

Weighing up the evidence: a systematic review of the effectiveness of workplace interventions to tackle socio-economic inequalities in obesity

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ABSTRACT

Background Addressing socio-economic inequalities in obesity is a public health priority and the workplace is seen as a potential health promotion site. However, there is a lack of evidence on what works. This article systematically reviews studies of the effects of workplace interventions on socio-economic inequalities in obesity.

Methods Following PRISMA guidelines, we searched for published or unpublished experimental and observational evaluation studies. Nine electronic databases were searched as well as websites and bibliographies. Included studies were data extracted, quality assessed and narratively synthesized.

Results Eighteen studies were included of which 14 examined behavioural interventions and 4 mixed or environmental ones. While most studies ($n = 12$) found no effects on inequalities in obesity—and a minority found increases ($n = 3$), there was also some evidence of potentially effective workplace interventions ($n = 3$) especially in terms of physical activity interventions targeted at lower occupational groups.

Conclusion There is experimental evidence that workplace delivered physical activity interventions have the potential to reduce inequalities in obesity by targeting lower occupational groups. However, overall, the evidence base is small, largely from the USA, and of a low quality. More high-quality, experimental study designs are required.

Keywords obesity, workplace, interventions, socio-economic status (SES), inequalities

Background

Tackling obesity is one of the major contemporary public health policy challenges and is vital in terms of addressing health inequalities.^{1,2} Obesity is causally linked to diabetes, coronary heart disease, stroke, hypertension, osteoarthritis and certain forms of cancer. Socio-economic inequalities in obesity and risk factors for obesity are large and widening.^{1,3–6} For example, in some areas of the UK, obesity rates in the most deprived areas are almost double those in the most affluent areas.^{7,8} Addressing inequalities in obesity therefore has a very high profile on the public health agenda internationally, nationally and locally.

However, there is increasing recognition that tackling inequalities in obesity requires integrated policy action across

different levels,^{1,9} targeting the broader societal determinants of obesity.⁴ This is because the aetiology of obesity is complex—it is the outcome of important structural drivers in the food system and in the contemporary organization of society. Settings-based approaches, as proposed by the Ottawa Charter for health promotion and alluded to in the Foresight

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Review,¹ have therefore been proposed as potentially important ways in which inequalities in obesity can be reduced.

Workplaces are potentially promising settings for health promotion given that adults spend a substantial amount of their time at work, they are controlled environments, and have existing delivery infrastructure and social networks.¹⁰ The workplace is also widely recognized as a social determinant of health and health inequalities,¹¹ with both the physical and the psychosocial work environments themselves associated with obesity.¹² The workplace is therefore considered to be one of the ways in which interventions can address inequalities via action on the social and behavioural determinants of health—living and working conditions.¹³

However, existing systematic reviews only examine the effects of workplace interventions that reduce overall levels of obesity, as opposed to the effects on *inequalities* in obesity.^{14–17} There is, therefore, no information to help policymakers and service commissioners assess what types of workplace interventions are most effective at reducing inequalities in obesity. Further, systematic reviews in public health have seldom examined the implementation of interventions. Context is increasingly recognized as an important factor in the success of public health interventions.¹⁸ Similarly, questions around implementation have been shown to be important in relation to other types of workplace interventions.¹⁹ However, the assessment of implementation has not really featured strongly in previous systematic reviews.

Against this backdrop—and as part of a wider review of individual, community and societal level interventions to reduce inequalities in obesity (<http://www.nets.nihr.ac.uk/projects/phr/09301014>), the objectives of this systematic review were twofold:

- (1) To systematically review the effectiveness of workplace interventions in reducing socio-economic inequalities in obesity; and
- (2) To establish how such interventions are organized, implemented and delivered.

The aim of the review was to determine if inequalities in obesity (differences in the prevalence of obesity by SES) can be reduced by workplace interventions.

Methods

This article is part of a wider systematic review funded by the National Institute for Health Research (NIHR) to examine the effectiveness of interventions to reduce inequalities in obesity in a whole systems way (<http://www.nets.nihr.ac.uk/projects/phr/09301014>). The review was registered with PROSPERO (registration number: CRD42013003612) and

the protocol is available online.²⁰ This article reports only on the findings of the subset of studies of workplace interventions.

