongest association is with television screen time, and based on the few studies that examined other types of screen time, there was no apparent association between body weight and video game or computer use (DGAC, 2010). Therefore, the impact of using digital media/technology on children's overall screen time should be taken into consideration when planning interventions or programs.

¹¹ Contento I. The Effectiveness of Nutrition Education and Implications for Nutrition Education Policy, Programs, and Research: A Review of Research. *J. Nutr Ed Behav.* 1995 Dec;27(6):277-420.

Evidence Summary Paragraphs

Kindergarten–Grade 5

Bannon, 2006 (Neutral Quality) conducted a randomized controlled trial to test the effects of nutrition messages framing on snack choice in young children. Three classrooms were randomly assigned to watch one of the following 60-second videos: (a) a gain-framed nutrition message (i.e., stated benefits of doing the behavior), (b) a loss-framed message (i.e., stated benefits that would be missed if behavior is not done), or (c) a control scene. Following the video, children were offered a choice of either animal crackers or an apple for snack. The final sample included 50 children (46 percent female, mean age=5 yrs). Results showed that children who saw one of the nutrition message videos, were more likely to choose apples as a snack (56 percent) than those who saw the control condition (33 percent; $p<0.01$). There were no differences in snack choices between children who saw the gain-framed compared to the loss-framed videos. These results suggest that videos containing nutritional messages may have a positive influence on children's short-term food choices.

Baranowski, 2003a (Positive Quality) investigated the effects of a group-randomized intervention to increase fruit, juice, and vegetable (FJV) consumption among elementary school children in the United States. The intervention involved the use of “Squire's Quest,” a 10-session, psychoeducational, computer game delivered over 5 weeks, with each session lasting about 25 minutes. The game was developed based on the Social Cognitive Theory. Children in the control group did not receive the intervention. Four days of dietary intake were assessed before and after the intervention using a multiple pass, 24-hour dietary intake interview directly with the children. The final sample included 1,489 subjects (689 boys, 763 girls; mean age=9 yrs). The results showed that children participating in the game increased their FJV consumption by 1.0 serving more than the children not receiving the program ($p=0.002$). The authors report that most of this increase was due to increased fruit and vegetable consumption, rather than increased 100% fruit juice intake. The authors concluded that psychoeducational multimedia games have the potential to substantially change dietary behavior.

Baranowski, 2003b (Neutral Quality) conducted a group randomized intervention to test the effects of an internet-based intervention on dietary intake and body weight in girls. Girls in the intervention group attended a special 4-week summer day camp, followed by a special 8-week home Internet intervention for the girls and their parents. Control group girls attended a different 4-week summer day camp, followed by a monthly home Internet intervention, neither of which components included the Internet program enhancements. Dietary intake was measured using two 24-hour recalls taken at baseline and after the 12-week intervention. The final sample included 35 African American girls (mean age=8 yrs). At the end of the 12-week intervention, those in the intervention group decreased calorie intake (-231 kcal) and percent calories from fat (-1.6 percent); increased consumption of water (1.4 servings/day) 100% juice/vegetables (1.2 servings/day); and lower consumption of sweetened beverages (-0.8 servings/day), though the differences were not significant. The authors concluded that summer day camp appears to offer promise for initiating health behavior change.

Cullen, 2005 (Positive Quality) investigated the effects of a group-randomized intervention to increase fruit, juice, and vegetable (FJV) consumption among elementary school children in the United States. The intervention involved the use of “Squire's Quest”, a 10-session, psychoeducational, computer game delivered over 5 weeks, with each session lasting about 25 minutes. The game was developed based on the Social Cognitive Theory. Children in the control group did not receive the intervention. Four days of dietary intake were assessed before and after the intervention using a multiple pass, 24-hour dietary intake interview directly with the children. The final sample included 1,578 subjects (736 boys, 803 girls; mean age=9 yrs). Results showed that significant increases were found for servings of fruit (+0.26 servings; $p<0.001$) and 100% fruit juice (+0.06 serving; $p<0.05$) at snacks (at home and in school, and regular vegetables (+0.16 servings; $p<0.01$) at lunch for intervention school children compared with children in control condition schools. There were no differences at breakfast and dinner. The authors concluded that psychoeducational multimedia games have the potential to substantially change dietary behavior, particularly at eating occasions where children might have more control over food choices.

Haire-Joshu, 2010 (Neutral Quality) conducted a randomized controlled trial in the United States to test the effects of a multicomponent diet and activity intervention on children's dietary intake. Children in the intervention group received 8 computer-tailored storybook sessions, parent action newsletters, and trained mentors. Children in the control group received the usual nutrition education provided in the school setting. A survey was used to assess child-related outcomes, including dietary intake. The final sample included 451 children (mean age 8.5 yrs; 37 percent African American; 49 percent female). For all subjects, fruit and vegetable consumption, total calorie intake, and percent energy from fat increased, with no differences between intervention and control groups. When results were stratified by weight status, overweight/obese children in the intervention group decreased consumption of calories from high fat foods, while normal weight children did not ($p=0.059$).

Horne, 2004 (Positive Quality) conducted a randomized controlled trial to evaluate a peer-modeling and rewards-based intervention designed to increase children's fruit and vegetable consumption. Over 16 days, children watched 6 minute video adventures featuring heroic peers (the Food Dudes) who enjoy eating fruit and vegetables, and received small rewards for eating these foods themselves. After 16 days, there were no videos and the rewards became more intermittent. Fruit and vegetable consumption was measured (i) at lunchtime using a 5-point observation scale; (ii) at snacktime using a weighed measure; (iii) at home using parental recall. The final sample included 435 children (ages 4–11 years). Results showed that compared to the control school, lunchtime fruit and vegetable consumption in the experimental school was substantially higher at intervention and follow-up than baseline ($P<0.001$), while snacktime consumption was higher at intervention than baseline ($P<0.001$). The lunchtime data showed particularly large increases among those who initially ate very few fruits and vegetables. There were also significant increases in fruit and vegetable consumption at home ($P<0.05$). The authors concluded that the intervention was effective in bringing about substantial increases in children's consumption of fruit and vegetables.

Mangunkusumo, 2007 (Positive Quality) conducted a cluster-randomized controlled trial in the Netherlands to determine whether Internet-tailored advice for schoolchildren and Internet-supported dietary counseling impact fruit and vegetable intake. During school hours, all children completed Internet-administered questionnaires on fruit/vegetable intake and related determinants. Children in the intervention group received immediate online tailored nutrition feedback, and a nurse also received information via the Internet to support a 5-minute counseling protocol to promote fruit/vegetable intake. The control group did not receive any of the intervention components. Children completed a similar post-test questionnaire 3 months after the first assessment. The final sample included 486 children (263 in the intervention, 223 in the control; mean age=10 yrs) from 30 classrooms (16 intervention, 14 control). There were no significant effects of the intervention on intake of fruits and vegetables. The authors concluded that while a tailored, Internet-based nutrition education tool can induce positive changes in nutrition-related knowledge, it did not translate into changes in dietary intake.

Moore, 2009 (Neutral Quality) conducted a quasiexperimental pilot study in the United States to determine the effect of a nutrition education program, Color My Pyramid, on children's nutrition knowledge and nutrition status. The intervention program incorporates an online component using www.MyPyramid.gov (the Blast-Off game) and consisted of six classes taught over a 3-month period. The content focused on general nutrition concepts, moderation and variety, portion sizes, exercise and activity, introduction to MyPyramid.gov for kids, and experiential learning with the Blast-Off Game. The intervention was then delivered in two different schools, with students in School 1 receiving a more didactic presentation on playing the Blast-Off Game, and students in School 2 using individual computers to evaluate their diets in small groups. Finally, a posttest was administered to re-evaluate children's nutrition knowledge and behaviors. The final sample included 126 students (64 from School 1, and 62 from School 2; age 9–11 yrs; 28 percent overweight, 43 percent obese; 93 percent African American). There was a significant increase in nutrition self-care practices from pretest to posttest among all students ($p<0.05$), but no differences between the intervention groups. The authors concluded that the computer-based Color My Pyramid program was effective in improving children's nutrition self-care practices.

Pempek, 2009 (Neutral Quality) conducted a randomized controlled trial to examine how advergames, which are online computer games developed to market a product, affect consumption of healthier and less healthy snacks by low-income African American children. Children played an advergame in which they were rewarded for having their computer character consume healthier or less healthy foods and beverages. Children were randomly assigned to

one of the following three conditions: (1) the healthier advergame condition, (2) the less healthy advergame condition, or (3) the control condition. Children in the treatment conditions played a less healthy or a healthier version of an advergame 2 times before choosing and eating a snack and completing the experimental measures. Children in the control group chose and ate a snack before playing the game and completing the measures. The final sample included 30 African American children (15 girls, 15 boys; mean age=9 yrs). Children who played the healthier version of the advergame selected and ate significantly more healthy snacks (1.4 ± 0.24 servings) than did those who played the less healthy version (0.20 ± 0.24) ($p=0.007$), with the control group falling in between (0.90 ± 0.24). Nine children (90 percent) in the healthy condition chose at least one healthy snack, whereas six children (60 percent) in the control group and one child (10 percent) in the less healthy group chose at least one healthy snack. The healthier and less healthy conditions differed significantly ($p=0.001$). The authors concluded that advergames affect children's food intake, but that advergames promoting healthier foods and beverages can be used to encourage selection and consumption of healthier foods.

Thompson, 2008 (Neutral Quality) conducted a randomized controlled trial in the United States to determine the efficacy of an Internet-based program on dietary intake. The intervention was 8 weeks long, and girls were randomized to receive immediate (weekly) or delayed (program end) incentives (\$5). The Internet-based program was designed based on the Social Cognitive Theory, and emphasized fruit, 100% juice, vegetable (FJV), and water intake, as well as physical activity. Participants' were given weekly goals to increase the target behaviors, and included focus on role modeling, problem solving, and goal setting/review. Dietary intake was assessed using a 7-item FFQ. The final sample included 73 African American girls (37 in the intervention, and 36 in the control group) who were 8–10 years of age. Statistically significant pre-post improvement was observed in FJV consumption, with girls reporting an increase of 1 serving/day at the end of the intervention ($p=0.002$). The authors did not report the contributions of each individual food group measured to the total increase in FJV consumption. The authors concluded that this Internet-based program was feasible, and effective in promoting healthy eating.

Turnin, 2001 (Positive Quality) conducted a randomized trial in France to investigate the impact of nutrition computer games on children's nutrition knowledge and dietary intake. All 16 schools in the same school district were randomized into two groups: games group and control group, both receiving conventional nutritional teaching by their teachers. The children in the games group played computer games during the conventional nutritional teaching period (2 hr/wk for 5 weeks). At completion of the study, nutrition knowledge and 3-day diet records were evaluated in both groups; however, this data was not assessed at the start of the study. The final sample included 1,876 children from 15 schools (mean age=9 yrs; 53 percent girls; 24 percent overweight, 11 percent obese). After the intervention, dietary intake differed significantly between the children in the games group compared to the control group; the game group consumed more carbohydrate (46.4 ± 0.2 percent vs. 45.7 ± 0.2 percent, $p<0.05$), less fat ($37.1\pm 0.1\%$ vs. $37.6\pm 0.2\%$, $p<0.05$), less protein ($16.5\pm 0.1\%$ vs. $16.7\pm 0.1\%$, $p<0.05$), less sugar ($11.5\pm 0.1\%$ vs. $12.2\pm 0.2\%$, $p<0.001$), more calcium ($p<0.001$) and more fiber ($p<0.05$). The authors concluded that children provided nutrition education via computer games compared to conventional teaching had slightly but significantly better nutritional knowledge and dietary intake.

Older than Grade 5

Baranowski, 2011 (Positive Quality) conducted a randomized controlled trial in the United States evaluating the effects of playing computer games on children's diet. The intervention group played two computer video games, Diab and Nano. The control group played diet and physical activity knowledge-based games on popular websites. Three 24-hour dietary recalls were used to assess dietary intake immediately after playing each game and 2 months later. The final sample included 133 children (ages 10–12 yrs; 44 percent female; 40 percent white). Results showed the children who played the computer video games increased fruit and vegetable intake by 0.67 servings/day compared to children who played the games on public websites ($p<0.018$).

Casazza, 2007 (Neutral Quality) conducted a nonrandomized group trial in the United States to determine which health education delivery method (computer-based or traditional education) would elicit a greater behavior change. A total of three schools participated: a control school, a traditional education school (investigator taught classes via lecture and pamphlets) and a computer-based education school (investigator designed a nutrition education CD-ROM and students independently navigated the program). Over a period of 16 weeks, subjects participated in five,

45-minute intervention sessions. Measurements were taken at baseline and 11 weeks after baseline. Dietary intake data was collected using two 24-hour recalls and an FFQ. Students also completed a nutrition knowledge questionnaire. The final sample included 275 students (66 percent female, mean age=16 yrs). There was a significant decrease in total energy intake in both intervention groups ($p<0.01$), with no difference between the groups. Saturated fat intake decreased ($p<0.01$) and dairy intake increased ($p<0.001$) in the computer-based group, but differences between the groups were not significant. There were no differences between the groups in any other dietary intake measure. This article showed that nutrition education delivered using a computer, as well as that delivered using traditional education techniques, led to improvements in students' dietary intake.

DeBar, 2006 (Positive Quality) and DeBar, 2009 (Neutral Quality) reported on results from a randomized controlled trial to examine website use and behavioral outcomes in a multi-component intervention promoting healthy diet and exercise. The 2-year intervention consisted of in-person and web components. Participants were encouraged to log-on to the study website at least once a week over the 2-year intervention. Dietary intake data was measured using 24-hour recalls. In **DeBar, 2006** the final sample included 209 girls (mean age=15 yrs). Participants in the intervention group reported significantly greater consumption of calcium in both study years ($p<0.001$), vitamin D in the first year ($p<0.02$), and fruits and vegetables (0.74 and 0.79 servings respectively, $p<0.01$) in both years. There was no effect of the intervention on soda consumption. In **DeBar, 2009** the final sample included 82 girls (mean age=15 yrs) who completed the web-based intervention. Overall website use was associated with increases in calcium intake ($p<0.01$). However, use of web pages related to behavioral feedback and communications was not significantly associated with behavioral outcomes. The authors concluded that a multi-component intervention that involved use of a website effectively improved dietary intake in adolescent girls, and that use of a website may promote retention and engagement in target behaviors.

Di Noia, 2008 (Positive Quality) conducted a group randomized controlled trial in the United States to examine the efficacy of an after-school program intervention for increasing fruit and vegetable consumption among economically disadvantaged African-American adolescents. Youths were randomized into the intervention group that participated in a computer-based intervention program or to a control group that received regular programs offered at after-school program sites. The program, which was based on the transtheoretical model, provided youths with four 30-minute sessions of CD-ROM-mediated intervention content related to fruit and vegetable consumption, with a staging measure which classified users into precontemplation, contemplation/preparation or action/maintenance. Fruit and vegetable intake was measured by asking students how many servings per week they consumed. The final sample included 507 students (61 percent female, mean age=12 yrs). After adjustment for covariates, youths in the computer intervention arm had higher fruit and vegetable consumption than those in the control arm (3.25 ± 1.5 servings vs. 2.46 ± 1.39 servings, $P<0.001$), and more youths in the computer intervention arm progressed to later stages and maintained recommended intake levels ($P<0.05$). The authors concluded that youths who used the computer-based program increased their intake of fruits and vegetables 38 percent (0.9 servings/day) more than youths who did not use the computer-based program.

Frenn, 2003 (Neutral Quality) conducted a non-randomized controlled trial in the United States to examine the effects of a school-based internet and video intervention on diet. Classrooms were assigned to either the intervention group or a control group. The intervention consisted of four Internet sessions, five videos, a healthy snack session, and a gym class. Dietary intake was collected pre- and post-intervention using a validated dietary intake questionnaire. The final sample included 130 students (ages 12–15 yrs; 52 percent female; 45 percent African American). Results showed that following the intervention, girls in the intervention group reduced their fat intake compared to control ($P<0.05$). However, there were no significant differences in fat intake between the intervention and control groups.

Haerens, 2006 (Positive Quality) and Haerens, 2007a (Neutral Quality) reported on a randomized controlled trial done in Belgium to evaluate the effects of a middle-school healthy eating promotion intervention combining environmental changes and computer-tailored feedback, with and without a parental involvement component. Fifteen schools with pupils in seventh and eighth grades were randomized to an intervention group with parental support, an intervention group without parental support, and a control group. The intervention schools implemented an intervention combining environmental changes with computer-tailored feedback based on the Transtheoretical

Model. Target behaviors of the intervention were increasing fruit and water intake and reducing soft drink and fat intake. Children in the parental involvement group were also given a CD of the computer program to use at home. Dietary intake was measured with food frequency questionnaires. **Haerens, 2007a (Neutral Quality)** included a final sample of 2,840 students (37 percent girls; mean age=13 yrs) who completed 9 months of the intervention. In girls, fat intake and percentage of energy from fat decreased significantly in the intervention group with parental support compared with the intervention alone group ($P<0.05$) and the control group ($P<0.001$), while in boys, there were no significant differences in fat intake or percentage of energy from fat as a result of the intervention. In addition, no effects of the intervention were found in boys or girls related to fruit, soft drinks and water consumption. **Haerens, 2006** included a final sample of 2,287 students (38 percent girls; mean age=13 yrs) who completed the 2-year intervention. In boys, there were no significant differences in fat intake or percentage of energy from fat as a result of the intervention. In girls, fat intake and percentage of energy from fat decreased significantly in the intervention groups compared to the control group ($P<0.05$), with no differences between the interventions groups with and without parental involvement. In addition, no effects of the intervention were found in boys or girls related to fruit, soft drinks and water consumption. The authors concluded that combining physical and social environmental changes with computer-tailored feedback in girls and their parents can result in lower fat intake.

Haerens, 2007b (Positive Quality) conducted a randomized controlled trial to evaluate the acceptability, feasibility and effectiveness of a computer-tailored dietary fat intake education program for adolescents. A random sample of 10 schools, 5 with general and 5 with technical-vocational education programs, were selected to participate. In each of the 10 schools, two classes of 7th graders were randomly assigned to the intervention or control condition. Students were exposed once in class to a 50-minute theory-based computer-tailored dietary fat intake intervention. Questionnaires were completed 1 week before (food frequency questionnaire for dietary fat intake + psychosocial determinants) and 3 months after (process evaluation + food frequency questionnaire for dietary fat intake + psychosocial determinants) the intervention. The final sample included 304 subjects (70 percent female; mean age=13 yrs). Results showed that girls enrolled in technical-vocational schools significantly decreased fat intake ($p<0.05$), as did boys and girls undertaking general education who reported to have read the intervention messages ($p<0.05$).

Long, 2004 (Neutral Quality) conducted a group nonrandomized trial in the United States to test the effects of a classroom and Web-based educational intervention on self-efficacy for healthy eating. Two schools were assigned to the intervention (5 hours of Web-based instruction and 10 hours of classroom curriculum), or to the control (nutrition education embedded in the standard school curriculum during a 1-month period, with exposure ranging from 0–3 hrs). The final sample included 121 adolescents (52 percent girls, mean age=13 yrs). Results showed that there were no differences between the schools in consumption of fat, fruits, or vegetables. The authors concluded that the Web-based program significantly improved adolescent's self-efficacy for fruit and vegetable intake, but that this did not translate into a difference in actual consumption of fruits and vegetables.

Thompson, 2009 (Positive Quality) conducted a randomized controlled trial in the United States to test the effects of a nutrition education intervention on fruit juice and low-fat vegetable intake in boys. The study population was derived from a group of Boy Scout troops. Forty-two Boy Scout troops were randomly assigned to one of two conditions. The intervention group participated in a 9-week program that included approximately 30 minutes of weekly troop time, plus approximately 25 minutes of weekly Internet programming. The control group participated in a mirror image intervention to increase physical activity. The intervention was designed using the Social Cognitive Theory, and scouts were encouraged to log-on to the internet site twice weekly to participate in a behavior change program and set goals, as well as to report goal attainment. The main outcomes were fruit juice and low-fat vegetable intake, which were assessed at baseline immediately following the intervention, and 6 months post-intervention using a modified, validated FFQ. The final sample included 473 boys (ages 10–14 yrs). Immediately following the intervention, subjects in the intervention significantly increased consumption of fruit and fruit juice (0.94 servings/day) compared to control subjects (0.56 servings/day; $p<0.003$). However, this difference was not maintained 6 months later. Also, at 6-month post-intervention, subjects in the intervention group increased low-fat vegetable intake compared to the control group (~1 serving/day, $p<0.05$).

Williamson, 2005 (Positive Quality) conducted a randomized controlled trial in the United States to assess the impact of an Internet-based intervention on weight loss in adolescent girls. Family pairs were randomized to either a behavioral group, which incorporated behavior modification techniques and email communication with a specialized case manager trained in weight management, or a control group, receiving basic information about nutrition and physical activity via different Web site. Dietary intake data was collected via a 24-hour recall and FFQ. The final sample included 50 African American adolescent girls (mean age=13 yrs; mean BMI=36 kg/m²). Girls in the behavioral intervention also reduced total energy intake (p<0.001), protein (p<0.05), and fat intake (p<0.05), while those in the control group only reduced fat intake (p<0.05).

Winett, 1999 (Neutral Quality) conducted a non-randomized controlled trial in the United States to investigate the effects of the Eat4Life Internet-based health behavior program on the nutrition and activity practices of adolescent girls. Eight 9th and 10th grade classes were randomized into two groups: the intervention group used the Eat4Life computer program in their health education classes, while the control group did not use the modules. The Eat4Life group used the computer program during class, and also received a sample of a food recommended in the module. The Eat4Life modules are based on the Social Cognitive Theory, and provide a brief assessment of the subject's nutritional practices, followed by personalized feedback. Food intake was measured pre- and post-intervention using a 24-hour recall and FFQ. The final sample included 180 girls (103 in the intervention group, 77 in the control group; mean age=15–16 yrs). Across four cohorts of classes, girls using the Eat4Life modules reported that they made relatively consistent changes in all areas of nutrition except for reducing the consumption of high-fat dairy products. The Eat4Life program was effective in increasing consumption of regular meals, fruits and vegetables, and breads/cereals (all p<0.001), and decreasing consumption of regular soft drinks and fast foods (p<0.05). The authors concluded that a computer-based nutrition education program was effective in improving nutrition-related behaviors of adolescent girls.

Overview Tables

Table 4-A.3. Studies examining the effects of nutrition education delivered to children in kindergarten–grade 5 using digital media and/or technology

Study	Participants	Methods	Outcomes	Strengths and Limitations
Bannon, 2006 Neutral Quality Randomized controlled trial	N = 50 boys and girls (46% female) Age: 5 yrs Race: White Attrition rate: 0% Location: United States	<u>Methods:</u> Three classrooms were randomly assigned to watch one of the following 60-sec videos: (a) a gain-framed nutrition message, (b) a loss-framed message, or (c) a control scene. <u>Outcome Measures:</u> Following the video, children were offered a choice of either animal crackers or an apple for snack. <u>Theory:</u> N/A <u>Duration/Intensity:</u> One session <u>Intervention Groups:</u> Two of three classrooms were randomly assigned to a 60-sec video with either (a) a gain-framed nutrition message or (b) a loss-framed message. <u>Comparison Group:</u> One classroom was assigned to watch one of the following 60-sec videos with a control scene.	Children who saw one of the nutrition message videos, were more likely to choose apples as a snack (56%) than those who saw the control condition (33%; $p < 0.01$). There were no differences in snack choices between children who saw the gain-framed compared to the loss-framed videos.	Limited generalizability due to small sample size and lack of racial diversity Short length of intervention makes it difficult to determine long-term effect Moderating variables were not accounted for The validity of the videos was not pre-tested
Baranowski, 2003a Positive Quality Randomized controlled trial	N = 1,489 boys and girls (749 intervention, 740 control; 689 boys, 763 girls) Age: 9 yrs (8–12 yr) Race: 17% African American, 44% Euro-American, 30% Hispanic, 7% Other Attrition rate: 6% Location: United States	<u>Methods:</u> The intervention tested the effects of a multimedia game on diet <u>Outcome Measures:</u> Food intake was assessed using multiple-pass, 24-hr recalls over 4 days before and after the intervention. <u>Theory:</u> Social Cognitive Theory <u>Duration/Intensity:</u> 10, 25-min sessions over 5 wks <u>Intervention Group:</u> Used “Squire’s Quest,” a psychoeducational, multimedia game. The game attempts to increase intake of fruit, 100% juice, and vegetables by associating fun with their consumption. <u>Comparison Group:</u> Children in the control group did not receive the intervention.	Children participating in Squire’s Quest increased their fruit, 100% juice, and vegetable consumption by 1.0 servings more than the children not receiving the program ($p = 0.002$). The authors reported that most of the increase was due to increased fruit and vegetable intake, rather than 100% fruit juice.	Limited detail provided regarding the comparison group Self-reported dietary intake Unknown how long the behavior change would be sustained after the end of the program
Baranowski, 2003b Neutral Quality Randomized controlled trial	N = 35 African-American girls (19 intervention, 16 control) Age: 8 yrs SES: ~55% had household income >\$40,000 Attrition rate: 0% Location: United States	<u>Methods:</u> A two-arm parallel group randomized controlled pilot study, the Girls health Enrichment Multisite Studies (GEMS) Fun, Food, and Fitness Project, was conducted to increase fruit, 100% juice, vegetable, and water intake, increase physical activity, and to prevent obesity in girls. <u>Theory:</u> Social Cognitive Theory <u>Duration/Intensity:</u> 12 wks (4 wk summer camp + 8 wk home intervention). Control girls were asked to log-on once a month, and intervention girls were asked to log-on weekly (48% of intervention girls logged-on weekly, 25% of control girls logged-on monthly)	At the end of the 12-wk intervention, those in the intervention group decreased in calorie intake (-231 kcal), percent calories from fat (-1.6%), increased consumption of water (1.4 servings/d), fruit/100% juice/vegetables intake (1.2 servings/d), and lower consumption of sweetened beverages (-0.8 servings/d), though the differences were not significant.	Included a very small sample of only girls may have inadequately powered results Website log-on rates were low, especially in the control groups Self-reported dietary intake Significant differences in BMI existed between the intervention and control groups at baseline Strengths included use of a theoretical framework, randomization, use of a control group, and extensive process evaluation.

Table 4-A.3. Studies examining the effects of nutrition education delivered to children in kindergarten–grade 5 using digital media and/or technology—continued

Study	Participants	Methods	Outcomes	Strengths and Limitations
		<p><u>Outcome Measures:</u> Diet was assessed using 2, 24-hr recalls taken at baseline and after the 12-wk intervention.</p> <p><u>Intervention Group:</u> Girls in the intervention group attended a 4-wk summer day camp, followed by an 8-wk home Internet intervention for the girls and their parents.</p> <p><u>Comparison Group:</u> Control group girls attended a different 4-wk summer day camp, followed by a monthly home Internet intervention, neither of which components included the GEMS enhancements.</p>		
<p>Cullen, 2005 Positive Quality Randomized controlled trial</p>	<p>N = 1,578 boys and girls (785 intervention, 793 control; 736 boys, 803 girls) Age: 9 yrs (8–12 yrs) Race: 17% African American, 44% Euro-American, 30% Hispanic, 7% Other Attrition rate: N/A Location: United States</p>	<p><u>Methods:</u> The intervention tested the effects of a multimedia game on diet</p> <p><u>Outcome Measures:</u> Food intake was assessed using multiple-pass, 24-hr recalls over 4 days before and after the intervention.</p> <p><u>Theory:</u> Social Cognitive Theory</p> <p><u>Duration/Intensity:</u> 10, 25-min sessions over 5 wks</p> <p><u>Intervention Group:</u> Used “Squire’s Quest,” a psychoeducational, multimedia game. The game attempts to increase intake of fruit, 100% juice, and vegetables by associating fun with their consumption.</p> <p><u>Comparison Group:</u> Children in the control group did not receive the intervention.</p>	<p>Children in the intervention significantly increased servings of fruit (+0.26 servings; $p < 0.001$) and 100% fruit juice (+0.06 servings, $p < 0.05$) at snacks (at home and in school, and regular vegetables (+0.16 servings; $p < 0.01$) at lunch for intervention school children compared with children in control condition schools.</p>	<p>Limited detail provided regarding the comparison group Self-reported dietary intake Unknown how long the behavior change would be sustained after the end of the program</p>
<p>Haire-Joshu, 2010 Neutral Quality Randomized controlled trial</p>	<p>N = 451 boys and girls Age: 8.5 yrs Race: 37% African American Attrition rate: N/A Location: United States</p>	<p><u>Methods:</u> Randomized controlled trial to test the effects of a multi-component diet and activity intervention on children’s dietary intake</p> <p><u>Outcome Measures:</u> A survey was used to assess child-related outcomes, including dietary intake.</p> <p><u>Theory:</u> Social Ecological Model</p> <p><u>Duration/Intensity:</u> 8 sessions over 5 mos (2.3–10.8 mos)</p> <p><u>Intervention Group:</u> Children in the intervention group received 8 computer-tailored storybook sessions, parent action newsletters, and trained mentors.</p> <p><u>Comparison Group:</u> Usual school-based nutrition education</p>	<p>For all subjects, fruit and vegetable consumption, total calorie intake, and percent energy from fat increased, with no differences between intervention and control groups.</p> <p>When results were stratified by weight status, overweight/obese children in the intervention group decreased consumption of calories from high fat foods, while normal weight children did not ($p = 0.059$).</p>	<p>Self-reported data Limited generalizability of study population</p>

Table 4-A.3. Studies examining the effects of nutrition education delivered to children in kindergarten–grade 5 using digital media and/or technology—continued

Study	Participants	Methods	Outcomes	Strengths and Limitations
<p>Horne, 2004 Positive Quality Randomized controlled trial</p>	<p>N = 435 boys and girls Age: 4–11 yrs Race: N/A Attrition rate: N/A Location: United Kingdom</p>	<p><u>Methods:</u> Over 16 days children watched 6-min video adventures featuring heroic peers (the Food Dudes) who enjoy eating fruit and vegetables, and received small rewards for eating these foods themselves.</p> <p><u>Outcome Measures:</u> Fruit and vegetable consumption was measured (i) at lunchtime using a 5-point observation scale; (ii) at snacktime using a weighed measure; (iii) at home using parental recall.</p> <p><u>Theory:</u> N/A</p> <p><u>Duration/Intensity:</u> 16 days; 6-min videos</p> <p><u>Intervention Group:</u> Over 16 days children watched 6 min video adventures featuring heroic peers (the Food Dudes) who enjoy eating fruit and vegetables</p> <p><u>Comparison Group:</u> No intervention control</p>	<p>Compared to the control school, lunchtime fruit and vegetable consumption in the experimental school was substantially higher at intervention and follow-up than baseline ($P < 0.001$), while snacktime consumption was higher at intervention than baseline ($P < 0.001$). The lunchtime data showed particularly large increases among those who initially ate very little.</p> <p>There were also significant increases in fruit and vegetable consumption at home ($P < 0.05$).</p>	<p>Short length of intervention</p> <p>Maintenance procedures were not fully implemented</p>
<p>Mangunkusumo, 2007 Positive Quality Randomized controlled trial</p>	<p>N = 486 boys and girls (263 in the intervention, 223 in the control; from 30 classrooms (16 intervention, 14 control). Age: 10 yrs Race: N/A Attrition rate: 3.5% Location: The Netherlands</p>	<p><u>Methods:</u> A cluster-randomized controlled trial was conducted to determine whether Internet-tailored advice for schoolchildren and Internet-supported dietary counseling impact fruit and vegetable intake. During school hours, all children completed Internet-administered questionnaires on fruit/vegetable intake and related determinants.</p> <p><u>Theory:</u> Behavioral Change Theory</p> <p><u>Duration/Intensity:</u> The intervention was delivered once, and additional details regarding intensity were not provided.</p> <p><u>Outcome Measures:</u> Children completed a questionnaire at baseline and at 3 mos that included a validated FFQ component.</p> <p><u>Intervention Group:</u> Children in the intervention group received immediate online tailored nutrition feedback, and a nurse also received information via the Internet to support a 5 min counseling protocol to promote fruit/vegetable intake.</p> <p><u>Comparison Group:</u> The control group did not receive any of the intervention components.</p>	<p>There were no significant differences between groups in fruit and vegetable intake following the intervention.</p> <p>Awareness of inadequate fruit intake (OR 3.0; 95% CI 1.8-5.3) and knowledge of recommended vegetable intake levels (OR 2.7; 95% CI 1.8-4.1) were significantly more likely at post-test in the intervention group than in the control group.</p>	<p>Dietary intake was self-reported by the children.</p> <p>The study sample is homogenous with regards to socio-demographic characteristics.</p> <p>Only one outcome measure timepoint was applied (3 mos).</p>

Table 4-A.3. Studies examining the effects of nutrition education delivered to children in kindergarten–grade 5 using digital media and/or technology—continued

Study	Participants	Methods	Outcomes	Strengths and Limitations
<p>Moore, 2009 Neutral Quality Non-randomized controlled trial</p>	<p>N = 126 boys and girls (64 from School 1, and 62 from School 2; 93% African American) Age: 9–11 yrs Attrition rate: 35% participation rate; attrition not reported Location: United States</p>	<p><u>Methods:</u> A quasiexperimental study was conducted to determine the effect of Color My Pyramid on children's nutrition knowledge and nutrition status. The intervention program incorporates an online component www.MyPyramid.gov (the Blast-Off game) <u>Theory:</u> Self-Care Deficit Nursing Theory <u>Duration/Intensity:</u> 6 classes taught over a 3-mo period <u>Outcome Measures:</u> A pre- and post-test was administered to re-evaluate children's nutrition knowledge and self-care practices (content validity and reliability assessed). <u>Intervention Group:</u> School 2 using individual computers to evaluate their diets in small groups. <u>Comparison Group:</u> School 1, the control school, received a more didactic presentation on playing the Blast-Off Game</p>	<p>There was a significant improvement in nutrition self-care practices in both groups ($p < 0.05$), but no difference between the groups.</p>	<p>Study length was 3 mos, so it is unclear what the longer term impacts would have been. Difficult to distinguish the difference in the intervention between School 1 and School 2 Limited generalizability due to small sample size and lack of racial diversity</p>
<p>Pempek, 2009 Neutral Quality Randomized controlled trial</p>	<p>N = 30 African American boys and girls (15 girls, 15 boys) Age: 9 yrs Attrition rate: 0% Location: United States</p>	<p><u>Methods:</u> An RCT was conducted to examine how advergames affect consumption of healthier and less healthy snacks by low-income African American children. Children played an advergame in which they were rewarded for having their computer character consume healthier or less healthy foods and beverages. <u>Theory:</u> None reported <u>Duration/Intensity:</u> This intervention was tested on one occasion. <u>Conditions:</u> Children were randomly assigned to 1 of the following 3 conditions: (1) the healthier advergame condition, (2) the less healthy advergame Children in the treatment conditions played a less healthy or a healthier version of an advergame 2 times before choosing and eating a snack and completing the experimental measures. Children in the control group chose and ate a snack before playing the game and completing the measures.</p>	<p>Children who played the healthier version of the advergame selected and ate significantly more healthy snacks (1.4 ± 0.24 servings) than did those who played the less healthy version (0.20 ± 0.24) ($p = 0.007$), with the control group falling in between (0.90 ± 0.24). Nine children (90%) in the healthy condition chose at least 1 healthy snack, whereas 6 children (60%) in the control group and 1 child (10%) in the less healthy chose at least 1 healthy snack. The healthier and less healthy conditions differed significantly ($p = 0.001$).</p>	<p>Small sample size Long-term effects of advergames on diet were not assessed. The study sample was limited to only African American children, and should be expanded to other ethnicities and age groups.</p>

