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Review

The effectiveness of workplace dietary modification interventions: A systematic review

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ABSTRACT

Objective. To evaluate the effectiveness of workplace dietary modification interventions alone or in combination with nutrition education on employees' dietary behaviour, health status, self-efficacy, perceived health, determinants of food choice, nutrition knowledge, co-worker support, job satisfaction, economic cost and food-purchasing patterns.

Method. Data sources included PubMed, Medline, Embase, Psych Info., Web of Knowledge and Cochrane Library (November 2011). This review was guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement. Studies were randomised controlled trials and controlled studies. Interventions were implemented for at least three months. Cochrane Collaboration's risk of bias tool measured potential biases. Heterogeneity precluded meta-analysis. Results were presented in a narrative summary.

Results. Six studies conducted in Brazil, the USA, Netherlands and Belgium met the inclusion criteria. Four studies reported small increases in fruit and vegetable consumption (≤half serving/day). These studies involved workplace dietary modifications and three incorporated nutrition education. Other outcomes reported included health status, co-worker support, job satisfaction, perceived health, self-efficacy and food-purchasing patterns. All studies had methodological limitations that weakened confidence in the results.

Conclusion. Limited evidence suggests that workplace dietary modification interventions alone and in combination with nutrition education increase fruit and vegetable intakes. These interventions should be developed with recommended guidelines, workplace characteristics, long-term follow-up and objective outcomes for diet, health and cost.

Contents

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Introduction

The increasing prevalence of diet-related diseases including obesity and cardiovascular disease is largely driven by the interlinked problems of poor diet, calorie excess and physical inactivity. This global epidemic continues to endanger population health and the sustainability of healthcare systems worldwide (WHO, 2003). Obesity in adults accounts for up to 6% of direct health costs in the EU and more than 12% in indirect costs including shortened lives, reduced productivity and lowered incomes (WHO, 2006). Cardiovascular disease (CVD) accounts for nearly half of all deaths in Europe and 35% of all premature deaths (before the age of 65). CVD costs the EU economy €192 billion representing a per capita annual cost of €391 (Allender et al., 2008).

There is a need to develop and evaluate dietary interventions in suitable environments to investigate if these interventions can improve dietary behaviours and reduce diet-related disease risk (Craig et al., 2008; National Institute of Health and Clinical Excellence, 2007). The workplace is regarded as an ideal environment to promote healthy dietary behaviours because most individuals spend two-thirds of their waking hours at work (Chu et al., 2000; WHO, 1991, 2003, 2008). Uncertainty remains regarding the effectiveness and cost-effectiveness of workplace dietary interventions.

Employees depend on their workplace to provide many of their daily meals (Lachat et al., 2009; Roos et al., 2004). Individual, environmental and societal factors can affect food choices (WHO, 2003). Dietary interventions focused on improving employees' dietary patterns need to surpass individual nutrition education and intervene at multiple levels of the workplace environment including food choice modifications and nutrition education (Mhurchu et al., 2010). Effective workplace health promotion is complex and multi-dimensional. Each workplace is uniquely defined by its employee organisation and structure; history and culture; and social, economic and political circumstances (Kreuter et al., 2004). The effectiveness of complex dietary interventions may be enhanced if they incorporate environmental modifications, are designed using established guidelines, take into account the needs and characteristics of the workplace and its employees and have the support of all relevant stakeholders (Kreuter et al., 2004).

Previous reviews have reported that workplace environmental and education interventions including diet, physical activity and other lifestyle factors modestly improve dietary quality (Maes et al., 2012; Mhurchu et al., 2010). This review differs from previous reviews because it focuses on dietary modification interventions only or in conjunction with nutrition education where the food choice offered has changed in the work environment during the intervention. There is some evidence to suggest that such interventions influence and may improve dietary behaviour (Engbers et al., 2006; Mhurchu et al., 2010; Seymour et al., 2004). The objective of this review is to evaluate the effectiveness of workplace dietary modification interventions alone or in combination with nutrition education on employees' dietary behaviour, clinical health status, self-efficacy, perceived health, determinants of food choice, nutrition knowledge, co-worker support, job satisfaction, economic cost and food-purchasing patterns.

Methods

Data sources and searches

This systematic review was guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement (Moher et al., 2009). Following an initial scoping search (4th November 2011, Appendix A), a full search strategy was developed for PubMed which included a Cochrane highly sensitive search filter for controlled trials (Robinson and Dickersin, 2002). This search strategy was modified for all databases including Medline (1951–November 2011), Embase (1974–November 2011), Psych Info. (1967–November 2011), Web of Knowledge (1900–November 2011) and the Cochrane Library (1972–November 2011), all of which were searched for English language publications (16th–17th November 2011, Appendix B). Reference lists of all included studies were hand searched. An advanced search was conducted in Google Scholar and the WHO website.

Study outcomes

Studies were included in the review if they reported the effects of workplace dietary modification interventions on any of the primary and secondary outcomes that were specified in the protocol for the review. The primary outcome of interest was a change in dietary behaviour. It was assessed using 24-h dietary recall measures, food diaries, weighed food records, food frequency questionnaires (FFQs) or other dietary assessment methods.

