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Review Article

Environmental interventions to promote healthier eating and physical activity behaviours in institutions: a systematic review

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Abstract

Objective: The present review evaluated the effectiveness of environmental-based interventions aimed at improving the dietary and physical activity behaviours and body composition indices of adults in institutions.

Design: A systematic review was conducted. Electronic databases (MEDLINE, Embase, PsycINFO, CINAHL, The Cochrane Library, Web of Science, ProQuest Dissertation and Theses, Scopus and Athena) were searched for relevant articles published between database inception and October 2017. Searching, selecting and reporting were undertaken according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.

Setting: Military establishments and maritime workplaces.

Participants: Adults in institutions, aged 18–45 years.

Results: A total of 27 842 articles were screened for eligibility, nine studies (reported in eleven articles) were included in the review. Five studies used multilevel strategies and four used environmental strategies only. Duration of follow-up ranged from 3 weeks to 10 years. Eight of the studies reported significant positive effects on dietary behaviours, but effect sizes varied. The study that targeted physical activity had no effect on activity levels but did have a significant positive effect on physical fitness. No evidence was identified that the studies resulted in improvements in body composition indices.

Conclusions: The evidence base appears to be in favour of implementing environmental interventions in institutions to improve the dietary behaviours of adults. However, due to the small number of studies included in the review, and the variable methodological quality of the studies and intervention reporting, further well-designed evaluation studies are required.

Keywords
Systematic review
Intervention
Health behaviours
Environment
Institutions

The prevalence of obesity among adults in the UK is increasing[1]. Evidence has been presented to Military Command demonstrating that the UK Armed Forces are not immune to this obesity epidemic[2–5]. This is of concern due to the inherent health[6], occupational[7,8] and economic risks[9] that this poses to the UK Armed Forces. Although the causes of overweight and obesity are complex and multifaceted, unhealthy diets and physical inactivity have been identified as major contributing factors[10,11] and should therefore be targeted in interventions which aim to reduce the prevalence of obesity among Service personnel.

Workplaces have been recognised as important settings for health promotion and disease prevention[12,13]. Interventions delivered in the workplace can offer an effective means of influencing the health behaviours of a broad captive audience through multiple levels of influence, by means of direct (e.g. health education and increasing opportunities for physical activity) or indirect efforts (e.g. changing social norms to promote healthier behaviours)[14].

There is an expanding evidence base that workplace interventions can improve the dietary[15–18] and physical activity behaviours of employees[17–21], which in turn may

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improve health and work-related outcomes[19]. However, the majority of reviews to date have focused on the effects of individual-level strategies (e.g. education) with few reviewing the effects of policy and environmental changes. As such, questions remain regarding the effectiveness of interventions which target multiple levels of the social system, where it is recognised that interventions targeting behaviour change are successful and sustainable only if the physical and social environments in which they are embedded are supportive[17,22–25].

Service personnel live and work in closed, semi-closed and open environments, where the level of constraint on their health behaviours is dependent upon the type and location of the establishment in which they are based. In a number of military establishments (e.g. onboard a warship) the environment is distinct from a traditional workplace, with Service personnel being a captive audience whose food and physical activity choices are constrained by the environment (i.e. a closed environment). A systematic review specifically evaluating environmental-based strategies targeted at improving the health behaviours of adults in such closed environments is lacking. Thus, the present systematic review aimed to evaluate the effectiveness of interventions, which included environmental strategies, aimed at improving the dietary and physical activity behaviours of adults in institutions (e.g. military establishments or ships). Specifically, it sought to determine which strategies were associated with improvements in diet, physical activity and body composition indices.

Methods

PROSPERO registration

The protocol for the present systematic review was registered on PROSPERO (registration number CRD42017076709) on 13 October 2017.

Literature search

The present systematic review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement[26]. Using Medical Subject Heading (MeSH) terms and text words, the following databases were searched for studies from database inception to October 2017: MEDLINE; Embase; PsycINFO; CINAHL; The Cochrane Library; Web of Science; ProQuest Dissertation and Theses; and Scopus. The reference lists of all identified reports and articles were searched for additional studies. An advanced search was conducted in Athena. Searches were limited to literature published in English. The strategy included a search for the following terms: Institutional Setting: (); AND Health Behaviour/Health Outcome: (); AND Intervention: () (see the online supplementary material).

Study inclusion/exclusion criteria

For a study to be included it needed to evaluate an intervention, comprising environmental changes, aimed at improving dietary intake and/or physical activity behaviours. The environmental intervention(s) had to comply with Hollands *et al.*'s[27] definition of environmental interventions, have been conducted within an institutional setting (e.g. military establishments, ship or prison), in a high-income economy as defined by the World Bank Group[28] and have targeted adults aged 18–64 years. Eligible interventions could be targeted at adults of any body composition, with or without identified risk factors or conditions. Studies were excluded if the focus was surgical or pharmaceutical.

Outcomes

Studies were eligible for inclusion if they reported the effects of the intervention on behavioural measures of physical activity behaviour and dietary intake or physiological measures associated with these behaviours. Primary outcomes were objective and subjective measures of physical activity behaviour and dietary intake. Secondary outcomes were objective and subjective measures of changes in body composition indices.