Table 4-A.3. Studies examining the effects of nutrition education delivered to children in kindergarten–grade 5 using digital media and/or technology—continued

Study	Participants	Methods	Outcomes	Strengths and Limitations
<p>Thompson, 2008 Neutral Quality Randomized controlled trial</p>	<p>N = 73 African American girls (37 in the intervention, and 36 in the control group) Age: 8–10 yrs Attrition rate: 9% Location: United States</p>	<p><u>Methods:</u> An RCT was conducted to determine the efficacy of an Internet-based program on dietary intake and physical activity. Girls were randomized to receive immediate (weekly) or delayed (program end) incentives (\$5). Participants' were given weekly goals to increase the target behaviors, and included focus on role modeling, problem solving, and goal setting/review. <u>Theory:</u> Social Cognitive Theory <u>Duration/Intensity:</u> 8 wks. Subjects were asked to log-on weekly, and weekly log-on rate averaged 74.5%. <u>Outcome Measures:</u> Dietary intake was assessed using a 7-item FFQ (validity not reported) <u>Intervention Group:</u> The Internet-based program emphasized fruit, 100% juice, vegetable (FJV), and water intake, as well as physical activity. <u>Comparison Group:</u> A delayed group was used as the comparison group.</p>	<p>Statistically significant pre-post improvement was observed in FJV consumption, with girls reporting an increase of 1 serving/d at the end of the intervention (p=0.002). A significant increase in FJV self-efficacy was also observed (p=0.003).</p>	<p>The study sample was a small sample of only African American girls, and should be expanded to other ethnicities, genders, and age groups. Dietary intake was self-reported by the children. Did not report separate results for fruit, 100% juice, vegetable</p>
<p>Turnin, 2001 Positive Quality Randomized controlled trial</p>	<p>N = 1,876 boys and girls from 15 schools (53% girls) Age: 9 yrs Race: N/A Attrition rate:16% Location: France</p>	<p><u>Methods:</u> 15 schools were randomized into two groups: games group and control group, both receiving conventional nutritional teaching by their teachers. <u>Theory:</u> None reported <u>Duration/Intensity:</u> The intervention was delivered for one hour, twice a week, for 5 wks. <u>Outcome Measures:</u> At completion of the study, nutrition knowledge and 3-day diet records were evaluated in both groups, however, this data was not assessed at the start of the study (validity not described) <u>Intervention Group:</u> The games group played computer games during the conventional nutritional teaching period. <u>Comparison Group:</u> The control group received conventionally taught nutrition education.</p>	<p>The games group had significantly better dietary intake than the control group: more carb (46.4±0.2% vs. 45.7±0.2%, p<0.05), less fat (37.1±0.1% vs. 37.6±0.2%, p<0.05), less protein (16.5±0.1% vs. 16.7±0.1%, p<0.05), less sugar (11.5±0.1% vs. 12.2±0.2%, p<0.001), more calcium (p<0.001) and more fiber (p<0.05). Nutrition knowledge test results were better in the games group (p<0.001) compared to the control group.</p>	<p>There was no pre-test, only a post-test, limiting the interpretation of the study findings. Long-term effects of advergames on diet were not assessed.</p>

Table 4-A.4. Studies examining the effects of nutrition education delivered to children in grade 6–grade 12 using digital media and/or technology—continued

Study	Participants	Methods	Outcomes	Strengths and Limitations
<p>Baranowski, 2011 Positive Quality Randomized controlled trial</p>	<p>N = 133 boys and girls (44% female) Age: 10–12 yrs Race: 40% White, 24% African American, 28% Hispanic, 8% Other Attrition rate: N/A Location: United States</p>	<p><u>Methods:</u> The intervention tested the effects of computer games on diet <u>Outcome Measures:</u> Food intake was assessed using three, 24-hr diet recalls <u>Theory:</u> Social Cognitive, Self-Determination, Persuasion theories <u>Duration/Intensity:</u> 2 sessions <u>Intervention Group:</u> Played 2 computer games (Diab, Nano) <u>Comparison Group:</u> Played diet and physical activity knowledge-based games on popular websites</p>	<p>Children in the intervention significantly increased servings of fruit and vegetables compared to control (0.67 servings/d; $p < 0.018$)</p>	<p>Self-reported dietary intake Unknown how long the behavior change would be sustained after the end of the program Small sample size Baseline differences between groups may have obscured results Unclear whether the games would be as effective without incentives Mediators and moderators not assessed</p>
<p>Casazza, 2007 Neutral Quality Non-randomized controlled trial</p>	<p>N = 275 boys and girls (66% female, 52% non-Hispanic Black) Age: 16 yrs SES: 51% traditional, 65% computer, and 71% control were eligible for free school lunch Attrition rate: 12% Location: United States</p>	<p><u>Methods:</u> A nonrandomized group trial was conducted to determine which health education delivery method (computer-based or traditional) would elicit a greater behavior change. <u>Theory:</u> None reported <u>Duration/Intensity:</u> Over a period of 16 wks, subjects had 5, 45-min intervention sessions <u>Outcome Measures:</u> Measurements were taken at baseline and 11 wks after baseline. Dietary intake data was collected using two 24-hr recalls and an FFQ (both validated) take 1 wk apart at pre (wks 1-3) and post (wks 13-16). <u>Intervention Groups:</u> A total of three schools participated: Control: No intervention Traditional Education: Received education via lecture and pamphlets Computer-Based Education: Received education via CD-ROM that each student independently navigated</p>	<p>The computer and traditional groups had significant decreases in total energy intake ($p < 0.01$), with no difference between the groups. There were no significant differences between the groups in any other dietary intake measure (fiber, fruits, and vegetables).</p>	<p>Subjects were a convenience sample, which limits generalizability Study duration was limited due to the school schedule</p>

Table 4-A.4. Studies examining the effects of nutrition education delivered to children in grade 6–grade 12 using digital media and/or technology—continued

Study	Participants	Methods	Outcomes	Strengths and Limitations
<p>DeBar, 2009 Positive Quality Randomized controlled trial</p>	<p>N = 209 boys and girls Age: 15 yrs Race: White Attrition rate: 9% Location: United States</p>	<p><u>Methods:</u> The 2-yr intervention consisted of in-person and web components. <u>Outcome Measures:</u> Dietary intake data was measured using 24-hr recalls. <u>Theory:</u> N/A <u>Duration/Intensity:</u> 2 yrs <u>Intervention Group:</u> The 2-yr intervention consisted of in-person and web components. Participants were encouraged to log-on to the study website at least once a week over the 2-yr intervention. <u>Comparison Group:</u> No intervention control</p>	<p>Participants in the intervention group reported significantly greater consumption of calcium in both study years ($p < 0.001$), vitamin D in the first year ($p < 0.02$), and fruits and vegetables (0.74 and 0.79 servings respectively, $p < 0.01$) in both years. There was no effect of the intervention on soda consumption.</p>	<p>Demographics limit the generalizability of the study Intervention may not be easily replication in other health care settings</p>
<p>DeBar, 2006 Neutral Quality Randomized controlled trial</p>	<p>N = 82 boys and girls Age: 15 yrs Race: 80.5% White Attrition rate: N/A Location: United States</p>	<p><u>Methods:</u> The 2-yr intervention consisted of in-person and web components. <u>Outcome Measures:</u> Dietary intake data was measured using 24-hr recalls. <u>Theory:</u> N/A <u>Duration/Intensity:</u> 2 yrs <u>Intervention Group:</u> A 2-yr intervention consisting of in-person and web components. Participants were encouraged to log-on to the study website at least once a week over the 2-yr intervention. <u>Comparison Group:</u> No intervention control</p>	<p>Overall website use was associated with increases in calcium intake ($p < 0.01$). However, use of web pages related to behavioral feedback and communications was not significantly associated with behavioral outcomes.</p>	<p>Study wasn't powered to examine the web components independently Demographics limit the generalizability of the study</p>

Table 4-A.4. Studies examining the effects of nutrition education delivered to children in grade 6–grade 12 using digital media and/or technology—continued

Study	Participants	Methods	Outcomes	Strengths and Limitations
<p>Di Noia, 2008 Positive Quality Randomized controlled trial</p>	<p>N = 507 boys and girls (61% female, 15% Hispanic) Age: 12 yrs Attrition rate: 8% Location: United States</p>	<p><u>Methods:</u> A group randomized controlled trial was done to examine the efficacy of an after-school program intervention based on increasing fruit and vegetable consumption among economically disadvantaged African-American adolescents. <u>Theory:</u> Transtheoretical model <u>Duration/Intensity:</u> Four 30-min sessions <u>Outcome Measures:</u> Fruit and vegetable intake was measured by asking students how many servings per week they consumed, using a validated tool from the 5 a Day Initiative. <u>Intervention Group:</u> Youths participated in a computer-based, CD-ROM-mediated intervention with content related to fruit and vegetable consumption that included a staging measure to classified users into stages of change. <u>Comparison Group:</u> Received regular programs offered at after-school program sites</p>	<p>After adjustment for covariates, youths in the computer intervention arm had higher fruit and vegetable consumption than those in the control arm (3.25±1.5 servings vs. 2.46±1.39 servings, P<0.001), and more youths in the computer intervention arm progressed to later stages and maintained recommended intake levels (P<0.05).</p>	<p>Limited generalizability due to use of a self-selected sample Quasi-experimental design limits internal validity More long-term studies are needed</p>
<p>Frenn, 2003 Neutral Quality Non-randomized controlled trial</p>	<p>N = 130 boys and girls (52% girls) Age: 12–15 yrs SES: 48% were of "lower SES" Location: United States</p>	<p><u>Methods:</u> A quasi-experimental study was conducted to evaluate the effects of a school-based internet/video intervention on diet <u>Theory:</u> Transtheoretical and Health Promotion Models <u>Duration/Intensity:</u> One semester, 6 sessions <u>Outcome Measures:</u> Dietary intake was measured with a validated questionnaire <u>Intervention Group:</u> 4 Internet sessions, 5 videos, 1 healthy snack session, 1 gym class <u>Comparison Group:</u> No intervention control</p>	<p>Girls in the intervention group reduced their fat intake compared to control (P<0.05) There were no differences between the intervention and control groups in boys.</p>	<p>Limited number of subjects Low test-retest of the study instruments used to measure diet</p>

Table 4-A.4. Studies examining the effects of nutrition education delivered to children in grade 6–grade 12 using digital media and/or technology—continued

Study	Participants	Methods	Outcomes	Strengths and Limitations
<p>Haerens, 2006 Positive Quality Randomized controlled trial</p>	<p>N = 2,287 boys and girls (38% girls) Age: 13 yrs SES: 68% were of "lower SES" Attrition rate: 25% at 2 yrs Location: Belgium</p>	<p><u>Methods:</u> A group RCT was conducted to evaluate the effects of a middle-school healthy eating promotion intervention combining environmental changes and computer-tailored feedback, with and without a parental involvement component. <u>Theory:</u> Transtheoretical Model <u>Duration/Intensity:</u> 9 mos, N/A <u>Outcome Measures:</u> Dietary intake was measured with a validated FFQ <u>Intervention Groups:</u> Schools were randomized to one of 3 groups: (1) Intervention group with parental support, (2) Intervention group without parental support, (3) Control group The intervention schools implemented a 9-mo intervention combining environmental changes with computer-tailored feedback. Target behaviors of the intervention were increasing fruit and water intake and reducing soft drink and fat intake. Children in the parental involvement group were also given a CD of the computer program to use at home.</p>	<p>In boys, there were no significant differences in fat intake or percentage of energy from fat as a result of the intervention. In girls, fat intake and percentage of energy from fat decreased significantly in the intervention groups compared to the control group (P<0.05), with no differences between the interventions groups with and without parental involvement. No effects of the intervention were found in boys or girls related to fruit, soft drinks and water consumption.</p>	<p>Self-reported measure of diet Unable to distinguish results of each component of the intervention; in particular it is not possible to draw a conclusion on the efficacy of digital media</p>
<p>Haerens, 2007a Neutral Quality Randomized controlled trial</p>	<p>N = 2,840 boys and girls (37% girls) Age: 13 yrs SES: 68% were of "lower SES" Attrition rate: N/A Location: Belgium</p>	<p><u>Methods:</u> A group RCT was conducted to evaluate the effects of a middle-school healthy eating promotion intervention combining environmental changes and computer-tailored feedback, with and without a parental involvement component. <u>Theory:</u> Transtheoretical Model <u>Duration/Intensity:</u> 9 mos, N/A <u>Outcome Measures:</u> Dietary intake was measured with a validated FFQ <u>Intervention Groups:</u> Schools were randomized to one of 3 groups: (1) Intervention group with parental support; (2) Intervention group without parental support; (3) Control group The intervention schools implemented a 9-mo intervention combining environmental changes with computer-tailored feedback. Target behaviors of the intervention were increasing fruit and water intake and reducing soft drink and fat intake. Children in the parental involvement group were also given a CD of the computer program to use at home.</p>	<p>In girls, fat intake and percentage of energy from fat decreased significantly in the intervention group with parental support compared with the intervention alone group (P<0.05) and the control group (P<0.001), while in boys, there were no significant differences in fat intake or percentage of energy from fat as a result of the intervention. No effects of the intervention were found related to fruit, soft drinks and water consumption.</p>	<p>Self-reported measure of diet Unable to distinguish results of each component of the intervention; in particular it is not possible to draw a conclusion on the efficacy of digital media</p>

Table 4-A.4. Studies examining the effects of nutrition education delivered to children in grade 6–grade 12 using digital media and/or technology—continued

Study	Participants	Methods	Outcomes	Strengths and Limitations
<p>Haerens, 2007b Positive Quality Randomized controlled trial</p>	<p>N = 304 boys and girls (70% female) Age: 13 yrs Race: White Attrition rate: 10% Location: Belgium</p>	<p><u>Methods:</u> A randomized controlled trial done to evaluate the acceptability, feasibility and effectiveness of a computer-tailored dietary fat intake education program for adolescents. <u>Outcome Measures:</u> Dietary intake was assessed using an FFQ <u>Theory:</u> Transtheoretical Model <u>Duration/Intensity:</u> Single 50-min session <u>Intervention Group:</u> Students were exposed once in class to a 50-min theory-based computer-tailored dietary fat intake intervention. <u>Comparison Group:</u> No intervention control</p>	<p>Girls enrolled in technical-vocational schools significantly decreased fat intake ($p < 0.05$), as did boys and girls undertaking general education who reported to have read the intervention messages ($p < 0.05$).</p>	<p>Study was short in duration, and long-term effects are not known Sample demographics may not be generalizable</p>
<p>Long, 2004 Neutral Quality Non-randomized controlled trial</p>	<p>N = 121 boys and girls (52% girls) Age: 13 yrs Attrition rate: 0% Location: United States</p>	<p><u>Methods:</u> A group nonrandomized trial was conducted to test the effects of a classroom and World Wide Web educational intervention on self-efficacy for healthy eating. <u>Theory:</u> None reported <u>Duration/Intensity:</u> See below <u>Outcome Measures:</u> A validated FFQ (YAQ) was used to measure dietary intake <u>Intervention Group:</u> Nutrition education was given using five hours of Web-based instruction and ten hours of classroom curriculum <u>Comparison Group:</u> Nutrition education was embedded in the standard school curriculum during a 1-month period, with exposure ranging from 0–3 hrs</p>	<p>There were no differences between the schools in consumption of fat, fruits, or vegetables.</p>	<p>Small sample from only 2 schools, and is not generalizable The survey used to assess nutrition knowledge had low reliability The intervention was limited to individuals, and did not include changes to the home or school environment</p>

Table 4-A.4. Studies examining the effects of nutrition education delivered to children in grade 6–grade 12 using digital media and/or technology—continued

Study	Participants	Methods	Outcomes	Strengths and Limitations
<p>Thompson, 2009 Positive Quality Randomized controlled trial</p>	<p>N = 473 boys Age: 10–14 yrs Attrition rate: Participation rate was 75%; attrition was not described. Location: United States</p>	<p><u>Methods:</u> A RCT was done to test the effects of a nutrition education intervention on fruit juice and low-fat vegetable intake boys. <u>Theory:</u> Social Cognitive Theory <u>Duration/Intensity:</u> See below <u>Outcome Measures:</u> Fruit juice and low-fat vegetable intake were assessed at baseline, immediately following the intervention, and 6-mos post-intervention using a modified, validated FFQ. <u>Intervention Group:</u> The intervention group participated in a 9-wk program that included approximately 30 min of weekly troop time, plus approximately 25 min of weekly Internet programming. Scouts were encouraged to log-on to the internet site twice weekly to participate in a behavior change program and set goals, as well as to report goal attainment. <u>Comparison Group:</u> The control group participated in a mirror image intervention to increase physical activity</p>	<p>Immediately following the intervention, subjects in the intervention significantly increased consumption of fruit juice (0.94 servings/d) compared to control subjects (0.56 servings/d; $p < 0.003$). However, this difference was not maintained 6 mos later. At 6-mo post-intervention, intervention subjects increased low-fat vegetable intake compared to control (1 serving, $p < 0.05$).</p>	<p>Log-on rates were acceptable, but the approach was labor intensive and costly Limited generalizability of the sample Use of an FFQ to assess diet</p>
<p>Williamson, 2005 Positive Quality Randomized controlled trial</p>	<p>N = 50 African American girls Age: 13 yrs Attrition rate: 12% Location: United States</p>	<p><u>Methods:</u> An RCT was done to compare the efficacy of an interactive Internet-based behavioral weight management program to a passive Internet-based health education program in overweight adolescent girls over a two-year intervention period. <u>Theory:</u> Not reported <u>Duration/Intensity:</u> There were 4 face-to-face sessions over a 12-wk period, and subjects were followed for 6 mos <u>Outcome Measures:</u> Dietary intake was measured using a multiple-pass 24-hr recall and the Block FFQ. <u>Intervention Group:</u> Internet-based intervention that provided nutrition education plus a behavior modification program (including internet counseling) that targeted adolescents and their parents <u>Comparison Group:</u> Internet-based education on healthy nutrition and exercise, but without prescribed behavior changes</p>	<p>Girls in the behavioral intervention also reduced total energy intake ($p < 0.001$), protein ($p < 0.05$), and fat intake ($p < 0.05$), while those in the control group only reduced fat intake ($p < 0.05$).</p>	<p>Self-reported measures of dietary intake Limited generalizability of the small study sample</p>

Table 4-A.4. Studies examining the effects of nutrition education delivered to children in grade 6–grade 12 using digital media and/or technology—continued

Study	Participants	Methods	Outcomes	Strengths and Limitations
<p>Winett, 1999 Neutral Quality Non-randomized controlled trial</p>	<p>N = 180 girls (103 in the intervention group, 77 in the control group) Age: 15–16 yrs Attrition rate: 0% Location: United States</p>	<p><u>Methods:</u> An RCT done to investigate the effects of the Eat4Life Internet-based health behavior program on the nutrition and activity practices of adolescent girls. The Eat4Life modules provide a brief assessment of the subject's nutritional practices, followed by personalized feedback. <u>Theory:</u> Social Cognitive Theory <u>Duration/Intensity:</u> The intervention was a semester long; additional details regarding intensity were not provided <u>Outcome Measures:</u> Food intake was measured using an adaptation of a 24-hr recall and FFQ (the Block). <u>Intervention Group:</u> Used the Eat4Life computer program in their health education classes, and also received a sample of a food recommended in the module. <u>Comparison Group:</u> Used the same curriculum, but did not receive the Eat4Life intervention</p>	<p>Girls using the Eat4Life modules reported that they made relatively consistent changes in all areas of nutrition except for reducing the consumption of high-fat dairy products. The Eat4Life program was effective in increasing consumption of regular meals, fruits and vegetables, and breads/cereals (all $p < 0.001$), and decreasing consumption of regular soft drinks and fast foods ($p < 0.05$).</p>	<p>The use of non-randomized group assignment Different teachers taught different study groups Study was short-term in nature, and long-term effects are unknown Use of self-reported measures Limited generalizability of the study sample</p>

Research Recommendations

1. Conduct research to determine whether subject characteristics, such as age, gender, race/ethnicity, socioeconomic status, or previous technology experience, affect outcomes from nutrition education delivered via digital media/technology.
Rationale: Studies previously done were not designed or adequately powered to determine whether certain types of children are more responsive to nutrition education delivered using digital media/technology.
2. Develop research to assess how engaging a game or tool is for children, whether the degree to which children are engaged impacts outcomes, and aspects of digital media/technology that enhance children's engagement. This may also include research on the degree to which log-on rate impacts outcomes, and strategies for increasing log-on rates.
Rationale: Research is needed to better understand the best approaches to developing digital media/technology educational tools that are engaging to students, and whether investing in more engaging games results in improved outcomes.
3. Extend research to include modes of digital media/technology currently being used to influence children's behavior, such as advergames, hand-held devices, and cellular telephones.
Rationale: The technology currently being used by children is rapidly evolving. Research is needed to better understand how newer and more advanced forms of technology can be used to deliver effective nutrition education.
4. Conduct research in which digital media/technology nutrition education is delivered over longer periods of time, at a greater frequency, or with greater intensity.
Rationale: This will allow for better understanding of the long-term impacts of nutrition education delivered via digital media/technology on children's behavior, as well as body weight and other health outcomes. Longer research may also allow for time within the study framework for ensuring that students have adequate time to become familiar with the technology and are able to use the features as designed.
5. Conduct research to investigate the effects of interventions done using digital media/technology delivered in different settings (school, home) and by different people (teachers, parents, researchers, peers).
Rationale: Research is needed to better understand whether the efficacy of nutrition education delivered via digital media/technology is enhanced when delivered in certain settings or guided by certain individuals.

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Chapter 4-B. The Effects of Nutrition Education with Parental Involvement Compared to No Parental Involvement on Children’s Dietary Intake-Related Behaviors

TECHNICAL ABSTRACT

Background

Many nutrition education programs target not only the child, but also the parents and/or nutritional gatekeepers. The objective of this systematic review was to determine the effects of nutrition education with parental involvement compared to no parental involvement on children’s dietary intake-related behaviors.

Conclusion Statement

Limited and inconsistent evidence is available to assess the effects of involving parents in nutrition education on children’s (ages 9 and older) dietary intake-related behaviors. Some evidence suggests that involving parents in a nutrition education intervention improves outcomes, while other evidence finds no added benefit of including parents. In children less than 9 years of age, there is no evidence to assess the effects of nutrition education with parental involvement on dietary intake-related behaviors (Grade: Limited).

Methods

Literature searches were conducted using PubMed, EBSCOhost, Education Fulltext, and Global Health to identify studies that compared nutrition education with and without parental involvement.

- Inclusion criteria: published between January 1995 and December 2010; conducted in subjects aged 0–18 years; randomized controlled trials, nonrandomized controlled trials, or quasi-experimental studies; subjects from countries with high or very high human development (based on the Human Development Index); subjects who were healthy or at elevated chronic disease risk; published in English in a peer-reviewed journal
- Exclusion criteria: systematic reviews, meta-analyses, narrative reviews, or prospective cohort, cross-sectional, or case-control designs; studies with no control group; subjects hospitalized, diagnosed with disease, and/or receiving medical treatment

The results of each included study were summarized in evidence worksheets (including a study quality rating), an evidence paragraph, and evidence table. A group of subject matter experts were involved in a qualitative synthesis of the body of evidence, development of a conclusion statement, and assessment of the strength of the evidence (grade) using pre-established criteria including evaluation of the quality, quantity, consistency, magnitude of effect, and generalizability of available evidence.

Findings

- Ten randomized controlled studies were included in this systematic review. Seven RCTs received a positive quality rating, and three received of neutral quality rating.
- All 10 studies were done in subjects age 9 to 18 years, with no studies identified in children less than 9 years. Younger children may respond differently to parental involvement than older children, but it is not possible to assess the impact of age due to the lack of research in younger children.
- Three out of the ten studies found that girls demonstrated greater improvements in dietary intake compared to

boys.

- Studies that found nutrition education with parental involvement was more effective for changing children's dietary intake were conducted outside of the United States, while the studies conducted in the United States found that including parental involvement in nutrition education did not improve outcomes.
- The studies used a variety of strategies to involve parents (e.g., direct, indirect, or a combination of direct and indirect methods), though none directly examined which method of parental involvement was most effective.
- Two of the studies reviewed directly examined the dose or level of parental involvement in relation to outcomes. One found that children with the highest dose of parental involvement improved dietary intake the most, while the other found no significant effects on dietary behaviors related to dose of adult participation.

Discussion

The ability to draw strong conclusions as to the effect of parental involvement in nutrition education on children's dietary intake is limited by the small number of relevant studies and the large degree of variation in intervention design and study characteristics. Specifically, research is needed to determine the effects of parental involvement among younger children, especially those younger than age 9 years. Furthermore, because several studies found greater improvements in dietary intake among girls compared to boys, there is some suggestion that girls may be more affected by parental involvement than boys. Finally, the method and dose of parental involvement may impact the degree to which children's dietary intake changes following nutrition education. However, the limited number of studies and inconsistency in study designs used limits the conclusions that can be drawn.

PLAIN LANGUAGE SUMMARY

The effects of including parents in nutrition education on what children eat

Many nutrition education programs target not only the child, but also the parents and others involved in buying and preparing a family's food. This summary of a NEL review presents what we know from research about the effects of nutrition education with and without involving parents on what children eat.

Conclusion

Limited and inconsistent evidence is available to assess the effects of involving parents in nutrition education on children's (ages 9 and older) dietary intake-related behaviors. Some evidence suggests that involving parents in a nutrition education intervention improves outcomes, while other evidence finds no added benefit of including parents. In children less than 9 years of age, there is no evidence to assess the effects of nutrition education with parental involvement on dietary intake-related behaviors

What the Research Says

- The results of the 10 studies in this review were mixed.
- All studies looked at children age 9 to 18 years. There were no studies done in children under 9 years of age, so more research is needed in this age group.
- Three studies found that girls' diets improved more than boys when parents were involved in nutrition education.
- Two studies looked at how much time parents were involved. One study found that the more time parents were involved, the more children improved their diets. The other study found that the amount of time did not matter.
- Results differed depending on where the study was done. U.S. studies found that involving parents in nutrition education did not improve children's diets. Non-U.S. studies found that children ate better when parents were involved in nutrition education.
- It is difficult to make stronger conclusions, because the results were mixed, and the studies were so different.

The studies involved parents in different ways, but none looked at which method was best. More research is needed in this area.

EVIDENCE PORTFOLIO

Conclusion Statement

Limited and inconsistent evidence is available to assess the effects of involving parents in nutrition education on children's (ages 9 and older) dietary intake-related behaviors. Some evidence suggests that involving parents in a nutrition education intervention improves outcomes, while other evidence finds no added benefit of including parents. In children less than 9 years of age, there is no evidence to assess the effects of nutrition education with parental involvement on dietary intake-related behaviors.

Grade

III – Limited

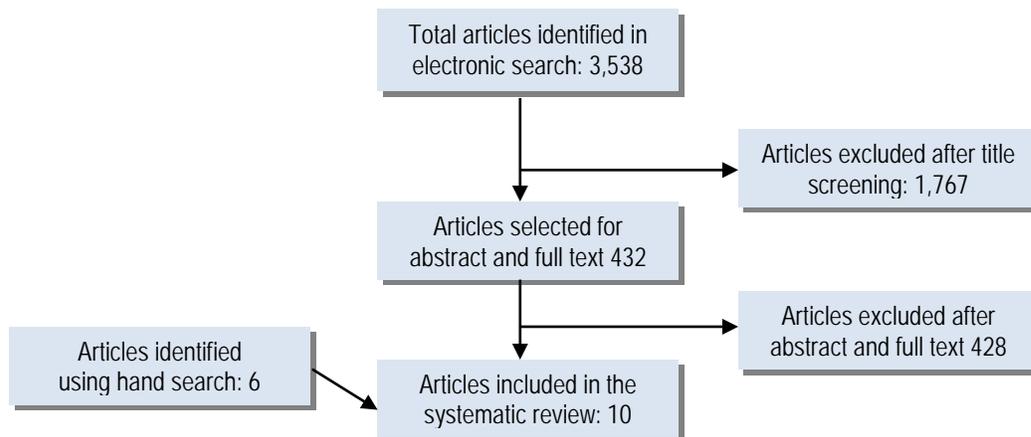
Evidence Summary Overview

Overall, the ability to draw strong conclusions as to the effect of parental involvement in nutrition education children's dietary intake is limited by the small number of relevant studies and large degree of variation in intervention design and study characteristics. Specifically, research is needed to determine the effects of parental involvement among younger children, especially those younger than age 9 years. Furthermore, because several studies found greater improvements in dietary intake among girls compared to boys, there is some suggestion that girls may be more affected by parental involvement than boys. Finally, the method and dose of parental involvement may impact the degree to which children's dietary intake changes following nutrition education. However, the limited number of studies and inconsistency in study designs used limits the conclusions that can be drawn.

Description of the Evidence

The literature search for studies that tested the effects of nutrition education delivered to children and adolescents with parental involvement compared to no parental involvement identified 3,538 articles, 432 of which were selected for review (Fig. 4-B.1). Of these 432 articles, 4 were selected for inclusion in the systematic review. In addition, 6 articles were identified via hand search. Therefore, this systematic review includes a total of 10 articles. A detailed description of literature search results, including the databases searched and the number of articles identified using each database, articles identified using hand search, a list of citations for all included articles, and a table that lists excluded studies with rationale for exclusion can be found in Appendix E.

Figure 4-B.1. Flow chart of literature search results for studies examining the effects of nutrition education delivered to children and adolescents with parental involvement compared to no parental involvement



All 10 studies included in this review were randomized controlled trials. [Beech et al, 2003 (Positive Quality); De Bourdeaudhuij et al., 2002 (Positive Quality); Haerens et al., 2006 (Positive Quality); Haerens et al., 2007a (Neutral Quality); Hopper et al., 1996 (Neutral Quality); Kitzman-Ulrich et al., 2009 (Neutral Quality); Luepker et al., 1996 (Positive Quality); Nader et al., 1996 (Positive Quality); Vandongen et al., 1995 (Positive Quality); Wind et al., 2008 (Positive Quality)]. Seven studies received a positive quality rating, and three received of neutral quality rating. Five studies took place in the United States, three studies took place in Belgium, one study was done in Australia, and one study was done in Europe (Norway, Spain, The Netherlands). Sample sizes varied from 42 to 4,019 study participants (2 studies had <100 subjects, 4 studies had 100–500 subjects, 1 study had 500 to 1,000 subjects, and 3 studies had >2,000 subjects). The ages of subjects ranged from 9 years to 18 years (three studies in 9-year-olds, one study in 10- to 12-year-olds, one study in 11-year-olds, one study in 12-year-olds, three studies in 13-year-olds, and one study in 15- to 18-year-olds), with no studies identified in children less than 9 years. One study (Beech et al., 1996) included 100 percent African American females. The other nine studies included both boys and girls.

A variety of intervention designs were used to test the influence of parent involvement in nutrition education on children’s dietary behaviors. One study compared a child-only intervention to a parent-only intervention (Beech, 1996). One study tested various combinations of fitness education, school nutrition education, and home nutrition education (Vandongen, 1995). Six studies compared a child-only intervention to a parent-child intervention (De Bourdeaudhuij, 2002; Haerens, 2006; Haerens, 2007a; Hopper, 1996; Kitzman-Ulrich, 2009; Luepker, 1996). Two studies conducted a post-hoc analysis to assess outcomes in relation to the level of parental participation that occurred (Nader, 1996; Wind, 2008).

On the whole, these studies varied widely in design and methodology, and it is possible that a number of factors that varied between the studies could have influenced the impact the role parental involvement had in the dietary intake of children. Some of these factors identified from these studies are discussed in further detail below.

Subject Characteristics

Age

The ages of subjects in the studies reviewed ranged from 9 years to 18 years, with no studies identified in children less than 9 years. In addition, 9 out of the 10 studies reviewed included children from 9–13 years of age, and only one study included older adolescents (15–18 years of age). It is possible that younger children, due to developmental factors, may respond differently to parental involvement than pre-adolescents or adolescents. However, because studies were not available in younger children, it is not possible to assess the impact of age on the effects of including parents in a nutrition education intervention. In addition, research was not available to fully investigate whether differences also exist between pre-adolescents and older adolescents. Further, none of the studies reviewed conducted secondary analyses to investigate whether age influenced outcomes. Therefore, more research is needed to assess the effects of parental involvement in nutrition education on dietary intake in children across the developmental spectrum, particularly among those less than 9 years of age, as well as in older adolescents.

Gender

Several of the studies reviewed report differential effects on dietary intake for girls and boys. Haerens et al. (2006) and Haerens et al. (2007a) found that while neither girls nor boys in the intervention groups improved intakes of fruit, soft drinks, or water, girls significantly decreased fat intake, while boys did not. In Vandongen et al. (1995), girls in the two groups that included a home component reduced fat intake and increased fiber intake, while boys in one of the groups that included a home component reduced sugar intake. Therefore, three out of the ten studies reviewed demonstrated differential effects in outcomes between girls and boys, and in all three cases, girls demonstrated greater improvements in dietary intake compared to boys. However, these studies were not designed to specifically address the effects of gender and parental involvement, and additional research is needed to explore the role of gender in more depth.

Country

The studies reviewed were conducted in several different countries, including the United States (5), Belgium (3), three countries of Europe (1), and Australia (1). All of the studies that found that nutrition education with parental involvement was more effective for changing children's dietary intake were conducted outside of the United States, while all of the studies conducted in the United States found that including parental involvement in nutrition education did not improve outcomes. Therefore, it appears that there may be some aspects of cultures outside of the United States that contribute to improved dietary intake when parents are involved in nutrition education. However, it is not possible to draw further conclusions from this body of literature, and more research is needed to better understand the effects of cultural differences.

Method of Parental Involvement

A variety of different strategies were used to involve parents. Some studies used more direct methods, such as face-to-face nutrition education sessions or meetings (Beech, 1996; Kitzman-Ulrich, 2009), others used indirect methods, such as newsletters or other educational materials sent home (De Bourdeaudhuij, 2002; Hopper, 1996; Vandongen, 1995; Wind, 2008). Several used a combination of direct and indirect methods (Haerens et al., 2006; Haerens, 2007a; Luepker, 1996; Nader, 1996). Of the two studies using direct methods to involve parents in the intervention, one (Beech et al., 1996) reported a positive, but non-significant trend for fewer sweetened beverages consumed by the parent-targeted group compared to the child-alone targeted group, while the other reported no effects (Kitzman-Ulrich et al., 2009). Among the four studies that used both direct and indirect methods to engage parents in intervention activities, three of the studies (Haerens et al., 2006; Haerens et al., 2007a; Luepker, 1996) reported some improvement in dietary intake with parental involvement. Of the three studies that used indirect methods to engage parents, two reported some improved outcomes with a parental component (Vandongen et al., 1995; Wind, 2008) and two reported no effects of parental involvement on children's dietary intake (De Bourdeaudhuij et al., 2002; Hopper et al., 1996). Methods of parental involvement were not thoroughly examined in this body of literature. More research is needed to determine whether using direct methods, or a combination of direct and indirect methods of involving parents in a nutrition education intervention, may be more effective for improving children's outcomes.