Inclusion/exclusion criteria

Studies of adults aged over 18 years, in any country, in any language were included. Interventions had to be implemented in actual workplaces and so non-workplace laboratory-based studies were excluded. Any behavioural (e.g. health education or exercise), environmental (such as removal of unhealthy foods, replacement of lifts with stairs) or organizational (e.g. changes to working hours) workplace interventions were included. Interventions were also classified in terms of whether they took a universal approach and included participants of all socio-economic status or a targeted approach i.e. they were aimed at low occupation participants only.²¹

Measures and proxy measures of SES were income, education, occupation or area level disadvantage. In terms of outcomes, we only included studies if they included a primary outcome for obesity. Obesity was measured in terms of proxies for body fat (weight and height; BMI; waist measurement/waist-to-hip ratio; percentage of fat content; skin fold thickness). Both objective and self-reported measures were included. Interventions involving drugs or surgery were excluded.

In keeping with previous workplace reviews, we included experimental (including cluster trials) and observational evaluation studies (prospective and retrospective with or without control groups).^{22–24} Only studies with duration of at least 12 weeks (combination of intervention and follow-up) were included.

Searches

Nine databases were searched from their start dates to 11th October 2012: MEDLINE; EMBASE; CINAHL; PsycINFO; Social Science Citation Index; ASSIA; IBSS; Sociological Abstracts; and the NHS Economic Evaluation Database. We searched for documents of any type, from any country, at any time and in any language using terms related to intervention, outcome and study design. The electronic database searches were supplemented with website and grey literature searches. The skills of a trained information scientist (H.J.M.) were used to develop and implement the electronic searches—which were piloted and refined as part of the peer review of our NIHR application and published protocol.²⁰ The searches were conducted as part of a much wider NIHR systematic review and as such covered a variety of interventions—not just workplace ones. The searches were also deliberately broad and inclusive so that the full papers of all studies

which fitted our population, intervention, design and outcome inclusion criteria would be examined—even if there was no mention of socio-economic inequalities in the abstract. This strategy meant that the review was less likely to exclude studies which undertook subgroup analyses by socio-economic status but did not mention the findings in the title or abstract. This increased the comprehensiveness of the electronic search strategy, although it obviously resulted in a higher number of hits. The full search strategy is available in Supplementary data, Appendix S1.

Data extraction and quality assessment

The initial screening of titles and abstracts was conducted by one reviewer (F.C.H.) with a random 10% of the sample checked by a second reviewer (H.J.M. or J.M.C.). Agreement between the reviewers was fair ($\kappa = 0.68$). The screening of the full papers was conducted by one reviewer (F.C.H.) with a random 10% of sample checked by a second reviewer (J.M.C.). Agreement between the reviewers at this stage was good ($\kappa = 0.93$). Data extraction and methodological quality appraisal of the included studies were conducted by one reviewer (F.C.H. or J.M.C.) using established data extraction forms and checked by a second reviewer (F.C.H. or J.M.C.). Any discrepancies were resolved through discussion between the authors and, if consensus was not reached, with the

project lead (C.B.). Methodological quality was appraised independently by two reviewers using the Cochrane Public Health Review Group recommended Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies^{25,26} (Supplementary data, Appendices S2 and S3). Any discrepancies were resolved through discussion between the authors and, if consensus was not reached, with the project lead.

Implementation

Data on the organization, implementation and delivery of interventions were extracted by adapting and refining the Egan and colleagues methodological tool for the assessment of implementation of complex public health interventions in systematic reviews (Box 1).¹⁹

Data analysis

The studies identified were not considered to be sufficiently homogenous to enable meta-analysis to be undertaken.^{22–24,27} We therefore use narrative synthesis to summarize the results, reporting study findings separately by type of intervention (behavioural or environmental) and reporting the main characteristics of included studies along with information regarding the study quality.

Box 1 Thematic checklist for the appraisal of the reporting, planning and implementation of workplace interventions (from Egan *et al.*²⁴)