Secondary outcomes considered in this review included:

1. Clinical health status outcomes such as body mass index (BMI), waist and hip ratio measures, and serum cholesterol levels (individual/employee level outcomes)
2. Self-efficacy (individual/employee level outcome)
3. Perceived health (individual/employee level outcome)
4. Nutrition knowledge (individual/employee level outcome)
5. Determinants of food choice outcomes including attitudes to food and food habits (individual/employee level outcomes)
6. Co-worker support (individual/employee level outcome)
7. Job satisfaction (individual/employee level outcome)
8. Economic cost outcomes including absenteeism, productivity, healthcare costs and profit margins (wider employer/worksite level outcomes)
9. Food purchasing patterns (wider employer/worksite level outcomes).

These outcome measures were selected to show the impact of these interventions on the employees and the workplace. The primary outcome was a change in dietary behaviour as these interventions were focused on dietary modification. The secondary outcomes measured the effectiveness of these interventions at the individual/employee level and the employer/worksite level. The mediating mechanisms affecting the impact of the intervention were also of interest (i.e. co-worker support and job satisfaction).

Study selection

All published articles from each database were imported into Endnote X3 2009 and any duplicates were removed. The titles and abstracts of the remaining studies were reviewed. Any full text articles retrieved were independently screened for eligibility by three review authors who were not blinded to authors' names, journal title or publication date. Any disagreements regarding study inclusion were resolved by discussion and consensus (Table C.1, Appendix C).

Stronger study designs including randomisation, controlled studies and comparable control groups were selected for this review to ensure in so far as is possible that the reported effects were attributed to the interventions. Randomised controlled trials (RCTs) with full and quasi-randomisation, by individual and workplace clusters, were included. Controlled trials that did not use appropriate randomisation strategies and controlled before and after studies were also included. A controlled before and after study was defined as a non-randomised study design where a control population of similar characteristics and performance as the intervention group was identified and where data were collected before and after the intervention in both the control and intervention groups (Higgins et al., 2008). Participants were adults (<18 years) in paid employment in public, voluntary or private organisations. Studies including selected groups of employees with pre-existing medical

conditions or co-morbidities (e.g. diabetes, high cholesterol, high blood pressure, obesity) were excluded.

Interventions implemented for at least 3 months were included to measure sustainable changes in dietary behaviour and to compare with the selection criteria of previous systematic reviews (Brunner et al., 1997; Pomerleau et al, 2005). Interventions were included if they involved any one or more of the following dietary modifications in the workplace or workplace canteens or other 'on-site' workplace food service establishments (e.g. on-site news agents or vending machines):

1. Changes in dietary content of available foods/meals as a result of modified food preparation practices (e.g. reduction in salt, sugar or fat content, increase in fruit, vegetables or fibre content).
2. Changes in portion size.
3. Changes in the food choices available to employees by increasing the availability of healthy options (e.g. addition of healthy foods to canteen menus, special cost offers with healthy food choices) or reducing the availability of unhealthy options or simultaneously increasing the availability of healthy options and decreasing the availability of 'unhealthy' options.

Studies where the workplace food modification intervention was delivered in conjunction with an education intervention were included. Studies where the workplace food modification intervention was delivered in conjunction with a co-intervention (besides an education intervention) were only included if the workplace food modification intervention (and/or education intervention) could be directly compared to the control group (if the co-intervention was not delivered to participants in the control group).

Studies were excluded if the workplace intervention:

1. was delivered to "employees" and "non-employees" of the same workplace (e.g. an intervention in a university that affected both university staff and university students) and where data obtained from employees and non-employees were combined thereby precluding evaluation of the intervention effect on employees.
2. included selected groups of employees with pre-existing medical conditions or co-morbidities (e.g. diabetes).
3. focused on the individual only rather than the organisation/environment (e.g. if a study implemented individual diet programmes only rather than changes to the workplace).
4. did not modify food choice for employees.
5. only involved the delivery of nutritional advice/education to employees.
6. was a computer only tailored dietary intervention.
7. did not include a control group in the study design.

Data extraction and risk of bias assessment

A standardised data extraction form was created, piloted and then used to abstract the available data for the outcomes. Data on participants, intervention design, setting and duration, outcome and outcome measures were extracted independently from all studies by three reviewers. Potential biases in included studies were assessed independently by three review authors using the Cochrane Collaboration's risk of bias tool (Higgins et al., 2008). The 'risk of bias' tool included six domains: sequence generation, allocation concealment, blinding (of participants, personnel and outcome assessors), incomplete outcome data, selective outcome reporting and other sources of bias. Study authors for all included studies were contacted to clarify the allocation concealment method and the blinding method for participants and personnel. All authors reached a consensus regarding potential bias in all included studies.

Data synthesis and analysis

Heterogeneity is investigated by examining the methodological and clinical characteristics of the included studies. The heterogeneity of all included studies precluded meta-analysis and therefore we presented a narrative summary of the results in each study.

