Interventions Designed to Increase Adult Fruit and Vegetable Intake Can Be Effective: A Systematic Review of the Literature[1–3]

Joceline Pomerleau,[4] Karen Lock, Cécile Knai, and Martin McKee

European Centre on Health of Societies in Transition, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, UK

ABSTRACT International recommendations advise increasing intakes of fruit and vegetables to help reduce the burden of chronic diseases worldwide. This project systematically reviewed evidence on the effectiveness of interventions and programs promoting fruit and/or vegetable intake in adults. In April 2004, we contacted experts in the field and searched 14 publication databases. We considered all papers published in English, French, Spanish, Portuguese, Russian, Danish, Norwegian, and Swedish, and reporting on interventions and promotion programs encouraging higher intakes of fruit and/or vegetables in free-living not acutely ill adults, with follow-up periods ≥3 mo, that measured change in intake and had a control group. Forty-four studies (mainly from developed countries) were included in the review and stratified by study setting. Larger effects were generally observed in individuals with preexisting health disorders. In primary prevention interventions in healthy adults, fruit and vegetable intake was increased by ~0.1–1.4 serving/d. Consistent positive effects were seen in studies involving face-to-face education or counseling, but interventions using telephone contacts or computer-tailored information appeared to be a reasonable alternative. Community-based multicomponent interventions also had positive findings. This literature review suggests that small increases in fruit and vegetable intake are possible in population subgroups, and that these can be achieved by a variety of approaches. More research is required to examine the effectiveness of specific components of interventions in different populations, particularly less developed countries. There is also a need for a better assessment of the effectiveness and cost-effectiveness of large community-based interventions. J. Nutr. 135: 2486–2495, 2005.

KEY WORDS: • *review* • *fruit* • *vegetables* • *adult* • *randomized controlled trial*

Cardiovascular diseases and cancer are major causes of morbidity and mortality worldwide, accounting for 29.3 and 12.5%, respectively, of all deaths and contributing to the rapidly growing epidemic of noncommunicable diseases in developing countries (1,2). The Global Strategy on Diet, Physical Activity and Health of the WHO urges healthier lifestyles to prevent this major threat, including eating more fruit and vegetables (3–5). However, survey data (6) and availability statistics from the FAO (7) suggest that most populations are not meeting currently recommended levels of fruit and vegetables (4) and that effective methods to promote dietary changes are urgently needed. In some developed countries (e.g., the United States, United Kingdom, Australia, Nordic countries), fruit and vegetable promotion initiatives are well established. In developing countries, a range of intersectoral projects has been established to encourage production and consumption, often as local food-based initiatives to reduce micronutrient deficiency. Various groups of researchers have also performed primary and secondary noncommunicable disease prevention trials.

Previous reviews of the literature suggested that a majority of the interventions that promote fruit and vegetable intake could increase consumption at least in the short term. However, these reviews have generally been limited in scope [e.g., focusing on community intervention programs (8), nutrition education (9), counseling in primary care units (10), school children (11), behavioral interventions (12)], or they have been geographically limited. This paper reports an up-to-date systematic review of evidence on the effectiveness of interventions and programs promoting fruit and vegetable intake among adults, to inform the joint WHO/FAO initiative on promoting fruit and vegetables for health (13,14).

MATERIALS AND METHODS

This review of the literature examined all individual and population-based interventions and promotion programs encouraging increased consumption of fruit and/or vegetables. It included all studies in free-living individuals who were not acutely ill, where the change

[1] This paper summarizes and discusses part of the results of a review of the literature conducted as background material for the Joint WHO/FAO workshop on fruit and vegetable intake for health that took place in Kobe in September 2004. Full details of methods and results can be found in the more technical workshop report [Pomerleau, J., Lock, K., Knai, C. & McKee, M. (2005) Effectiveness of Interventions and Programmes Promoting Fruit and Vegetable Intake. WHO, Geneva, Switzerland].

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[3] Summary details of the studies included in the review (Supplemental Tables 1 and 2) are available as Online Supporting Material with the online posting of this paper at www.nutrition.org.

[4] To whom correspondence should be addressed.
E-mail: Joceline.Pomerleau@lshtm.ac.uk.

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in fruit and/or vegetable intake was measured, with at least 3 mo follow up, and with a control group.

Search strategy. Fourteen 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 Gray Literature); New York Academy of Medicine (Gray literature); INGENTA. The search strategy was developed in PUBMED and adapted to other databases. It was complemented by a comprehensive search for gray literature and other relevant material, and contacts with experts.