Dose of Parental Involvement

In addition to the methods of parental involvement used, the dose, or amount of time parents were involved, may also impact study outcomes. Two of the studies reviewed directly examined the dose of parental involvement in relation to outcomes (Nader et al., 1996; Wind et al., 2008). Both studies conducted secondary analyses of data collected as part of a nutrition education intervention that included parental involvement. The studies determined parents' level of involvement, and conducted dose response analyses to determine whether increasing the "dose" of parental involvement was associated with improved outcomes among children in the study. Nader et al. (1996) found no significant effects on dietary behaviors related to dose of adult participation. However, Wind et al. (2008) found that children with the highest dose of parental involvement showed the highest increases in vegetable intake compared with children whose parents had lower levels of participation. Because the available evidence reviewed is conflicting, there is a need for additional research to investigate whether dose, or level of parental participation as part of a nutrition education intervention, leads to greater improvements in children's dietary intake, and if so, what dosage is optimal.

Table 4-B.1. Summary of outcomes and type of parental involvement tested from studies examining the effects of nutrition education delivered with and without parental involvement

Study	Outcomes	Type of Parental Involvement
Beech et al., 1996	<p>Ø There was a NS trend for children in the parent-targeted group to consume fewer sweetened beverages than the child-targeted group (-0.64 servings/d; p=0.09) and a trend toward reduced BMI.</p> <p>(+) Children in the parent-targeted active intervention group significantly reduced intake of sweetened beverages compared to the control group (p<0.001).</p>	<p>Child-targeted intervention (girls only) vs. parent-targeted intervention (parents only) vs. a control group (no intervention)</p> <p>Both interventions consisted of 90 min/wk educational sessions for 12 wks (direct parental involvement)</p>
De Bourdeaudhuij et al., 2002	<p>Ø No significant differences between the three intervention groups in fat intake.</p> <p>Subjects with baseline fat intake above recommended levels significantly decreased fat intake post-intervention; however, there were no differences between the groups.</p>	<p>Family-based (child + parent) vs. parent (parent alone) vs. child (child alone)</p> <p>Intervention consisted of tailored nutrition education letters mailed home for 4 wks (indirect parental involvement)</p>
Haerens, 2006	<p>Ø Boys and Girls: intervention groups compared to control → no differences in fruit, soft drinks and water consumption.</p> <p>(+) Girls: Interventions with and without parental support compared to control → decreased fat intake (g and % energy) (p<0.05)</p> <p>Ø Boys: intervention groups compared to control → no differences in fat intake</p>	<p>Computer-based intervention with parental support vs. computer-based without parental support vs. no intervention.</p> <p>Results of a 2-yr school-based program, combined with environmental changes and computer-tailored feedback were reported.</p> <p>Parental involvement consisted of in-person meetings, provision of a computer CD on reducing fat intake, and educational materials and newsletters sent home (direct and indirect parental involvement)</p>
Haerens, 2007a	<p>Ø Boys and Girls: intervention groups compared to control → no differences in fruit, soft drinks and water consumption.</p> <p>(+) Girls: Intervention with parental support compared to intervention alone and control → decreased fat intake (g and % energy) (p<0.05)</p> <p>Ø Boys: intervention groups compared to control → no differences in fat intake</p>	<p>Computer-based intervention with parental support vs. computer-based without parental support vs. no intervention.</p> <p>Results of a 1-yr school-based program, combined with environmental changes and computer-tailored feedback were reported.</p> <p>Parental involvement consisted of in-person meetings, provision of a computer CD on reducing fat intake, and education materials and newsletters sent home (direct and indirect parental involvement).</p>
Hopper et al., 1996	<p>Ø No significant differences between the school-home and school-only groups in fat intake following the intervention.</p> <p>Both the school-home and school-only groups decreased fat intake compared to control (p<0.05).</p>	<p>School-home intervention vs. school-only intervention vs. control</p> <p>School intervention: 2.5 hr nutrition education sessions per week for 6 weeks.</p> <p>The school-home intervention combined the school-based nutrition education with a parent/home education component. The parent/home education component included weekly packets sent home (indirect parental involvement).</p> <p>The control group received the usual school nutrition education.</p>
Kitzman-Ulrich et al., 2009	<p>(-) Psychoeducation-only group demonstrated a greater decrease in energy intake compared to the multifamily therapy plus psychoeducation and control groups (p<0.01).</p>	<p>Multi-family therapy + psycho-education vs. psycho-education-only vs. control (no intervention)</p> <p>The psycho-education intervention consisted of a 16-wk educational curriculum with behavioral-skill building and psychosocial components (direct parental involvement).</p> <p>Multi-family therapy intervention consisted of a 45-min group session.</p>
Luepker et al., 1996	<p>Ø No significant differences between the intervention groups in any dietary behaviors following the intervention.</p> <p>(+) Both intervention groups significantly decreased total fat, saturated fat, MUFA, PUFA, and cholesterol compared to control (p<0.01). There was a trend for decreased sodium and increased protein and carbohydrate intake in the intervention groups compared to control (p<0.09).</p>	<p>School-family vs. school-only vs. control</p> <p>The CATCH intervention included modifications to the school food environment, physical education, and nutrition education curriculum.</p> <p>The home curriculum included packets sent home and a family activity night (direct and indirect parental involvement).</p> <p>The control group received the usual health curricula, physical education, and food service programs.</p>

Table 4-B.1. Summary of outcomes and type of parental involvement tested from studies examining the effects of nutrition education delivered with and without parental involvement

Study	Outcomes	Type of Parental Involvement
Nader et al., 1996	∅ No significant effect in dietary behaviors due to dose of adult participation.	Secondary analysis of data from the CATCH study to conduct a dose analysis of the family component for effects of level of adult participation on outcomes. See description of CATCH above (direct and indirect parental involvement)
Vandongen et al., 1995	(+) Comparisons were only made relative to control, and not between intervention groups. (+) Girls: fat intake decreased significantly in the two home nutrition groups and fiber intake increased in the school-home nutrition and fitness groups. (+) Boys in the fitness, fitness-school nutrition, and school-home nutrition group reduced sugar intake.	Fitness-only vs. fitness-school nutrition vs. school nutrition-only vs. school nutrition-home nutrition vs. home nutrition-only vs. control School Nutrition: classroom-based nutrition education Home Nutrition (indirect parental involvement): Educational materials sent home for use by the parent and child Control: No intervention
Wind et al., 2008	(+)/∅ Children with the highest parental involvement showed the highest increase in frequency of vegetable intake compared with children who had medium or low parental involvement (p<0.05). ∅ No significant associations were found between parental involvement and changes in frequency of fruit intake.	Intervention: School nutrition education targeting increased fruit and vegetable intake. Parental involvement via newsletters (indirect involvement), a computer-tailored tool (direct involvement), and changes to the school food service environment. Modifiable by participating European countries. Analyses were conducted to determine the effects of parental involvement (whether or not parents participated in intervention components at home) on fruit and vegetable intake.
(+): indicates a positive association (-): indicates an inverse association ∅: indicates a non-significant difference		

Evidence Summary Paragraphs

Beech et al., 2003 (Positive Quality) conducted a randomized controlled trial in the United States to assess the effects of a culturally tailored, family-based intervention to prevent excess weight gain in African-American girls. The girls were randomly assigned to one of three intervention groups: (1) a child-targeted intervention, (2) a parent-targeted intervention, and (3) a control group. Both interventions were 12 weeks long, and consisted of 90 minutes/week education sessions. The final sample included 60 girls (mean age=9 yrs). There was a non-significant trend for the parent-targeted group to consume fewer sweetened beverages than the child-targeted group (-0.64 servings/day; $p=0.09$). The parent-targeted intervention group significantly reduced intake of sweetened beverages compared to the control group ($p<0.001$).

De Bourdeaudhuij et al., 2002 (Positive Quality) conducted a randomized controlled study in Belgium to investigate the effects of a tailored nutrition education program. Children were randomly assigned to one of three intervention groups: (1) family-based (child + parent), (2) parent (parent alone), and (3) child (child alone). The intervention consisted of tailored nutrition education letters mailed home. The final sample included 134 subjects (15–18 yrs). There were no significant differences between the intervention groups in fat intake following the intervention. Subjects with baseline fat intake above recommended levels significantly decreased ($p<0.001$) fat intake post-intervention; however, there were no differences between the groups.

Haerens et al. 2006 (Positive Quality) and Haerens et al. 2007a (Neutral Quality) reported results from a group randomized controlled study in Belgium to evaluate the effects of a middle school physical activity and healthy eating intervention. Young adults were randomly assigned to one of three conditions: (1) intervention with parental involvement, (2) intervention alone, and (3) control. The intervention consisted of a 2-year school-based program combining environmental changes with computer-tailored feedback to promote healthy food and physical activity. The parental component involved school meetings, newsletters, and a computer CD sent home. **Haerens et al. (2007a)** reported results at the one-year time point from a final sample of 2,840 subjects (13 yrs; 37 percent female). Girls in the intervention group with parental support decreased fat and percent energy from fat significantly more than the intervention group without parental support ($p<0.05$) and control ($p<0.001$). For boys, there were no significant differences in fat intake between any of the groups. Also, in both girls and boys, there were no significant differences between any of the groups for fruit, soft drink, or water intake. **Haerens et al. (2006)** reported results at the 2-year time point from a final sample of 2,287 subjects (13 yrs; 38 percent female). In both girls and boys, there were no significant differences between the intervention groups in any dietary behaviors following the intervention. The girls in both intervention groups significantly decreased fat intake and % energy from fat compared to control ($p<0.05$). For boys, there were no significant differences between the intervention groups and the control group in any dietary behaviors following the intervention.

Hopper et al., 1996 (Neutral Quality) conducted a randomized control trial in the United States to examine the efficacy of school-based exercise and nutrition programs. In this study, subjects from 5th and 6th grade classrooms were randomly assigned to three different treatments conditions: (1) school-home intervention, (2) school-only intervention, and (3) control. The school intervention consisted of an enhanced classroom-based nutrition education program, while the school-home intervention combined the school-based nutrition education with a parent/home education component. The control group received the usual school nutrition education. The final sample included 132 subjects (12 yrs). There were no significant differences between the school-home and school-only groups in fat intake following the intervention. Both the school-home and school-only groups decreased fat intake compared to control ($p<0.05$).

Kitzman-Ulrich et al., 2009 (Neutral Quality) conducted a randomized control study in the United States to determine the effects of nutrition education delivered via multi-family therapy and/or psycho-education. Teenage girls were randomly assigned to one of three groups: (1) multi-family therapy + psycho-education, (2) psycho-education-only, or (3) control. The psycho-education intervention consisted of a 16-week educational curriculum with behavioral-skill-building and psychosocial components. The multi-family therapy intervention consisted of a 45-minute group session. The final sample included 42 girls (13 yrs). The psychoeducation-only group demonstrated

a greater decrease in energy intake compared to both the multifamily therapy plus psychoeducation and control groups ($p < 0.01$).

Luepker et al., 1996 (Positive Quality) conducted a randomized controlled multi-state study (CATCH) to assess the outcomes of health behavior interventions, focusing on the school environment, classroom curricula, and home programs, for the primary prevention of cardiovascular disease. Children were randomly assigned to one of three groups: (1) school-family, (2) school-only, or (3) control. The CATCH intervention consisted of modifications to the school food environment, physical education interventions, and nutrition education curriculum. The parent component included educational materials that complemented classroom education materials. The control group received usual health curricula, physical education, and food service programs. The final sample included 4,019 subjects (9 yrs; 32 percent female). No significant differences in any of the measured dietary behaviors were found between the intervention groups following the intervention. The intervention groups significantly decreased total fat, saturated fat, MUFA, PUFA, and cholesterol compared to the control group ($p < 0.01$). There was a trend for decreased sodium and increased protein and carbohydrate intake in the intervention groups compared to the control group ($p < 0.09$).

Nader et al., 1996 (Positive Quality) conducted a secondary analysis of data from a randomized controlled multi-state study (CATCH) to assess the effect of the level of adult participation on outcomes (see Luepker et al. for study details). This secondary analysis included a dose analysis of the family component to assess the effects of level of adult participation on outcomes. Adult participation was determined by the number of activity packets that adult household members completed with the child. The final sample included 336 children (9 yrs). There were no significant differences in measured dietary behaviors by dose of adult participation.

Vandongen et al., 1995 (Positive Quality) conducted a randomized controlled trial in Australia to test the effects of nutrition and fitness programs. Youths were randomized to one of six groups: (1) fitness-only, (2) fitness-school nutrition, (3) school nutrition-only, (4) school nutrition-home nutrition, (5) home nutrition-only, or (6) control. The fitness intervention included classroom-based physical education, the school nutrition intervention included classroom-based nutrition education, the home nutrition intervention included educational materials sent home for use by the parent-child, and the control group received no intervention. The final sample included 423 subjects (10-12 yrs). Comparisons were only made relative to control, and not between intervention groups. In girls, fat intake decreased significantly ($p < 0.05$) in the two home nutrition groups and fiber intake increased ($p < 0.05$) in the school-home nutrition and fitness groups. Boys in the fitness, fitness-school nutrition, and school-home nutrition group reduced sugar intake ($p < 0.05$).

Wind et al., 2008 (Positive Quality) conducted a randomized controlled trial in Europe (Norway, Spain, The Netherlands) to test the effects of a school-based intervention on children's fruit and vegetable intake. The intervention consisted of school nutrition education, parental involvement via newsletters, a computer-tailored tool, and changes to the school food service environment. Analyses were conducted to determine the effects of parental involvement (whether or not parents participated in intervention components at home) on fruit and vegetable intake. The final sample included 868 subjects (11 yrs; 55 percent female). Children with the highest parental involvement showed higher increases in frequency of vegetable intake compared with children who had medium or low parental involvement ($p < 0.05$). No significant associations were found between parental involvement and changes in frequency of fruit intake.

Overview Table

Table 4-B.2. Studies examining the effects of nutrition education delivered with and without parental involvement

Study	Participants	Methods	Outcomes	Limitations
Beech et al., 1996	N = 60 girls Mean age=9 yrs Race: African American Location: United States	Child-targeted intervention (girls only) vs. Parent-targeted intervention (parents only) vs. A comparison group Both interventions consisted of 90 min/wk educational sessions for 12 wks. Dietary intake was assessed using dietary recall.	There was a NS trend for the parent-targeted group to consume fewer sweetened beverages than the child-targeted group (-0.64 servings/d; p=0.09). The parent-targeted intervention group significantly reduced intake of sweetened beverages compared to the control group (p<0.001).	Fewer meetings for the comparison group versus the active arms (3 vs. 12) Limited generalizability due to small sample size and lack of racial and gender diversity
De Bourdeaudhuij et al., 2002	N = 134 males and females Mean age=15-18 yrs Race: White Location: Belgium	Family-based (child + parent) vs. Parent (parent alone) vs. Child (child alone) The intervention consisted of tailored nutrition education letters mailed home 6 weeks after completion of a FFQ at baseline. Post-test questionnaires collected after 4 weeks Dietary intake was assessed using a FFQ.	No significant differences between the intervention groups in fat intake following the intervention. Subjects with baseline fat intake above recommended levels significantly decreased fat intake post-intervention; however, there were no differences between the groups.	Selection bias due to self-selected recruitment, oversampling of mothers with lower fat intake may not be representative of the general populations, long-term effects not examined, the amount of family participation was not measured or controlled directly Limited generalizability due to lack of racial diversity
Haerens et al., 2006	N = 2,287 males and females (38% female) Mean age=13 yrs Race: White Location: Belgium	Intervention with parental involvement vs. Intervention alone vs. Control The intervention consisted of a 2-yr school-based program combining environmental changes with computer-tailored feedback to promote healthy food and physical activity. The parental involvement component consisted of in-person meetings, provision of a computer CD on reducing fat intake, and educational materials and newsletters sent home. Dietary intake was assessed using an FFQ.	Girls and Boys: No significant differences between the intervention groups in any dietary behaviors following the intervention. Girls in both intervention groups significantly decreased fat and % energy from fat compared to control (p<0.05). For boys, there were no significant differences between the intervention groups and the control group in any dietary behaviors following the intervention.	Lack of process evaluation data on levels of parental involvement makes it hard to draw conclusions High percentage of dropouts (25%) Self-reported character of measurements of dietary intake and physical activity. Limited generalizability due to lack of racial diversity
Haerens et al., 2007a	N = 2,840 males and females (37% female) Mean age=13 yrs Race: White Location: Belgium	Intervention with parental involvement vs. Intervention alone vs. Control The intervention consisted of a 1-yr school-based program combining environmental changes with computer-tailored feedback to promote healthy food and physical activity. The parental involvement component consisted of in-person meetings, provision of a computer CD on reducing fat intake, and educational materials and newsletters sent home. Dietary intake was assessed using an FFQ.	Girls: Intervention group with parental support decreased fat/% energy from fat significantly more than the intervention group without parental support (p<0.05) and control (p<0.001). Boys: No significant differences between any of the groups. Girls and Boys: No significant differences between any of the groups for fruit, soft drink, or water intake.	The self-reported character of the measurements. Self-reported measures used to assess dietary intakes of adolescents tend to result in reporting errors and limited data are available to understand the reporting bias in this age group. Limited generalizability due to lack of racial diversity
Hopper et al., 1996	N = 132 males and females Mean age=12 yrs Race: N/A Location: United States	School-home intervention vs. School-only intervention vs. Control The school intervention consisted of classroom-based nutrition education, while the school-home intervention combined the school-based nutrition education with a parent/home education component. The parent/home education component included educational materials sent home. The control group received the usual school nutrition education. Dietary intake was assessed using 24-hr dietary recall.	No significant differences between the school-home and school-only groups in fat intake following the intervention. Both the school-home and school-only groups decreased fat intake compared to control (p<0.05).	The measurement tools may not have been sensitive enough to detect differences. Intervention was done at the classroom level, and it was not possible to control for classroom-to-classroom differences in intervention delivery. Small sample size

Table 4-B.2. Studies examining the effects of nutrition education delivered with and without parental involvement—continued

Study	Participants	Methods	Outcomes	Limitations
Kitzman-Ulrich et al., 2009	N = 42 females Mean age=13 yrs Race: 55% White Location: United States	Multi-family therapy + psycho-education vs. Psycho-education-only vs. Control The psycho-education intervention consisted of a 16-wk educational curriculum with behavioral-skill building and psychosocial components. The multi-family therapy intervention consisted of a 45-min group session. Dietary intake was assessed using 24-hr dietary recall.	Psychoeducation-only group demonstrated a greater decrease in energy intake compared to the multifamily therapy plus psychoeducation and control groups (P<0.01).	Low attendance (<50%) may have reduced the impact of the intervention. The intervention was relatively short, and long-term effects are not known. Limited generalizability due to lack of gender diversity The accuracy of the 24-hr dietary recall methods may not have captured changes in this small sample.
Luepker et al., 1996	N = 4,019 boys and girls (32% female) Mean age=9 yrs Race: 69% White Location: United States	School-family vs. School-only vs. Control The CATCH intervention consisted of modifications to the school food environment, physical education interventions, and nutrition education curriculum. The home curriculum included packets sent home and a family activity night. The control group received usual health curricula, physical education, and food service programs. Dietary intake was assessed using 24-hr dietary recall	No significant differences between the intervention groups in any dietary behaviors following the intervention. The intervention groups significantly decrease total fat, saturated fat, MUFA, PUFA, and cholesterol compared to control (p<0.01). There was a trend for decreased sodium and increased protein and carbohydrate intake in the intervention groups compared to control (p<0.09).	Participation and attrition rates were relatively high. The amount of intervention that was feasible in public elementary schools was limited due to costs, staff time, and competing classroom instructional requirements.
Nader et al., 1996	N = 336 males and females Mean age=9 yrs Race: N/A Location: United States	Secondary analysis of data from the CATCH intervention to conduct a dose analysis of the family component to assess the effects of level of adult participation on outcomes. The CATCH intervention consisted of modifications to the school food environment, physical education interventions, and nutrition education curriculum. The home curriculum included packets sent home and a family activity night. Parental participation was assessed as number of completed activity packets. Dietary intake was assessed using 24-hr dietary recall.	No significant differences in measured dietary behaviors by dose of adult participation.	Validity of self-reported measures Limited ability to analyze family characteristics that may explain the variance in adult participation, as well as adult-child interaction
Vandongen et al., 1995	N = 423 males and females Mean age=10-12 yrs Race: N/A Location: Australia	Fitness-only vs. Fitness-School Nutrition vs. School Nutrition-only vs. School Nutrition-Home Nutrition vs. Home Nutrition-only vs. Control School Nutrition: classroom-based nutrition education Home Nutrition: Educational materials sent home for use by the parent-child Control: No intervention Dietary intake was assessed using food records.	Comparisons were only made relative to control, and not between intervention groups. Girls: fat intake decreased significantly in the two home nutrition groups and fiber intake increased in the school-home nutrition and fitness groups. Boys in the fitness, fitness-school nutrition, and school-home nutrition group reduced sugar intake.	
Wind et al., 2008	N = 868 boys and girls (55% female) Mean age=11 yrs Race: N/A Location: Europe	The intervention consisted of school nutrition education, parental involvement via newsletters, a computer-tailored tool, and changes to the school food service environment. Analyses were conducted to determine the effects of parental involvement (whether or not parents participated in intervention components at home) on fruit and vegetable intake. Dietary intake was assessed using a validated questionnaire.	Children with the highest parental involvement showed the highest increase in frequency of vegetable intake compared with children or had medium or low parental involvement (p<0.05). No significant associations were found between parental involvement and changes in frequency of fruit intake.	Self-report dietary intake measures Lack of ability to state causality Validity/reliability of the assessment of the intervention characteristics weren't tested

Research Recommendations

1. Studies need to be conducted where the effects of method (direct/indirect) and dose of family or parental involvement are investigated.

Rationale: Based on this review it is unclear whether the way in which parents are involved in the intervention affects outcomes. Therefore, more research is needed to better understand the most effective methods for involving parents, and what dose, or level of parent participation, results in the best outcomes.

2. Conduct research to determine whether subject characteristics such as age and gender, race/ethnicity, and socioeconomic status affect outcomes from nutrition education delivered with a parental component.

Rationale: The ages of subjects in the studies reviewed ranged from 9 years to 18 years (9 out of 10 studies were in 9–13 year olds), with no studies identified in children less than 9 years. It is possible that younger children may respond differently to parental involvement than older children. Therefore, more research is needed to assess the effects of nutrition education with parental involvement on dietary intake in children less than 9 years of age, as well as in older adolescents (>13 years of age). Further, several of the studies reviewed report differential effects on dietary intake for girls and boys. However, these studies were not designed to specifically address the effects of gender and parental involvement, and additional research is needed to explore the role of gender in more depth. Finally, few studies determined whether other factors (e.g., race/ethnicity, socioeconomic status, level of education) impacted study outcomes, and therefore, this information is needed.

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Chapter 4-C. The Effects of the Type of Educator Who Delivers Nutrition Education on Children's Dietary Intake-Related Behaviors

TECHNICAL ABSTRACT

Background

Nutrition education programs have been delivered by a variety of different types of educators (e.g., nutritionists, teachers, parents, healthcare providers, paraprofessionals). The objective of this systematic review was to investigate whether different types of educators may be more effective when delivering nutrition education, therefore resulting in greater improvements to children's dietary intake-related behaviors.

Conclusion Statement

There is insufficient evidence to determine whether certain types of educators who deliver nutrition education are more effective in changing children's dietary intake-related behaviors. (Grade: Not Assignable)

Methods

Literature searches were conducted using PubMed, EBSCOhost, Education Fulltext, and Global Health to identify studies that compared nutrition education delivered by different educators.

- Inclusion criteria: published between January 1995 and December 2010; conducted in subjects aged 0–18 years; randomized controlled trials, non-randomized controlled trials, or quasi-experimental studies; subjects from countries with high or very high human development (based on the Human Development Index); subjects who were healthy or at elevated chronic disease risk; published in English in a peer-reviewed journal
- Exclusion criteria: systematic reviews, meta-analyses, narrative reviews, or prospective cohort, cross-sectional, or case-control designs; studies with no control group; subjects hospitalized, diagnosed with disease, and/or receiving medical treatment

The results of each included study were summarized in evidence worksheets (including a study quality rating), an evidence paragraph, and evidence table. A group of subject matter experts were involved in a qualitative synthesis of the body of evidence, development of a conclusion statement, and assessment of the strength of the evidence (grade) using pre-established criteria including evaluation of the quality, quantity, consistency, magnitude of effect, and generalizability of available evidence.

Findings

- One randomized controlled trial study was included in this systematic review. The study received a positive quality rating.
- Two fourth grade classrooms from each of ten schools were randomly assigned to one of two intervention groups that received the same nutrition education curriculum, delivered by either the regular classroom teacher or a nutritionist. There was no no-intervention control group in this study.
- Results from this study were mixed:
 - For much of the study, there were no significant differences in dietary intake between the intervention groups.
 - However, between period 2 and period 3, the number of subjects consuming ≥ 2 portions per day of

legumes increased in the Teacher group, but decreased in the Nutritionist group. And, for all food categories, changes in dietary intake were significantly greater in the Teacher group compared to the Nutritionist group ($P < 0.0001$).

- This study had several limitations. In addition to the type of educator, the timing, dose, and format of nutrition education differed between the groups. These differences limit the conclusions that can be drawn from the results of this study.

Discussion

The literature search identified one study that tested the effects of a nutrition education intervention delivered by two different types of educators, so it was not possible to draw any conclusions. Therefore, more research is needed to determine whether different types of educators are more effective when delivering nutrition education to children.

PLAIN LANGUAGE SUMMARY

The effects of nutrition education taught by different educators on what children eat

Nutrition education programs have been taught by different types of educators (for example, nutritionists, teachers, parents, healthcare providers, paraprofessionals). This summary of a NEL review presents what we know from research about whether different types of educators are more effective when teaching nutrition education resulting in children making better food choices.

Conclusion

There is insufficient evidence to determine whether certain types of educators who deliver nutrition education are more effective in changing children's dietary intake-related behaviors.

What the Research Says

- One study was included in this review.
 - For most of the study, there were no differences in what children ate after getting nutrition education from a classroom teacher or a nutritionist.
 - At one point during the study, children improved what they ate more when taught by a teacher compared to a nutritionist.
- There was only one study in this review and it had many weaknesses, so conclusions cannot be drawn. More research is needed in this area.

EVIDENCE PORTFOLIO

Conclusion Statement

There is insufficient evidence to determine whether certain types of educators who deliver nutrition education are more effective in changing children’s dietary intake-related behaviors.

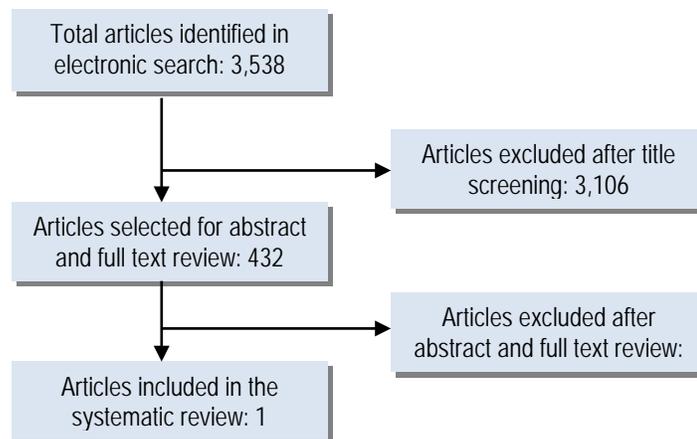
Grade

V – Grade Not Assignable

Evidence Summary Overview

The literature search for studies that tested the effects of nutrition education delivered to children and adolescents by different types of educators identified 3,538 articles, 432 of which were selected for review (Fig. 4-C.1). Of these 432 articles, 1 was selected for inclusion in the systematic review. A detailed description of literature search results, including the databases searched and the number of articles identified using each database, articles identified using hand search, a list of citations for all included articles, and a table that lists excluded studies with rationale for exclusion can be found in Appendix F.

Figure 4-C.1. **Flow chart of literature search results for studies examining the effects of nutrition education delivered to children and adolescents via different types of educators**



The purpose of this research question was to investigate whether different types of educators (e.g., teachers, nutritionists, parents, health care providers) may be more effective when delivering nutrition education, therefore resulting in greater improvements to children’s dietary intake-related behaviors. Because the literature search identified one study (Panunzio et al., 2007) that tested the effects of a nutrition education intervention delivered by two different types of educators, it was not possible to draw any conclusions. Therefore, more research is needed to determine whether different types of educators are more effective when delivering nutrition education to children.

Evidence Summary Paragraph

Panunzio et al., 2007 (Positive Quality) conducted a group randomized controlled trial in Italy to compare the effectiveness of a school-based intervention delivered by a classroom teacher to an intervention delivered by a nutritionist to increase fruit and vegetable consumption among children. Two fourth grade classrooms from each of ten schools were randomly assigned to one of two intervention groups that received the same nutrition education curriculum, delivered by either the regular classroom teacher or a nutritionist. There was no control group in this study. The teacher-delivered intervention consisted of three periods:

- In the first 12-week period, teachers attended a basic nutrition training course (one 2-hour meeting per week)
- In the second 12-week period, teachers participated in additional training sessions (one 2-hour meeting per week) emphasizing nutrition teaching aids
- In the third 12-week period, teachers provided nutrition education to students by integrating the nutrition concepts into all school curricula.

The nutritionist-delivered intervention consisted of three periods:

- During the first two 12-week periods, nutritionists taught nutrition classes to students (one 2-hour class per week).
- During the third 12-week period, no classes or activities took place.

The final sample included 471 fourth grade school children (10 yrs). There were no significant differences in dietary intake between the intervention groups in period 1 (weeks 0–12) and period 2 (weeks 12–24), or between period 1 (weeks 0–12) and period 3 (weeks 24–36). Between period 2 and period 3, in both intervention groups, the number of subjects consuming ≥ 2 portions per day of fruits and vegetables increased and the number consuming ≥ 2 portions per day of chips and sugar-sweetened beverages decreased. Also, the number of subjects consuming ≥ 2 portions per day of legumes increased in the Teacher group, but decreased in the Nutritionist group. However, for all food categories changes in dietary intake were significantly greater in the Teacher group compared to the Nutritionist group ($P < 0.0001$).

This study had several limitations to consider. Children in each intervention group received different levels of education duration across the 3 periods, with the children in the nutritionist group receiving the nutrition education during periods 1 and 2 (24 weeks), while children in the teacher group only received nutrition education during period 3 (12 weeks). In addition, during periods 1 and 2, children in the Nutritionist group received the nutrition education once a week for 2 hours, while children in the Teacher group had the nutrition education integrated into all classroom curriculum over the 3rd period. Therefore, in addition to the type of educator, the timing, dose, and format of nutrition education differed between the groups. These differences limit the conclusions that can be drawn from the results of this study.

Overview Table

Table 4-C.1. Studies examining the effects of nutrition education delivered by different types of educators

Study	Participants	Methods	Outcomes	Strengths and Limitations
<p>Panunzio et al., 2007 Positive Quality Class: A</p>	<p>N = 471 Age: 8–11 yrs Attrition rate: 9.6% Location: Italy</p>	<p><u>Methods:</u> Two fourth-grade classrooms in each of 10 schools were randomly assigned to one of two intervention groups that received the same nutrition education curriculum, delivered by either the regular classroom teacher or a nutritionist</p> <p><u>Outcomes Measures:</u> Diet records (daily for 12 wks)</p> <p><u>Duration Intensity:</u> Teacher intervention was 12 wks (integrated into all classroom curricula); Nutritionist intervention was 24 wks (2 hrs, once per week)</p> <p><u>Teacher-delivered intervention</u></p> <p>1st period: Teachers were trained (2 hr classes, weekly for 12 wks). 2nd period: Teachers received additional training (2 hr classes, weekly for 12 wks). 3rd period: Children received nutrition education integrated into all classroom curricula.</p> <p><u>Nutritionist-delivered intervention</u></p> <p>1st period: Nutritionists taught nutrition classes for 2 hrs per wk for 12 wks 2nd period: Nutritionists continued teaching 2 hrs per wk. 3rd period: No classes were held</p>	<p>There were no significant differences in dietary intake between the teacher and nutritionist groups during periods 1 and 2.</p> <p>In period 3, the teacher group had significant improvements in dietary intake compared to the nutritionist group.</p>	<p>Ethnic and socioeconomic factors not reported for this population of children from southern Italy</p> <p>Teacher involvement in data collection could bias results</p> <p>In addition to the type of educator, both the timing and dose of nutrition education differed between the study group, limiting the conclusions that can be drawn from this study.</p>

Research Recommendations

1. Conduct research to determine whether type of educator (e.g., trained teachers, trained parents, nutritionists, paraprofessionals) affects nutrition education outcomes, what characteristics associated with these different types may be attributable to their efficacy. Research should consider nutrition education delivered directly to children, as well as to parents and/or other nutritional gatekeepers.
2. Develop research to assess different kinds of approaches to delivering nutrition education and the level of change that may be expected in terms of dietary intake behaviors.
3. Additional research is needed with a more diverse population and with varying types of curriculums.

Rationale: There is a lack of research comparing different kinds of nutrition educators, precluding the possibility of recommending one set of educator characteristics that will have a beneficial effect upon changing children's dietary intake. It is important to determine whether a particular set of characteristics of the educator and the way in which he/she teaches influences behavior change in children, which could eventually translate into changes in anthropometric measurements and other health outcomes.

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Chapter 4-D. The Effects of Combining Changes to the Food Environment and Nutrition Education Compared to Either of These Strategies Alone on Children’s and Adolescent’s Dietary Intake-Related Behaviors

TECHNICAL ABSTRACT

Background

In an effort to improve children’s dietary intake, many schools are implementing changes to the food environment, such as offering and marketing healthier options at school meals or in vending machines. The objective of this systematic review was to determine the effects of combining changes to the food environment and nutrition education compared to either of these strategies alone on children’s and adolescent’s dietary intake-related behaviors.

Conclusion Statement

Consistent evidence suggests that combining nutrition education with changes to the school food environment is more effective for improving children’s and adolescents’ dietary intake than making changes to the food environment alone (Grade: Strong).

Methods

Literature searches were conducted using PubMed, EBSCOhost, Education Fulltext, and Global Health to identify studies that compared a combination of changes to the food environment and nutrition education to either food environment changes or nutrition education alone.

- Inclusion criteria: published between January 1995 and December 2010; conducted in subjects aged 0–18 years; randomized controlled trials, non-randomized controlled trials, or quasi-experimental studies; subjects from countries with a high or very high human development index; subjects who were healthy or at elevated chronic disease risk; published in English in a peer-reviewed journal
- Exclusion criteria: systematic reviews, meta-analyses, narrative reviews, or prospective cohort, cross-sectional, or case-control designs; studies with no control group; subjects hospitalized, diagnosed with disease, and/or receiving medical treatment

The results of each included study were summarized in evidence worksheets (including a study quality rating), an evidence paragraph, and evidence table. A group of subject matter experts were involved in a qualitative synthesis of the body of evidence, development of a conclusion statement, and assessment of the strength of the evidence (grade) using pre-established criteria including evaluation of the quality, quantity, consistency, magnitude of effect and generalizability of available evidence.