Results

Searches generated 785 relevant references (Fig. 1). After screening titles and abstracts, 762 non-relevant articles were excluded. Of the

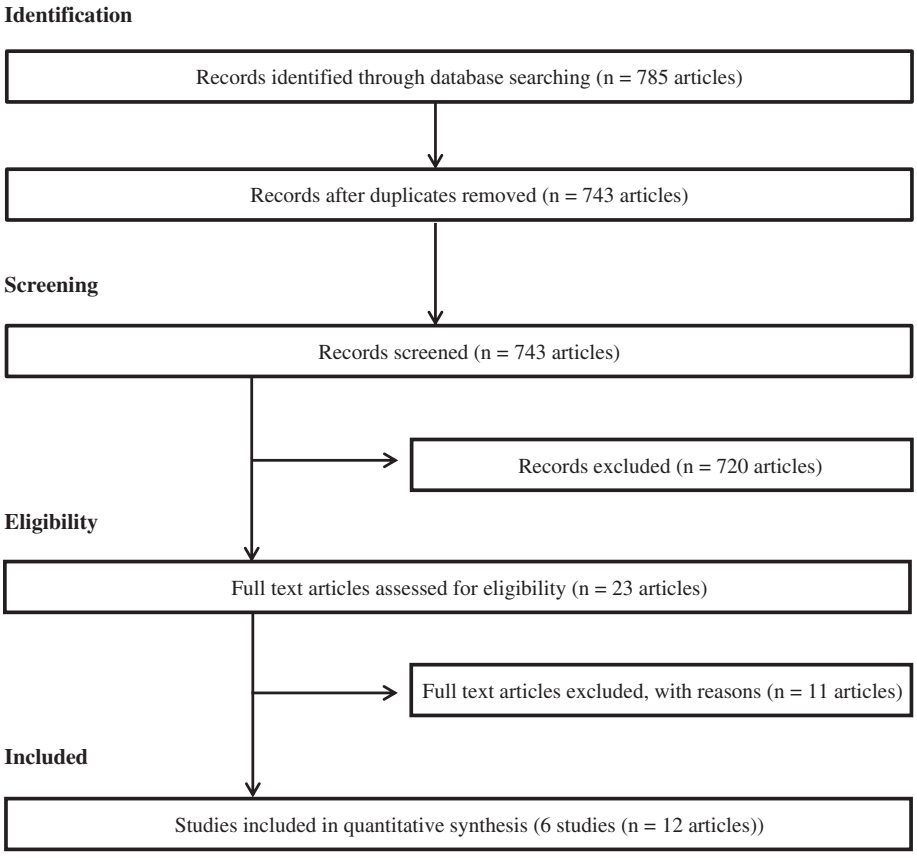

Fig. 1. Study flow diagram: search strategy.

remaining 23 articles, six studies (reported in 12 articles) met the selection criteria (Table 1). The reasons for excluding the remaining 11 articles are provided in Table C.1 (Appendix C).

The included studies were conducted in private and public workplace settings including companies focused on manufacturing, food processing, finance/legal, education, government, research, health and community health care. The studies were conducted in the USA (three studies) (Backman et al., 2011; Beresford et al., 2001; Sorensen et al., 1999), Brazil (one study) (Bandoni et al., 2010), Netherlands (one study) (Steenhuis et al., 2004) and Belgium (one study) (Braeckman et al., 1999). Study sizes ranged from 391 to 2800 employees and from four to 29 workplaces. Five studies recruited both male and female employees and one study enrolled males only. The duration of follow-up was three months in two studies (Backman et al., 2011; Braeckman et al., 1999), six months in two studies (Bandoni et al., 2010; Steenhuis et al., 2004), 19.5 months in one study (Sorensen et al., 1999) and 24 months in one study (Beresford et al., 2001).

A variety of workplace dietary modification interventions were introduced in the six studies. These modifications included workplace cafeteria changes with menu modification (Bandoni et al., 2010; Beresford et al., 2001; Braeckman et al., 1999), alterations in food presentation (Bandoni et al., 2010) and increased availability and accessibility of fruit and vegetables (Backman et al., 2011; Sorensen et al., 1999; Steenhuis et al., 2004) (Table 1). Two studies increased fruit and vegetable options in the staff vending machines (Backman et al., 2011; Sorensen et al., 1999) and two studies used point-of-choice labelling for fruit and vegetables (Bandoni et al., 2010; Sorensen et al., 1999). One study also increased the availability of low-fat products, fruit and vegetables (Steenhuis et al., 2004) while another study offered taste tests (Beresford et al., 2001). Five studies also introduced nutrition education programmes that focused on group education only or group and individual education (Bandoni et al., 2010; Beresford et al., 2001; Braeckman et al., 1999; Sorensen et al., 1999; Steenhuis et al., 2004). Group education methods included menu planning, educational materials (napkins, posters and videos), group information sessions (presentations) and multimedia (newsletters). Individual education methods included individual nutrition counselling and personal advice. The theoretical model underpinning the intervention was described in two studies. One study followed the stages of change model (Beresford et al., 2001) while the other study based their intervention on an ecological model (Bandoni et al., 2010). None of the workplace dietary modification interventions were designed in accordance with established guidelines for developing, evaluating and implementing complex interventions. Employee advisory boards (EABs) assisted in the development and implementation of the interventions in two studies and monitored project activities (Beresford et al., 2001; Sorensen et al., 1999).

All included studies reported on changes in dietary behaviour which was the primary outcome of interest. Dietary intake was measured using self-reported methods. Four studies used food frequency questionnaires (FFQs) (Backman et al., 2011; Beresford et al., 2001; Sorensen et al., 1999; Steenhuis et al., 2004) while one study analysed one day food records (Braeckman et al., 1999) and another study included a survey to calculate portions of fruit and vegetables consumed at work (Bandoni et al., 2010).

