Effectiveness of interventions and programmes promoting fruit and vegetable intake

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1. Introduction

1.1 Background

Fruit and vegetables are important components of a healthy diet, and recent epidemiological advances suggest that regular consumption of adequate amounts could help prevent major chronic diseases such as cardiovascular diseases and some cancers (*1−5*).

Results from the Global Burden of Disease Project for the year 2000 showed that up to 2.7 million deaths worldwide, and 1.8% of the total global disease burden may be attributed to inadequate levels of fruit and vegetable consumption (*6*). Increasing individual fruit and vegetable intake could reduce the burden of ischaemic heart disease by 31% and ischaemic stroke by 19%. For stomach, oesophageal, lung and colorectal cancer the potential estimated reductions were 19%, 20%, 12% and 2% respectively. Earlier studies have estimated that low fruit and vegetable consumption was responsible for 2.4%, 2.8% and 3.5% of the burden of disease in New Zealand, Australia and the European Union respectively (*7−9*).

In 2002, an expert consultation (for the World Health Organization (WHO) and the Food and Agriculture Organization (FAO)) assessed the strength of the evidence for the relationship between fruit and vegetable intake and health. The experts concluded that, with an increased consumption of fruit and vegetables, there is convincing evidence of reduced risk of cardiovascular disease, a probable reduced risk of some cancers, diabetes and obesity, as well as an association with the prevention and alleviation of several micronutrient deficiencies (especially in less developed countries) (*1*). The expert consultation recommended that a daily intake of fresh fruit and vegetables in an “adequate quantity” is needed to reduce these disease risks. They defined an “adequate quantity” as being at least 400 to 500 grams per day (g/d). This amount is generally considered to be equivalent to five servings of 80g of fruit and/or vegetables (which is the internationally recognized standard serving size). However, there is clear variation in the understanding of serving size. Current international recommendations thus propose the intake of a minimum of 400g of fruit and vegetables per person per day (excluding potatoes and other starchy tubers). However, survey data and availability statistics from FAO suggest that most populations are not meeting this recommendation, and that increased fruit and vegetable consumption is urgently needed (*6, 10*).

1.2 Prevention of cardiovascular disease

There is now much epidemiological evidence for the links between fruit and vegetable intake and cardiovascular disease risks. Observational studies have found that people who consume large amounts of fruit and vegetables have lower rates of coronary heart disease and stroke (*11, 12*). A few trials of dietary interventions for secondary prevention of coronary heart disease have included advice to eat more fruit and vegetables (*13−15*). The Lyon Diet Heart study showed that a "Mediterranean diet" (which is high in fruit and vegetables) substantially reduced the risk of incidence and mortality from myocardial infarction compared with a low-fat diet (*15*). The results of the Indian Experiment of Infarct Survival (IEIS) showed that the consumption of a low-fat diet enriched with fruit and vegetables, compared with a standard low-fat diet, was associated with about 40% reduction in cardiac events and 45% reduction in mortality after one year (*14*). Results from the Dietary Approaches to Stop Hypertension (DASH) trial suggested that changes in dietary fats do not necessarily accompany an increase in fruit and vegetable intake. In this trial, hypertensive participants were randomized to receive for eight weeks either a control diet, a diet rich in fruit and vegetables, or a combination diet rich in fruit and vegetables and reduced in saturated fat, fat and cholesterol (*16, 17*). Both the combination diet and the fruit and vegetable diet significantly reduced systolic and diastolic blood pressure. After eight weeks, 70% of the participants on the combination diet had a normal blood pressure, compared with 45% of those on the fruit and vegetable diet, and 23% of those on the control diet. The fruit and vegetable diet produced few changes in blood lipids but was still likely to reduce coronary heart disease risk independently. However, the DASH trial was a controlled feeding trial in which all food was supplied by the researchers. It is therefore not possible to use this trial to make any assumptions about how changes in fruit and vegetable intake might affect other aspects of the diet in people who have a free choice of food.

1.3 Prevention of cancer

Observational studies have consistently found that people who consume large amounts of fruit and vegetables have lower rates of oesophageal, gastric, colorectal, lung, pharyngeal and laryngeal cancers (*1, 2, 4, 18*). There is little experimental evidence for the effects of increasing fruit and vegetables in the diet on cancer outcomes. The Beta-Carotene and Retinol Efficacy Trial (CARET) and the Alpha-Tocopherol, Beta-Carotene Cancer Prevention Study (ATBC) were randomized controlled trials designed to investigate the effect of high-dose supplementation of beta-carotene on lung cancer (*19, 20*). The results

suggested a harmful effect (increase in incidence and mortality) of beta-carotene supplementation in current smokers. Given the lack of randomized-controlled trials that investigated the association of fruit and vegetable consumption with cancer outcomes, current evidence of causality is mainly derived from observational studies. Although more research is needed to investigate the biological mechanisms for the protective relationship, at present there is no justification for advocating a diet based on specific types of fruit or vegetables and it is also clear that the effects of fruit and vegetable consumption cannot be achieved by individual dietary supplements. These findings justify clear advice to policy-makers that increasing consumption of a range of fruit and vegetables is important for cancer prevention.

1.4 Previous reviews of fruit and vegetable interventions

In some developed countries, including Australia, Nordic countries, the United Kingdom of Great Britain and Northern Ireland, and the United States of America, fruit and vegetable promotion initiatives ("5 a Day" type campaigns, or nutrition education and information approaches) have been established for several years. National fruit and vegetable programmes have now been set up in many countries worldwide. In Table 1, a summary is presented of various national approaches to promoting fruit and vegetable consumption. In developing countries, a range of intersectoral projects has been established to encourage production and consumption of fruit and/or vegetables, often as local food-based initiatives to reduce micronutrient deficiency (Annex 1 provides examples of projects in developing countries). Various groups of researchers have also performed food-based intervention studies for primary and secondary prevention of chronic conditions.

The findings of previous reviews are interesting, suggesting that the majority of fruit and vegetable promotion interventions lead to increased consumption at least in the short term. However, it should be noted that no review has conducted a meta-analysis quantifying the effectiveness of fruit and vegetable interventions. This has been due to the large amount of variability in the type of interventions and population characteristics between studies, and the frequent inadequacy of the statistical information required for conducting meta-analysis.

Contento et al. reviewed all types of nutrition education interventions in the United States, not specifically focused on fruit and vegetable consumption (*21*). The main factors that contributed to the effectiveness of nutrition education interventions included those studies that were behaviourally focused and theory based. Some of the specific programme elements that made behavioural change strategies most effective included the use of a systematic behavioural change process (e.g. self-assessment and goal-setting), individually

tailored education and counselling (in individual or small groups), and social support (such as family or peer educators). Education or communications were most effective when motivational or reinforcing factors were personalized, when there was active participation or self-evaluation. Environmental interventions varied. Point of purchase information appeared to be highly effective in changing behaviour, but only as long as the intervention lasted. However, interventions in schools, worksites and communities appeared to be important for long-term behaviour change.

Ciliska et al. reviewed 15 different community interventions (18 reports) to increase fruit and vegetable consumption in people over four years of age in developed countries (*22*). Their findings suggest that the outcomes of interventions vary more with the intensity and clarity of the message than by the age or site of the intervention. They concluded that the most effective fruit and vegetable promotion interventions incorporated behavioural theories and goals providing a consistent framework; gave clear messages about increasing fruit and vegetable consumption; provided longer, more intensive interventions rather than a few contacts; and actively involved influential people such as family members. Interventions also seemed to have the greatest impact on those whose knowledge or intake was lowest at the beginning of the study.

Miller and Stafford reviewed a range of interventions in developed countries to promote knowledge and consumption of fruit and vegetables (*23*). They found that in supermarket interventions, consumer awareness ranged from 5% to 50%, and changes in intake, if any, were of small magnitude and were short lived. They suggested that the more successful approaches were interactive rather than simply promotional. School-based interventions reviewed mainly came from the United States. Out of 16 studies, 14 achieved a net positive effect for fruit or fruit and vegetable intake, with a magnitude ranging from 0.2 to 0.77 servings/day. The effective interventions relied on longer-term curriculum-based interventions reinforced by teacher training, food service changes and family support. The authors concluded that it was difficult to determine which individual activities were most responsible for increasing consumption. Two out of three worksite interventions resulted in increases in fruit and vegetable intake (0.1−0.5 servings/day) but as they were multi-component it was difficult to determine what was specifically useful for changing consumption. Although the food-service interventions reviewed had not exclusively focused on fruit and vegetables, the studies showed that price reductions of about 50% can result in increases of twofold to fourfold in purchases in the intervention period, although purchases appeared to return to baseline three weeks after an intervention. The community-based

interventions were very varied in the strategies used, and seemed to suggest that educational strategies can improve knowledge about fruit and vegetable consumption, and may increase consumption in the short term.

Ammerman et al. reviewed the efficacy of behavioural interventions to modify fruit and vegetable intake focusing on studies in North America, Europe and Australia (*24*). Among the 12 interventions considered, 77% of the studies found there to have been a significant effect in increasing fruit and vegetable intake. Although the authors did not conduct a meta-analysis, they attempted to summarize the studies quantitatively by using a "difference in deltas analysis" which calculated the change in mean intake from baseline to the first follow-up period for intervention and control groups. Overall, the intervention groups increased their intake of fruit and vegetables by about 17% over control groups, representing an average increase of 0.6 servings/day. However, this effect was not sustained when the analysis was performed using six studies which had a second, longer follow-up period. The intervention effect decreased, with only a 6.7% greater increase in fruit and vegetable consumption in intervention versus control participants. When the authors examined the relative effectiveness of the interventions, using a simple four-point scoring system, three characteristics appeared to be significantly associated with a greater likelihood of observing a significant effect for fruit and vegetable intake: goal-setting, food-related activities, and the theoretical basis. However, all these analyses had limitations as they required small numbers of heterogeneous studies to be grouped. The majority of the studies included in the review were described as "downstream" (individual-level interventions). Clearly, effective interventions for fruit and vegetable promotion will need to include individual-level interventions, population-level prevention strategies and "upstream" macro-level policy and environmental interventions.

Pignone et al. reviewed randomized controlled trials to examine the effectiveness of counselling to promote a healthy diet among patients in primary health care settings (*25*). They identified 10 studies that addressed changes in consumption of fruit and vegetables. Three studies produced increases of less than 0.3 servings/day, five demonstrated increases of 0.3-0.5 servings/day, and two demonstrated large effects (1.4 and 3.3 servings/day respectively). They conclude that, among factors influencing all types of dietary change (not just fruit and vegetable intake), moderate or high-intensity counselling, including the use of interactive tools, is more effective than brief counselling.

Burchett reviewed primary-school-based nutrition intervention studies that included fruit and vegetable consumption (*26*). The five studies (reported in 12 papers)

included in the review were all from the United States, and were focused on behavioural change based on social cognitive theory. The review concluded that the main factors influencing fruit and vegetable consumption among schoolchildren were: the availability of fruit and vegetables; the preparation skills for eating and cooking fruit and vegetables; and the taste preferences of the children for vegetables. Greater effects were seen for fruit consumption, and those interventions that were maintained appeared to have better results over time.

Table 1. **Selected national fruit and vegetable promotion programmes identified**

Country	Name of fruit and vegetable programme	Types of activities	Website link
Argentina	*5 al dia*	Event sponsorship, seminars, partnership with horticulture sector	www.5aldia.com.ar
Australia (Western Australia)	Go for 2 and 5	Mass media campaign including television advertisements and kids in kitchen television series, cookbooks, consumer literature. School canteen accreditation (STARCAP), school fruit and vegetable week, under-five daycare scheme, low-income project (food cents)	www.gofor2and5.com.au
Canada	5 to 10 a day	Three-year media campaign including television, radio stations, and print media. Information materials distributed to health offices, schools, grocery retail stores and dieticians	www.5to10aday.com
Denmark	*6 om dagen,* School fruit programme	Media campaign and educational material, worksite interventions, subscription school fruit scheme	www.6omdagen.dk www.frugtkvarter.dk
France	*10 par jour*	Newsletters, media campaigns, recipes	www.10parjour.net
Hungary	3 a day	Started in 1997 as a partnership funded both by agriculture and health. Target groups: children, young people and housewives. Activities include supermarket promotions, cooking shows, taste-testing at school, advertising and public relations materials.	www.kertnet.hu/HungarianHorticulture/gb/129s.htm
Germany	*5 am tag*	Campaigns, published literature	www.5amtag.de
Japan	*Vegefru-7*	Started in 2002 as a partnership between government (agriculture, education) and the Japan Produce Alliance for Better Health (producers, retailers, industry). Dietary education tool distributed to classrooms, supermarket tours, harvesting tours, communications strategy and materials	www.vf7.jp
Mexico	*5 x dia*	Formation of *Fundacion Campo Y Salud Organisation,* communications strategy	ww.cincopordia.com.mx
Netherlands	2+2	Interactive website for children, recipes, communication strategy	www.vgf.info
New Zealand	5 a day	National media campaign, 5+ a day week, 5+ a day school programme, various projects	www.5aday.co.nz

Norway	*5 om dagen*, school fruit programme	Subscription school fruit scheme	www.frukt.no/ www.skolefrukt.no
Poland	5 a day	National campaign co-organized between cancer centres and private sector (producers, processors, retailers). "5 a day" promotion activities in kindergarten, primary and secondary schools	
Spain	*5 al dia*	Information campaign, activities for children, symposia, events with agricultural sector	www.5aldia.com
Sweden	*5 om dan*	Series of activities involving health, nutrition, education and commercial sectors	www.fruktogront.se
Switzerland	*5 am tag/ par jour/ al giorno*	Consumer information, media campaign, food giveaway sessions in public places	www.swisscancer.ch/ fr/content/violett/nationprog_5amtag_aktivitaeten.php
United Kingdom of Great Britain and Northern Ireland	5 a day	Communications programme including media campaigns and written information, school fruit scheme, local "5 a day" community projects and local project workers, work with retail sector applying "5 a day" logo to foodstuffs	www.dh.gov.uk/PolicyAndGuidance/HealthAndSocialCareTopics/FiveADay/fs/en
Uruguay	*5 por dia*	Series of activities involving health, nutrition, education and commercial sectors	www.mercadomodelo.net/ programa.php
United States of America	5 a day (Produce for Better Health Foundation)	Public/ private partnership, communications strategy, "5 a day" week, endorsement of "5 a day" logo.	www.5aday.com
	5 to 9 a day for better health (National Cancer Institute)		www.5aday.gov/

1.5 The need for a literature review on the effectiveness of fruit and vegetable interventions

The findings of previous reviews of the effectiveness of fruit and vegetable promotion programmes and interventions have been encouraging. However, those reviews have generally been limited in scope (focusing for example on community intervention programmes, nutrition education, counselling in primary care units, schoolchildren or behavioural interventions), or geographically limited, focused on North America, Australasia and Europe, or even on the United States only (*21, 22, 24–26*). A number of studies have

also been conducted since these reviews were published, which has created a need for a new systematic review of fruit and vegetable promotion initiatives worldwide, comparing all settings.

Evidence for decision-making is being increasingly demanded, and the extent to which public health policy is based on evidence is being questioned (*27, 28*). WHO is developing a global fruit and vegetable promotion initiative which fits within the framework of the Global Strategy on Diet, Physical Activity and Health and the implementation mandate of the WHO Global Strategy for the Prevention and Control of Noncommunicable Disease. An up-to-date systematic review of all types of interventions and programmes promoting fruit and vegetable intake is therefore urgently needed. As was stressed at the WHO Fruit and Vegetable Promotion Initiative Meeting in August 2003, evidence of effectiveness for fruit and vegetable interventions is essential in order to develop effective and appropriate policies in different countries worldwide, and to ensure that current fruit and vegetable programmes (such as those underway in the United Kingdom and the United States) have maximized their potential to improve public health (*29*). In response to the recommendations agreed at this meeting, the current project aimed to summarize evidence of the effectiveness of fruit and vegetable promotion interventions and programmes worldwide.

1.5.1 Aim and objectives

The aim of this project was to conduct a systematic review of worldwide evidence on the effectiveness of interventions and programmes promoting fruit and vegetable intake in individuals of all ages.

The specific objectives were to:

- systematically collect and summarize worldwide evidence, using published and "grey" literature, from current evaluations of all interventions and programmes which promote fruit and vegetable consumption;
- discuss the implications for regions where data are lacking and suggest ways of filling this information gap;
- recommend a set of parameters for future evaluations;
- discuss ways to increase effectiveness of fruit and vegetable promotion projects, and the appropriateness and feasibility of different approaches in different countries and settings.

2. Methods

The methods for the systematic review were based on the recommendations of the Centre for Reviews and Dissemination of the University of York (United Kingdom) for systematic reviews of effectiveness (*30*).

2.1 Criteria for considering studies for this review

2.1.1 Types of studies

This review set out to include all individual and population-based interventions and promotion programmes encouraging the consumption of a diet relatively higher in fruit and/or vegetables, where the primary outcome (see below) was measured, provided they followed individuals for at least three months. These covered population-based studies (large-scale fruit and vegetable promotions, such as "5 a Day" programmes, nutrition education and information approaches, social marketing approaches) and studies with an individual focus (small-scale and large-scale intervention studies).

2.1.2 Types of participants

Studies of free-living children and adults of both genders were included. However, studies of acutely ill and institutionalized individuals were excluded.

2.1.3 Types of interventions or programmes

The intervention had to promote a diet high in fruit and vegetables. This could involve dietary advice taking any form (for example, verbal or written nutrition education, single or multiple contacts with individuals or groups), publicity campaigns, social marketing approaches, or by increasing production such as home gardening.

Studies were included if outcome data on fruit and vegetable intake could be collected. They were excluded if they were multiple risk-factor intervention studies on lifestyle factors other than diet unless the effect of diet could be separated out from the other interventions.

2.1.4 Types of outcome measures

- Primary outcome:
    - Change in fruit and/or vegetable intake, derived from self-reported measures or observation, or from availability data (if used as a proxy for intake).
- Secondary outcomes:
    - Change in rates of noncommunicable diseases and risk factors.

2.2 Search strategy for the identification of studies

After consultation with the senior librarian at the London School of Hygiene and Tropical Medicine, a range of databases and other information resources was searched to locate published and unpublished relevant literature. In addition, the bibliographies of retrieved documents were searched for further studies.

The following databases were searched from the earliest record to April 2004:

- PUBMED
- CAB Abstracts (including nutritional abstracts and reviews)
- The Cochrane Library (including DARE: Database of Abstracts and Reviews of Effects)
- Web of Knowledge (including Web of Science and ISI database)
- IBSS (international bibliography of the Social Sciences)
- Psychinfo (BIDS)
- EMBASE
- AGRICOLA
- LILACS (Latin American and Caribbean Health Science Literature Database)
- ID21 (Development research reporting service)
- ERIC (Educational Resources Information Center)
- SIGLE (System for Information on Grey Literature)
- New York Academy of Medicine (Grey literature)
- INGENTA

The search strategy was designed to be used in PUBMED and adapted to the other databases. Full details, including years searched, are given in Annex 2.

Free text terms used to search included [(diet* OR food habit*) AND (fruit* OR vegetable*)]; with intervention*, evaluation*, health promotion*, health education*, health knowledge, health behaviour (and "behavior"), health practice, counselling (and "counseling"), clinical trial*, meta-analysis, cost effectiveness, economic evaluation, decision-analysis; limited to human studies and not animals.

MeSH terms used included diet*, food habit*, fruit* (not exploded to exclude nuts and seeds), vegetable*; with intervention studies, evaluation studies, health promotion, health education, health knowledge, health behavior, public health practice, counseling, clinical trial*, meta-analysis, cost-benefit analysis, decision-support techniques; limited to human studies and not animals.

The database search was complemented by a comprehensive search for grey literature and other relevant material. Published systematic reviews addressing fruit or vegetable intake were sought. Cochrane Review Groups in areas related to this review were contacted and asked to search their trial registers for relevant trials.

Experts in the field were contacted for references to studies not identified by the database search process. WHO regional nutrition officers, coordinators of national fruit and vegetable promotion programmes (e.g. "5-a-Day" programmes, see Table 1) and WHO nutrition collaborating centres worldwide were contacted. Those who provided information are listed in Annex 3 (116 people in 51 countries).

Messages requesting help in identifying data sources were posted on a nutritional epidemiology scientific mailing list (NUTEPI@listserv.gmd.de). This generated six replies.

All retrieved references were entered into one large endnote bibliographic file.

2.3 Process for selecting included studies

Only papers or reports in Danish, English, French, Norwegian, Portuguese, Russian, Spanish, and Swedish were considered (languages spoken by the authors). Articles were rejected on initial screening only if the reviewer could determine from the title and abstract that the article was not a report of a fruit and vegetable intervention study or promotion programme; or if any of the following exclusion criteria were met.

- the study did not address fruit or vegetable intake;
- the intervention was not on humans;
- the report was on acutely ill or institutionalized individuals;
- the intervention was of less than three months' duration;
- the study did not have a control group;
- the study was multi-factorial and the effect of diet could not be separated out from the other intervention(s);
- the primary outcome (fruit and vegetable intake) was not measured.

It was also decided to exclude studies in which participants were paid substantial amounts of money for their involvement. However, studies where participants received small financial incentives such as coupons were included in the review. Such coupons are often part of educational programmes designed for low-income population groups or used in supermarkets.

When a paper could not be rejected with certainty from review of the abstract, the full text of the article was obtained for further evaluation.

In each selected article, reference lists were checked and other articles that appeared to be appropriate to the review were retrieved.

2.4 Methods of the review

2.4.1 Data collection

An in/out Excel spreadsheet was used to assess studies' inclusion (or otherwise) into the review. The inclusion of studies was assessed independently by two assessors and differences between reviewers' results were resolved by discussion and, when necessary, in consultation with a third reviewer. Reasons for exclusion were noted.

Forms were also designed for the assessment of study quality and for data extraction. The quality assessment tool (Annex 4) was developed based on those used by previous reviews by the Centre for Reviews and Dissemination of the University of York, United Kingdom, and the previous study by Ciliska et al (*22*). Quality assessment forms were completed independently by two reviewers. Studies that were considered of poor quality ("weak") based on the quality assessment criteria were excluded from the review (a listing of these studies is given in Annex 5). Data abstraction was performed by one reviewer and checked by a second reviewer. Disagreements between reviewers' results were resolved by discussion and, when necessary, in consultation with a third reviewer. When several articles described the same study, the most complete article was used as the main source of data and the other articles used for supplemental information. Annex 6 provides details of the studies included in the review.

Results were examined and categorized by life-course stage and study setting, as described in Table 2. Initially the aim was to include a subcategory for the elderly but no studies of this population were found that met the selection criteria.

Table 2. Categorization of studies by life-course stage and study setting

Life-course stage	Study setting
Children	Elementary school High school / secondary school
Adults	General population
	Worksite
	Primary health care, and other health care settings
	Churches
	Special programmes for low-income groups
	Supermarkets and other retail settings
Adults with health conditions	Cardiovascular diseases
	Cancer

Because of heterogeneity in the study populations, types of interventions, and outcome assessment measures, meta-analysis was not attempted.

2.5 Estimation of effect size

The review team set out to summarize the effect size of the interventions reported by the studies in the following ways:

- **Net effect:** the difference between the change in fruit and vegetable intake in the intervention group and the change in the fruit and vegetable intake in the control group. A positive net effect signifies that the intervention group has a greater increase in fruit and vegetable intake than the control group comparing intakes at baseline and follow-up. Thus, net effect = (Follow-up $\text{intake}_{\text{Intervention}}$ - Baseline $\text{intake}_{\text{Intervention}}$) - (Follow-up $\text{intake}_{\text{Control}}$-Baseline $\text{intake}_{\text{Control}}$).
- **Differences between groups at follow-up:** difference between the intervention and control groups for fruit and vegetable intake at follow-up. This measure was used for studies that only reported fruit and vegetable intake at follow-up. This was subcategorized into those studies that reported a higher fruit and vegetable intake in the intervention group at follow-up, or those studies that reported a higher intake in the control group at follow-up. Thus the difference between groups at follow-up = Follow-up $\text{intake}_{\text{Intervention}}$ - Follow-up $\text{intake}_{\text{Control}}$).

- **Change in intake within each group**: assessment of the significance of the change in fruit and vegetable intake in the intervention group and of the significance of the change in fruit and vegetable intake in the control group. This measure was used for studies that did not statistically compare groups, with subcategorization into studies that had a significant increase in fruit and vegetable intake in the intervention group only (no change in the control group) and those studies that had no significant increase in fruit and vegetable intake in both the intervention and control groups.

3. Results

3.1 Retrieval and characteristics of reviewed studies

A total of 3499 unduplicated records were identified for review from the literature searches and contacts with experts. After review of the abstracts 306 articles were identified that reported on interventions designed to increase fruit and vegetable intake. These were rated as potentially relevant and the full articles retrieved. After full review using the chosen quality assessment tool an additional 228 studies were excluded from the analysis because they did not meet the eligibility criteria. Of the studies that met the inclusion criteria, eight were rated as "weak" on the quality criteria and excluded from the review (see Annex 5).

The final pool of 70 articles reported results of 60 independent studies, which were used in the analysis. Some general characteristics of these studies are given in Table 3.

Table 3. Characteristics of the studies included in the review of the literature by life-course stage, study setting and WHO region

Life-course stage and study setting	Africa % (n)	Americas % (n)	South-East Asia % (n)	Europe % (n)	Western Pacific % (n)	All (n)
Children						
Primary school	-	66.6(8)	-	33.3 (4)	-	(12)
Secondary school	-	100 (4)	-	-	-	(4)
Adults						
General population	-	50 (2)	25 (1)	25 (1)	-	(4)
Worksite	-	91 (10)	-	-	9 (1)	(11)
Primary health care and other health care settings	-	77.8 (7)	-	22.2 (2)	-	(9)
Churches	-	100 (3)	-	-	-	(3)
Special programmes for low-	-	100 (5)	-	-	-	(5)

Life-course stage and study setting	Africa % (n)	Americas % (n)	South-East Asia % (n)	Europe % (n)	Western Pacific % (n)	All (n)
income groups						
Supermarkets and retail settings	-	100 (2)	-	-	-	(2)
Adults with health conditions						
Cardiovascular diseases	-	12.5 (1)	37.5 (3)	50 (4)	-	(8)
Cancer	-	100 (2)	-	-	-	(2)
All (n)	(0)	(44)	(4)	(11)	(1)	(60)

3.2 Study results

The following sections present summary details of the studies considered for the review; first those targeting children, then adults. The studies targeting children are described by age group (primary and secondary school ages) and then by intervention type. The studies focusing on adults are analysed first by setting, then by intervention type. The tables in Annex 6 provide more in-depth detail on the study design, the recruitment and characteristics of participants, the nature of the intervention, the methods of data collection and analysis, and the results (including details of statistical significance of the results, including *P*-values and/or confidence intervals where reported).

3.2.1 Children

Sixteen studies (reported in 18 papers) focusing on children were identified for inclusion in the review (see Table 4 for summary details and Annex 6 for full details). The majority of studies were carried out in the United States, three in the United Kingdom, and one in Ireland (*31*−*34*). Most studies were school-based except for one targeting girl scouts (*35*). All studies ─ except for the girl scouts ─ included both boys and girls. Since the studies usually involved entire classes across several schools, the number of participants for most studies was fairly high: three had 500−999 participants and 11 had 1000 or more. Only two had less than 500 participants (*33, 35*).

Primary school-aged children

Twelve studies were identified targeting primary schoolchildren: all but one took place in the school setting, and all included boys and girls, with the exception of the study on girl scouts (*35*). The study populations were from Ireland, the United Kingdom, and the United States.

Seven studies were randomized controlled studies, two non-randomized controlled and three, quasi-experimental, with cross-sectional surveys at baseline and follow-up. The length of follow-up period ranged from under 11 months (four studies), 12−24 months (six studies) and two years or more (two studies). The studies used a wide variety of data collection methods, often utilizing more than one method in the same study.

The type of intervention varied among studies but the majority of the school-based approaches (11 studies) had a classroom intervention (nine studies), with varying kinds and degrees of school and community-wide activities. One study took place outside the school setting, promoting fruit and vegetable consumption among girl scout troops in the United States (*35*).

A whole-school approach was employed in several interventions. For example, the Active Programme Promoting Lifestyles in Schools study used the health-promoting schools approach, based on action plans developed by individual schools according to perceived needs. It involved teacher training, modification of school meals, curriculum development and healthy tuck shops (*32*). Other studies such as the 5-a-Day Power Play! Campaign employed a whole-school and community approach, including a state-wide social marketing campaign where one intervention group received the social marketing activities in the school environment only, and a second intervention group was exposed to community-wide interventions through community youth organizations, supermarkets, farmers' markets and the mass media (*38*).

Table 4. General characteristics of the studies in children by age group

	Primary school-aged children	Secondary school-aged children
Total number of studies (16)	12	4
Countries	Ireland, UK, US	US
Study design		
Randomized controlled trial	7	4
Non-randomized controlled trial	2	-
Quasi-experimental, with cross-sectional surveys at baseline and follow-up	3	-
Number of participants		
Range		
100−499	2	1
500−999	3	-
≥1000	7	4
Gender		
Boys and girls	11	4
Boys only	-	-
Girls only	1	-
Age range	5−12	13−18
Type of intervention		
School-based curricula	1	1
School-based curricula with integrated school-wide activities	5	3
School-based curricula with integrated school /community-wide activities	4	-
Other interventions	2	-
Length of follow-up		
3−5 months	3	-
6−11 months	1	-
12−24 months	6	2
≥24 months	2	2
Data collection method for fruit and vegetable intake (*NB some studies used multiple methods*)		

	Primary school-aged children	Secondary school-aged children
Food-frequency questionnaire	4	2
Dietary history	3	-
Food record	3	-
24-hour recall (s)	6	1
Other	3	2
Number of studies with measured effect		
No significant effect	1	
Statistically significant effect		
1) Positive net effect [a]	1	1
2) Differences between groups at follow-up [b]		
- Higher intake in intervention group at follow-up [b]	8	-
- Higher intake in control group at follow-up [b]	-	-
- No difference at follow-up [b]	-	2
3) Change in intake within groups [c]		
- Significant increase in intervention group only [c]	-	1
- Significant increase in intervention and control groups [c]	1	-
- Non-significant change in all groups [c]	1	-

[a] The net effect is the difference in the change in fruit and vegetable intake in the intervention and the change in the fruit and vegetable intake in the control group. A positive net effect signifies that the intervention group has a greater increase in fruit and vegetable intake than the control group, comparing intake at baseline and follow-up. It is calculated as = (Follow-up intake$_{Intervention}$-Baseline intake$_{Intervention}$)-(Follow-up intake$_{Control}$-Baseline intake$_{Control}$).

[b] The difference between groups at follow up is reported when studies only report fruit and vegetable intake at follow up. Studies were subdivided into those that have higher fruit and vegetable intake in the intervention group at follow-up, or those studies that have higher fruit and vegetable intake in the control group at follow-up. The difference between groups at follow-up is calculated as = (Follow-up intake$_{Intervention}$-Follow-up intake$_{Control}$).

[c] Some studies only estimated the statistical significance of the change in intake within each group. These were subdivided into: 1) those studies which reported a statistically significant increase in fruit and vegetable intake in the intervention group but no statistically significant change in the control group; and 2) those that showed no statistically significant change in both the intervention and the control group.

Classroom intervention typically involved interactive learning through skill-building and problem-solving exercises to familiarize students with fruit and vegetables, teach them how to prepare them and how to promote them at home. Two studies also reported using video as a medium to convey the intervention messages, often to be watched with parents, featuring for example a sports celebrity, or cartoon characters representing the students' peers (for example Food Dudes) having adventures and extolling the benefits of fruit and vegetable consumption (*31, 39*). Another form of classroom activity was a competition in which students would receive prizes for completing relevant activities (*31, 35, 39*).