Study selection process

All potentially relevant abstracts were imported into Endnote and any duplicates were removed. The titles and abstracts of the remaining studies were screened by one reviewer (A.M.S.) and were scored as follows: 'positive' (if inclusion and exclusion criteria were certainly met); 'negative' (if inclusion and exclusion criteria were certainly not met); or 'unclear' (if the reviewer was unsure or if not enough detail was provided in the abstract to make a clear decision). The full text of articles scored as 'positive' or 'unclear' was retrieved and assessed for eligibility by two review authors (A.M.S. and E.L.P.). Discrepancies between the two authors were resolved through discussion with a third reviewer (S.A.W.). The reference lists of the included articles were manually searched for additional articles.

Study design

Data were included from controlled trials (with or without randomisation), before-and-after (BA) studies and cohort studies, where comparators could be other interventions or no treatment. Studies were categorised by study design using the National Institute for Health and Care Excellence guidelines[29].

Data extraction and risk of bias assessment

A standardised data extraction form was completed for all eligible studies. Data were recorded on study design, setting, intervention type, participant and intervention characteristics, study outcome measures and reported

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results. Depending on the study design, either the Cochrane Collaboration's risk of bias tool[30] or the risk of bias in non-randomised studies of interventions (ROBINS-I) tool[31] was used to assess potential biases in the included studies. The template for intervention description and replication checklist (TIDieR)[32] was used to evaluate the quality of reporting of the interventions, the typology of choice architecture interventions[27] was used to classify the types of environmental intervention, and the behaviour change technique taxonomy v1[33] was used to classify the types of behaviour change techniques that were employed in the interventions. Two review authors (A.M.S. and E.L.P.) extracted the information from all retrieved articles. Discrepancies between the two authors were resolved through discussion with a third reviewer (S.A.W.).

Data analysis

Meta-analysis was not possible due to the considerable heterogeneity in the design and quality of the studies, the types of interventions and outcomes measured. As such, a narrative summary of the results for each study is presented. Where possible, data provided were used to calculate and report standardised effect sizes for mean differences using a calculator provided by the Campbell Collaboration[34]. Effect sizes were used to quantify the size of the difference between two groups, such that the effectiveness of an intervention could be determined.

Results

Literature search

The search identified 27 842 potentially relevant articles. After the removal of duplicates, 24 130 articles remained. Of these articles, 24 111 were excluded following screening the titles, abstracts or both against the study inclusion and exclusion criteria. After full-text assessment of the nineteen remaining articles, eight articles were excluded because they did not meet one or more of the inclusion criteria. Checking the references of the eleven remaining articles produced no additional articles. Nine studies