Findings

- Five articles were included in this systematic review. Three studies were randomized controlled trials (RCT) and two were non-randomized controlled trials. Three studies (two RCTs, one non-RCT) received a neutral quality rating, and two received a positive quality rating (one RCT, one non-RCT).
- Types of changes made to the school food environment included: free breakfast provided at school, increased availability and promotion of fruits and vegetables in the school cafeteria and vending machines, free fruit and

vegetable snack, and increased choice, marketing, and improvement in the preparation and appearance of fish served in the school cafeteria.

- The four studies that compared “nutrition education combined with changes to the school food environment” to “changes to the school food environment alone” found that combining nutrition education with changes to the school food environment improved dietary intake, and provide some evidence that this improvement was greater than when compared to only making changes to the school food environment.
- The study that compared “nutrition education combined with changes to the school food environment” to “nutrition education alone” found some evidence that combining nutrition education with changes to the school food environment improved dietary intake more than only providing nutrition education.

Discussion

The studies included in this review provide evidence suggesting that combining changes to the school food environment with nutrition education is more effective for improving children and adolescent’s dietary intake than changing the food environment alone. It is important to note that in two studies, the direct comparison between the combination intervention and the food environment intervention did not differ significantly, though the combination intervention led to improvements compared to control while the food environment alone intervention did not. Also, in one study effects were seen only in boys, and not in girls.

PLAIN LANGUAGE SUMMARY

The effects on children’s diets of combining changes to the school food environment with nutrition education compared to either of these strategies alone

Many schools are making changes to the food environment to improve children’s eating habits. Examples of these changes include healthier food choices in the cafeteria or in vending machines. This summary of a NEL review presents what we know from research about the effects on children’s diets of combining changes to the school food environment with nutrition education compared to either one of these alone.

Conclusion

Consistent evidence suggests that combining nutrition education with changes to the school food environment is more effective for improving children’s and adolescents’ dietary intake than making changes to the food environment alone.

What the Research Says

- All five studies in this review found that children improved their diets when changes to the food environment at school were combined with nutrition education.
- The types of changes made to the school environment were free breakfast provided at school; promotion of and more fruits and vegetables in the school cafeteria and vending machines; free fruit and vegetable snack; and more choices, promotion, and better cooking and look of fish served in the school cafeteria.
- Four of the five studies looked at “nutrition education combined with changes in the school environment” to “changes to the school environment alone” and found that the combination led to a greater improvement in what children ate than just only changing the school environment.
- One study looked at “nutrition education combined with changes in the school environment” to “changes in nutrition education alone” and found that the combination improved children’s food choices. But, the effects were seen only in boys, and not in girls.

EVIDENCE PORTFOLIO

Conclusion Statement

Consistent evidence suggests that combining nutrition education with changes to the school food environment is more effective for improving children’s and adolescents’ dietary intake than making changes to the food environment alone.

Grade

I – Strong

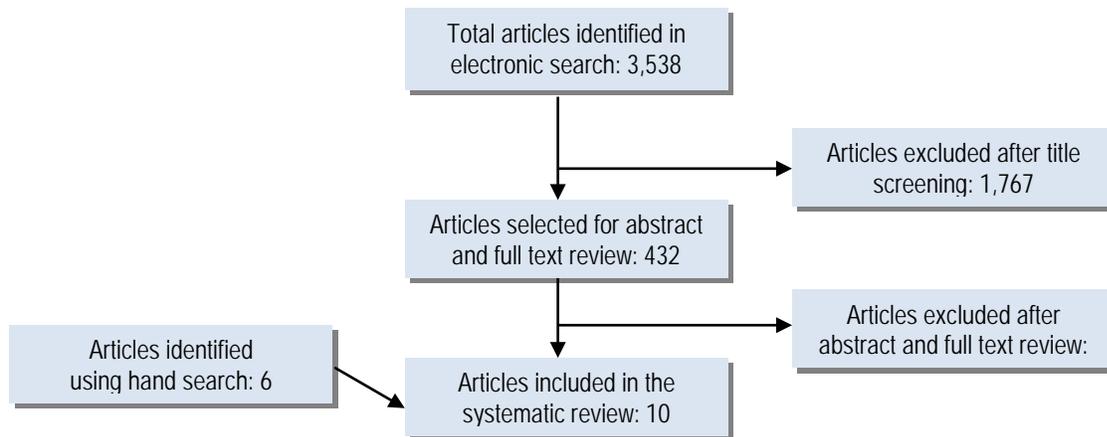
Evidence Summary Overview

The studies included in this review provide evidence suggesting that combining changes to the school food environment with nutrition education is more effective for improving children and adolescent’s dietary intake than changing the food environment alone. All four studies comparing “nutrition education combined with changes to the school food environment” to “changes to the school food environment alone” found some evidence that combining nutrition education with changes to the school food environment improved dietary intake more than only making changes to the school food environment. It is important to note that in two of these studies, the direct comparison between the combination intervention and the food environment intervention did not differ significantly, though the combination intervention led to improvements compared to control while the food environment alone intervention did not. The study that compared “nutrition education combined with changes to the school food environment” to “nutrition education alone” found some evidence that combining nutrition education with changes to the school food environment improved dietary intake more than only providing nutrition education. However, the study had mixed results, with some differences that were based on gender.

Description of the evidence

The literature search for studies that tested the effects of nutrition education combined with changes to the food environment identified 3,538 articles, 432 of which were selected for review (Figure 4-D.1). Of these 432 articles, 3 were selected for inclusion in the systematic review. In addition, two articles were identified via hand search. Therefore, this systematic review includes a total of five articles. A detailed description of literature search results, including the databases searched and the number of articles identified using each database, articles identified using hand search, a list of citations for all included articles, and a table that lists excluded studies with rationale for exclusion can be found in Appendix G.

Figure 4-D.1. **Flow chart of literature search results for studies examining the effects of nutrition education combined with changes to the food environment**



Of the five studies included in this review, three were randomized controlled trials (Birnbaum, 2002 [Positive Quality]; He, 2009 [Neutral Quality]; Prell, 2005 [Neutral Quality]) and two were non-randomized controlled trials (Ask, 2001 [Neutral Quality]; Horne, 2004 [Positive Quality]). Three studies received a neutral quality rating and two studies received a positive quality rating.

Studies were conducted in Canada, Norway, Sweden, the United Kingdom, and the United States. Sample sizes of these studies ranged from 54 to 3,503. All five studies included both boys and girls. Mean subject age ranged from 12 years to 15 years; two studies did not report mean age, one of which was conducted in 7th graders and one which included subjects who were 5–11 years of age. Most of the studies did not report the race/ethnicity of subjects, though one study included a predominantly minority population (>80 percent), and one included a majority of white subjects (69 percent). Information regarding the socio-economic status of subjects was also not widely reported; one study only included schools with ≥ 20 percent of students eligible for free- or reduced-price meals, and one included schools with 46 to 67 percent of students eligible for free meals.

The types of modifications made to the school food environment varied between the studies. Types of environmental changes made included:

- Free breakfast provided at school (Ask, 2006)
- Increased availability and promotion of fruits and vegetables in the school cafeteria and vending machines (Birnbaum, 2002)
- Free fruit and vegetable snack (He, 2009; Horne, 2004)
- Increased choice, marketing, and improvement in the preparation and appearance of fish served in the school cafeteria (Prell, 2005)

Overall, all five studies included in this review showed that combining changes to the school food environment with nutrition education is effective for improving children and adolescent’s dietary intake, and some evidence suggested that the combination led to greater improvement than either making changes to the food environment or providing nutrition education alone.

All four of the studies that compared “nutrition education combined with changes to the school food environment” to “changes to the school food environment alone” found that combining nutrition education with changes to the school food environment improved dietary intake, and provide some evidence that this improvement was greater than when compared to only making changes to the school food environment. Two studies found that dietary intake improved more when children received the combination intervention compared to the food environment alone intervention. In the other two studies, the direct comparison between the combination intervention and the food

environment intervention did not differ significantly, though the combination intervention led to improvements compared to control while the food environment alone intervention did not.

- One study found that combining a peer leadership program with nutrition education and food environment changes improved dietary intake more compared to nutrition education + food environment changes or food environment changes alone. Nutrition education combined with food environment changes also led to improved dietary intake compared to food environment changes alone. (Birnbaum, 2002)
- One study found that combining nutrition education with changes to the school food environment increased fruit and vegetable consumption at school compared to a control (no intervention). There were no significant differences in school fruit and vegetable consumption between the school food environment group alone and either the control or the school food environment combined with nutrition education. (He, 2009)
- One study found that combining nutrition education with changes to the school food environment led to increased lunchtime, snack time, and home consumption of fruits and vegetables compared to changes to the school food environment only. (Horne, 2004)
- One study found that combining nutrition education with changes to the school food environment led to increased fish consumption compared to a control (no intervention). Changing the school food environment alone did not significantly increase fish consumption compared to either the control group or the group that received the combination of changes to the food environment and nutrition education. (Prell, 2005)

The study that compared “nutrition education combined with changes to the school food environment” to “nutrition education alone” found some evidence that combining nutrition education with changes to the school food environment improved dietary intake more than only providing nutrition education. However, the study had mixed results, with some differences that were based on gender:

- Males who received nutrition education combined with food environment changes increased scores on a unique, author-developed “healthy eating index” compared to no change in scores among males in the nutrition education only group. There were no differences among females between the two groups. (Ask, 2006)

Evidence Summary Paragraphs

Ask et al., 2006 (Neutral Quality) conducted a non-randomized controlled trial in Norway to evaluate the effects of providing nutrition education with or without free breakfast on dietary intake among adolescents. Two classrooms were assigned to one of two conditions for four months: (1) Intervention: received nutrition education and a free breakfast at the beginning of each school day (nutrition education + changes to the school food environment), and (2) Comparison: received nutrition education on the importance of healthy eating (nutrition education alone). Dietary intake-related outcomes were assessed using a non-validated 27-item FFQ, and eleven food items from the FFQ were used to calculate an author-created “healthy eating index” score. The final sample included 54 subjects (mean age = 15 yrs). Results showed that males in the intervention group had a significant increase in their healthy eating index score ($P < 0.001$), while there was no change among males in the comparison group. There were no changes in the healthy eating index scores of females in either the intervention or the comparison group.

Birnbaum et al., 2002 (Positive Quality) conducted a randomized controlled trial in the United States to evaluate the effects of school-based, multi-component nutrition interventions on dietary intake among adolescents. Schools were randomly assigned to one of four conditions for 2 years: (1) Intervention 1: received a peer leadership component plus classroom nutrition education plus an environmental intervention (increased availability and promotion of fruits and vegetables in the school cafeteria and vending machines) (nutrition education + changes to the school food environment), (2) Intervention 2: received classroom nutrition education plus the school environment intervention (nutrition education + changes to the school food environment), (3) Intervention 3: received the school environment intervention only (changes to the school food environment only), (4) Control: did not receive any intervention. Dietary intake-related outcomes (average number of daily fruit and vegetable servings)

were measured using a validated modified version of the Behavioral Risk Factor Surveillance System (BRFSS) survey. The final sample included 3,503 students (7th grade at baseline, 9th grade at follow-up). The peer leaders + nutrition education + food environment group significantly increased fruit and vegetable intake (+1 serving; $P < 0.05$) and fruit intake (+0.5 serving; $P = 0.01$), with a borderline significant increase in vegetable intake (+0.4 servings; $P = 0.059$). The nutrition education + food environment group had a borderline significant increase in fruit and vegetable intake (+0.5 servings; $P = 0.056$) and fruit intake (+0.25 servings; $P = 0.052$). There were no significant changes in fruit and/or vegetable intake in either the food environment alone or control groups.

He et al., 2009 (Neutral Quality) conducted a randomized controlled trial in Canada to measure the influence of the Northern Fruit and Vegetable Pilot Program on children's fruit and vegetable consumption. Schools were randomly assigned to one of three groups for the 21-week intervention: (1) Intervention 1: received a free fruit and vegetable snack (3 times/week) and enhanced classroom nutrition education (nutrition education + changes to the school food environment), (2) Intervention 2: received a free fruit and vegetable snack (3 times/week) (changes to the school food environment only), and (3) Control: did not receive any intervention. Dietary intake-related outcomes (fruit and vegetable servings as defined by Canada's Food Guide to Healthy Eating) were measured using a 24-hour fruit and vegetable recall questionnaire. The final sample included 1,277 students (mean age=12 yrs). Children in the nutrition education + changes to the school food environment group consumed more fruits and vegetables at school compared to control (0.49 serving/d; $P < 0.05$). There were no significant differences in school fruit and vegetable consumption between the school food environment group and the control group. There were no significant differences between any of the groups in fruit and vegetable intake at home or total fruit and vegetable intake.

Horne et al., 2004 (Positive Quality) conducted a non-randomized controlled trial in the United Kingdom to evaluate a peer-modeling and rewards-based intervention designed to increase children's fruit and vegetable consumption. Schools were assigned to one of two groups for 16 days (followed by a 4 month maintenance phase): (1) Intervention: received fruit at snack time, rewards for consuming the fruit ("Food Dude" school supplies), and peer-modeling nutrition education videos (nutrition education + changes to the school food environment), (2) Comparison: received fruit at snack time and rewards for consuming the fruit (changes to the school food environment only). Dietary intake-related outcomes were measured after the intervention and during the maintenance phase using visual estimation by trained observers (fruit and vegetable consumption at lunch) weighed intake (fruit and vegetable consumption at snack), and a 24-hour recall completed by parents after the intervention (fruit and vegetable consumption at home). The final sample included 749 children (ages 5–11 yrs). Lunchtime consumption of fruits and vegetables in the nutrition education + changes to the school food environment group was significantly higher immediately after the intervention and after the maintenance phase than baseline ($P < 0.001$), while snack time consumption was higher immediately after the intervention than baseline ($P < 0.001$) compared to changing to the school food environment only, but not after the maintenance phase. There were also significant increases in fruit and vegetable consumption at home immediately after the intervention ($P < 0.05$).

Prell et al., 2005 (Neutral Quality) conducted a randomized controlled trial in Sweden to examine the effects of school-based interventions on fish consumption among adolescents. Schools were randomly assigned to one of three groups for 5 weeks: (1) Intervention 1: received changes to the school cafeteria (increased choice, marketing, and improved preparation/appearance of fish) and home economics nutrition education (nutrition education + changes to the school food environment), (2) Intervention 2: received changes to the school cafeteria (changes to the school food environment only), or (3) Control: did not receive any intervention. Dietary intake-related outcomes (fish consumption) were measured using structured observations in the school cafeteria once a week when fish was served. The final sample included 228 subjects (mean age=14 yrs). The nutrition education + changes to the school food environment group significantly increased fish consumption following the intervention, compared to the control group ($P < 0.01$). The school food environment only group did not significantly increase fish consumption compared to either the control group or the group that received changes to the school food environment only.

Overview Table

Table 4-D.1. Studies examining the effects of nutrition education combined with changes to the food environment

Study	Participants	Study Description	Outcomes	Limitations
Nutrition Education + Food Environment Change vs. Food Environment Change Only				
Birnbaum et al., 2002 Positive Quality Randomized Controlled Trial	N = 3,503 Age: 7th grade Gender: Not reported Race: 69% White, 10% African American, 7% Asian or Pacific Islander, 6% Mixed, 9% Other SES: ≥20% eligible for free- or reduced-price meals Location: United States	Intervention 1: received a peer leadership component plus classroom nutrition education plus environment intervention (increased availability and promotion of fruits and vegetables in the school cafeteria and vending machines) (nutrition education + changes to the school food environment) (2 yr) Intervention 2: received classroom nutrition education plus the school environment intervention (nutrition education + changes to the school food environment) (2 yr) Intervention 3: received the school environment intervention only (changes to the school food environment alone) (2 yr) Control: did not receive any intervention	Intervention 1 increased fruit and vegetable intake (+1 serving; P<0.05) and fruit intake (+0.5 serving; P=0.01), and had a borderline significant increase in vegetable intake (+0.4 servings; P=0.059) Intervention 2 had borderline significant increases in fruit and vegetable intake (+0.5 servings; P=0.056) and fruit intake (+0.25 servings; P=0.052) Intervention 3 and Control had no changes in fruit and/or vegetable intake	Peer leaders may have been more likely to give more socially desirable answers
He et al., 2009 Neutral Quality Randomized Controlled Trial	N = 1,277 Age: 12 yrs Gender: 55% female Race: Not reported SES: Not reported Location: Canada	Intervention 1: received a free fruit and vegetable snack (3 times/wk) and enhanced classroom nutrition education (nutrition education + changes to the school food environment) (21 wk) Intervention 2: received a free fruit and vegetable snack (3 times/wk) (changes to the school food environment alone) (21 wk) Control: did not receive any intervention	Intervention 1 consumed more fruits and vegetables at school compared to control (0.49 serving/d; P< 0.05). There were no significant differences in school fruit and vegetable consumption between Intervention 2 and either the control group or Intervention 1. There were no significant differences between any of the groups in fruit and vegetable intake at home.	The 24-hr recall used has been validated, but was not pre-tested in this study population. The 24-hr recall was complicated, which may have resulted in a substantial number of missing values. Due to missing values, sample size decreased, and the study may not have been adequately powered.
Horne et al., 2004 Positive Quality Non-Randomized Controlled Trial	N = 749 Age: 5–11 yrs Gender: Not reported Race: >80% Ethnic minorities ES: 46–67% eligible for free meals Location: United Kingdom	Intervention: received fruit at snack time, rewards for consuming the fruit, and nutrition education videos (nutrition education + changes to the school food environment) (16 d + 4 mo maintenance phase) Comparison: received fruit at snack time (changes to the school food environment only) and rewards for consuming the fruit (16 d + 4 mo maintenance phase)	Lunchtime consumption of fruits and vegetables in the nutrition education + changes to the school food environment group was significantly higher immediately after the intervention and after the maintenance phase than baseline compared to the school food environment only group (P<0.001) Snack time consumption was higher after the intervention than baseline compared to changing to the school food environment only (P<0.001) (but not after the maintenance phase) Home fruit and vegetable consumption increased after the intervention in the combination group compared to the food environment only group (P<0.05).	Intervention was short, and it was unclear how outcomes would have changed had the intervention phase been longer. The maintenance phase was not implemented consistently.

Table 4-D.1. Studies examining the effects of nutrition education combined with changes to the food environment—continued

Study	Participants	Study Description	Outcomes	Limitations
<p>Prell et al., 2005</p> <p>Neutral Quality Randomized Controlled Trial</p>	<p>N = 228</p> <p>Age: 14 yrs</p> <p>Gender: 47% female</p> <p>Race: Not reported</p> <p>SES: Not reported</p> <p>Location: Sweden</p>	<p>Intervention 1: received changes to the school cafeteria (increased choice, marketing, and improved preparation/appearance of fish) and home economics nutrition education (5 wk) (nutrition education + changes to the school food environment)</p> <p>Intervention 2: received changes to the school cafeteria (5 wk) (changes to the school food environment only)</p> <p>Control: did not receive any intervention</p>	<p>Intervention 1 significantly increased fish consumption following the intervention, and this increase differed significantly from the control group (P<0.01).</p> <p>Intervention 2 had no significant impact on fish consumption, and did not differ from Intervention 1 or the control group.</p>	<p>Baseline differences in fish consumption between groups may have influenced results.</p> <p>Did not include a comparison group that received the home economics education alone to determine the impact of this component alone on fish consumption.</p> <p>In adequate control for potentially confounded factors</p>
Nutrition Education + Food Environment Change vs. Nutrition Education Only				
<p>Ask et al., 2006</p> <p>Neutral Quality Non-Randomized Controlled Trial</p>	<p>N = 54</p> <p>Age: 15 yrs</p> <p>Gender: 46% female</p> <p>Race: Not reported</p> <p>SES: Not reported</p> <p>Location: Norway</p>	<p>Intervention: received nutrition education and a free breakfast at the beginning of each school day (nutrition education + changes to the school food environment) (4 mo)</p> <p>Comparison: received nutrition education (4 mo) (nutrition education alone)</p>	<p>Males in the intervention group had a significant increase in their healthy eating index scores after the intervention (P<0.001), while there was no significant change among males in the comparison group.</p> <p>There were no changes in the healthy eating index score of females in either group.</p>	<p>Small sample size</p> <p>Lack of teacher participation delayed lesson implementation</p> <p>Study staff were not well trained, and the study was not well implemented</p> <p>Regular breakfast consumption at home was not assessed and accounted for</p> <p>Use of a non-validated dietary assessment tool</p>

Research Recommendations

1. Conduct more research to test the effects of combining nutrition education with changes to the food environment in the United States.

Rationale: Previously conducted studies were carried out in a variety of countries, all of which are considered to have “very high human development” based on the Human Development Index 2010. However, because only one of the studies was conducted in the United States, more research is needed to better understand how these types of interventions work most effectively in U.S.-based school settings and populations.

2. Conduct research to investigate whether different types of food environment changes have differential impacts on dietary intake, or whether additional interventions could be combined with nutrition education and food environment changes to increase the efficacy of these interventions for improving children’s and adolescent’s dietary intake-related behaviors.

Rationale: The studies reviewed tested several different types of changes to the food environment, and it was not clear from the research whether one type of environmental change or specific combinations of changes are better than others for eliciting behavior change. Therefore, more research is needed to better understand the effects of different environmental change strategies on dietary intake. Research is also needed to determine whether combining nutrition education and changes to the food environment with additional intervention components, such as parental or family involvement, cooking or gardening education, or use of digital media/technology, would lead to even greater changes in dietary-intake related outcomes. In addition, more information would be needed to determine which combinations of components lead to the biggest return on investment in terms of improved dietary intake and health.

3. Conduct research in which nutrition education combined with food environment changes is delivered over longer periods of time, at a greater frequency, with greater intensity, or with a longer duration of follow-up.

Rationale: The duration of the studies reviewed ranged widely from 16 days to 2 years. In addition, the frequency and intensity of the interventions tested were not well characterized. Therefore, it is unclear whether there is an optimal “dose” of nutrition education and environmental change for affecting behavior change. Research in this area will allow for better understanding of the dose-response effects and the long-term impacts of these types of interventions on children’s behavior, as well as body weight and other health outcomes.

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Chapter 4-E. The Effects of Multi-Component Compared to Single-Component Nutrition Education Interventions on Children’s Dietary Intake-Related Behaviors

TECHNICAL ABSTRACT

Background

It has been suggested that nutrition education interventions with multiple different components (i.e., nutrition education provided via two or more methods) may be more effective than single-component nutrition education interventions, as they engage students on a variety of different levels. The objective of this systematic review was to determine the effects of multi- vs. single-component nutrition education interventions on children’s dietary intake-related behaviors.

Conclusion Statement

There is inconsistent evidence to suggest that multi-component nutrition education interventions may be more effective for improving children’s and adolescents’ dietary intake-related behaviors than single-component interventions. Limited evidence also suggests that multi-component nutrition education interventions that combine classroom nutrition education with a hands-on educational component may be particularly effective. (Grade: Limited)

Methods

Literature searches were conducted using PubMed, EBSCOhost, Education Fulltext, and Global Health to identify studies that compared multi-component nutrition education interventions to single-component nutrition education interventions.

- Inclusion criteria: published between January 1995 and December 2010; conducted in subjects aged 0–18 years; randomized controlled trials, non-randomized controlled trials, or quasi-experimental studies; subjects from countries with high or very high human development (based on the Human Development Index); subjects who were healthy or at elevated chronic disease risk; published in English in a peer-reviewed journal
- Exclusion criteria: systematic reviews, meta-analyses, narrative reviews, or prospective cohort, cross-sectional, or case-control designs; studies with no control group; subjects hospitalized, diagnosed with disease, and/or receiving medical treatment
- For this review, an intervention is described as a “single-component” intervention when subjects are provided nutrition education using one distinct method. An intervention is described as a “multi-component” intervention when subjects are provided nutrition education via two or more different methods. Some of the included studies also had a control group that received no intervention.

The results of each included study were summarized in evidence worksheets (including a study quality rating), an evidence paragraph, and evidence table. A group of subject matter experts were involved in a qualitative synthesis of the body of evidence, development of a conclusion statement, and assessment of the strength of the evidence (grade) using pre-established criteria including evaluation of the quality, quantity, consistency, magnitude of effect and generalizability of available evidence.

Findings

- Fourteen studies were included in this systematic review; 10 randomized controlled trials and four non-randomized controlled trials. Four studies received a positive quality rating (4 RCTs, 1 non-RCT), and 10

received a neutral quality rating (6 RCTs, 4 non-RCTs).

- Results of the studies were mixed:
 - Six studies found that multi-component nutrition education interventions were better than single-component interventions for improving dietary intake; though, three of these studies had mixed results that differed depending on the outcome being considered.
 - A number of studies showed that multi-and single-component interventions were equally effective for improving dietary intake (two studies, one with mixed results), or, conversely, had no effect on dietary intake (four studies, three with mixed results).
 - Some of the studies included in the review (three studies, two with mixed results) found that single-component nutrition education interventions were better than multi-component interventions for improving dietary intake.
- Three studies that found a multi-component intervention to be better than a single-component intervention included a “hands-on” component, such as cooking or gardening, combined with classroom-based nutrition education.

Discussion

The nutrition education interventions tested in the studies in this review included a wide range of different components or combinations of components, making it difficult to draw strong conclusions. In addition, more research is needed to test which components, when combined, create effective multi-component nutrition education interventions.

PLAIN LANGUAGE SUMMARY

The effects of single versus multi-component nutrition education on what children eat

Using several different approaches to deliver nutrition education (multi-component) to children may be more effective than just using one approach (single-component). This summary of a NEL review presents what we know from research about the effects of multiple versus single part nutrition education on what children eat.

Conclusion

There is inconsistent evidence to suggest that multi-component nutrition education interventions may be more effective for improving children’s and adolescents’ dietary intake-related behaviors than single-component interventions. Limited evidence also suggests that multi-component nutrition education interventions that combine classroom nutrition education with a hands-on educational component may be particularly effective.

What the Research Says

- The results of the 14 studies in this review were mixed.
- There was no agreement on whether nutrition education programs with two or more components were either more, less, or equally effective for improving what children ate than programs with just one component.
- Three studies found that using a “hands-on” approach, such as cooking or gardening, along with nutrition education taught in the classroom seemed to be very effective.
- It is difficult to make stronger conclusions, because the results were mixed, and the studies were so different. More research is needed in this area to determine which components, when combined, are most effective.

EVIDENCE PORTFOLIO

Conclusion Statement

There is inconsistent evidence to suggest that multi-component nutrition education interventions may be more effective for improving children's and adolescents' dietary intake-related behaviors than single-component interventions. Limited evidence also suggests that multi-component nutrition education interventions that combine classroom nutrition education with a hands-on educational component may be particularly effective.

Grade

III – Limited

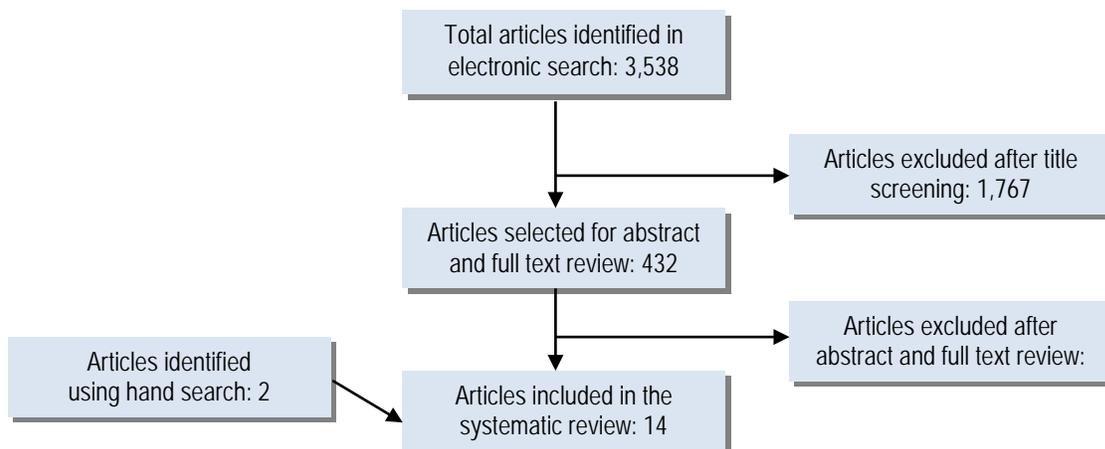
Evidence Summary Overview

This systematic review includes 14 studies that examined the effects of single- vs. multi-component nutrition education interventions on dietary intake-related behaviors in children and adolescents. An intervention is described as a “single-component” intervention when subjects are provided nutrition education using one distinct method, while an intervention is described as a “multi-component” intervention when subjects are provided nutrition education via two or more different methods. Several studies included in this systematic review (six studies) found that multi-component nutrition education interventions were better than single-component interventions for improving dietary intake; though, three of these studies had mixed results that differed depending on the outcome being considered. A number of studies showed that multi- and single-component interventions were equally effective for improving dietary intake (two studies, one with mixed results), or, conversely, had no effect on dietary intake (four studies, three with mixed results). In addition, some of the studies included in the review (three studies, two with mixed results) found that single-component nutrition education interventions were better than multi-component interventions for improving dietary intake. Again, several of these studies had mixed results depending on outcome. Finally, the studies were compared to determine whether any specific component was particularly effective. Three out of six studies that found a multi-component intervention to be better (e.g., there were no mixed results that differed depending on outcome) than a single-component intervention included a “hands-on” component, such as cooking or gardening, combined with classroom-based nutrition education. None of the other studies included in this review included similar hands-on components.

Description of the Evidence

The literature search for studies that tested the effects of multi- vs. single-component nutrition education interventions identified 3,538 articles, 432 of which were selected for review (Figure 4-E.1). Of these 432 articles, 12 were selected for inclusion in the systematic review. In addition, two articles were identified via hand search. Therefore, this systematic review includes a total of 14 articles. A detailed description of literature search results, including the databases searched and the number of articles identified using each database, articles identified using hand search, a list of citations for all included articles, and a table that lists excluded studies with rationale for exclusion can be found in Appendix H.

Figure 4-E.1. **Flow chart of literature search results for studies examining the effects of multi- vs. single-component nutrition education interventions**



Of the 14 studies included in this review:

- Ten studies were randomized controlled trials [DeBar et al., 2006 (Positive Quality); He et al., 2009 (Neutral Quality); Hopper et al., 2005 (Positive Quality); Hopper et al., 1996 (Neutral Quality); Kitzman-Ulrich et al., 2009 (Neutral Quality); McKenzie et al., 1996 (Positive Quality); Neumark-Sztainer et al., 2003 (Neutral Quality); Prell et al., 2005 (Neutral Quality); Reinaerts et al., 2008 (Neutral Quality); Sahota et al., 2001 (Positive Quality)].
- Four studies were nonrandomized trials [Long, 2004 (Neutral Quality); McAleese & Rankin, 2007 (Neutral Quality); Olvera et al., 2010 (Neutral Quality); Parmer et al., 2009 (Neutral Quality)].
- Four studies received a Positive Quality rating and ten studies received a Neutral Quality rating.
- Ten studies took place in the United States, and one each took place in Canada, The Netherlands, Sweden and the United Kingdom.
- The majority of studies included in this review were conducted in a school setting, though a few were conducted in other locations, such as an HMO clinic (DeBar, 2006), at home (Kitzman-Ulrich, 2009; McKenzie, 1996), or at neighborhood community centers (Olvera, 2010).
- Sample sizes of these studies ranged from 35 to 1,277 (3 studies had <100 subjects, 9 studies had 100-500 subjects, 1 study had 500-1000 subjects, and 1 study had >1,000 subjects).
- Ten studies included a mix of boys and girls, with a range of 30 to 56 percent girls. Four studies included only female subjects (Neumark-Sztainer et al., 2003; Olvera et al., 2010; Kitzman-Ulrich et al., 2009; and Debar et al, 2006).
- The mean age of the subjects ranged from 7–15 years. One study did not report mean age of subjects, but included children ages 4–11 years.
- Many studies did not provide information regarding the race/ethnicity of subjects. Five studies reported including a mix of races/ethnicities, with white subjects accounting for 42 to 83 percent of the population (Debar, 2006; Hopper, 2005; Kitzman-Ulrich, 2009; Long, 2004; Neumark-Sztainer, 2003). One study (Olvera et al., 2010) included 100% Latino females.
- None of the studies provided detailed information regarding subjects' socioeconomic status, though one study indicated that subjects were mainly “middle- to upper-middle income” (DeBar, 2006), and another had mostly “upper class” subjects (McKenzie, 1996).

For this review, an intervention is described as a “single-component” intervention when subjects are provided nutrition education using one distinct method. An intervention is described as a “multi-component” intervention

when subjects are provided nutrition education via two or more different methods. Some of the included studies also had a control group that received no intervention.

The nutrition education interventions tested in the studies in this review included a wide range of different components or combinations of components that were intended to facilitate positive dietary intake-related behavior change. Table 4-E.1 provides a description of the components tested in each of the fourteen studies included in this review.

Table 4-E.1. Description of components tested in studies of the effects of single- vs. multi-component nutrition education interventions on dietary intake-related behavior

Study	Intervention Groups			Outcomes*
	Single-Component (SC) Intervention	Multi-Component (MC) Intervention	Control	
DeBar, 2006 RCT	Individual counseling visits	<ul style="list-style-type: none"> • Individual counseling visits • Telephone calls • Group meetings • Diet self-monitoring • Use of a study website • Youth/parent newsletters • Fitness center membership 	No control group	<ul style="list-style-type: none"> • MC > SC for calcium, vitamin D, fruit, vegetables* • MC = SC for soda (no change)
He, 2009 RCT	Free fruit/vegetable snack	<ul style="list-style-type: none"> • Free fruit/vegetable snack • Classroom nutrition education 	Control group received no intervention	<ul style="list-style-type: none"> • MC > Control for fruit/ vegetable consumed at school* • SC = MC and control for fruit/ vegetable consumed at school (no change) • MC, SC = control for fruit/ vegetable consumed at home (no change)
Hopper, 2005 RCT	Usual school nutrition education curriculum	<ul style="list-style-type: none"> • Classroom nutrition education • Physical education • Parental involvement 	No control group	<ul style="list-style-type: none"> • MC > SC for fat intake* • MC = SC for calories, protein, carbohydrate, saturated fat, cholesterol, sodium, % energy from carbohydrate, % energy from fat (no change)
Hopper, 1996 RCT	Classroom nutrition education	<ul style="list-style-type: none"> • Classroom nutrition education • Parental involvement 	Usual school nutrition education curriculum	<ul style="list-style-type: none"> • MC = SC for fat (both decreased significantly compared to controls)*
Kitzman-Ulrich, 2009 RCT	Family-based psychoeducation	<ul style="list-style-type: none"> • Family-based psychoeducation • Multifamily group therapy 	Control group received no intervention	<ul style="list-style-type: none"> • SC > MC, control for calories*
Long, 2004 Quasi-experimental	Usual classroom nutrition education curriculum	<ul style="list-style-type: none"> • Classroom nutrition education • Web-based nutrition education 	No control group	<ul style="list-style-type: none"> • MC = SC
McAleese, 2007 Non-RCT	Classroom nutrition education	<ul style="list-style-type: none"> • Classroom nutrition education • School gardening 	Control group received no intervention	<ul style="list-style-type: none"> • MC > SC and control group for fruit, vegetables, vitamin A, vitamin C, fiber*
McKenzie, 1996 RCT	Home nutrition education (parent-child auto-tutorial)	<ul style="list-style-type: none"> • Individual counseling sessions (child and parent) • Take-home nutrition education materials • Telephone access to an RD 	Control group received no intervention	<ul style="list-style-type: none"> • SC decreased fruit (fruit and fruit juice) * • MC, Control – no significant changes
Neumark-Sztainer, 2003 RCT	Distribution of educational materials on healthy eating and physical education in school	<ul style="list-style-type: none"> • Nutrition education sessions • Physical activity sessions • Social support sessions • Lunch meetings with healthy food • Parental involvement 	No control group	<ul style="list-style-type: none"> • MC = SC
Olvera, 2010 Non-RCT	Behavioral counseling sessions	<ul style="list-style-type: none"> • Nutrition education sessions • Physical activity sessions • Behavioral counseling sessions 	No control group	<ul style="list-style-type: none"> • MC = SC (no change)
Parmer, 2009 Non-RCT	Classroom nutrition education	<ul style="list-style-type: none"> • Classroom nutrition education • School gardening 	Control group received no intervention	<ul style="list-style-type: none"> • MC > SC > Control for vegetables*

Table 4-E.1. Description of components tested in studies of the effects of single- vs. multi-component nutrition education interventions on dietary intake-related behavior—continued

Study	Intervention Groups		Control	Outcomes*
	Single-Component (SC) Intervention	Mult-Component(MC Intervention)		
Prell, 2005 RCT	Modification of school meals	<ul style="list-style-type: none"> • Modification of school meals • Home economics education/cooking 	Control group received no intervention	<ul style="list-style-type: none"> • MC > Control for fish* • MC increased fish* • SC = Control and MC (no change)
Reinaerts, 2008 RCT	Free fruit/vegetable snack	<ul style="list-style-type: none"> • Classroom nutrition education • Parental involvement 	Control group received no intervention	<ul style="list-style-type: none"> • MC = SC > Control* (increased fruit, total fruit, juice, vegetables) • SC > MC, and Control – vegetable intake at snack and dinner*
Sahota, 2001 RCT	Usual school nutrition education curriculum	<ul style="list-style-type: none"> • Teacher training • Modification of school meals, foods sold in school • Action plans developed and implemented for nutrition and physical education curriculum 	No control group	<ul style="list-style-type: none"> • MC > SC for vegetables* • SC > MC (obese subjects) for fruit* • SC > MC (overweight subjects) for sugar*

* indicates that the differences in outcomes described were statistically significant at the p≤0.05 level
 > indicates an improvement in one group compared to another
 = indicates no differences between groups

Description of Outcomes

Six out of the 14 studies in this review showed some evidence that multi-component interventions were more effective than single-component interventions in improving dietary intake (DeBar, 2006; Hopper, 2005; McAleese, 2007; Parmer, 2009; Prell, 2005; Sahota, 2001). However, three of these studies had mixed results that differed depending on which outcome was being considered (DeBar, 2006; Hopper, 2005; Sahota, 2001).