Parental[1] involvement was an essential component of the majority of primary school interventions. The level of parental involvement differed: most studies provided parents with "parent packs" which included information on the intervention, recipes, tips on purchasing and preparing fruit and vegetables at home and short family assignments. Parents often took part in fruit and vegetable promotion activities; for example one study offered parents nutrition education classes taught by local programmes (*37*). Educational "family nights" (for example with the local produce supplier) were organised and most studies encouraged parents to promote fruit and vegetables at home (*37, 39*).

The school food-service staff played an important role in the interventions and often received training on the purchase, preparation and promotion of fruit and vegetables (*31, 37, 40, 42, 43*). School food-service staff were asked to support healthy eating messages taught in the classroom, making available and actively promoting particular fruit or vegetables according to the lesson plan (*36, 41, 42*). In one cafeteria-based study, students in intervention schools received more verbal encouragement by school food-service staff to eat fruit and vegetables and this was found to be significantly associated with higher intakes (*40*).

Teachers also often received training in nutrition education, fruit and vegetable promotion, and/or how to integrate the intervention goals into the existing curriculum (*32, 34, 37−39, 41, 42*).

A measured increase in fruit and vegetable intake in the intervention group compared with the control group was seen in all but one study *(35)*. One study had a positive net effect of +0.7 servings/day (*38*) and consisted of a whole-school and community approach including training and involvement of the school food-service providers, parents/families and teachers. Eight studies had higher intakes in the intervention groups at follow-up (+0.14 to +0.99

[1] Includes guardians

servings/day) (*32, 34, 36, 37, 39-42*). One study had a significant increase in both intervention and control groups (*33*) and finally one had non-significant changes in all groups (*31*).

Secondary school–aged children

Four studies were identified which targeted secondary school-aged children and adolescents: all of them took place in the school setting and all were randomized controlled trials. The study populations all came from the United States. The length of follow-up period was between 12 to 24 months for two studies and two years or more for the other two studies (*44−47*). A wide variety of data collection methods were utilized.

As in the studies targeting primary schoolchildren, the types of intervention varied among studies, but the classroom intervention typically comprised a behavioural curriculum approach (see above). At least three of the four studies had active collaboration from the school food-service staff. Two of the studies were mainly limited to classroom activities and the other two utilized a school-wide approach (*45−47*). In one study, a school-wide marketing campaign to increase awareness, reinforce concepts and promote positive attitudes toward fruit and vegetables was implemented (*46*). In the other, a School Nutrition Advisory Council was formed by staff, parents and student representatives; it aimed to develop policy practices to enhance the healthfulness of the school environment (*44*). Another essential element in this study was the training of peer leaders in a one-day training programme. The peer leaders helped teachers to deliver classroom interventions and lead small group discussions about fruit and vegetables.

Parents were involved in interventions in two out of four studies (*44−46*). Parents received "parent packs", and in addition at least one study offered monetary rewards to parents for completing "parent pack" activities with their children in the form of redeemable coupons (*36*). The other used parent-teacher-association meetings to conduct fruit and vegetable taste-testing and general fruit and vegetable promotion as part of a parent-focused component of the study ("Raisin Teens") designed to encourage parents to serve fruit and vegetables at home (*46*).

In two studies, teachers received training in nutrition education, fruit and vegetable promotion, and/or how to integrate the intervention goals into the existing curriculum, and in one, all school staff received flyers asking them to support the intervention messages (*44−46*).

A measured increase in fruit and vegetable intake in the intervention group compared with the control group was seen in all studies. One study had a positive net effect (+0.32

servings/day) although only in girls (*45*), another study had a significant increase in the intervention group (+0.9 servings/day) (*44*) and two studies found no differences between groups at follow-up (*46, 47*),

3.2.2 Adults

The results for adults are summarized by settings, both in tables 5 and 6, with commentary given in the subsections that follow. The section on adults concludes with a discussion of the results by intervention type across all the settings. Full details of all the studies included are given in Annex 6.

General population or community interventions

Four studies (reported in six papers) were identified which targeted adults in the general population (*48− 52*).

All the studies included both men and women (although in one study women made up 80% of the study population), and all had at least 500 participants. The study populations came from Japan, the United Kingdom, and the United States. Two studies were randomized controlled trials, two were non-randomized controlled studies. Two had follow-up periods of one year, while the others were followed up at five and ten months. The studies used a range of different methods for assessing dietary intake.

The types of interventions used varied among studies. However, they can be classified into two main types: interventions that focused on individual counselling or education; and multi-component community interventions.

Two studies looked at individual education or counselling. One study from the United States delivered education in a brief telephone education session followed up by two reinforcing mail outs (*51, 52*). The other, in Japan, combined individual diet counselling with group lectures plus regular newsletters (*53*). Both studies found significant increases in fruit and/ or vegetable intake that were greater in the intervention versus the control group at follow-up. In the study from the United States, the net difference in fruit and vegetable intake between intervention and control groups was greatest at four weeks after the start of the intervention (+0.63 servings/day using a food-frequency questionnaire). At 12 months follow-up the net difference was reduced to +0.44 servings/day. In the Japanese study the net difference at 10 months was significant for fruit intake (+17.1 g/d), and for green and yellow vegetables (+22.4 g/d).

Table 5. General characteristics of the studies in adults by study setting

	General population	Worksites	Health care settings	Low-income populations	Churches	Supermarkets or other retail settings
Total number of studies	4	11	9	5	3	2
Countries	Japan, UK, US	New Zealand, US	UK, US	USA	USA	USA
Study design						
Randomized controlled trial	2	8	9	5	3	2
Non-randomized controlled trial	2	1	-	-	-	-
Randomized controlled trial with cross-sectional surveys at baseline and follow-up	-	2	-	-	-	-
Number of participants						
Range	550-1706	Approximately 250−10 000 (2−114 worksites)	271−2208	242−3122	1011−3737	296−960
100−499	-	1	2	-	-	1
500−999	2	1	5	2	-	1
≥1000	2	9	2	2	3	-
Gender						

	General population	Worksites	Health care settings	Low-income populations	Churches	Supermarkets or other retail settings
Men and women	4	9	8	2	3	2
Men only	-	1	-	-	-	-
Women only	-	1	1	2	-	-
Age range	18−70 years	Adults	18+ years	18+ years	18+ years	18+ years
Type of intervention						
Individual counselling/ education	1	-	3	-	-	-
Group counselling/ education	-	-	1	-	-	-
Computer based tool	-	-	3	-	-	1
Individual counselling/ education + other interventions	1	3	2	5	2	-
Peer-education	-	1	-	-	-	-
Point of purchase information	-	-	-	-	-	1
Multi-component community or worksite interventions	2	7	-	-	1	-

/continued

(continued) Table 5. General characteristics of the studies in adults by study setting

	General population	Worksites	Health care settings	Low-income populations	Churches	Supermarkets or other retail settings
Length of follow-up	5−12 months	15−30 months	3−18 months	3-12 months	6-24 months	8-12 months
3−5 months	1	-	2	-	-	-
6−11 months	1	-	3	3	1	1
≥12 months	2	11	4	2	2	1
Data collection method for fruit and vegetable intake (*NB some studies used multiple methods*)						
Food-frequency questionnaire	2	10	7	4	3	2
Dietary history	2	-	-	-	-	-
Weighed food record	1	-	-	-	-	-
Non-weighed food record	-	-	1	-	-	-
24-hour recall (s)	2	2	2	1	-	-
Other	-	2	4	-	-	Food receipts
Number of studies with measured effect						
No significant effect	-	4	1	-	-	1
Statistically significant effect	-	7	-	-	3	-
1) Positive net effect [a]	2	6	8	4	-	-

	General population	Worksites	Health care settings	Low-income populations	Churches	Supermarkets or other retail settings
2) Differences between groups at follow-up [b]						
- Higher intake in intervention group at follow-up [b]	1	-	-	-	-	1
- Higher intake in control group at follow-up [b]	-	-	-	-	-	-
3) Change in intake within groups [c]						
- Significant increase in intervention group only [c]	-	1	-	1	-	-
- Non-significant change in all groups [c]	1	-	-	-	-	-

[a] The net effect is the difference in the change in fruit and vegetable intake in the intervention and the change in the fruit and vegetable intake in the control group. A positive net effect signifies that the intervention group has a greater increase in fruit and vegetable intake than the control group comparing intake at baseline and follow-up. It is calculated as = (Follow-up intake$_{Intervention}$-Baseline intake$_{Intervention}$)-(Follow-up intake$_{Control}$-Baseline intake$_{Control}$).

[b] The difference between groups at follow-up is reported when studies only report fruit and vegtable intake at follow-up. This was subdivided into those studies that have higher fruit and vegetable intake in the intervention group at follow-up, or those studies that have higher fruit and vegetable intake in the control group at follow-up. Difference between groups at follow-up is calculated as = (Follow-up intake$_{Intervention}$-Follow-up intake$_{Control}$).

[c] Some studies only estimated the statistical significance of the change in intake within each group. These were subdivided into: 1) those studies which reported a statistically significant increase in fruit and vegetable intake in the intervention group but no statistically significant change in the control group; and 2) those that showed no statistically significant change in both the intervention and the control group.

Two studies evaluated the effect of large-scale multi-component community interventions. One targeted a specific community group, Spanish-speaking Latinos in a California town (*49*). The other was an evaluation of "5 a day" projects in five locations in England that promoted fruit and vegetable intake in the community through a diverse range of activities that were not identical across the five places (*48, 50*). Both programmes had activities targeting a range of settings including food retailers and farmers' markets, schools and pre-schools, workplaces and caterers. Interventions included education, advertisements, use of the media, community festivals and events, food-shop merchandizing and promotions, and also community projects such as cooking classes and food cooperatives. The results varied between the two studies, which is unsurprising considering the differences in populations and activities. The Californian study showed a significant net positive effect in fruit and vegetable consumption (+0.63 servings/day) in the target Spanish-speaking Latino Group, but a net negative effect in English speakers. In fact, amongst the English speakers, the control group had a net increase of +1.47 servings/day compared with those in the intervention group. This effect was attributed to a separate English language nutrition programme operating in the control area, which was another town in California. Among the Spanish speakers there were significant positive correlations between exposure to aspects of the campaign and to participants' beliefs, awareness, attitudes and fruit and vegetable intake. The English "5 a day" evaluation showed no increase in intake in the intervention group (although it states that the intervention prevented decreases in fruit and vegetable intake against national trends, and compared with the control group).

There were several other evaluations of large general population interventions, including other "5 a day" programmes, that did not meet the inclusion criteria for this systematic review. For information purposes, studies that met the inclusion criteria with the exception of not having a control group are summarized in Annex 7. Their results will not be discussed further as part of the systematic review findings, nor do they form part of the conclusions of this review.

Worksite interventions

Eleven studies (reported in 14 papers) were identified which targeted worksites (*54−67*).

All studies but one were randomized controlled trials using worksites as the unit of randomization. In some cases, a matched-pair design was used (*57, 60, 61, 63*). In other cases, data at baseline and follow-up were collected using cross-sectional samples of workers (with only a subsample of respondents having provided information at both time points) (*61,*

65). Ten studies came from the United States and were generally large. The smallest study came from New Zealand; it included only two worksites, one as the intervention group and one as the control group. All interventions were carried out for at least six months, with follow-up periods lasting a minimum of 12 months. All used a food-frequency questionnaire to assess fruit and vegetable intake, some complementing it with other dietary data collection methods. One study was in women only and one study in men only (*66, 67*).

Seven studies examined the effect of multi-component programmes targeting changes in individual eating behaviour and worksite environment (*54, 55, 57, 60–62, 65*). All had established an advisory board for the project. Of these studies, one had two intervention groups in order to assess the effect of an additional component consisting of family-related activities (*55*). Another specifically measured the effect of integrating occupational health and safety into a standard health promotion intervention (*62*). The other four studies focused on individualized education (nutrition classes, self-help materials, personalized feedback, newsletter), individualized information with social support activities (computer-tailored information magazines and worksite natural helpers), with peer-education, or nutrition displays in the canteen (*63, 64, 66, 67*).

A statistically significantly greater increase in fruit and/or vegetable intake in the intervention group compared with the control group was seen in seven studies (*54, 55, 57, 61, 65–67*). In one study, a significant increase in the proportion of participants consuming at least two to three servings of vegetables each day was seen only in the intervention group. In the other studies, the net effect for fruit and vegetable intake ranged from +0.13 to +0.70 servings/day. The highest effect was observed in the women-only study that included a programme based on individualized nutrition education and social support activities (*66*). Two additional studies showed significant net effects at interim measurements (one year or 18 months), but not after a longer follow-up period (two years) (*63, 64*). The study testing the effect of integrating occupational health and safety into a standard health promotion intervention showed no significant difference in the change of fruit and vegetable intake between the groups (net effect) (*62*).

Interventions in health care settings

Nine randomized controlled trials (reported in ten papers) were identified in which the participants were adults recruited via health maintenance organizations (HMOs) (three studies) or general practices (six studies) (*68–77*).

Seven studies were from the United States and two from the United Kingdom. Seven studies included at least 500 participants, and most trials included both men and women (two

included only women). Only two studies had a follow-up period of less than six months; three had a follow-up period of six months, three a follow-up period of one year, and one a follow-up of 18 months. All studies used a food-frequency questionnaire or similar data collection tool to collect information on fruit and vegetable intake. Some used food records or 24-hour recalls as additional tools.

The types of interventions implemented varied among studies. However, they can be classified into three main types: 1) interventions that focused on individual or group counselling; 2) interventions based on the provision of computer-tailored printed nutrition information in formats such as newsletters, booklets, or, for one study, in weekly telephone communication with an interactive computer-based voice system; and 3) interventions that included a combination of printed tailored nutrition information and individual motivational counselling sessions (*68*−*77*).

Where interventions used tailored printed material or a telephone computer-based voice system, the information had been prepared on the basis of theoretical constructs such as the stage of readiness to change fruit and vegetable intake (e.g. stage-of-change, trans-theoretical model of change, or health belief model).

One of the interventions, which compared the effect of mailed nutrition information with that of mailed computer-tailored information and of a control group which received no information, showed no significant difference in fruit and vegetable intake among groups (*72*). The other studies, based on computer-tailored information, showed net effects ranging from +0.7 to 1.1 servings/day at six months (*68, 74*). The study that showed the largest net difference among groups provided the participants with weekly communication with an interactive computer-based voice system (*74*). In that case, the control group used the same technology but with the aim of increasing the level of physical activity among the participants The other study showed that non-tailored newsletters, tailored newsletters, or tailored newsletters with goal-setting, could all significantly help improve fruit and vegetable intake compared with the control group; however, the food-frequency questionnaire used in that study included potatoes in the calculation of fruit and vegetable intake.

The four interventions based on individual or group counselling showed net effects ranging from +0.62 to +1.4 servings/day for fruit and vegetables. The highest net effect was observed in a study that used a brief negotiation method (a 25-minute meeting plus two follow-up phone calls) accompanied with leaflets and other materials (*76*). A slightly lower effect was observed when the intervention included two 45-minute counselling sessions and two follow-up phone calls (*70, 71*). The most intensive intervention, which used periodical

group meetings, showed an increase in the net effect over time up until the 18-month follow-up (*73*). Finally, the intervention that showed the lowest net effect in that subgroup of studies used two 15-minute individual behavioural counselling sessions (at baseline and two weeks later) based on the social learning theory and stage-of-change model (*77*). However, the smaller effect in that case might be due to the fact that the comparison group also received two counselling sessions providing nutrition education (but without a behavioural approach) and thus the study assessed specifically the effect of the behavioural approach.

There were two studies that used a combination of computer-tailored printed information and personal counselling. The simplest intervention (computer generated tailored newsletters and a motivation phone call) showed the lowest net effect (+0.46 servings/day at 12-months) (*69*). The other study was more intensive with the use of a tailored letter, endorsement of the recommendations by the participants' health providers, and two motivational counselling sessions (*75*). The net effect in that case was +0.60 servings/day.

Low-income projects

Five studies (reported in six papers) were identified which targeted adults in low-income projects (*78−83*).

All five studies were randomized controlled trials, were from the United States, and had at least 200 participants. They had follow-up periods of at least six months. Four studies used a food-frequency questionnaire while one used 24-hour recalls to measure fruit and vegetable intake. Two studies were only in women, but in another study, 98% of the participants were female (*81*).

The interventions in all five studies were similar, focusing on a combination of individual or group counselling reinforced by a range of other activities (including audiovisual and written material, demonstration of cooking skills, field trips on selecting and buying foods, group meetings, newsletters, individually tailored direct mail and telephone calls). One of the studies formed part of the curriculum in a low-literacy project (*83*).

All the studies showed a statistically significant greater increase in fruit and vegetable intake in the intervention group than in the control group. The net effect ranged from +0.15 servings/day at approximately six months (*81*) to +0.43 servings/day maintained at 8 months and 12 months later (*79*).

Church-based projects

Three studies (reported in four papers) were identified which targeted the members of Black Churches in the United States (*84−87*).

All three studies were randomized controlled trials with over a thousand participants, 73% of whom were females, and had at least six months follow-up. Each study used at least two dietary data collection methods.

One study targeted individual-level changes by comparing the effect of standard nutrition education materials (control group) with that of culturally sensitive self-help material with or without motivational counselling telephone calls (*86, 88*). Another study used a more ecological model with a strong environmental component (*84, 85*). This multi-component intervention used activities at the individual, social network and community level (including church-wide activities, newsletters, lay health advisors, pastor support, and so on) and compared them with no intervention. The last study used a combination of individual and ecological approaches (church-wide activities, self-help materials and motivational interviewing) (*87*).

All studies showed a statistically significantly greater increase in fruit and vegetable intake in the intervention than in the control group. The net effect or difference at follow-up ranged from +0.7 to +1.12 servings/day. In one study, multiple motivational counselling phone calls were shown to be a promising strategy compared with standard nutrition education materials (net effect +1.12 servings/day) or with culturally sensitive multi-component self-help material with one telephone cue call (net effect of +0.98 servings/day) (*86*).

Supermarkets and retail interventions

Two studies were identified which targeted adults in supermarkets (*89, 90*).

Both studies were randomized controlled trials. In one study randomization was at the level of the supermarket. Both studies were in the United States and had over 160 participants. One had a follow-up of 12 months, while the other had a follow-up of 8−10 months (4-6 months after the intervention). Both studies used a food-frequency questionnaire to measure fruit and vegetable intake, additionally using other methods including annotated shopping receipts. Both trials targeted males and females but in one study 96% of participants were female (*89*).

The types of interventions varied between the studies. One study used a computer-based intervention located in the supermarket to deliver 15-week individualized education, goal-setting and feedback (*89*). There were small monetary incentives for completing study questionnaires and returning food shopping receipts, and weekly food coupons printed from the computer. The other supermarket-based intervention was an eight-month storewide

programme of informational flyers, recipes, coupons and supermarket signs delivering point-of-purchase information and in-store activities including cookery demonstrations (*90*).

The storewide promotion showed no significant effect. Neither the purchase of fruit and vegetables nor consumption of fruit and vegetables changed as a result of the supermarket intervention. The individual supermarket-located computer-based education tool had a net effect of +0.52 servings/day measured by food-frequency questionnaire; but this effect was not shown by shopping receipts.

Adults with pre-existing health conditions

Eight studies (reported in nine papers) were identified which targeted adults who presented cardiovascular disease or risk factors for these diseases ("CVD studies") (*91−99*). Two studies (reported in three papers) targeted cancer patients ("Cancer studies") (*100−102*). Table 6 presents a summary of the general characteristics of the studies.

Of the ten studies, nine were randomized controlled trials and one a controlled intervention (with one county randomized to intervention and the other to the control group). Studies were from five different countries and four included at least 1000 participants. Three had follow-up periods of six months; the others had follow-up times of at least one year. Various methods of dietary assessment were used, sometimes in combination, to assess fruit and vegetable intake. These included food frequency questionnaires (four studies), 24-hour recalls (three studies), or food records or dietary history (four studies).

Of the two "Cancer studies", one was in women only and concerned secondary prevention of breast cancer (*102*). The other included participants (55% males) with large-bowel adenomatous polyps (*100*).

Of the eight "CVD studies", five included men only or at least 85% men (*91−94, 98*). Two specifically followed participants who had just suffered from a myocardial infarction (one from France and one from India) (*91, 92*), two included participants who specifically had high blood pressure (*96, 97*), and the others studied individuals who had a combination of risk factors for cardiovascular diseases (*93, 94*). In four studies, recruitment was made through general advertisements and mass-media announcements, mass mailing, community-based screening, or registration systems of a general practice and pharmacies (*93, 96, 98, 99*).

Seven "CVD studies" focused on individual or group counselling; the other used prompt sheets to help remind participants to consume fruit and vegetables (*97*). One "Cancer study" included individual intensive nutrition education (*100*). The other used telephone

counselling reinforced by a range of other activities (including cooking classes and individual newsletters (*102*).

Of the eight "CVD studies", only the one using prompt sheets (*97*) showed non-significant statistical changes in fruit and vegetable intake among groups. One showed a greater improvement in the intervention compared with the control group only for fruits with a difference at follow-up of +0.6 servings/day (*91*). The others reported greater total fruit and vegetable intakes in the intervention group than in the control group, with a net effect or a difference between groups at follow-up ranging from +0.71 to +4.9 servings/day. Results from the two "Cancer studies" showed net effects of +1.3 servings/1000 kcal to +3.8 servings/day.

Table 6. General characteristics of the studies in adults with health conditions by study setting

Characteristics	Cardiovascular diseases or risk factors	Cancer
Total number of studies	8	2
Countries	France, India, Netherlands, UK, US	US
Study design		
Randomized controlled trial	7	2
Non-randomized controlled trial	1	-
Controlled pre- and post-test cross-sectional study	-	-
Number of participants		
Range	266−3114	2079−2970
100−499	3	-
500−999	2	-
≥1000	3	2
Gender		
Men and women	7	1
Men only	1	
Women only		1
Age range (years)	Adults	18−89
Type of intervention		
Individual counselling/ education	6	1
Group counselling/ education	1	-
Computer based tool	-	-
Individual counselling/education + other interventions	-	1
Point of purchase information	-	-
Multi-component community interventions	-	-
Prompt sheets	1	-
Length of follow-up		
3−5 months	-	-
6−11 months	3	-
≥12 month	5	2
Data collection method for fruit and vegetable intake (*NB some studies used multiple methods*)		
Food-frequency questionnaire	4	1
Dietary history	1	-

Weighed food record	1	-
Non-weighed food record	1	1
24-hour recall (s)	2	1
Other	-	-
Number of studies with measured effect		
No significant effect	1	-
Statistically significant effect	7	2
1) Positive net effect [a]	3	2
2) Differences between groups at follow-up [b]		
- Higher intake in intervention group at follow-up [b]	4	-
- Higher intake in control group at follow-up [b]	-	-
3) Change in intakes within groups [c]		
- Significant increase in intervention group only [c]	-	-
- Non-significant change in all groups [c]	-	-

[a] The net effect is the difference is the change in fruit and vegetable intake in the intervention and the change in the fruit and vegetable intake in the control group. A positive net effect signifies that the intervention group has a greater increase in fruit and vegetable intake than the control group comparing intake at baseline and follow-up. It is calculated as = (Follow-up intake$_{Intervention}$-Baseline intake$_{Intervention}$)-(Follow-up intake$_{Control}$-Baseline intake$_{Control}$).

[b] The difference between groups at follow-up is reported when studies only report fruit and vegetable intake at follow-up. This was subdivided into those studies that have higher fruit and vegetable intake in the intervention group at follow-up, or those studies that have higher fruit and vegetable intake in the control group at follow-up. Difference between groups at follow-up is calculated as = (Follow-up intake$_{Intervention}$-Follow-up intake$_{Control}$).

[c] Some studies only estimated the statistical significance of the change in intake within each group. These were subdivided into: 1) those studies which reported a statistically significant increase in fruit and vegetable intake in the intervention group but no statistically significant change in the control group; and 2) those that showed no statistically significant change in both the intervention and the control group.

The two studies of individuals who had suffered a myocardial infarction showed more favourable health effects in the intervention groups at follow-up. These included a decrease in cardiac events and total mortality after one to four years in the French study or after three years in the Indian study, lower blood lipoprotein levels and body weight were also observed in the Indian study (*91, 92*). Another study conducted in India with adults with angina pectoris, myocardial infarction or surrogate risk factors for coronary heart disease also showed a reduction of total cardiac endpoints, of sudden cardiac death and of non-fatal

myocardial infarction in the intervention group (*93*). Of the two studies targeting high blood pressure, the one which showed a significant net effect as a result of the intervention on fruit and vegetable intake also showed an associated greater reduction in blood pressure (*96*). The other showed no significant difference in the change of fruit and vegetable intake and blood pressure between groups (*97*).

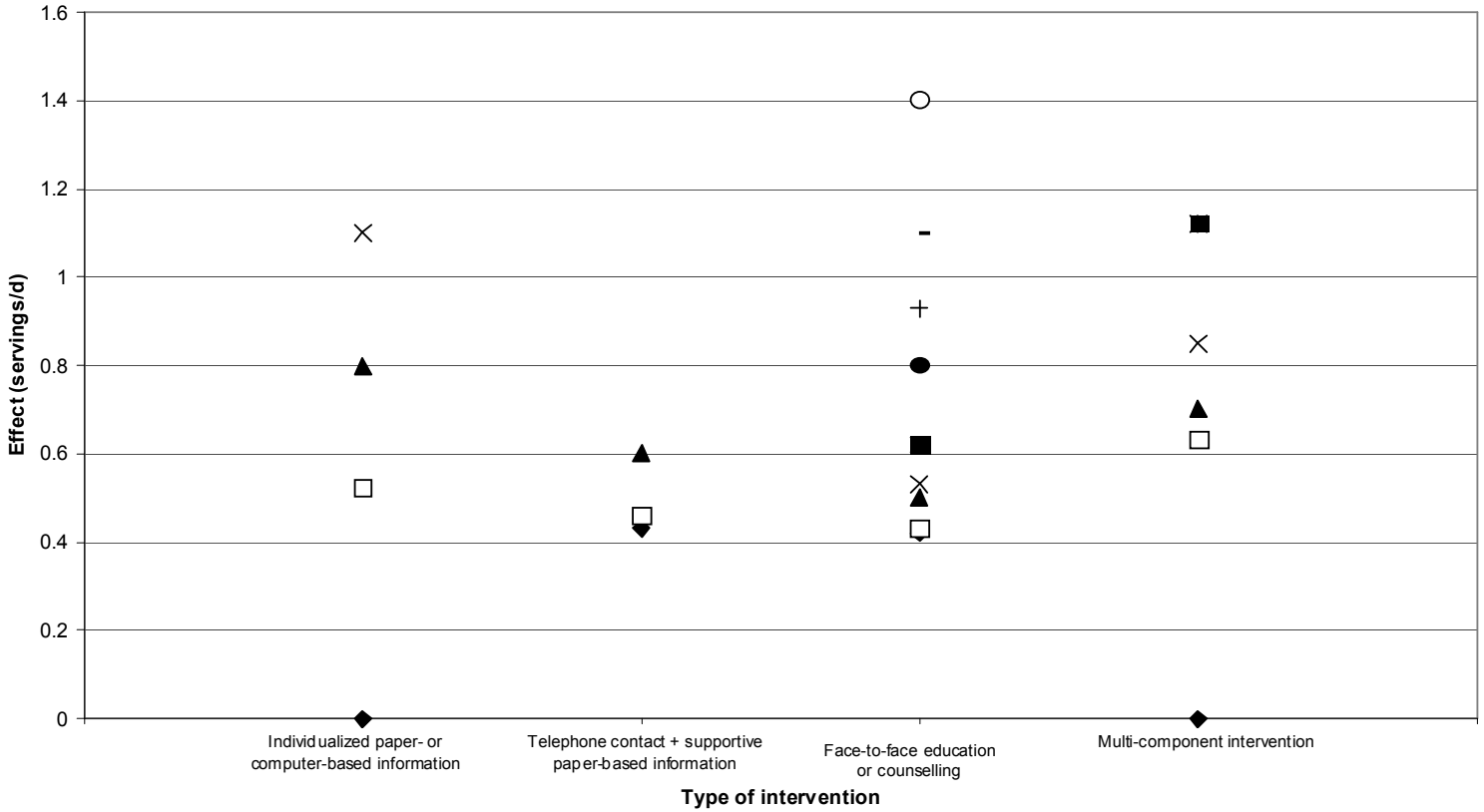
3.2.3 Overview of adult studies by intervention type

The findings were compared by intervention type across settings of all adult studies meeting the review criteria. However, this excluded worksite interventions as the context is so specialized (see section 3.2.2 above). The net effects for worksite interventions ranged from +0.13 to +0.70 servings/day. The highest effect was observed in a women-only study that included a programme based on individualized nutrition education and social support activities (*66*). Studies of adults with pre-existing health conditions were excluded from the comparisons. There appears to be a generally higher net intervention effect in studies of individuals with pre-existing disease compared with studies of adults without disease. This is unsurprising as adults with health conditions are considered to be more motivated in behavioural change programmes.

Using data from all other settings, four main types of intervention were defined. The first three types involved individualized educational approaches: 1) paper- or computer-based information; 2) a combination of telephone contact with supportive paper-based information; and 3) face-to-face education or counselling with or without other interventions (for example written material). It was hypothesized that interventions with more human contact would lead to a greater effect. However, the findings were not entirely consistent with that hypothesis, as described below and as illustrated in Figure 1. The fourth type consisted of multi-component interventions.

The first category of individualized educational approaches was information delivered either by a computer or paper-based information only (*68, 72, 74, 89*). Three of the four studies in this category showed significant net effects on fruit and vegetable intake (range +0.52 to +1.1 servings/day, median=0.56, mean=0.61). Tailored paper-based information appeared to be more effective than non-tailored information. Of the two computer-based interventions, the interactive computer-generated voice system showed a greater effect (+1.1 servings/day) than the hands-on computer package (+0.52 servings/day), possibly due to the greater intensity of its intervention (six months of weekly communication with the computer compared with 15 weekly sessions at the computer).

Figure 1. 'Effect size'[a] of the interventions on fruit and vegetable intake in selected studies in adults



[a] Please refer to Section 2 for a description of how effect size was estimated.

Please note that Figure 1 should only be used as an illustration of the variation of effect sizes among studies. It should not be used to compare studies within and between intervention types as variations around the estimates of effect sizes (i.e. details of confidence intervals or other measures of variability) were often not provided in the papers).

Three studies looked at individualized telephone contact with supportive paper-based information (*51, 52, 69, 75*) A short educational intervention by telephone delivering education, and/ or behavioural and motivational messages seemed to show a consistent positive effect on fruit and vegetable intake. The net effect of the interventions ranged between +0.43 and +0.60 servings/day (median=0.46, mean=0.50).

Face-to-face education or counselling (either individual or group counselling with or without other follow-up interventions such as written information) was the most common type of intervention used in the studies reviewed. All nine face-to-face interventions resulted in statistically significant increases in fruit and vegetable intake, with eight studies reporting a positive net effect compared with controls and one study which showed a significant increase in the intervention group of +1.1 servings/day (*53, 70, 71, 73, 76−82, 103*). There was a consistent net increase in intake in the low-income groups of +0.42 to +0.53 servings/day, irrespective of the intensity of face-to-face contact and other factors. Across all settings the intervention effect varied from approximately +0.5 to +1.4 servings/day (median=0.62 mean=0.75). The size of the effect did not show any consistent pattern of increase or decrease with duration or intensity of the intervention (more/longer contact or addition of supportive interventions) or length of follow-up.