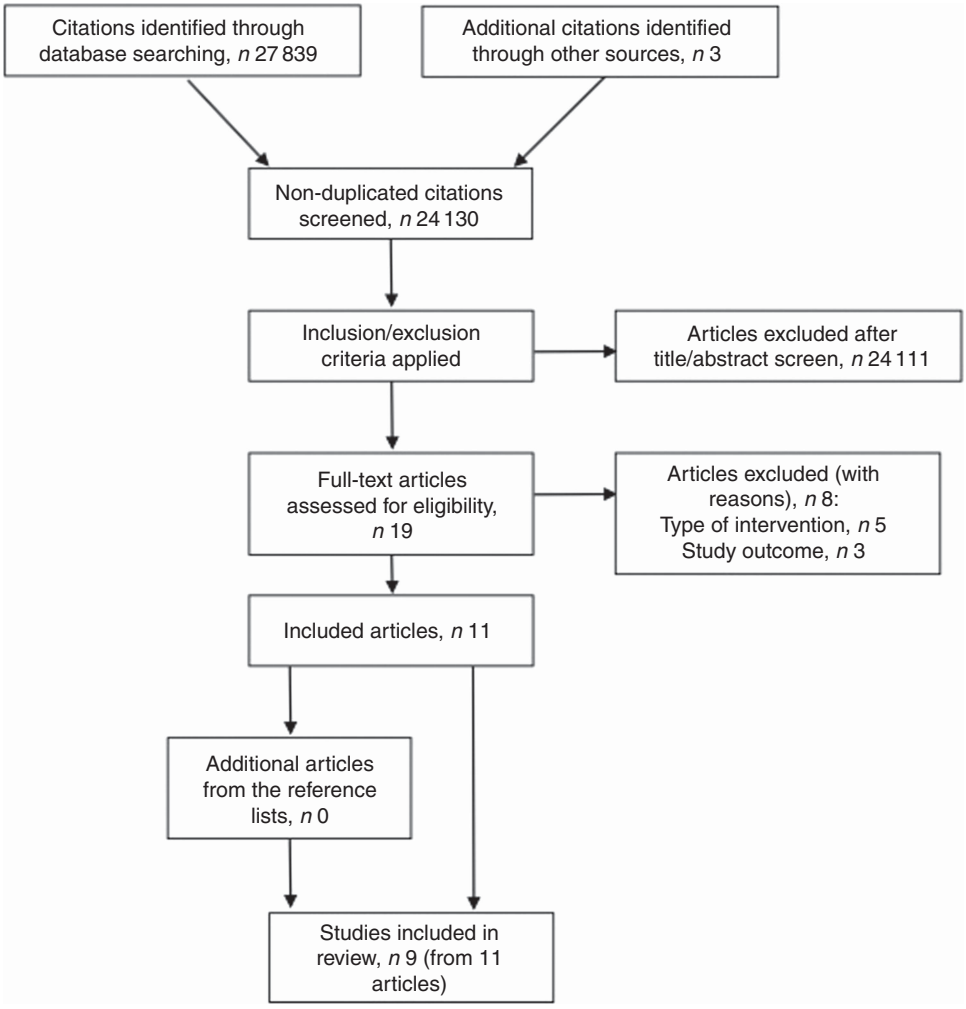

Fig. 1 Flowchart of study selection process for the present review on environmental interventions to promote healthier eating and physical activity behaviours in institutions

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(reported in eleven articles) were included in the systematic review[35–45]. Figure 1 presents a flowchart of the study selection process.

Study characteristics

Descriptions of the included studies are provided in Table 1. Studies were published between 1995 and 2016. The studies were conducted in the USA (*n* 5)[35,37,38,41,45], Denmark (*n* 2)[39,40,42], Finland (*n* 1)[36] and Norway (*n* 1)[43,44]. Settings included military bases (*n* 8)[35–38,40–45] and a shipping company (*n* 1)[39]. Study sizes ranged from 148 to 606 and from one to ten settings. There was a range of different study designs: one randomised controlled trial[45], one cluster-randomised controlled trial[37], four non-randomised controlled trials[35,36,38,43,44] and three BA studies[39–42].

Risk of bias

The risk of confounding bias (see Table 2 for an overview) was considered serious in two articles, moderate in four and low in three. Selection bias was considered moderate in four articles, low in five and unclear in two due to incomplete reporting. Allocation concealment, performance and detection bias were considered unclear due to incomplete reporting in the two articles assessed for these types of bias. Classification of intervention bias was considered low in all articles assessed (*n* 9). Deviation from intended intervention bias was considered serious in one article and low in eight. Attrition bias was considered serious in one article, moderate in five, low in four and unclear in one due to incomplete reporting. Outcome measurement bias was considered moderate in all articles assessed (*n* 9). Reporting bias, reflecting on whether the outcomes reported were pre-planned, was considered low in all the articles assessed (*n* 11). Risk of other bias not covered elsewhere was considered low in the two articles assessed.

Descriptions of the interventions

Of the nine interventions described in the eleven included articles, five were multicomponent[36,37,39,40,42–44] and four included environmental changes only[35,38,41,45]. The most commonly used strategies were making healthy changes to food content and/or options (*n* 7)[35–38,40,42–45], introducing health promotion information and/or education (*n* 4)[36,37,41,43,44], labelling food items (*n* 3)[35,36,41] and introducing cooking courses for canteen staff (*n* 2)[39,40,42]. Few interventions attempted to improve fitness facilities (*n* 1)[39], offer individual exercise guidance (*n* 1)[39] and offer individual health check-ups (*n* 1)[39]. Duration of follow-up ranged from 3 weeks to 10 years.

According to Hollands *et al.*'s typology (Table 3), eight interventions primarily altered the placement of objects or stimuli (*n* 8 availability (i.e. adding behavioural options within an environment))[35–40,42–45], four primarily altered the properties of objects or stimuli (*n* 3 labelling (i.e. applying labelling or endorsement information to product or at point of choice)[35,37,41] and *n* 1 presentation (i.e. altering sensory qualities or visual design of the product))[40,42] and one altered both the properties and placement of objects or stimuli through prompting (i.e. using non-personalised information to promote or raise awareness of a behaviour)[43,44].

The most frequently used behaviour change technique was restructuring the physical environment (*n* 8 (e.g. healthy changes to food options))[35–40,42–45], followed by using prompts/cues (*n* 3)[35,37,41] and using information about health consequences (*n* 2)[39,43,44]. Only one intervention used feedback on behaviour, biofeedback, feedback on outcome(s) of behaviour, social support, information on how to perform a behaviour and demonstration of behaviour[39].

Intervention reporting

According to the TIDieR checklist[32] (Table 4), all included articles specified the name of the intervention ('brief name'), described the rationale ('why'), reported the procedures applied ('what', 'procedures'), described the mode of delivery ('how'), described the location in which the intervention occurred ('where'), and described the period of time over which the intervention was delivered, or the dose or intensity of the intervention ('when and how much'). All articles except one described the materials used ('what', 'materials'). Four out of the nine articles did not adequately report who had delivered the intervention ('who provided'). Only one article reported whether the intervention was modified during the study ('modifications'), whether the intervention was tailored ('tailoring') and the actual adherence/fidelity ('how well', 'actual'). None of the articles reported the planned strategies for ensuring adherence/fidelity ('how well', 'planned').