Theme	Checklist question for workplace reviews
A. Motivation	Does the study describe why the management decided to subject the employee population to the organizational change?
B. Theory of Change	Was the intervention design influenced by a theory of change describing the proposed pathway from implementation to health outcome?
C. Context	Does study provide any useful contextual information relevant to implementation of the intervention (e.g. political, economic or managerial factors)?
D. Experience	Does study establish whether those implementing the intervention had appropriate experience (e.g. Had the implementers conducted similar interventions before; or if managers/employees were involved, were they appropriately trained for new roles)?
E. Consultation	Is there a report of consultation/collaboration processes between managers, employees and any other relevant parties during the planning stage?
F. Collaborations	Is there a report of consultation/collaboration processes between managers, employees and any other relevant parties during the delivery stage?
G. Manager support	Were on-site managers/supervisors supportive of the intervention (e.g. Do authors comment on manager's views of intervention?)?
H. Employee support	Were employees supportive of the intervention (e.g. do authors comment on employee's views of intervention?)?
I. Resources	Does study give information about the resources required in implementing the intervention (e.g. time, money, people and equipment)?
J. Differential effects, population characteristics	Does the study provide information on the characteristics of people for whom the intervention was beneficial, and the characteristics of those for whom it was harmful or ineffective?

Results

Our broad database searches identified 70 730 records (Supplementary data, Fig. S1). After title and abstract screening, 3142 papers were retrieved for full paper review. Supplementary searching revealed four additional studies. After full paper screening, 76 studies met our full review inclusion criteria (reported elsewhere <http://www.nets.nih.ac.uk/projects/phr/09301014>) of which 18 related to workplace interventions.

Fourteen studies evaluated behavioural interventions (including exercise, counselling and education), three studies examined behavioural and environmental interventions (e.g. behaviour interventions plus access to healthy food, stairwell enhancements) and one study examined a workplace food voucher scheme. There were no studies located on the effects of organizational changes on inequalities in obesity. Nine studies examined interventions targeted at lower grade workers, while 10 were universal and examined the effects of interventions on the social gradient in obesity.

Interventions were usually focused on particular occupational settings, including manufacturing, health care or education. A number of studies were of predominantly male ($n = 5$) or female ($n = 6$) populations. Thirteen studies were from the USA (with one each from Chile, Brazil, Australia, Korea and Germany). There were only five experimental studies and the rest were observational. Overall, the quality of the evidence was low as there were only two 'strong' and eight 'moderate' quality studies.

While most studies ($n = 12$) found no effects on inequalities in obesity—and a minority found increases ($n = 3$), there was also some evidence of potentially effective workplace interventions ($n = 3$) especially in terms of physical activity interventions targeted at lower occupational groups. Interventions were considered to be effective in reducing inequalities if they: (i) reduced obesity in all SES groups equally (if a universal study); or (ii) they particularly reduced obesity in lower SES groups (if a universal study) or (iii) if they reduced obesity in lower SES groups only (if targeted).

These are summarized in Tables 1–4 and synthesized narratively by intervention type (behavioural, mixed, environmental), level (targeted or universal) and study design/quality.

Behavioural interventions ($n = 14$)

Behavioural—targeted ($n = 8$)

A strong quality RCT²⁸ examined a 5-year workplace health promotion programme among 538 blue collar female workers in the USA. There were two interventions across nine worksites—individualized computer-tailored health messages and lay health advisors—and a waiting list control. There were

two follow-ups at 6 and 18 months. There were no significant changes in BMI in either intervention group.

A strong quality cluster RCT²⁹ investigated the effects of workplace interventions in four manufacturing workplaces in the USA among predominantly male, middle-aged, blue collar workers ($n = 690$). Intervention site A received health screening and health education; site B received health screening, health education and follow-up counselling; and site C received health screening, health education, follow-up counselling and organized physical activities. The control site received health screening only. At 3-year follow-up, the results showed that only intervention group C experienced significant weight loss (2 kg; $P < 0.001$).

A small ($n = 37$), moderate quality RCT³⁰ investigated the effects of a workplace exercise programme among blue collar, female workers in the USA. Participants engaged in walking, jogging or cycling for 3 days a week. At follow-up (24 weeks), the intervention group lost an average of 2 kg relative to the control group (between group difference $P < 0.025$). There was no difference between the groups in terms of body fat ($P < 0.056$).

A small ($n = 30$), weak quality, non-randomized controlled trial³¹ investigated the effects of an 8-week computer-assisted instruction weight management programme for overweight middle-aged, predominantly male, blue collar employees of an automobile manufacturing company in the USA. A second worksite acted as a non-randomized control group. There were no statistically significant changes in weight at 1 year follow-up.

A weak quality, controlled prospective cohort design (using a self-selected comparison group) was used to investigate the effects of a cardiovascular health awareness programme.³² The intervention—which involved health screening and individual and group counselling—was conducted among 198 mainly middle-aged, low-income female employees of a hospital in the USA. There were no statistically significant differences in BMI or waist circumference at the 4-year follow-up point.