There were five community-based multi-component interventions, with all except one reporting a significant net effect (*48−50, 86, 87*). Unsurprisingly, it appears that the larger community interventions comprising multiple activities in various settings across the general community have smaller effects on increasing fruit and vegetable intake (no significant effect in one study and +0.63 servings/day in Spanish speakers in the other study) than those targeting a smaller, focused community (where delivered to church communities, the net effect was from +0.7 to +1.12 servings/day). Also, individual counselling or follow-up appears to increase the effectiveness of general interventions. For example, in the church studies, the net intervention effect was larger when the multi-component church-based interventions were supplemented by motivational interviewing or phone calls.

4. Discussion and conclusions

This systematic review identifies a wide range of interventions and programmes promoting fruit and vegetable intake in children and adults that have been undertaken in many parts of the world. However, most of the studies that could be included in this review were from industrialized countries. Searches of the literature and contact with experts indicated that fruit

and vegetable promotional activities (for example, education materials, leaflets, posters, advertising, radio programmes, special events) are taking places in many countries. However, their effectiveness is either not being evaluated at all, or not being reviewed with sufficient rigour (see Table 1 and Annex 7). This is particularly the case in developing countries where no studies from Africa and Asia met the selection criteria (see examples in Annex 1). It highlights the urgent need for the collection of data on the effectiveness of interventions in these countries.

The tremendous diversity in study design, populations studied, types of intervention, and outcome measures assessed in the studies reviewed is notable and made it impossible to use summary analytic methods such as meta-analyses or to identify one type of intervention as the most effective in increasing fruit and vegetable consumption. However, the importance for future health of increasing fruit and vegetable intake in populations worldwide was a compelling reason to draw a number of principal conclusions.

4.1 Effectiveness and feasibility

4.1.1 Children

None of the 16 studies of fruit and vegetable intake promotion among children of primary and secondary school-age showed a detrimental effect on fruit and vegetable consumption. None led to a reduction in fruit and vegetable intake among the children targeted.

A multi-component, focused approach seems to be the most effective in increasing fruit and vegetable consumption in children: specific fruit and vegetable messages (not embedded in a "healthy eating" message, but with particular attention to fruit and vegetables), hands-on skill-building (as opposed to passive learning), active provision of fruit and vegetables at lunch, and involvement of parents, teachers and peers (optimally through officially established advisory committees) seem to lead to successful results. In at least two studies the intervention was administered at different levels of intensity and on both occasions, the greatest intensity of intervention (involving components at the classroom, school and community levels) achieved the greatest increase in fruit and vegetable consumption (*38, 44*). However, inevitably there are cost considerations to be considered and these were, in general, not addressed.

It is generally recognized that the family plays an important role in shaping the eating habits of children (*104*). As described in the results section, parental involvement was fundamental to the effectiveness of most interventions. However, few studies used a design that allowed determination of whether the addition of a parental component increased the

impact of school nutrition education beyond that of changes in the curricula and other aspects of the interventions.

School staff serving food were used in many ways but few of the studies measured whether their involvement had an effect on the fruit and vegetable uptake of children. In one study, active encouragement by food-service staff to consume fruit and vegetables achieved a positive effect that was statistically significant. The training and involvement of peer leaders has also been shown to be effective. Another sort of peer, that seen in cartoon characters like the "Food Dudes", has proved to be an effective motivator for change in children's fruit and vegetable consumption, a finding that is relevant to the use of similar characters to promote unhealthy food.

Using existing structures to promote a new message can also be effective. For example, in the South African intervention, where a food production project was implemented using an existing growth monitoring system, although there was no detectable effect that could be attributed to the intervention, the entire cohort had increased its fruit and vegetable intake at one year. School-based studies where fruit and vegetable messages were incorporated into existing school subjects may also have helped in achieving effectiveness.

4.1.2 Adults

The review of 32 studies of interventions intended to promote fruit and vegetable intake in adults found none that had negative effects on fruit and vegetable consumption. None led to a lowering of fruit and vegetable intake in the target populations. On the contrary, most interventions led to an increase in intake compared with control groups.

The largest effects were generally observed among individuals who were already at a higher risk for disease. This could reflect an elevated motivation among these individuals to improve their dietary intake, suggesting that they should be considered separately from the general population.

In other study populations there was an increase of approximately half a serving of fruit and vegetables per day, although, as discussed below, what constitutes a meaningful increase will need to be the subject of further research. Relatively greater effects were seen in those studies involving face-to-face counselling interventions, but there was no consistent change in intake related to the intensity of contact. The observation that interventions employing a more personal approach appeared slightly more effective seems intuitive. However, this must be balanced against the higher cost, the greater time demands and need

for trained staff that this approach would require. This does not seem to be a feasible whole-population approach.

Printed, individually-tailored information and computer-based information (particularly if this was individually tailored) appears to be a reasonable alternative to face-to-face dietary education, demonstrating significant intervention effects. Clearly this is the easiest and cheapest individual-based approach and the outcomes are relatively good. Computer-tailored nutrition education is an innovative and promising tool to motivate people to make healthy dietary changes. It provides respondents with individualized feedback about their dietary behaviours, motivation, attitudes, norms, and skills, and mimics the process of "person-to-person" dietary counselling. The available evidence suggests that computer-tailored nutrition education is more effective in motivating people to make dietary changes than general nutrition information. However, no trials of this were found outside Europe and the United States, so that its effectiveness in other settings remains unevaluated. It does not appear to be appropriate in rural settings, especially in developing countries.

Worksites are a unique setting for delivering interventions promoting fruit and vegetables. However, they require a comprehensive approach, which is time- and resource-consuming, as well as requiring the collaboration of the company and other stakeholders. Unfortunately, so far, the effect sizes reported in such programmes have not been very large. However, this may reflect the diffuse nature of such multi-component interventions.

The effectiveness of broad, community-wide approaches varied considerably. Unfortunately, although there were reports of several programmes from a variety of countries, most evaluations did not use a control group (see examples in Annex 7). For this and other reasons, the results were difficult to assess and compare. Most studies were unable to conclude which activity was more effective. It is also difficult to draw conclusions about the effectiveness of approaches targeting the general population through information or education. However, despite the diffuse nature of such interventions, multi-component approaches appeared to be effective, especially when combined with personal follow-up.

4.2 Barriers to effectiveness

The results of this review have to be examined in light of the difficulties of changing individual behaviour. There is a need to understand the factors influencing food choices and dietary intake, including economic, social and environmental factors that influence food availability and an individual's ability to make healthy choices.

There is an extensive research literature on barriers to increasing consumption of fruit and vegetables. At an individual level, people often perceive that they eat enough, or that some foods (particularly fruits) have a high cost, while personal and family eating habits can be difficult to change (*105*). Other environmental barriers include the lack of, or limited supply of fruit and vegetables (for example little variety on offer in work canteens or local shops), poor quality and high cost in low-income areas, lack of skills in preparing fruits and vegetables, and misperceptions that they are time-consuming to cook (*106*). These barriers should be identified and addressed in dietary change programmes.

Barriers to school-based interventions include competition against other school priorities. Nutrition is not seen as a priority in increasingly crowded curricula. Furthermore, some interventions could be perceived as too demanding, or may gain insufficient support due to lack of teacher involvement.

Fruit and vegetable promotion programmes directed at the general public (for example, through social marketing) have been popular interventions in the past. However, as many of these campaigns have not been established as research projects (often lacking a control group), the degree to which the observed changes in attitudes and consumption can be attributed to the campaign cannot be determined. More generally, there are perceived barriers involving both the fruit and vegetable industry (where there is often mixed support for generic fruit and vegetable promotion) and the health sector, where the small promotional budgets and lack of sustained funding for social marketing have limited the ability to produce long-term changes in intake.

There are inherent difficulties with the evaluation of point-of-sale promotions in supermarkets. These include the problems of enrolling representative intervention and control groups, obtaining baseline and follow-up measures, and separating the effects of point-of-sale from other influences on purchase and consumption.

Worksite interventions have the possibility to influence the fruit and vegetable intake of large numbers of people, especially men, who tend to have a lower consumption of these foods. However, for many interventions there have been low rates of recruitment and retention, and perhaps a limited understanding and assessment of environmental barriers and opportunities in different workplaces. It can be time-consuming and hence difficult to involve workers and management in decisions about environmental initiatives when there are other seemingly more pressing work-related priorities.

Few food-service interventions have focused solely on fruit and vegetables, and most such interventions have been incorporated as part of multi-component programmes, for

example in schools or workplaces. Some studies have showed that price reductions could lead to short-term increases in fruit and vegetable purchases; however, purchases generally returned to baseline levels within three weeks after the intervention. The potential barriers affecting this type of study include resistance by management and staff if the programme is perceived as costly or time-consuming. Some of these studies can indeed be demanding of staff time and resources and require development of suitable staff training methods. There is also the need to create an environment for change, for example by involving workers and management in decisions on food promotion initiatives.

4.3 Generalizability of the findings

While much is being learnt about the promotion of fruit and vegetables through reviews such as this one, it is difficult to generalize many of the review's findings to populations worldwide since the great majority of studies were carried out in industrialized countries and in particular in Europe and the United States. Not only are the cultural and socioeconomic contexts very different but also nutrition priorities in developing countries are still mainly focused on the control of micronutrient deficiencies and the alleviation of hunger. The nutrition transition means that, in some developing countries, this emphasis is shifting and adults and children are increasingly suffering the double burden of overnutrition and undernutrition. However, deficiencies in micronutrients such as vitamin A are still the focus of nutritional health efforts among children in developing countries. Fruit and vegetable promoting programmes in these countries are mainly developed as food-based strategies to alleviate these shortages, compared to the focus of fruit and vegetable programmes in developed countries, which generally aim to reduce obesity and noncommunicable disease risks (*43*).

As can be seen from the review of studies targeting children, the majority are school-based. However, in 2002, it was estimated that 113 million school-age children were not in school, with the majority of these living in sub-Saharan Africa and South-East Asia (*107*). This fact warrants a continued effort to encourage school attendance as well as a special focus on non-school-based approaches, such as the home-based food production programme described by Faber et al., (although this study was excluded from the final review as it did not meet the quality criteria) (*43*). Regarding school-based interventions in developing countries, in 2000, USAID chaired a School Feeding/Food for Education stakeholders' meeting with experts and practitioners who either administer or implement school nutrition programmes. They concluded that, even in school feeding programmes, much of the emphasis is on

improving learning by alleviating hunger and addressing communicable disease (*107*). One lesson learnt from that meeting could have implications for this review: the greatest impact in developing countries may be achieved through working in communities. Getting the community involved and giving community members ownership of school feeding programmes greatly increases the chance of success and sustainability. Furthermore, nutrition and health education, micronutrient supplementation and de-worming should be provided in parallel in order to maximize school programmes (*107*).

In adults there is very little information on the effectiveness of fruit and vegetable interventions by population subgroups, for example in different ethnic groups or those at high risk of disease. There have been a number of fruit and vegetable projects developed for low-income groups in the United States, which show that interventions targeted at low-income mothers have similar effects to those targeted at general population groups (the results of the interventions are summarized in Annex 6, Table A6). However, as with the studies in children, there were few studies from developing or transition countries, which limits the generalizabilty of the information on "low-income" research.

4.4 Limitations of the literature review

This review of the literature has several limitations. First, although a range of bibliographic databases was searched and numerous experts from all world regions contacted, some studies might have been missed (NB contact was attempted with more than 200 persons, with information successfully received from 116 persons in 51 countries, listed in Annex 3). Studies not identified may have been published in languages that the review group did not read (see columns giving "data collection methods" in annexes), from recent yet unpublished studies, or from other unpublished studies, especially in developing countries (if people were unaware of the review being conducted). There are also unpublished studies, or those in progress, that were known of but of which sufficient details were unavailable. Some of these are listed as "ongoing studies" in Annex 8, which details planned or ongoing studies. The possibility of publication bias (for example, small negative studies) was not assessed and it is thus possible that the review presents an overly optimistic impression.

Second, although non-randomized studies were accepted, studies that lacked a control group were rejected. This restriction has the unfortunate effect of excluding the majority of developing countries, national or large-scale promotion interventions, some of which have shown positive effects on increasing fruit and vegetable consumption in pre-test and post test evaluations.

Third, the main outcome measure relied in most cases on self-reported information and is thus subject to the limitations of dietary assessment methods, particularly for measuring small changes in dietary intake. In addition, the inability to blind those involved means that individuals receiving the interventions might have been more likely to report positive changes compared with individuals in control groups, which could lead to an overestimation of the effect size. Most studies did not define which foods were considered as fruit and vegetables or what constituted a serving. Some studies, for example some of the "5 a day" programmes in the United States, used the same food-frequency questionnaire developed by the National Cancer Institute. Unfortunately this food-frequency questionnaire included potatoes in the count of fruit and vegetable servings consumed, which makes comparisons with current international recommendations more difficult. Although some studies used biomarkers of dietary intake, this was not common, and it is unclear whether the biomarkers used accurately reflected the observed changes in intakes.

Fourth, although over two thirds of the studies examined had been implemented for at least one year, they do not provide information on the long-term effectiveness of the different types of interventions used or of the factors affecting the risk of relapse to lower intakes, which may include seasonal availability of fruit and vegetables. In addition, few studies examined the long-term effect of the interventions on the risk of major chronic diseases. This is mainly because the studies were too recent, of short duration, or investigated relatively young healthy populations. Interventions that did look at health outcomes were studying population groups with a higher risk of diseases (for example, individuals with a diagnosis of cancer at risk of recurrence). The specific long-term effects of small increases in fruit and vegetable intake at a population level on the incidence of chronic disease thus remain unclear. However, data from observational epidemiological studies suggest that a higher consumption of food from this food group is likely to be associated with lower rates of chronic diseases such as cardiovascular diseases and some cancers, as described in section 1.

Finally, the information available was insufficient to assess the cost of the dietary interventions in relation to the effects achieved. The search in this survey identified only one Australian study looking at the cost effectiveness of fruit and vegetable interventions. The economic evaluation estimated that the Australian State campaigns to increase fruit and vegetable intake prevented 3626 disability-adjusted life years (DALYs) each year with corresponding cost savings of approximately 125 million Australian dollars each year over the implementation costs (estimated at approximately $2.5 million each year) (*108*). The evaluation suggests that a national Australian campaign is likely to be cost-effective with an

estimated cost per DALY ratio of $677 per DALY gained (95% uncertainty interval $513, $16 392). The report also concludes that a national fruit and vegetable promotion campaign is likely to be acceptable and feasible. There is a clear need for economic evaluation of other interventions for comparison. It would also be useful to have a fuller review of studies that would enable decision-makers to debate the value of small effects on fruit and vegetable intake at a population level, as opposed to larger effects on consumption among a few people.

4.5 Preliminary recommendations

4.5.1 Improving programme evaluation

Many fruit and vegetable programmes have been initiated in developing and transition countries without evaluation of their effectiveness. The lack of data identified from non-industrialized countries highlights the need to encourage and support investigators in these countries to improve study methods and approaches to evaluation. As a matter of good practice, any new intervention or initiative should have evaluation included as part of the project plan.

Minimum standards for evaluation design need to be devised for the future. These should include standard validated measures of fruit and vegetable intake and tools to measure predictors of intake (that is, knowledge, attitude, social support). These tools are needed to increase confidence in programme evaluations and to allow valid comparison between intervention results. These measures should be as simple as possible to encourage their use when the intervention, and not research, is the primary objective. However, it is not possible to develop a worldwide standard measure since the foods that are eaten, the way they are eaten, and the way food servings are measured vary so much from country to country. Therefore a series of standard measures appropriate for climate, culture, and level of urbanization should be developed.

One important issue is the need to standardize the way that fruit and vegetable intake is measured. Studies used a wide range of data collection methods, from a single-question food-frequency estimate, to multiple-item food frequency questionnaires, 24-hour recalls, or several days' food diary. In the United States, many "5 a day" studies used the same food-frequency questionnaire. Although this would not necessarily be generalizable to other regions, it will be important to adapt simple validated tools to different cultural contexts (with validation through pilot studies). Whatever tools are used, any programme evaluation should aim to be explicit about the definition of fruit, vegetables and juices that are counted. A series of standard measures should be developed in order to count fruit and vegetable portions

realistically. This would exclude potatoes and also help to limit the amount of fruit juices counted.

In future, all studies should have a much better description of the methods used. This should include information on generalizability, response rates, randomization method (if used), precise details of the intervention (including the intervention intensity), training of individuals involved with intervention delivery, blinding of outcome assessors, and existence of ongoing reinforcement or maintenance interventions.

All evaluations should ideally have a control or comparison group, although it is accepted that this is unrealistic for national programmes. Randomized controlled trials are still the "gold-standard" for assessing the effectiveness of interventions, and are the best method for reducing bias. However, although randomized controlled trials are potentially feasible in developing countries, there may be other factors, such as financial cost and lack of expertise, that limit their use (*109*). Yet it is feasible and good practice to incorporate a control group into the evaluation. This should enable unequivocal findings about the change an intervention has made in the target population independent of any other interventions that may contaminate the results.

4.5.2 Future research

It is clear from this review that, although several projects and interventions have been developed to increase fruit and vegetable intake, in many cases the design was suboptimal. Perhaps the most important issue is that better methods are required for assessment of dietary intake. This includes developing or adapting tools for different cultural contexts (for example, so that tools are appropriate, validated and reliable for urban-based projects and in rural areas in developing countries). As study techniques improve, intervention designs may need to incorporate validated biochemical markers of fruit and vegetable intake and novel methods of measuring dietary consumption (to address concerns about measurement bias).

Studies are also needed that examine in more depth the effectiveness of specific components of interventions, and how these effects vary in different countries, particularly in developing countries.

Some studies should incorporate longer follow-up periods. These should examine factors that prevent relapse and take account of seasonal variations in intake. Also, longer follow-up periods could potentially enable assessment of long-term effectiveness, in terms of health outcomes, although the time required may not be feasible. This should include an estimation of what constitutes clinically meaningful changes in intake.

Although economic evaluation can be time-consuming and costly, such studies (for example, the Australian evaluation) can reveal how cost-effective fruit and vegetable programmes can be at preventing disease. Although studies in adults seem to show greater benefits with face-to-face dietary advice, cost-effectiveness studies comparing interventions will be essential in the future in order to compare which interventions would be best suited for a particular country or a region's needs. They are also highly persuasive evidence when deciding how best to allocate scarce resources.

4.5.3 Implications for WHO regions

Despite an extensive search of contacts in all regions of the world, it is disappointing to find that the majority of studies in this review come from Europe and the United States. For this reason caution must be exercised as regards the generalizability of the results and recommendations to other countries and regions, particularly those with developing economies. The study reviewed interventions by settings, such as schools, workplaces, and health care facilities. Clearly these settings will be different across different cultural contexts, which may mean that specific types of intervention that appear in this review may be inappropriate in some countries.

There is now a need for an initiative that will begin to fill this information gap. One way would be to provide support to countries to design and conduct good-quality, robust evaluations of any fruit and vegetable interventions that are currently being devised or implemented. For example, there are a number of projects aimed at tackling micronutrient deficiencies through food-based approaches and promotion of fruit and or vegetables. Only one is included in this review because the others were inadequately evaluated. This seems to be an important topic that is as yet under-researched. There are already many organizations in Africa, Asia, South America, Central and Eastern Europe that are developing "5 a day" type programmes (see Table 1) or other fruit and vegetable initiatives, although currently the number that are being evaluated are few. Ideally there would also be new initiatives providing funding to conduct fruit and vegetable intervention trials, and to validate standard fruit and vegetable measurement instruments in developing countries.

Annexes

Annex 1. Examples of projects in developing or transition countries, promoting fruit and vegetable intake, not meeting study criteria

The following table contains examples of projects from developing countries that did not meet the review criteria. This is not an exhaustive list but is meant to illustrate the wide range of interventions that have been conducted in several world regions.

Name of study and reference	Who conducted the study	Where the study took place	Intervention	Results
ASIA				
Home gardening in hilly and Terai areas in Nepal: Impact on food production and consumption *Nepal Nutrition Bulletin*, 2001, 1(1).	Aminuzzaman Talukder, Country Director, Helen Keller International	Nepal: 566 households in nine districts both in hilly and Terai areas	Promotion of year-round production and consumption of vegetables and fruits through home gardening and nutrition education programmes.	Monitoring before and one year after the start of the programme showed: 1. Increased consumption of micronutrient-rich vegetables and fruits 2. Increased retinol equivalent intake 3. Increased family income by selling the surplus (which was used for food).
Increasing the production and consumption of vitamin A rich fruits and vegetables – Lessons learned in taking the Bangladesh homestead gardening programme to a national scale *Food Nutrition Bulletin,* 2001, 21(2).	Aminuzzaman Talukder, Lynnda Kiess, Nasreen Huq, Saskia de Pee, Ian Darnton Hill, Martin Bloem, Helen Keller International	Throughout Bangladesh	National programme on promotion of vegetable and fruit production and consumption with 700 000 households. Involves social marketing, gardening, peer nutrition education.	1. Increased production and intake of fruits and vegetables 2. Increased diversity of produce 3. Increased family income 4. Increased empowerment of women Long-term evaluation suggests the project is sustainable.
Impact of a social marketing campaign promoting dark-green leafy vegetables and eggs in central Java, Indonesia	Saskia de Pee	Indonesia	Promotion of micronutrient-rich foods through social marketing.	1. Increased consumption of eggs 2. Increased consumption of fruit and vegetables
Improving micronutrient status of vulnerable groups through improving household food security by using local resources, behavioral change and demand creation, Nepal (ongoing study)	Aminuzzaman Talukder, Country Director, Helen Keller International, Nepal	Nepal: four different ethnic groups in three districts in the eastern part of Nepal	Nutrition education for demand creation and increasing production and consumption of vegetables, fruits and animal sources of food.	1. Assess vegetable/fruit production in different ethnic groups 2. Identify foods/food groups of which intake should be increased 3. Increase demand of micronutrient-rich foods from both plant and animal sources
Homestead food production in Nepal for improving micronutrient status of women and children, poverty reduction and promotion of gender equality *Nepal Nutrition Bulletin,* 2004, 2(2).	Aminuzzaman Talukder, Country Director, Helen Keller International, Nepal	Nepal: marginal and landless group in four districts in hilly and Terai areas	Promotion of year- round availability and consumption of vegetable, fruits, animal sources of food by establishing village model nurseries and poultry frames, and individual household gardens.	Monitoring of 10% of households (300) showed after four months: 1. Increased production of and access to micronutrient-rich foods from animal and plant sources 2. Increased family income 3. Better utilization of local resources

Name of study and reference	Who conducted the study	Where the study took place	Intervention	Results
				4. Empowerment of women
Nutritional intervention programme among homes for the elderly in Hong Kong, incorporating the promotion of fruit and vegetable consumption	Elderly Health Services, Hong Kong	Hong Kong: private residential care homes for the elderly	Programme to educate food-service staff of residential homes to plan and design menus that can meet healthy eating guidelines.	84% (n=100) of the homes that completed the nutritional programme showed improved menu design (statistically significant). Statistically significant increase in homes including all food groups including fruits and vegetables.
Community-based interventions in Singapore: public education and promoting availability. Sean Wong, personal communication	Health promotion Board, Ministry of Health	Nationwide in Singapore	Public education of "2+2" message via mass media, face-to-face activities and educational materials. Promoting availability in restaurants, food retail outlets, schools.	Evaluation one year after implementation showed 20% increase in awareness of message (intake not assessed). Availability of fruit and vegetables has increased but intake not assessed.
AFRICA				
Effect of communal vegetable gardens on nutritional status of children, South Africa Schmidt M, Vorster HH. *Development South Africa,* 1995, 12 (5):713−722.	MI Schmidt and HH Vorster, Potchefstroom University.	Slough village, Kudumane district of Bophuthat-swana, South Africa	Controlled trial; 18 children from families receiving food aid (ages 6−13 years) whose parents participated in a communal vegetable garden. Random paired sampling matched children in control group whose households did not participate in the garden.	Children in both groups had similar dietary patterns. Vegetables were eaten slightly more often by children in the experimental group but both groups had very low intake. No households ate vegetables daily, with the highest frequency of consumption being 12 times per month. A communal vegetable garden did not necessarily guarantee better nutritional status. Constraints included lack of resources (land, water, labour).
Food Security and Nutrition Improvement pilot via promotion of gardening activities in Tanzania (aim to increase availability of fruit and vegetables year round).	Moshi Urban Horticulture Association P.O Box 9609 Moshi Contact: Agenta Shayo	Tanzania: Kilimanjaro Region (Ongoing project)	Seed and irrigation support to initiate home gardening. Training of gardeners on improved gardening techniques using demonstration sites. Nutrition education of women, and training and financial support to enable sale of produce.	Project reports from 1994 to 1997 indicate an increase in the number of home gardens (11%) and gardening activities, with an increase in the production of fruits and vegetables. There has also been increased consumption of fruits and vegetables. Of 446 women sampled, 98.5% now say they eat vegetables almost every day, and 41.3% say they eat vegetables each day. There has been a large increase in fruit consumption from virtually nil to about 30% now eating fruit every day.
Home gardening and preservation project, Tanzania *Food Nutrition Bulletin*, 2001, 22(4).	Tanzania Food and Nutrition Centre, PO Box 977 Dar Es Salaam: Laurent Mselle (Government institution under Health Ministry)	Tanzania: Singida Region	Promote adoption of solar dryer and consumption of dried vitamin-A rich vegetables	Subclinical vitamin A deficiency was reduced significantly and retention of beta-carotene was increased by using an improved dryer
PACIFIC ISLANDS				
Nutritional study of Marshallese Pandanus and other foods (including breadfruit), Marshall islands	Dr. Lois Englberger in conjunction with the Ministry of Resources and Development and staff of other departments including Health, College of Marshall Islands, and the private sector. Supported by Sight and	Majuro Atoll, Republic of the Marshall Islands (RMI)	Study of pandanus and breadfruit varieties, describing primary identifying characteristics; assessing carotenoid content; listing varieties known to be growing on other atolls; photographing the plants, fruits, and preserved pandanus products; gathering information about rare varieties; and listing other information related to pandanus and also other foods, including seeded breadfruit which is eaten raw as a fruit.	Results indicated that the higher levels of carotenoid content are found in the varieties with the darker shades of orange colouration of the edible portion. Little information is documented on varieties of RMI pandanus and breadfruit although this was a major staple food in the past; further work is still needed. Some pandanus varieties are becoming rare.

Name of study and reference	Who conducted the study	Where the study took place	Intervention	Results
	Life, Switzerland; Secretariat of the Pacific Community; and Healthy Living in the Pacific Islands.			Traditional knowledge on pandanus is being lost. More promotion is needed.
Pandanus study in Kiribati	Dr. Lois Englberger	Tarawa, Republic of Kiribati	Similar study	Similar findings in Kiribati (see above)
Demonstration fruit and vegetable garden	Nutrition Centre, Ministry of Health in Samoa	Samoa	Training of health workers, community workers, teachers, students about benefits of fruit and vegetable intake, and how to grow and prepare them.	Unevaluated
School curriculum reform	Ministry of Education, Sports, Culture, Samoa	Samoa	Food and textiles curriculum for 9−11 years now incorporates information on the benefits of fruit and vegetables, and fruit and vegetables are used in cookery classes. Agriculture curriculum (9−11 years) now includes a practical horticulture programme.	No evaluation known

Annex 2. Search strategy

MEDLINE

The PUBMED search covered the date range 1986 to April 2004. The search was carried out on 31 March 2004 and identified 2721 records.

1. “Diet”[MeSH] OR “Food Habits”[MeSH] OR diet* OR “food habit” Limits: Human

2. "Fruit"[MeSH] OR "Vegetables"[MeSH] OR fruit* OR vegetable* Limits: Human

3. #1 AND #2 Limits: Human

4. intervention* Limits: Human

5. "health education" Limits: Human

6. evaluation* Limits: Human

7. "health promotion" Limits: Human

8. "health knowledge" Limits: Human

9. "health behaviour" Limits: Human

10. "health behavior" Limits: Human

11. "health practice" Limits: Human

12. counselling Limits: Human

13. "clinical trial" Limits: Human

14. "meta-analysis" Limits: Human

15. "cost effectiveness" Limits: Human

16. "economic evaluation" Limits: Human

17. "decision analysis" Limits: Human

18. #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 Limits: Human

19. "Decision Support Techniques"[MAJR] OR "Cost-Benefit Analysis"[MAJR] OR "Intervention Studies"[MeSH] OR "Evaluation Studies"[MeSH] OR "Health Promotion"[MeSH] OR "Health Education"[MeSH] OR "Health Knowledge, Attitudes, Practice"[MeSH] OR "Health Behavior"[MeSH] OR "Public Health Practice"[MeSH] AND "Counseling"[MeSH] OR "Meta-Analysis"[Publication Type] OR "Clinical Trials"[MeSH] Limits: Human

20. #18 OR #19 Limits: Human

21. #3 AND #20 Limits: Human

CAB Abstracts

The CAB Abstracts search covered the date range 1973 to 2004, was carried out on 31 March 2004, and identified 2160 records.

1. (fruit , vegetable*)

2. (fruit , vegetable* - animal)

3. ("food habit")

4. (diet*)

5. (food habit*)

6. (intervention* , evaluation* , "health promotion" , "health education" , "health knowledge" , "health behaviour" , "health behavior" , "health practice" , "health informatics" , counselling , counseling , "clinical trial" , "clinical trials")

7. ((intervention* , evaluation* , "health promotion" , "health education" , "health knowledge" , "health behaviour" , "health behavior" , "health practice" , "health informatics" , counselling , counseling , "clinical trial" , "clinical trials") & (fruit , vegetable* - animal))

8. (((intervention* , evaluation* , "health promotion" , "health education" , "health knowledge" , "health behaviour" , "health behavior" , "health practice" , counselling , counseling , "clinical trial" , "clinical trials") & (fruit , vegetable* - animal)) & human)

9. (((intervention* , evaluation* , "health promotion" , "health education" , "health knowledge" , "health behaviour" , "health behavior" , "health practice" , counselling , counseling , "clinical trial" , "clinical trials" , "cost -effectiveness" , "economic evaluation" , "decision -analysis") & (fruit , vegetable* - animal)) & human) (((intervention* , evaluation* , "health promotion" , "health education" , "health knowledge" , "health behaviour" , "health behavior" , "health practice" , counselling , counseling , "clinical trial" , "clinical trials" , "cost -effectiveness" , "economic evaluation" , "decision -analysis") & (fruit , vegetable* - animal)) & human)v

The Cochrane Library

The Cochrane library search covered the date range 1800 to 2004, was carried out on 5 April 2004, and identified 741 records.

1. (intervention* or evaluation* or (health next promotion) or (health next education) or (health next knowledge) or (health next behavior) or (health next behaviour) or (health next practice) or counseling or counselling or (clinical next trial) or meta-analysis or (cost next effectiveness) or cost-effectiveness or (economic next evaluation) or (decision next analysis))

2. ((diet* or (food next habit)) and (fruit* or vegetable*))

3. INTERVENTION STUDIES single term (MeSH)

4. EVALUATION STUDIES single term (MeSH)

5. HEALTH PROMOTION single term (MeSH)

6. HEALTH EDUCATION single term (MeSH)

7. HEALTH BEHAVIOR single term (MeSH)

8. COUNSELING single term (MeSH)

9. PUBLIC HEALTH PRACTICE single term (MeSH)

10. META-ANALYSIS single term (MeSH)

11. COST-BENEFIT ANALYSIS single term (MeSH)

12. DECISION SUPPORT TECHNIQUES single term (MeSH)

13. (#1 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12)

14. (#13 and #2)

Web of Science

The Web of Science database search covered the date range 1981 to 2004, was carried out on 5 April 2004, and identified 300 records.

1. TS=(intervention* OR evaluation* OR health promotion* OR health education* OR health knowledge OR health behaviour* OR health behavior* OR health practice OR counselling OR counseling OR clinical trial OR meta-analysis OR cost effectiveness OR decision analysis OR economic evaluation)

2. TS=(diet* OR food habit)

3. TS=(fruit* OR vegetable*)

4. #2 AND #3

5. #1 AND #5

IBSS (international bibliography of the Social Sciences)

The IBSS database search covered the date range 1951 to 2004, was carried out on 5 April 2004, and identified 1 record.