Selection of documents. Documents in English, French, Spanish, Portuguese, Russian, Danish, Norwegian, and Swedish were considered. Articles were rejected on initial screening if the reviewer could determine from the title and abstract that the study was not a fruit and vegetable intervention study or promotion program, or if the study did not meet our selection criteria. When a paper could not be rejected with certainty from the title and abstract, the full text of the article was obtained for further evaluation. The suitability and quality of each selected paper were assessed independently by 2 assessors; differences between assessors' results were resolved by discussion and, when necessary, in consultation with a third reviewer. Study quality was measured using a quality assessment tool developed on the basis of those used in previous reviews (9,14,15). Studies considered of poor quality were excluded from the review. Data abstraction was performed by one reviewer and checked by a second.

Estimation of effect size. The effect size was estimated using 1 of 3 methods depending on data availability: *1*) Net effect: difference between the change in fruit and vegetable intake in the intervention group (I) and control group (C) = [(Follow-up intake$_I$ − Baseline intake$_I$) − (Follow-up intake$_C$ − Baseline intake$_C$)]; *2*) differences between groups at follow-up: *difference* in fruit and vegetable intake between the intervention and control groups at follow-up = [Follow-up intake$_I$ − Follow-up intake$_C$]; *3*) change in intakes within each group: assessment of the significance of the change in fruit and vegetable intake within each group (no statistical comparison between groups).

Comparisons of study findings. Because of heterogeneity in the study populations, study settings, types of interventions, and outcome assessment measures (see above), and because some studies did not provide all of the information required (variability estimates for the outcomes) to obtain a statistically pooled effect, we did not attempt meta-analysis. We compared findings within and across 7 different study settings. Differences were considered significant at $P < 0.05$.

RESULTS

Retrieval of papers. A total of 3499 unduplicated records were identified; 306 of these reported on interventions designed to increase fruit and/or vegetable intake. Of these, 228 studies did not meet the eligibility criteria, and 8 were rated as methodologically weak. The remaining 70 articles reported results of 60 independent studies; of these, 44 were among adults (16–69).

Results by study setting. **Table 1** gives a general description of the 44 studies examined; 72.7% were from the United States, 15.9% were from Europe, 6.8% were from Asia (India), and 4.5% from the Western Pacific. Most included at least 500 participants, both genders, and had follow-up times of at least 6 mo. A majority of studies used personal counseling or education with or without other interventions. Dietary intake data were collected mainly by FFQ. **Tables 2–5** summarize the types of interventions used and study effects for each study, stratifying by study setting. Supplemental Tables 1 and 2 provide further details of the results of each study.

Most studies targeting the general population, African-American churches, supermarkets, and worksites combined face-to-face approaches, printed educational material, and environmental changes (Tables 2 and 3). In general population interventions, 3 of 4 showed effects ranging from approximately +0.2 to +0.6 serving/d after using either individual counseling [face-to-face (16) or telephone counseling (17,18)] with printed documents, or social marketing techniques (19); one study showed an effect only for fruit. The other study evaluated "5-a-Day" projects in England (20); it showed no increase in intake in the intervention group after 1 y, but it appears to have prevented decreases in intake against national trends and compared with the control group.

Three studies that targeted smaller focused communities, African American churches, had larger effects than general population interventions, i.e., +0.7 to +1.4 serving/d. These studies used ecological approaches with or without individual counseling. One intervention showed that culturally sensitive multicomponent self-help material with telephone motivational interviewing was more effective than the same material with 1 telephone cue call (+0.99 serving/d) or than standard nutrition education materials (+1.12 serving/d) (24).

In supermarket-based interventions, store-wide environmental changes (promotion and activities, e.g., to encourage sales) had no significant effect (26). However, a computer-based individualized education program demonstrated a significant net effect of approximately +1.3 servings after 8–10 mo (27).

Eight of 11 worksite interventions examined showed positive effects (2 only for vegetables): 7 studies reported effects ranging from +0.13 to +0.7 serving/d (29,31–35,39,41), and one showed an increase of 5.9% in the proportion of participants eating at least 2–3 servings of vegetables daily (28). The largest effects were observed in studies that incorporated social support activities using natural helpers (31), peer education (33), or family members (33). The "Treatwell '5-a-Day' Study" (33) also found that the number of activities offered and greater participation both correlated with increased consumption.