Five studies focused on fruit and vegetable consumption and the intakes were reported separately in one study (Steenhuis et al., 2004) and combined in the other studies (Backman et al., 2011; Bandoni et al., 2010; Beresford et al., 2001; Sorensen et al., 1999) (Table 2). Fruit and vegetable intake was measured in servings per day in four studies (Backman et al., 2011; Sorensen et al., 1999; Steenhuis et al., 2004; Thompson et al., 1995) and grams per day in one study (Bandoni et al., 2010). In four studies, implementation of the workplace intervention was associated with small but statistically significant increases in fruit and vegetable consumption (Table 2). Three of these studies were dietary modification and nutrition education interventions (Bandoni et al., 2010; Beresford et al., 2001; Sorensen et al., 1999) and one study was a dietary modification intervention only (Backman et al., 2011). No study reported an effect size greater than one half serving increase in intake per day. In one study, no significant differences in fruit and vegetable consumption were reported between the environmental interventions and the education interventions or between the environmental interventions and the control groups ($p \geq 0.16$) (Steenhuis et al., 2004).

Changes in fat intake were reported in three studies. In one study, following adjustment for baseline differences, there was a statistically significant difference between the intervention and control groups for percentage of energy obtained from total fat (total fat: −1.56% [95% CI −2.98, −0.13] ($p < 0.05$) and polyunsaturated fat: −0.81% [95% CI −1.49, −0.13] ($p < 0.05$)) (Braeckman et al., 1999). In another study, the difference in total fat intake between the intervention and control groups was non-significant, (−4.27% [95% CI −10.20, 1.66], $p > 0.05$) (Bandoni et al., 2010). In the remaining study, there was no statistically significant difference in mean fat intake between the study groups ($p \geq 0.16$) (Steenhuis et al., 2004). A number of studies also showed other positive dietary changes. In one study, following adjustment for baseline differences, the difference between the intervention and control groups showed a statistically significant reduction in energy intake (−142 kcal/day [95% CI −276, −8.83], $p < 0.05$) and an increase in protein intake (0.79% [95% CI 0.161, 1.43], $p < 0.05$) and carbohydrate intake (0.81% [95% CI 0.51, 2.18], $p < 0.05$) (Braeckman et al., 1999).

Changes in clinical health status outcomes were reported in one study. Following adjustment for baseline differences, the difference between the intervention and control groups reported a statistically significant increase in BMI in the intervention group (0.258 kg/m^2 [95% CI 0.128, 0.389], $p < 0.001$) and a statistically significant reduction in mean serum high density lipoprotein (HDL) cholesterol in the intervention group (−0.06 mmol/l [95% CI −3.63, −1.21], $p < 0.001$). The differences between the intervention and control groups were non-significant for mean serum total cholesterol levels (0.07 mmol/l [95% CI −1.13, 6.73], $p > 0.05$) and waist and hip ratio measures (0.004 [95% CI −0.0016, 0.011], $p > 0.05$) (Braeckman et al., 1999).

Self-efficacy was reported in one study (Backman et al., 2011). There was a statistically significant increase in self-efficacy towards eating 2 daily servings of fruit in the intervention groups (slope coeff. 0.18, SE 0.09 ($p < 0.03$)) compared with the control groups but there was a non-significant difference in self-efficacy towards eating 3 daily servings of fruit (slope coeff. 0.11, SE 0.08 ($p > 0.05$)), job satisfaction (slope coeff. 0.05, SE 0.06 ($p > 0.05$)) and perceived health (slope coeff. 0.04, SE 0.05 ($p > 0.05$)) (Backman et al., 2011). Changes in nutrition knowledge were recorded in one study and the mean score (score/10) was significantly greater in the intervention group when compared with the control group and adjusted for baseline differences (1.34/10 [95% CI 1.09, 1.59], $p < 0.001$) (Braeckman et al., 1999). Co-worker support was assessed in one study. It was measured according to six items, each measured on a 4-point scale (never, seldom, sometimes and often). The self-reported measure was completed by the participants (employees). During analysis, the six items were combined so that a low score revealed low perceived co-worker support and a high score revealed high perceived support. There was a statistically significant intervention effect on reported co-worker support ($p < 0.009$) between the worksite intervention group, the worksite and family intervention group and the control group when adjusted mean values at baseline and final assessments were controlled for worksite (Sorensen et al., 1999).

Two studies evaluated the effect of the workplace interventions on food purchasing patterns. In one study (Backman et al., 2011), there was a statistically significant increase in self-purchasing of fruit (slope coeff. 0.16, SE 0.05, $p < 0.01$) and family purchasing of vegetables (slope coeff. 0.14, SE 0.05, $p < 0.01$) in the intervention groups compared to the control groups. However, there was a non-significant

Table 1
Characteristics of included studies.