1. ((diet* OR "food habit") AND (fruit* OR vegetable*)) AND (intervention* OR evaluation* OR "health promotion" OR "health education" OR "health knowledge" OR "health behaviour" OR "health behavior" OR "health practice" OR counselling OR counseling OR "clinical trial" OR meta-analysis OR "cost effectiveness" OR "economic evaluation" OR "decision-analysis")

Psychinfo (BIDS)

The Psychinfo database search covered the date range 1872 to 2004, was carried out on 5 April 2004, and identified 174 records.

1. (fruit*)or(vegetable*)

2. (diet*)or("food habit")

3. ((diet*)or("food habit")) and ((fruit*)or(vegetable*))

4. ((intervention*)or(evaluation*)or("health promotion")) or (("economic evaluation")or("decision analysis")) or (("clinical trial")or(meta-analysis)or("cost effectiveness")) or (("health practice")or(counseling)or(counselling)) or (("health behaviour")or("health behavior")or("health practice")) or (("health education")or("health knowledge"))

5. (((diet*)or("food habit")) and ((fruit*)or(vegetable*))) and (((intervention*)or(evaluation*)or("health promotion")) or (("economic evaluation") o r("decision analysis")) or (("clinical trial")or(meta-analysis)or("cost effectiveness")) or (("health practice") or (counseling)or(counselling)) or (("health behaviour")or ("health behavior") or ("health practice")) or (("health education") or ("health knowledge")))

EMBASE

The Embase database was carried out on 5 April 2004, and identified 710 records.

1. fruit.mp. [mp=title, abstract, subject headings, drug trade name, original title, device manufacturer, drug manufacturer name] limited to human

2. vegetable.mp., limited to human

3. diet.mp., limited to human

4. food habit.mp., limited to human

5. #1 OR #2

6. #3 OR #4

7. #5 AND #6

8. intervention.mp, limited to human

9. evaluation.mp, limited to human

10. health promotion.mp, limited to human

11. health education.mp, limited to human

12. health knowledge.mp, limited to human

13. health behaviour.mp, limited to human

14. health behavior.mp, limited to human

15. health practice.mp, limited to human

16. counseling.mp, limited to human

17. counselling.mp, limited to human

18. clinical trial.mp, limited to human

19. meta-analysis.mp, limited to human

20. cost effectiveness.mp, limited to human

21. economic evaluation.mp, limited to human

22. decision analysis.mp, limited to human

23. #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22

24. #7 AND #23

AGRICOLA

The Agricola database search was carried out on 6 April 2004, and identified 158 records.

1. (intervention* OR evaluation* OR counseling OR counselling OR meta-analysis OR education* OR promotion*)[in Keyword Anywhere] OR ("health promotion")[in Keyword Anywhere] OR ("cost effectiveness")[in Keyword Anywhere] OR ("health promotion")[in Keyword Anywhere] AND (fruit OR vegetable)[in Keyword Anywhere] AND (diet)[in Keyword Anywhere] OR ("food habit")[in Keyword Anywhere]

LILACS (Latin American and Caribbean Health Science Literature Database)

The LILACS database search was carried out on 12 April 2004 and identified 9 records.

1. ("fruit") or ("vegetable") and ("diet") or ("food habits") and ("intervention") or ("evaluation") or ("health promotion") or ("health education") or ("health knowledge, attitudes, practice") or ("health behaviour") or ("counselling") or ("clinical trials") or ("meta-analysis") or ("cost effectiveness") or ("decision analysis") or ("economic evaluation")

ID21 (Development research reporting service)

Search terms utilized in other searches did not function in the ID21 database. Manual browsing of the website yielded two records.

ERIC (Educational Resources Information Center)

The ERIC database search was carried out on 8 April 2004 and identified 91 records.

1. (fruit* OR vegetable*) AND (diet* OR "food habit") AND (intervention* OR evaluation* OR "health promotion" OR "health education" OR "health knowledge" OR "health behaviour" OR "health behavior" OR counselling OR counseling OR "health practice" OR "meta-analysis" OR "cost effectiveness" OR "clinical trial" OR "economic evaluation" OR "decision analysis")

SIGLE (System for Information on Grey Literature)

The SIGLE database search was carried out on 6 April 2004 and identified 23 records.

1. (((diet*)or("food habit")) and ((fruit*)or(vegetable*))) and (((intervention*)or(evaluation*)or("health promotion")) or (("economic evaluation")or("decision analysis")) or (("clinical trial")or(meta-analysis)or("cost effectiveness")) or (("health practice")or(counseling)or(counselling)) or (("health behaviour")or("health behavior")or("health practice")) or (("health education")or("health knowledge")))

2. *(separate search)* (fruit OR vegetable) AND (diet OR food habit)

Annex 3. List of contacts who contributed to the review

Contacts listed by country, area or institution in alphabetical order

Argentina, Adrian Cabrera , Maria Ester Gomez del Rio, Mariano Winograd.

Australia, Davina Ghersi, Sarah Pennell, Christina Pollard, Trevor Shilton, Shawn Somerset

Bangladesh, Nazmul Hassan, Nina Kolbjornsen

Brazil, Carlos Monteiro, Angela Peres

Brunei Darussalam , Hjh Masni Binti Hj Ibrahim

Bulgaria, Stefka Petrova

Canada, Donna Ciliska, Ron Lemaire, Alexia Prescod

China, Hong Kong Special Adminstrative Region, Priscilla Kwok

China, Macao Special Adminstrative Region, Tang Chi Ho

Chile, Maria Teresa Oyarzun, Sonia Olivares, Ricardo Uauy

Denmark; Morten Strunge Meyer, Birgit Noller, Robert Pederson

El Salvador, Veronica Siman de Betancourt

Estonia, Sirje Vaask

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Finland, Ritva Prättälä, Liisa Valsta

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Ireland, Sharon Friel

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Japan, Fumi Kaneda, Nobuko Murayama

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Malaysia, Mirnalini Kandiah

Marshall Islands (the), Diane Myazoe

Mongolia, Robert Hagan, Varja Liposesk

Mozambique, Jose Manual da Graca, Otilla Mucauro

Nepal, Sharada Pandey, Aminuzzaman Talukder

Netherlands (the), Karin van Gorp, Marja Slagmoolen

New Zealand, Megan Grant, Paula Dudley

Norway, Lars Johansson

Pacific Islands, Lois Engelberger

Philippines (the), Cecilia Florencio, Myrna C. Cabotaje

Republic of Korea (the), Cho-il Kim

Saudi Arabia, Abdul Aziz Al-Othaimeen

Singapore, Annie Ling, Chew Suok Kai

Slovenia , Mojca Gabrejelcic

South Africa, Este Vorster, Edelweis Wentzel Vilgren

Switzerland, Francoise Michel, Silvia Schnidrig, Ursula Zybach

United Republic of Tanzania, Laurent Mselle, Helen Semu, Agenta Shayo

Thailand, Dr Somchai Durongdej

United Kingdom of Great Britain, and Northern Ireland, Annie Anderson, Jenny Bellorini, Silvia Bickely, Eric Brunner, MA Burke, Janet Cade, Lucy Cooke, Iris Gordon, C Fergus Lowe, Hazel Fraser, Allan Hackett , Pauline Horne, Tim Lobstein, Barry Margetts, Theresa Moore, Andy Ness, Karen Peploe, Jenny Pollard, Joan Ransley, Margaret Thorogood

United States of America, Betsy Frazao, Mary K Hunt, Alan R Kristal, John Pierce

Vanuatu, Theto Moses, Marie Paul Nabon

Venezuela, Rene Sleiman Figueroa

Viet Nam, Ho Hong Ngoc

Western Samoa, Christine Quested

Agencies:

International Food Policy Research Institute, United States, Marie Ruel

Secretariat for the Pacific Community, New Caledonia, Wendy Snowdon

FAO Regional Office for Asia and the Pacific, Lattita Bhattacharjee

WHO Regional Office for Africa , Aristide Sagboham

WHO Regional Office for Europe, Aileen Robertson

WHO Regional Office for the Eastern Mediterranean, Kunal Bagchi

WHO Regional Office for South-East Asia, Rukhsana Haider

WHO Regional Office for the Americas, Enrique Jacoby

WHO Regional Office for the Western Pacific, L. Tomasso Cavalli Sforza

WHO Headquarters, Switzerland, Ingrid Keller

Annex 4

QUALITY ASSESSMENT TOOL

Endnote #:_____
Author(s):_____
Journal:_____
Year:_____
Reviewer:_____

IN ☐ **OUT** ☐ If OUT why?

- ☐ Language not ok
- ☐ Individuals acutely ill or institutionalised
- ☐ Not about fruit and/or vegetable
- ☐ Follow-up <3 months
- ☐ Multiple risk studied and FV intake not identifiable
- ☐ Main outcome not measured
- ☐ No control group
- ☐ Other reason (specify)_____

CLASSIFICATION DETAILS:

COUNTRY (specify): _____

GENDER (circle): Males Females Both

AGE GROUP: Children Adults

TYPE OF INTERVENTION (specify – e.g. leaflets, social marketing, etc.):_____

TYPE OF POPN (specify- e.g., community, employees at workplace, etc.):_____

FINAL DECISION OF BOTH REVIEWERS (circle one)
1 STRONG
2 MODERATE
3 WEAK

QUESTIONNAIRE

A) SELECTION OF PARTICIPANTS

1) Were the selection methods shown to be valid?
1) Low risk of bias
2) Moderate risk of bias
3) High risk of bias
4) Can't tell

2) Are the individuals selected to participate in the study likely to be representative of the target population?
1) Very likely
2) Somewhat likely
3) Not likely
4) Can't tell

3) What percentage of selected individuals agreed to participate?
1) 80-100% agreement
2) 60-79% agreement
3) less than 60% agreement
4) Not applicable
5) Can't tell

Q4. Was the required sample size estimated and appropriate?
1) Yes, based on described sample size calculations
2) Required sample size not calculated but sample size > 50 per group at follow-up
3) Required sample size not calculated and sample size < 50 per group at follow-up
4) Can't tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
	1	2	3

B) STUDY DESIGN

1) Indicate the study design:

1) Randomised controlled trial
2) Non-randomised controlled trial
3) Non-randomised non-controlled trial
4) Other (specify)_____
5) Can't tell

If the study was not described as randomised, go to component C

2) If the study was described as randomised, was the method of randomisation described?

1) Yes
2) No
3) Can't tell

3) If the study was described as randomised, was the method appropriate?

1) Yes
2) No
3) Can't tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
	1	2	3

C) CONFOUNDERS

Q1. Were there important differences between groups prior to the intervention?

1) Yes
2) No
3) Can't tell

Q2. The following are examples of confounders. Circle those that were considered in the study.

1) Race/ethnicity
2) Sex
3) Age
4) Marital status/family
5) Income/social class
6) Education
7) Health Status
8) Pre-intervention score on outcome measure
9) Other (specify)_____

Q3. Were data collection tools for relevant confounders shown to be valid?

1) Yes
2) No
3) Can't tell

Q4. Were data collection tools for relevant confounders shown to be reliable?

1) Yes
2) No
3) Can't tell

Q5. Were relevant confounders controlled for (either in the design or analysis)?

1) Yes
2) No
3) Can't tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
	1	2	3

D) BLINDING

Q1. Was (were) the outcome assessor(s) aware of the intervention or exposure status of participants?

1) Yes
2) No
3) Can't tell

Q2. Were the study participants aware of the research question?

1) Yes
2) No
3) Can't tell

RATE THIS SECTION	STRONG 1	MODERATE 2	WEAK 3

E) DATA COLLECTION METHODS FOR FRUIT AND VEGETABLE INTAKE

Q1. What data collection method(s) was (were) used to assess fruit and/or vegetable intake?

1) 24-hour recall (specify # days) _____
2) Food diary (specify # days)_____
3) Weighed food record (specify # days)_____
4) Food frequency questionnaire
5) Food diary
6) Other (specify) _____
7) Can't tell

Q2. Were data collection tools shown to be valid?

1) Yes
2) No
3) Can't tell

Q3. Were data collection tools shown to be reliable?

1) Yes
2) No
3) Can't tell

RATE THIS SECTION	STRONG 1	MODERATE 2	WEAK 3

F) DATA COLLECTION METHODS FOR SECONDARY OUTCOMES

OUTCOME 1 (specify)_____

Q1. Were data collection tools shown to be valid?

1) Yes
2) No
3) Can't tell

Q2. Were data collection tools shown to be reliable?

1) Yes
2) No
3) Can't tell

OUTCOME 2 (specify)_____

Q3. Were data collection tools shown to be valid?

1) Yes
2) No
3) Can't tell

Q4. Were data collection tools shown to be reliable?

1) Yes
2) No
3) Can't tell

G) <u>WITHDRAWALS AND DROP-OUTS</u>

Q1. Were withdrawals and drop-outs reported in terms of numbers and reasons per group?
1) Yes
2) No
3) Can't tell

Q2. Indicate the percentage of participants completing the study (if the percentage differs by group, record the lowest)
1) 80-100%
2) 60-79%
3) <60%
4) Can't tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
	1	2	3

H) <u>INTERVENTION INTEGRITY</u>

Q1. Was the intervention clearly described?
1) Good description
2) Moderate
3) Poor
4) Can't tell

Q2. Was the consistency of the intervention assessed?
1) Yes
2) No
3) Can't tell

Q3. Is it likely that subjects received an unintended intervention (contamination or co-intervention) that may influence the results?
1) Yes
2) No
3) Can't tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
	1	2	3

I) <u>ANALYSES</u>

Q1. Indicate the unit of allocation (circle one)
1) Community
2) Organization/institution
3) Practice/office
4) Individual

Q2. Indicate the unit of analysis (circle one)
1) Community
2) Organization/institution
3) Practice/office
4) Individual

Q3. Are the statistical methods appropriate for the study design?
1) Yes
2) No
3) Can't tell

Q4. Is the analysis performed by intervention allocation status (i.e. intention to treat) rather than the actual intervention received?
1) Yes
2) No
3) Can't tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
	1	2	3

GLOBAL RATING (Please transcribe the information from the boxes on pages 1-4 onto this page)

A) SELECTION OF PARTICIPANTS

RATE THIS SECTION	STRONG	MODERATE	WEAK
	1	2	3

B) STUDY DESIGN

RATE THIS SECTION	STRONG	MODERATE	WEAK
	1	2	3

C) CONFOUNDERS

RATE THIS SECTION	STRONG	MODERATE	WEAK
	1	2	3

D) BLINDING

RATE THIS SECTION	STRONG	MODERATE	WEAK
	1	2	3

E) DATA COLLECTION METHODS FOR FRUIT AND VEGETABLE INTAKE

RATE THIS SECTION	STRONG	MODERATE	WEAK
	1	2	3

G) WITHDRAWALS AND DROPOUTS

RATE THIS SECTION	STRONG	MODERATE	WEAK
	1	2	3

H) INTERVENTION INTEGRITY

RATE THIS SECTION	STRONG	MODERATE	WEAK
	1	2	3

I) ANALYSES

RATE THIS SECTION	STRONG	MODERATE	WEAK
	1	2	3

GLOBAL RATING FOR THIS PAPER (circle one)

1 STRONG (5+ STRONG ratings with no WEAK ratings)
2 MODERATE (<5 STRONG ratings and 1 WEAK rating)
3 WEAK (2+ WEAK ratings)

WITH BOTH REVIEWERS DISCUSSING THE RATINGS:

Is there a discrepancy between the two reviewers with respect to the component (A-I) ratings?

No Yes

If yes, indicate the reason for the discrepancy

1) **Oversight**
2) **Differences in interpretation of criteria**
3) **Differences in interpretation of study**

Comments:_____

_____

Annex 5. Studies excluded according to quality criteria

The following studies were rated as "weak" after assessment using the quality criteria, and were therefore excluded from the review.

Excluded study	Reason for exclusion
Auld GW et al. Outcomes from a school-based nutrition education programme alternating special resource teachers and classroom teachers. *The Journal of School Health,* 1999, 69 (10):403−408.	There were inconsistencies in the number of participants; it was difficult to assess whether the study participants were aware of the research question; and part of the reason for participant withdrawals is that the study ran out of fruit and vegetables.
Lee AJ et al. Sustainability of a successful health and nutrition programme in a remote aboriginal community. *Medical Journal of Australia,* 1995,162 (12):632−635.	The study measured changes in shop sales and not intake.
Faber M, Venter S L, Benade A J. Increased vitamin A intake in children aged 2−5 years through targeted home-gardens in a rural South African community. *Public Health Nutrition,* 2002, 5(1):11−16.	The intervention investigated home gardening, which targeted vegetable consumption. However, only changes in micronutrient consumption were reported.
Resnicow K et al. A three-year evaluation of the Know your body program in inner-city schoolchildren. *Health Education Quarterly,* 1992, 19(4):463−480.	The study design was complicated and unclear; the proportion of participants completing the study was low; and there was no evidence that the data collection tool was valid or reliable.
Siega-Riz AM et al. The effect of participation in the WIC program on preschoolers" diets. *The Journal of Pediatrics,* 2004,144(2):229−234.	This study was based on secondary data analysis of a nationally representative cross-sectional survey conducted by USDA.
Overall evaluation report for the United Nations Fund Project "Improving the outlook of adolescent girls and boys in Mongolia" DRAFT: United Nations, 2004.	There were no baseline data and there was not enough information about the intervention concerning promoting fruit and vegetable consumption.
Winett RA et al. Nutrition for a Lifetime System: A multimedia system for altering food supermarket shoppers' purchases to meet nutritional guidelines. *Computers in Human Behavior,* 1997, 13(3):371−392.	Food purchase was used as a proxy for consumption.
Anderson ES et al. The effects of a multimedia system in supermarkets to alter shoppers' food purchases: national outcomes and caveats. *Journal of Health Psychology* 1997,2: 221−232.	Food purchase was used as a proxy for consumption.

Annex 6. Details of the studies included in the review: children, adults (various settings)

CHILDREN

Table A6-1. Summary of studies with primary school-age children

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Girls Scouts Eat 5, United States Cullen et al. (*35*)	Randomized pre-test, post-test control group design	Twenty-two junior girl scout troops with about 300 girls were recruited from a local girl scout council. All of the troops participated in the pre-test and three-month follow-up. However, 48 girls were not present at the post-test and an additional 48 girls were not present at the three-month follow-up.	There were four sessions. In session 1, the girls learned how to complete three-day food records. During the next three sessions the girls went through activities designed to increase fruit and vegetable exposure and preparation skills and knowledge, and skills in self evaluation, self monitoring, goal-setting and problem-solving, and to establish troop norms for serving and eating fruit and vegetables. Fruit and vegetables were prepared and tasted at each meeting. Parent information sheets were sent home and parents were encouraged to promote fruit and vegetable consumption at home. Girl scouts completing the activities received an "Eat 5" badge. Follow-up: three months	1) Food recognition form (FRF) at baseline, and at three months, one- page modified food frequency questionnaire (FFQ) with 12 items. 2) Determinants of food behaviour questionnaires were filled out immediately before session 1 was started (pre-test) and then about one week after all activities had been completed (post-test).	Only 20% of girls consumed five or more fruit and vegetable servings per day; 17% reported consuming 0 servings on the survey day. There were significant differences in fruit and vegetable intake between conditions at pre-test. The change in fruit and vegetable intake for girls in the intervention condition troops was significantly greater at post-test than the control condition troops (P<0.0019) [at pre-test intervention n=126 had mean fruit and vegetable intake of 3.02 (SD 2.21) and at post-test (n= 101) they had a mean intake of 3.39 (SD 1.93); at pre-test control n=133 had a mean fruit and vegetable intake of 2.20 (SD 1.96) and at post-test they (n=82) had a mean fruit and vegetable of 2.06 (SD 1.71). Intervention group levels returned to pre-test levels at the three- month follow-up (P > 0.13).	

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Integrated Nutrition Project, United States Auld et al. (*37*)	Cross-sectional, quasi-experimental pre-test (third quarter 1997) post-test (second quarter 1998)	The integrated nutrition project has been going on since 1993. From 1993−1997 it has involved about 1250 children in three Denver schools. This study reports on students selected in year 3 (n=268 treatment and n=181 comparison) and year 4 (n=456 treatment and n=395 comparison).	The intervention consisted of several components: 1) 24 weekly special resource teacher- taught classes that included food preparation and eating; 2) teacher training through three after-school in services and weekly classroom role modelling from the resource teacher; 3) parent education consisting of 12 bimonthly bilingual low-literacy newsletters; nutrition classes taught by existing community nutrition education programmes and two family fun nights per school; and 4) community nutrition / food resource development. In years 4 and 6 corresponding parent-taught school lunchroom activities were added. Follow-up: four years	1) Plate waste assessment to visually estimate fruit and vegetable selected and consumed in the school lunchroom; 2) food recall / record; survey 3) classroom survey on knowledge and attitudes to fruit and vegetables; 4) five-minute interview with kindergarten children about their knowledge of fruit and vegetables	Fruit and vegetable intake: Complete plate waste data from 226 participants and survey data from 295 participants. Post-test fruit and vegetables intake from plate waste (year 4) indicated that treatment students consumed significantly more fruit and vegetables then comparison students: 0.19 more fruit servings, 0.25 more vegetable servings and 0.4 more fruit and vegetables servings in total. Knowledge, attitudes and self-reported behaviour outcomes: Treatment children demonstrated higher levels of knowledge than the comparison students.	
5-a-Day Power Play! Campaign, United States Foerster et al. (*38*)	Experimental cohort study, non-randomized, controlled	Forty-nine schools and 151 classrooms (4th and 5th grade children) in California participated in the study. When the cohort was matched pre-study and post-study, 2684 cases were established: the data reported here are based on these cases. There were 15 schools in the control group, 19 in T1,15 in T2.	T1 intervention consisted of Power Play! activities conducted only in school. T2 intervention consisted of Power Play! activities simultaneously conducted in schools, community youth organizations, supermarkets, farmers' markets, and mass media. The control group got any nutrition activities except for Power Play!. Follow-up: ~ one school year	California Children's Food Survey ─ a 24-hour recall self-reported food diary	Both intervention sites reported significant increases in self-reported fruit and vegetable intake compared with the control site but not compared with each other. Increases were highest for T2 (0.4 serving, from 2.9 to 3.3) compared with 0.2 serving (from 2.7 to 2.9) in T1. Consumption decreased for the control group by 0.3 serving (2.6 to 2.3 servings). Changes in self-reported consumption between treatment and control groups was statistically significant at $P<0.001$; the change between treatment groups was not significant.	

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
5-a-Day Power Plus Programme, United States Perry et al. (*36*) and Story et al. (*110*)	Randomized controlled trial (matched-pair design)	Fourth-grade children in 20 elementary schools were chosen to include a group of children with considerable ethnic and socioeconomic diversity, matched by pairs based on size, ethnic makeup, percentage of students participating in the free or reduced-price lunch programme. One school per pair randomized to intervention. 1750 students enrolled, 1612 completed the health behaviour questionnaire. 657 selected at random for dietary measurements: 652 observed during lunchtime, 580 completed a one-day food record of whom 536 completed a 24-hour recall. Of these 536, 441 completed a 24-hour recall at follow-up.	March−May 1995 (Grade 4) and Oct 95−Jan 96 (children then in Grade 5). The intervention included four components: 1) behavioural curricula in classroom (two x 16 classroom sessions of 40 to 45 minutes, twice weekly, for eight weeks: including skill-building, problem-solving, snack-preparation, taste-testing, comic books and adventure story, team competitions, prize rewards); 2) parental involvement/education (five information/activity packets and four snack packs); 3) school food-service changes (point-of-purchase fruit and vegetable promotions using characters and messages from the classroom curricula, enhancing the attractiveness of fruit and vegetables served every day, increasing variety and choices, providing an additional fruit item on days when a baked dessert was served, trays and signs to show available fruit and vegetable choices each day); 4**)** industry involvement and support (support from the 72-member Minnesota "5-a-Day" Coalition, fruit and vegetable supply for classroom taste testing/home snack packs/school lunch, a 30-minute presentation on fruit and vegetables, and provision of additional educational and incentive materials). Follow-up: ~10 months	In all students: group-administered health behaviour questionnaires measuring a variety of factors related to fruit and vegetable intake. In a random sample of students: self-completed 24-hour non-quantified food record and observation of students in lunchroom to record all items eaten at lunch and their portion size (same day) and 24-hour recall (next day). Students who completed the 24-hour recall at baseline were recruited a year later for the follow-up lunchroom observation and 24-hour recall.	Lunchroom observations at follow-up (424 students): compared with the control group, intervention students had a higher mean intake of fruits and vegetables (1.53 versus 1.06 serving, $P<0.01$), fruits (0.74 versus 0.44, $P<0.01$), fruit and vegetables in servings per 1000 kcal (3.02 versus 2.19$P<0.01$) and fruit in servings per 1000 kcal (1.67 versus 0.95, $P<0.01$). As well, vegetable intake was greater in girls in the intervention versus control group (0.26 serving, $P<0.05$). 24-hour recalls at follow-up (407 students): compared with the control group, intervention students had a higher mean intake of fruits (5.24 versus 4.66, $P=0.02$), fruit and vegetables, in servings per 1000 kcal (2.82 versus 2.41, $P=0.02$), fruit in servings per 1000 kcal (1.51 versus 1.16, $P=0.02$). Health behaviour questionnaire (1028 to 1271 students depending on the question being asked): there was significantly more perceived teacher support for eating fruit and vegetables ($P<0.01$), greater perceived need to eat fruit and vegetables ($P<0.01$), more reports of asking for fruit and vegetables ($P=0.03$) and more reported usual daily servings of fruit and vegetables ($P<0.01$).	There were high levels of participation, dose, and fidelity for all the intervention components, with the exception of parental involvement.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
A study on nutrition education at primary school, Ireland Friel et al. (*34*)	Quasi - experimental comparative study, with schools the unit of randomization	821 Irish schoolchildren aged 8−10 years in eight schools in both urban and rural areas (453 in intervention and 368 in control schools)	A pilot dietary education programme for primary school pupils, followed up at three months. The intervention comprised 20 sessions over 10 weeks including worksheets, homework and an exercise regime. In addition to classroom sessions, "parent packs" were mailed home to parents / guardians with short family assignments. Follow-up: three months	Five-day food diary at baseline and three months	Following the intervention there was no significant change in the control group but there was a very small significant increase in the number of intervention children consuming the recommended amount of fruit and vegetables (four or more servings per day).	Schools were selected for practical reasons, not necessarily compatible
Eat Well and Keep Moving, United States Gortmaker et al. (*41*)	Quasi-experimental field trial	Intervention group: six public elementary schools in Baltimore. Control: eight matched schools	A classroom-based intervention: delivered by teachers and integrated into maths, science, language arts, social studies classes, and included links to food school services, physical education, teacher and other staff-member wellness programmes, families and classroom-based campaigns. Units were implemented during two school years and consisted of 13 lessons each for grade 4 and 5 students. Eighteen “Eat Well” cards were created to introduce students to new foods, used in the classroom, and linked to food services. Activities such as "Get 3 at School” and “5 a Day" were promoted in the classroom but also at home and so involved family members. Follow-up: two years	Food frequency questionnaire and 24-hour recall	Analyses from the 24-hour recalls found that there was an increase in the consumption of fruit and vegetables (0.36 servings / 4184 KJ; 95% CI, 0.10-0.62; *P*=0.01). This difference in fruit and vegetable consumption is equivalent to an increase of 0.73 servings /day given a mean total intake of 8473 KJ.	