Interventions in other study settings (Tables 4 and 5) used a combination of personalized education approaches reinforced by a range of other activities, mainly tailored or nontailored printed documents. Eight of 9 interventions in health care settings reported positive findings with effects ranged from +0.5 to +1.4 serving/d. Three studies delivered computer-tailored information (42–44). The 1st study showed the largest effect (+1.1 serving/d of fruit) with weekly communication over 6 mo with an interactive computer-based counseling voice system (44). The 2nd study suggested that printed computer-tailored information (particularly if participants were given the specific goal of increasing fruit and vegetable intake to ≥5 serving/d) was slightly more effective (but not significantly) than nontailored information; differences with the control group ranged from +0.6 to +0.8 serving/d (42). The 3rd study showed no significant difference between printed tailored or nontailored information (43). Telephone counseling with printed tailored information (45,46) was used in 2 studies. The simplest approach (computer-generated tailored newsletters and motivation phone call) had the least effect (45). The other study was more intensive (tailored letter, endorsement by health provider, 2 motivational telephone counseling sessions) but of shorter duration (46). Face-to-face individual or group counseling (47–50) had net effects ranging from +0.62 to +1.4 serving/d. The highest effect was observed in a study that used a brief negotiation method (50), the lowest in a study specifically examining the effect of behavioral

TABLE 1

General characteristics of the studies included in the review, by study setting

	General population	African American Churches	Supermarkets	Worksites	Health care settings	Low-income populations	Cardiovascular disease or risk factors/Cancer
Total number of studies	4	3	2	11	9	5	10
Countries (*n*)	USA (2), UK (1), Japan (1)	USA (3)	USA (2)	USA (10), New Zealand (1)	USA (7), UK (2)	USA (5)	USA (3), UK (2), India (3), France (1), Netherlands (1)
Study design							
Randomized controlled trial	2	3	2	10	9	5	9
Nonrandomized controlled trial	2			1			1
Number of participants							
Range	550–1706	1011–3737	296–960	~250–10000 (2–114 worksites)	271–2208	242–3122	266–3114
100–499			1	1	2		3
500–999	2		1	1	5	2	2
≥1000	2	3		9	2	2	5
Gender							
Men and women	4	3	2	9	8	2	8
Men only				1			1
Women only				1	1	2	1
Length of follow-up							
3–5 mo	1				2		
6–11 mo	1	1	1		3	3	3
≥12 mo	2	2	1	11	4	2	7
Type of intervention							
Prompt sheets							1
Point of purchase information			1				
Computer based tool			1		3		
Personal counseling/education	1				3		7
Personal counseling/education + other interventions	1	2		3	2	5	1
Group counseling/education					1		1
Peer-education				1			
Multicomponent community or worksite interventions	2	1		7			
Data collection method for FV intake (some studies used multiple methods)							
FFQ	2	3	2	10	7	4	5
Dietary history	2						1
Weighed food record	1						1
Nonweighed food record					1		2
24-h recall (s)	2			2	2	1	3
Other food receipts				2	4		

counseling vs. no behavioral counseling (both targeting increased intake) (51).

All 5 trials targeting adults living on a low income increased fruit and vegetable intake. Four reported an effect ranging from approximately +0.42 to +1.1 serving/d (52–56). The other showed that individuals with a moderate fat intake at baseline who received a newly developed education curriculum focusing on the reduction of dietary fat increased their vegetable intake by 2.5 serving/d in ~7–8 mo, compared with no significant increase in those receiving an existing general nutrition curriculum (57). Two studies showed that the effect could be maintained over 1 y after an initial follow-up time of 8 mo (54–56).

Trials conducted among individuals with preexisting health problems generally had greater effects than those targeting other populations. An intervention using only prompt sheets was the only one to report no significant effect (58). The other studies reported effects ranging from +0.27 serving/d (62,63) up to +4.9 serving/d (60); 2 studies showed an effect only for fruit (59,66). The highest effects were found in trials of individuals with cardiovascular risk factors (+3.9 or +4.2 serving/d) or suspected infarction in India (+4.9 serving/d) (59,60,65).