Outcomes: effects of interventions

All nine interventions reported measures of dietary intake and one reported measures of physical activity. Dietary intake was measured objectively through sales data, digital photography/plate waste methods and weighed food intake in four interventions[35,37,40–42], and was based on self-reported data in five interventions[36,38,39,43–45]. Physical activity level was based on self-reported data[39]. Three of the nine interventions reported measures of body composition[38,39,45]. Two of these reported metabolic factors[38,39]. Other outcome measures reported included self-reported acceptability and satisfaction of changes (*n* 4)[35,37,44,45], physical fitness (*n* 2)[39,45] and nutrition knowledge (*n* 1)[43,44].

For the primary outcomes, of the four interventions that measured energy and nutrient intakes, all four reported significant positive effects. Effect sizes could be calculated

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Table 1 Summary of studies included in the present review on environmental interventions to promote healthier eating and physical activity behaviours in institutions

Study	Design	Setting	Sample	Intervention type	Intervention	Follow-up time	Main outcome measure(s)	Major findings
Belanger and Kwon (2016)[35]	Non-RCT	1 DFAC at 1 Army base, USA	CTL: $n_{surveys}$ 154, n_{photos} 135 INT: $n_{surveys}$ 131, n_{photos} 124	Environmental	Healthy changes to food content and options; food items labelled	3 weeks	Energy and nutrient intakes	Decreased: EI ($P<0·001$, $d=-0·65$), % energy from fat ($P<0·001$, $d=-0·46$), % energy from saturated fat ($P<0·01$, $d=-0·44$) Increased: % energy from CHO ($P<0·05$, $d=0·26$), Na intake ($P<0·001$, $d=-0·58$)
							Food selection quality	Decreased number of red-labelled items selected ($P<0·001$, $d=-1·42$) Increased number of green-labelled items selected ($P<0·001$, $d=1·02$)
							Number of healthy options	22 % less meals labelled red, 20 % more meals labelled green
							Self-reported satisfaction and meal acceptability	Increase in food appeal ($P<0·05$, $d=-0·19$)
Bingham *et al.* (2012)[36]	Non-RCT	2 garrisons, Finland	INT, *n* 362; CTL, *n* 242	Multicomponent	Healthy changes to food content and options; health promotion information introduced	8 weeks	Self-reported food intake	At FU: INT had a lower F&V index (IE: $P<0·01$, $d=0·48$, TE: $P<0·01$), fruit and berries intake (IE: $P<0·001$, $d=0·51$) and fat index (IE: $P<0·01$, $d=0·39$) *v.* CTL At FU: INT had a higher porridge and cereal intake (IE: $P<0·01$, $d=0·11$) *v.* CTL At FU *v.* B: increase in potato chip (IE: $P<0·05$, $d=0·30$, TE: $P<0·001$), soft drink (IE: $P<0·05$, $d=0·25$, TE: $P<0·05$) and dessert (IE: $P<0·01$, $d=0·54$, TE: $P<0·01$) intake was higher in CTL *v.* INT
Crombie *et al.* (2013)[37]	Cluster RCT	10 DFAC at 1 Army base, USA	INT: B, *n* 341; 6M, *n* 254; 12M, *n* 276 CTL: B, *n* 296; 6M, *n* 301; 12M, *n* 286	Multicomponent	Healthy changes to food content and options; food items labelled; health promotion information and education introduced	12 months	Energy and nutrient intakes	At 6M FU: INT had lower EI ($P<0·01$, $d=0·32$), total fat ($P<0·01$, $d=0·40$), % energy from fat ($P<0·01$, $d=0·38$) and saturated fat ($P<0·01$, $d=0·44$) and higher % energy from CHO ($P<0·01$, $d=0·41$) *v.* CTL At 12M FU: INT had higher % energy from CHO ($P<0·01$, $d=0·05$) and lower % energy from protein ($P<0·01$, $d=0·46$) *v.* CTL

Table 1 *Continued*

Study	Design	Setting	Sample	Intervention type	Intervention	Follow-up time	Main outcome measure(s)	Major findings
								INT at 6M and 12M FU *v.* B: EI, total fat and % energy from fat were lower and percentage % from CHO was higher ($P<0·01$)
							Food selection quality	At FU: INT had lower intake of refined grains ($P<0·01$, $d=0·11$) *v.* CTL, no difference in intake of whole grains or F&V, INT had lower refined grains intake *v.* B
							Self-reported satisfaction and meal acceptability	Customer satisfaction significantly higher for INT *v.* CTL
Fiedler *et al.* (1999)[45]	RCT	1 Air Force base, USA	INT, *n* 402; CTL, *n* 422	Environmental	Healthy changes to food content	6 weeks	Self-reported: food and nutrient intake; DQI	At FU: larger improvement in DQI for INT *v.* CTL, % energy from fat was lower for INT *v.* CTL, daily servings of CHO increased for INT and decreased for CTL, F&V intake decreased for both groups, no change in protein intake for INT but a 20 % reduction for CTL
							Cost-effectiveness	New menus were 20 % more expensive and not within allowance
							Self-reported satisfaction	No differences between groups
							Body weight	No differences between groups
							Physical fitness	No differences between groups
Friedl *et al.* (1995)[38]	Non-RCT	1 military academy, USA	INT, *n* 205; CTL, *n* 190	Environmental	Healthy changes to food content and options	10 years	Self-reported: energy and nutrient intakes	Decreased: EI in male cadets ($P<0·05$, $d=0·25$); fat intake ($P<0·01$, $d=1·1$); % energy from fat and alcohol
								Increased: CHO intake ($P<0·01$, $d=-0·50$ males, $d=-0·57$ females); % energy from CHO; number of cadets deriving <35 % of their EI from fat
								No change: protein intake
							Metabolic factors	Trend to support a more favourable lipid profile
							Body fat	No changes
Hjarnoe and Leppin (2013)[39]	BA	2 shipping companies, Denmark	*n* 606	Multicomponent	Cooking course for chefs; improved fitness facilities; individual exercise guidance; individual health check-ups	1 year	Exercise level	No changes
							Overeating frequency	No changes
							Self-reported high-sugar-product intake	Decreased % of participants reporting frequent intake of high-sugar products ($P<0·05$)
							WC	No changes
							Physical fitness	Increase in % of participants with a high fitness score ($P<0·001$)
							Metabolic syndrome	Reduction in participants with metabolic syndrome ($P<0·05$)