Included study	Study Design	Participants	Intervention	Outcomes
Beresford, 2001 (Beresford et al., 2001)	Cluster RCT	A total of 28 worksites (educational, medical and other) randomised to intervention (n = 14) or control (n = 14) arms on completion of baseline data collection. Intervention group recruited 1169 participants and control group recruited 1226 participants. All worksites with 250 to 2000 employees, located in the metropolitan area of Seattle, USA and had food serving cafeterias were eligible for the study.	– Based on the stages of change model. – Focused on changes in the work environment and individual behaviour. – In each worksite, an employee advisory board (EAB) implemented the intervention, guided the project activities and complied with a protocol that specified minimum activities. – Environmental elements included training for the cafeteria workers, new company catering policies, modified selections in vending machines and a nutrition resource kiosk was provided. Individual elements aimed to improve consciousness on healthy eating using posters, napkins, a self-evaluation brochure, cooking demonstrations and taste testings. – Control group, minimal intervention focused on increasing fruit and vegetable consumption using posters, newsletters, food demonstrations and a self-help manual. – Final follow-up was at 24 months.	Fruit and vegetable consumption (servings/day)
Backman, 2011 (Backman et al., 2011)	Prospective, randomised block experimental design	Convenience sample of 391 low-wage employees in 6 intervention work sites and 137 low-wage employees in 3 control work sites in Los Angeles, CA	– Fresh fruit deliveries with enough for 1 serving per employee, 3 days a week for 12 consecutive weeks. – The control work sites did not receive the fruit deliveries.	Participants' fruit and vegetable consumption, fruit and vegetable purchasing habits, self-efficacy, job satisfaction and overall health.
Bandoni, 2010 (Bandoni et al., 2010)	Randomised controlled study	29 companies of Sao Paulo (intervention and control), Brazil with 2510 workers	– The intervention focused on change in the work environment and was based on an ecological model for health promotion. – Included menu planning, food presentation, point-of-choice labelling and motivational strategies to encourage the consumption of fruit and vegetables. – Intervention duration 6 months.	Change in availability of fruits and vegetables (in grams) served to each customer at lunch, consumption of fruit and vegetables in the workplace by workers, availability of energy, macronutrients and fibre.

Braeckman, 1999 (Braeckman et al., 1999)	Quasi-experimental design carried out in Belgium.	Study conducted in 4 work sites in Belgium ranging from 250 to 500 workers with a predominantly male, blue-collar and Caucasian workforce. All male employees aged 35–69 years were recruited. Baseline characteristics were similar for the 2 control groups and 2 intervention groups. Employees were pooled into 1 control group (n = 366) and 1 intervention group (n = 272).	– Short-term and low-intensity nutrition intervention. – Consisted of an individualized health risk appraisal, group sessions, education, mass media activities and environmental changes. – Intervention duration 3 months.	BMI, blood lipids, nutrition knowledge and dietary changes.
Steenhuis, 2004 (Steenhuis et al., 2004)	A clustered randomised pre-test–post-test experimental design	17 worksite cafeterias (1013 respondents) of large Dutch companies and governmental organisations with mainly white collar workers were recruited through the head of catering organisations.	– 4 conditions: the educational programme; the food supply programme plus educational programme; the labelling programme plus educational programme; and a control group. – In the educational programme, determinants of eating less fat and more fruit and vegetables were targeted. – Food supply programme plus educational programme included an increased availability of low-fat products, fruit and vegetables. – Labelling programme plus educational programme: low-fat products in the 6 food categories (butter/margarine, milk, cheese, meat products, desserts and snacks) were labelled with a sign in front of the product. – Intervention duration was 6 months.	Changes in dietary behaviour (total fat, fruit + vegetable intake) during lunch in the worksite cafeteria. Sales data for some targeted product categories including milk, butter, cheese, meat products and desserts.
Sorensen, 1999 (Sorensen et al., 1999)	Cluster RCT	22 community health centres were randomly assigned to a minimal intervention, worksite intervention or worksite plus family intervention. No. of participants, n = 1359. No details regarding age.	– 3 intervention arms: – Control arm: minimal intervention (offered to all groups, included national 5-a-day media campaign, 5-a-day slide presentation and taste test) (8 sites). – The worksite intervention: employee advisory boards, individual behaviour change (media campaign per year, presentations, videos, group sessions and individual advice) and environmental change (increase in fruit and vegetables in vending machines, taste-tests and point-of-choice labelling of fruit and vegetables) (7 sites). – The worksite plus family intervention incorporated family-focused interventions into the worksite programme, including a learn-at-home programme, newsletter, family festival and materials mailings (7 sites). – Follow-up was at 19.5 months.	Fruit and vegetables servings/day, co-worker and household support for healthy eating, employee participation and changes in awareness.

Table 2
Fruit and vegetable consumption.