DISCUSSION

This systematic review identified various types of interventions used to promote and increase fruit and vegetable intake in adults, and most interventions had positive effects in spite of known difficulties in changing individual diets (70). The largest effects were generally observed among individuals already at higher risk of disease. This could reflect enhanced

TABLE 2

Type of intervention and effect size for studies of the general population, African-American churches, and supermarkets[1]

		Face-to-face education/ counseling	Other face-to-face		Phone call		Computer	Printed documents			Environmental changes				Others				
	No intervention	Individualized	Peer education/ lay advisors	Lecture/ workshop/ speaker	Counseling/ education call	Cue call	Interactive education	Tailored documents	Nontailored documents	Culturally sensitive nontailored	Nutrition displays	Cafeteria promotion/ choices	Community-based activities	Social marketing	Pastor support	Community involved	Monetary incentive/ coupons	FU[2] (mo)	Effect size (serving/d)
General population																			
Hiraka Dietary Intervention (16) Japan	C[2]	I		I					I									10	F = 0.2; V = NS
Study of callers to the Cancer Info. Service (17, 18) USA	C				I			I										12	0.44
California Latino '5-a-Day' Campaign (19) USA	C													I				5	0.63
'5-a-Day' Community Pilot (20, 21) UK	C												I					12	I = NS; C = −0.5
African-American churches																			
Black Churches United for Better Health (52, 53) USA	C		I	I				I	I		I	I			I	I		24	0.85
Eat for Life Program (54) USA					I2	I1			C, I1, I2	I1, I2								I2	I2 vs. C = 1.12; I2 vs. I1 = 0.99
Body and Soul (55) USA	C			I	I				I	I	I	I			I	I		6	0.7 to 1.4[3]
Supermarkets																			
Supermarket intervention to increase FV intake (56) USA	C								I		I						I	12	NS
Computerized intervention for nutrition behavior (57) USA	C						I										I	8–10	1.3/10 MJ

[1] For fruit and vegetable intake estimated as a net effect, difference between groups at follow-up or change in intake within each group.
[2] Abbreviations: FU, follow-up; C, control group; I, intervention group (there may be several groups); F, fruit; V, vegetable; NS, nonsignificant at $P < 0.05$.
[3] 2-item FFQ = 0.7 serving/d and 17-item FFQ = 1.4 serving/d.

TABLE 3

Type of intervention and effect size for worksite interventions[1]

	No intervention	Face-to-face education/ counseling: Individualized	Other face-to-face: Peer education/ lay advisors	Other face-to-face: Lecture/ workshop/ speaker	Printed documents: Tailored documents	Printed documents: Nontailored documents	Environmental changes: Nutrition displays	Environmental changes: Cafeteria promotion/ choices	Environmental changes: Exposure to '5-a-Day' events	Environmental changes: Family involvement	Environmental changes: Advisory board	Environmental changes: Occupational safety program	FU[2] (mo)	Effect size (serving/d)
Study of noncommunicable disease prevention (32) New Zealand	C			I			I				I		12	F = NS; V = +5.9% with 2–3 serving/d
Study of peer education (33) USA			I	C, I		C, I	C, I	C, I					24	FFQ = NS; 24 h = 0.40
Next Step Trial (34) USA	C			I		I	I						24	NS
Health Works for Women (35) USA			I		C, I								18	0.7
Treatwell Study (22) USA	C			I			I				I		15	F = NS; V = 0.16
Treatwell 5 a Day Study (23, 24) USA				I1, I2			I1, I2	I1, I2	C, I1, I2	I2	I1, I2		20	I2 vs. C = 0.48; I1 vs. C = NS; I2 vs. I1 = 0.29
Working Well Trial (25–27) USA	C			I		I	I	I			I		24	0.18
Working Healthy Project (28) USA	C			I	I	I	I				I		30	NS
WellWorks Study (29) USA	C							I		I			24	0.13
WellWorks-2 Study (30) USA				C,I		C,I	C, I			C, I	I		24	NS
Seattle '5-a-Day' program (31) USA	C			I		I	I	I		I	I		~24	FFQ = 0.30; 24 h = NS

[1] For fruit and vegetable intake estimated as a net effect, difference between groups at follow-up or change in intake within each group.
[2] Abbreviations: FU, follow-up; C, control group; I, intervention group (there may be several groups); F, fruit; V, vegetable; 24 h. 24-h recall; NS = nonsignificant at $P < 0.05$.