Table 1 *Continued*

Study	Design	Setting	Sample	Intervention type	Intervention	Follow-up time	Main outcome measure(s)	Major findings
							Fidelity	30 % received exercise guidance (37 % received FU guidance); 54 % received extra health check; 75 % of chefs attended cooking course; 64 % of ships requested a fitness facility upgrade (70 % reported improvements)
Lassen *et al.* (2004)[40]	BA	1 military base, Denmark	*n* 190	Multicomponent	Cooking and health promotion course for canteen staff; healthy changes to food content and options	8 months	F&V consumption F&V content of meals	Increase in daily consumption of F&V ($P<0·001$, $d=-1·4$) Increase in F&V content of the hot meal ($P<0·001$, $d=-1·97$)
Thorsen *et al.* (2010)[42]	BA	1 military base, Denmark	*n* 148	Multicomponent	Cooking and health promotion course for canteen staff; healthy changes to food content and options	5 years	F&V consumption	Compared with 8-month FU: decrease in daily consumption of F&V ($P<0·05$) Compared with B: no changes
Sproul *et al.* (2003)[41]	BA	1 Army base, USA	*n* 149	Environmental	Food items labelled; health promotion information	5 weeks	Sales data	No differences in sales of targeted entrées; 60 % of respondents reported noticing the promotional materials
							Meal selection decisions and attitudes towards nutrition	79 % of respondents reported that the materials did not influence their meal selection decisions; 75 % reported that the materials did not influence their attitude about nutrition for the better
Uglem *et al.* (2014)[43]	Non-RCT	2 military camps, Norway	INT, *n* 374; CTL, *n* 105	Multicomponent	Healthy changes to food content and options; health promotion materials and information introduced	5 months	Self-reported food intake	At FU: higher intake of vegetables, fruits and semi-wholegrain bread for INT *v.* CTL ($P<0·05$) INT at FU: groups with a low and medium intake at B had a higher intake of vegetables, fruits and semi-wholegrain bread ($P<0·001$); the lowest group had the highest percentage increase; no change in the high-intake group CTL at FU: group with low intake at B had higher intake of vegetables, fruits and semi-wholegrain bread ($P<0·05$); no change in the medium-intake group; reduction in the high-intake group ($P<0·001$)
							Nutritional knowledge	At FU: INT increased knowledge ($P<0·001$); INT had higher knowledge *v.* CTL ($P<0·001$)

Table 1 *Continued*

Study	Design	Setting	Sample	Intervention type	Intervention	Follow-up time	Main outcome measure(s)	Major findings
Uglem *et al.* (2013)[44]	Non-RCT	2 military camps, Norway	INT, *n* 374; CTL, *n* 105	Multicomponent	Healthy changes to food content and options; health promotion materials and information introduced	5 months	Self-reported food intake	At FU in INT group: increase in vegetable ($P<0·001$), fruit ($P<0·05$) and semi-wholegrain bread ($P<0·001$) and decrease in potato ($P<0·001$) intake; reduction of recruits consuming <150 g vegetables ($P<0·001$) At FU in CTL group: no change in vegetable or semi-wholegrain bread intake, decrease in fruit ($P<0·05$) and potato ($P<0·001$) intake; no change in frequency of recruits consuming <150 g vegetables At FU INT *v.* CTL: vegetable, fruit and semi-wholegrain bread intakes were higher ($P<0·001$) and potato intake was lower ($P<0·001$)
							Nutritional knowledge	At FU: INT increased knowledge ($P<0·001$); CTL no change
							Self-reported satisfaction	No significant differences between groups

BA, before and after; RCT, randomised controlled trial; DFAC, dining facility; CTL, control; INT, intervention; B, baseline; 6M, 6 months; 12M, 12 months; DQI, diet quality index; WC, waist circumference; F&V, fruit and vegetables; EI, energy intake; CHO, carbohydrates; FU, follow-up; IE, intervention effect; TE, time effect.