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
A study on "Gimme 5" fruit, juice and vegetables for fun and health, United States Baranowski et al. (*39*)	Randomized controlled trial	Participants were 1253 children in fourth and fifth grades at 16 elementary schools	The intervention group received a six-week, 12-session "Gimme 5" curriculum which encouraged and assisted children to eat more fruit and vegetables. Teachers had handouts, posters, worksheets, newsletters, videos. Point of purchase education was conducted at shops per school that parents most used. Follow-up: three years	The 1253 children completed a seven-day food record for all three years	Increases in mean consumption only occurred in the two lowest quintile groups, and were highest in the intervention group (lowest quintile: +.47 servings and +0.82 servings for control and intervention groups respectively). Declines in consumption occurred in the top three quintiles, which were least for the intervention group (highest quintile: -1.59 and -0.88 servings for control and intervention groups respectively)	

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
High 5 Project, United States Reynolds et al. (*42*)	Randomized controlled trial (matched-pair design)	Participants were 28 elementary schools pair-matched based on ethnic composition and proportion of students receiving free or reduced-price meals. 1698 families or fourth-grade children (69% participation rate) agreed to participate.	There were three intervention components based on social cognitive theory: 1) classroom component (14-lesson curriculum taught by nine curriculum coordinators employed by the "High 5" project. The curriculum was delivered on three consecutive days each week with a 30−45 minute lesson on day 1, a "High 5" day on day 2 (challenge to eat five servings of fruit and vegetables) and a 30−45 minute lesson on day 3. This included modelling, self-monitoring, problem-solving, reinforcement, taste-testing, other methods); 2) Parent component (kick-off night, parents asked to encourage and support behaviour change and do seven homework assignments with their child); 3) Food service component (half-day of training on purchasing, preparing and promoting fruit and vegetables, intervention activities). Control: usual care, follow-up: two years	Children: two methods: 1) one 24-hour recall (a "5 a Day Guidelines Fruit and Vegetable Score" was created by eliminating from the count of servings all fruit and vegetables containing more than the stipulated amount of salt, fat and sugar defined by "5 a Day" guidelines); 2) cafeteria observation (a sample of 425 students were observed during school lunch to assess fruit and vegetable consumption). Parents: food frequency questionnaire (fruit and vegetable items from the Health Habits and History Questionnaire). NB: some psychosocial data collection measures were also included for students and parents.	24-hour recall: There was no difference at baseline in fruit (intervention=1.00 serving/day, control=0.85, $P<0.14$), vegetables (1.32 versus 1.33, $P<0.89$) or fruit and vegetables (2.61 versus 2.51, $P<0.59$). The intervention group had higher intakes at one year (fruit: 1.71 versus 0.83, $P<0.0001$; vegetables: 1.84 versus 1.15, $P<0.0001$; fruit and vegetables: 3.96 versus 2.26, $P<0.0001$) and two years (fruit: 1.21 versus 0.65, $P<0.0001$; vegetables: 1.60 versus 1.25, $P<0.09$; fruit and vegetables: 3.20 versus 2.21, $P<0.0001$). Similar findings were found for the "5 a Day Fruit and Vegetable Score". Differences among groups were found in boys and girls, and in children of different ethnic groups (African- and European- Americans) and socioeconomic status. Cafeteria observation: no differences between groups were observed at baseline, one year and two years. Parents' food frequency questionnaire: at one year, intervention parents consumed more servings of vegetables (2.38 versus 2.21, $P<0.0359$) and fruit and vegetables (4.23 versus 3.94, $P<0.0366$). No differences were observed at two years.	The intervention group had lower intakes of fat and saturated fat and higher intakes of carbohydrates, fibre, folate, beta-carotene and vitamin C compared with the control group at one year and two years. A shift towards higher stages of stage-of-change for five fruit and vegetables was seen in the intervention group at one year.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
A study on the "APPLES" health promotion programme, United Kingdom Sahota et al. (*32*)	Randomized control trial, randomization of schools	Participants were 636 children aged 8−10 years (314 intervention, 322 controls) in 10 primary schools in Leeds	Five schools undertook the APPLES (Active programme promoting lifestyles in schools) health promotion programme. APPLES is a one- year multi-disciplinary programme designed to influence diet and physical activity. It uses a health promotion approach targeting the whole school community including parents, teachers and catering staff. It is based on action plans developed by individual schools based on perceived needs. It involves teacher training, modification of school meals, curriculum development, physical education, tuck shops and playground activities. Looking at risk factors for obesity. Control: The other five schools received the usual school curriculum. Follow-up: 12 months	24 hour recall, and three- day diet diary at baseline and 12 months	Intervention children had a higher vegetable intake after the study, the weighted mean difference was 0.3 serving (95% CI 0.2−0.4), which is 50% of baseline intake. This was true for all children and for the categories of overweight, and obese children. The three-day diet diary did not show these differences.	It is suggested that five schools in each arm is too small to show an effect.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Food Dude Healthy Eating Programme, United Kingdom Lowe et al. (*31*)	Non-randomized, controlled trial	Children aged five to seven years in two primary schools in deprived areas of south London (364 in intervention school and 384 in control).	Children in the intervention school received the 16-day "Food Dude" programme including a supply of fruit and vegetables at snacktime and lunchtime. Those in the control school had fruit and vegetables made available but no programme was introduced. The " Food Dude" programme teaches children to name fruit and vegetables, with reinforcement using a video in which older peer "Food Dudes" have adventures and extol the benefits of eating a number of fruit and vegetables. Prizes (stickers, badges etc) are awarded to children who consume sufficient quantities of targeted foods. A 10-week maintenance phase followed in both schools, in which fruit and vegetables continued to be presented but rewards were intermittent. Follow-up: four months	Consumption was measured at baseline, during the intervention and at follow-up after four months. At snacktime all foods were weighed before and after consumption. At lunch, consumption was recorded on a five point scale by researchers (and inter-observer and inter-measure agreement was checked). Parents completed questionnaires about their child's consumption at home, and a subset took part in parental recall interviews during baseline and intervention phases.	In the experimental school, lunchtime consumption of fruit and vegetables was significantly higher at follow-up than baseline, while for the control school, consumption of vegetables was significantly lower at follow-up than baseline. At lunchtime, fruit consumption increased in the experimental school, from 36% to 79% during intervention, and remained raised at 61% at four months. At snacktime, fruit consumption increased in the experimental school from 75% (baseline) to 87% during the intervention ($P<0.001$), but returned again to baseline levels (76%) at follow-up (no significant difference with baseline). In the control school, consumption remained between 60% and 65% throughout the three study phases. In experimental schools the lowest consumers had the greatest increase, compared with little change in this group at the control school.	Over 80% of children in both schools were from ethnic minorities, 40−55% had special educational needs, and 46−67% were entitled to free school meals.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
A study on the prevention of obesity in children, United Kingdom Warren et al. (*33*)	Randomized controlled study	Participants were 213 five to seven year-olds from three primary schools in Oxford.	The primary goal of the intervention is obesity prevention. Children were randomly assigned to a control group ("Be Smart" - learned about food in a non-nutrition sense) or one of three intervention groups: nutrition (Eat Smart), PA (Play Smart), and combined nutrition and PA (Eat Smart Play Smart). Fruit and vegetables were promoted using tasting sessions and games based on the "Gimme 5" intervention. Interventions were set in lunchtime clubs where age- appropriate curriculum was delivered. Follow-up: 20 weeks over four school terms	Dietary intake was assessed using a combination of two questionnaires completed by the parents on behalf of the children: a 24-hour recall questionnaire and a food frequency questionnaire.	Overall fruit and vegetable intake increased significantly (P<0.01 and P<0.05 respectively). In males there was a significant increase in fresh fruit consumption (P<0.01). A significant increase in fruit consumption was found in the "Eat Smart" and "Be Smart" groups.	
5-A-Day Cafeteria Power Plus Project, United States Perry et al. (*40)*	Randomized controlled trial	Participants were 1668 students in first and third grades, randomly selected from 26 elementary schools randomized to intervention or control groups (35 per grade and per school)	The aim was to increase opportunities during school lunch to eat a variety of fruit and vegetables, provide new healthful role models who ate fruit and vegetables, and institute social support at lunch. It involved daily activities (increasing the availability, appeal, and encouragement of fruit and vegetables in the school lunch programme, emphasizing changes in the lunch line, school snack cart, encouragement of food-service staff) and special events (two-week kick off campaign, monthly sampling of fruit and vegetables during the lunch period, challenge week at midyear of each intervention year (competition to eat three servings of fruit and vegetables per day at lunch), theatre production in first year, final special event). Control: Delayed intervention after the end of the active study phase. Follow-up: two years.	The number of servings of fruit and vegetables consumed during lunch was recorded during observation by trained observers, who, from a distance, recorded items eaten and their portion size. There was also direct observation of the lunch offerings (whether the fruit and vegetables were appealing); observation of verbal encouragement by the food-service staff; and recording of the number of fruit and vegetables on the school snack cart.	After two years, there was a significant difference between groups for the intake of fruit without juice (intervention: 0.37 serving versus control 0.21 serving, P<0.01), fruit with juice (0.79 versus 0.63, P=0.01), fruit and vegetables without potatoes and juice (0.64 versus 0.50, P=0.02), and fruit and vegetables without potatoes, with juice (1.06 versus 0.92, P=0.03). Intervention schools had significantly more verbal encouragement by school food-service staff (P=0.01) and more fruit and vegetables on the lunch line (P<0.01). Verbal encouragement was significantly associated with higher intake.	The overall change came from a change in fruit consumption rather than vegetable intake. [Environmental interventions alone may have limited impact without classroom and parental involvement]

Table A6-2. Summary of studies with secondary school-age children

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Gimme 5, United States Nicklas et al. (*46*)	Randomized paired design	Nineteen of 22 high schools in New Orleans, Louisiana, agreed to participate. Twelve schools (six pairs) were randomized to intervention or control condition (total 2213 students at baseline). Seven other schools served as pilot testing sites.	One school in each pair was randomly assigned to receive the "Gimme 5" measurements and interventions while the other schools received the "Gimme 5" measurements only (controls). Three primary end points were assessed at the school level: 1) increased awareness 2) increased positive attitudes and knowledge toward eating at least five daily servings of fruit and vegetables, and 3) increased daily consumption of fruit and vegetables. Changes from baseline (second quarter 1994) to end intervention (second quarter 1997) were assessed at intervention and control schools. Intervention: longitudinal following a cohort of students from grades 9−12. It comprised a school-wide media marketing campaign; classroom activities; school meal modification (Fresh Choices); and parental involvement (Raisin Teens). The whole school benefited from the media campaign and school meal modification; only the intervention cohort also got parental involvement and classroom activities. Follow-up: three years	The Knowledge, Attitudes and Practices questionnaire, a class-administered, 45-minute instrument to evaluate knowledge, self-efficacy, programme awareness, stages of change, and fruit and vegetable consumption. Fruit and vegetable intake was measured by the self-reported number of servings of fruit and vegetables usually consumed on a daily basis.	Fruit and vegetable intake: Reported consumption of daily fruit and vegetable servings was significantly higher in the intervention schools than in the control schools in 1995 and 1996 ($P<0.05$). This difference was not sustained at follow-up in 1997. From 1994 to 1996 a significant linear increase in the reported daily consumption of fruit and vegetable servings was observed in the intervention group compared to no significant linear trend shown in the control group ($P<0.001$). The intervention group reported a 14% increase (+ 0.37 servings) in consumption of fruit and vegetable servings after two years of intervention, from 2.63 servings at baseline in 1994 to 3.00 servings in 1996. At follow-up in 1997 reported consumption remained stable in the intervention group, concomitant with increased consumption in the control group, so no significant difference existed between groups at follow-up.	

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
CATCH, United States Perry et al. (47)	Randomized controlled trial	Participants were 1186 students i.e. all students who participated in the 24-hour recall, among the 5106 students in the original CATCH study	CATCH was implemented in 96 schools in four states in the US from 1991to 1994. The intervention involved modifications in school food service, physical education, classroom curricula and parental involvement. CATCH originally mainly assessed fats (cf. 5010 and 5002- out) but this paper addresses whether the CATCH message helped to increase fruit and vegetable intake. Follow-up: three years	24-hour recalls	There were no significant overall differences between conditions in fruit and vegetable consumption at follow-up. Baseline: average consumption among all students was 2.12 servings of fruits and 2 servings of vegetables in 24 hours. At follow-up: the intervention group n=707 consumed 4.17 servings (SE 0.19) of fruit and vegetables; 2.25 servings (SE 0.16) of fruit; and 1.90 servings (SE 0.10) of vegetables. The reference group n=479 consumed 4.10 servings (SE 0.23) of fruit and vegetables; 2.20 servings (SE 0.19) of fruit; and 1.89 servings (SE 0.13) of vegetables.	
Planet Health, United States Gortmaker et al . (45)	Randomized controlled trial	Ten public schools from four communities in Boston MA metropolitan area were randomly assigned to either intervention (n=5) or control (n=5). Participants were boys and girls from Grades 6 to 8.	Each intervention school received the “Planet Health” programme of teacher training workshops, classroom lessons, physical education materials, wellness sessions and fitness funds. Each theme was addressed in one lesson per subject (e.g. language, maths) for a total of 16 core lessons each in year 1 and year 2 (32 total). Follow-up: two years	Food and activity survey, and youth food frequency questionnaire	Overall participation n= 1560 students. Only statistically significant fruit and vegetable intake change occurred in girls: 0.32 servings/day; 95% CI, 0.14-0.50 servings/day; P=0.003).	

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Teens Eating for Energy and Nutrition at School, United States Birnbaum et al. (44) , Lytle et al. (111)	Randomized controlled trial	Sixteen schools with at least 20% of students approved for a free and reduced-priced lunch programme, and with at least 30 students in each of the seventh and eighth grades. Schools were pair-matched based on the proportion of seventh graders expected to receive all school-based components of the intervention and the proportion of students receiving free or reduced-price meals. The paper reports only on the effects of intervention in the seventh-grade.	Four groups: 1) Control: no intervention. 2) School environment interventions only: promotion of fruit, vegetables and low-fat snacks (food tastings, increasing availability of fruits, vegetable, low-fat snacks, posters, prize raffles). 3) As for (2), plus classroom curriculum. The curriculum consisted of 10 curriculum sessions and three "Parent Packs" (activities and intervention-related messages). 4) As for (3) plus peer leaders. Peer leaders were trained elected students who helped teachers to deliver the curriculum sessions. Follow-up: two years	Modified version of the Behavioural Risk Factor Surveillance System (BRFSS) measure. This includes items on the frequency of consuming fruit juices, fruit (excluding fruit juices), green salad, potatoes (excluding French fries, fried potatoes and potato chips), carrots, and vegetables (excluding carrots, potatoes, and salads) during the past year.	Year 1: Groups 1 and 2: no significant changes in fruit, vegetable, or fruit and vegetable intakes. Group 3: borderline significant increases in intakes of fruit (P =0.056, +~1/2 serving/day), vegetable (P =0.052, +~1/4 serving/day) and fruit and vegetable (P =0.097, +~1/2serving/day). Group 4: significant increases in fruit (P=0.02, +~1/2 serving/day) and fruit and vegetables (P =0.012, +0.9serving/day) and borderline significant increase in vegetable intake (P =0.059, +0.4 serving/day). Year 2: no significant differences between the groups in fruit and vegetable consumption.	Includes potatoes

ADULTS

Table A6-3. Summary of studies with adults - GENERAL POPULATION

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Hiraka Dietary Intervention Study, Japan Takashashi et al. (*53*)	Randomized controlled trial (crossover after 10 months)	Participants were 550 men and women aged 40−69 years from two rural villages in Akita Prefecture recruited through public magazines and posters.	Two 15-minute personal dietary counselling sessions, one group lecture, and two newsletters. The aim was to decrease sodium intake and increase vitamin C and carotene intakes. There was an emphasis on lower intakes of miso, salted vegetable pickles, salted fish and seasonings with a high salt content, and higher intakes of fruit and vegetables (particularly carotene- and vitamin C-rich vegetables, such as dark-green leafy vegetables and carrots). Control: only baseline and final assessments, follow-up: 10 months	470 participants completed a self-administered dietary history at baseline, five months and ten months.	There was a higher increase in fruit intake in the intervention (+20.0g) versus the control group (+2.9g, 95%) (*P* =0.009), and in green and yellow vegetable intake (intervention: +27.7g versus control: +5.3g, *P* =0.010). For other vegetables, changes were not significantly different among groups (intervention: -14.6g versus control: -5.4g, *P* =0.846). Total vegetable intake also did not differ among groups (intervention: +13.1g versus control: -0.1g, *P* =0.08).	Akita Province has a high incidence of stomach cancer and stroke, high salt intake and low carotene intakes. Some respondents may have been from the same family. Comparisons of blood carotenoid levels and reported carotenoid intakes suggest that intakes may have been overestimated by respondents.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
A study on increasing fruit and vegetable intake among callers to the Cancer Information Service, United States Marcus et al. (*51, 52*)	Randomized controlled trial	Participants were 1706 adults (78.7% females) over 18 years of age who called six regional offices of the National Cancer Institute's Cancer Information Service (CIS) for questions unrelated to diet. Participants were not cancer patients in treatment or awaiting treatment, nor on a diet that would limit fruit and vegetable intake.	Baseline telephone assessment (fruit and vegetable intake and demographics) followed by a short series of educational and motivational messages based on the trans-theoretical model and a short list of behavioural suggestions for increasing fruit and vegetable consumption. Two follow-up mailouts (mailed at baseline and two weeks). Material derived from the NCI "5 A Day for Better Health" programme. Control: Baseline and follow-up assessments only. Follow-up: Reassessment of fruit and vegetable intake at four weeks, and follow-up at four and 12 months.	Three methods: 1) single-item question at baseline, four weeks, four months, 12 months; 2) two-item question used in the Block food frequency questionnaire at baseline, four weeks, four months, 12 months; 3) Seven-item food frequency index on fruit and vegetable and juices in half the participants at four weeks, and in all respondents at four months and 12 months; 4) 24-hour recall in half the participants at four weeks and at four months.	1022 participants completed a 12-month follow-up. At baseline, there was no difference in fruit and vegetable intake between the intervention and control groups (3.79 versus 3.73 serving, P >0.05). At four weeks, differences were 0.88 serving (4.70 versus 3.82, P <0.001) with the single-item question, 0.63 serving (5.11 versus 4.49, P <0.001) with the seven-item question. At four months, differences were 0.63 serving (4.29 versus 3.66, P <0.001) with the single-item question, 0.39 serving (4.68 versus 4.29, P =0.002) with the seven-item question, 0.67 serving (6.75 versus 6.07, P =0.015) with the 24-hour recall. At 12 months, differences were 0.43 serving (4.27 versus 3.84, P <0.001) with the single-item question and 0.44 serving (5.04 versus 4.59, P=0.002) with the seven-item question. At each follow-up time point, intervention participants were more likely than controls to correctly identify the "5 A Day" programme and the specific "5 A Day" guidelines for fruit and vegetable intake, and to report a specific attempt to increase their intakes.	Includes potatoes. Approximately 80% were females.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
A study on the "5 a Day" Community Pilot Initiatives, England Department of Health, (*50*)	Controlled pre-test and post-test cross-sectional study	Participants were 1560 adults living in the five project areas across England (randomly selected from the electoral register). There were 400 control subjects living in another area, who were taking part in another study (EPIC) but had not been advised to change their diet.	Five community-based "5 a day" pilot interventions lasting 12 months and targeting a total population of 1 million people. These were multi-component interventions and took place in a variety of settings including the health service, food retailers and farmers' markets, schools and pre-schools, workplaces and caterers, and the wider community. Full details can be found in the five pilot project reports. Follow-up 12 months	Self administered postal questionnaires at baseline and after one year. Two methods were used: a 49- item food frequency questionnaire was used to determine usual fruit and vegetable intake over one year. A short questionnaire (FACET) with nine questions was used to determine how many portions of fruit and vegetable were eaten in one day. The control group also provided detailed information from weighed food diaries for reference purposes.	At baseline the mean fruit and vegetable intake was 1.5 portions/ day higher in the control group (4 intervention, 5.5 control). At follow-up there was no change in overall intake in the intervention group, but there was a decline in the control group (by about 0.5 portion), reflecting national trends as observed in the National Food Survey. People in intervention areas that ate the least (less than five portions a day) at baseline tended to increase their fruit and vegetable intakes by about one portion a day. Those who ate five a day or more at baseline decreased intakes by about one portion per day. Similar trends were observed in the control group.	Both the food frequency questionnaires and FACET questionnaires tended to overestimate the frequency of fruit and vegetable intake compared with the reference method (1.5 servings). Eating frequency appeared to have a greater impact on total fruit and vegetable intake. The intervention increased perception of better knowledge and access to fruit and vegetables.
A study on the "Latino 5 a day" Campaign, California Backman and Gonzaga (*49*)	Non-randomized controlled trial	Participants were 969 Latino adults (18−65 years old) living in two counties in California	The population living in Fresno were exposed to social marketing interventions for four months. These targeted predominately Spanish-speaking Latinos, included bi-lingual television, radio, and outdoor advertisements; media interviews that featured information from Latinos "5 a day" spokespeople; festival and farmers' markets activities, and grocery-store merchandizing and promotions. The control population living in Riverside/ San Bernadino did not receive the intervention (baseline and follow-up assessments only). Follow-up five months	675 participants completed both the baseline and follow-up telephone interview surveys (24- hour recall)	At baseline there was no significant difference in fruit and vegetable intake between intervention and control communities. At follow-up Spanish speakers in the intervention reported an increase of 1.63 servings per day in fruit and vegetable intake (baseline 4.41, follow-up 6.04 servings, P <0.05), compared to Spanish-speakers in the control community who reported an increase of one serving per day (baseline 4.05, follow-up 5.05 servings, P <0.05). English- speaking participants in the intervention community only reported an increased intake of 0.43 serving per day (baseline 4.37, follow-up 4.80, P >0.05) compared with a large increase of 1.80 servings in the control community (baseline 4.06, follow-up 5.86, P <0.05). The difference in change in fruit and vegetable intake between the intervention and control communities was significant among Spanish and English speakers.	There were significant positive correlations between exposure to some aspects of the campaign, and to participants' awareness, attitudes and beliefs and fruit and vegetable intake. There was a significant negative correlation between participants' beliefs that they could overcome barriers to fruit and vegetable intake. Similar increases in fruit and vegetable consumption in the English-speaking control community are attributed to other English-language nutrition education programmes operating at the same time.

Table A6-4. Summary of studies with adults - WORKSITES

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Treatwell Study, United States Hunt et al. (*54*)	Randomized controlled trial	Sixteen worksites specialized in life insurance sales, health care delivery, computer manufacture and sales, wholesale food sales, telecommunications, construction and manufacturing, with between 200 to 2000 workers. Worksites were stratified by size and proportion of women and randomized to intervention and control groups. Analyses were based on eight control worksites and five that received the full intervention, including a total of 2365 individuals at baseline and 1762 with adequate data at both baseline and follow-up.	Focused on discrete food-based eating messages (to increase consumption of fruit, vegetables, high-fibre products, whole-grain breads/rice/pasta, potatoes, legumes, to substitute low-fat dairy products, remove skin of chicken and visible fat from meat or substitute fish and poultry for other meat). These were delivered through programmes targeting employees' individual eating behaviours (classes, taste tests, food demonstrations) and the worksite environment (labelling of recommended foods in cafeteria and bulletin- board displays). A standard intervention was tailored to the individual worksite in cooperation with an employee advisory board established at each site. Control: no intervention. Follow-up: 15 months.	Self-administered 67-item food frequency questionnaire	Changes in fruit intake did not vary significantly between groups (+2.948 servings/month in the control group and +6.820 servings/month in the intervention group, p=0.21). For vegetables, however, the changes were statistically significant between groups (p<0.02) (-1.581 servings/month in the control group and +3.288 servings/d in the intervention group) for an estimtated net effect of +4.869 servings/month or approximately +0.16 servings/d.	The only other significant difference in dietary changes was a greater reduction of processed margarine and butter in the intervention group.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Treatwell 5 a Day Study, United States Sorensen et al. (*55*), Hunt et al. (*56*)	Randomized controlled trial	Twenty-two community health centres located in underserved areas with between 27 to 640 workers (20 worksites employed fewer than 120 workers). Block randomization to three groups was done to achieve balance in size and ethnicity across conditions. Eligible workers were permanent employees working at least 15 hours per week. Two cross-sectional surveys of 1359 individuals at baseline and 1306 individuals at follow-up were performed. About 47% of the respondents at baseline also provided information at follow-up.	Minimal intervention control group (G3): there was periodic exposure to the national "5 a Day" media campaigns, promotion of the Cancer Information Service Hot Line, and a one-hour general nutrition presentation and taste test were provided at the worksites. Worksite intervention (G2): As for the minimal intervention control group plus worker participation in programme planning and implementation (worksite coordinator and employee advisor board) plus programmes targeting individual behaviour change (kick-off event, 10, 30-minute information sessions from the "Eatwell 5 a Day" discussion series, at least one educational campaign each intervention year lasting for three to five weeks, and holiday events) plus worksite environmental changes (increased offerings of fruit and vegetable, point-of-choice labelling of fruit and vegetable, posters, videos and brochures). Worksite-plus-family (G1): as for worksite intervention, plus written five-part series learn-at-home programme, plus annual family newsletter, plus annual family festival, plus periodic mailings of materials to family (nine mailings). Follow-up: 19.5 months	Self-administered seven-item food frequency questionnaire developed for use in the National Cancer Institute "5 a Day for Better Health" research projects.	Baseline: There was no significant difference in geometric mean intakes among groups (G1=2.8 serving/day, G2=3.0 serving/day, G3=2.9 serving/day) (*P*=0.62). Follow-up: Adjusted changes in fruit and vegetable intake varied significantly among groups (*P*<0.05). Intakes increased significantly more in G1 (+0.49 serving/day or +19%) compared with G3 (+0.01 serving/day or +0.4%) (*P*=0.018). No difference was found between G2 (+0.2 serving/day or +7%) and G3 (*P*=0.47).	84% females, 23% Latino and 18% non-Latino Black workers. Fruit and vegetable intakes include potatoes. A higher number of activities offered per employee were significantly correlated with greater change in fruit and vegetable consumption (r= 0.55; *P*=0.04). Greater participation in activities was significantly correlated with increased fruit and vegetable intake (r=0.55; *P*=0.04).

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Working Well Trial, United States Sorensen et al. (*57*), Patterson et al. (*58*) and Glanz et al. (*59*)	Randomized controlled trial (matched-pair design)	Participants were 114 manufacturing, communications, public services or utilities worksites with between 49 to 1700 employees (total of more than 28 000 workers) in 16 states. Sites were matched by the presence of a cafeteria, worksite size, type of smoking policy, company type, sex distribution, distribution of blue/white-collar jobs, and response rate to the baseline survey. One site per pair was randomized to the intervention. Two cross-sectional surveys of individuals and key informants were performed at baseline and follow-up. Three sites were lost due to economic dislocation and three matched sites lost accordingly.	The intervention focused on promotion and building awareness, plus action and skills training, plus maintenance of behaviour and preventing relapse (stage-of-change model). Participatory strategies included worksite coordinator and gatekeeper, plus employee advisory boards. Interventions directed at the individuals included a kick-off event, interactive activities, posters and brochures, self-assessments, self-help materials, campaigns and contests, and direct education through classes and groups. Interventions directed at environmental changes included consultation on the formation and implementation of smoking policy, changes in food offerings and/or nutrition education in cafeterias and vending machines, and catering policies. Control: no intervention, follow-up: two years.	Self-administered 88-item food frequency questionnaire listing portion sizes. In this, fruit and vegetable intake was calculated on the basis of two questions asking about usual intakes of fruit (excluding juice) and vegetables (excluding potatoes and salads), plus responses to items about salad, potatoes, and fruit juice servings.	Follow-up (using data from 108 worksites): fruit and vegetable intake changed from 2.60 to 2.80 servings/day in the intervention sites and from 2.58 to 2.60 servings/day in the control sites, for a net effect of +0.18 servings/day (or 5.6% (SE 1.3), $P<0.001$). Increased intake was consistently higher in intervention sites and was negligible in most control sites.	The intervention was based on a theoretical model derived from individual, organizational and community activation theories. Fruit and vegetable intakes included potatoes. Using data from the 55 intervention worksites, contests and direct education were associated with fruit ($r=0.31$, $P<0.05$) and vegetable ($r=0.38$, $P<0.05$) intakes. Intervention dose for activities directed toward individuals was associated with fruit and vegetable intake ($R2=0.16$, $P=0.004$). It was also associated with a greater reduction of fat intake in the intervention worksites.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Working Healthy Project - imbedded in the *Working Well Trial,* United States (see above) Emmons et al (*60*)	Randomized controlled trial (randomized matched-pair design)	Twenty-six manufacturing worksites with an average of 337 eligible employees per site (SD 135). One site per pair randomized to intervention. Three sites were lost due to economic dislocation and three matched sites lost accordingly. Analyses based on 22 matched-pair worksites with 2055 study participants.	Multiple risk-factor approach targeting nutrition, physical activity, and smoking. Each worksite had an employee advisory board as well as a worksite coordinator (main contact person and typically the chairperson of the advisory board). The intervention protocol included a number of individually focused intervention activities (informational/educational/ motivational materials, self-assessment with feedback, self-help/self-skills management programmes, direct education, contests and monetary incentive) as well as strategies targeted at social norms and health-related worksite policies (labelling in cafeteria and vending machines, catering policy, smoking-control policy, enforcement of policy). Follow-up: 2 ½ years	Self-administered 88-item food frequency questionnaire based on the Block food frequency questionnaire. In this, fruit and vegetable intake was calculated on the basis of two questions asking about usual intakes of fruit (excluding juice) and vegetables (excluding potatoes and salads), plus responses to items about salad, potatoes, and fruit juice servings.	Baseline (n=2055): there was no significant difference in fruit and vegetable intake between groups (2.8 (SD 1.8) servings/day in each group). Follow-up (n=2055). At follow-up, fruit and vegetable intake increased to 3.0 (SD 2.0) servings/day (+0.20 servings/day) in the intervention group. It decreased to 2.6 servings/day (SD 1.8) servings/day (-0.20 servings/day) in the control group. The difference at follow-up between the groups did not reach significance (*P*=0.06).	The intervention was based on individual, organizational, and community activation theories, including a participatory strategies model. Fruit and vegetable intake included potatoes. Fibre intake and physical activity levels were higher in the intervention group than in the control group at follow-up.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
WellWorks Study, United States Sorensen et al (*61*)	Randomized controlled trial (matched-pair design) with cross-sectional sample surveys at baseline and follow-up.	Twenty-four predominantly manufacturing worksites with between 250 to 2500 employees, use of known or suspected occupational carcinogens. Worksites were matched by pairs based on site characteristics including presence of a cafeteria, size, smoking policy, company type, distribution by sex and by blue/white-collar jobs, response rate to baseline survey. One site per pair randomized to intervention. Two cross-sectional surveys of 5914 individuals at baseline and 5406 at follow-up were performed. 2658 individuals provided information at both time points (considered in these analyses). Of these, 272 were excluded from the analysis because of out-of-range or missing dietary values.	Integrated programme targeting both behavioural risk factors (dietary habits and cigarette smoking) and exposure to hazards on the job. Strategy: joint worker-management participation in programme planning and implementation, operationalized through an employee advisory board and a designated work-site liaison, plus consultation by project staff with management on worksite environmental changes including tobacco-control policies, increased availability of healthy foods and reduction in the potential for exposure to occupational hazards, plus health education programmes targeting individual behaviours. Control: no intervention, follow-up: two years.	Self-administered 88-item food frequency questionnaire. In this, fruit and vegetable intake was calculated on the basis of two questions asking about usual intakes of fruit (excluding juice) and vegetables (excluding potatoes and salads), plus responses to items about salad, potatoes, and fruit juice servings.	Follow-up: Significant net effect (adjusted) of +0.13 serving/day of fruit and vegetables (P=0.03) (adjusted changes in the intervention group: 2.29 to 2.52 servings/day (or 10%), and 2.26 to 2.36 servings/day (or 4%) in the control group).	76% males. Fruit and vegetable intakes include potatoes. Professional and managerial workers increased their fruit and vegetable intake more than other workers did, although this difference was apparent in both groups. Percentage energy from fat was also reduced more in the intervention group than in the control group.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
A study on changing risk behaviours for noncomm-unicable diseases in NZ working men, New Zealand Cook et al. (*67*)	Controlled field trial	Male hourly-paid employees at two manufacturing worksites. Participation was voluntary (42% of employees volunteered): 132 participants at intervention site and 121 at control site.	Health promotion programme targeting dietary behaviours and physical activity. At the intervention site participants attended a 30-minute workshop once a month for six months. Topics included nutrition and noncommunicable diseases. Six nutrition displays were rotated through the cafeteria. Illustrated point-of-choice messages were installed promoting fruit and vegetables and lower-fat items, and water as a beverage. Follow-up: 12 months	Ten-minute questionnaire on self-reported behaviour including questions on frequency of fruit and vegetable intake.	Measured change in percentage of participants consuming two to three servings/day of fruit and two to three servings/day of vegetables. There was a significant difference between groups for the change in vegetable intake from baseline (P=0.007). In the intervention group, 12.2% more people (from 14.4% to 26.6%) ate two to three servings/day at six months (P=0.002); the change from baseline dropped to 7.1% at twelve months but remained significant (P=0.05). In the control group vegetable intake fell at six months (from 21.5% to 14.1%), and then returned to baseline levels (22.7%) at 12 months. The intervention did not significantly affect fruit intake (P=0.78).	This intervention targeted both diet and physical activity. Diet focus was low-fat, high-fruit and vegetable intake. The study did not quantify the change in actual intake.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
WellWorks-2 study, United States Sorensen et al. (*62*)	Randomized controlled trial	Fifteen manufacturing worksites with between 400 to 2000 employees and probable use of chemical hazards. Eight sites randomized to the control group and seven to the intervention group. There were two cross-sectional surveys of 9019 individuals at baseline, 7327 at follow-up were performed. Of these, 5156 individuals provided data at both time points (embedded cohort).	Health promotion (HP), plus an occupational health and safety programme (HP/OHS). Control: health promotion only. The health promotion programme included interventions at the individual, organizational and environmental levels (including an employee advisory board for worker-manager input into the programme) and focused on nutrition and tobacco use. The HP/OHS programme also addressed both occupational health and safety (exposure to hazardous substances). Follow-up: ~two years	Self-administered seven-item food frequency questionnaire from the "5 a Day for Better Health" programme.	Baseline (cross-sectional sample): Adjusted mean intakes were 3.45 servings/day in the HP/OHS programme and 3.53 servings/day in the HP programme. In the follow-up (cross-sectional sample), there was no significant difference between groups for the change in fruit and vegetable intake (net effect=-0.06 serving/day, *P*=0.54. Change in fruit and vegetable intake: -0.03 serving/day in the HP/OHS and +0.03 serving/day in the HP). Follow-up (embedded cohort): there was no significant difference between groups for the change in fruit and vegetable intake (net effect=-0.15 serving/day, *P*=0.24. Change in fruit and vegetable intake: -0.10 serving/day in the HP/OHS and +0.05 serving/day in the HP).	~60% males. Fruit and vegetable intakes included potatoes.
A study on the effect of peer education on increasing fruit and vegetable intake, United States Buller et al. (*63*)	Randomized controlled trial (matched-pair design)	Participants were 2091 labour and trades blue-collar employees from 10 public employers recruited by formal work group. (There were 126 work groups with 2530 eligible employees, 2091 of whom completed the baseline survey). These were divided into 93 cliques (informal networks in which members interact more with each other than surrounding people within their work group).	Baseline awareness programme: nine-month general "5 a Day" programme delivered to all employees at each worksite regardless of job type through formal worksite communication channels (mail, posters, cafeteria promotion, guest speakers). Control: nine-month continuation of the programme. Intervention: nine-month continuation of the programme, plus peer education programme. One worker was selected from each intervention clique to be a peer-educator and trained (16-hours over an eight-week period); they were paid for time spent in training, travelling to training, distributing material and keeping daily logs of	Two methods: 1) 24-hour recall (estimates excluded olives, avocados, coconut, fried potatoes, fried potatoes, cranberry juice); 2) interviewer-administered seven-item food frequency questionnaire from the "5 a Day for Better Health" programme.	Baseline: Total fruit and vegetable intake tended to be lower in the intervention than control cliques (intervention 3.32 (SD 0.88) servings/day with the 24-hour recall and 2.80 (SD 0.64) with the food frequency questionnaire; control: 3.55 (SD 1.16) servings/day with the 24-hour recall and 2.80 (SD 0.64) with the food frequency questionnaire). Eighteen-month follow-up: 1) Significant (adjusted) net effect for fruit and	74% males. Ethnic origin: 46% White/Anglo, 42% Hispanic. Fruit and vegetable intakes included potatoes. Intervention increased awareness and knowledge of the fruit and vegetable recommendations.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
		Forty-six matched-pairs (matched on: average fruit and vegetable intake, stage of readiness to change, clique density, co-worker and management support for health, perceived self-efficacy for change, percentage Hispanic employees, percentage females, and size) were randomized to intervention and control groups. At eight or nine months, some reorganization took place (some cliques no longer existed, some did not want to participate further, no employee would serve as peer leader, etc.) and 41 matched-pairs were left, representing 332 employees in the control group and 363 in the intervention group who completed the trial.	contacts with co-workers, speaking to researchers about their progress. In addition to discussion with co-workers they provided various materials to help co-workers practise dietary skills and stimulate discussion. Follow-up: Assessment at baseline, at 18-months, and six months after the intervention (24 months after baseline)		vegetable intake of +0.77 serving/day (SD 0.14, *P*<0.001) with the 24-hour recall and +0.46 serving/day (SD 0.14, *P*=0.002) with the food frequency questionnaire. Using the 24-hour recall, the (adjusted) net effect was +0.41 serving/day for fruit (SD 0.09, *P*<0.001), +0.10 for juice servings (SD 0.15, *P*=0.175), +0.26 for vegetable servings (SD 0.07, *P*=0.075). Slightly smaller effects were seen with the food frequency questionnaire (+0.25 for fruits (SD 0.06, *P*<0.001), +0.01 for juice servings (SD 0.06, *P*=0.806) and +0.19 for vegetable servings (SD 0.09, *P*-0.047). 22 months after baseline survey: the significant net effect in the total number of daily servings of fruit and vegetable persisted only when measured by 24-hour recall (+0.41serving/day (SD 0.10), *P*=0.034 versus food frequency questionnaire: -0.04 (SD 0.12), *P*=0.743).	