Study ID	Gender	Intervention setting	Intervention duration	Outcome measure	Baseline		Final follow-up		Effect Size
					Intervention [I]	Control [C]	Intervention [I]	Control [C]	
Backman, 2011	Men	Los Angeles, CA (USA) workplaces — manufacturing + food processing.	3 months	Fruit + veg: mean servings/day (FFQ)	N/A[a]	N/A[a]	N/A[a]	N/A[a]	Slope coefficient 0.13 ($p < 0.01$) SE 0.04[b]
Bandoni, 2010	Men and women	Workplaces — companies of Sao Paulo, Brazil	6 months	Fruit + veg: mean g/day (worker survey portions consumed at lunch converted into grams)	n = 651 104.85 g/day (95% CI 98.71,110.99)	n = 645 102.1 g/day (95% CI 94.89,109.31)	n = 630 123.03 g/day (95% CI 117.14,128.93)	n = 584 109.65 g/day (95% CI 103.28,116.02)	11.75 g/day (2.73, 20.77)[c] increase in consumption in the intervention group controlling for control group consumption.
Steenhuis, 2004	Men and women	Netherlands, Dutch companies	6 months	Fruit: mean servings/day (FFQ)	N/A[d]	N/A[d]	N/A[d]	N/A[d]	Effect sizes not reported. No significant differences between study groups (all p-values ≥0.16)[e]
				Vegetables: mean servings/day (FFQ)	N/A[d]	N/A[d]	N/A[d]	N/A[d]	
Beresford, 2001	Men and women	Seattle (USA) workplaces — manufacturers, healthcare, finance/legal, education, research, others	24 months	Fruit + veg: mean servings/day (abbreviated FFQ)	n = 1342 3.68 (SD not reported)	n = 1400 3.63 (SD not reported)	n = 1169 4.18 (SD not reported)	n = 1126 3.84 (SD not reported)	0.3 servings; $p < 0.05$[f] difference in change from baseline scores between intervention and control groups
Sorensen, 1999	Men and women	Boston, community health centres.	19.5 months	Fruit + veg: mean servings/day (7-item 'screener' FFQ)	WI[h] + FI[h] (n = not reported) 2.55 (SD not reported)	MI[h] (n = not reported) 2.66 (SD not reported)	WI[h] + FI[h] (n = not reported) 2.96 (SD not reported)	MI[h] (n = not reported) 2.62 (SD not reported)	WI[h] + FI[h] = 16% increase (approx. 0.4–0.5 servings) versus 2% decrease in control [$p < 0.05$ versus control][g] WI[h] = 3% increase (approx. 0.1 servings) versus 2% decrease in control [$p > 0.05$ versus control][g]
					WI[h] (n = not reported) 2.73 (SD not reported)		WI[h] (n = not reported) 2.81 (SD not reported)		

[a] Data on mean consumption at baseline and follow-up were not provided. There were 391 participants in the intervention and 137 in the control worksites. Participants were allowed to enter the study at any of the four assessment periods. Of the 528 participants, 175 completed the baseline questionnaire, 221 completed the week 4 questionnaire, 251 completed the week 8 questionnaire and 328 completed the week 12 questionnaire.
[b] Intervention effect estimated using growth curve analysis with hierarchical linear modelling. The slope co-efficient indicates change over the 4 assessments between the study groups.
[c] Estimate obtained from linear regression model for the difference (change from baseline) in the intervention group, adjusted for fruit and vegetable consumption in the control group and for sex, education and age of workers.
[d] Data on mean consumption at baseline and 6 month follow-up were not provided. There were three intervention groups: 1) LP + EP [n = 215], 2) FSP + EP [n = 290] and 3) EP [n = 293] and one control group: NP [n = 215].
[e] In a regression analysis using persons as unit of analysis, there were no significant differences at 1 month follow-up between study groups correcting for baseline consumption and educational level, BMI and shopping behaviour. These analyses were repeated with consumption scores months after the start of the intervention as the dependent variable (n = 621). There were no significant differences for all comparisons between intervention groups and between intervention and control groups.
[f] Mixed model regression with fixed treatment arm, random pair and pair by arm effects adjusted for baseline, age, gender, education, autonomy, time between end of intensive intervention and follow-up evaluation.
[g] Percentages of change adjusted for gender, education, occupation, race/ethnicity, and co-worker support.
[h] WI = worksite intervention (7 sites), FI = worksite plus family intervention (7 sites) and MI = minimal intervention (8 sites).

difference reported for self-purchasing of vegetables (slope coeff. 0.08, SE 0.05, $p > 0.05$) and family purchasing of fruit (slope coeff. 0.08, SE 0.05, $p > 0.05$). In another study, the sales proportions of low-fat products were measured and there were no findings reported comparing the food supply programme plus educational programme (dietary modification intervention), educational programme and the control groups (Steenhuis et al., 2004).

Assessment of quality of evidence

The assessment of the quality of included studies was impeded by incomplete reporting and consequently an 'unclear risk of bias' judgement was frequently reached for domains in the 'risk of bias' tool (Fig. 2). The risk of selection bias was judged to be acceptable in two studies for random sequence generation as one study used statistical software and the other study used a method of closed tickets. The remaining studies did not provide sufficient information on random sequence generation. For allocation concealment, the risk of selection bias was judged to be adequate in one study as closed tickets were used to randomly assign the condition to the groups. The method of allocation concealment was not described or was described in insufficient detail in the other studies. The risk of performance bias was judged to be high in one study as the participants were aware of the intervention and unclear in the remaining studies as there was inadequate information provided to determine whether the study participants and personnel were blinded to group allocation. The risk of detection bias was unclear in all included studies as there was insufficient information to decide if the outcomes measures were determined without knowledge of group assignment. Attrition bias was judged to be low in three studies as two studies imputed missing data using appropriate statistical methods. The remaining study reported a low attrition rate and the characteristics of the responders were not different to the non-responders. The risk of reporting bias was judged to be low in one study as the study protocol was available with preliminary results and the outcomes were reported in the pre-specified way. The remaining five studies provided inadequate detail to permit a judgement. All included studies were judged to be free of other sources of bias.