Table 2 Risk of bias in studies included in the present review on environmental interventions to promote healthier eating and physical activity behaviours in institutions

Study	Confounding bias	Selection bias	Allocation concealment bias	Classification of interventions bias	Deviations from intended interventions bias	Performance bias	Detection bias	Attrition bias	Outcome measurement bias	Reporting bias	Other bias
Belanger and Kwon (2016)[35]	Moderate	Low	n/a	Low	Low	n/a	n/a	Moderate	Moderate	Low	n/a
Bingham *et al.* (2012)[36]	Low	Low	n/a	Low	Low	n/a	n/a	Unclear	Moderate	Low	n/a
Crombie *et al.* (2013)[37]*	n/a	Unclear	Unclear	n/a	n/a	Unclear	Unclear	Low	n/a	Low	Low
Fiedler *et al.* (1999)[45]*	n/a	Unclear	Unclear	n/a	n/a	Unclear	Unclear	Low	n/a	Low	Low
Friedl *et al.* (1995)[38]	Moderate	Moderate	n/a	Low	Low	n/a	n/a	Moderate	Moderate	Low	n/a
Hjarnoe and Leppin (2013)[39]	Serious	Moderate	n/a	Low	Serious	n/a	n/a	Serious	Moderate	Low	n/a
Lassen *et al.* (2004)[40]	Serious	Low	n/a	Low	Low	n/a	n/a	Low	Moderate	Low	n/a
Thorsen *et al.* (2010)[42]	Moderate	Low	n/a	Low	Low	n/a	n/a	Low	Moderate	Low	n/a
Sproul *et al.* (2003)[41]	Moderate	Low	n/a	Low	Low	n/a	n/a	Moderate	Moderate	Low	n/a
Uglem *et al.* (2014)[43]	Low	Moderate	n/a	Low	Low	n/a	n/a	Moderate	Moderate	Low	n/a
Uglem *et al.* (2013) [44]	Low	Moderate	n/a	Low	Low	n/a	n/a	Moderate	Moderate	Low	n/a

n/a, not applicable for type of study.
Risk of bias assessed using the risk of bias in non-randomised studies of interventions (ROBINS-I) tool, except where noted otherwise.
*Risk of bias assessed using the Cochrane Collaboration's risk of bias tool.

Table 3 Classification, according to the Hollands *et al.*[27] emergent typology of choice architecture interventions, of studies included in the present review on environmental interventions to promote healthier eating and physical activity behaviours in institutions

	Coding of included studies by intervention type								
	Alter properties			Alter placement			Alter both properties and placement		
Study	Ambience	Functional design	Labelling	Presentation	Sizing	Availability	Proximity	Priming	Prompting
Belanger and Kwon (2016)[35]	N	N	Y	N	N	Y	N	N	N
Bingham *et al.* (2012)[36]	N	N	N	N	N	Y	N	N	N
Crombie *et al.* (2013)[37]	N	N	Y	N	N	Y	N	N	N
Fiedler *et al.* (1999)[45]	N	N	N	N	N	Y	N	N	N
Friedl *et al.* (1995)[38]	N	N	N	N	N	Y	N	N	N
Hjarnoe and Leppin (2013)[39]	N	N	N	N	N	Y	N	N	N
Lassen *et al.* (2004)[40] and Thorsen *et al.* (2010)[42]	N	N	N	Y	N	Y	N	N	N
Sproul *et al.* (2003)[41]	N	N	Y	N	N	N	N	N	N
Uglem *et al.* (2013 and 2014)[43,44]	N	N	N	N	N	Y	N	N	Y

N, absence of intervention type; Y, presence of intervention type.

for three interventions; Cohen's d ranged from 0·05 to 1·10 (no effect to a large-sized effect). Of the eight interventions that measured food intake and/or food selection quality, seven reported significant positive effects. However, one of these interventions reported no effects on some measures[37] and one reported negative effects on some measures, including fruit intake[36]. Effect sizes could be calculated for three interventions; Cohen's d ranged from 0·11 to 1·42 (no effect to a large-sized effect). No significant effects were reported in the intervention that measured physical activity levels. For the secondary outcomes, none of the three interventions that measured body composition indices reported significant effects. Of the two interventions that measured metabolic factors, one reported a trend to support a more favourable lipid profile and one reported a significant reduction in participants with metabolic syndrome.

For the other outcomes, of the four interventions that measured self-reported satisfaction, two reported significant positive effects. Effect sizes could be calculated for one intervention; Cohen's d was 0·19 (no effect). One out of the two interventions that measured physical fitness reported a significant positive effect, and a significant positive effect was reported in the one intervention that measured nutrition knowledge. Effect sizes could not be calculated for these measures.

For the eight interventions which altered the placement of objects or stimuli through increasing the availability of healthier food options[35–40,42–45], the effects did not differ from the overall findings.

Of the three interventions which applied labelling to foods at the point of choice[35,37,41], two interventions reported significant positive effects on energy and nutrient intakes (effect sizes d = 0·05–0·65, no effect to medium-sized effect), food intake and/or food selection quality (effect sizes d = 0·11–1·42, no effect to large-sized effect) and self-reported satisfaction (effect size d = 0·19 (one intervention), no effect). One of the three interventions reported no significant effects on some measures of food intake[37]. There were no differences in the sales of targeted entrées in the intervention by Sproul *et al.*[41], with 79 % of respondents reporting that the materials did not influence their food selection.