Conversely, 3 of the 14 studies showed some evidence that single-component interventions were more effective than multi-component interventions in improving dietary intake (Kitzman-Ulrich, 2009; Reinaerts, 2008; Sahota, 2001). Two of these had mixed results that differed depending on which outcome was being considered (Reinaerts, 2008; Sahota, 2001).

In addition, 8 of the 14 studies showed some evidence that multi- and single-component interventions did not differ (DeBar, 2006; He, 2009; Hopper, 2005; Hopper, 1996; Long, 2004; Neumark-Sztainer, 2003; Olvera, 2010; Reinaerts, 2008), with 4 showing that neither intervention improved dietary intake (DeBar, 2006; He, 2009; Hopper, 2005; Olvera, 2010) and 2 showing that multi- and single-component interventions are equally as effective for improving dietary intake (Hopper, 1996; Reinaerts, 2008). Two of the studies showed that multi- and single-component interventions did not differ, but did not indicate whether dietary intake improved or not (Long, 2004; Neumark-Sztainer, 2003). Again, several of these studies had mixed results depending on outcome (DeBar, 2006; He, 2009; Hopper, 2005; Reinaerts, 2008).

Finally, two studies indirectly reported results, showing that the multi- or single-component intervention was better than control, but either the multi- vs. single-component comparison was not made (McKenzie, 1996) or there was no statistically significant difference between the multi- and single-component interventions (Prell, 2005).

The studies were compared to determine whether any specific component might be associated with improved outcomes. Three studies that showed the multi-component intervention was more effective than the single-component intervention (McAleese, 2007; Parmer, 2009; Prell, 2005) included a “hands-on” component (i.e., cooking or gardening) combined with classroom nutrition education.

- McAleese & Rankin (2007) found that combining school gardening with nutrition education was more effective for increasing fruit, vegetable, vitamin A, vitamin C, and fiber intake compared to nutrition education alone.

- Parmer et al. (2009) found that combining school gardening with nutrition education significantly increased vegetable intake, while nutrition education alone had no effect on vegetable intake.
- Prell et al. (2005) found that combining home economics classes (cooking) with school cafeteria changes significantly increased fish consumption compared to control. Intake did not change in the group that only received changes to the school cafeteria compared to control, and there was no significant difference between the single- and multi-component groups.

The studies were also compared to determine whether any of the following factors may have affected whether an intervention was effective or not, but no clear trends emerged:

- Duration of the intervention
- Total number of components included in the intervention
- Subject age or grade level
- Theoretical framework used to develop the intervention
- Whether the intervention targeted the dietary intake-related outcomes that were measured

Evidence Summary Paragraphs

DeBar et al., 2006 (Positive Quality) conducted a randomized controlled trial in the United States to test the effects of a health plan-based multi-component lifestyle intervention designed to improve diet, increase physical activity, and increase bone mineral density in adolescent girls. Subjects were randomly assigned to one of two groups for 2 years: (1) Multi-Component: received annual individual visits, telephone calls, group meetings, weekly self-monitoring, use of a study website, youth and parent newsletters, and membership to a fitness center, and (2) Single-Component: received annual individual visits with a health professional. Dietary behavioral outcomes (calcium, vitamin D, soda, and fruit and vegetables intake) were measured using 24-hour recalls. The final sample included 209 girls (101 girls in the multi-component group, 108 girls in the single-component group; mean age=15 years). Compared with the single-component group, girls in the multi-component group reported significantly greater intake of calcium in both study years ($P < 0.001$), vitamin D in the first year ($P < 0.02$), and fruits and vegetables in both years ($P < 0.001$). However, no effects on soda consumption were found.

He et al., 2009 (Neutral Quality) conducted a randomized controlled trial in Canada to measure the influence of the Northern Fruit and Vegetable Pilot Program (NFVPP) on children's fruit and vegetable consumption. Schools were randomly assigned to one of three groups for the 21 week intervention: (1) Multi-Component: received a free fruit and vegetable snack (3 times/week) and enhanced classroom nutrition education, (2) Single-Component: received a free fruit and vegetable snack (3 times/week), and (3) Control: did not receive any intervention. Dietary intake-related outcomes (fruit and vegetable consumption) were measured using a 24-hour fruit and vegetable recall questionnaire. The final sample included 1,277 students (400 children in the multi-component group, 470 children in the single-component group, 407 children in the control group; mean age=12 yrs). Children in the nutrition education + changes to the school food environment group consumed more fruits and vegetables at school compared to control (0.49 serving/d; $P < 0.05$). There were no significant differences in school fruit and vegetable consumption between the school food environment group and the control group. There were no significant differences between any of the groups in fruit and vegetable intake at home or total fruit and vegetable intake.

Hopper et al., 2005 (Positive Quality) conducted a randomized controlled trial in the United States to test the effects of a school-based cardiovascular health promotion program on children's dietary intake. Schools were randomly assigned to one of two groups for 20 weeks: (1) Multi-Component: received enhanced classroom nutrition education, enhanced physical education, and a home program that requested parents and children complete nutrition and exercise activities; and (2) Single-Component: received nutrition and physical education provided in the regular school curriculum. Dietary intake-related outcomes (intake of calories, protein, carbohydrates, total fat, saturated fat, dietary cholesterol, fiber, sodium, percentage of calories from carbohydrates, and percentage of calories from fat) were assessed before and after the intervention using two 24-hour dietary recalls taken at each time point. The final

sample included 238 children (142 children in the multi-component group, 96 children in the single-component group; mean age=9 yrs). Results showed that the multi-component group had significantly lower total fat intake compared to the single-component group ($P<0.05$). There were no differences between the groups for any of the other measured outcomes.

Hopper et al., 1996 (Neutral Quality) conducted a randomized controlled trial in the United States to examine the effects of a school-based exercise and nutrition program on children's dietary fat intake. Classrooms were randomly assigned to one of three conditions for 10 weeks: (1) Multi-Component: received classroom-based nutrition education and a parent/home education component; (2) Single-Component: received classroom-based nutrition education; and (3) Control: received no intervention. Dietary intake-related outcomes (fat intake) were measured before and after the intervention using one 24-hour dietary recall taken at each time point. The final sample included 132 subjects (45 children in the multi-component group, 43 children in the single-component group, 44 children in the control group; mean age=12 yrs). Results showed no significant differences in fat intake between the multi-component and single component intervention groups, though both groups decreased fat intake compared to control ($p<0.05$).

Kitzman-Ulrich et al., 2009 (Neutral Quality) conducted a randomized controlled trial in the United States to examine the effects of nutrition education delivered using a family-based psychoeducational and behavioral skill-building program on adolescent's dietary intake. Subjects were randomly assigned to one of three intervention groups for 16 weeks: (1) Multi-Component: received multiple family therapy sessions, and a family-based psychoeducation curriculum (educational curriculum delivered to subjects and their families that focused on skill-building and psychosocial components related to nutrition), and (2) Single-Component: received a family-based psychoeducation curriculum; and (3) Control: received no intervention. Dietary intake-related outcomes (energy intake) were measured before and after the intervention using three 24-hour dietary recalls taken at each time point. The final sample included 42 adolescent girls (15 girls in the multi-component group, 16 girls in the single-component group, 11 girls in the control group; mean age=13 years). Energy intake decreased in the single-component group compared to the multi-component and control groups ($P<0.01$).

Long, 2004 (Neutral Quality) conducted a quasi-experimental study in the United States to test the effects of a classroom and web-based nutrition education intervention on adolescents' dietary intake. Subjects were randomly assigned to one of two groups for 1 month: (1) Multi-Component: web-based instruction (5 hours) plus classroom-based nutrition education (10 hours); and (2) Single-Component: nutrition education embedded in the standard school curriculum for one month (0–3 hours). Dietary intake-related outcomes (fruit, vegetable, and fat intake) were measured using the validated Youth and Adolescent FFQ. The final sample included 121 adolescents (63 children in the multi-component group, 58 children in the single-component group; median age=13 yrs). Results showed that there were no differences between the intervention and control groups in consumption of fruit, vegetables, or fat.

McAleese & Rankin, 2007 (Neutral Quality) conducted a non-randomized controlled trial in the United States to investigate the effects of a garden-based nutrition education intervention on fruit and vegetable consumption in adolescents. Schools were assigned to one of three groups for 12 weeks: (1) Multi-Component: received nutrition education curriculum and corresponding gardening activities; (2) Single Component: received the nutrition education curriculum only; and (3) Control: received no intervention. Dietary intake-related outcomes (fruit, vegetable, vitamin A, vitamin C, and fiber intake) were determined using two 24-hour food recalls. The final sample included 99 subjects (45 children in the multi-component group, 25 children in the single-component group, 25 children in the control group; mean age=11 yrs). The results showed that children in the multi-component group increased fruit ($P<0.001$), vegetable ($P<0.001$), vitamin A ($P=0.004$); vitamin C ($P=0.016$), and fiber ($P=0.001$) intake compared to students in the single-component or control groups.

McKenzie et al., 1996 (Positive Quality) conducted a randomized controlled trial in the United States to determine the effects of a nutrition intervention on dietary intake among children with and without hypercholesterolemia. Subjects were randomly assigned to one of four groups for 3 months: (1) Multi-Component: children with hypercholesterolemia received one face-to-face counseling session with a registered dietitian, take-home print materials with dietary information, and free telephone access to the dietitian; (2) Single-Component: children with

hypercholesterolemia received home-based nutrition education in the form of a parent-child autotutorial program; (3) At-Risk Control: children with hypercholesterolemia and did not receive a nutrition intervention; and (4) Not-At-Risk Control: children with normal cholesterol and did not receive a nutrition intervention. Dietary intake-related outcomes (10 different food groups and fat intake) were determined by three 24-hour dietary recalls. The final sample consisted of 303 children (71 children in the multi-component group, 77 children in the single-component group, 79 children in the at-risk control group, 76 children in the not-at-risk control group; age=4–10 years). Children in the single-component group significantly decreased fruit intake (~1 serving of fruit and fruit juice; $P<0.006$) compared to baseline. There were no changes in any of the measured dietary-intake related outcomes following the intervention for either the multi-component or control groups, and there were no significant differences between groups.

Neumark-Sztainer et al., 2003 (Neutral Quality) conducted a randomized controlled trial in the United States to test the feasibility and effects of a multi-component, school-based obesity prevention program (New Moves) among adolescent girls. Schools were randomly assigned to one of two groups for a period of 16 weeks (with an 8 month follow-up period): (1) Multi-Component: received the New Moves Program which included physical activity sessions, nutrition education sessions, social support sessions, and a parent component; and (2) Single-Component: received written materials on healthy eating and physical education. Dietary intake-related outcomes (fruit, vegetable, breakfast, soda, and fast food intake) were assessed using an FFQ. The final sample included 190 girls (84 children in the multi-component group, 106 children in the single-component group; mean age=15 yrs). The results showed no significant differences between the multi- and single-component groups for any of the dietary intake-related outcomes measured.

Olvera et al., 2010 (Neutral Quality) conducted a non-randomized controlled trial in the United States to assess the effects of a family-based community program (BOUNCE) on dietary intake in low-income Latino mothers and daughters. Subjects were assigned to one of two groups for 12 weeks: (1) Multi-Component: mothers and daughters received three weekly physical activity sessions, two weekly nutrition sessions, and one weekly behavioral counseling session; and (2) Single-Component: mothers and daughters received educational materials on nutrition and counseling topics and participated in light intensity activity weekly. Dietary intake-related outcomes (high fat food, sweetened beverage, and fruit and vegetable intake) were determined using the School Physical Activity and Nutrition (SPAN) survey completed by the girls. The final sample consisted of 35 children (18 children in the multi-component group, 17 children in the single-component group; mean age=10 yrs). The results showed no significant changes in any of the measured dietary intake-related outcomes in either study group.

Parmar et al., 2009 (Neutral Quality) conducted a non-randomized controlled trial in the United States to examine the effects of a school-based gardening program on children's vegetable intake. Classrooms were assigned to one of three intervention groups for 28 weeks: (1) Multi-Component: received classroom nutrition education instruction and school gardening; (2) Single-Component: received classroom nutrition education; and (3) Control: received no intervention. Dietary intake-related outcomes (vegetable intake) were measured by using structured lunchroom observation. The final sample consisted of 115 subjects (39 children in the multi-component group, 37 children in the single-component group, 39 children in the control group; mean age=7 yrs). The multi-component group ate significantly more vegetables ($P<0.01$), the single-component group had no significant change in consumption, and the control group ate significantly fewer vegetables ($P<0.001$) at post-test, compared to the pre-test.

Prell et al., 2003 (Neutral Quality) conducted a randomized controlled trial in Sweden to examine the effects of school-based interventions on fish consumption among adolescents. Schools were randomly assigned to one of three groups for 5 weeks: (1) Multi-Component: received changes to the school cafeteria (increased choice, marketing, and improved preparation/appearance of fish) and home economics nutrition education, (2) Single-Component: received changes to the school cafeteria; and (3) Control: did not receive any intervention. Dietary intake-related outcomes (fish consumption) were measured using structured observations in the school cafeteria once a week when fish was served. The final sample included 228 subjects (87 children in the multi-component group, 58 children in the single-component group, 83 children in the control group; mean age=14 yrs). The nutrition education + changes to the school food environment group significantly increased fish consumption following the intervention, compared to the control group ($P<0.01$). The school food environment only group did not significantly increase fish

consumption compared to either the control group or the group that received changes to the school food environment only.

Reinaerts et al., 2008 (Neutral Quality) conducted a randomized controlled trial in the Netherlands to assess the effects of school-based interventions designed to improve children's fruit and vegetable consumption. Subjects were randomly assigned to one of three treatment groups for 1 year (with 1 year of follow-up): (1) Multi-Component: received classroom nutrition education and parental involvement; (2) Single-Component: received a daily free fruit and vegetable; and (3) Control: received no intervention. Dietary intake-related outcomes (fruit and vegetable intake) were determined using one 24-hour food recall and an FFQ. The final sample consisted of 436 children (124 children in the multi-component group, 85 children in the single-component group, 227 children in the control group; mean age=8 yrs). The results showed that both intervention groups increased fruit and total fruit, juice, and vegetable intake compared to control ($P<0.05$). The single-component group also increased vegetable snack intake ($p<0.05$) and vegetable intake during dinner ($p<0.01$) compared to the multi-component and control groups.

Sahota et al., 2001 (Positive Quality) conducted a randomized controlled trial in the United Kingdom to assess the effects of a school based intervention on dietary intake among children. Schools were randomly assigned to one of two groups for 1 year: (1) Multi-Component: received teacher training, modification of school meals, and school action plans targeting the curriculum, physical education, school stores, and playground activities, or (2) Single-Component: received the usual health curriculum with no additional intervention. Dietary intake-related outcomes (consumption of high-fat foods, food and drinks high in sugars, fruit, and vegetables) were measured using one 24-hour recall and 3-day food records. The final sample consisted of 593 children (292 children in the multi-component group, 301 children in the single-component group; mean age=8 yrs). Results from the 24-hour recalls showed that the multi-component group had higher vegetable consumption compared to the children in the single-component group ($P<0.05$). Also, fruit consumption was lower in obese children in the multi-component group ($P<0.05$) than those in the single-component group. Results from the 3-day food records showed that overweight children in the multi-component group consumed more high sugar foods ($P<0.05$) compared to the single-component group post-intervention.

Overview Table

Table 4-E.2. Studies examining the effects of multi- vs. single-component nutrition education interventions

Author, year	Description of Intervention, Comparison, and/or Control			Study Population	Description of Outcomes	Limitations
	Single-Component Intervention	Multi-Component Intervention	Control			
Debar, 2006 Positive Quality Randomized Controlled Trial	Individual counseling visits	<ul style="list-style-type: none"> • Individual counseling visits • Telephone calls • Group meetings • Diet self-monitoring • Use of a study website • Youth/parent newsletters • Fitness center membership 	N/A	N = 209 Age: 15 yrs Location: United States Gender: 100% female Race: 81% White SES: Majority middle- to upper-middle income	The multi-component group compared to the single-component group reported greater intake of: – Calcium in both study years (adjusted mean difference [AMD], 216.6 and 241.3 mg, respectively; P<0.001) – Vitamin D in the first year (AMD, 34.3 IU; P<0.02) – Fruits and Vegetables in both years (AMD, 0.74 and 0.79 servings, respectively; P<0.001). No effects on soda consumption were found.	Limited generalizability (population was largely white, middle- to upper-middle-income females, with relatively high calcium intake at baseline) Some intervention elements may not be easily replicated in all medical settings. Health plans might have less participant contact than schools do.
He et al., 2009 Neutral Quality Randomized Controlled Trial	Free fruit/vegetable snack	<ul style="list-style-type: none"> • Free fruit/vegetable snack • Classroom nutrition education 	No intervention control	N = 1,277 Age: 12 yrs Location: Canada Gender: 55% female Race: N/A SES: N/A	The Multi-Component group consumed more fruits and vegetables at school compared to control (0.49 serving/d; P< 0.05). There were no significant differences in school fruit and vegetable consumption between the Single-Component group and control. There were no significant differences between any of the groups in fruit and vegetable intake at home.	The 24-hr recall used has been validated, but was not pre-tested in this study population. The 24-hr recall was complicated, which may have resulted in a substantial number of missing values. Due to missing values, sample size decreased, and the study may not have been adequately powered.
Hopper, 2005 Positive Quality Randomized Controlled Trial	Usual school nutrition education curriculum	<ul style="list-style-type: none"> • Classroom nutrition education • Physical education • Parental involvement 	N/A	N = 238 Age: 9 yrs Location: United States Gender: 49% female Race: 83% White, 5% Native American, 5% Asian, 5% Hispanic, 2% African American SES: N/A	The multi-component group had significantly lower total fat intake (64.68 ±0.87 vs. 57.05±4.21; P<0.05) compared to the single-component group. There were no differences between the groups in other dietary intake variables measured.	Research is needed to determine how to deliver the intervention with increased parent participation, and less time/resource burden for teachers Parent participation rates were low
Hopper et al., 1996 Neutral Quality Randomized Controlled Trial	Classroom nutrition education	<ul style="list-style-type: none"> • Classroom nutrition education • Parental involvement 	Usual school nutrition education curriculum	N = 132 Age: 12 yrs Location: United States Gender: N/A Race: N/A SES: N/A	There were no significant differences in fat intake between the multi-component and single component intervention groups, though both groups decreased fat intake compared to control (p<0.05)	The intervention was delivered at the classroom level, making it difficult to control variations in delivery between classrooms. Low parental participation rates

Table 4-E.2. Studies examining the effects of multi- vs. single-component nutrition education interventions—continued

Author, year	Description of Intervention, Comparison, and/or Control			Study Population	Description of Outcomes	Limitations
	Single-Component Interventions	Multi-Component Intervention	Control			
Kitzman-Ulrich et al., 2009 Neutral Quality Randomized Controlled Trial	Family-based psychoeducation	<ul style="list-style-type: none"> Family-based psychoeducation Multifamily group therapy 	No intervention control	N = 42 Age: 13 yrs Location: United States Gender: 100% female Race: 55% White SES: N/A	Energy intake decreased in the single-component group (-365 kcal/day) compared to the multi-component (+61 kcal/d) and control (+327 kcal/d) groups (P<0.01).	Modest attendance rates (below 50%) may have reduced the impact of the intervention or results in selection bias Long-term research is needed to determine affects on weight/BMI 24-hr dietary recall may not be accurate Small sample size
Long, 2004 Neutral Quality Non-Randomized Controlled Trial	Usual school nutrition education curriculum	<ul style="list-style-type: none"> Classroom nutrition education Web-based nutrition education 	N/A	N = 121 Age: 13 yrs Location: United States Gender: 52% female Race: 47% White, 40-43% Hispanic, 10-13% Black SES: N/A	There were no differences between the intervention groups in consumption of fruit, vegetables, or fat	As students were drawn from 2 volunteer schools, results may not be generalizable to other student populations The study was limited to education of individual adolescents, and changes to the home and school environment were not included; future research should include all strategies in order to determine the effects of education combined with supportive environmental changes Children in the single-component intervention received a much lower dose (0-3 hrs) compared to those in the multi-component intervention (~15 hrs)
McAleese & Rankin, 2007 Neutral Quality Non-Randomized Controlled Trial	Classroom nutrition education	<ul style="list-style-type: none"> Classroom nutrition education School gardening 	No intervention control	N = 99 Age: 11 yrs Location: United States Gender: 56% female Race: N/A SES: N/A	The multi-component group increased fruit (1.3 servings; P<0.001), vegetable (1.44 servings; P<0.001), vitamin A (P=0.004); vitamin C (P=0.016), and fiber (P=0.001) intake compared to students in the single-component or control groups.	Non-randomized design limits generalizability to this specific study population
McKenzie et al., 1996 Positive Quality Randomized Controlled Trial	Home nutrition education (parent-child auto-tutorial)	<ul style="list-style-type: none"> Individual counseling sessions (child and parent) Take-home nutrition education materials Telephone access to an RD 	No intervention control	N = 303 Age: 4–10 yrs Location: United States Gender: Males and females Race: N/A SES: N/A	The single-component group significantly decreased fruit intake (3.2 to 2.4 servings/day of fruit and fruit juice combined; P<0.006) There were no changes in any of the measured dietary-intake related outcomes following the intervention for either the multi-component or control groups, and there were no significant differences between groups.	Study population was mostly upper-class white children from highly educated two parent homes, which limits generalizability of the study Report changes in fruit intake, but do not distinguish between whole fruit, fruit juice, and 100% fruit juice

Table 4-E.2. Studies examining the effects of multi- vs. single-component nutrition education interventions—continued

Author, year	Description of Intervention, Comparison, and/or Control			Study Population	Description of Outcomes	Limitations
	Single-Component Intervention	Multi-Component Intervention	Control			
Neumark-Sztainer, 2003 Neutral Quality Randomized Controlled Trial	Distribution of educational materials on healthy eating and physical education	<ul style="list-style-type: none"> • Nutrition education sessions • Physical activity sessions • Social support sessions • Lunch meetings with healthy food • Parental involvement 	N/A	N = 190 Age: 15 yrs Location: United States Gender: 100% female Race: 42% White, 29% African American, 21% Asian, 4% Hispanic, 1% Native American, 3% Other SES: N/A	There were no significant differences between the multi- and single-component groups for any of the dietary intake-related outcomes measured	Study includes a subgroup from the larger school population and may not be representative Small sample size limits statistical power Short study length, more long-term studies are needed
Olvera, 2010 Neutral Quality Non-Randomized Controlled Trial	Individual counseling sessions	<ul style="list-style-type: none"> • Nutrition education sessions • Physical activity sessions • Behavioral counseling sessions 	N/A	N=35 Age: 10 yrs Location: United States Gender: 100% females Race: 100% Latino SES: N/A	There were no significant changes in any of the measured dietary intake-related outcomes in either study group	Small sample size, high dropout rate (76% completed the study), and exclusive analysis of Latina females limits study generalizability Short study duration; longer-term studies are needed
Parmer, 2009 Neutral Quality Non-Randomized Controlled Trial	Classroom nutrition education	<ul style="list-style-type: none"> • Classroom nutrition education • School gardening 	No intervention control	N = 115 Age: 7 yrs Location: United States Gender: 30% female Race: N/A SES: N/A	The multi-component group ate significantly more vegetables ($t=3.04, P<.01$), the single-component group had no significant change in consumption, and the control group ate significantly fewer vegetables ($t=-2.64, P<0.001$) at post-test compared the pre-test.	Relatively small sample size and short study length. Non-randomized design limits the scope of inference to this specific study population Study population may not be representative, limiting generalizability
Prell et al., 2005 Neutral Quality Randomized Controlled Trial	Modification of school meals	<ul style="list-style-type: none"> • Modification of school meals • Home economics education 	No intervention control	N = 228 Age: 14 yrs Location: Sweden Gender: 47% female Race: N/A SES: N/A	The multi-component group significantly increased fish consumption following the intervention, and this increase differed significantly from the control group ($P<0.01$). The single-component group had no significant change in fish consumption, and did not differ from control. The single-component and multi-component groups did not differ.	Baseline differences in fish consumption between groups may have influenced results. Did not include a comparison group that received the home economics education alone to determine the impact of this component alone on fish consumption.

Table 4-E.2. Studies examining the effects of multi- vs. single-component nutrition education interventions—continued

Author, year	Description of Intervention, Comparison, and/or Control			Study Population	Description of Outcomes	Limitations
	Single-Component Intervention	Multi-Component Intervention	Control			
Reinaerts, 2008 Neutral Quality Randomized Controlled Trial	Free fruit/vegetable snack	<ul style="list-style-type: none"> Classroom nutrition education Parental involvement 	No intervention control	<p>N = 436</p> <p>Age: 8 yrs</p> <p>Location: The Netherlands</p> <p>Gender: 53% female</p> <p>Race: N/A</p> <p>SES: N/A</p>	<p>Both intervention groups increased fruit and total fruit, juice, and vegetable intake compared to control (P<0.05)</p> <p>The single-component group also increased their vegetable snack intake (p<0.05) and vegetable intake during dinner (p<0.01), as compared to the multi-component and control groups</p>	<p>Schools were assigned randomly to interventions, but control schools were matched to intervention schools based on size/ethnicity, which resulted in significant baseline differences between groups</p> <p>High attrition rates (46% at yr 1, 75% at yr 2) due to missing questionnaires</p> <p>Few schools were willing to participate due to limited time</p> <p>The study relied heavily on parental reports for intake of their children which might threaten validity.</p>
Sahota et al., 2001 Positive Quality Randomized Controlled Trial	Usual school nutrition education curriculum	<ul style="list-style-type: none"> Teacher training Modification of school meals, foods sold in school Action plans for nutrition and physical education curriculum 	N/A	<p>N = 593</p> <p>Age: 8 yrs</p> <p>Location: United Kingdom</p> <p>Gender: 45% female</p> <p>Race: N/A</p> <p>SES: N/A</p>	<p>Results from the 24-hr recalls showed that the multi-component group had higher vegetable consumption compared to the single-component group (+0.3 portions/d, 95% CI 0.2, 0.4).</p> <p>Fruit consumption was lower in obese children in the multi-component group (-1.0 portions/d, 95% CI -1.8, -0.2) than those in the single-component group.</p> <p>Results from the 3-day food records showed that overweight children in the multi-component consumed more high sugar foods (+0.8 portions/day, 95% CI 0.1, 1.6) than the single-component group.</p>	<p>Inadequate sample size for group randomization (5 schools)</p> <p>Dietary intake-related outcomes were self-reported</p>

Research Recommendations

1. Conduct research designed specifically to test which components, when combined, create effective multi-component nutrition education interventions, and how best to tailor the components for specific subject populations. This may be accomplished using statistical modeling and/or component analyses. This research should also consider the feasibility and affordability of implementing multi-component interventions.

Conduct more research to explore the validity of measurement instruments for use in children and adolescents (e.g., single vs. multiple 24-hour recalls, plate waste estimates, FFQ, lunchroom observation). This includes instruments used to measure dietary-intake related outcomes, as well those that measure compliance with, participation, or fidelity intervention.

Rationale: The research included in this review was not explicitly designed to test the effects of specific components alone and within a multi-component intervention. In order to determine which combinations of components are most effective for changing children's and adolescents' dietary intake-related behaviors, more carefully designed trials are needed, or statistical modeling and/or component analyses need to be undertaken. In addition, it is unclear whether certain populations would benefit more from different multi-component interventions, and therefore, more research is needed to determine which multi-component interventions would work best for specific populations (e.g., based on age, gender). Finally, more research would help determine whether differences in study results may be due to study design, outcomes assessed, or measurement techniques.

More research would also help determine whether differences in study results may be due to measurement techniques. In addition, use of validated measurement instruments would aid in understanding how well certain components of a multi-component interventions were implemented and adopted. This information would be useful in determining which components are most effective, as well as in determining the feasibility and affordability of such interventions.

2. Research to determine whether certain outcomes (e.g., fruit and vegetable, whole grain, sugar sweetened beverage, and nutrient intake) are differentially affected by certain types of interventions.

Rationale: More research would help determine whether differences in study results may be due to the outcomes being targeted.

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Chapter 4-F. Mediators of the Effects of Nutrition Education Interventions on Children and Adolescents' Dietary Intake-Related Behaviors

TECHNICAL ABSTRACT

Background

In designing nutrition education programs, it may be important to consider whether there are certain variables that could act as mediators, explaining the effects of a nutrition education intervention on children's dietary intake. The objective of this systematic evidence scan was to examine factors that mediate the effects of nutrition education interventions on children's and adolescents' dietary-intake related behavior.

Methods

Literature searches were conducted using PubMed, EBSCOhost, Education Fulltext, and Global Health to identify studies that conducted mediator analyses related to nutrition education interventions.

- Inclusion criteria: published between January 1995 and December 2010; conducted in subjects aged 0–18 years; randomized controlled trials, non-randomized controlled trials, or quasi-experimental studies; subjects from countries with high or very high human development (based on the Human Development Index); subjects who were healthy or at elevated chronic disease risk; published in English in a peer-reviewed journal
- Exclusion criteria: systematic reviews, meta-analyses, narrative reviews, or prospective cohort, cross-sectional, or case-control designs; studies with no control group; subjects hospitalized, diagnosed with disease, and/or receiving medical treatment

The results of each included study were summarized in evidence worksheets (including a study quality rating), an evidence paragraph, and evidence table. A group of subject matter experts were involved in a review of the body of evidence and development of research recommendations. Due to the limited and disparate nature of the literature identified, conclusions were not drawn.

Findings

Eight studies were included in this systematic evidence scan; four randomized controlled trials and four non-randomized controlled trials. Five studies received a neutral quality rating (1 RCT, 4 non-RCTs), and three studies received a positive quality rating (3 RCTs).

The studies included in this systematic evidence scan examined a wide range of variables as potential mediators. Because few studies were identified that conducted mediator analyses, and each study differed in terms of the variables tested, it is difficult to compare results across studies.

Discussion

This systematic evidence scan was conducted to examine factors that mediate the effects of nutrition education interventions on children's and adolescents' dietary-intake related behavior. The studies identified and reviewed examined a wide range of variables as potential mediators. However, because few studies were identified that conducted mediator analyses, and each study differed in terms of the variables tested, it is difficult to compare results across studies. Therefore, a full systematic review was not conducted, and instead, a systematic evidence scan was completed. This systematic evidence scan provides an overview of existing research that addresses this topic area, and offers a series of research and systematic review recommendations for the future.

PLAIN LANGUAGE SUMMARY

Mediators of nutrition education programs

When developing nutrition education programs, it may be important to think about factors that act as mediators. Mediators are factors that explain the effects of the program on what children eat. In nutrition education examples of mediators include: nutrition knowledge, self-efficacy, and attitude. This summary of a NEL evidence scan presents what we know from research about mediators of nutrition education programs.

What the Research Says

- Eight studies were included in this scan.
- We are unable to compare the results across studies because few studies analyzed these factors and the studies tested different factors and measured different outcomes.
- More research is needed to understand what factors mediate the effects of nutrition education programs.

EVIDENCE PORTFOLIO

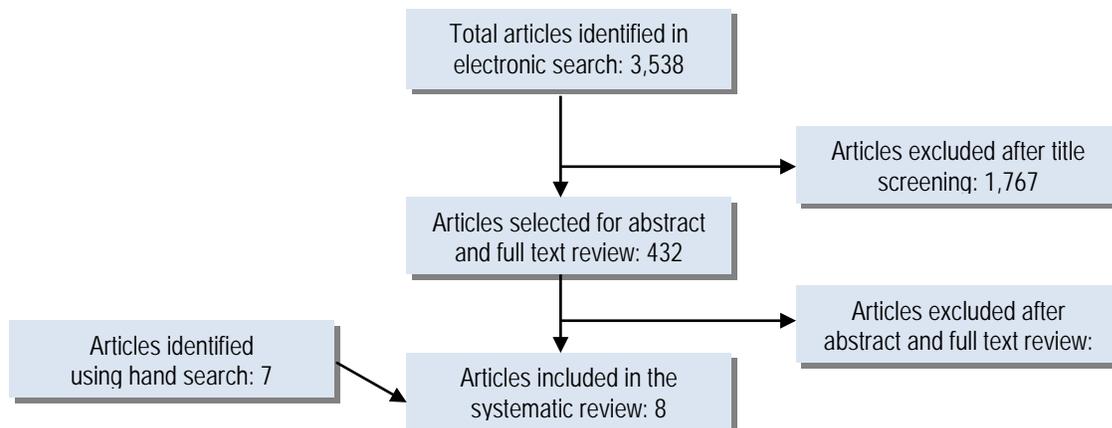
Evidence Summary Overview

This systematic evidence scan was conducted to examine factors that mediate the effects of nutrition education interventions on children and adolescent's dietary-intake related behavior. The studies identified and reviewed examined a wide range of variables as potential mediators. However, because few studies were identified that conducted mediator analyses, and each study differed in terms of the variables tested, it is difficult to compare results across studies. Therefore, a full systematic review was not conducted, and instead, a systematic evidence scan was completed. This systematic evidence scan provides an overview of existing research that addresses this topic area, and offers a series of research and systematic review recommendations for the future.