Three small, weak quality, uncontrolled prospective cohort studies of lifestyle counselling interventions in Chile,^{33,47} Germany³⁴ and the USA³⁵ found no significant effects on BMI or weight.

Behavioural—universal ($n = 6$)

A moderate quality RCT³⁶ examined telephone and Internet behaviour counselling interventions compared with a control group. The participants were mainly female and from a variety of workplaces in the USA. The study found significant reductions after 6 months in waist circumference among both the telephone (−1.9 cm, 95% CI −2.7; −1.0 cm) and the Internet groups (−1.2 cm, 95% CI −1.7; −0.5 cm) as well as reductions in weight (telephone −1.5 kg, 95% CI −2.2;

Table 1 Targeted behavioural interventions (n=8)

<i>Study</i>	<i>Design and quality appraisal^a</i>	<i>Setting and participants</i>	<i>Intervention and implementation^b</i>	<i>Inequality^c</i>	<i>Summary of effects on inequalities in obesity*</i> ↑ = increased ↓ = decreased ↔ = no effect
Campbell <i>et al.</i> ²⁸	Cluster randomized controlled trial 6- and 18-month follow-up Final sample = 538 Quality = Strong	9 worksites, USA 100% Women No mean age provided	Health works for women (HWW)—two strategies: (1) individualized computer-tailored health messages combined health behaviour change theory, communication theory, social marketing and new technology; (2) a natural helpers program at the workplace (lay health advisor) designed to affect behavioural and social change through the 'natural' social networks of individuals Implementation = 5	Targeted: low-income workplaces	BMI ↔
Erfurt <i>et al.</i> ²⁹	Cluster randomized controlled trial 3-year follow-up Final sample = 690 Quality = Strong	4 workplaces, USA 39–43 years Predominately male	Workplace wellbeing interventions: screening only (control) vs. screening + health education (A) vs. screening + health education + follow-up counselling (B) vs. screening + health education + follow-up counselling + organized physical activities (C) Implementation = 6	Targeted: blue collar employees	Body weight ↔ Intervention A ↔ Intervention B ↓ Intervention C ↔
Grandjean <i>et al.</i> ³⁰	Randomized controlled trial 24-week follow-up Final sample = 37 Quality = Moderate	Workplace, USA 100% female Sedentary	Workplace exercise programme—walking, jogging, cycling or combination at least 3 days per week for 24 weeks (individualized exercise prescription) carried out at workplace fitness facility Implementation = 3	Targeted: blue collar employees	Weight ↓ Body fat ↔
Dennison <i>et al.</i> ³¹	Controlled (quasi-experimental) trial 1-year follow-up Final sample = 30 Quality = Weak	2 workplaces, USA 47 years 90% male 20–35% over ideal weight	'Weigh to Go' programme—nutrition information; computerized food intake and activity analysis and feedback; personal guidelines; incentives for weight loss (t-shirts, lunch bags, books) Implementation = 6	Targeted: blue collar workers	Weight ↔
Pescatello <i>et al.</i> ³²	Prospective controlled cohort study 4-year follow-up Final sample = 198 Quality = Weak	1 workplace, USA Mean = 41 years 87% female	Cardiovascular health awareness program (CHAP)—annual cardiovascular screens and results counselling (individualized feedback and methods to adopt or maintain healthy lifestyle behaviours) Encouragement to participate in formal, group education and behavioural support programs held at the workplace and off site Implementation = 3	Targeted: low-income employees	BMI ↔ waist ↔ circumference ↔ Waist-to-hip ratio ↔
Kain <i>et al.</i> ³³	Uncontrolled prospective cohort 5- and 24-month follow-up Final sample = 47 Quality = Weak	Workplaces (schools), Chile Teachers Age/sex not reported	Teacher intervention: 3 × 15 min counselling sessions healthy eating and physical activity; plus goal setting—with nutritionist Implementation = 6	Targeted: low-income area	BMI ↔ Waist ↔ circumference ↔

Continued

Table 1 Continued

Study	Design and quality appraisal ^a	Setting and participants	Intervention and implementation ^b	Inequality ^c	Summary of effects on inequalities in obesity* ↑ = increased ↓ = decreased ↔ = no effect
Hugk and Winkelvoss ³⁴	Uncontrolled before/after study 1-year follow-up Final sample = 50 Quality = Weak	1 workplace, Germany 22–67 years 95% male Obese	Outpatient weight reduction programme; individual doctor interviews discussing current behaviours diet, lifestyle; nutrition and physical activity education; calorie reduced diet Implementation = 3	Targeted: blue collar workers	Body weight ↔
Williams and Wold ³⁵	Uncontrolled prospective cohort 1-year follow-up Final sample = 71 Quality = Weak	2 workplaces, USA Working age	Mobile nursing cardiovascular risk factor identification programme—screening; individualized education-based interview focused on dietary and physical activity behaviour change; follow-up report and letter Implementation = 6	Targeted: low-income areas	BMI ↔

BMI, body mass index.