TABLE 4

Type of intervention and effect size for studies based in health care settings and low-income populations[1]

		Face-to-face education/counseling				Other face-to-face	Phone call	Computer		Printed documents			Others			
	No intervention	Individualized	Individualized: behavioral	Individualized: brief-negotiation	Group counseling/education	Peer education/lay advisors	Counseling/education call	Counseling voice system	Interactive education	Tailored documents	Tailored documents + goal	Nontailored documents	Doctor's endorsement	Family involvement	FU[2] (mo)	Effect size (serving/d)
Health care settings																
Study of newsletter interventions to increase FV intake (36) USA	C									I2	I3	I1			6	I1 vs. C = 0.6; I2 vs. C = 0.7; I3 vs. C = 0.8
Study of tailored messages to improve diet (37) USA	C									I2		I1			~4.5	NS
Study of computer-based voice system to improve diet (38) USA	C							I							6	F = 1.1; V = NS
Puget Sound Eating Patterns Study (49) USA	C						I			I		I			12	FFQ = 0.46; 24 h = NS
EatSmart (40) USA	C						I			I		I	I		3	0.62
Computer-assisted intervention to increase FV and reduce fat intakes (41,42) USA	C	I					I		I						12	0.93
Women's Health Trial Feasibility Study in Minority Populations (43) USA					I							C		I	18	F = 0.53; V = 0.27
Study of a brief negotiation method to increase FV intake (44) UK	C			I			I					I			6	1.4
Study of behavioral counseling to increase FV intake (45) UK		C	I												12	0.62
Low income populations																
Calif. Expanded Food Nutr. Educ. Program (46) USA	C	I													6	I = 1.1; C = NS
High 5, Low Fat Program (47) USA	C	I			I							I			~6	0.53
Women, Infants & Children '5-a-Day' Program (48, 49) USA	C				I	I				I	I				20	0.43
Women, Infants & Children food for life (50) USA	C				I	I	I					I			20	0.42
Stanford Nutrition Action Program (SNAP) (51) USA					C, I[3]		I					I			~7–8	F = NS; V = 2.5 in moderate fat diet + SNAP group[3]

[1] For fruit and vegetable intake estimated as a net effect, difference between groups at follow-up or change in intake within each group.
[2] Abbreviations: See Table 3.
[3] Control group: existing general nutrition curriculum; Intervention group; Stanford Nutrition Action Program (SNAP). In the analyses, participants were divided into 3 groups: high baseline fat intake, moderate fat intake with general nutrition curriculum, moderate fat intake with SNAP curriculum.

TABLE 5

Type of intervention and effect size for studies of individuals with health conditions[1]

		Face-to-face education/counseling		Other face-to-face		Phone call	Printed documents			Others		
	No intervention	Individualized	Group counseling/ education	Peer education/ lay advisors	Lecture/ workshop/ speaker	Counseling/ education call	Tailored documents	Nontailored documents	Prompt sheets	Family involvement	FU[2] (mo)	Effect (serving/d)
Cardiovascular diseases or risk factors												
Dietary advice for hypertensive patients (58) UK	C[3]								I[3]		6	NS
Lyon Diet Heart Study (59) France	C[4]	I									12–48	F = 0.6; V = NS
Dietary advice for patients with myocardial infarction (60) India	C[4]	I									12	4.9
Indo-Mediterranean Diet Heart Study (61) India	C[4]	I									24	4.2
Diet and Angina Rand. Controlled Trial (DART2) (62, 63) UK	C[5]	I										0.27
PREMIER Clinical Trial (64) USA	C[4]	C[6], I1[6], I2[6]	I1, I2					C, I1, I2			6	I3 vs. C = 2.5; I2 vs. I1 = 2.5; I1 vs. C = NS
Indian Diet Heart Study (65) India	C[4]	I									~6	3.9
Mediterranean α-linolenic enriched Groningen study (66) Netherlands	C[4]		I		I		I	I		I	12	F = 0.7; V = NS
Cancer												
Women's Healthy Eating & Living Study (67) USA	C[4]				I	I		I			12	F = 0.6; V = 3.2
Polyp Prevention Trial (68,69) USA	C[4]	I		I		I		I			48	2.2

[1] For fruit and vegetable intake estimated as a net effect, difference between groups at follow-up or change in intake within each group.
[2] Abbreviations: See Table 3.
[3] The comparison group included participants who received a booklet on hypertension and/or low sodium salt. The intervention group received prompt sheets (reminder to eat fruit, vegetables and fiber, and use low-fat products) with or without the booklet and/or low sodium salt.
[4] The control group received general dietary advice or the AHA dietary recommendations.
[5] Participants received advice to eat more soluble fiber (including increasing FV intake), or advice to eat more fatty fish or take fish oil, both types of advice, or neither. The analyses compared participants who received the advice to eat more soluble fiber (I) with all other respondents (C).
[6] Control: one session to discuss factors affecting blood pressure; I1: behavioral intervention on lifestyle changes; I2: as I1+ "Dietary Approach to Stop Hypertension" (DASH) diet.