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Next Step Trial, United States Tilley et al. (*64*)	Randomized controlled trial	Twenty-eight automotive industry worksites participated with at least 45 eligible employees from the pattern and model-making areas (representing a total of 5042 employees). Eligible employees, considered to be at high risk of colorectal cancer, included employees who were active, on layoff, or retired and had worked at least two years at 20% effort in plant pattern and model-making areas. Fifteen worksites were randomized to intervention (n=1578 individuals included) and 13 to control status (n=1899 individuals included).	The aim was to decrease fat intake and increase consumption of fibre and fruit and vegetables. The intervention included five nutrition classes on paid work time, plus mailed self-help materials in the first 12-month period, and worksite posters, plus personalized feedback from food frequency questionnaires (comparison of employees' diets to the USDA Food Guide Pyramid and motivational messages) in the second 12-month period, and quarterly newsletters throughout the trial. Control: no intervention, follow-up: two years	Self-administered food frequency questionnaire, a modified version of the National Cancer Institute food frequency questionnaire. Servings of fruit and vegetable were calculated following the approach used by the national "5 a Day for Better Health" programme.	Baseline (n=3477): There was no difference in fruit and vegetable intake (intervention: 3.4 (SD 1.9) servings/day and control: 3.4 (SD 1.7) servings/day), fruit intake (1.7 (SD 1.2) versus 1.6 (SD 1.1)) or vegetable intake (1.8 (SD 1.0) versus 1.7 (SD 1.9)). Follow-up (n=3477 at year 1 and n=3485 at year 2 using a modified intention-to-treat approach). There was a significant net effect at year 1 (adjusted) +0.20 serving/day ((SE 0.06), *P*=0.001, intakes at one year: intervention=3.56 (SE 0.04), control=3.35 (SE 0.05)) but non- significant net effect at year 2 (adjusted) +0.10 serving/day ((SE 0.06), *P*=0.11, intakes at two years: intervention=3.62 (SE 0.04), control=3.52 (SE 0.05)). Similar findings were observed for fruit (adjusted net effect=+0.11 serving/day (SE 0.04) at 1year (*P*=0.02) and +0.07 serving/day (SE 0.03) at 2-yr (*P*=0.15)) and vegetables (adjusted net effect=+0.09 serving/day (SE 0.03) at 1 year (*P*=0.005) and +0.03 serving/day (SE 0.03) at 2 years (*P*=0.19)).	98% males. The intervention was based on the concepts from social cognitive theory, social support principles, and the stages-of-change construct from the trans-theoretical model of behaviour change. There was also significant improvement in the intervention group at one year for fat and fibre, but this remained significant at two years only for fibre intake. Intervention effects were larger in younger (<50 years), active employees and class attendees.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Seattle 5 a Day programme United States Beresford et al. (*65*)	Randomized controlled trial with cross-sectional sample surveys at baseline and follow-up	Twenty-eight worksites with between 250 and 2000 employees and with cafeterias. Fourteen worksites were randomized to the intervention and 14 to the control group. Cross-sectional surveys were performed of 2828 individuals at baseline (1428 in the intervention and 1400 in the control group) with a mean age of 41.1 years (SD 3.2), and 2395 individuals at follow-up (1169 in the intervention and 1226 in the control group). 1681 individuals provided information at both time points (cohort data).	Intervention: four-phase activities addressing work environment and individual behaviour: 1) "teaser" campaign to increase awareness about "5 a Day"; 2) worksite kick-off event about the benefits of fruit and vegetable and to assess personal knowledge and diet; 3):skill-building for individuals, signs/displays/etc in cafeterias, incentives in some sites; 4) emphasis on ways to adapt new skills to every day, importance of social support and environmental changes. An employee advisory board at each worksite guided the intervention, aided by an intervention specialist from the research team. Control: no intervention, follow-up: ~2 years	Four self-administered methods: 1) Seven-item food frequency questionnaire during the past month; 2) Fat- and fibre-related diet behaviour questionnaire with a six-item fruit and vegetable subscale (about eating 1+ vegetable at lunch, 2+ vegetable at dinner, fruit for dessert, raw vegetables for snacks, fruit for snacks, fruit at breakfast); 4)Three 24-hour recalls (eight persons/ worksite); 5) Usual-day checklist including 12 questions on usual fruit and vegetable- eating habits. Two unobtrusive indicators: 1) plate observation (one lunch hour); 2) community-level fruit and vegetable availability checklist to record the presence of these offerings in the cafeterias.	Baseline (n=2742 individuals): No difference in fruit and vegetable intake between the intervention (food frequency questionnaire: 3.68 servings/day, fat- and fibre-related diet behaviour questionnaire: 0.92, 24-hour recall: 5.17, usual-day checklist : 5.75, single question: 2.62) and control group (food frequency questionnaire: 3.63, fat- and fibre-related diet behaviour questionnaire: 0.95, 24-hour recall: 5.05, usual-day checklist: 5.80, single question: 2.93). Follow-up (n=2395 individuals): there was a significant net effect (adjusted) for fruit and vegetable with the food frequency questionnaire (+0.30 serving/day, *P*<0.05; unadjusted changes: intervention=+0.51, control=+0.21), fat- and fibre-related diet behaviour questionnaire (+0.12 serving/day *P*<0.05; unadjusted changes: intervention=+0.13, control=+0.01), and single question (+0.19 serving/day, *P*<0.01; unadjusted changes: intervention=+0.27, control=+0.08). No significant (adjusted) net effect with the usual-day checklist (+0.40 serving/day, *P*=0.08, unadjusted changes: intervention=+0.52, control=+0.12) or 24-hour	58% males. The intervention was designed around the stage-of-change model. The fruit and vegetable intakes included potatoes. The group of persons surveyed at baseline and follow-up was not entirely the same. Plate observation: net=+0.16 serving on average (95% CI -0.27, 0.57). Checklist: there was a non-significant effect for the number of types of vegetables and fruits offered.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
					recall (+0.73 serving/day, *P*=0.19, unadjusted changes: intervention=+0.29, control=-0.44). Cohort data (n=1681): non-significant net effect (+0.25 (95% CI -0.01,0.50)) with the food frequency questionnaire, but significant with fat- and fibre-related diet behaviour questionnaire (+0.11 (95% CI 0.04,0.17)), usual-day checklist (+0.47 (95% CI 0.04,0.90)), single question (+0.13 (95% CI 0.03,0.22)).	

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Health Works for Women, United States Campbell et al. (*66*)	Randomized controlled trial	Participants were 859 blue-collar women aged 18+ years and working in nine rural small to medium-size (125 to 350 employees) textile or light manufacturing industries in North Carolina employing a majority of women and with no current comprehensive health promotion programme onsite.	There were two interventions (one at baseline and one at six months), individualized computer-tailored women's magazines that provided personalized feedback, strategies for change, and community resource information plus social- support activities using worksite natural helpers (women in the workplace trained to diffuse information and provide support for healthy behaviour change). The intervention addressed multiple health behaviours (physical inactivity, unhealthy diet (high-fat, low-fruit and vegetable intake), smoking, and breast and cervical cancer screening). Delayed intervention: after six months, one individualized computer-tailored women's magazine but no worksite natural helpers programme. Follow-up: 18 months (measurements at baseline, six-months and 18-months).	Self-administered 28-item food frequency questionnaire based on a validated instrument (four assessed fruit intake and six assessed vegetable intake)	Baseline: Women in the intervention group consumed significantly more fruit and vegetables compared with the delayed intervention group (2.9 (SD 2.4) servings/day versus 3.4 (SD 3.1) servings/day). Follow-up (n=660 at six-months and n=538 at 18-months): At 18-months, the mean fruit and vegetable intake was higher in the intervention group (3.6 (SD 3.1) servings/day) than in the control group (3.4 SD (3.1) servings/day) (adjusted comparison $P<0.05$). Between baseline and 18-months, there was a significantly higher change (adjusted analyses) in fruit and vegetable intake in the intervention group (+0.7 serving/day) than in the control group (0 serving/day) (net effect: +0.7 serving/day, $P=0.01$), and higher changes in fruit intake (+0.5 serving/day versus +0.1 serving/day, net effect=+0.6 serving/day, $P=0.02$) and vegetable intake (+0.2 serving/day versus -0.1 serving/day, net effect=+0.3 serving/day, $P=0.03$).	

Table A6-5. Summary of studies with adults – HEALTH CARE SETTINGS

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Recruitment through Health Maintenance Organizations (HMO)						
A study on newsletter interventions to improve fruit and vegetable consumption in healthy adults, United States Lutz et al. (*68*)	Randomized controlled trial	Participants were 710 adults aged 18+ years, primary subscribers to a HMO in North Carolina (only one participant per household). There were 180 participants in the control group, 177 in the Intervention 1 group, 176 in Intervention 2 and 177 in Intervention 3.	Intervention 1 (I1): Non-tailored nutrition newsletters. Intervention 2 (I2): Tailored nutrition newsletters without a goal-setting component. Intervention 3 (I3): Tailored newsletters with tailored goal-setting information. Newsletters were sent each month for four months. Computer-tailored messages were based on the participants' responses to the baseline survey. Tailored goal-setting messages covered the specific goal of increasing fruit and vegetable intake to 5+ servings/day plus three subgoals based on answers to the baseline questionnaire. Control: no newsletters, follow-up: six months	Self-administered food frequency questionnaire including 17 fruit and vegetable items (developed for this study). The number of fruit and vegetable items eaten at least once a week were also counted and added to determine variety.	Based on data from respondents who provided information at baseline and follow-up (n=573), fruit and vegetable intake changes were more favourable in all intervention groups compared with the control group (P<0.002). Changes in intake ranged from +0.1 serving/day in the control group (from 3.5 to 3.6), +0.7 serving/day in I1 (3.4 to 4.1), +0.8 serving/day in I2 (3.3 to 4.1), and +0.9 serving/day in I3 (3.5 to 4.4). There was no significant difference among the intervention groups. Using intention-to-treat analyses (n=710), improved intakes were seen only for I2 and I3 compared with the control group (but no significant difference between I2 and I3).	64.4% female, 77.9% White. Newsletter content was tailored using theoretical constructs (self-efficacy from the social cognitive theory, stage or readiness to change from the trans-theoretical model of change, and perceived barriers and benefits from the health belief model). French fries were excluded from the calculation of the number of daily servings. Post-intervention variety scores were higher for all intervention groups compared with the control group (P=0.0001).

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Puget Sound Eating Patterns Study, United States Kristal et al. (*69*)	Randomized controlled trial	Participants were 1459 adults aged 18−69 years, randomly selected from computerized lists of enrolees of a large HMO, stratified into three age groups (18−34, 35−54, 55−69 years) (only one participant per household). There were 729 in the intervention group and 730 in the control group. Analyses were based on 1205 (601 in the intervention group, 604 in the control group) with data at the baseline, three-month and 12-month follow-ups.	Computer-generated personalized letter, plus motivational phone call, plus self-help manual, plus package of supplementary self-help materials, plus computer-generated behavioural feedback based on a self-administered food frequency questionnaire, plus semi-monthly newsletters sent until one year post-randomization. The aim was to lower fat intake and increase fruit and vegetable intake. Control, usual care, follow-up: 12 months	Two methods: 1) a six-item interviewer administered food frequency questionnaire was used for the evaluation in the "5-a-Day for Better Health" programme. 2) 24-hour recall (optional at 12-months but completed by 67% of respondents at baseline and 12-months).	Food frequency questionnaire (intervention n=610, control n=604): There was a significant net effect (adjusted) in fruit and vegetable intake: 0.46+/-0.10 serving/day (unadjusted changes: intervention=0.47+/-1.83, baseline=3.62 servings/day; control=0.14+/-1.80, baseline=3.47). The intervention effect did not differ between fruit and vegetables (both +0.23 serving/day). 24-hour recall: the net effect was not significant (0.25 serving/day, 95% CI=-0.2; 0.7).	49% females, 85.9% White. The intervention was based on the social learning theory, stages-of-change construct from the trans-theoretical model, and diet individuation model. The fruit and vegetable measure included potatoes. Intervention effects were modestly larger among women. They were larger for those in the action or maintenance stages of dietary change at baseline, those who used at least two of the materials, and those who received behavioural feedback. Cost: approximately $57 for individuals completing all intervention activities.
A study on computer-assisted intervention to decrease consumption of fat and increase consumption of fruit and vegetables, United States Stevens et al. (*70, 71*)	Randomized controlled trial	616 women aged 40−70 years, members of a HMO in Oregon, recruited by mail, with a negative mammogram during the previous two months. There were 308 in the intervention group and 308 in the control group.	Two 45-minute counselling sessions (including a 20-minute interactive computer-based intervention) ~two to three weeks apart and two 5−10 minute follow-up telephone contacts. The aim was to reduce dietary fat and increase intake of fruit, vegetables and whole grains. Control: intervention focusing on breast self-examination. Follow-up: 12 months	Two methods: 1) 24-hour recalls (two at baseline and one at four-months), administered by telephone with instructions and dimensional charts of geometric shapes to estimate serving sizes; 2) Self-administered Block food frequency questionnaire (accompanied with pictures of ¼−1/2 cup serving sizes) at baseline and 12-month follow-up.	24-hour recall at four-months: Significant net effect (adjusted) for fruit and vegetable intake: +1.04 servings/day (P<0.001) (unadjusted changes: intervention=5.11 to 5.54, control=5.01 to 4.50 servings/day). Food frequency questionnaire at 12months: significant net effect (adjusted) for fruit and vegetable intake: +0.93 serving/day (P<0.001) (unadjusted changes: intervention=3.09 to 4.33, control=3.21 to 3.40 servings/day).	Intervention used strategies from the trans-theoretical model, principles of motivational interviewing, and social-cognitive theory. There was significantly less fat consumption in the intervention than control group at 12 months.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Recruitment through general practices						
A study on improving dietary behaviour through tailored care messages in primary care settings, United States Campbell et al . (*72*)	Randomized controlled trial	Participants were 558 adults aged 18+ years from four family practices (two urban and two rural) in North Carolina recruited at check-in for any type of medical appointment, randomized to three groups.	Tailored intervention: One-time mailed computer-developed nutrition information packet tailored to the participant's stage of change, dietary intake, and psychological information, mailed within three weeks of baseline assessment. The aim was to increase fruit and vegetable and decrease fat intake. Comparison intervention: one-time mailed nutrition information packet providing standard information based on the 1990 Dietary Guidelines for Americans, mailed within three weeks of baseline. Control: did not receive nutrition messages, follow-up: four months	Self-administered 28-item food frequency questionnaire (10 items for fruit and vegetables) to recall intake during the previous three months.	Fruit and vegetable intake decreased by 0.3 serving/day in each group (from 3.6 servings/day at baseline, SD~0.19). The net change was thus 0 serving/day when comparing the tailored intervention with the control group (*P*=0.817) and when comparing the comparison intervention with the control group (*P*=0.968). Analyses based on n=394.	43.4% females, 47.9% non-White. The intervention used a stage-of-change approach based on the trans-theoretical framework to match tailored information to the participant's specific needs. At baseline, fruit and vegetable intake was correlated with stage of change. Seasonal factors may have affected intake as baseline data collection was carried out in two different seasons.
Women's Health Trial Feasibility Study in Minority Populations, United States Coates et al. (*73*)	Randomized controlled trial	Participants were 2208 postmenopausal women, 50 to 79 yrs, enrolled at clinics in Atlanta, Birmingham and Miami, with fat intake >=36% dietary energy but no history of major chronic diseases and no lipid medication. Since randomization occurred between Sept 92 and Apr 94 and the trial ended in June-Aug 94, follow-up time was not the same for all women. Thus the FFQ was completed by 2207 women at baseline, 1780 women at 6-months, 1141 at 12-months and 479 at 18-months. This represented response rates of 100% at baseline and between 75% and 85% during follow-up.	The primary aim was to reduce total fat intake to <=20% energy, the secondary aims were to reduce intake of saturated fat and cholesterol and increase intake of fruit and vegetables and grain products. The Vanguard Women's Health Trial Programme was modified to include the secondary aims. Nutritionists assigned personal goals and met study participants in group sessions (weekly for five weeks, biweekly for five weeks, monthly for nine months, and then quarterly). Each session integrated nutritional and behavioural change strategies. Forms and materials were translated into Cuban Spanish. Staff members were of varied racial/ethnic backgrounds. Family members were invited to some sessions. Controls received only the Dietary Guidelines for Americans, follow-up: 18 months	Two methods: 1) Self-administered 100-item food frequency questionnaire, designed to be sensitive to changes in intake of fat-modified foods; 2) four-day food record with foods recorded on alternate days (half of the data were analysed).	Food frequency questionnaire at 18 months (n=285 intervention and n=194 control): there was a significant net effect for fruit = +0.53 serving/day (95% CI=0.33,0.73) (changes: intervention=+0.54, control=+0.02 serving/day). There was a significant net effect for vegetables = +0.27 serving/day (95% CI=0.07,0.47) (changes: intervention=+0.35, control=+0.08). Stratified analyses by ethnic group showed significant net effects for fruit in Blacks and Whites, and for vegetables in Whites. Food records: results generally paralleled those of the food frequency questionnaire but intervention effects were somewhat smaller.	56% White, 28% Black, 16% Hispanic. There were also significant net effects for changes in fat, saturated fat, cholesterol and energy intakes (greater reduction in the intervention group) at 18 months. There was little variation in the results by education level.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
A study on the use of a "talking computer" to improve adults' eating habits, United States Delichatsios et al. (*74*)	Randomized controlled trial	Participants were 298 adults aged 25+ years recruited from a multi-specialty group practice, with sedentary behaviour and suboptimal diet quality. 148 participants were randomized to intervention and 150 to the control group.	Six-months of weekly communication with an interactive computer-based voice system (Telephone-Linked Communications - TLC). The system monitored dietary habits and provided educational feedback, advice and behavioural counselling. Control: Same TLC technology but with a content focusing on increasing physical activity. Follow-up: six months	Two methods sent by mail: 1) Self-administered 131-item food frequency questionnaire to recall intake during the previous year (at baseline) or the past three months (at follow-up); 2) 18-item Prime Screen instrument targeting intake of fruit, vegetables, dairy products, whole grains and meats.	Food frequency questionnaire (n=61 intervention and n=53 control): Significant net effect (adjusted) for fruit = +1.1 servings/day (95% CI=0.4,1.7) (unadjusted changes: intervention= 2.8 to 3.2 and control=2.4 to 2.0 servings/day). Non-significant net effect (adjusted) for vegetables = +0.8 serving/day (95% CI=-0.3,1.8) (unadjusted changes: intervention=3.8 to 4.5 and control=3.5 to 3.6 servings/day). Prime Screen (n=148 intervention and n=150 control, intention-to-treat analysis): Significant net effect (adjusted) for fruit = +0.4 serving/day (95% CI=0.2,0.6) (unadjusted changes: intervention=1.1 to 1.5 and control=1.2 to 1.2 servings/day). Non-significant net effect (adjusted) for vegetables = +0.1 serving/day (95% CI=-0.1;0.3) (unadjusted changes: intervention=1.3 to 1.5 and control=1.2 to 1.4 servings/day).	42% females, 45% African Americans. Intervention used social cognitive theory as the guide to behaviour change. The intervention also improved diet quality, increased fibre intake, and decreased saturated fat and energy intake. There was a generally low usage of the TLC system but the level of use was not significantly related to change in fruit intake at six months.
EatSmart, United States Delichatsios et al. (*75*)	Randomized controlled trial (matched-pair design)	504 adults aged 18+ yrs were recruited via the appointment system at six group practices in the primary care research network in New England. Practices were paired by size of patient panels and randomly assigned within each pair to intervention and control groups. There were 230 participants in the intervention, 274 in the control group.	Recommendations and educational booklets were sent by mail, tailored to baseline dietary intake and stage-of-change, plus provider endorsement of the recommendations at the routine office visit, plus two motivational counselling sessions by trained telephone counsellors two weeks and two months after the provider visit. The aim was to increase fruit and vegetable intake, decrease red and processed meat intake, and replace whole-fat by low-fat dairy products. Control: no intervention, follow-up, three months	18-item Prime Screen instrument (see Delichatsios et al. above).	Significant net effect (adjusted) in fruit and vegetable intake: +0.6 (95% CI=0.3,0.8) (intention-to-treat analysis with n=195 intervention and n=252 control) (unadjusted changes: intervention=2.9 to 4.0 and control=3.3 to 3.7 servings/day).	77.4% females, 16.6% non-White. There was a non significant difference in stage progression for fruit and vegetables.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
A study on the effects of fruit and vegetable consumption on plasma antioxidant concentrations and blood pressure, United Kingdom John et al. (*76*)	Randomized controlled trial	Participants were 729 adults aged 25−64 years recruited from two general practices in Oxfordshire. 364 were randomized to the intervention and 365 to the control group.	The brief negotiation method was used to encourage participants to identify specific and practical ways (consistent with their habits and preferences) of eating more fruit and vegetables (5+ servings/day), performed by a research nurse. Two weeks later a phone call was made to reinforce the message and discuss problems. At three months a letter reinforcing the "5-a-day" message was sent together with a booklet of seasonal recipes and a strategy checklist. Control, no intervention until six months, then assigned to receive the intervention. Follow-up: six months	A self-administered dietary instrument for nutrition education was modified to assess fruit and vegetable intake and include stage of change questions.	There was a significant net effect (adjusted) in fruit and vegetable intake (n=329 intervention and n=326 control): +1.4 servings/day (95% CI=1.2,1.6, *P*<0.0001) (unadjusted changes: intervention=+1.4 with baseline= 3.4 servings/day, control=+0.1 with baseline=3.4 servings/day).	The intervention was associated with significantly larger increases in blood levels of alpha-carotene, beta-carotene, lutein, beta-cryptoxanthin, and vitamin C, and larger decreases in systolic and diastolic blood pressure.
A study on behavioural counselling to increase consumption of fruit and vegetables in low-income adults, United Kingdom Steptoe et al. *(77)*	Randomized controlled trial	Participants were 271 adults aged 18 to 70 years, registered at one primary health centre in a deprived inner city area, recruited by letter. 136 were in the behavioural counselling group and 135 in the nutrition counselling group. Overall, 177 were with a lower income (<$640).	The two groups received two 15-minute individualized consultations (one carried out after the baseline assessment and one two weeks later) with personalized specific advice and setting of short-term and long-term goals, plus written information. The aim was to increase the intake of fruit and vegetables. The nutrition counselling group received education about the importance of increased fruit and vegetable intake and a "5-a-day" message. Behavioural counselling group: the intervention was founded on social learning theory and the stage of change model. Follow-up: 12 months	Two methods: 1) Interviewer-administered two-item food frequency questionnaire; 2) Self-completed dietary instrument for nutrition education , a weighted food frequency questionnaire that accounts for most fat and fibre in the typical UK diet.	There was a significant net change (adjusted) for fruit and vegetable intake: +0.62 serving/day (95% CI=0.09,1.13) (intention-to-treat analyses with full sample). Adjusted changes in each group: nutrition counselling=+0.87 (95% CI=0.50,1.25, baseline=3.67 servings/day), behavioural counselling=+1.49 (95% CI=1.12,1.86, baseline=3.60 servings/day). There were similar findings in a lower income subsample (n=177): net adjusted change=0.89 (95% CI=0.25,1.24); nutrition counselling: +0.78 (95% CI=0.31,1.24), baseline=0.87 serving/day; behavioural counselling: +1.67 (95% CI=1.22,2.11), baseline=3.34 servings/day.	The proportion of participants consuming 5+ servings/day increased significantly more in the behavioural counselling group, based on the whole sample, but not in the low-income subsample. The increase in blood levels of beta-carotene was greater in the behavioural counselling group.

Table A6-6. Summary of studies with adults - LOW-INCOME POPULATIONS

Study and reference	Design	Participants	Intervention	Data collection methods: FV intake	Results	Comments
California Expanded Food and Nutrition Education Program, United States Del Tredici et al. (*82*)	Randomized controlled trial	Participants were 683 low-income adults (355 in the intervention group and 328 in the control group), responsible for planning and preparing meals for their family, and eligible to receive the Expanded Food and Nutrition Education Programme. Participants were selected from 15 counties in California.	Repeated visits of a nutrition assistant (mean number 7.8 of mean duration of 80.5 min) and one-to-one instruction on nutrition facts, selection and buying of foods, cooking skills, economical preparation, food safety, preserving. The methods used were mainly lecture/discussion and written materials, but also included demonstrations, audiovisuals, field trips. Control group: no instruction, follow-up: six months.	24-hour recall at baseline and six months	There was a significant increase in fruit and vegetable intake of 1.1 servings/day in the intervention group (baseline 2.6, SD 2.0, follow-up 3.7, SD 2.4 servings/day, $P<0.001$) but not in the control group (baseline 2.8, SD 2.3, follow-up 2.6, SD 2,0, servings/day, NS). Also there were significant increases in the intervention group for vitamin C-rich fruit and vegetable intake (1.4 to 2.2, $P<0.01$) and vitamin A-rich fruit and vegetable intake (0.3 to 0.6 $P<0.01$). No significant changes were observed in the control group (respectively: 1.4 to 1.4 servings/day of vitamin-C-rich fruit and vegetables, 0.4 to 0.3 servings/day of vitamin-A-rich fruit and vegetables)	The results also showed an increase in the number of different fruit and vegetables consumed in the intervention group (2.7 to 3.4 types, $P<0.01$) but not in the control group (2.6 to 2.5). The majority of the participants were female (percentage not stated).

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
High 5, Low Fat Program, United States Haire-Joshu et al. (*81*)	Randomized controlled trial	Participants were 910 high-needs African American parents (single parents, low-income, minority ethnicity, or living with stressors). Recruited from "Parents As Teachers" (PAT) programmes in 12 school districts (divided into six matched pairs) with randomization of districts within each matched pair.	Parent educators from PAT delivered a dietary change programme via five personal visit sessions, 10 bimonthly newsletters, and group meetings. The primary aims were to decrease fat intake and increase fruit and vegetable intake. The secondary aims were to improve nutrition-related skills and parental modelling of dietary behaviours. Control: PAT programme but without H5LF sessions, follow-up: from the third quarter to second quarter	Modified short-form block food frequency questionnaire for use with African American parents was administered by telephone interview pre-test and post-test. 731 participants completed both.	Baseline: intervention and control groups mean fruit and vegetable intake was 4.65 (SE 2.7) and 4.86 (SE 2.9) servings/ day respectively (no significant difference between groups). At follow-up there were significant differences between groups for changes in vegetable and fruit and vegetable intakes (P=0.03 and P=0.04 respectively). For fruit and vegetable intake, intake increased by 0.19 serving/day in the intervention group and decreased by 0.34 serving/day in the control group. Vegetable intake increased by 0.08 serving/day in the intervention group and decreased by 0.34 serving/day in the control group. There was no significant change in fruit intake.	98% were African American females

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Women, Infants, and Children 5 a day programme United States Havas et al. (*79*), Langenberg et al. (*80*)	Randomized controlled trial crossover design	3122 women (18+ years of age) enrolled in 16 women, infants, and children (WIC) sites across the state of Maryland. The participants were low-income, pregnant, postpartum and breastfeeding women and mothers of children enrolled at these sites (1443 intervention and 1679 control). In phase 1, eight sites were randomized to intervention and eight to control status. In phase 2, control sites became intervention sites and vice versa. Persons in phase 1 were ineligible for phase 2.	The intervention comprised three components over six months; 1) nutrition sessions conducted by peer educators (brief messages at enrolment and three group discussion sessions), 2) printed materials and reminders, 3) individually tailored direct mail all related to participant's set goals. Control sites experienced normal activities, which generally included less than 10 minutes' nutrition education at bimonthly visits. Follow-up: 8 months + 12 months later for those in phase 1	Mean daily consumption at baseline and end of intervention was assessed by a self administered seven-item food frequency questionnaire.	Baseline: the intervention group consumed significantly fewer mean servings of fruit and vegetable (3.9) compared with controls (4.2, *P*=0.04). Follow-up (eight months) the intervention group increased mean fruit and vegetable intake by 0.56 (SE 0.11) compared with an increase of 0.13 (SE 0.07) among controls, a significant difference (*P*=0.002). One year later (those in phase 1), mean fruit and vegetable intake had increased by an additional 0.27 (SE 0.09) servings among intervention, and 0.27 (SE 0.07) servings among control participants. The difference in mean change in fruit and vegetable intake from baseline between intervention and controls remained significant (*P*=0.004). The biggest change occurred in women who were consuming fewer than two servings/day at baseline. 75% of intervention and 76% of control participants completed the study.	The "intention to treat" paradigm was used for all analyses.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Women, Infants, and Children food for life programme, United States Havas et al. (*78*)	Randomized controlled trial, crossover design	2066 women (over 18 years of age) enrolled in 10 sites of the Special Supplemental Nutrition Program for Women, Infants, and Children in Maryland. In Phase 1, five sites were randomized to intervention and five to control group. In Phase 2, control sites became intervention sites and vice versa.	Phase 1: A five-minute video featuring enthusiastic participants from pilot study, attractive Food For Life brochure, individualized feedback on baseline food frequency questionnaire, kick-off fair, four 45-minute workshops, newsletters, mail packets, personalized invitations, behaviour-reinforcing incentives, phone calls. Phase 2: As for Phase 1 but with slightly modified messages, five day-long fairs, mailed recipes with one food item, individualized dietary counselling/interactive cooking demonstration/free bag of food added to the fairs. Control: no intervention, follow-up: 8 months + an additional 12 months in participants from Phase 1.	Self administered 90-item food frequency questionnaire in a format modified from the Block 1995 food frequency questionnaire	Baseline: no difference in mean fruit and vegetable intake between groups (both 3.5 servings/ day). Follow-up (eight months): there was a significant difference between groups for changes in fruit and vegetable intakes (net change=0.4 serving/day, *P*=0.0003). Intake increased by 0.16 (SE0.08) serving/day in the intervention group and decreased by 0.24 (SE 0.08) serving/day in the control group. The largest changes were in women in the pre-contemplation, contemplation and preparation stages of change at baseline. Twelve months later (those in phase 1), the net change in fruit and vegetable intake remained significant (intervention: +0.1 serving/day versus control: -0.32 serving/d, *P*=0.03). Only 53% of intervention and 60.2% of control participants completed the last follow-up survey.	The overall attendance at sessions was suboptimal but there was a greater increase in intake with attendance at more sessions (*P*-value for trend=0.002).