^aGlobal quality appraisal from EPHPP; see Supplementary data, Appendix S2.

^bNumber of implementation appraisal criteria met out of 10.

^cTargeted/universal approach to inequality, measure of inequality/SES.

* $P < 0.05$. For controlled studies, this is for the relative mean differences between intervention and control at follow-up. For uncontrolled studies, it represents the change between baseline and follow-up.

−0.8 kg; Internet group −0.6 kg, 95% CI −1.3; −0.01 kg). There were no differences in outcomes by educational background.

A moderate quality, uncontrolled prospective cohort study evaluated a pedometer physical activity programme among 604 middle-aged, participants in Australia.³⁷ It found a significant difference in waist circumference reduction by education group: between baseline and 4-month follow-up, participants who had completed tertiary education at baseline had a 2.1 cm larger reduction than lower educated participants.

Four uncontrolled observational studies (moderate/weak quality) of advice-based interventions in the USA^{38,40,41} and Korea³⁹ found no significant differences in weight loss or BMI by occupational grade or income.

Behavioural and environmental workplace interventions ($n = 3$)

Universal ($n = 3$)

A moderate quality cluster RCT investigated the effects of a mixed weight prevention intervention in predominantly female hospital employees, conducted across six worksites in the USA ($n = 648$).⁴² The intervention included social marketing, environmental strategies promoting physical activity (e.g. stairway signs, walking groups) and healthy eating

(cafeteria signs, Farmer's Markets), and strategies promoting interpersonal support. There was no significant impact on BMI at 12- or 24-month follow-up. However, differential effects were found in terms of weight gain with those with a higher education or income level least likely to gain weight.

A moderate quality-controlled prospective cohort study (with 1- and 5-year follow-ups) investigated the effects of a worksite wellness programme in the USA which comprised individual action plans with environmental modifications. Individual action plans included maintaining an exercise journal and joining 'Weight Watchers At Work'.⁴³ The environmental modifications involved opening up and decorating the stairwell (prompts were also used) and replacing unhealthy options in the vending machines. A total of 19 559 participants were recruited into the study with a national control group taken from insurance records. The results showed that participants lost weight relative to the control with a 1.10% average reduction in BMI ($P < 0.01$). However, lower educated participants lost weight at a quicker rate (college graduate: −0.88%, $P < 0.01$; some college: −1.41%, $P < 0.01$; high school only: −1.45%, $P < 0.01$).

A moderate quality, uncontrolled prospective cohort study of 1222 employees in six organizations in the USA⁴⁴ found that while body weight decreased on average, there were no

Table 2 Universal behavioural interventions ($n = 6$)