Description of the Evidence

The literature search for studies that tested which factors mediate the effects of nutrition education interventions identified 3,538 articles, 432 of which were selected for review (Figure 4-F.1). Of these 432 articles, 1 was selected for inclusion in the systematic evidence scan. In addition, seven articles were identified via hand search. Therefore, this systematic evidence scan includes a total of eight articles. A detailed description of literature search results, including the databases searched and the number of articles identified using each database, articles identified using hand search, a list of citations for all included articles, and a table that lists excluded studies with rationale for exclusion can be found in Appendix I.

Figure 4-F.1. **Flow chart of literature search results for studies examining the effects of mediators of nutrition education interventions**



Of the eight studies included in this review:

- Four were randomized controlled trials (Amaro, 2006 [Neutral Quality]; Chin, 2008 [Positive Quality]; Reynolds, 2004 [Positive Quality]; Reynolds, 2002 [Positive Quality]).
- Four studies were non-randomized controlled trials (Di Noia, 2010 [Neutral Quality]; Haerens, 2007 [Neutral Quality]; MacKinnon, 2001 [Neutral Quality]; Tak, 2009 [Neutral Quality]).
- Five studies received a neutral quality rating, and three studies received a positive quality rating.
- Four studies were conducted in the United States, two studies were conducted in the Netherlands, one study was conducted in Belgium, and one was conducted in Italy.
- Sample sizes of the studies ranged from 241 to 1,584.
- Six studies included both boys and girls, one study included only girls, and one study included only boys.
- Mean subject age ranged from 8 years to 15 years.
- Two studies did not report the race/ethnicity of subjects, one study included only African American subjects, one study included only White subjects, and three studies included a majority of White subjects.
- Information regarding the socio-economic status of subjects was not widely reported; three studies included subjects with a mean household income between \$40,000 and \$50,000, and one study included subjects who resided in communities in which ≥ 20 percent of families had household incomes below federal poverty levels.

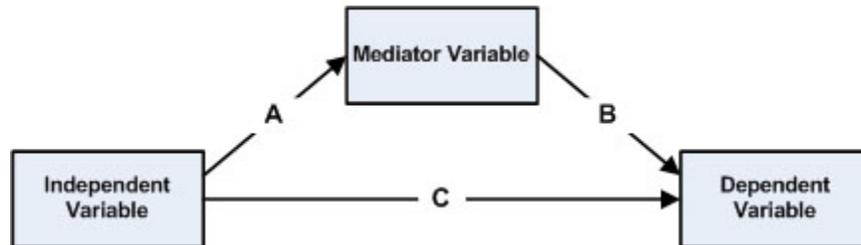
Description of Mediation

A mediator is a variable that accounts for, or explains, the relationship between an independent variable and a dependent variable (Fig. 4-F.2). In order for a variable to function as a mediator, four statistical conditions must be met:

- Step 1: The independent and dependent variables must be significantly related.
- Step 2: The independent variable must be significantly related to the mediator.
- Step 3: The mediator must be significantly related to the dependent variable, while controlling for the independent variable.
- Step 4: The relationship between the independent and dependent variable should be zero and no longer be significant when the mediating variable is controlled.

If all four steps have been satisfied, then complete mediation has been established. However, if only the first three steps are satisfied, then partial mediation has been established. (Baron and Kenny, 1986)

Figure 4-F.2. A simple model of mediation. (Source: <http://en.wikipedia.org/wiki/File:Mediation.jpg>)



In the field of nutrition education, a mediator variable would explain the effects of a nutrition education intervention (independent variable) on children’s and adolescents dietary intake-related behaviors (dependent variable). Some examples of possible mediations of nutrition education interventions are nutrition knowledge, self-efficacy, attitude, and perceived benefits. For example, if nutrition knowledge is a mediator of the effects of a nutrition education intervention on fruit intake, the following conditions would be met:

- Step 1: The nutrition education intervention would be significantly associated with increased fruit intake.
- Step 2: The nutrition education intervention would be significantly associated with increased nutrition knowledge.
- Step 3: Nutrition knowledge would be significantly related to increased fruit intake, while controlling for the nutrition education intervention.
- Step 4: The relationship between the nutrition education intervention and fruit intake would be zero and no longer be significant when nutrition knowledge is controlled.

Therefore, nutrition knowledge would explain the effects of the nutrition education intervention on fruit intake, such that the intervention increased nutrition knowledge, which in turn led to increased fruit intake.

Description of Outcomes

The studies included in this systematic evidence scan examined a wide range of variables as potential mediators. Because few studies were identified that conducted mediator analyses, and each study differed in terms of the variables tested, it is difficult to compare results across studies. Table 1 provides a summary of the mediators examined in each study included in this evidence scan. This table illustrates the wide range of factors that were tested as mediators in this set of studies.

Table 4-F.1. A description of the mediators tested and outcomes of the mediator analyses

Study	Mediators Tested	Results	Description of Results
Amaro, 2006	Nutrition knowledge	No	
Chin, 2008	Attitude	Yes	<u>Boys</u> : Attitude was a significant partial mediator of the effect of the intervention on decreased SCB consumption (P<0.05) <u>All (intervention + control subjects combined)</u> : Attitude was a significant partial mediator of the effect of the intervention on decreased SCB consumption and high-kcal snack intake (P<0.05)
	Behavioral control	Yes	<u>All (intervention + control subjects combined)</u> : Behavioral control was a significant partial mediator of the effect of the intervention on decreased SCB consumption and high-kcal snack intake (P<0.05)
	Subjective norm	No	
	Habit strength	Yes	<u>Boys</u> : Habit strength were significant partial mediator of the effect of the intervention on decreased SCB consumption (P<0.05) <u>All (intervention + control subjects combined)</u> : Habit strength was a significant partial mediator of the effect of the intervention on decreased SCB consumption and high-kcal snack intake (P<0.05)
Di Noia, 2010	Pros	Yes	<u>Single-Mediator Model</u> : "Pros" mediated 7% of the intervention effect on increased fruit and vegetable intake (P<0.05)
	Cons	No	
	Self-efficacy	No	
	Stages of change	Yes	<u>Single-Mediator Model</u> : "Forward stage movement" mediated 31% of the intervention effect on increased fruit and vegetable intake (P<0.05) <u>Multiple-Mediator Model</u> : "Forward stage movement" mediated 72% of the intervention effect on increased fruit and vegetable intake (P<0.001)
Haerens, 2007	Attitude	No	
	Social support	No	
	Self-efficacy	No	
	Perceived benefits	No	
	Perceived barriers	Yes	<u>Single-Mediator Model</u> : Perceived barriers significantly suppressed changes in fat intake (0.15g fat/d; P=0.011)
MacKinnon, 2001	Intent to use anabolic steroids (AS)	No	
	Strength training self-efficacy	No	
	Knowledge of the effects of AS	Yes	<u>Single-Mediator Model</u> : Knowledge of the effects of AS mediated the effects of the intervention on improved nutrition behaviors measured at posttest
	Perceived coach tolerance of AS use	Yes	<u>Single-Mediator Model</u> : Perceived coach tolerance of AS use mediated the effects of the intervention on improved nutrition behaviors measured at posttest
	Team as an information source	Yes	<u>Single-Mediator Model</u> : Team as an information source mediated he effects of the intervention on improved nutrition behaviors measured at posttest and 1-yr f/u <u>Multiple-Mediator Model</u> : Team as an information source mediated 8% and 14% of the effects of the intervention on improved nutrition behaviors measured at posttest and 1-yr f/u respectively

Table 4-F.1. A description of the mediators tested and outcomes of the mediator analyses—continued

Study	Mediators Tested	Results	Description of Results
	Peers as an information source	Yes	<u>Single-Mediator Model</u> : Peers as an information source mediated the effects of the intervention on improved nutrition behaviors measured at posttest and 1-yr f/u <u>Multiple-Mediator Model</u> : Peers as an information source mediated 22% and 31% of the effects of the intervention on improved nutrition behaviors measured at posttest and 1-yr f/u respectively
	Ability to turn down drug offers	No	
	Perceived peer tolerance of drug use	No	
	Normative beliefs about AS use	No	
	Perceived severity of AS use	Yes	<u>Single-Mediator Model</u> : Perceived severity of AS use mediated the effects of the intervention on improved nutrition behaviors measured at 1-yr f/u
	Perceived susceptibility to AS effects	No	
	Beliefs in media advertisements	Yes	<u>Multiple-Mediator Model</u> : Beliefs in media advertisements negatively mediated 9% and 14% of the effects of the intervention on nutrition behaviors measured at posttest and 1-yr f/u respectively
	Reasons for using AS	No	
	Reasons for not using AS	Yes	<u>Single-Mediator Model</u> : Reasons for not using AS mediated the effects of the intervention on improved nutrition behaviors measured at posttest
Reynolds, 2004	Availability	No	
	Eating meals together	No	
	Knowledge	Yes	Alabama: Knowledge of the recommended number of fruit and vegetable servings mediated 9.78% of the total intervention effect on increased fruit and vegetable intake (P<0.05)
	Positive outcome expectancy	No	
	Parent consumption	No	
	Self-efficacy	No	
	Family norms	No	
	Peer norms	No	
	Teacher norms	No	
Reynolds, 2002	Availability	No	
	Eating meals together	No	
	Knowledge	No	
	Positive outcome expectancy	Yes	<u>Single-Mediator Model</u> : Positive outcome expectancies significantly mediated 7.2% of the effects of the intervention on increased fruit and vegetable consumption (P<0.05)
	Parent consumption	No	
	Self-efficacy	No	
	Family norms	No	
	Peer norms	No	
	Teacher norms	No	
Tak, 2009	Appreciation of the intervention	Yes	Appreciation of the intervention partially mediated the effects of the intervention on increased fruit intake (P<0.05)

Evidence Summary Paragraphs

Amaro et al., 2006 (Neutral Quality) conducted a randomized controlled trial in Italy to test the effects of a nutrition education board game (Kaledo) on changes in nutrition knowledge and dietary behavior among middle school children. Classrooms were randomly assigned to one of two groups for 24 weeks: (1) Intervention group: participated in one Kaledo play session/week; (2) Control group: received no intervention. Dietary intake-related behavior (weekly vegetable intake) was measured using a non-validated 34-item questionnaire given before and after the intervention. A series of regression models were used to test whether “nutrition knowledge” mediated the effect of the intervention on weekly vegetable intake. The final sample included 241 students (mean age=12 yrs). Results showed that children playing Kalèdo had higher weekly vegetable intake compared to children in the control group ($p<0.01$). However, “nutrition knowledge” did not mediate the effects of the intervention on weekly vegetable intake.

Chin et al., 2008 (Positive Quality) conducted a randomized controlled trial in the Netherlands to identify the mediating mechanisms of a school-based obesity prevention program (DOiT) among secondary school students. Schools were randomly assigned to one of two groups for 9 months: (1) Intervention group: received the DOiT-program, which consisted of nutrition education, changes to the school cafeteria, and physical education classes aimed at improving energy balance behaviors; (2) Control group: received the regular classroom curriculum. Dietary intake-related behaviors (weekly sugar-containing beverage (SCB) and high-calorie snack intake) and potential mediators were measured before and immediately following the intervention using the non-validated DOiT-questionnaire. Regression analyses (multi-level linear analysis) were conducted to determine whether attitude, subjective norm, behavioral control, and habit strength mediated the effects of the intervention on energy balance related behaviors. The final sample included 854 students (mean age=13 yrs). Results showed that boys and girls receiving the DOiT-program reduced SCB consumption ($P<0.05$). There were no effects on high-calorie snack intake. In boys, the DOiT program significantly improved the subjective norm for decreasing snack consumption, and improved attitude and decreased habit strength for consumption of SCB ($P<0.05$). In girls, the DOiT program did not affect any of the hypothesized mediators. For boys, attitude and habit strength were significant partial mediators of the effect of the intervention on SCB consumption ($P<0.05$). For girls, none of the mediators were significant. In addition, some mediators were significantly predictive of behavior change, regardless of whether subjects were exposed or not to the intervention: attitude, perceived behavioral control, and habit strength regarding reducing SCB and high calorie snack consumption ($P<0.05$).

Di Noia et al., 2010 (Neutral Quality) conducted a non-randomized controlled trial in the United States to identify mediators of an intervention to promote fruits and vegetable consumption among economically disadvantaged African American adolescents. Subjects were assigned to one of two groups for 1 month: (1) Intervention: received nutrition education from a CD-ROM; (2) Control group: received no intervention. Dietary intake-related behaviors (fruit and vegetable intake) and potential mediators were measured before and immediately following the intervention using a staging measure from the Cancer Prevention Research Center. ANCOVA and Sobel tests were used to test whether pros, cons, self-efficacy, and stages of change mediated the effects of the intervention on fruit and vegetable intake. The final sample included 507 students (mean age=12 yrs). The intervention group increased fruit and vegetable consumption compared to controls ($P<0.001$). The intervention also increased “pros” for consuming fruits and vegetables ($P<0.05$), and promoted forward stages of change movement ($P<0.001$). The single-mediator models found that increases in “pros” ($P<0.001$) and forward stage movement ($P<0.001$) were associated with increases in fruit and vegetable consumption. Forward stage movement was also related to increases in intake in the multiple-mediator model ($P<0.001$), while pros were not. “Pros” mediated 7% of the intervention effect ($P<0.05$), while forward stage movement mediated 31 percent of the effect in the single-mediator models and 72% of the intervention effect in the multiple-mediator model ($P<0.001$).

Haerens et al., 2007 (Neutral Quality) conducted a non-randomized controlled trial in Belgium to examine mediation effects of changes in psychosocial determinants of dietary fat intake on changes in fat intake in adolescent girls. Schools were randomly assigned to one of three groups for 1 year: (1) Intervention group with parental support: received a multi-component school-based intervention program, combining environmental changes with a computer tailored fat intake intervention and parental support; (2) Intervention group without parental support: received a multi-component school-based intervention program, combining environmental changes with a computer

tailored fat intake intervention; and (3) Control: received no intervention. For this study, only girls in the intervention group with parental support and the control groups were included. Dietary intake-related outcomes (fat intake) and psychosocial determinants of fat intake were measured before (September) and immediately following (June) the intervention using a validated FFQ and survey. A product-of-coefficient test was used to determine whether attitude, self-efficacy, social support, perceived benefits, or perceived barriers mediated the effects of the intervention on fat intake. The final sample included 788 girls (mean age=13 yrs). The intervention group reduced fat intake by 9 g/day more than did the control group ($P<0.05$). However, the intervention did not lead to significant positive changes in the psychosocial determinants measured, and compared to the control group, the intervention appeared to have negative effect on changes in perceived barriers ($P<0.01$). None of the psychosocial factors tested showed a reliable mediating effect on changes in fat intake. The single-mediator model revealed a statistically significant suppression effect of perceived barriers on changes in fat intake (0.15g fat/day; $P=0.011$) due to the intervention having a negative effect on this psychosocial factor ($P=0.002$). However, this effect was no longer significant in the multiple-mediator model.

MacKinnon et al., 2001 (Neutral Quality) conducted a randomized controlled trial in the United States to identify the mediating mechanisms responsible for the effects of a program designed to reduce intentions to use anabolic steroids, improve nutrition, and increase strength training self-efficacy among high school football players. Football teams were randomly assigned to one of two groups for 7 weeks (with follow-up at 1 yr): (1) Intervention: received a multi-component program that addressed the social influences promoting ergogenic drug use and engaging students in healthy nutrition and strength training alternative behaviors; and (2) Control: received no intervention. Dietary intake-related behaviors were measured before, immediately following, and one year after the intervention using a survey. Multilevel modeling analyses were conducted to determine whether variables related to beliefs, knowledge, norms, or resistance skills mediated the effects of the intervention on nutrition behaviors. The final sample included 1,226 boys (mean age=15 yrs). The single mediator model showed that the effects of the intervention on nutrition behaviors were mediated by knowledge of AAS effects, perceived coach tolerance of AAS use, peers as an information source, team as an information source, and reasons for not using AAS ($P<0.05$) immediately after the intervention, and peers and team as information sources and perceived severity were significant mediators at the 1-year follow-up ($P<0.05$). The multiple mediator model, at both posttest and 1-year follow-up, showed that the following factors were significant mediators of the effects of the program on nutrition behaviors: peers as an information source (22 and 31 percent mediated at posttest and 1-yr follow-up), team as an information source (14 and 8 percent mediated at posttest and 1-yr follow-up), and beliefs in media advertisements (9 and 14 percent mediated at posttest and 1-yr follow-up) ($P<0.001$). The mediated effect of beliefs in media advertisements was a counterproductive effect.

Reynolds et al., 2004 (Positive Quality) used data from two randomized controlled trials in the United States to identify mediators of the effects of school-based nutrition interventions on children's fruit and vegetable intake. In Minnesota, schools were randomly assigned to one of two groups for 1 year: (1) Intervention: received classroom nutrition education, parental involvement/education, school food service changes, and industry support and involvement, and (2) Control: received the regular classroom curriculum. In Alabama, schools were randomly assigned to one of two groups for 2 years: (1) Intervention: received of classroom nutrition education, family involvement, and school food service changes, and (2) Control: received the regular classroom curriculum. Dietary intake-related behaviors (fruit and vegetable intake) were measured before and immediately following the intervention using a single 24-hour dietary recall. A full mediational analysis was conducted to determine whether the following variables mediated the effects of the intervention on fruit and vegetable intake: availability of fruit and vegetables at home, knowledge of the recommended number of servings of fruit and vegetables, and parental fruit and vegetable consumption. The final sample included 1,584 fourth graders in Alabama and 522 fourth graders in Minnesota (mean age =10 yrs). The intervention increased fruit and vegetable consumption in Alabama ($P<0.0001$) and Minnesota ($P<0.001$) compared to control. In Alabama, knowledge of the recommended number of fruit and vegetable servings mediated 9.78 percent of the total intervention effect ($P<0.05$). In Minnesota, none of the variables tested met all four mediation conditions.

Reynolds et al., 2002 (Positive Quality) conducted a randomized controlled trial in the United States to test the effects of a school-based nutrition intervention on changes in fruit and vegetable consumption among 4th graders,

and analyzed the data to identify mediators of the intervention. Fourth grade classes were assigned to one of two groups for 7 weeks: (1) Intervention: received classroom nutrition education, a family component, and a cafeteria component; (2) Control: received the usual classroom curriculum. Dietary intake-related behaviors (fruit and vegetable intake) were measured before and immediately following the intervention using a single 24-hour dietary recall. A mediational analysis using regression was conducted to determine whether availability of fruits and vegetables at home, eating meals as a family, fruits and vegetable knowledge, positive outcome expectancies, perceived self-efficacy, parental fruit and vegetable intake, or family, peer, and teacher social norms mediated the effects of the intervention on fruit and vegetable intake. The final sample included 1,505 children at year 2 and 1,382 children at year 3 (mean age=10 yrs). The intervention significantly increased fruit and vegetable consumption across years one to two ($P<0.001$) and years one to three ($P<0.001$) compared to control. The mediation analysis showed that positive outcome expectancies had a significant mediating effect on fruit and vegetable consumption, explaining 7.2 percent of the intervention effect (using the single mediator model) ($P<0.05$).

Tak et al., 2009 (Neutral Quality) conducted a non-randomized controlled trial in the Netherlands to evaluate the long-term effects of the school-based intervention on fruit and vegetables (F&V) consumption by children and to assess whether children's appreciation of the project mediated intervention effects. Schools were assigned to one of two groups for 2 years: (1) Intervention: received nutrition education and a free piece of fruit or ready-to-eat vegetables twice a week; (2) Control: received their usual nutrition education programs. Dietary intake-related behaviors (fruit and vegetable intake) were assessed at baseline and at 1-year and 2-year follow-ups using the validated Pro Children food frequency questions completed by both children and parents independently. Regression analyses were conducted to determine whether children's appreciation of the project mediated the effects of the intervention on fruit and vegetable intake. The final sample included 771 children (mean age=10 yrs). The intervention group had a significantly higher fruit intake at 2-year follow-up compared to control ($P<0.05$). No significant effects on vegetable intake were observed. Some evidence was found for partial mediation of the intervention effects on fruit intake by appreciation of the intervention. Children in the intervention group were more likely to appreciate the intervention, and the children who appreciated the intervention increased their fruit intake ($P<0.05$).

Overview Table

Table 4-F.2. Studies examining factors that mediate the effects of nutrition education interventions

Study	Study Population	Study Description	Description of Primary Study Outcomes	Mediator Analysis Outcomes	Limitations
Amaro, 2006 Neutral Quality Randomized Controlled Trial	N = 241 (45% female) Mean age=12 yrs Race: 100% White SES: N/A Italy	Intervention group: participated in one Kaledo play session/week (24 wk) Control group: received no intervention	Children playing Kaledo had higher weekly vegetable intake compared to children in the control group (3.7 vs. 2.8 servings; $p < 0.01$).	"Nutrition knowledge" did not mediate the effects of the intervention on vegetable intake	Use of a non-validated tool to measure dietary intake. Because classrooms were the unit of randomization there may have been contamination between classes within a school. Subject population may not be generalizable due to homogeneity of ethnicity and age. Kaledo was designed to impact nutrition knowledge, and not change behavior.
Chin, 2008 Positive Quality Randomized Controlled Trial	N = 854 (51% female) Mean age=13 yrs Race: N/A SES: N/A The Netherlands	Intervention group: received the DOIIT-program, which consisted of nutrition education, changes to the school cafeteria, and physical education classes aimed at improving energy balance behaviors (9 mo). Control group: received the regular classroom curriculum	Boys and girls receiving the intervention reduced sugar-containing beverages (SCB) consumption (-303.5 ml/d for boys, -222.3 ml/d for girls; $P < 0.05$). There were no effects on high-calorie snack intake. Boys: the intervention improved the subjective norm for decreasing snack consumption, and attitude and decreased habit strength for consumption of SCB ($P < 0.05$). Girls: the intervention did not affect any of the mediators.	For boys, attitude and habit strength were significant partial mediators of the effect of the intervention on SCB consumption ($P < 0.05$). For girls, none of the mediators were significant. Some mediators were significantly predictive of behavior change, regardless of whether subjects were exposed or not to the intervention: attitude, perceived behavioral control, and habit strength regarding reducing SCB and high calorie snack consumption ($P < 0.05$).	Dietary intake and mediator data was self-reported. Measurements tool were not validated. Hypothetical mediators and behavioral outcomes were measured at the same time point, so the mediator analysis is correlational and cannot establish causality.

Table 4-F.2. Studies examining factors that mediate the effects of nutrition education interventions

Study	Study Population	Study Description	Description of Primary Study Outcomes	Mediator Analysis Outcomes	Limitations
<p>Di Noia, 2010 Neutral Quality Non-Randomized Controlled Trial</p>	<p>N = 507 (61% female) Mean age=12 yrs Race: 85% African American, 15% African American-Hispanic SES: Subjects resided in communities in which ≥20% of families had household incomes below federal poverty levels United States</p>	<p>Intervention group: received nutrition education from a CD-ROM (1 mo) Control group: received no intervention</p>	<p>The intervention group increased their fruit and vegetable consumption compared to the control group (P<0.001) The intervention group increased “pros” for consuming fruits and vegetables (P<0.05), and promoted forward stages of change movement (P<0.001)</p>	<p>“Pros” (P< 0.05) and forward stage movement (P<0.001) were significant mediators of fruit and vegetable consumption in the single-mediator model, and forward stage movement was also a significant mediator in the multiple-mediator model (P<0.001). “Pros” mediated 7% of the intervention effect (P<0.05), while forward stage movement mediated 31% of the effect in the single-mediator models. Forward stage movement mediated 72% of the intervention effect in the multiple-mediator model (P<0.001).</p>	<p>Use of a self-selected sample limits the generalizability of the findings The non-randomized, quasi-experimental design limits internal validity Data for the study were based on self-report</p>
<p>Haerens, 2007 Neutral Quality Non-Randomized Controlled Trial</p>	<p>N = 788 (100% female) Mean age = 13 yrs Race: N/A SES: N/A Belgium</p>	<p>Intervention group: received a multi-component school-based intervention program, combining environmental changes with a computer tailored fat intake intervention and parental support (1 yr) Control: received no intervention</p>	<p>The intervention group reduced fat intake by 9 g/day more than did the control group (P<0.05). The intervention did not lead to significant positive changes in the psychosocial determinants measured, and compared to the control group, the intervention appeared to have negative effect on changes in perceived barriers (P<0.01).</p>	<p>None of the psychosocial factors tested showed a reliable mediating effect on changes in fat intake. The single-mediator model revealed a statistically significant suppression effect of perceived barriers on changes in fat intake (0.15g fat/day; P=0.011) due to the intervention having a negative effect on this psychosocial factor (P=0.002). However, this effect was no longer significant in the multiple-mediator model.</p>	<p>Measurements were based on self-reports, and the reliability of the self-efficacy measure may have been too low to detect effects. It was not possible to determine which intervention components were responsible for which effects, and through which pathways. It is not clear if weak program components or implementation issues were to blame for the lack of change in the hypothesized mediators. Limited generalizability due to lack of gender diversity.</p>

Table 4-F.2. Studies examining factors that mediate the effects of nutrition education interventions—continued

Study	Study Population	Study Description	Description of Primary Study Outcomes	Mediator Analysis Outcomes	Limitations
<p>MacKinnon, 2001 Neutral Quality Non-Randomized Controlled Trial</p>	<p>N = 1226 (0% female) Mean age=15 yrs Race: 78% White, 5% African American, 3% Asian, 3% Hispanic, 1% Native American, 10% Mixed SES: Median annual family income was \$50,000 United States</p>	<p>Intervention: received a multi-component program that addressed the social influences promoting ergogenic drug use (AAS) and engaging students in healthy nutrition and strength training alternative behaviors (7 wks + 1 yr follow-up) Control: received no intervention</p>	<p>Not described.</p>	<p>Single mediator model: The effects of the intervention on nutrition behaviors were mediated by knowledge of AAS effects, perceived coach tolerance of AAS use, peers and team as an information source, and reasons for not using AAS ($P < 0.05$) immediately after the intervention, and peers and team as information sources and perceived severity were significant mediators at the 1-yr follow-up ($P < 0.05$). Multiple mediator model: The effect of the intervention on nutrition behaviors was mediated by peers as an information source (22% and 31% mediated at posttest and 1-yr follow-up), team as an information source (14% and 8% mediated at posttest and 1-yr follow-up), and beliefs in media advertisements (9% and 14% mediated at posttest and 1-yr follow-up) ($P < 0.001$). The mediated effect of beliefs in media advertisements was counterproductive.</p>	<p>Data were analyzed at the individual level, ignoring the clustering of individuals in schools Data was based on self-report Conclusions are based on data 1 yr after the intervention was delivered, and mediators of longer term effects may differ from those observed at the 1-yr mark Nutrition was a secondary focus and prevention of AAS use was primary; thus, there was little detail about the nutrition aspects of the intervention Limited generalizability due to lack of gender diversity</p>

Table 4-F.2. Studies examining factors that mediate the effects of nutrition education interventions—continued

Study	Study Population	Study Description	Description of Primary Study Outcomes	Mediator Analysis Outcomes	Limitations
Reynolds, 2004 Positive Quality Randomized Controlled Trial	N = 1584 (AL), 522 (MN) (50% female) Mean age=8 yrs (AL), 10 yrs (MN) Race: AL: 78% White, 20% African American, 2% Other; MN: 50% White, 28% Asian American, 15% African American, 5% Hispanic, 2% Native American SES: AL: median household income was \$40,000-\$50,000; MN: >60% of students received free or reduced cost lunches United States	MN: Intervention: received classroom nutrition education, parental involvement/education, school food service changes, and industry support and involvement Control: received the regular classroom curriculum AL: Intervention: received of classroom nutrition education, family involvement, and school food service changes Control: received the regular classroom curriculum.	The intervention increased fruit and vegetable consumption in AL (P<0.0001) and MN (P<0.001) compared to control.	In AL, knowledge of the recommended number of fruit and vegetable servings mediated 9.78% of the total intervention effect (P<0.05). In MN, none of the variables tested were mediators.	Limited number of mediators were tested. Only one 24-hr recall was used to assess dietary intake. Social desirability may have impacted outcomes.
Reynolds, 2002 Positive Quality Randomized Controlled Trial	N = 1,505 (Yr 2); 1,382 (Yr 3) (Gender: N/A) Mean age=10 yrs Race: 82% White, 17% African American, 1% Other SES: Median household income was between \$40,000-50,000 United States	Intervention: received classroom nutrition education, a family component, and a cafeteria component (7 wks) Control: received the usual classroom curriculum	The intervention significantly increased fruit and vegetable consumption across years 1 to 2 (P<0.001) and years 1 to 3 (P<0.001) compared to control	Positive outcome expectancies had a significant mediational effect on fruit and vegetable consumption, explaining 7.2% of the intervention effect (using the single mediator model) (P<0.05).	Multicollinearity among the mediators could have inflated standard errors and decreased power to detect mediators. Only one 24-hr recall was use for dietary assessment. Measurement error in the mediators might have contributed to decreased power.
Tak, 2009 Neutral Quality Non-Randomized Controlled Trial	N = 771 (53-57% female) Mean age=10 yrs Race: Intervention: 39% Dutch, 5% Western, 56% non-Western; Control: 71% Dutch, 4% Western, 25% non-Western SES: N/A The Netherlands	Intervention: received nutrition education and a free piece of fruit or ready-to-eat vegetables twice a week (2 yrs) Control: received their usual nutrition education programs	The intervention group had a significantly higher fruit intake at 2-yr follow-up compared to control (servings/d: 0.15 for child reports; 0.19 for parent reports); P<0.05). No significant effects on vegetable intake were observed.	Some evidence was found for partial mediation of the intervention effects on fruit intake by appreciation of the intervention. Children in the intervention group were more likely to appreciate the intervention, and the children who appreciated the intervention increased their fruit intake (P<0.05)	Used a non-randomized study design, which led to significant baseline differences between groups

Research Recommendations

1. Future systematic reviews should be conducted looking at specific mediators and outcomes in order to refine the focus of the review. The specific mediators and outcomes examined should be focused on those that most directly impact and/or derive from national nutrition priorities and guidelines.

Rationale: The studies included in this systematic evidence scan examined a wide range of variables as potential mediators. Therefore, because few studies were identified that conducted mediator analyses, and each study differed in terms of the variables tested, it was difficult to compare results across studies. As more studies are published examining mediators of nutrition education interventions, more refined and focused systematic reviews can be conducted.

2. More research is needed to understand how mediators may have different effects among subpopulations of subjects (e.g., based on gender, age, ethnicity), and/or how mediators and moderators interact to impact the outcomes of nutrition education interventions.

Rationale: Some of the evidence identified in this systematic evidence scan found different mediators for girls and boys. These findings suggest that even when a population receives the same intervention, the variables that mediate the effects of the intervention may differ for different subpopulations.

3. Research is needed that takes mediators into consideration when the interventions is being designed and the analysis of the intervention is being planned, to ensure that those mediators likely to be affected by the intervention are measured and can be analyzed when the study is completed.

Rationale: When examining mediators, it is important to consider whether the intervention was designed to (1) affect change in the outcome being measured, and (2) affect change in the mediator being tested. An intervention may have been designed to impact one or the other, but not both, therefore making the results of the mediator analysis difficult to interpret. Because there is a wide range of potential mediating variables that could explain the effects of nutrition education interventions, it is possible that there are other variables that could be mediating the effects that were not measured as part of the study. Therefore, if more researchers consider potential mediators during the design phase, more research could be available to include in future systematic reviews.

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Chapter 4-G. Moderators of the Effects of Nutrition Education Interventions on Children and Adolescents' Dietary Intake-Related Behaviors

TECHNICAL ABSTRACT

Background

In designing nutrition education programs, it may be important to consider whether there are certain variables that could act as moderators, impacting the strength of the relationship between nutrition education interventions and children's dietary intake. The objective of this systematic evidence scan was to examine factors that moderate the effects of nutrition education interventions on children's and adolescents' dietary-intake related behavior.

Methods

Literature searches were conducted using PubMed, EBSCOhost, Education Fulltext, and Global Health to identify studies that conducted moderator analyses related to nutrition education interventions.

- Inclusion criteria: published between January 1995 and December 2010; conducted in subjects aged 0–18 years; randomized controlled trials, non-randomized controlled trials, or quasi-experimental studies; subjects from countries with high or very high human development (based on the Human Development Index); subjects who were healthy or at elevated chronic disease risk; published in English in a peer-reviewed journal
- Exclusion criteria: systematic reviews, meta-analyses, narrative reviews, or prospective cohort, cross-sectional, or case-control designs; studies with no control group; subjects hospitalized, diagnosed with disease, and/or receiving medical treatment

The results of each included study were summarized in evidence worksheets (including a study quality rating), an evidence paragraph, and evidence table. A group of subject matter experts were involved in a review of the body of evidence and development of research recommendations. Due to the limited and disparate nature of the literature identified, conclusions were not drawn.

Findings

- Thirty studies were included in this systematic evidence scan; twenty-one randomized controlled trials and nine non-randomized controlled trials. Eighteen studies received a neutral quality rating (12 RCTs, 6 non-RCTs) and 12 studies received a positive quality rating (9 RCTs, 3 non-RCTs).
- The studies included in this systematic evidence scan examined a wide range of variables as potential moderators. Because each study differed in terms of the variables tested and the outcomes measured, it is difficult to compare results across studies.

Discussion

This systematic evidence scan was conducted to examine factors that moderate the effects of nutrition education interventions on children's and adolescents' dietary-intake related behavior. The studies identified and reviewed examined a wide range of variables as potential moderators. However, because each study differed in terms of the variables tested and the outcomes measured, it is difficult to compare results across studies. Therefore, a full systematic review was not conducted, and instead, a systematic evidence scan was completed. This systematic evidence scan provides an overview of existing research that addresses this topic area, and offers a series of research and systematic review recommendations for the future.

PLAIN LANGUAGE SUMMARY

Moderators of nutrition education programs

When developing nutrition education programs, it may be important to think about the factors that act as moderators. Moderators can affect the strength of the impact of a nutrition education program on what children eat. In nutrition education, common moderators include: gender, age, race and/or ethnicity, or body weight.

This summary of a NEL evidence scan presents what we know from research about the moderators of nutrition education programs.

What the Research Says

- Thirty studies were included in this review.
- We are unable to compare the results across studies because the studies tested different factors and measured different outcomes.

More research is needed to understand what factors moderate the effects of nutrition education programs.