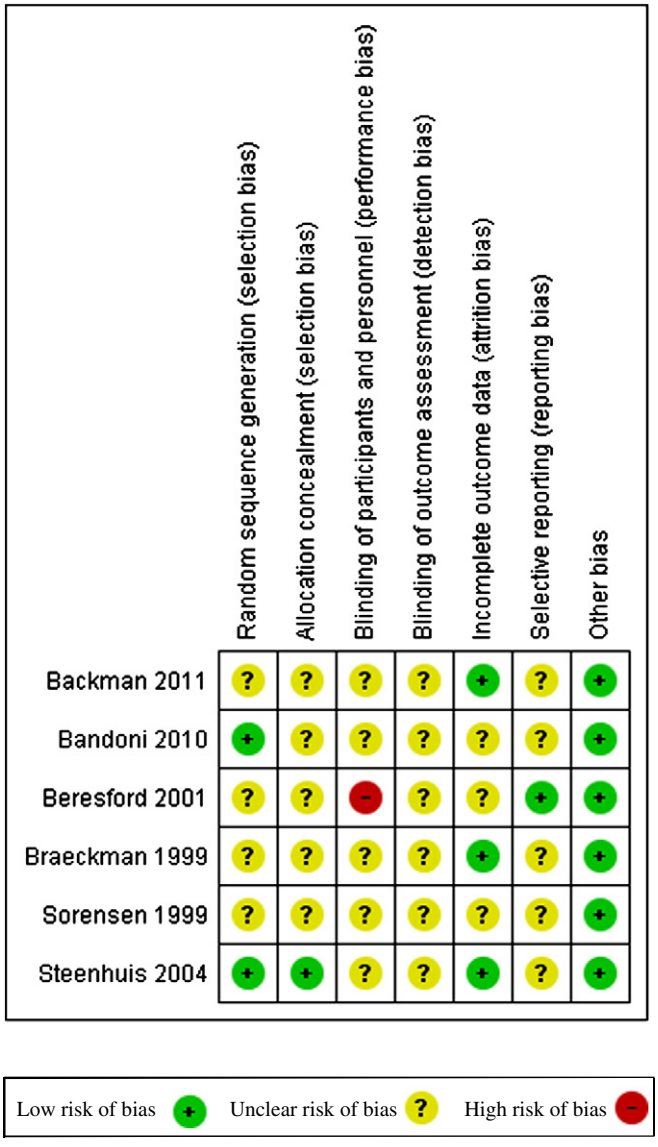

Fig. 2. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

Discussion

Main findings

This systematic review sought to evaluate the effects of workplace dietary modification interventions used either alone or in combination with nutrition education. Six studies that varied in duration from 3 to 24 months with 8443 participants were included. The methodological and clinical heterogeneity of the studies precluded meta-analysis and therefore a narrative summary of the results of each study was presented.

In one study, the intervention focused on dietary modification only (Backman et al., 2011). In the remaining studies dietary modification was combined with nutrition education (Bandoni et al., 2010; Beresford et al., 2001; Braeckman et al., 1999; Sorensen et al., 1999; Steenhuis et al., 2004). Only two studies based their intervention designs on a theoretical understanding including the stages of change model (Beresford et al., 2001) and an ecological model (Bandoni et al., 2010). None of the included studies complied with established guidelines to develop and evaluate complex interventions. Only two studies used Employee Advisory Boards (EAB) to involve employees in the development, implementation and monitoring of worksite interventions (Beresford et al., 2001; Sorensen et al., 1999).

All included studies measured a change in dietary behaviour from baseline to follow-up using self-reported dietary assessments (Backman et al., 2011; Bandoni et al., 2010; Beresford et al., 2001; Braeckman et al., 1999; Sorensen et al., 1999; Steenhuis et al., 2004). In four studies, the interventions improved employees' fruit and vegetable consumption. In three of these studies, food modification was combined with nutrition education (Bandoni et al., 2010; Beresford et al., 2001; Sorensen et al., 1999) and in the remaining study the intervention consisted of dietary modification only (Backman et al., 2011). Due to the limited duration of the studies it is unclear if these modest dietary improvements can be sustained over a long period of time. Three studies measured the change in fat intake. One study reported a statistically significant difference between the intervention and control groups for percentage of energy obtained from total fat and polyunsaturated fat while the other two studies found non-significant differences for total fat intake (Bandoni et al., 2010; Steenhuis et al., 2004). Some studies showed additional positive dietary changes including a statistically significant reduction in energy intake and a statistically significant increase in protein and carbohydrate intakes (Braeckman et al., 1999).

Clinical health status outcomes were reported in one study and showed a statistically significant increase in BMI and a statistically significant reduction of serum HDL cholesterol in the intervention group. The differences between the intervention and control groups were non-significant for mean serum total cholesterol levels and waist and hip ratio measures (Braeckman et al., 1999).

In a combined dietary modification and nutrition education intervention study, nutrition knowledge was significantly better in the intervention group when compared to the control group (Braeckman et al., 1999). There was a statistically significant intervention effect on reported co-worker support when the worksite intervention group, the worksite and family intervention group and the control group were compared (Sorensen et al., 1999). Self-efficacy towards eating two daily servings of fruit significantly increased in the dietary modification intervention groups when compared to the control groups but there was no significant difference reported in self-efficacy towards eating 3 daily servings of fruit, job satisfaction and perceived health (Backman et al., 2011). The same study found a statistically significant increase in self-purchasing of fruit and family purchasing of vegetables (Backman et al., 2011). Another study investigated the intervention effect on the sales proportions of low-fat products but no findings reported comparing the dietary modification intervention with the nutrition education or control groups (Steenhuis et al., 2004). However, isolated findings from individual studies require confirmation in additional studies.