Study	Design and quality appraisal ^a	Setting and participants	Intervention and implementation ^b	Inequality ^c	Summary of effects on inequalities in obesity* ↑ = increased ↓ = decreased ↔ = no effect
Van Wier <i>et al.</i> ³⁶	Randomized controlled trial 3 arms: phone, internet and control 6-month follow-up Final sample size = 982 Quality = Moderate	Work settings, USA Overweight employees with BMI ≥ 25 kg/m ² Mean age = 43 years 65% female	Treatment: three-arm randomized controlled trial. Two arms received a 6-month lifestyle intervention with behaviour counselling by either phone (phone group) or e-mail (Internet group). The third arm received usual care in the form of lifestyle brochures (control group). 10 × biweekly counselling sessions by phone and e-mail Implementation = 6	Universal: education	Body weight ↔ Waist ↔ circumference ↔
Freak-Poli <i>et al.</i> ³⁷	Prospective cohort study 4-month follow-up Final sample = 604 Quality = Moderate	10 workplaces, Australia Mean age \approx 40 years 57% female	Pedometer-based workplace health intervention—target of at least 10 000 steps/day for 125 days; weekly encouragement emails; website for logging daily steps, accessing additional health information, communication among participants and comparing team progress Implementation = 6	Universal: education	Waist ↑ circumference ↑
Jeffery <i>et al.</i> ³⁸	Uncontrolled prospective cohort study 6-month follow-up Final sample = 34 Quality = Moderate	Workplace, USA 86% female Mean age = 42 years	Weigh-ins; group education sessions—diet, physical activity; weight loss manual; monitoring diet intake; incentive Implementation = 5	Universal: occupation	Body weight ↔
Hwang <i>et al.</i> ³⁹	Uncontrolled prospective cohort study 3-month follow-up Final sample = 62 Quality = Weak	Electronics company in Korea High BMI workers (>27 kg/m ²) Mean age = 33.6 ± 7.4 years 88% male	3-month, obesity management programme 'Turn fat into gold'; counselling by factory nurses, self-help group, free gym facilities, trainers and health information; health information via email Implementation = 6	Universal: office vs. factory workers	BMI ↔ Body weight ↔ Body fat ↔
Stunkard <i>et al.</i> ⁴⁰	Uncontrolled prospective cohort study 12-week follow-up Final sample = 1146 Quality = Weak	15 workplaces, USA 38 years 52% female Overweight	Workplace weight loss competitions—weekly weigh-ins; weight loss advice; teammate support; public awareness of progress in; cash incentive for winning team Implementation = 6	Universal: blue collar vs. white collar	Body weight ↔
Rohrer <i>et al.</i> ⁴¹	Uncontrolled retrospective cohort study 6-month follow-up Final sample = 936 Quality = Weak	Workplace, USA 18 + adult employees 64.1% males	Telephone coaching programme. Coaches called participants up to 7 times. Coaching was based on collaborative goal-setting and included self-management health education Implementation = 6	Universal: income	Body weight ↔

BMI, body mass index.

^aGlobal quality appraisal from EPHPP; see Supplementary data, Appendix S2.

^bNumber of implementation appraisal criteria met out of 10.

^cTargeted/universal approach to inequality, measure of inequality/SES.

* $P < 0.05$. For controlled studies, this is for the relative mean differences between intervention and control at follow-up. For uncontrolled studies, it represents the change between baseline and follow-up.

Table 3 Behavioural and environmental interventions ($n = 3$)

Study	Design and quality appraisal ^a	Setting and participants	Intervention and implementation ^b	Inequality ^c	Summary of effects on inequalities in obesity* ↑ = increased ↓ = decreased ↔ = no change
Lemon <i>et al.</i> ⁴²	Cluster randomized controlled trial 12- and 24-month follow-up Final sample = 648 Quality = Moderate	6 hospital worksites, USA 18–65 years 80% female	Social marketing campaign, environmental strategies promoting physical activity, environmental strategies promoting healthy eating and strategies promoting interpersonal support. Types of intervention strategies include stairway signs, cafeteria signs, Farmer's Markets, walking groups, challenges, workshops, educational displays, newsletters, project website, project information centre and print materials Implementation = 7	Universal: education	BMI ↔ Weight ↑ gain
Scoggins <i>et al.</i> ⁴³	Controlled cohort study 1-year follow-up Final sample = 19559 Quality = Moderate	Worksite, USA 18–69 years 49.9% female	'Healthy Incentives' weight management intervention sponsored by employer. Environmental modifications (e.g. decorating stairwells and prompting stair use, healthy options in vending machines, room converted to free gym, garden for employees to grow healthy food) plus individual action plans encouraging healthy activities, weight management, exercise, nutrition, stress management and smoking cessation; monthly electronic newsletter, website and poster campaigns Implementation = 6	Universal: education	BMI ↓
VanWormer <i>et al.</i> ⁴⁴	Prospective cohort study 24-month follow-up Final sample = 1222 Quality = Moderate	6 worksites, USA Mean age = 44.2 years 61% female	'HealthWorks' intervention—Healthy foods/beverages made affordable, access modifications to healthy foods, aesthetic stairwell enhancements, free access to pedometers and website step tracking tools, improved scale access for self-weighing (including balance beam scales placed at various locations within the workplace such as rest rooms), worksite advisory groups and site-wide publicity of nutrition and physical activity Implementation = 5	Universal: education	Body weight ↔

BMI, body mass index.

^aGlobal quality appraisal from EPHPP; see Supplementary data, Appendix S2.

^bNumber of implementation appraisal criteria met out of 10.