EVIDENCE PORTFOLIO

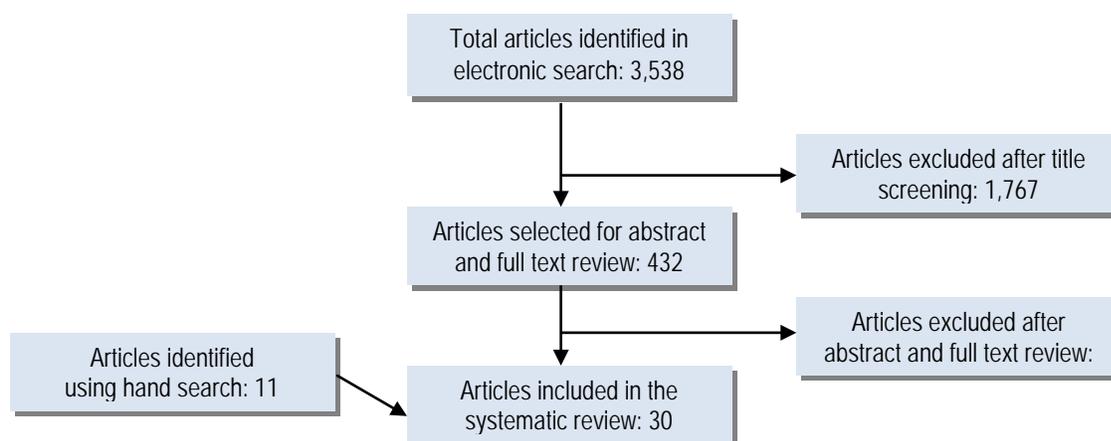
Evidence Summary Overview

This systematic evidence scan was conducted to examine factors that moderate the effects of nutrition education interventions on children and adolescent's dietary-intake related behavior. The studies identified and reviewed examined a wide range of variables as potential moderators. However, because each study differed in terms of the variables tested and the outcomes measured, it is difficult to compare results across studies. Therefore, a full systematic review was not conducted, and instead, a systematic evidence scan was completed. This systematic evidence scan provides an overview of existing research that addresses this topic area, and offers a series of research and systematic review recommendations for the future.

Description of the Evidence

The literature search for studies that tested which factors moderate the effects of nutrition education interventions identified 3,538 articles, 432 of which were selected for review (Fig. 4-G.1). Of these 432 articles, 19 were selected for inclusion in the systematic evidence scan. In addition, 11 articles were identified via hand search. Therefore, this systematic evidence scan includes a total of 30 articles. A detailed description of literature search results, including the databases searched and the number of articles identified using each database, articles identified using hand search, a list of citations for all included articles, and a table that lists excluded studies with rationale for exclusion can be found in Appendix J.

Figure 4-G.1. Flow chart of literature search results for studies examining the effects of moderation of nutrition education interventions



Of the 30 studies included in this review:

- Twenty-one studies were randomized controlled trials [Bannon, 2006 (Neutral Quality); Baranowski, 2003 (Neutral Quality); Baranowski, 2002 (Neutral Quality); Baranowski, 2000 (Neutral Quality); Bere, 2006a (Neutral Quality); Bere, 2006b (Neutral Quality); DeBar, 2009 (Neutral Quality); Dzewaltktowski, 2009 (Positive Quality); Gortmaker, 1999 (Positive Quality); Haerens, 2007a (Neutral Quality); Haerens, 2007b (Positive Quality); Haerens, 2006 (Positive Quality); Patrick, 2001 (Neutral Quality); Pempek, 2009 (Neutral Quality); Perry, 1998 (Positive Quality); Sahota, 2001 (Positive Quality); Te Velde, 2008 (Neutral Quality); Thompson, 2009 (Positive Quality); Townsend, 2006 (Neutral Quality); Turnin, 2001 (Positive Quality); Williamson, 2007 (Positive Quality);].
- Nine studies were non-randomized controlled trials [Fahlman, 2008 (Positive Quality); Foerster, 1998 (Neutral Quality); Horne, 2009 (Positive Quality); Horne, 2004 (Positive Quality); Prell, 2005 (Neutral Quality); Reinaerts, 2007 (Neutral Quality); Salminen, 2005 (Neutral Quality); Stock, 2007 (Neutral Quality); Tak, 2009 (Neutral Quality)].
- Eighteen studies received a neutral quality rating, and 12 studies received a positive quality rating
- Fifteen studies were conducted in the United States, three studies were conducted in Belgium, two studies were conducted in Norway, two studies were conducted in the UK, two studies were conducted in The Netherlands, one study was conducted in Europe, and one study each were conducted in Canada, Finland, France, Ireland, and Sweden.
- Sample sizes of the studies ranged from 30 to 5,112 (3 studies had <100 subjects, 9 studies had 100-500 subjects, 7 studies had 500-1000 subjects, and 11 studies had >1,000 subjects).
- Twenty-eight studies were conducted in girls and boys, and two studies were conducted only in boys.
- Mean subject age ranged from 5 years to 16 years.

All of the included studies conducted statistical analyses to determine whether one or more variables moderated the effects of the nutrition education intervention on any of the measured dietary intake-related outcomes. A moderator is a variable that affects the direction and/or strength of an association between an independent and dependent variable (Baron and Kenny, 1986). Moderators can be qualitative (e.g., sex, race, weight status) or quantitative (e.g., age, body mass index). In the field of nutrition education, common moderators include: gender, age, race and/or ethnicity, body mass index and/or weight status.

Description of the Results

The studies included in this systematic evidence scan examined a wide range of variables as potential moderators. Therefore, because each study differed in terms of the variables tested and the outcomes measured, it is difficult to compare results across studies.

Table 4-G.1 summarizes the moderators examined, as well as the results of the moderator analyses, in the studies included in this systematic evidence scan.

Table 4-G.1. A description of the moderators tested and outcomes of the moderator analyses

Author, year	Moderators Tested	Significant Results	Description of Results
Bannon, 2006	Preferences	No	
Baranowski, 2003	Age	No	
	Gender	No	
	Ethnicity	No	
Baranowski, 2002	Setting (urban vs. church-based)	No	
Baranowski, 2000	Ethnicity	No	
	Gender	No	
Bere, 2006a	Gender	No	
	Habitual f/v intake	No	
	Household income	No	
	Preferences	No	
	Parent education	No	
Bere, 2006b	Gender	No	
DeBar, 2009	Website usage	Yes	Overall website use was associated with increased calcium intake (P=0.01) Use of specific study web pages related to dietary intake-related behaviors was not associated with any outcomes
Dzewalkowski, 2009	BMI	No	
	Free/reduced lunch eligibility	No	
	Gender	No	
	Race	No	
Fahlman, 2008	Gender	No	
Foerster, 1998	Attitudinal variables	Yes	The following were associated with increased F/V consumption: Helping to fix vegetables/salad for dinner (P<0.05) Asking for favorite fruit at snack (P<0.05) Choosing juice bar over ice cream bar (P<0.01) Choosing veggie pizza over pepperoni pizza (P<0.01) Choosing strawberry shortcake over chocolate cake (P<0.05) Family interest in what the child learns about F/V (P<0.01) Perception that cafeteria serve like when the child eats F/V (P<0.01) Friends making fun of a child for eating F/V each day (P<0.05) When all variables were included in a regression model, the treatment effect was a stronger predictor of changes in fruit and vegetable intake than any one variable.
Gortmaker, 1999	Gender	Yes	Girls: Estimated daily energy intake increased less (P<0.05) and F/V intake increased more (P=0.003) in the intervention group compared to control Boys: No changes in any of the measured dietary intake outcomes
Haerens, 2007a	Gender	Yes	In girls, there was a trend for decreased fat intake and % of energy from fat in the intervention groups compared to the control group (P<0.09), but not in boys. In girls, fat intake and % energy from fat decreased more in the intervention with parental support group compared with both other conditions (P<0.001)

Table 4-G.1. A description of the moderators tested and outcomes of the moderator analyses—continued

Author, year	Moderators Tested	Significant Results	Description of Results
Haerens, 2007b	Attitude	No	
	Gender	Yes	Girls in the intervention from technical-vocational schools decreased dietary fat intake compared to control ($P \leq 0.05$). There were no gender effects in general school students.
	Read the intervention messages	Yes	Students who read the intervention messages decreased dietary fat intake (14.4 g) compared to those who did not (-4.6 g) ($P < 0.05$). In intervention subjects who read the messages, boys/girls in general schools and girls in tech-voc schools decreased fat intake compared to control ($P \leq 0.05$).
	Stages of change	Yes	Fat intake decreased 10.1 g among precontemplators, 6.2 g among contemplators, 33.7 g among preparators, 12.3 g among actors, and 6.4 g among maintainers. ($P < 0.05$)
	Type of school	Yes	Girls in the intervention from technical-vocational schools decreased dietary fat intake compared to control ($P \leq 0.05$) In intervention subjects who read the messages, boys/girls in general schools and girls in tech-voc schools decreased fat intake compared to control ($P \leq 0.05$)
Haerens, 2006	Gender	Yes	In boys, there were no significant 2-yr post-baseline intervention effects on eating behaviors. In girls, at 2-yr post-baseline, fat intake and percent energy from fat decreased more in the intervention group compared to the control group ($P < 0.05$).
Horne, 2009	Age	No	
Horne, 2004	Age	Yes	During the maintenance phase, lunchtime vegetable consumption decreased among 7- to 11-year-olds, but not for 5- to 7-year-olds
	F/V intake at baseline	Yes	Children who ate the least during baseline (0–19% consumed) showed the largest increases in consumption during intervention and at follow-up
Patrick, 2001	Gender	No	
Pempek, 2009	Gender	No	
Perry, 1998	Gender	Yes	Girls in the intervention consumed more vitamin C than boys ($P < 0.02$)
	Race/ethnicity	Yes	Asian subjects decreased total fat and saturated fat ($P < 0.01$), African American subjects decreased saturated fat ($P < 0.03$), while there was no change in white subjects, and a non-significant trend for Hispanic subjects to increase saturated fat intake ($P < 0.06$)
Prell, 2005	Gender	Yes	No significant gender differences were found with regards to changes in fish consumption, though boys may have benefited from the intervention somewhat more than girls (based on visual inspection of the relative position value)
Reinaerts, 2007	Age	Yes	Veg. dinner intake increased in the comparison group for 4–6th graders ($P < 0.01$) Veg. snack intake increased in the comparison group for 4–6th graders ($P < 0.01$) and in the intervention group for 1–3rd graders ($P < 0.05$) Total FJV increased in the comparison group: preschoolers increased intake ($P < 0.05$) less than 4–6th graders ($P < 0.01$)
	Ethnicity	Yes	Veg. dinner intake increased in non-native children ($P < 0.01$) Total FJV increased in the intervention group: native children increased consumption ($P < 0.05$) less than non-native children ($P < 0.01$)
	Gender	Yes	Veg. snack intake increased in the intervention group for girls ($P < 0.01$)

Table 4-G.1. A description of the moderators tested and outcomes of the moderator analyses—continued

Author, year	Moderators Tested	Significant Results	Description of Results
Sahota, 2001	Weight status	Yes	Vegetable consumption did not differ by weight status. Obese children in the intervention group consumed less fruit (95% CI -1.8, -0.2) compared to the whole intervention group combined Overweight children consumed more high sugar foods (95% CI 0.1, 1.6) compared to the whole sample combined
Salminen, 2005	Gender	Yes	Boys in the intervention compared to control group 1 decrease frequency of eating cakes and pastries and frequency of adding salt to food, while girls in the intervention compared to control group 1 decrease frequency of consuming greasy snacks. Girls in the intervention compared to control group 1 decreased frequency of consumption of observable fat and ice cream decreased and increased rye bread consumption.
Stock, 2007	Gender	Yes	In K–3rd graders, female students in the intervention group had significantly higher scores than females in the control group (P=0.013) (but not males) In 4–7th graders, no differences by gender were reported
Tak, 2009	Education level	No	
	Ethnicity	No	
	Gender	No	
	Region of resident	No	
Te Velde, 2008	Country of residence	Yes	After 2 yrs, the intervention effect was significant only in Norway (P<0.05). The effect in Norway was for total fruit and vegetable intake, as well as for fruit intake alone (P<0.05). In Spain and the Netherlands, the effect of the intervention for total fruit and vegetable intake decreased during the second follow-up, and in Spain this was due mainly to weaker effects for fruit intake alone.
Thompson, 2009	Preferences	No	
	Availability at home	No	
	Household education	No	
	Self-efficacy	No	
Townsend, 2006	Age	No	
	Ethnicity	Yes	White subjects scored the highest using total scores (P<0.0001). Significant gains for 2 indicators were found for White and Hispanic subjects in the intervention compared to control (both, P<0.0001); no gains were identified among black subjects.
	Gender	Yes	Girls scored higher than boys using total scores (P<0.001), and significant gains were found for girls for 2 indicators and boys for 3 indicators in the intervention compared to control (both, P<0.0001).
Turnin, 2001	BMI	Yes	Outcomes did not differ between normal and overweight subjects. Obese subjects had significantly lower energy intake (P<0.0005) and sugar intake (P<0.05), as well as ate significantly more energy at lunch (P<0.005) and skipped breakfast more often (P<0.005) compared to those who had normal or overweight subjects.
Williamson, 2007	BMI at baseline	Yes	Baseline BMI was negatively correlated with changes in plate waste for all dietary variables (r = -0.18 to -0.26) and positively correlated with changed in food intake for all dietary variables except saturated fat (r = 0.10 to 0.19).
	Dietary intake at baseline	Yes	For all subjects combined and for all dietary intake measures assessed, higher baseline intake values were associated with greater change scores.

Evidence Summary Paragraphs

Bannon, 2006 (Neutral Quality) conducted a randomized controlled trial in Belgium to test the effects of nutrition messages framing on snack choice in young children. Three classrooms were randomly assigned to one of three conditions, in which they watched one of the following 60-second videos: (1) a gain-framed nutrition message, (2) a loss-framed message, or (3) a control scene. After viewing the video, children were offered a choice of either animal crackers or an apple for a snack. A Fisher's exact test was used to determine whether a child's pre-test preferences for apples and animal crackers significantly predicted snack choice. The final sample included 50 children (mean age=5 yrs). Results showed that children who saw one of the nutrition message videos were significantly more likely to choose apples as a snack than those who saw the control condition ($P<0.01$). There were no differences in snack choices between children who saw the gain-framed and those who saw the loss-framed videos. Pre-test apple and animal cracker preference did not have a significant relationship to snack choice in any of the conditions.

Baranowski et al., 2003 (Neutral Quality) conducted a randomized controlled trial in the United States to investigate the effects of computer-based intervention on fruit, juice, and vegetable (FJV) consumption among elementary school children. Elementary schools were randomly assigned to one of two conditions for 5 weeks: (1) Intervention: received "Squire's Quest," a psychoeducational computer game, or (2) Control: received no intervention. Dietary intake-related behavior (FJV consumption) was assessed before and immediately following the intervention using four multiple pass, 24-hour dietary intake interviews. To test for potential moderation effects on FJV consumption by age, gender, or ethnicity, an interaction term was included in a mixed-model ANCOVA. The final sample included 1,489 subjects (mean age=9 yrs). Results showed that children participating in Squire's Quest significantly increased FJV consumption compared to children in the control group ($p=0.002$). There was no evidence for moderation of this effect by age, gender, or ethnicity.

Baranowski et al., 2002 (Neutral Quality) conducted a randomized controlled trial in the United States to test the effects of the "5 a Day Achievement Badge" program on fruit, juice, and vegetable (FJV) consumption among African-American Boy Scouts. Boy Scout troops were randomly assigned to one of two groups for 3 months: (1) Intervention: received nutrition education on to increase the availability and accessibility of fruits and vegetables at home, increase preferences for vegetables, and training in FJV preparation, or (2) Control: no intervention (delayed intervention). Dietary intake-related behavior (FJV consumption) was assessed before and immediately following the intervention using two non-consecutive 24-hour recalls. ANCOVA was used to assess whether the intervention worked or worked better with urban- versus church-based Boy Scout troops. The final sample included 186 boys (age range=9–18 years). Results showed a trend for a significant increase in FJV consumption among boys in the intervention group compared to the control group ($P<0.09$). There were no significant differences between urban and church-based Boy Scout Troops.

Baranowski et al., 2000 (Neutral Quality) conducted a randomized controlled trial in the United States to evaluate the effects of a multi-component intervention (Gimme 5) on fruit, juice, and vegetable (FJV) consumption among fourth and fifth-grade children. Schools were randomly assigned to one of two groups for one year: (1) Intervention: received a multi-component intervention that included a curriculum, newsletters, videotapes, and point-of-purchase education, or (2) Control: no intervention. Dietary intake-related behavior (FJV consumption) was assessed before, half-way through, and immediately following the intervention using 7-day food records. Mixed-model repeated-measures ANOVA was used to whether ethnicity or gender moderated outcomes. The final sample included 1,172 subjects (4th and 5th graders). Results showed that children in the intervention group significantly increased total FJV ($P<0.05$) and vegetable ($P<0.01$) consumption compared to children in the control group. There was no evidence for moderation of this effect by gender, or ethnicity.

Bere et al., 2006a (Neutral Quality) conducted a randomized controlled trial in Norway to evaluate the effects of the Norwegian School Fruit Program and the Fruit and Vegetables Make the Marks (FVMM) educational program on fruit and vegetable intake at the end of the intervention and 1 and 2 years after the end of the intervention. Schools were randomly assigned to one of two groups for 2 years: (1) Intervention: received the FVMM program and free subscription to the Norwegian School Fruit Programme, and (2) Control: received no intervention. In year 2, four

intervention schools continued to participate in the standard Norwegian School Fruit Programme (paid fruit), while five schools did not take part in the program (no fruit). Dietary intake-related behavior (fruit and vegetable intake) was assessed before, immediately following the intervention, and 1 year later using a single 24-hour fruit and vegetable recall. Mixed model regression was used to test for interaction effects between condition and gender, habitual fruit and vegetable intake, preferences, parent's educational level, and household income. The final sample included 517 subjects (mean age=11 yrs). Results showed that after the intervention, fruit and vegetable intake at school ($P<0.001$) and all day ($P<0.05$) was significantly higher in the intervention group compared to control. After 1 year, all day fruit and vegetable intake was still significantly higher among intervention children compared to control ($P<0.05$). After year 2, the paid fruit group had significantly higher fruit and vegetable intake at school compared to the no fruit group. There was no evidence for moderation of this effect by gender, habitual fruit and vegetable intake, preferences, parent's educational level, and household income.

Bere et al., 2006b (Neutral Quality) conducted a randomized controlled trial in Norway to evaluate the effect of the Fruits and Vegetables Make the Marks (FVMM) intervention on fruit and vegetable intake among sixth and seventh graders. Schools were randomly assigned to one of two groups for 6 months, and follow-up measures were taken at 3 months and 15 months after the intervention was complete: (1) Intervention: received the FVMM program, which consisted of a school-based fruit and vegetable intervention consisting of a home economics classroom component, parental involvement, and encouraged participation in the Norwegian School Fruit Program, and (2) Control: no intervention. Dietary intake-related behavior (fruit and vegetable intake) was measured before, immediately following the intervention, and 1-year later using a single 24-hour recall. Mixed-model regression was used to determine whether there were interaction effects between condition and gender. The final sample included 369 subjects (mean age =11 yrs). Results showed that there was no effect of the intervention for intake of fruit and vegetables eaten at school or all day, either at follow-up 1 or at follow-up 2. There was also no evidence for moderation of outcomes by gender.

DeBar et al., 2009 (Neutral Quality) conducted a randomized controlled trial in the United States to examine the effects of a multi-component lifestyle intervention on diet and exercise among adolescent girls. Subjects were randomly assigned to one of two groups for 2 years: (1) Intervention: received in-person counseling (overnight retreat, monthly events), coaching calls, and use of a study website, and (2) Control: received no intervention. Dietary intake-related behavior (calcium, fruit, and vegetable intake) was measured at baseline and every 2 months during the 2-year intervention using three 24-hour recalls. The relationship between outcomes and website usage was analyzed using random effects models. The final sample included 82 subjects (mean age=16 yrs). Results showed that overall website use was associated with increases in calcium intake ($P=0.01$). However, use of specific study web pages related to dietary intake-related behaviors were not associated with any of the measured behavioral outcomes.

Dzewaltowski et al., 2008 (Positive Quality) conducted a randomized controlled trial in the United States to investigate the effects of the Healthy Youth Place intervention on fruit and vegetable consumption and physical activity among youth. Schools were randomly assigned to one of two groups for 2 years: (1) Intervention: received the Healthy Youth Places intervention which consisted of group training for adult school leaders, environmental change skill curriculum, and youth-led fruit/vegetable and physical activity change teams, (2) Control: received no intervention. Dietary intake-related behaviors (fruit and vegetable intake) were measured before the intervention and at year 1 and year 2 using the validated YAQ FFQ. Analysis of covariance was used to determine whether demographic variables (gender, race, free and reduced lunch eligibility, BMI) moderated the effects of the intervention. The final sample included 1,582 subjects (mean age=12 yrs). Results showed no significant change in fruit and vegetable intake for either the intervention or control group. There was also no evidence for moderation of outcomes by gender, race, free and reduced lunch eligibility, or BMI.

Fahlman et al., 2008 (Positive Quality) conducted a non-randomized controlled trial in the United States to determine the effects of the Michigan Model nutrition curriculum on nutrition knowledge, efficacy expectations, and eating behaviors in middle school students. Subjects were assigned to one of two groups for 1 month: (1)

Intervention: received classroom nutrition education, and (2) Control: received no intervention. Dietary intake-related behaviors (yesterday's fruit, vegetable, grains, meat, dairy, and "other" intake) were assessed before and immediately following the intervention using a validated survey instrument. ANOVA was used to determine whether outcomes different by gender. The final sample included 576 students (mean age=12 yrs). Results showed that students in the intervention group had significantly higher intake of fruit ($P=0.047$), vegetables ($P=0.018$), and other ($P=0.025$) compared to the control group. There was also no evidence for moderation of outcomes by gender.

Foerster et al., 1998 (Neutral Quality) conducted a non-randomized controlled trial in the United States to evaluate the effectiveness of the Power Play! Campaign, a large-scale social marketing initiative. Schools from three separate media markets were assigned to one of three groups for 1 year: (1) Power Play-School: received the Power Play! Activities at school, (2) Power Play-Community: received the Power Play! At school and in community locations, and (3) Control: did not received Power Play!. Dietary intake-related behavior (fruit and vegetable intake) was assessed before and immediately following the intervention using the California Children's Food Survey, which included a 24-hour food diary. Regression analysis was done to determine whether attitudinal survey questions were related to changes in fruit and vegetable consumption. The final sample included 2,684 children (3rd – 6th graders). Both intervention groups had significant increases in fruit and vegetable intake compared to the control group ($P<0.001$), but there was no difference between the intervention groups. The following variables were significant associated with increased fruit and vegetable consumption: helping to fix vegetables/salad for dinner ($P<0.05$), asking for favorite fruit at snack ($P<0.05$), choosing juice bar over ice cream bar ($P<0.01$), choosing veggie pizza or pepperoni pizza ($P<0.01$), choosing strawberry shortcake over chocolate cake ($P<0.05$), family interest in what the child learns about fruits and vegetables ($P<0.01$), perception that cafeteria servers like when the child eats fruits and vegetables ($P<0.01$), and friends making fun of a child for eating fruits and vegetables each day ($P<0.05$). However, when all variables were included in a regression model, the treatment effect was a stronger predictor of changes in fruit and vegetable intake than any one variable.

Gortmaker et al., 1999 (Positive Quality) conducted a randomized controlled trial in the United States to evaluate the impact of a school-based health behavior intervention (Planet Health) on obesity among boys and girls in grades 6 to 8. Schools were randomly assigned to one of two groups for 2 school years: (1) Intervention: received the Planet Health curriculum in 4 major subjects and physical education, and (2) Control: received no intervention. Dietary intake-related behavior (% energy from fat and saturated fat, fruit and vegetable intake, total energy intake) was assessed before and immediately following the intervention using the Youth FFQ. Regression analyses were conducted separately for boys and girls. The final sample included 1560 subjects (mean age=12 yrs). Among girls, there was less of an increase in estimated energy intake per day in the intervention group compared to control ($P<0.05$), and an increase in fruit and vegetable consumption ($P=0.003$). There were no significant changes in other measured dietary intake variables among girls, and no significant changes in any of the measured dietary intake outcomes in boys.

Haerens et al., 2007a (Neutral Quality) conducted a randomized controlled trial in Belgium to evaluate the effects of a middle-school healthy eating promotion intervention combining environmental changes and computer-tailored feedback, with and without an explicit parental involvement component. Schools were randomly assigned to one of three groups for 1 year: (1) Intervention (nutrition education, environmental changes) with parental support, (2) Intervention (nutrition education, environmental changes) without parental support, and (3) a control group that received no intervention. Dietary intake-related behavior (fat, fruit, soft drink, and water intake) was measured before and immediately following the intervention using a FFQ. Linear mixed models were used to test whether gender moderate the effects of the intervention. The final sample included 2,840 children (mean age=13 yrs). Results showed that the intervention was not effective in increasing fruit or water intake, or decreasing soft drink intake. There was a trend for a significant condition by gender interaction effect for fat intake and percentage of energy from fat such that the intervention was effective in girls but not in boys ($P<0.09$). Fat intake and percentage energy from fat decreased significantly more in girls of the intervention with parental support group compared with both other conditions ($P<0001$).

Haerens et al., 2007b (Positive Quality) conducted a randomized controlled trial in Belgium to evaluate the acceptability, feasibility, and effectiveness of a computer-tailored dietary fat intake education program for adolescents. Schools were randomly assigned to one of two groups for a single intervention session and 3 months of follow-up: (1) Intervention: received a single computer-tailored dietary fat intake session, and (2) Control: received no intervention. Dietary intake-related behavior (fat intake) was assessed before and 3 months after the intervention the using a FFQ. Linear mixed models were used to determine whether outcomes differed based on gender and school type, as well as stages of changes and process evaluation items. The final sample included 304 children (mean age=13 yrs). Results showed that among students from general schools, there were no significant Gender X Condition effects. However, in girls enrolled in technical-vocational schools, dietary fat intake decreased in the intervention group compared to control ($P \leq 0.05$). Among subjects who reported to have read the intervention messages, boys and girls in general schools and girls in technical-vocational schools dietary fat intake decreased in the intervention group compared to control ($P \leq 0.05$). Baseline “stage of change” moderate the effects of the intervention on fat intake ($P < 0.05$); fat intake decreased 10.1 g/day among precontemplators, 6.2 g/day among contemplators, 33.7 g/day among preparators, 12.3 g/day among actors, and 6.4 g/day among maintainers. Also, reading the intervention messages moderate the intervention effects; students who reported to have read the intervention messages decreased dietary fat intake (14.4 g/day) compared to those who did not read the intervention messages (-4.6 g/day) ($P < 0.05$). Attitude did not have a moderating effect on intervention outcomes.

Haerens et al., 2006 (Positive Quality) analyzed data from a randomized controlled trial conducted in Belgium to evaluate the effects of middle-schools physical activity and healthy eating intervention, including an environmental and computer-tailored component, and parental involvement. Schools were randomly assigned to one of three groups for 2 years: (1) Intervention (nutrition education, environmental changes) with parental support, (2) Intervention (nutrition education, environmental changes) without parental support, and (3) a control group that received no intervention. Dietary intake-related behavior (fat, fruit, soft drink, and water intake) was measured before the intervention and at the ends of the first and second school years using a FFQ. Linear mixed models were used to analyze results, which was done separately for boys and girl since 1-year post-intervention analyses showed clear gender differences. The final sample included 2,287 children (mean age=13 yrs). Results showed no significant effects of the second intervention year on eating behaviors in boys or girls. In boys, there were no significant 2-year post-baseline intervention effects on eating behaviors. In girls, 2-year post-baseline intervention effects were found for eating behaviors. Decreases in fat intake and percent energy from fat were significant higher in the interventions group compared to the control group ($P < 0.05$).

Horne et al., 2009 (Neutral Quality) conducted a non-randomized controlled trial in the United Kingdom to evaluate a peer-modeling and rewards-based intervention designed to increase children's fruit and vegetable consumption. Schools were assigned to one of two groups for 16 days (followed by a 12-month maintenance phase): (1) Intervention: received fruit at snack time, rewards for consuming the fruit, and nutrition education videos, (2) Comparison: received fruit at snack time and rewards for consuming the fruit. Dietary intake-related outcomes were measured after the intervention and during the maintenance phase using visual estimation by trained observers (fruit and vegetable consumption at lunch) and weighed intake (fruit and vegetable consumption at snack), and a 24-hour recall was completed by parents after the intervention (fruit and vegetable consumption at home). ANOVA was used to determine whether the effects of the interventions were moderated by subject age. The final sample included 435 children (ages 5–11 yrs). Results showed that consumption of school-provided foods increased during the intervention in the experimental school ($P < 0.0001$), whereas the control school experienced a significant decline ($P = 0.001$). At the 12-month follow-up, children in the experimental schools consumed significantly more lunchbox fruit, vegetables, and juice relative to baseline and compared to the control school ($P < 0.001$). Age did not have a moderating effect on intervention outcomes.

Horne et al., 2004 (Positive Quality) conducted a non-randomized controlled trial in the United Kingdom to evaluate a peer-modeling and rewards-based intervention designed to increase children's fruit and vegetable consumption. Schools were assigned to one of two groups for 16 days (followed by a 4-month maintenance phase): (1) Intervention: received fruit at snack time, rewards for consuming the fruit, and nutrition education videos, (2)

Comparison: received fruit at snack time and rewards for consuming the fruit. Dietary intake-related outcomes were measured after the intervention and during the maintenance phase using visual estimation by trained observers (fruit and vegetable consumption at lunch) and weighed intake (fruit and vegetable consumption at snack), and a 24-hour recall was completed by parents after the intervention (fruit and vegetable consumption at home). ANOVA was used to determine whether the effects of the interventions were moderated by subject age and baseline fruit/vegetable consumption. The final sample included 749 children (ages 5–11 yrs). Lunchtime consumption of fruits and vegetables in the intervention group was significantly higher immediately after the intervention and after the maintenance phase than baseline ($P<0.001$), while snack time consumption was higher after the intervention than baseline ($P<0.001$) compared to the comparison group (but not after the maintenance phase). There were also significant increases in fruit and vegetable consumption at home after the intervention ($P<0.05$). The effects of the intervention were moderated by age and baseline fruit/vegetable intake. During the maintenance phase, lunchtime vegetable consumption declined among 7- to 11-year-olds, but not for 5- to 7-year-olds. In addition, children who ate the least during baseline (0–19 percent consumed) showed the largest increases in consumption during intervention and at follow-up.

Patrick et al., 2001 (Neutral Quality) conducted a randomized controlled trial in the United States to test the effects of a patient-centered assessment and counseling program on adolescents' dietary intake. All subjects received a computerized assessment, created tailored action plans to change behaviors, and discussed the plans with their health care provider. Subjects were then randomly assigned to one of four groups for 4 months: (1) Intervention 1: extended intervention via mail only, (2) Intervention 2: extended intervention via infrequent telephone and mail, (3) Intervention 2: extended intervention via frequent telephone and mail, and (4) Intervention 4: no further contact or intervention. Dietary intake-related behaviors (fruit, vegetable, and fat intake) were assessed before and immediately following the intervention using a validated brief food frequency survey of commonly eaten high-fat foods and validated survey questions regarding daily fruit and vegetable intake. Repeated measures analysis of variance was conducted to determine whether the effects of the intervention were moderated by gender. The final sample included 117 subjects (mean age=14 yrs). All subjects showed improvement in fruit and vegetable intake ($P=0.002$) and fat intake ($P=0.02$), with no differences between intervention groups. In addition, there were no significant effects of gender on outcomes.

Pempek and Calvert, 2009 (Neutral Quality) conducted a randomized controlled trial in the United States to examine how advergames affect snack consumption among low-income African American children. Children were randomly assigned to one of three conditions: (1) the healthier advergame condition, (2) the less healthy advergame condition, or (3) the control condition. Children in the treatment conditions played a less healthy or a healthier version of an advergame 2 times before choosing and eating a snack and completing the experimental measures. Children in the control group chose and ate a snack before playing the game and completing the measures. Analyses were conducted to determine whether gender moderated the effects of the intervention. The final sample included 30 African American children (mean age=9 yrs). Children who played the healthier version of the advergame selected and ate significantly more healthy snacks than did those who played the less healthy version ($p=0.007$), with the control group falling in between ($P=NS$). Nine children (90 percent) in the healthy condition chose at least one healthy snack, whereas six children (60 percent) in the control group and one child (10 percent) in the less healthy group chose at least one healthy snack; the healthier and less healthy conditions differed significantly ($p=0.001$). There was no effect of gender on study outcomes.

Perry et al., 1998 (Positive Quality) conducted a randomized controlled trial in the United States to test the effects of a school-based intervention on children's dietary change. Schools were randomly assigned to one of two groups for approximately 3 months: (1) Intervention: received nutrition education curriculum, parental involvements, school food service changes, and industry involvement and support, or (2) Control: no intervention (delayed intervention). Dietary intake-related outcomes (fruit and vegetable intake) were measured before and 3–8 months following the intervention using one 24-hour recall. Mixed-model regression analyses were conducted to determine whether gender or racial/ethnic group moderated the effects of the intervention. The final sample included 441 subjects (4th and 5th graders). Results showed that the intervention group significantly increased fruit servings

($P < 0.02$) and fruit and vegetable servings per 1,000 calories ($P < 0.02$), and decreased total fat intake ($P < 0.02$) compared to control. Further analyses revealed that there were differences in outcomes by gender, such that girls in the intervention consumed more vitamin C than boys ($P < 0.02$). There were also differences by racial/ethnic group: Asian subjects decreased total fat and saturated fat ($P < 0.01$), African American subjects decreased saturated fat ($P < 0.03$), while there was no change in White subjects, and a non-significant trend for Hispanic subjects to increase saturated fat intake ($P < 0.06$).

Prell et al., 2005 (Neutral Quality) conducted a randomized controlled trial in Sweden to examine the effects of school-based interventions on fish consumption among adolescents. Schools were randomly assigned to one of three groups for 5 weeks: (1) Intervention 1: received changes to the school cafeteria (increased choice, marketing, and improved preparation/appearance of fish) and home economics nutrition education (fish and nutrition), (2) Intervention 2: received changes to the school cafeteria, or (3) Control: did not receive any intervention. Dietary intake-related outcomes (fish consumption) were measured before and immediately following the intervention using structured observations in the school cafeteria once a week when fish was served. Analyses were conducted to determine whether the outcomes were moderated by gender. The final sample included 228 subjects (mean age = 14 yrs). The nutrition education + changes to the school food environment group significantly increased fish consumption following the intervention, and this increase differed significantly from the control group ($P < 0.01$). The change to the school food environment only group did not significantly increase fish consumption, and did not differ from either the group that also received nutrition education or the control group. No significant gender differences were found with regards to changes in fish consumption.

Reinaerts et al., 2007 (Neutral Quality) conducted a non-randomized controlled trial in The Netherlands to measure the effects of two school-based interventions on children's fruit and vegetable intake. Schools were randomly assigned to one of two groups for 1 year: (1) Intervention: multicomponent school-based program consisting of a classroom curriculum, parental involvement, and supermarket marketing; (2) Comparison: free fruit and vegetable distribution at school. Dietary intake-related outcomes (fruit and vegetable intake) were measured before and immediately following the intervention using one 24-hour recall and FFQ. Multilevel regression analyses were conducted to determine whether gender, ethnicity, or age moderated the effects of the intervention. The final sample included 939 subjects (mean age = 9 yrs). Results showed that both interventions increased children's fruit intake ($P < 0.0001$). Vegetable intake at dinner was increased only in the comparison group for children in 4th-6th grades ($P < 0.01$) and for non-native children ($P < 0.01$). Vegetable snack intake was increased in the comparison group for children in the 4th-6th grades ($P < 0.01$) and in the intervention group for children in the 1st-3rd grades ($P < 0.05$) and for girls ($P < 0.01$). Total 24-hour fruit/juice/vegetable intake increased in the intervention group, and effects differed by ethnicity: native children increased consumption ($P < 0.05$) less than non-native children ($P < 0.01$). The comparison group also increased 24-hour fruit/juice/vegetable intake, with differences depending on age: preschoolers increased intake ($P < 0.05$) less than 4th-6th graders ($P < 0.01$). Further analyses revealed that the comparison program was more effective for increasing vegetable intake at dinner among children in 4th-6th grades ($P < 0.001$) and non-native children ($P < 0.01$), and increasing vegetable snack intake for 4th-6th graders ($P < 0.05$) and boys ($P < 0.05$). Both programs were equally effective for increasing total 24-hour fruit/ juice/ vegetable intake for all age groups, and for native and non-native children.