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
A study on predicting achievement of a low-fat diet, adults with low literacy skills, United States Winkleby et al .(*83*)	Randomized controlled comparison using a cluster design	Participants were 242 low-income adults who participated in vocational and basic skills training classes. Twenty-four classes were matched in pairs on type of class and one of each class pair was randomly assigned to receive either the Stanford Nutrition Action Program (SNAP) or an existing general nutrition (GN) control curriculum.	There were two curriculum interventions: General nutrition (GN) consisting of an existing general nutrition curriculum. Stanford Nutrition Action Program (SNAP) a nutrition program with the primary goal of reducing fat intake (also emphasising increase in FV and grains) and with material designed for low literacy adults and based on social learning theory. Both had six to seven 60-minute classes, each taught once a week by health educators. In addition to this SNAP provided six maintenance contacts by phone during the 12- week period following the intervention. Randomization occurred at classroom level but analysis occurred at individual level. Follow-up: 3 months post intervention (12 weeks after completion of the SNAP maintenance contacts).	Low-literacy survey questionnaires were developed and were administered in a group setting. Measurement of dietary intake was obtained using a self-administered 98-item National Cancer Institute food frequency questionnaire that had been validated.	Three "signal detection subgroups" were created based on the probability of meeting the goal of <30% energy from fat at follow-up: Group 1 - high baseline dietary fat; Group 2 - moderate baseline dietary fat plus GN curriculum; and Group 3 - moderate baseline dietary fat plus SNAP curriculum. Change in fruit and vegetable intake was different between three "signal detection subgroups". Group 3 showed significant increases in vegetables (15.6 to 18.1 servings/week) while Groups 1 and 2 showed no significant increases (respectively 22.3 to 18.1 servings/week and 16.6 to 14.6 servings/week).	Group 3 also had greater improvement in nutrition knowledge and self efficacy scores compared with G1 and G2.

Table A6-7. Summary of studies with adults - CHURCHES

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Black Churches United for Better Health Project , United States Campbell et al. (*84, 85*)	Randomized controlled trial (matched-pair design)	Participants were adult members more than 18 years old of 50 Black churches located in 10 rural counties of North Carolina. Counties were matched by demographic and geographic characteristics and randomized to intervention or control groups. 3737 individuals provided information at baseline, 459 at one year (a one-eighth subsample), and 2519 at the two-year follow-up. The 25 churches in the intervention group were further randomized into two groups for a subintervention.	Activities were conducted at the individual, social network, and community levels, targeting predisposing factors (computer-tailored bulletins and printed materials), enabling factors (gardening, educational sessions, cookbook and recipe tasting, serving more fruit and vegetables at church functions), and reinforcing factors (training of a Nutrition Action Team and lay health advisors, community coalitions, pastor support, grocer-vendor involvement, church-initiated activities). The intervention lasted approximately 20 months. The 25 intervention churches were randomized to two sub-interventions and received, during the first year of intervention, either: I1: an expert-oriented bulletin which used scientific language and messages from nutritionists; or I2: a spiritually oriented bulletin which used religious language and messages from the church pastor. Control: no programme activities until the completion follow-up survey, follow-up: two years	Two methods: 1) interviewer-administered 15-item food frequency questionnaire. Seven items were developed by the National Cancer Institute to measure fruit and vegetable intake in the "5-a-Day" studies. The other eight items represented eight fruit and vegetable items drawn from the Block food frequency questionnaire and previous research, designed to provide more information about specific kinds of fruit and vegetables that are commonly consumed in this population. 2) three-day food record on a subset of 146 individuals who provided information at one-year follow-up.	Baseline (n=3737): no difference in fruit and vegetable intakes among the three groups (results for I1 and I2 are merged) (overall: 3.84 (SE 0.10) versus 3.65 (SE 0.10) servings/day, *P*=0.21; fruit: 2.14 (SE 0.06) versus 2.04 (SE 0.06); vegetable: 1.69 (SE 0.04) versus 1.61 (SE 0.04)). Vegetable intakes were approximately 0.15 serving lower when fried potatoes were excluded. Follow-up (two years) (n=2519): the intervention group (results for I1 and I2 are merged as there was no difference among intervention groups) had a significantly higher fruit and vegetable intake at follow-up than the control group (adjusted analyses). Overall: +0.85 (SE 0.12) serving/day (4.45 (SE 0.08) versus 3.60 (SE 0.08), *P*=0.0001). Overall difference without fried potatoes +0.87. Fruit: +0.66 (SE 0.09) serving/day (2.64 (SE 0.06) versus 1.98 (SE 0.06), p=0.0001). Vegetables: +0.19 (SE 0.04) serving/day (1.82 (SE 0.03) versus 1.63 (SE 0.03), *P*=0.0003).	73% females. The intervention used concepts from the stages-of-change trans-theoretical model, social cognitive theory and social support models. It included potatoes. At baseline, approximately 23% of both groups were consuming 5+ servings/day. At follow-up, this proportion increased to 33% in the intervention group and decreased to 21% in the control group (*P*<0.0001). The difference in fruit and vegetable intake at follow-up was significant across gender, age (except among the 18−37 year group), marital status, education and income strata. The intervention was also associated with higher stage-of-change and with better knowledge of the recommendations. In the intervention group, more frequent church attendance during the study period was a strong predictor of increased fruit and vegetable intake at follow-up.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Eat for Life Programme United Sates Resnicow et al. (*86*)	Randomized controlled trial (matched pair)	African Americans aged 18+ years were recruited from 14 Baptist and Methodist churches. Churches were pair-matched based on size and socioeconomic status, and randomized to the treatment groups (four in Group 1, six in Group 2 (including two smaller churches), and four in Group 3). 1011 participants were recruited by a liaison in each church using a quota sampling framework (first come, first served) (mean number of participants per church=72). Of these, 861 provided information at one year.	Group 1 (G1): received standard nutrition education materials (National Institute of Health brochures addressing fruit and vegetable intake). Group 2 (G2): received a culturally sensitive multi-component self-help intervention (including a video, a cookbook containing recipes and information, printed education material, and a quarterly newsletter) with one telephone cue call (~two weeks after the health fair). Group 3 (G3): As for Group 2 , plus three telephone counselling calls based on motivational interviewing performed by trained dieticians (3, 6, and 10 months after baseline). Follow-up: one year	Three methods: 1) Self-administered seven-item food frequency questionnaire based on the Behavioural Risk Factor Surveillance System (BRFSS) that assessed fruit and vegetable intake (excludes potatoes). To reduce over-reporting, response categories of four and five times per day were removed; 2) Self-administered two-item food frequency questionnaire (FFQ) to assess usual fruit and vegetable intake; 3) A self-administered 36-item food frequency questionnaire was developed for this study based on the Health Habits and History Questionnaire (HHHQ) modified to ask about intake during the past week (rather than a longer timeframe), to use open-ended questions when asking about frequency of consumption, embedding portion size in the questions, separating some questions (excludes potatoes).	Baseline (n=861): No difference in fruit and vegetable intake among groups (mean of 3 FFQ: G1=3.64, G2=3.97, G3=3.78). Follow-up (n=861): Across the 3 FFQ, the change in fruit and vegetable intake was largest in G3. For total fruit and vegetable intake (mean of 3 FFQ) there were significant net effects:+1.12 servings/day (P<0.01) when comparing G1 and G3 and +0.98 serving/day (P<0.01) when comparing G2 and G3 (changes: G1=3.64 to 3.91 servings/day; G2=3.97 to 4.38 servings/day; G3=3.78 to 5.17 servings/day). For fruit intake (mean of 3 FFQ), there were significant net effects: +0.63 serving/day (P<0.01) when comparing G1 and G3 and +0.56 serving/day (P<0.01) when comparing G2 and G3 (changes: G1=1.79 to 1.95 servings/day; G2=1.94 to 2.17 servings/day; G3=1.85 to 2.64 servings/day). For vegetable intake (mean of 3 FFQ, there were significant net effects: +0.50 serving/day (P<0.01) when comparing G1 and G3 and +0.44 serving/day (P<0.01) when comparing G2 and G3 (changes: G1=1.88 to 1.98 servings/day; G2=2.04 to 2.20 servings/day; G3=1.93 to 2.53 servings/day).	73% females. No differences were seen by gender, age, education, and income. There was no difference among groups for the change in knowledge of portion size, self-efficacy, outcome expectations, or high fat practices.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Body and Soul, United States Resnicow et al. (*87*)	Randomized controlled trial (matched pair, effectiveness trial)	Adult members of 16 Black churches pair-matched based on size, socioeconomic status and urban city (eight intervention and eight control); one control church dropped out. 1022 individuals were recruited by liaisons in each church using a quota sampling framework (first come, first served) and provided information at baseline. Of these, 854 (526 in the intervention and 328 in the control group) were assessed at six months.	The intervention was developed from the Black Churches United for Better Health Project and the Eat for Life Programme. It involved church-wide activities (a kick-off event, forming a project coordination committee, conducting church-wide nutrition events, plus one additional event involving the pastor, making at least one policy change), self-help materials (*Eat for Life* cookbook, American Cancer Society educational pamphlets, public screening of a video developed for the "Eat for Life" Programme), motivational interviewing delivered by lay church members trained by project staff). Control: no programme activities, follow-up: 6 months	Two methods: 1) Self-administered 19-item food frequency questionnaire (FFQ) developed by the National Cancer Institute to assess intake in the past month. However, the two items assessing fried potatoes were excluded leaving 17 items (four items for fruits and 13 for vegetables); 2) Self-administered two-item food frequency questionnaire used to assess usual fruit and vegetable intake.	Baseline (n=854): There was no significant difference in fruit and vegetable intakes between the intervention and control groups. Two-item FFQ: 4.0 (SD 1.94) servings/day versus 3.8 (SD 1.94). 17-item FFQ: 5.5 (SD 4.83) servings/day versus 4.7 (SD 4.38). Follow-up (n=854): two-item FFQ: There were significant differences (P<0.05) at follow-up (adjusted) for fruit and vegetables = +0.7 serving/day (post-test values: intervention=4.8 (SE 0.12) and control=4.1 serving/day SE 0.12)), for fruit = +0.4 serving/day (post-test values: intervention=2.4 (SE 0.08) and control=2.0 (SE 0.09)), and for vegetables = +0.2 serving/day (post-test values: intervention=2.4 (SE 0.07) and control=2.2 (SE 0.07)). 17-item FFQ: there was a significant difference (P<0.05) at follow-up (adjusted) for fruit and vegetables = +1.4 servings/day (post-test values: intervention=6.6 (SE 0.39) and control=5.2 servings/day (SE 0.45)). There were non-significant differences at follow-up (adjusted) for fruit = +0.9 serving/day (post-test values: intervention=3.3 (SE 0.26) and control=2.4 (SE 0.30)), and for vegetables = +0.5 serving/day (post-test values: intervention=3.2 (SE 0.17) and control=2.7 (SE 0.19)).	73% females. There were significantly greater changes (in the desirable direction) in the intervention group for the proportion of energy from fat, intrinsic and extrinsic motivation to eat fruit and vegetables, self-efficacy to eat fruit and vegetables, and social support to eat more fruit and vegetables.

Table A6-8. Summary of studies with adults - SUPERMARKETS

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
A study on computerized social cognitive intervention for nutrition behaviour, United States Anderson et al. (*89*)	Randomized controlled trial	There were 296 participants (148 intervention, 148 control) recruited in five supermarkets. Recruitment was by brief face-to-face contact and mail back of enrolment materials including four weeks of annotated food receipts.	The Nutrition for Lifetime System (NLS) is a self-administered computer-based intervention based on social cognitive theory. NLS computers were located in kiosks in the five supermarkets. Intervention participants had passwords to access the system. The NLS programme guided users to decrease fat consumption and to increase fruit and vegetable and fibre in food purchases and consumption. The NLS consisted of 15 brief weekly segments (requiring 5−10 minutes) which used pictures, audio tracks and graphics to suggest strategies to monitor and plan food purchases and meal preparation and provided opportunities for personalized goal-setting and feedback for each targeted food group or behaviour-change strategy. There were monetary incentives for completing study questionnaires, as well as weekly food coupon printed from the computer ($8−12 a week redeemable within a week of printing). Control participants did not have access to the NLS computer. Follow-up four to six months after the end of the intervention.	163 participants completed the follow-up. There were two methods; self-administered food frequency questionnaires were collected at baseline, 4 weeks, 15 weeks and post-test; food shopping receipt data were collected at baseline and the last six weeks of each study phase. There was also a composite measure of the two.	Baseline: There were no significant differences between the groups. At follow-up intervention users had higher levels of fruit and vegetable intake in the food frequency questionnaire ($p<0.05$) but not with the composite measure ($0.05<p<0.10$) or shopping receipts ($p>0.10$). In controls the fruit and vegetable intake remained virtually unchanged. Using the food frequency questionnaire, the intervention group increased fruit and vegetable intake by 0.55 servings/1000 kcal (baseline 2.79 (SD 1.14), follow-up 3.34 (SD 1.46). The control group increased fruit and vegetable intake by 0.03 servings (baseline 2.77 (SD 1.40), follow-up 2.80 (SD 1.40).	96% female, 92% white. Neither intervention nor control group attained fruit and vegetable goals at follow-up.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
An evaluation of a supermarket intervention to increase consumption of fruit and vegetables, Iowa, United States Kristal et al. (*90*)	Randomized controlled trial (randomization at the level of supermarket)	There were eight supermarkets of the same chain in similar sized small towns in Iowa with only modest ongoing health promotion activity, separated by at least 35 miles. At each store 120 shoppers (aged 18+ years) completed interview surveys.	The supermarkets received an eight-month (approximately) intervention consisting of informational flyers including recipes and coupons for money off fruit and vegetables, and linked supermarket signage. The flyers were distributed weekly but became bi-weekly halfway through. There were also awareness- raising activities including people dressing up as large vegetables and food demonstrations. Control supermarkets carried on business as usual. Follow-up 12 months	There was a repeated cross-sectional survey at baseline and one year post-randomization. At each shop, a random sample of 120 shoppers completed exit interviews and a take-home survey including a modified food frequency questionnaire. Interview periods were balanced over time of day and day of week.	The crude increases in fruit and vegetable intake (after adjustment) were 0.33 servings per day in intervention respondents (baseline 3.21 (SD 1.75), follow-up 3.54 (SD 1.79)), and 0.30 servings per day in control respondents (baseline 3.14 (SD 1.74), follow-up 3.44 (SD 1.83)). After adjusting for age, gender, income and education, the changes were +0.21 servings/d in the intervention group ($p<0.09$) and +0.27 servings/d in the control group ($p<0.03$). The intervention effect was not statistically significant.	Neither the purchase of fruit and vegetables, usual consumption of fruit and vegetables, nor fruit and vegetable related dietary habits changed as a result of the supermarket-based intervention. Only 43% of people recalled having seen the intervention fliers in the previous six months.

Table A6-9. Summary of studies with adults – with HEALTH CONDITIONS

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Cardiovascular disease						
Lyon Diet Heart Study, France de Lorgeril et al. (*91*)	Randomized controlled trial	Participants were 605 adults <70 years of age recruited in six services within Lyon Cardiovascular Hospital, who survived a myocardial infarction within six months of enrolment (without heart failure, hypertension, inability to complete an exercise test due to recurrent angina, ventricular arrhythmias, atrioventricular block, clinically unstable after coronary angioplasty or bypass, or other condition thought to limit survival or ability to participate in a long-term trial). There were 302 in the intervention and 303 in the control group.	A one-hour long advice session with the research cardiologist and dietician to promote a Mediterranean-type diet (more bread, more root vegetables and green vegetables. more fish, less meat (beef, lamb, pork to be replaced with poultry), no day without fruit; butter and cream to be replaced with rapeseed-based margarine supplied by the study, only rapeseed and olive oils as the selected oils for salads and food preparation, moderate alcohol consumption in the form of wine allowed at meals). Control: participants were expected to follow the dietary advice given by their attending physicians (not involved in the study) and stay close to the Step 1 Diet of the American Heart Association (30% energy from fat, 10% saturated, 10% monounsaturated, 10% polyunsaturated, <300 mg/d cholesterol). Follow-up: one to four years	Two methods: 1) One 24-hour recall; 2) food frequency questionnaire. For the first four years, diet was assessed only in the intervention group (so as not to influence the behaviour of controls). However, the diet of 192 consecutive controls was evaluated once. At baseline it was assumed that the diet of the intervention group was similar to that of the control group.	Baseline: It was assumed that the diet of the intervention group was similar to that of the control group. Follow-up: After one to four years' follow-up, the intervention group had a higher fruit intake (251 (SE 12) g/d) than the control group (203 (SE 12)) (difference of +48 g/d or ~0.6 serving, *P*=0.007), but not significantly different intakes of vegetables (316 (SE 10) versus 288 (SE 12), *P*=0.07).	91% males. Intervention associated with a lower risk of non-fatal myocardial infarction (*P*=0.001), cardiovascular death (*P*=0.02) and death (all causes, *P*=0.02).

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Cardiovascular disease						
A study on cardio-protective diet in patients with recent acute myocardial infarction, India Singh et al. *(92)*	Randomized controlled trial	Participants were 406 adults with a mean age of 50.5 years (SD 9.3) and with a clinical diagnosis of possible or definite acute myocardial infarction and unstable angina during the previous 24−48 hours. There were 204 in the intervention group and 202 in the control group.	Both groups: personal advice was given to replace meat, eggs, hydrogenated oils, butter and clarified butter with vegetarian meat substitutes and to consume soya bean, sunflower and ground nut oils so as to provide a prudent diet reflecting the recommendations of the American Heart Association. In both groups, participants had a mainly vegetarian diet, eating eggs four to five times a week and meat one or two times a week. Other health-related advice (stopping smoking, reducing alcohol intake, counselling to relieve mental stress and on physical activity) was given to both groups, but the advice was regularly reinforced only in the intervention group. Control: As above. Intervention: As above, plus additional advice to eat fruit and vegetables, pulses, nuts and fish. Follow-up: one year (for diet, but follow-up of three years for health outcomes).	Detailed history of pre-study food intake from spouse. Dietary diary with the help of a dietician on days 3, 6 and 10 after infarction and then every week for six weeks, and finally every 1 to 12 weeks.	Baseline (n=406): Fruit and vegetable intakes were similar in the intervention (172 (SD 23.5) g/d) and control (165 (SD 18.8) g/d) groups. 1-year follow-up (n=406 based on intention-to-treat analyses): fruit and vegetable intakes were significantly higher in the intervention group (575 g/d (SE 91.4)) than in the control group (185 g/d (SE 25.4)) (P<0.001 for a difference of 390 g/d (4.9 servings/day at follow-up).	85.5% males. Lower intakes of saturated fat and cholesterol and higher intake of fibre in the intervention group at one-year follow-up. The intervention was associated with lower blood lipoprotein concentrations, lower body weight, cardiac events, and total mortality, compared with the control group.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Indo-Mediterranean Diet Heart Study, India Singh et al. (*93*)	Randomized controlled trial	Participants were 1000 adults aged >25 years with angina pectoris, myocardial infarction, or surrogate risk factors for coronary heart disease (hypertension, hypercholesterolaemia, diabetes), recruited through advertisements in newspapers and local service clubs. There were 499 in the intervention group and 501 in the control group.	Control: Instructed to follow the National Cholesterol Education Program (NCEP) in the Step 1 prudent diet (<30% energy from total fat, <10% from saturated fat, <300 mg cholesterol/day). Given an instruction sheet by a dietician at each visit (weeks 4, 8,12, 24 and then at 12 week intervals). Intervention: As for the control group but also advised to consume 400−500+ g/d of fruits, vegetables and nuts per day (that is, 250−300g fruit, 125−150g vegetables, 25−50g walnuts or almonds). They were encouraged to eat 400−500g/d of whole grains (legumes, rice, maize and wheat), as well as mustard seed or soy bean oil in three to four servings/day (consistent with recommendations from the Indian Consensus Group). They were given a thorough explanation of the usefulness of the experimental diet and the types of food that are rich in n-3 fatty-acids. Follow-up: two years. At each visit, patients in both groups were provided with additional motivation by a dietician to adhere to the advice about diet. They were also provided with physical activity advice.	One-week weighed food diary.	Baseline (n=1000): Intake of fruit and vegetables, nuts and legumes were similar in the intervention (215 g/d (SD 29)) and control (207 g/d (SD 23)) groups. Follow-up (n=1000 based on intention to treat analyses): intakes of fruit and vegetables, nuts and legumes increased to 573 g/d (SD 127) in the intervention group and to 231 g/d (SD 19) in the control group, for a net effect of +334 g/d (~4.2 servings/day, *P*<0.0001).	89.7% males. Intakes presented include legumes and nuts. Total cardiac end points were significantly fewer in the intervention group (*P*<0.001 versus control). Sudden cardiac deaths were also reduced (*P*-0.015) as were non-fatal myocardial infarctions (*P*<0.001).

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Cardiovascular disease						
Diet and Angina Randomized controlled Trial (DART2), United Kingdom Ness et al. (*94*), Burr et al. (*95*)	Randomized controlled trial (factorial design)	Participants were 3114 men aged 37to 70 years with treated angina, recruited from general practices in South Wales (between 1990 and 1992 and between 1992 and 1996), not awaiting coronary artery by-pass surgery, not currently eating oily fish twice a week, and who could tolerate oily fish or fish oil. Of these, a sample of 1191 were sent (from April to December 2000) a brief self-administered questionnaire including a food frequency questionnaire; of these 1036 were still alive and completed questionnaires were obtained from 944 men.	There were four groups. Group 1: personal advice was given to eat two portions of oily fish each week or to take up to 3g of fish oil ("Maxepa") as a partial or total substitute. Group 2: personal advice was given to increase intake of soluble fibre by eating four to five servings of fruit and vegetables (apart from potatoes) and to drink at least one glass of natural orange juice daily and also to increase the intake of oats, so as to obtain a higher intake of vitamin C and at least 8 g of soluble fibre from all sources every day. Group 3: a combination of advice from groups 1 and 2. Group 4: given non-specific advice ("sensible eating") that did not include either of the above interventions.	The food frequency questionnaire was derived (with only minor modifications) from a questionnaire that had previously been validated against seven-day weighed dietary records.	Follow-up (n=944 surviving men): at follow-up, men that had been advised to eat more fruit and vegetables (groups 2 and 3) had significantly higher fruit and vegetable intakes than those who had not received such advice (groups 1 and 4) (373.2 g/d (SD 161.5) versus 351.7 g/d (SD 351.7), for a difference at follow-up of 21.5 g/d or 0.27 serving/day, *P*=0.05). The difference was significant for vegetables (140.2 (SD 62.1) versus 131.2 (SD 59.6), *P*=0.03) but not for fruit (233.1 (SD 146.2) versus 220.5 (SD 135.3) g/d, *P*=0.17).	Results from the DART Trial showed that all-cause mortality was not reduced by either form of advice (fish advice or soluble fibre advice). Risk of cardiac death was higher among men advised to take oily fish than among other men.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
PREMIER Clinical Trial, United States Appel et al. (*96*)	Randomized controlled trial	Participants were 810 adults aged 25+ years with a body mass index between 18.5 kg/m^2 and 45 kg/m^2, with above-optimal blood pressure, including stage 1 hypertension, who were not taking anti-hypertensive medications, drugs that affect blood pressure or weight-loss medications, who were without prior cardiovascular event, congestive heart failure, angina, cancer diagnosis or treatment during the past two years, or diabetes, whose alcohol consumption was more than 21 drinks/week, recruited using mass mailings and community-based screening, and mass-media announcements. There were 273 in Group 1, 268 in Group 2, and 269 in Group 3.	Group 1: Advice-only comparison group: an interventionist (typically a registered dietician) discussed non-pharmacological factors that affect blood pressure and provided printed educational materials (a 30-minute individual session without counselling on behaviour change). Group 2: Established intervention: a behavioural intervention that implemented traditional lifestyle recommendations (weight loss among those overweight, reduced sodium intake, increased physical activity, limited alcohol intake among those who drank alcohol, fat intake <30% energy, saturated fat <=10%). Included 18 face-to-face intervention contacts (14 group meetings and four individual counselling sessions) during the initial six months. Group 3: stablished intervention + DASH: Same traditional recommendations as Group 2 + DASH diet (higher intake of fruit and vegetables (9−12 servings/day), low-fat dairy products (2−3 servings/day), lower saturated fat intake (<=7% energy), lower fat intake (<=25% energy). Same contact pattern as Group 2. Follow-up: six months	Unannounced 24-hour dietary recalls conducted by telephone interview (one on a weekday and the other on a weekend day).	Baseline (n=641): Fruit and vegetables intakes were similar among groups (Group 1: 4.4 (SD 2.3) servings/day, Group 2: 4.6 (SD 2.4) servings/day, Group 3: 4.8 (SD 2.5) servings/day). Follow-up (n=641, based on intention-to-treat analyses): change in fruit and vegetable intake was significantly higher in Group 3 (+3.0 (SD 3.6) servings/day) compared with Group 1 (0.5 (SD 2.8) serving/day) (net effect of +2.5 servings/day, *P*<0.001) and compared with Group 2 (0.5 (SD 2.6) servings/day (net effect of +2.5 servings/day, *P*<0.001).	38% males, 34% African-Americans. Changes in urinary potassium levels paralleled those observed for fruit and vegetable intake. The mean net reduction in systolic blood pressure was 3.7 mm Hg in Group 2 (*P*<0.001) and 4.3 mm Hg in Group 3 (no significant difference between Groups 2 and 3). Compared with the baseline prevalence of hypertension of 38%, the prevalence at follow-up was 26% in Group 1, 17% in Group 2 (*P*=0.01 compared with Group 1), and 12% in Group 3 (*P*<0.001 compared with Group 1, *P*=0.12 compared with Group 2).

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Cardiovascular disease						
A study on dietary advice for patients with a single high blood pressure reading in primary care, United Kingdom Little et al. (*97*)	Randomized controlled trial (factorial design)	Participants were 296 adults aged 18+ years with blood pressure >160/90 mm Hg (but systolic <=200 and diastolic <=120 mm Hg) but not taking hypertensive drugs, recruited from six general practices in the Southampton area.	Interventions consisted of: the British Hypertension Society's booklet "Understanding High Blood Pressure" which includes information about blood pressure and its treatment (explained by a nurse), low-sodium salt to be used in cooking and on food instead of normal salt, the fatty food swap sheet lists (to help people swap high-fat foods to similar but lower fat foods), fruit-vegetable-fibre daily prompt sheets (to help remind patients to eat fruit and vegetable and fibre). There were eight groups: Group 1: booklet + salt + prompt. Group 2: booklet + salt. Group 3: booklet + prompt. Group 4: prompt + salt. Group 5: booklets. Group 6: salt. Group 7: prompt. Group 8: no intervention. Follow-up: six months	Self-administered food frequency questionnaire	Baseline (n=296): fruit and vegetable intake was similar among groups. It was 392 g/d (SD 226) in participants who received "prompts" and 403 g/d (SD 247) in the other participants. Follow-up: after one month, participants who received "prompts" had a significant increase in fruit and vegetable intake (+106 g/d (95% CI 51,161), *P*<0.001). However, at six months, this change was no longer significant (+48 g/d (95% CI -8,104), *P*=0.09).	56% males. "Prompts" were significantly associated with weight loss but not with changes in blood pressure.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Cardiovascular disease						
Indian Diet Heart Study, India Singh et al. (*98*)	Randomized controlled trial	Participants were 621 adults with a mean age of 46.3 years (SD 8.6) recruited by advertisements by local clubs, newspapers, hospitals and clinics using pamphlets and loudspeaker announcements stating that all subjects with hypertension, diabetes mellitus, hypercholesterolemia, obesity and heart attack, or symptoms simulating these problems would be given free advice by experts. Respondents were shopkeepers, office workers, business men, teachers, doctors, and engineers, all with sedentary occupations from the middle socioeconomic group. There were 310 in the intervention group and 311 in the control group.	The control group were instructed to follow the American Heart Association Step 1 Diet for four weeks (stabilization period), to then follow the same diet for 12 weeks, and finally to follow it for another eight weeks during which the participants were given a sheet containing advice on diet and exercise. Intervention: the group were instructed to follow the American Heart Association Step 1 Diet and to eat at least 400g/d of fruit and vegetables for four weeks (stabilization period), to then follow the same diet for 12 weeks, and finally to follow it for another eight weeks during which participants were given repeated advice to have a supervised exercise programme including brisk walking and/or intermittent jogging. In both diets, meat, eggs, hydrogenated solid oils, cheese, butter and clarified butter were replaced with soy beans, cottage cheese and oils of soybean, sunflower and ground nuts. The intervention also included fruits such as guava, apple, tomato, green vegetables, legumes, cereals, and nuts. Follow-up: 24 weeks	Food diary	Baseline (n=621): Fruit and vegetable intakes were similar in the intervention (256.4 g/d (SD 45.8)) and control (261.4 g/d (SD 47.8)) groups. Follow-up (n=621 based on intention-to-treat analyses): fruit and vegetable intakes increased significantly in the intervention group between baseline and the measurements made at 16 weeks (592.0 g/d (SD 112.0), *P*=0.01) and 24 weeks (580.0 g/d (SD 186), *P*=0.01). No significant change was observed in the control group between baseline and the measurements made at 16 weeks (278.5 g/d (SD 65.5)) and 24 weeks (268.5 g/d (SD 56.5)). At the 24-week follow-up, intakes were significantly higher in the intervention than in the control group (*P*=0.01, for a difference at follow-up of +311.5 g/d or 3.9 servings/day).	89.9% males. At follow-up, there were higher intakes of fibre, lower intakes of saturated fat and cholesterol, and more exercise in the intervention group. Improvement in blood cholesterol was significantly greater in the intervention group.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Cardiovascular disease						
The Netherlands Mediterranean alpha-linolenic enriched Groningen dietary intervention (MARGARIN) study Bemelmans et al. (*99*)	Controlled trial with randomization to two strata within each of the intervention and control groups	Participants were 266 adults aged 30 to 70 years with hypercholesterolaemia and at least two other cardiovascular risk factors (high blood pressure or use of anti-hypertensive medication, excess weight, smoking, diagnosis of coronary heart disease or first-degree relative with a coronary heart disease history before age 60), recruited by an invitation to all inhabitants aged 30+ in two counties, by registration systems of one general practice and three pharmacies in the two counties, and by invitation through a local radio programme. Participants in the intervention group were recruited from one county and those in the control group from the other county.	The control group was subdivided into two strata: A) usual care in the form of a leaflet with the Dutch guidelines for a healthy diet + supply of linoleic acid-rich margarine. B1) usual care (as A) plus supply of alpha-linolenic acid-enriched margarine. The intervention group was subdivided into two strata: B2) nutritional education about the Mediterranean diet in groups of 10 people (three meetings of two hours each, with their partner), (five to seven slices of bread, 400g vegetables, two pieces of fruit, fish at dinner twice a week, less red meat, less fat, cheese, and fewer eggs, limited alcohol to one to two drinks/day + supply of linoleic acid-rich margarine; B3) nutritional education (as B2) + supply of alpha-linolenic acid-enriched margarine. Follow-up: 12 months	Self administered 165-item food frequency questionnaire	Baseline (n=262): there was no significant difference in fruit and vegetable intake. Follow-up (n=225): The change in fruit intake was greater in the intervention group (+39 g/d (SD 213)) than in the control group (-18 g/d (SD 159)) (for an estimated net effect of +57 g/d (~0.71 serving/day), $P<0.05$). There were no significant differences in change of intake of vegetables between the groups.	44% males. Some respondents were from the same household (thus randomized to the same subgroup).