The one intervention that improved the presentation of healthier food options[40,42] reported significant positive effects on food intake (effect size d = 1·40, large-sized effect). The one intervention that used prompting[43,44] reported significant positive effects on food intake and nutrition knowledge (no effect size calculated), but no changes in self-reported satisfaction.

Discussion

The aim of the present review was to systematically examine the effectiveness of interventions, which included

Table 4 Coding, against TIDieR criteria[32], of studies included in the present review on environmental interventions to promote healthier eating and physical activity behaviours in institutions

Study	Brief name	Why	What		Who provided	How	Where	When and how much	Tailoring	Modifications	How well	
			Materials	Procedures							Planned	Actual
Belanger and Kwon (2016)[35]	82	83	84	84	84	84	83	84	X	X	X	X
Bingham *et al.* (2012)[36]	2	2	4	3–4	X	3–4	2	4	X	X	X	X
Crombie *et al.* (2013)[37]	921	921	922–923	922–924	923	922–924	921	921	X	X	X	X
Fiedler *et al.* (1999)[45]	155	155	156	156, 158	156, 158	156, 158	155–6	156	X	158	X	X
Friedl *et al.* (1995)[38]	527	527	527	527	X	527	527	527	X	X	X	X
Hjarnoe and Leppin (2013)[39]	5	2	5	5	5	5	3	5	X	X	X	7, 8
Lassen *et al.* (2004)[40]	264	264	264, 267	264, 267	X	267	264	264	264	X	X	X
Thorsen *et al.* (2010)[42]	1647	1647	X	1648	X	1648	1648	1648	X	X	X	X
Sproul *et al.* (2003)[41]	557	557	557	557	557	557	557	557	X	X	X	X
Uglem *et al.* (2014)[43]	1013	1013	1015	1015	1015	1015	1013	1014	X	X	X	X
Uglem *et al.* (2013)[44]	2	2	2–4	2–4	2, 3	2–4	2	2	X	X	X	X

TIDieR, template for intervention description and replication checklist.
X means no information provided, number indicates article page number.

environmental strategies, aimed at improving the dietary and physical activity behaviours of adults in institutions. The current evidence base appears to be in favour of implementing environmental interventions in institutions to improve the dietary behaviours of adults. However, it was difficult to draw conclusions concerning the effectiveness of environmental interventions on improving physical activity behaviours or body composition indices, or to make clear recommendations about the content and delivery of interventions, due to the small number of studies and the variable methodological quality of the studies and intervention reporting included in the review.

Across the nine interventions included, eight produced significant positive effects on dietary behaviours. Reported effects included: decreased energy intake; decreased percentage energy from fat and saturated fat, and increased percentage energy from carbohydrates; positive changes in the number of red- and green-labelled items purchased; reductions in the proportion of participants reporting frequent intakes of high-sugar products; and increases in fruit and/or vegetable consumption. Effect sizes could not be calculated for all studies. Where they could be calculated, there was considerable variation between and within studies, with effect sizes ranging from no effect to large-sized effects. Only one of the nine interventions used strategies to improve physical activity levels[39]. There was a significant positive effect on physical fitness but no effect on self-reported activity levels. A possible reason for the lack of effectiveness was poor fidelity: less than half of the ships included in the study reported actual improvements in fitness facilities; and less than a third of participants reported receiving exercise guidance.

No evidence was identified that the interventions included in the review resulted in significant positive changes in body measurement and/or body composition indices, although this was measured in only one-third of the studies. A possible explanation for this is that extensive lifestyle changes are required to affect body composition. Compensatory behaviours (e.g. dietary intake at the evening meal) were not measured in any of the included studies. Thus, although the interventions improved the dietary behaviours of participants during the meal times assessed, it was unknown whether this led to compensatory behaviours at other meals or between meals (e.g. snacking behaviour).

Similar to the findings reported by Allan *et al.*[46], the types of intervention strategies most commonly employed in the interventions included in the review were increasing the availability of healthier options and food labelling. Only one intervention altered the presentation of foods on offer, and one introduced prompts to the environment. The interventions included in the review contained between one and five different components. Four of the interventions used environmental strategies only, and five used multilevel strategies. This made it difficult to identify

precisely what worked and for whom. As positive effects on dietary behaviours were reported in eight out of nine of the interventions, it could be assumed that all types of environmental strategies applied across the interventions were successful to some degree and that potentially it was the multilevel and multicomponent nature of the interventions that was successful.

In the study that reported no significant positive effects[41], labelling and health promotion information focusing on health attributes were used unsuccessfully to increase sales of healthier meal options. The authors suggested that a better strategy would have been to highlight the sensory attributes of healthier foods such as taste and quality. In contrast, two other interventions included in the review that used point-of-purchase labelling reported positive effects. These interventions used multiple environmental strategies. As such, it cannot be determined whether food labelling *per se* was a successful strategy.