Sahota et al., 2001 (Positive Quality) conducted a randomized controlled trial in the United Kingdom to assess the effects of a school based intervention on dietary intake among children. Schools were randomly assigned to one of two groups for one year: (1) Multi-Component: received teacher training, modification of school meals, and the development of school action plans targeting the curriculum, physical education, school stores, and playground activities, or (2) Single-Component: received the usual health curriculum with no additional intervention. Dietary intake-related outcomes (consumption of high-fat foods, food and drinks high in sugars, fruit, and vegetables) were measured before and 12 months later using one 24-hour recall and 3-day food records. All outcome measures were assessed in the whole cohort, in overweight children, and in obese children. The final sample consisted of 593 children (mean age = 8 yrs). Results from the 24-hour recalls showed that the multi-component group had higher vegetable consumption compared to the children in the single-component group ($P < 0.05$). Also, fruit consumption was lower

in obese children in the multi-component group ($P<0.05$) than those in the single-component group. Results from the 3-day food records showed that overweight children in the multi-component group consumed more high sugar foods ($P<0.05$) compared to the single-component group.

Salminen et al., 2005 (Neutral Quality) conducted a non-randomized controlled trial in Finland to investigate the effects of a family-based health education and counseling intervention on children's health behaviors. Children were assigned to one of three groups for 3 years: (1) Intervention: received individual counseling sessions (2 for children at school and 3 for children at home with their family) on diet and nutrition, exercise, cigarette smoking, and drugs and alcohol, children were from high-risk families (family history of cardiovascular disease); (2) Control group 1: received no intervention, children were from high-risk families; (3) Control group 2: received no intervention, children were not from high-risk families. Analyses were conducted to determine whether intervention effects differed depending on gender using logistic regression (analyses for boys and girls were conducted separately). Dietary intake-related behaviors (fat, fiber, and salt intake behaviors) were assessed before and immediately following the intervention using a questionnaire (validity not reported). The final sample included 1,055 subjects (mean age=11 yrs). For boys and girls in the intervention group compared to control group 1, improvements were seen in type of fat used in food preparation and baking, type of milk used, and type of ice cream eaten ($P<0.05$). Among boys in the intervention compared to control group 1, frequency of eating cakes and pastries and frequency of adding salt to food decreased, and among girls in the intervention compared to control group 1, frequency of consuming greasy snacks decreased. Fiber intake did not differ between the intervention group and control group 1. For boys and girls in the intervention group compared to control group 2, improvements were seen in type of fat used in food preparation and baking, type of milk used, type of ice cream eaten, and salt added to food ($P<0.05$). Among girls in the intervention compared to control group 1, frequency of consumption of observable fat and ice cream decreased and rye bread consumption increased.

Stock et al., 2007 (Neutral Quality) conducted a non-randomized controlled trial in Canada to test the effects of a peer-based health promotion program on children's dietary intake. Schools were assigned to one of two groups for 21 weeks: (1) Intervention: received a school-based nutrition education program (involved peer teaching from older to younger schoolchildren); (2) Control: received no intervention. Dietary intake-related behaviors ("health behavior score") were assessed at the beginning and end of the school year using a validated, self-reported questionnaire, and health behavior scores were determined based on responses to questions related to healthy eating and physical activity. Analyses were conducted to determine whether intervention effects differed depending on age and gender. The final sample included 360 subjects (kindergarten–7th grade). In kindergarten through 3rd graders, there were no significant difference in health behavior scores between the all children in intervention and control groups; however, female students in the intervention group had significantly higher scores than females in the control group ($P=0.013$). In 4th through 7th graders, health behaviors scores were significantly greater in the intervention group compared to the control group ($P=0.025$); however, no differences by gender were reported.

Tak et al., 2009 (Neutral Quality) conducted a non-randomized controlled trial in the Netherlands to evaluate the effects of a school-based intervention on children's fruit and vegetable intake. Schools were assigned to one of two groups for 2 years: (1) Intervention: received a piece of fruit or vegetables for free twice a week and school nutrition education curriculum, (2) Control: received no intervention. Dietary intake-related behaviors (fruit and vegetable intake) were assessed at baseline and 1-year and 2-year follow-ups using a validated survey instrument. ANCOVA was conducted to determine the moderating effects of gender, ethnicity, education level, and region of residence on outcomes. The final sample included 771 subjects (mean age=10 yrs). After 2 years, fruit intake ($P<0.005$) and vegetable intake ($P<0.025$) in the intervention group was significantly higher than in the control group. There were no significant moderating effects of gender, ethnicity, education level, or region of residence.

Te Velde et al., 2008 (Neutral Quality) conducted a randomized controlled trial in Norway, The Netherlands, and Spain to examine the effects of the Pro Children intervention on children's fruit and vegetable intake. Schools were randomized to one of two groups for 2 years: (1) Intervention: the Pro Children intervention consisted of a classroom nutrition education component, additional fruits and vegetables at school meals, a family component, and

a community participation components; and (2) Control: no intervention. Dietary intake-related behaviors (fruit and vegetable intake) were assessed before, immediately following the intervention, and 1-year later using one 24-hour recall and an FFQ. Multilevel regression analyses were conducted to determine any potential interaction effects of the intervention with country of residence. The final sample included 1,472 subjects (mean age=10 yrs). After 1 year, the intervention group reported significantly higher fruit and vegetable intake compared to control ($P<0.05$). After 2 years, intervention results differed by country, such that the intervention effect was significant only in Norway ($P<0.05$). Further analyses revealed that the effect in Norway was for total fruit and vegetable intake, as well as for fruit intake alone ($P<0.05$). In Spain and The Netherlands, the effect of the intervention for total fruit and vegetable intake decreased during the second follow-up, and in Spain this was due mainly to weaker effects for fruit intake alone.

Thompson et al., 2009 (Positive Quality) conducted a randomized controlled trial in the United States to test the effects of a nutrition education intervention on fruit, fruit juice, and low-fat vegetable intake in boys. Boy Scout troops were randomly assigned to one of two conditions for 9 weeks: (1) Intervention: participated in a program that included weekly troop time, plus weekly Internet programming, (2) Control: participated in a mirror image intervention to increase physical activity. Dietary intake-related outcomes (fruit, fruit juice, and low-fat vegetable intake) were assessed at baseline, immediately following the intervention, and 6 months post-intervention using a validated FFQ. Analysis of covariance was conducted to assess the moderating effects of demographics and anthropometric characteristics. The final sample included 473 boys (ages 10–14 yrs). Immediately following the intervention, subjects in the intervention significantly increased consumption of fruit and fruit juice compared to control subjects ($P<0.003$). However, this difference was not maintained 6 months later. Also, at 6-month post-intervention, subjects in the intervention group increased low-fat vegetable intake compared to the control group ($p<0.05$). Neither household education nor psychosocial characteristics (self-efficacy, fruit/juice/vegetable preferences, home fruit/juice/vegetable availability) moderated the effects of the intervention.

Townsend et al., 2006 (Neutral Quality) conducted a randomized controlled trial in the United States to examine the effects of the Youth Expanded Food and Nutrition Education Program (EFNEP) on dietary intake among low-income children. Youth groups were randomly assigned to one of two groups for 1 year: (1) Intervention: Received group-based knowledge-based nutrition education at school, summer day camp, or community-after school programs; (2) Control: No intervention (delayed intervention). Dietary intake-related behaviors were assessed before and immediately following the intervention using a validated survey instrument. Analysis of covariance was conducted to determine whether outcomes differed depending on age, ethnicity, and gender. The final sample included 5,112 children (mean age=10 yrs). Children in the intervention group improved scores in all four target areas, including “eat a variety of foods,” “nutrition knowledge,” “food selection,” and “food preparation skills and safety practices.” Children in the intervention group made greater gains in “food selection” ($P<0.008$) and “food preparation skills and safety practices” ($P<0.0001$) compared to children in the control group. Females scored significantly higher than males on the posttest using total scores ($P<0.001$), and statistically significant gains were found for females for two indicators and males for three indicators in the intervention group compared to control (both, $P<0.0001$). White subjects scored the highest on the posttest using total scores ($P<0.0001$). Statistically significant gains for two indicators were found for white subjects and Hispanic subjects (both, $P<0.0001$), while no gains were identified among black subjects. Age did not have a significant impact on outcomes.

Turnin et al., 2001 (Positive Quality) conducted a randomized controlled trial in France to investigate the impact of nutrition computer games on children’s dietary intake. Schools were randomly assigned to one of two groups for 5 weeks: (1) Intervention: played computer games during the conventional nutritional teaching period, and (2) Control: received conventional classroom nutrition education. Dietary intake-related outcomes (calorie, fat, protein, sugar, calcium, and fiber intake; meal patterns) were assessed only at the completion of the study, using 3-day diet records. Analyses were conducted to determine whether study outcomes were different according to subject’s BMI. The final sample included 1,876 children from 15 schools (mean age=9 yrs). After the intervention, dietary intake differed significantly between the children in the games group compared to the control group; the game group consumed more carbohydrate ($P<0.05$), less fat ($P<0.05$), less protein ($P<0.05$), less sugar ($P<0.001$), more calcium

($p < 0.001$) and more fiber ($p < 0.05$). There were no significant differences in diet between children with a normal BMI compared to those with an overweight BMI. However, those subjects with an obese BMI had significantly lower energy intake ($P < 0.0005$) and sugar intake ($P < 0.05$), as well as ate significantly more energy at lunch ($P < 0.005$) and skipped breakfast more often ($P < 0.005$) compared to those who had normal or overweight BMIs.

Williamson et al., 2007 (Positive Quality) conducted a randomized controlled trial in the United States to examine the effects of an environmental approach on children's dietary intake. Schools were randomly assigned for 2 years to one of two groups: (1) Intervention: the Healthy Eating and Exercise program included modifications to the school environment and cafeteria to improve dietary intake and increase physical activity; (2) Comparison: received an alcohol/drug/tobacco use program. Dietary intake related behavior (food selection, plate waste, and food intake of total calories, carbohydrate, protein, fat, saturated fat) was assessed at baseline and month 18 using digital photography of three lunch meals. Analysis of covariance was conducted to determine whether outcomes were affected by baseline BMI and dietary intake. The final sample included 586 subjects (mean age=9 yrs). Results showed that subjects in the intervention group consumed significantly fewer total calories and lower percentage of calories from fat, saturated fat, and protein compared to the control group ($p < 0.05$). ANCOVA results for all subjects combined showed that for all dietary intake measures assessed, higher baseline intake values were associated with greater change scores. In addition, baseline BMI was negatively correlated with changes in plate waste for all dietary variables ($r = -0.18$ to -0.26) and positively correlated with changed in food intake for all dietary variables except saturated fat ($r = 0.10$ to 0.19).

Overview Table

Table 4-G.2. Studies examining factors that moderate the effects of nutrition education interventions

Study	Study Population	Study Description	Moderator Analysis Outcomes	Limitations
Bannon, 2006 Neutral Quality Randomized Controlled Trial	N = 50 (46% female) Mean age=5 yrs Race: 92% White, 4% Black, 4% Hispanic, 6% Other SES: School district had a mean per capita income of \$28, 882 United States	<u>Intervention 1</u> : children watched a 60-sec video with a gain-framed nutrition message <u>Intervention 2</u> : children watched a 60-sec video with a loss-framed nutrition message <u>Control</u> : children watched a 60-sec video with a control scene	Pre-test apple or animal cracker preference did not moderate the effects of the intervention	Small sample size Short length of intervention makes it difficult to determine long-term effects Some confounding variables were not accounted for The validity of the videos was not pre-tested.
Baranowski, 2003 Neutral Quality Randomized Controlled Trial	N = 1,489 (53% female) Mean age=9 yrs Race: 18% African-American, 44% Euro-American, 31% Hispanic, 7% Other SES: N/A United States	<u>Intervention</u> : "Squire's Quest," a psychoeducational computer game <u>Control</u> : no intervention	Age, gender, or ethnicity did not moderate the effects of the intervention	Unclear what aspects of the game caused behavior change Computer game can be expensive and create technological challenges Limited generalizability due to small sample size, and lack of racial and gender diversity Self-reported dietary intake Long-term effects of the program are unknown
Baranowski, 2002 Neutral Quality Randomized Controlled Trial	N = 186 (0% female) Age=9–18 yrs Race: 88% African American, 12% Mexican- American SES: N/A United States	<u>Intervention</u> : nutrition education to increase preference, preparation skills, and at-home availability/accessibility of fruits and vegetables <u>Control</u> : no intervention	Setting did not moderate the effects of the intervention	Pretest group differences may not have been fully controlled for Inadequately powered due to small sample Long-term effects were not measured
Baranowski, 2000 Neutral Quality Randomized Controlled Trial	N = 1172 (Gender: N/A) Age=4th and 5th grade Race: 15% African- Americans, 85% Euro-American SES: N/A United States	<u>Intervention</u> : multi- component intervention that included a curriculum, newsletters, videotapes, and point-of-purchase education <u>Control</u> : no intervention	Ethnicity and gender not moderate the effects of the intervention	Self-reported dietary intake-related outcomes Long-term effects were not measured Study conducted in winter, which may have affected results

Table 4-G.2. Studies examining factors that moderate the effects of nutrition education interventions—continued

Study	Study Population	Study Description	Moderator Analysis Outcomes	Limitations
Bere, 2006a Neutral Quality Randomized Controlled Trial	N = 517 (48% female) Mean age=11 yrs Race: N/A SES: N/A Norway	<u>Intervention:</u> FVMM program and free subscription to the Norwegian School Fruit Programme <u>Control:</u> no intervention. *In year 2, 4 intervention schools continued to participate in the standard Norwegian School Fruit Programme (paid fruit), while 5 schools did not (no fruit)	Gender, habitual f/v intake, preferences, parent education, and household income did not moderate the effects of the intervention	
Bere, 2006b Neutral Quality Randomized Controlled Trial	N = 369 (54% female) Mean age=11 yrs Race: N/A SES: N/A Norway	<u>Intervention:</u> FVMM program, which consisted of a school-based fruit and vegetable intervention consisting of a home economics classroom component, parental involvement, and encouraged participation in the Norwegian School Fruit Program <u>Control:</u> no intervention	Gender did not moderate the effects of the intervention	Some schools did not fully implement the intervention
DeBar, 2009 Neutral Quality Randomized Controlled Trial	N = 82 (Gender: N/A) Mean age=16 yrs Race: 81% White SES: Mean household income was \$68,656 United States	<u>Intervention:</u> In-person counseling (overnight retreat, monthly events), coaching calls, and use of a study website <u>Control:</u> no intervention	Overall website use was associated with increases in calcium intake (P=0.01). Use of specific study web pages related to dietary intake-related behaviors was not associated with any of the measured behavioral outcomes	Inadequately powered to detect differences Subjects self-reported dietary intake Generalizability is limited as subjects had high levels of parental post-secondary education and household income.
Dzewalkowski, 2009 Positive Quality Randomized Controlled Trial	N = 1582 (54% female) Mean age=12 yrs Race: 78% White, 9–10% Black, 4–5% Hispanic, 1–2% American Indian, 1–4% Asian SES: 30-37% eligible for free or reduced price lunch United States	<u>Intervention:</u> Healthy Youth Places intervention which consisted of group training for adult school leaders, environmental change skill curriculum, and youth-led fruit/vegetable and physical activity change teams <u>Control:</u> no intervention	Gender, race, free and reduced lunch eligibility, or BMI did not moderate the effects of the intervention	Schools volunteered and were not selected randomly. Could not determine which intervention components contributed to the effects.

Table 4-G.2. Studies examining factors that moderate the effects of nutrition education interventions—continued

Study	Study Population	Study Description	Moderator Analysis Outcomes	Limitations
Fahlman, 2008 Positive Quality Non-Randomized Controlled Trial	N = 576 (51% female) Mean age=12 yrs Race: 24–87% African American, 0–4% Asian, 5–71% White, 1–7% Other SES: 67% of the intervention group and 25% of the control group were eligible for free and reduced price lunch United States	<u>Intervention</u> : classroom nutrition education <u>Control</u> : no intervention	Gender did not moderate the effects of the intervention	Short-term pilot study Teachers' willingness to participate may have biased findings towards success Self-reported measures of eating behaviors; only assessed intake "yesterday" One-third of students did not complete the post-test Data were analyzed at the student level and not at the school level (this could have resulted in statistical errors in the CI)
Foerster, 1998 Neutral Quality Non-Randomized Controlled Trial	N = 2684 (50% female) Age=3rd-6th grade Race: >70% Hispanic SES: 54-65% eligible for free and reduced price lunch United States	<u>Power Play-School</u> : received the Power Play! Activities at school <u>Power Play-Community</u> : received the Power Play! At school and in community locations <u>Control</u> : did not receive Power Play!	The following were associated with increased f/v consumption: helping to fix vegetables/salad for dinner (P<0.05), asking for favorite fruit at snack (P<0.05), choosing juice bar over ice cream bar (P<0.01), choosing veggie pizza over pepperoni pizza (P<0.01), choosing strawberry shortcake over chocolate cake (P<0.05), family interest in what the child learns about f/v (P<0.01), perception that cafeteria serve like when the child eats f/v (P<0.01), and friends making fun of a child for eating f/v each day (P<0.05). When all variables were included in a regression model, the treatment effect was a stronger predictor of changes in fruit and vegetable intake than any one variable.	Dietary intake was self-reported Weather and a labor strike affected f/v price and availability during the study Seasonal variations in f/v may have affected outcomes between groups Variation in the ethnic composition of student participating could have affected results
Gortmaker, 1999 Positive Quality Randomized Controlled Trial	N = 1,560 (48% female) Mean age=12 yrs Race: 62% White, 11% African-American, 11% Hispanic, 9% Asian/Pacific Islander, 2% American Indian, 5% Other SES: N/A United States	<u>Intervention</u> : Planet Health curriculum in 4 major subjects and physical education <u>Control</u> : no intervention	Among girls, there was less of an increase in estimated energy intake per day in the intervention group compared to control (P<0.05), and an increase in fruit and vegetable consumption (P=0.003). There were no significant changes in other measured dietary intake variables among girls, and no significant changes in any of the measured dietary intake outcomes in boys.	Self-reported dietary intake-related outcomes Long-term effects were not measured

Table 4-G.2. Studies examining factors that moderate the effects of nutrition education interventions—continued

Study	Study Population	Study Description	Moderator Analysis Outcomes	Limitations
Haerens, 2007a Neutral Quality Randomized Controlled Trial	N = 2,840 (37% female) Mean age=13 yrs Race: N/A SES: 68% lower SES Belgium	<u>Intervention with parental involvement:</u> nutrition education, environmental changes with parental support <u>Intervention without parental involvement:</u> nutrition education, environmental changes without parental support Control: no intervention	There was a trend for a significant condition by gender interaction effect for fat intake and percentage of energy from fat such that the intervention was effective in girls but not in boys (P<0.09). Fat intake and percentage energy from fat decreased significantly more in girls of the intervention with parental support group compared with both other conditions (P<0001).	Self-reported dietary intake-related outcomes Did not assess the effects of each intervention component Long-term effects were not measured
Haerens, 2007b Positive Quality Randomized Controlled Trial	N = 304 (70% female) Mean age=13 yrs Race: N/A SES: N/A Belgium	<u>Intervention:</u> a single computer-tailored dietary fat intake session <u>Control:</u> no intervention	There were no gender effects in general school students. Girls in the intervention from technical-vocational schools decreased dietary fat intake compared to control (P≤0.05). Students who read the intervention messages decreased dietary fat intake (14.4 g) compared to those who did not (-4.6 g) (P<0.05). In intervention subjects who read the messages, boys/girls in general schools and girls in tech-voc schools decreased fat intake compared to control (P≤0.05). Fat intake decreased 10.1 g among precontemplators, 6.2 g among contemplators, 33.7 g among preparators, 12.3 g among actors, and 6.4 g among maintainers (P<0.05). Attitude did not have a moderating effect on intervention outcomes.	Subjects reported that the survey and intervention messages were too long and boring
Haerens, 2006 Positive Quality Randomized Controlled Trial	N = 2,287 (38% female) Mean age=13 yrs Race: N/A SES: 33% higher SES Belgium	<u>Intervention with parental involvement:</u> nutrition education, environmental changes with parental support <u>Intervention without parental involvement:</u> nutrition education, environmental changes without parental support Control: no intervention	In boys, there were no significant 2-yr post-baseline intervention effects on eating behaviors. In girls, at 2-yr post-baseline, fat intake and percent energy from fat decreased more in the intervention group compared to the control group (P<0.05).	Level of parental involvement was not assessed High drop-out rate at 2 yrs (25%) Self-reported dietary intake-related outcomes Did not assess effects of individual study components
Horne, 2009 Positive Quality Non-Randomized Controlled Trial	N = 435 (Gender: N/A) Age=5–11 yrs Race: N/A SES: N/A Ireland	<u>Intervention:</u> received fruit at snack time, rewards for consuming the fruit, and nutrition education videos <u>Comparison:</u> received fruit at snack time and rewards for consuming the fruit	Age did not moderate the effects of the intervention	Limited generalizability due to lack of information about subject population

4-G.2. Studies examining factors that moderate the effects of nutrition education interventions—continued

Study	Study Population	Study Description	Moderator Analysis Outcomes	Limitations
Horne, 2004 Positive Quality Non-Randomized Controlled Trial	N = 749 (Gender: N/A) Age=5–11 yrs Race: 80% ethnic minorities SES: 67% received the free meal entitlement United Kingdom	<u>Intervention</u> : received fruit at snack time, rewards for consuming the fruit, and nutrition education videos <u>Comparison</u> : received fruit at snack time and rewards for consuming the fruit	During the maintenance phase, lunchtime vegetable consumption decline among 7- to 11-year-olds, but not for 5- to 7-year-olds. Children who ate the least during baseline (0-19% consumed) showed the largest increases in consumption during intervention and at follow-up.	Limited generalizability due to lack of racial diversity
Patrick, 2001 Neutral Quality Randomized Controlled Trial	N = 117 (37% female) Mean age=14 yrs Race: 57% White, 21% African American, 10% Hispanic, 3% Asian, 9% Other SES: N/A United States	Subjects received a computerized assessment, tailored behavior changes plans, and met with a health care provider, and then randomized to 1 of 4 groups: <u>Intervention 1</u> : extended intervention via mail only <u>Intervention 2</u> : extended intervention via infrequent telephone and mail <u>Intervention 3</u> : extended intervention via frequent telephone and mail <u>Intervention 4</u> : no further contact or intervention	Gender did not moderate the effects of the intervention	Self-reported dietary intake-related outcomes
Pempek, 2009 Neutral Quality Randomized Controlled Trial	N = 30 (50% female) Mean age=9 yrs Race: 100% African American SES: Low-income United States	<u>Intervention 1</u> : played the healthier advergame before choosing and eating a snack <u>Intervention 2</u> : played the less healthy advergame before choosing and eating a snack <u>Control</u> : chose and ate a snack before playing the game and completing the measures	Gender did not moderate the effects of the intervention	Long-term effects of advergames on diet were not assessed The study sample was small, and limited to only African American children, and should be expanded to other ethnicities and age groups.
Perry, 1998 Positive Quality Randomized Controlled Trial	N = 441 (Gender: N/A) Age=4th–5th grade Race: 48% White, 25% Asian, 19% African American, 6% Hispanic, 1% Native American SES: 60% free- or reduced-price lunch United States	<u>Intervention</u> : nutrition education curriculum, parental involvements, school food service changes, and industry involvement and support <u>Control</u> : no intervention	There were differences in outcomes by gender, such that girls in the intervention consumed more vitamin C than boys (P<0.02). There were also differences by racial/ethnic group: Asian subjects decreased total fat and saturated fat (P<0.01), African American subjects decreased saturated fat (P<0.03), while there was no change in white subjects, and a non-significant trend for Hispanic subjects to increase saturated fat intake (P<0.06).	Unclear what role reporting bias may have played in outcomes related to gender and race/ethnicity

4-G.2. Studies examining factors that moderate the effects of nutrition education interventions—continued

Study	Study Population	Study Description	Moderator Analysis Outcomes	Limitations
<p>Prell, 2005 Neutral Quality Non-Randomized Controlled Trial</p>	<p>N = 28 (47% female) Mean age=14 yrs Race: N/A SES: N/A Sweden</p>	<p><u>Intervention</u>: school lunch intervention (expanded marketing and choice, and improved preparation and appearance of fish served in the cafeteria) plus home economics education (education about fish and nutrition) <u>Comparison intervention</u>: school lunch intervention (SL) <u>Control</u>: no intervention</p>	<p>No significant gender differences were found with regards to changes in fish consumption, though boys may have benefited from the intervention somewhat more than girls (based on visual inspection of the relative position value)</p>	<p>Baseline differences may have influenced results. There was not a comparison group that received the home economics education alone. Small sample size.</p>
<p>Reinaerts, 2007 Neutral Quality Non-Randomized Controlled Trial</p>	<p>N = 939 (52% female) Mean age=9 yrs Race: N/A SES: N/A The Netherlands</p>	<p><u>Intervention</u>: multicomponent school-based program consisting of a classroom curriculum, parental involvement, and supermarket marketing <u>Comparison</u>: free fruit and vegetable distribution at school</p>	<p>Veg. dinner intake increased in the comparison group for 4-6th graders (+22%, P<0.01) and non-native children (+32%, P<0.01). Veg. snack intake increased in the comparison group for 4-6th graders (+33%, P<0.01) and in the intervention group for 1-3rd graders (+50%, P<0.05) and for girls (P<0.01). Total FJV increased in the intervention group: native children increased consumption (0.2 portions, P<0.05) less than non-native children (1.6 portions, P<0.01). Total FJV increased in the comparison group: preschoolers increased intake (0.1 portions, P<0.05) less than 4-6th graders (0.5 portions, P<0.01).</p>	<p>Measures were not validated in the target population tested Schools were not randomly assigned, but were matched based on size and ethnicity Low participation rate (21% of eligible schools) may limit generalizability</p>
<p>Sahota, 2001 Positive Quality Randomized Controlled Trial</p>	<p>N = 595 (45% female) Age=7–11 yrs Race: N/A SES: 7–29% eligible for free school meals United Kingdom</p>	<p><u>Intervention</u>: teacher training, modification of school meals, and the development of school action plans targeting the curriculum, physical education, tuck shops, and playground activities <u>Control</u>: the usual health curriculum, with no additional intervention</p>	<p>Vegetable consumption did not differ by weight status. Obese children in the intervention group consumed less fruit (-1.0 portions/d, 95% CI -1.8, -0.2) compared to the whole intervention group combined. Overweight children consumed more high sugar foods (0.8 portions/d, 95% CI 0.1, 1.6)) compared to the whole sample combined.</p>	<p>Inadequate sample size in group randomization Accuracy of self-reported dietary intake was difficult to determine.</p>

4-G.2. Studies examining factors that moderate the effects of nutrition education interventions—continued

Study	Study Population	Study Description	Moderator Analysis Outcomes	Limitations
Salminen, 2005 Neutral Quality Non-Randomized Controlled Trial	N = 1,055 (48% female) Mean age=11 yrs Race: N/A SES: N/A Finland	<u>Intervention</u> : individual counseling sessions (2 sessions at school and 3 at home with their family) on nutrition, exercise, cigarette smoking, and drugs/alcohol; from high-risk families (family history of CVD) <u>Control group 1</u> : no intervention, from high-risk families <u>Control group 2</u> : no intervention, not from high-risk families	Boys in the intervention compared to control group 1 decrease frequency of eating cakes and pastries and frequency of adding salt to food, while girls in the intervention compared to control group 1 decrease frequency of consuming greasy snacks. Girls in the intervention compared to control group 1 decreased frequency of consumption of observable fat and ice cream decreased and increased rye bread consumption.	Lack of randomization may have introduced bias Confounding variables were not examined in detail and may have impacted results Use of a non-validated questionnaire to assess outcomes
Stock, 2007 Neutral Quality Non-Randomized Controlled Trial	N = 360 (36–72% female) Age=K-7th grade Race: N/A SES: Average income of \$57,052 Canada	<u>Intervention</u> : school-based nutrition education program consisting of 21 healthy-living lessons (involved peer teaching from older to younger schoolchildren) <u>Control</u> : no intervention	In kindergarten through 3rd graders, female students in the intervention group had significantly higher scores than females in the control group (P=0.013) (but not males). In 4th through 7th graders, no differences by gender were reported.	Inadequate sample size The control group had lower rates of participation in the assessment Pubertal stage was not controlled for Study was not designed to test whether a student-led intervention is more effective than a traditional teacher-led intervention Long-term effects of the intervention are not known
Tak, 2009 Neutral Quality Non-Randomized Controlled Trial	N = 771 (53-57% female) Mean age=10 yrs Race: N/A SES: N/A The Netherlands	<u>Intervention</u> : received a piece of fruit or vegetables for free twice a week and school nutrition education curriculum <u>Control</u> : no intervention	No significant moderating effects of gender, ethnicity, education level, or region of residence.	Inadequate statistical power to assess moderators. Subjects were not randomly assigned to groups.
Te Velde, 2008 Neutral Quality Randomized Controlled Trial	N = 1,472 (44-51% female) Mean age=10 yrs Race: N/A SES: N/A Norway, Netherlands, Spain	<u>Intervention</u> : the Pro Children intervention consisted of a classroom nutrition education component, additional fruits and vegetables at school meals, a family component, and a community participation components <u>Control</u> : no intervention	After 2 years, the intervention effect was significant only in Norway (+91.5 g/d; P<0.05). The effect in Norway was for total fruit and vegetable intake, as well as for fruit intake alone (P<0.05). In Spain and the Netherlands, the effect of the intervention for total fruit and vegetable intake decreased during the second follow-up, and in Spain this was due mainly to weaker effects for fruit intake alone.	Selective participation might have biased the results and limits the generalizability of findings. The intervention was better implemented during the first year, and degree of implementation was highest in Norway, following by Spain and the Netherlands.

4-G.2. Studies examining factors that moderate the effects of nutrition education interventions—continued

Study	Study Population	Study Description	Moderator Analysis Outcomes	Limitations
Thompson, 2009 Positive Quality Randomized Controlled Trial	N = 473 (0% female) Age=10–14 yrs Race: N/A SES: N/A United States	<u>Intervention</u> : participated in a 9-wk program that included approximately 30 min of weekly troop time, plus approximately 25 min of weekly Internet programming <u>Control</u> : participated in a mirror image intervention to increase physical activity	None of the variables tested (household education, self-efficacy, fruit/juice/vegetable preferences, home fruit/juice/vegetable availability) moderated the effects of the intervention.	Limited generalizability due to a predominantly Euro-American, middle-class sample of only males
Townsend, 2006 Neutral Quality Randomized Controlled Trial	N = 5,112 (51% female) Mean age = 10 yrs Race: 19% White, 13% Black, 3% Hispanic, 12% Asian, 3% Native American, 10% Other SES: N/A United States	<u>Intervention</u> : Received group-based knowledge-based nutrition education at school, summary day camp, or community-after school programs <u>Control</u> : No intervention	Girls scored higher than boys using total scores ($P<0.001$), and significant gains were found for girls for 2 indicators and boys for 3 indicators in the intervention compared to control (both, $P<0.0001$). White subjects scored the highest using total scores ($P<0.0001$). Significant gains for 2 indicators were found for white and Hispanic subjects in the intervention compared to control (both, $P<0.0001$); no gains were identified among black subjects. Age did not moderate outcomes.	Did not monitor or enforce leader fidelity to delivery of the intervention. Survey items were forced into 4 outcome categories; and individual food and nutrient outcomes were not reported Data collection was not well controlled
Turnin, 2001 Positive Quality Randomized Controlled Trial	N = 1,876 (53% female) Mean age=9 yrs Race: N/A SES: N/A France	<u>Intervention</u> : played computer games during the conventional nutritional teaching period (2 hr/wk for 5 wks) <u>Control</u> : conventional nutrition education from their teacher	Outcomes did not differ between normal and overweight subjects. Obese subjects had significantly lower energy intake ($P<0.0005$) and sugar intake ($P<0.05$), as well as ate significantly more energy at lunch ($P<0.005$) and skipped breakfast more often ($P<0.005$) compared to those who had normal or overweight subjects.	There was no pre-test, only a post-test, limiting the interpretation of the study findings. Long-term effects of games on diet were not assessed.
Williamson, 2007 Positive Quality Randomized Controlled Trial	N = 586 (49% female) Mean age=9 yrs Race: 95% White, 2.4% Black, 2.7% Other SES: N/A United States	<u>Intervention</u> : the Healthy Eating and Exercise program included modifications to the school environment and cafeteria to improve dietary intake and increase physical activity <u>Comparison</u> : Alcohol/Drug/Tobacco Use program aimed to modify beliefs and attitudes regarding use of tobacco, alcohol, and drugs	For all subjects combined and for all dietary intake measures assessed, higher baseline intake values were associated with greater change scores. In addition, baseline BMI was negatively correlated with changes in plate waste for all dietary variables ($r = -0.18$ to -0.26) and positively correlated with changed in food intake for all dietary variables except saturated fat ($r = 0.10$ to 0.19).	Inadequate statistical power Limited generalizability due as sample was predominantly white, middle-class

Research Recommendations

1. Future systematic reviews should be conducted looking at specific moderators and specific outcomes in order to refine the focus the review. The specific moderators and outcomes examined should be focused on those that most directly impact and/or derive from national nutrition priorities and guidelines.

Rationale: The studies included in this systematic evidence scan examined a wide range of variables as potential moderators and measured a wide range of dietary intake-related outcomes. Therefore, it was difficult to compare results across studies. As more studies are published that include an analysis of potential moderators, more refined and focused systematic reviews can be conducted.

2. More research is needed to understand how mediators and moderators interact to impact the outcomes of nutrition education interventions.

Rationale: Some of the evidence identified in another systematic evidence scan found different mediators for girls and boys. These findings suggest that even when a population receives the same intervention, the variables that moderate the effects of the intervention may differ for different subpopulations.

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Chapter 5. Conflict of Interest

Role of the Funding Agency and Stakeholder Group

Members of the funding agency participated in this project as members of the Stakeholder Group. The Stakeholder Group was comprised of Federal USDA employees, who represented potential end-users of the review and possessed varying perspectives and expertise related to nutrition education. The Stakeholder Group:

- Assisted in refining and prioritizing systematic review questions to ensure the questions were valuable for informing federal policy and programs;
- Provided input on research recommendations and implications; and
- Identified strategies to communicate results.

Members of the funding agency also served as Peer Reviewers for the project. Peer Reviewers reviewed and provided comment on the systematic review products throughout the project, and after this draft report was produced. The Peer Reviewers were instructed to focus their review on ensuring the readability and clarity of the final report, and could not make changes to the conclusion statements or grades.

Conflicts of Interest

None of the TEC members declared any conflicts of interest.