^cTargeted/universal approach to inequality, measure of inequality/SES.

* $P < 0.05$. For controlled studies, this is for the relative mean differences between intervention and control at follow-up. For uncontrolled studies, it represents the change between baseline and follow-up.

differences after 2 years by educational level as a result of a mixed environmental and behavioural intervention. Interventions included making healthy foods/beverages affordable, increasing access to healthy foods, aesthetic stairwell enhancements, free pedometers, on-site self-weighing, worksite advisory groups and site-wide publicity of nutrition and exercise activities.

Environmental-level studies ($n = 1$)

Targeted ($n = 1$)

A weak quality, retrospective controlled cohort study of routine annual workplace health monitoring surveys of 10 368 workers investigated the annual effects of the Brazilian national Food Workers' Programme over a 5-year period (1995–2000).^{45,46} Implemented since the 1970s, the

Table 4 Environmental interventions ($n = 1$)

Study	Design and quality appraisal ^a	Setting and participants	Intervention and implementation ^b	Inequality ^c	Summary of effects on inequalities in obesity* ↑ = increased ↓ = decreased ↔ = no change
Veloso and Santana 2002; Veloso <i>et al.</i> 2007 ^{45,46}	Retrospective cohort group with non-randomized comparison group 5-year follow-up Final sample = 10,368 Quality = Weak	Workplaces, Brazil Working age 22% female	Prevention: Workers' Food Programme (Programa de Alimentação do Trabalhador; PAT)—coupons or food provided in workplace (main meal of 1400 calories and minor meals of 300 calories, & 6% protein) Implementation = 5	Universal: occupation	overweight ↑

BMI, body mass index.

^aGlobal quality appraisal from EPHPP; see Supplementary data, Appendix S2.

^bNumber of implementation appraisal criteria met out of 10.

^cTargeted/universal approach to inequality, measure of inequality/SES.

* $P < 0.05$. For controlled studies, this is for the relative mean differences between intervention and control at follow-up. For uncontrolled studies, it represents the change between baseline and follow-up.

programme aimed to ensure adequate nourishment for low-income workers by funding employers to provide food or food coupons. The study found that the incidence of overweight increased per year to a greater extent in workplaces implementing a food programme compared with workplaces with no programme: odds ratio of overweight = 1.91 (95% CI 1.26–2.91). There were significant differences by occupational group with higher incidence of overweight in low and medium grade workers compared with higher grade workers.

Assessment of implementation

Data on the organization, implementation and delivery of interventions were reported for all of the studies, with 15 providing information for five or more of the ten domains of the methodological tool.⁶ These are summarized in Supplementary data, Appendix S1. Most of the studies provided data for motivation, context, experience of the intervention team and resources. The type and level of information varied substantially for each of the domains making comparisons between the studies difficult. There were no apparent differences between interventions that were successful in reducing inequalities in obesity and those that were not. There appeared to be no differences in the experience of intervention team between successful and unsuccessful interventions (for example trained or professional facilitators were reported for both), and interventions reporting a level of resources (incentives, supportive materials, contact time and training of facilitators) did not appear to be related to outcomes. Only

three studies reported consultation or collaboration processes (for example public or participant involvement).^{28,29,40} Some studies mentioned problems affecting sustainability, for example Scoggins *et al.*⁴³ discussed the willingness of employees as a significant resource and how it was important to incentivize employees to participate in the programme.

Discussion

Main findings

The evidence reviewed here suggests that workplace counselling or advice-based interventions—whether targeted or universally delivered—are ineffective in reducing inequalities in obesity, with none of the 11 studies of these finding any effects on BMI or weight. However, two RCTs (strong/moderate quality) found that physical activity interventions targeted at low-income workers could be effective in reducing inequalities in obesity with small weight reductions (2 kg) detected in both evaluations.^{29,30} However, an observational study (moderate quality) of a universally delivered physical activity intervention found that it increased educational inequalities in waist circumference.³⁷

The effects on inequalities in obesity of interventions that combined behavioural interventions with environmental modifications were inconclusive. A moderate quality cluster RCT found that weight gain was least likely among higher educated participants,⁴² while a controlled prospective cohort study (moderate quality) found that BMI reductions were

slowest among this group.⁴³ The third study—a moderate quality uncontrolled prospective cohort study—found no significant differences by education. Additionally, the weak quality, retrospective controlled cohort study of an employer delivered food voucher scheme found that there was a higher incidence of overweight in low and medium grade workers compared with higher grade workers.^{45,46}

What is already known on this subject?