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Cancer						
Polyp Prevention Trial, United States Schatzkin et al. (*100*), Lanza et al. (*101*)	Randomized controlled trial	Participants were 2079 adults aged 35 to 89 years with at least one histologically confirmed large-bowel adenomatous polyp removed during a colonoscopy within the previous six months, recruited from eight United States clinical centres. There were 1037 in the intervention and 1042 in the control group.	The aim was to increase fruit and vegetable (3.5 servings/1000kcal, equivalent to 5−8 daily servings) and fibre (18 g/1000kcal) intakes and to reduce fat intake (20% energy). Each participant received personal dietary goals at the beginning and then engaged in an intensive nutrition education and counselling programme over four years (offered a total of 50 hours of counselling sessions). The programme consisted of four elements: 1) nutrition skill-building; 2) behaviour modification; 3) self-monitoring; 4) provision of standardized nutrition and behaviour modification materials. In addition, three special campaigns were launched during years 2−4. Control: Usual diet with provision of general dietary guidelines but no additional nutritional or behavioural information. Follow-up: four years	Three methods: 1) Self-administered food frequency questionnaire (modified Block-National Cancer Institute food frequency questionnaire at baseline and at the end of years 1, 2, 3, 4); 2) four-day food record at baseline and at the end of years 1, 2, 3, 4; 3) Unannounced 24-hour recalls in a newly selected random 10% sample of participants throughout each trial year.	Baseline (n=1905 who completed the study): there was no significant difference in fruit and vegetable intake between the intervention and control groups using food frequency questionnaire data: 2.05 (SE 0.03) servings/1000 kcal versus 2.00 (SE 0.03) servings/1000 kcal. Follow-up (n=1830): there was a significant net effect (using food frequency questionnaire data) +1.13 servings/1000 kcal for fruit and vegetable intake. Changes in each group: intervention 2.05 (SE 0.03) to 3.41 (SE 0.04) servings/1000 kcal, control 2.00 (SE 0.03) to 2.23 (SE 0.03) servings/1000 kcal. Results from the four-day food records from a random sample of 20% of subjects showed a net effect of 1.8 servings/1000 kcal.	35% females. There were also significant net effects (favourable changes in the intervention group) for fat and fibre intake. Dietary changes generally occurred within the first year and were subsequently maintained. There was a significant increase in total serum carotenoids in the intervention group compared with the control group. The rate of recurrence of large or advanced adenomas did not differ significantly between the groups.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
Cancer						
Women's Healthy Eating and Living (WHEL) Study, United States Pierce et al. (*102*)	Randomized controlled trial	Participants were 2970 women, aged 18 to 70 years when diagnosed with early-stage breast cancer within the four-year preceding enrolment, enrolled in the WHEL Study, who provided complete dietary data at baseline, and who had not had a study end point (e.g., breast cancer event) by the 12-month follow-up.	The aim: consumption of five vegetable servings/day, 480 mL/d of vegetable juice, three fruit servings/day, 30 g/d fibre and <20% energy from fat. The intervention consisted of telephone dietary counselling and monthly cooking classes and newsletters. Control: print materials that included dietary guidelines from the United States Department of Agriculture and the National Cancer Institute, including the "5-a-Day" programme, plus an invitation to four cooking classes (food themes other than vegetables, fibre and fat), plus a bimonthly cohort maintenance newsletter. Follow-up: 12 months	Four 24-hour recalls	Baseline (n=2970): There was no significant difference in fruit and vegetable intake between groups. Mean intake: 3.9 servings/day of vegetables and 3.3 servings/day of fruit. Follow-up (n=2970): vegetables: there was a significant increase in vegetable intake in the intervention group (+3.2 servings/day, 95%CI 3.0,3.4) but not in the control group (+0.0, 95% CI -0.1,0.1) (difference between groups *P*<0.05, net effect of +3.2 servings/day). The observed increase in vegetable consumption in the intervention group was facilitated in part by a marked increase in vegetable juice consumption (mean 232 mL/d at 12-months). Fruit: there was a significant increase in fruit intake in the intervention group (+0.6 serving/day, 95% CI 0.5, 0.7) but not in the control group (+0.0 serving/day, 95% CI -0.1, 0.1) (difference between groups *P*<0.05, net effect +0.6 serving/day).	Potatoes were included. There was a significant increase in fibre intake and decrease in fat intake in the intervention group but no change in the control group. There was also a significant increase in plasma carotenoid concentrations (alpha-carotene, beta-carotene, lutein, lycopene) in the intervention group but no change in the control group.

Annex 7. Examples of programme evaluations, in developed countries, not meeting study criteria

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
7 a day, Australia. Reeve, Outcomes of the Coles 7-a-day Program in 2000 (1 page communique). Dieticians Association of Australia 19th National Conference, 2000, Canberra.	Pre-test and post- test cross-sectional survey	Participants were a nationally representative sample of 2602 subjects over 14 years of age.	National fruit and vegetable promotion programme through an intersectoral partnership between the Dieticians Association of Australia and Coles Supermarkets. Involved supermarket fliers, recipes, point-of-purchase information, and children's activities.	Telephone interview survey with one 24-hour recall, pre-launch and after one year.	Overall there was a reported mean increase of 0.3 servings a day (P<0.05). The increase was greatest in older age groups.	No control group
Grab 5 ! United Kingdom Edmund LD. Summary of the Grab 5! Evaluation Report. London: Sustain: The alliance for better food and farming, 2002.	Pre-test and post -test cross-sectional survey	Children aged 7 to 11 years in 26 schools in England	A local coordinator was provided to support the schools. All participating school staff attended a one-day workshop. All schools adopted a "whole school" approach but identified their own scheme of work, including growing schemes, tasting, fruit tuck shops, curriculum development. All received supporting materials.	624 children at baseline and 753 children at one year completed the "Day in the Life" questionnaire.	There was a significant increase from 1.7 items to 2.2 items of fruit and vegetable intake per day (with reduction in high-fat snacks). Four schools showed significant changes, three some changes and only two showed no change.	No control group
"5 a day" community project, Somerset, United Kingdom Chant S, Grant T, Andrews F. *Five-a-day keeps the doctor away.* Report of a five-a-day pilot project in Somerset. Executive summary. Aug 2000−Aug 2001, Department of Health, 2002.	Non-randomized, non-controlled programme evaluation	Participants were 3500 adults aged 16 to 74 years in Somerset Health Authority GROUP registered population	"5 a day" community project in Somerset (population 500 000). Activities included work with community groups, pre-school children, parents, schools, working adults and older people. A community grant scheme supported community-based initiatives (£500 grants awarded to 51 projects). Training for health visitors, and population-based media and campaigns.	Population-based survey using self-completion postal questionnaire at baseline and after one year.	There was an increase in fruit and vegetable consumption in all ages, sex groups. There was an increase in those eating at least five portions a day from 62% to 69%.	No control group. The top five influences on consumption were reported to be health, taste, price, local availability and accessibility of shops.

Study and reference	Design	Participants	Intervention	Data collection methods: fruit and vegetable intake	Results	Comments
"5 a day" project, County Durham and Darlington, United Kingdom Coady J, O'Hara E. *Five -a day community project, County Durham and Darlington.* Report of a five-a-day pilot project. Sept 2000-Aug 2001, Department of Health, 2002.	Non-randomized, non-controlled programme evaluation	Face-to-face interviews with 505 adults pre-intervention and 701 adults post-intervention	"5 a day" community project in County Durham and Darlington (population 200 000). Four work phases of three months in different settings; food shops and farmers' markets, schools, workplaces and leisure services, primary care and social services. Community development projects in disadvantaged areas and media activities took place through the whole year.	Face-to-face street interview survey on frequency of consumption pre- and post- intervention.	Overall, the proportion of people eating five portions per day fell from 28% to 25%.	No control group. The survey design was poor and the use of street interviews created limitations on the gathering accurate data on consumption.
"2 Fruit 'n 5 Veg Every Day", Australia Dixon H et al. Public reaction to Victoria's "2 Fruit 'n 5 Veg Every Day" campaign and reported consumption of fruit and vegetables. *Preventive Medicine,* 1998, 27(4):572−582	Repeated telephone survey of random sample	Four random samples of over 500 adults over 20 years in Victoria, Australia	The population-wide "2 Fruit 'n 5 vegetable every day" campaign in the State of Victoria aimed at increasing awareness of the need to eat fruit and vegetables and their consumption. It was a broad-based multi-level state-wide nutrition promotion initiative of both communication and social marketing activities conducted between 1992 and 1995. It included television, radio and print advertising, point-of-sale promotions and sponsorship of sports and arts events.	Evaluation by four annual post campaign telephone surveys two to three weeks after the intervention using identical sampling frames and common questions on frequency of consumption.	Between phases 1 and 2 there was a significant increase in the mean consumption of both fruit and vegetables (from 1.53 to 1.71 servings/day of fruit and from 2.65 to 3.10 servings/day of vegetables), followed by no significant changes between stages 2 to 4.	No control group. Reported consumption and beliefs about how much should be consumed were strongly associated for both fruit (r=0.54) and vegetables (r=0.58).

Annex 8. Planned or ongoing studies

Anderson AS. Family-based intervention aimed at changing diet and physical activity in people at moderate to high risk of colorectal cancer (United Kingdom) (personal communication).

Anderson AS et al. The impact of a school-based nutrition education intervention on dietary intake and cognitive and attitudinal variables relating to fruits and vegetables (personal communication).

Dastgiri S et al. Effectiveness of the promotion of consumption of fruit and vegetable in schools in Iran (personal communication).

Dudley P. "Free Fruit in Schools" project (children - New Zealand) (Personal communication).

Kandiah M. Increasing fruit and vegetable intake: a six-month randomized controlled diet counseling in a Malaysian worksite community (control group educational materials only) (personal communication).

Kelishadi R Isfahan Healthy Heart project. Controlled study looking at risk factors for cardiovascular disease in Iran (completion 2005). Also involves healthy eating interventions in shops, restaurants, canteens and using the media.

Ministry of Agriculture, Forestry and Fisheries, Japan. Study evaluating knowledge, attitudes and behaviors of adults and 5th Grade students in Hyogo and Mie prefectures before and after launching the "Vegefru-seven" campaign in Hyogo. Assessments at baseline in June 2003 and at follow-up after one year. Results expected Winter 2004. Plus in Japan evaluations occurring of Vegefru Seven project and 5 a day project (personal communication, N Murayama).

Pollard J. Research protocol for the "Five for all" intervention designed to promote fruit and vegetable consumption in pre-school children, aged 3−5 years (UK) (personal communication).

Pro Children Study. Research project funded by the European Union, covering nine European countries. The project began in April 2002 and it will last until March 2006. The main objective of this project is to develop effective strategies to promote adequate consumption levels of fruit and vegetables. The main target groups of this project are young adolescents (11 to 13 years old) and their parents.

Ransley J. Evaluation of the New Opportunities Fund's National School Fruit Scheme (children – UK) (personal communication).

Resnicow K. Healthy Body Healthy Spirit Trial (personal communication).

Slagmoolen M. School Fruit & Vegetables (SchoolGruiten) Project, Netherlands. Product board for Horticulture Holland/Holland Produce Promotion (personal communication).
Strunge Meyer M. FRUITAVAIL: Increasing availability of fruit and vegetables in schools and workplaces (personal communication).
Vaask S. 3−year “5 a day” programme (effectiveness to be assessed in 2004) (personal communication).

References

1. *Diet, nutrition and the prevention of chronic diseases. Report of a joint FAO/WHO Expert Consultation,* Geneva, World Health Organization, 2003 (WHO Technical Report Series, No. 916).
2. World Cancer Research Fund, American Institute for Cancer Research. *Food, Nutrition and the Prevention of Cancer: A Global Perspective*. Washington, American Institute for Cancer Research, 1997.
3. Klerk M et al. *Fruits and Vegetables: chronic disease prevention*. Wageningen, Netherlands, Wageningen Agricultural University, 1998.
4. *International Agency for Research on Cancer (IARC) Handbooks of Cancer Prevention. Vol. 8: Fruit and Vegetables.* Lyon, IARC Press, 2003.
5. Robertson A et al. *Food and health in Europe: a new basis for action*. Copenhagen, World Health Organization Regional Publications, European Series, No. 96, 2004.
6. Lock K et al. Low fruit and vegetable intake. In: Ezzati M et al., eds. *Comparative quantification of health risks: global and regional burden of disease due to selected major risk factors*. Geneva, World Health Organization, 2004.
7. Tobias M. The burden of disease and injury in New Zealand. Wellington: New Zealand Ministry of Health, 2001.
8. Mathers C, Vos T, Stevenson C. *The burden of disease and injury in Australia*. Canberra: Australian Institute of Health and Welfare, 1999.
9. National Institute of Public Health. *Determinants of the Burden of Disease in the EU*. Stockholm, National Institute of Public Health, 1997.
10. Faostat database, Food and Agriculture Organization, Rome, 2004.
11. Ness AR, Powles J. The role of diet, fruit and vegetables and antioxidants in the aetiology of stroke. *Journal of Cardiovascular Risk,* 1999, 6(4):229−234.
12. Ness AR, Powles JW. Fruit and vegetables, and cardiovascular disease: a review. *International Journal of Epidemiology,* 1997, 26:1−13.
13. Rinzler S. Primary prevention of coronary heart disease by diet. *Bulletin of the New York Academy of Medicine* 1968, 44:936−949.

14. Singh RR et al. Randomised controlled trial of cardioprotective diet in patients with recent acute myocardial infarction: results of one year follow up. *British Medical Journal,* 1992, 304:1015−1019.

15. de Logeril M et al. Mediterranean alpha-linolenic acid-rich diet in secondary prevention of coronary heart disease. *Lancet,* 1994,343:1454−1459.

16. Conlin P et al. The effect of dietary patterns on blood pressure control in hypertensive patients: results from the Dietary Approaches to Stop Hypertension (DASH) trial. *American Journal of Hypertension,* 2000,13(9):949−955.

17. Obarzanek E et al. Effects on blood lipids of a blood pressure-lowering diet: the Dietary Approaches to Stop Hypertension (DASH) trial. *American Journal of Clinical Nutrition,* 2001,74(1):80−89.

18. Ribioli E, Norat T. Epidemiologic evidence of the protective effect of fruit and vegetables on cancer risk. *American Journal of Clinical Nutrition,* 2003,78(supplement):559S−569S.

19. Alpha-Tocopherol, Beta Carotene Cancer Prevention Study Group. The effect of vitamin E and beta carotene on the incidence of lung cancer and other cancers in male smokers. *New England Journal of Medicine,* 1994,330:1029−1035.

20. Omenn GS et al. Effects of a combination of beta carotene and Vitamin A on lung and cardiovascular disease. *New England Journal of Medicine,* 1996, 334:1150−1155.

21. Contento I et al. The effectiveness of nutrition education and implications for nutrition education policy, programs, and research: a review of research. *Journal of Nutrition Education,* 1995, 27(6):277−418.

22. Ciliska D et al. The Effectiveness of Community Interventions to Increase Fruit and Vegetable Consumption in People Four Years of Age and Older. Effective Public Health Practice Project. Canada, Ontario Ministry of Health, Public Health Research, Education and Development Program, 1999.

23. Miller M, Stafford H. An intervention portfolio to promote fruit and vegetable consumption; review of interventions. Melbourne, National Public Health Partnership, 2000.

24. Ammerman AS et al. The efficacy of behavioral interventions to modify dietary fat and fruit and vegetable intake: a review of the evidence. *Preventive Medicine,* 2002, 35(1):25−41.

25. Pignone MP et al. Counseling to promote a healthy diet in adults: a summary of the evidence for the US Preventive Services Task Force. *American Journal of Preventive Medicine,* 2003, 24(1):75−92.
26. Burchett H. Increasing fruit and vegetable consumption among British primary schoolchildren: a review. *Health Education,* 2003, 103(2):99−109.
27. Brownson R, Gurney J, Land G. Evidence-based decision making in public health. *Journal of Public Health Management Practice,* 1999, 5(86−97).
28. European Advisory Committee on Health Research, WHO Regional Office for Europe. Considerations in defining evidence for public health. *International Journal of Technology Assessment in Health Care,* 2003,19(559−572).
29. *Fruit and vegetable promotion initiative. A meeting report, Geneva 25−27 August 2003*. Geneva, World Health Organization, 2003.
30. Centre for Reviews and Dissemination. Undertaking systematic reviews of research on effectiveness. CRD's Guidance for those Carrying Out or Commissioning Reviews. York, CRD, University of York, 2001.
31. Lowe F, Horne P. Food Dudes. Increasing children's consumption of fruit and vegetables. Changing the nation's diet: a programme to increase children's consumption of fruit and vegetables. Working Paper no. 3. Bangor Wales, University of Wales, Bangor, 2002.
32. Sahota P et al. Randomised controlled trial of primary school based intervention to reduce risk factors for obesity. *British Medical Journal (Clinical Research edition),* 2001, 323(7320):1029−1032.
33. Warren JM et al. Evaluation of a pilot school programme aimed at the prevention of obesity in children. *Health Promotion International,* 2003,18(4):287−296.
34. Friel S et al. Evaluation of the Nutrition Education at Primary School (NEAPS) programme. *Public Health Nutrition,* 1999,2(4):549−555.
35. Cullen K, Bartholomew L, Parcel G. Girl scouting: an effective channel for nutrition education. *Journal of Nutrition Education,* 1997, 29:86−91.
36. Perry CL et al. Changing fruit and vegetable consumption among children: the 5-a-Day Power Plus program in St. Paul, Minnesota. *American Journal of Public Health,* 1998, 88(4):603−609.

37. Auld GW et al. Outcomes from a school-based nutrition education program using resource teachers and cross-disciplinary models. *Journal of Nutrition Education,* 1998, 30(5):268−80.

38. Foerster SB et al. The California Children's 5 a day - Power Play! campaign: evaluation of large scale social marketing initiative. *Family Community Health,* 1998, 21:46−64.

39. Baranowski T et al. Gimme 5 fruit, juice, and vegetables for fun and health: outcome evaluation. *Health education & behavior : the official publication of the Society for Public Health Education,* 2000, 27(1):96−111.

40. Perry CL et al. A randomized school trial of environmental strategies to encourage fruit and vegetable consumption among children. *Health education & behavior : the official publication of the Society for Public Health Education,* 2004, 31(1):65−76.

41. Gortmaker SL et al. Impact of a school-based interdisciplinary intervention on diet and physical activity among urban primary school children: eat well and keep moving. *Archives of pediatrics & adolescent medicine,* 1999,153(9):975−983.

42. Reynolds KD et al. Increasing the fruit and vegetable consumption of fourth-graders: results from the high 5 project. *Preventive Medicine,* 2000, 30(4):309−319.

43. Faber M, Venter SL, Benade AJ. Increased vitamin A intake in children aged 2−5 years through targeted home-gardens in a rural South African community. *Public Health Nutrition,* 2002, 5(1):11−16.

44. Birnbaum AS et al. Are differences in exposure to a multicomponent school-based intervention associated with varying dietary outcomes in adolescents? *Health education & behavior : the official publication of the Society for Public Health Education,* 2002, 29(4):427−443.

45. Gortmaker SL et al. Reducing obesity via a school-based interdisciplinary intervention among youth: Planet Health. *Archives of pediatrics & adolescent medicine,* 1999,153(4):409−418.

46. Nicklas TA. Outcomes of a high school program to increase fruit and vegetable consumption: Gimme 5--a fresh nutrition concept for students. *Journal of School Health,* 1998, 68(6):248−253.

47. Perry CL, Lytle L, Feldman H, Coauthors. Effects of the Child and Adolescent Trial for Cardiovascular Health (CATCH) on fruit and vegetable intake. *Journal of Nutrition Education,* 1998, 30(6):354−360.

48. *Five-a-day community pilot initiatives: Key findings*. London, Department of Health, 2002.

49. Backman DR. *Media, festival, farmers/flea markets and grocery store interventions lead to improved fruit and vegetable consumption for California Latinos*, California Department of Health Services, Public Health Institute, 2003.

50. Five-a-day pilot initiatives. Executive summary of the pilot initiatives evaluation study. London, Department of Health, 2002.

51. Marcus AC et al. Increasing fruit and vegetable consumption among callers to the CIS: results from a randomized trial. *Preventive Medicine,* 1998, 27(5 Pt 2):S16−28.

52. Marcus AC et al. A randomized trial of a brief intervention to increase fruit and vegetable intake: a replication study among callers to the CIS. *Preventive Medicine,* 2001, 33(3):204−16.

53. Takashashi Y. A population-based dietary intervention trial in a high-risk area for stomach cancer and stroke: changes in intakes and related biomarkers. *Preventive Medicine,* 2003, 37(5):432−441.

54. Hunt MK et al. Impact of a worksite cancer prevention program on eating patterns of workers.. *Journal of Nutrition Education*, 1993, 25:236-44.

55. Sorensen G et al. Increasing fruit and vegetable consumption through worksites and families in the Treatwell 5-a-day study. *American Journal of Public Health,* 1999, 89(1):54−60.

56. Hunt MK. Process tracking results from the Treatwell 5-a-Day Worksite Study. *American Journal of Health Promotion,* 2000,14(3):179−187.

57. Sorensen G et al. Work site-based cancer prevention: primary results from the Working Well Trial. *American Journal of Public Health,* 1996, 86(7):939−947.

58. Patterson RE et al. Components of the Working Well Trial intervention associated with adoption of healthful diets. *American Journal of Preventive Medicine,* 1997,13(4):271−276.

59. Glanz K et al. Impact of work site health promotion on stages of dietary change: the Working Well Trial. *Health education & behavior : the official publication of the Society for Public Health Education,* 1998,25(4):448−463.

60. Emmons KM et al. The Working Healthy Project: a worksite health-promotion trial targeting physical activity, diet, and smoking, *Journal of occupational and environmental medicine / American College of Occupational and Environmental Medicine,* 1999, 41(7):545−555.
61. Sorensen G et al. The effects of a health promotion-health protection intervention on behavior change: the WellWorks Study. *American Journal of Public Health,* 1998, 88(11):1685−1690.
62. Sorensen G et al. A comprehensive worksite cancer prevention intervention: behavior change results from a randomized controlled trial (United States). *Cancer Causes Control* 2002, 13(6):493−502.
63. Buller DB et al. Randomized trial testing the effect of peer education at increasing fruit and vegetable intake. *Journal of the National Cancer Institute,* 1999, 91(17):1491−1500.
64. Tilley BC et al. Nutrition intervention for high-risk auto workers: results of the Next Step Trial. *Preventive Medicine,* 1999, 28(3):284−292.
65. Beresford SA et al. Seattle 5 a Day worksite program to increase fruit and vegetable consumption. *Preventive Medicine,* 2001, 32(3):230−238.
66. Campbell MK et al. Effects of a tailored health promotion program for female blue-collar workers: Health Works for Women. *Preventive Medicine: An International Journal Devoted to Practice and Theory,* 2002, 34(3):313−323.
67. Cook C et al. Changing risk behaviours for non-communicable disease in New Zealand working men--is workplace intervention effective? *New Zealand Medical Journal,* 2001,114(1130):175−178.
68. Lutz SF et al. Innovative newsletter interventions improve fruit and vegetable consumption in healthy adults. *Journal of the American Dietetic Association,* 1999,99(6):705−709.
69. Kristal AR et al. A randomized trial of a tailored, self-help dietary intervention: the Puget Sound Eating Patterns study. *Preventive Medicine,* 2000, 31(4):380-389.
70. Stevens VJ et al. Randomized trial of a brief dietary intervention to decrease consumption of fat and increase consumption of fruits and vegetables. *American Journal of Health Promotion : AJHP,* 2002, 16(3):129−134.
71. Stevens VJ. One-year results from a brief, computer-assisted intervention to decrease consumption of fat and increase consumption of fruits and vegetables. *Preventive Medicine,* 2003, 36(5):594−600.

72. Campbell MK et al. Improving dietary behavior: the effectiveness of tailored messages in primary care settings. *American Journal of Public Health,* 1994, 84(5):783−787.

73. Coates RJ et al. The Women"s Health Trial Feasibility Study in Minority Populations: changes in dietary intakes. *American Journal of Epidemiology,* 1999,149(12):1104−1112.

74. Delichatsios HK et al. Randomized trial of a "talking computer" to improve adults" eating habits. *American Journal of Health Promotion,* 2001,15(4):215−224.

75. Delichatsios H et al. EatSmart: Efficacy of a multifaceted preventive nutrition intervention in clinical practice. *Preventive Medicine,* 2001, 33(2):91−98.

76. John JH et al. Effects of fruit and vegetable consumption on plasma antioxidant concentrations and blood pressure: a randomised controlled trial. *Lancet,* 2002, 359(9322):1969−1974.

77. Steptoe A et al. Behavioural counselling to increase consumption of fruit and vegetables in low income adults: randomised trial. *British Medical Journal,* 2003, 326(7394):855.

78. Havas S et al. Final results of the Maryland WIC Food for Life program. *Preventive Medicine,* 2003, 37(5):406−416.

79. Havas S et al. Final results of the Maryland WIC 5-A-Day Promotion Program. *American Journal of Public Health,* 1998, 88(8):1161−1167.

80. Langenberg P et al. Psychosocial factors and intervention-associated changes in those factors as correlates of change in fruit and vegetable consumption in the Maryland WIC 5 a day promotion program. *Annals of Behavioral Medicine,* 2000, 22(4):307−315.

81. Haire-Joshu D et al. Improving dietary behavior in African Americans: the Parents As Teachers High 5, Low Fat Program. *Preventive Medicine,* 2003, 36(6):684−691.

82. Del Tredici AM et al. Evaluation study of the California Expanded Food and Nutrition Education Program: 24-hour food recall data. *Journal of the American Dietetic Association,* 1988, 88(2):185−190.

83. Winkleby MA et al. Predicting achievement of a low-fat diet: a nutrition intervention for adults with low literacy skills. *Preventive Medicine* 1997, 26(6):874−882.

84. Campbell MK et al. Fruit and vegetable consumption and prevention of cancer: the Black Churches United for Better Health project. *American Journal of Public Health,* 1999, 89(9):1390−1396.

85. Campbell MK et al. Varying the message source in computer-tailored nutrition education. *Patient education and counseling,* 1999, 36(2):157−169.

86. Resnicow K et al. A motivational interviewing intervention to increase fruit and vegetable intake through Black churches: results of the Eat for Life trial. *American Journal of Public Health,* 2001, 91(10):1686−1693.

87. Resnicow K et al. Body and Soul: An effectiveness trial of a dietary intervention conducted through Black churches. *American Journal of Preventive Medicine,* in press.

88. Resnicow K et al. Results of the Healthy Body Healthy Spirit Trial. *Health Psychology,* in press.

89. Anderson ES et al. A computerized social cognitive intervention for nutrition behavior: direct and mediated effects on fat, fiber, fruits, and vegetables, self-efficacy, and outcome expectations among food shoppers. *Annals of behavioral medicine : a publication of the Society of Behavioral Medicine,* 2001, 23(2):88−100.

90. Kristal AR et al. Evaluation of a supermarket intervention to increase consumption of fruits and vegetables. *American Journal of Health Promotion,* 1997, 11(6):422−425.

91. de Lorgeril M et al. Mediterranean alpha-linolenic acid-rich diet in secondary prevention of coronary heart disease. *Lancet,* 1994, 343:1545−1459.

92. Singh RB et al. Randomised controlled trial of cardioprotective diet in patients with recent acute myocardial infarction: results of one year follow up. *British Medical Journal,* 1992, 304(6833):1015−1019.

93. Singh RB et al. Effect of an Indo-Mediterranean diet on progression of coronary artery disease in high risk patients (Indo-Mediterranean Diet Heart Study): a randomised single-blind trial. *Lancet,* 2002, 360(9344):1455−1461.

94. Ness AR et al. The long-term effect of dietary advice on the diet of men with angina: the diet and angina randomized trial. *Journal of Human Nutrition and Dietetics,* 2004, 17(2):117−119.

95. Burr ML et al. Lack of benefit of dietary advice to men with angina: results of a controlled trial. *European Journal of Clinical Nutrition,* 2003, 57(2):193−200.

96. Appel LJ et al. Effects of comprehensive lifestyle modification on blood pressure control: main results of the PREMIER clinical trial. *JAMA : the journal of the American Medical Association,* 2003, 289(16):2083−2093.

97. Little P et al. Randomised controlled factorial trial of dietary advice for patients with a single high blood pressure reading in primary care. *British Medical Journal,* 2004, 328(7447):1054−1060.

98. Singh RB et al. Effects of diet and lifestyle changes on atherosclerotic risk factors after 24 weeks on the Indian Diet Heart Study. *The American journal of cardiology,* 1993, 71(15):1283−1288.

99. Bemelmans WJ et al. Impact of Mediterranean diet education versus posted leaflet on dietary habits and serum cholesterol in a high risk population for cardiovascular disease. *Public Health Nutrition,* 2000, 3(3):273−283.

100. Schatzkin A et al. Lack of effect of a low-fat, high-fiber diet on the recurrence of colorectal adenomas. Polyp Prevention Trial Study Group. *New England Journal of Medicine,* 2000, 342(16):1149−1155.

101. Lanza E et al. Implementation of a 4-y, high-fiber, high-fruit-and-vegetable, low-fat dietary intervention: results of dietary changes in the Polyp Prevention Trial. *American Journal of Clinical Nutrition,* 2001, 74(3):387−401.

102. Pierce JP et al. Telephone Counseling Intervention Increases Intakes of Micronutrient- and Phytochemical-Rich Vegetables, Fruit and Fiber in Breast Cancer Survivors1. *Journal of Nutrition,* 2004, 134:452–458.

103. Dallongeville J et al. Association between nutrition knowledge and nutritional intake in middle-aged men from Northern France. *Public Health Nutrition,* 2001, 4(1):27−33.

104. Contento I, Manning A, Shannon B. Research perspective on school-based nutrition education. *Journal of Nutrition Education,* 1992, 24:247−260.

105. Anderson AS. Who are the healthy eaters? Eating patterns and health promotion in the West of Scotland. *Health Education Journal*, 1993, 51(3−10).

106. Anderson AS et al. Take Five, a nutrition education intervention to increase fruit and vegetable intakes: impact on attitudes towards dietary change.[comment]. *British Journal of Nutrition,* 1998, 80(2):133−140.

107.. School-aged children. Their health and nutrition. *SCN News. A periodic review of developments in international nutrition*, 2002.

108. Commonwealth Department of Health and Ageing. *Priorities for Action in Cancer Control 2001-2003*. Canberra: Commonwealth of Australia, 2001.

109. Smith P, Morrow R, eds. *Field Trials of health interventions in developing countries: a toolkit*. 2nd edition ed. London: Macmillan Education Ltd, 1996.

110. Story M et al. 5-a-Day Power Plus: Process Evaluation of a Multicomponent Elementary School Program to Increase Fruit and Vegetable Consumption. *Health Education & Behavior,* 2000, 27(2):187−200.

111. Lytle L et al. School based approaches to affect adolescents' diets: results from the TEENS study. *Health Education Behaviours,* 2004, 31(2):270−287.