Strengths and limitations

This systematic review was conducted in accordance with the PRISMA statement (Moher et al., 2009). We rated the risk of bias in included studies using the Cochrane Collaboration's risk of bias tool (Higgins et al., 2008). There was limited ability to draw conclusions due to the heterogeneity of interventions and outcomes and the limited quality of included studies. The instruments used to record dietary data varied between studies and there may have been differences in the accuracy with which dietary data were recorded in different studies. No conclusions can be drawn about the effects of workplace dietary modification interventions on attitudes, food habits, determinants of food choice, absenteeism, productivity, healthcare costs and profit margins as no studies reported these outcome measures. The review was confined to studies published in the English language and indexed in selected electronic databases. It is therefore possible that relevant unpublished studies, non-English language publications and studies indexed in other electronic databases may have been overlooked.

Comparisons with other reviews

Several reviews have evaluated the effectiveness of workplace interventions designed to promote healthy nutrition (Brunner et al., 2007; Engbers et al., 2006; Maes et al., 2012; Mhurchu et al., 2010; Pomerleau et al., 2005). These reviews differ significantly from each other and from this review in terms of the types of study designs included, the type of interventions evaluated and the types of outcome variables included. Despite these differences, some common themes emerge from these reviews in relation to issues such as the limited quality of the available evidence on the effectiveness of interventions and the inability to conduct formal meta-analyses of the results of included studies due to the heterogeneity of study designs, interventions and outcomes (Brunner et al., 2007; Engbers et al., 2006; Maes et al., 2012; Mhurchu et al., 2010; Pomerleau et al., 2005).

The findings of this review and previous reviews have reported that nutrition education and multi-component workplace dietary interventions have a moderate positive effect on dietary behaviour (Maes et al., 2012) in particular regarding fruit and vegetable consumption (Engbers et al., 2006; Mhurchu et al., 2010). Another review noted that workplace interventions focused on increasing fruit and vegetable intakes were most effective among participants at a higher risk of disease (Pomerleau et al., 2005). There is a consensus that workplace health promotion needs to surpass the realm of education and intervene at multiple levels of the worksite environment to have a sufficient influence on dietary behaviour (Engbers et al., 2006; Mhurchu et al., 2010).

Study implications

The quality of future trials evaluating the effects of workplace dietary modification interventions can be enhanced if the following key concepts are applied. Researchers should comply with the Medical Research Council's (MRC) recommended guidance for developing and evaluating complex interventions (Craig et al., 2008). Future studies of this kind should be reported using standardised guidelines like the TREND statement (Des Jarlais et al., 2004). The TREND statement recommends the measurement of standard outcomes and probes researchers to consider methods to control for bias and confounding. Standardised reporting will improve the quality of these studies and reduce the heterogeneity of future studies regarding study design, intervention design and outcomes. The follow-up period needs to be extended to over a year to accurately measure the long-term impact on dietary behaviour and to allow for dietary change due to seasonal variability. Outcomes such as employee absenteeism, productivity, healthcare costs and workplace profit margins should be measured to facilitate analyses of the cost-effectiveness of these workplace dietary modification interventions. Objective outcomes such as nutrient analysis of foods at workplaces, blood cholesterol, resting blood pressure and 24-h urinary analysis are important outcomes for future studies evaluating the effects of these interventions.

Intervention studies should also include assessment of dietary patterns outside the workplace to measure the true impact on dietary behaviour and investigate if other health compensatory behaviours are evident away from the work environment. The evaluation of the effects of these interventions could be enhanced by using mixed methods to examine not only 'what' changes using quantitative measures but also 'how' and 'why' these changes take place using qualitative measures (i.e. interviews). Detailed process evaluations using qualitative measures may facilitate the identification of critical elements in the success or failure of these interventions.

The implementation of future multi-level dietary interventions should also consider improving the physical, social and organisational environments in the workplace to allow maximum impact (Quintiliani et al., 2010). The WHO Concepts of Health Promoting Workplaces and the WHO Global Healthy Work Approach, outlines that key stakeholders that influence working life and employee participation are pivotal for effective development and implementation of workplace health promotion strategies (Chu et al., 2000). Additional work factors can also potentially affect dietary behaviour such as rotating work schedules, work-related stress, rest breaks, overtime and shift patterns (Lowden et al., 2010; Quintiliani et al., 2010).

Conclusion

There is limited evidence to suggest that workplace dietary modification interventions alone or in combination with nutrition education can increase fruit and vegetable consumption. It would be premature to recommend implementation of these interventions as the size of the effect is small. Ambiguity exists including the long-term effect on dietary behaviour, the absence of information on determinants of food choice, clinical health status and economic cost outcomes and the limited quality of existing research. Future complex dietary modification interventions should be designed using recommended guidelines, reported in standardised manner, developed according to the context of the study workplaces, have long-term follow-up periods and include objective measures for diet, health status and cost.

Contributions of authors

F.G. was primarily responsible for the final content of the paper and is the guarantor. F.G. and P.B. developed the protocol and selection criteria. F.G. developed the search strategy.

C.K., F.G. and J.H. applied the selection criteria. C.K. and F.G. designed the data extraction form. F.G., C.K., and J.H. were involved in the assessment of study quality. P.B. and F.G. were involved in the extraction and analysis of data relating to fruit and vegetable intake. F.G. analysed all additional data. All authors interpreted the results of the included studies. P.B., F.G., B.A.G. and I.J.P. co-wrote the paper. All authors approved the final version of the paper for publication.

Conflict of interest statement

The authors declare that there are no conflicts of interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.ypmed.2013.06.032.

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