The duration of follow-up in the studies ranged from 3 weeks to 10 years, with less than half of the studies incorporating follow-up times of 1 year or longer. One of the studies that included two follow-up points reported that, at the second follow-up point at 5 years, there was a failure to sustain the increase in fruit and vegetable intake that was achieved at the first follow-up point[42]. To determine the duration of beneficial effects after an intervention has ended long-term follow-up studies are required[17,47].

Comparison with other reviews

The findings from the present systematic review are broadly comparable with those of other reviews undertaken in a workplace setting. The present and previous reviews have reported that health promotion interventions that include environmental strategies have a positive effect on dietary behaviours[15–17,21,46,48–50]. As in the present review, Engbers *et al.*[21] reported inconclusive evidence for an effect on physical activity, whereas other reviews[17,49,50] have reported that multicomponent interventions incorporating individual-level and environmental strategies improved physical activity behaviours. Similar to the present review, the reviews undertaken by Allan *et al.*[46] and Engbers *et al.*[21] reported little evidence that health promotion interventions have an effect on body composition indices. Conversely, other reviews have reported that interventions achieved modest improvements in weight status, which might be explained by these reviews including studies where changes in weight was a primary outcome[49,51,52].

In the present review, the most commonly used environmental strategies were increasing the availability of healthier options and food labelling. This was also the case in the review undertaken by Allan *et al.*[46]. Due to the numerous strategies that were employed by the interventions in the present review, it is difficult to identify precisely what worked and for whom. Previous reviews have also reported that it is difficult to determine the effective components of interventions and suggest that interventions should be multilevel and multicomponent[15,17,21,46,49,52].

Methodological quality of studies

Only two out of the nine studies employed a randomised or cluster-randomised controlled design. The quality assessment indicated several common methodological limitations across the studies, which were common to previous workplace reviews[15–17,21,46,48]. A possible explanation of this is due to studies being performed in institutions, where organisational and logistical problems may have compromised the strength of the research design. A particular cause for concern was the use of self-reported methods of outcome measurement, where five out of the nine studies used self-reported measures of behaviour. This may have caused recall or reporting bias and resulted in no blinding of the outcome assessment. Other issues with using self-report methods to measure dietary and physical activity behaviours are that it takes time and effort to complete diaries, which may be an intervention in itself (self-monitoring) and may therefore obscure the impact of the intervention. Future research should therefore use valid and reliable measures to assess behaviours and where possible use these in combination with objective measures.

Other limitations of the studies included the: lack of concealed intervention allocation; lack of assessment of compensatory behaviours; variable reporting quality including insufficient reporting of effect sizes (or data to allow their calculation); and the absence of intention-to-treat analyses, which may have led to the under- or over-estimation of effects. There were also sampling limitations and the lack of use of validated questionnaires in some of the studies. Generalisation of the findings to other contexts is limited by the fact that all the studies were conducted in the USA or Northern European countries. This highlights the need for further well-designed evaluation studies.

The impact of an intervention is maximised when attrition is low. In the present review there was considerable variation in attrition bias between the included studies. It is important that strategies are identified to sustain participant involvement. This could be achieved by exploring the feasibility and acceptance of interventions and including some involvement from the target population during the development of the intervention, which was the case in three of the studies included in the review. Self-reported satisfaction was measured in two out of five of the studies that were classified as having a moderate to serious risk of attrition bias[35,43,44]. In one study there was no effect of the intervention on satisfaction and in the

other study food appeal rating increased after the intervention, suggesting that attrition was not a result of the intervention itself.

One notable finding from the coding of the interventions against TIDieR guideline recommendations was that the majority of studies failed to report planned or actual strategies to assess adherence or fidelity. Fidelity is an important component of programme evaluation, which enables researchers and practitioners to understand how and why an intervention works, and the extent to which outcomes can be improved.

Limitations

Limitations of the present review should be taken into account when interpreting the findings. One potential limitation is the literature search. The search was limited to articles published in the English language, which may have resulted in relevant studies published in other languages being missed. Second, it is possible that the search did not identify all published studies, which might have resulted in selection bias. This was minimised by checking the references of the articles retrieved in the search. A third issue that should be considered is publication bias due to selective publishing of studies demonstrating positive outcomes. A further limitation of the present review was that the heterogeneity of design, interventions and outcome measures negated a quantitative synthesis of results by meta-analysis. In addition, effect sizes could not be calculated for all studies or all measured variables.

Conclusions

In conclusion, the evidence base appears to be in favour of implementing environmental-based interventions in institutions to improve the dietary behaviours of adults. However, due to the multilevel and multicomponent nature of the intervention studies it is difficult to determine which strategies were successful and which were not. Environmental strategies that were typically employed in the interventions targeted reducing barriers, increasing opportunities for and accessibility of healthy choices, restricting the availability of less healthy options, and increasing cues to healthy behaviour.

It is difficult to draw conclusions concerning the effectiveness of environmental-based interventions at improving the physical activity behaviours or the body composition indices of adults in institutions. Furthermore, it is difficult to make clear recommendations about the content and delivery of environmental-based interventions that aim to improve the dietary and physical activity behaviours and body composition indices of adults in institutions, due to the small number of studies included in the review and the variable methodological quality of the studies and intervention reporting. Further well-designed evaluation studies are required.

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Supplementary material

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