motivation to improve dietary intake, suggesting that these trials should be considered separately from studies targeting the general population. In healthy adult populations, increases in fruit and vegetable intake ranged from about +0.1 to +1.4 serving/d, but what constitutes a meaningful increase remains a subject for further research. Other interventions used less individualized approaches. This might seem intuitive but must be balanced against the high cost, time demands, and need for trained staff required by individualized counseling; in addition, such an approach is not feasible for whole populations. Conversely, printed individually tailored information and computer-based information (particularly if this was individually tailored) appeared to be a reasonable alternative to face-to-face or telephone contact, demonstrating significant effects. Clearly this is an easier and less expensive approach. 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 behaviors, motivations, attitudes, norms, and skills, and mimics the process of "person-to-person" dietary counseling. Available evidence suggests that computer-tailored nutrition education is more effective in motivating people to make dietary changes than general nutrition information. However, we found no such trials outside the United States and Europe; thus, its effectiveness in other settings remains unevaluated and it is unlikely to be appropriate in developing countries particularly in poor and rural communities.

Workplaces are unique settings offering several advantages: they reach large audiences including some that traditionally do not come into contact with health services regularly (e.g., working-age men), interventions can be enhanced by co-worker support, and they provide opportunities for reinforcement and environmental support. However, they generally use a comprehensive, wide-ranging approach that is time and resource intensive and requires the collaboration of the company and many stakeholders (71). The effect sizes reported in such programs generally have not been very large, but this may reflect the diffuse nature of these multicomponent interventions.

The generalizability of our findings worldwide and the applicability of the interventions examined in developing countries are limited. The great majority of studies were conducted in industrialized countries, whereas in developing countries, fruit and vegetable promotion may focus on consumption of adequate micronutrients and high-quality protein, or improving methods used in the preparation of fruit/vegetable dishes (to conserve nutrients or control fat intakes), rather than promoting intake of fruits and vegetables as such. Although some countries now suffer the double burden of over- and undernutrition associated with the nutrition transition (72), deficiencies of micronutrients (e.g., vitamin A) remain a key issue for children and adults in developing countries (73), with fruit- and vegetable-promoting programs mainly part of food-based strategies to alleviate these conditions. In comparison, the focus of fruit and vegetable programs in developed countries is generally to reduce obesity and the risk of noncommunicable disease.

This review has some methodological limitations. First, some studies may have been missed (e.g., published in other languages, recent unpublished studies) and the possibility of publication bias could not be assessed. Second, because the analyses were restricted to studies with a control group, several studies were excluded, including some national or large-scale promotion interventions (74). A third limitation is that intake data relied in most cases on self-reported information and are thus subject to the limitations of dietary assessment methods, particularly for measuring small changes in intake (75,76). In addition, because the studies were not blinded, there may have been measurement bias with a possible overestimation of effect sizes. Most studies also failed to define the "fruit and vegetable" food group or what constituted a serving. Several studies included potatoes in the calculations, making comparisons with current international recommendations more difficult (4). Fourth, interventions had a relatively short follow-up time and did not provide information on the long-term effect on dietary changes or on the risk of major chronic diseases at a population level. Finally, we could not assess the cost effectiveness of the studies. However, an Australian study estimated that national campaigns to increase fruit and vegetable intake prevent 3626 disability adjusted life years each year with corresponding cost savings of ~AUS$125 million (US$163 million) each year over the implementation costs [estimated at ~$2.5 million (US$3.3 million) a year] (77).

Future research should pursue the promising results shown in this review and attempt to identify new cost-effective and efficient ways of increasing population fruit and vegetable intake. However, the effectiveness of all new interventions should be assessed, particularly in developing countries in which several programs have been initiated but without the evaluation of effectiveness. In addition, reports should give a better description of the methods used and include estimates of variability for the selected outcomes. Finally, studies are also required that examine in more depth the effectiveness of specific components of interventions, and how these effects vary in different populations. There is a need to understand better the factors influencing fruit and vegetable intake, including economic, social, and environmental factors that influence food availability and the ability of an individual to make healthy choices, and barriers to change.

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