Obesity is causally linked to such chronic diseases as diabetes, coronary heart disease, stroke, hypertension, osteoarthritis and certain forms of cancer. It is a major cause of premature mortality as well as long-term incapacity and associated reductions in quality of life.²⁰ Obesity is associated with social and economic deprivation in developed countries worldwide, with higher prevalence in the lowest income quintile.^{9,48–50} In the UK, there are strong associations between obesity and socio-economic status.⁷ In some areas, obesity rates in the most deprived quintile were almost double those in the least deprived quintile.^{7,8} Tackling inequalities in obesity is seen to be a public health priority.⁵¹

The workplace has potential as a site of health promotion and the National Institute for Health, Social Care and Clinical Excellence (NICE) has released guidance that highlights the important role of workplaces in public health.^{52,53} Systematic reviews have found that workplace smoking cessation interventions can be effective.⁵² There is also evidence that workplace interventions—both behavioural and environmental—can be effective in terms of changing risk factors for obesity e.g. by increasing physical activity.⁵³ Workplace interventions also have some promise in terms of reducing overall rates of obesity.^{14–17} However, a Dutch systematic review found that the equity effects of workplace obesity interventions are small and those interventions with counselling components are the least effective.⁵⁴ Our international review reinforces these findings. The meta-analysis by Rongen *et al.*,¹⁵ which examines the effects of workplace health promotion interventions on a range of health outcomes, found that they are more effective among white-collar workers, which implies that such interventions may widen rather than narrow health inequalities. Their suggestion that workplace interventions be tailored to specific groups is supported by the varied and mixed findings in our systematic review.

What this study adds

This is the first international study to systematically review the effects of workplace interventions on inequalities in obesity. It has found a small ($n = 18$), generally low quality and largely observational international evidence base dominated by behavioural interventions. While there is no evidence

of effectiveness for workplace lifestyle advice/counselling interventions and the evidence of environmental interventions is inconclusive, there is some experimental evidence to suggest that workplace delivered physical activity interventions may be effective in reducing inequalities in obesity.

Limitations

This review entailed an extremely thorough search of the international literature with a very broad inclusion and exclusion criteria that has ensured that the entire relevant experimental and observational evidence base was captured. However, we only included studies that reported proxies for body fat. The evidence base itself is subject to a number of limitations, most notably the small number of experimental studies, the dominance of studies from the USA, the heterogeneity of interventions and study designs, and the few environmental studies found and the entire lack of any studies of the effects of organizational interventions of inequalities in obesity. Furthermore, only a limited number of studies (10%) were double screened; a pragmatic decision made based on the high volume of studies elicited from the searches as part of the wider NIHR review ($n = 70\,730$). We deliberately undertook broad and comprehensive searches of nine databases in order to ensure that the full papers of all studies, which fitted our population, intervention, design and outcome inclusion criteria, would be examined—even if there was no mention of socio-economic inequalities in the abstract. This strategy meant that the review was less likely to exclude studies which undertook subgroup analyses by socio-economic status but did not mention the findings in the title or abstract. This increased the comprehensiveness of the electronic search strategy, although it obviously resulted in a higher number of hits. There is always a trade-off in systematic reviews between comprehensive searches ('how far do you go'—to quote Ogilvie *et al.*, 2005)⁵⁵ and the time-taken to double-screen and double-data extract. It is often necessary to make pragmatic decisions in systematic reviews and on this occasion we prioritized a comprehensive search.⁵⁶

Conclusion

There is some experimental evidence that workplace delivered physical activity interventions have the potential to reduce inequalities in obesity by targeting lower occupational groups. However, overall, the evidence base is small, heterogeneous, largely from the USA and of a low quality. More high-quality, experimental study designs are required.

Supplementary material

Supplementary material is available at *PUBMED* online.

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Authors' contributions

J.M.C. was responsible for data collection, and contributed to analysis and synthesis. J.M.C. and C.B. drafted this article jointly. C.B. was the principal investigator and was responsible for overall design, co-ordination and project management. She provided methodological and conceptual direction, and led analysis, synthesis and interpretation. F.H. contributed to data collection, analysis and synthesis. H.M. designed and conducted the searches and contributed to data collection. C.S. provided methodological input. All authors contributed to revised successive drafts of this article and approved the final version submitted for publication.

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