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# Systematic review of the use of financial incentives in treatments for obesity and overweight

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## Summary

Nine studies met the criteria for inclusion in this systematic review of randomized controlled trials of treatments for obesity and overweight involving the use of financial incentives, with reported follow-up of at least 1 year. All included trials were of behavioural obesity treatments. Justification of sample size and blinding procedure were not mentioned in any study. Attrition was well described in three studies and no study was analysed on an intention to treat basis. Participants were mostly women recruited through media advertisements. Mean age ranged from 35.7 to 52.8 years, and mean body mass index from 29.3 to 31.8 kg m<sup>-2</sup>. Results from meta-analysis showed no significant effect of use of financial incentives on weight loss or maintenance at 12 months and 18 months. Further sub-analysis by mode of delivery and amount of incentives although also non-statistically significant were suggestive of very weak trends in favour of use of amounts greater than 1.2% personal disposable income, rewards for behaviour change rather than for weight, rewards based on group performance rather than for individual performance and rewards delivered by non-psychologists rather than delivered by psychologists.

**Keywords:** Financial incentives, obesity, systematic review.

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## Introduction

Advice on lifestyle modification is widely recommended as first-line treatment for obesity (1) as well as being adjuvant therapy to pharmacological and surgical obesity treatments. Tailoring this advice to the individual patient's needs in keeping with evidence-based medicine is mostly based on behavioural approaches to weight control. These aim to modify environmental influences through the concept of controlling the antecedent environment and/or the consequent lifestyle behaviours such as eating and physical activity (2,3), and the use of rewards falls into the latter category. The use of (non-food) rewards in obesity treatments has been recommended (4). Some reviews have studied the effects of economic or financial incentives in improving compliance in a variety of patient behaviours (5–7). Wall *et al.* (8) studied the effects of financial incentives in modifying eating behaviour, but the outcome of interest was not necessarily weight loss. To date, there is no

systematic review of evidence for the effects of financial contingencies in the behavioural treatment of obesity, necessitating this review. Unlike some similar reviews (5–8), we focused on the use of only guaranteed incentive schemes (and excluded non-guaranteed schemes, e.g. lottery), to avoid confounding from participants' perception of uncertainty in receiving the incentive.

## Methods

This study was conducted using a pre-specified protocol to systematically review randomized controlled trials (RCTs) of obesity treatments involving the use financial incentives as rewards contingent on weight loss or other behaviour change, with outcome data including weight change, and minimum follow-up of 1 year, carried out in adults (age  $\geq 18$  years) with body mass index (BMI)  $\geq 28$  kg m<sup>-2</sup> (based on the cut-off for pharmaceutical trials as used in a previous review by one of the authors) (9). Allowance was

made for ethnic groups with specific data available to justify a lower cut-off for BMI (10).

### Literature search

We updated the search performed (with modifications in keeping with database changes to search terms/symbols) by Avenell *et al.* (9) in Medline, Embase, Cinahl, PsychINFO, Cochrane Database of Systematic Reviews, Cochrane register of controlled clinical trials and Sportdiscus. We used regular citation alerts in all our databases (except the Cochrane databases where this was not possible) and searched relevant journals (International Journal of Obesity, Addictive Behaviour, Eating Behaviour, Journal of Consulting and Clinical Psychology, Journal of Applied Behaviour Analysis, Journal of Health Psychology and Professional Psychology) using words like 'financial', 'contract(ing)', 'mone(tar)y', 'pay(ment)', 'reward', 'contingency', 'motivation', 'reinforcement', 'obesity' and 'overweight'. We searched for authors who had published in this field (results of preceding searches and reviewing reference lists) in the databases and journals, and reviewed reference lists of retrieved articles and books. Titles and abstracts were scanned and full-text articles of identified relevant studies retrieved. Full-text articles were also retrieved where the decision to include or exclude was unclear from abstracts alone. Authors were contacted for studies where there was a stated intention to report results at a later date that may have allowed for study inclusion.

### Selection of studies

Both reviewers were independently involved in identifying and retrieving likely articles. To be included in the review however, both reviewers had to agree to relevance of the study to the review according to the *a priori* criteria.

### Quality assessment of studies

Consensus also had to be reached by both reviewers on the quality of the study using the quality assessment from Avenell *et al.* (9).

### Data abstraction

Data were abstracted using the form from Avenell *et al.* (9), by the first author and checked by the second author and consensus reached in areas of differences through discussion. Authors were contacted for further details as required. Where only graphical weight data were provided, images were scanned onto computer and analysed.

The monetary value of the incentive (maximum possible reward) calculated as a percentage of personal disposable

income (PDI) at the year of publication was generated using published data for the appropriate country (11,12).

All weight data were converted to kg where necessary. Missing standard deviations (SD) were computed using the linear regression plot of the SD of the mean change in weight on the absolute mean change for weight already derived in Avenell *et al.* (9):

$$\text{SD of weight change} = 5.915 + (0.283 \times \text{absolute value of mean change in weight})$$

### Data analysis

Studies were entered into Review Manager by author and year, and accompanying alphabet characters (see explanations under 'other observations' in Table 1) to allow for different within-study group comparisons. Statistical meta-analysis was undertaken to determine the effect size of financial incentives by calculating the weighted mean difference (WMD) for weight change and 95% confidence interval (CI). Individual within-study groups differing only in the provision of financial incentives were compared, but for studies where groups were combined for meta-analysis, this is stated under the 'other observations' column in Table 1. Further pre-specified subgroup analyses were planned to compare duration of use of incentives above and below the median intervention period; monetary value of incentive (as a percentage of PDI) above and below the median of the maximum value; reward based on weight change and reward based on other behaviour change; reward for group performance and reward for individual performance; reward by psychologist and reward by non-psychologist. Subgroup analysis was also planned to compare ethnic groups at high risk for metabolic syndrome with those who were not. Heterogeneity across studies was explored and where  $I^2$  was <50% a fixed effects approach was used. A random effects approach was used where the  $I^2$  was >50% (13).

## Results

### Result of search strategy

Of the 45 589 publications identified (see Fig. 1), 38 were identified as RCTs of obesity treatments using financial incentives. Of these, nine studies met criteria for inclusion in the review, and seven were used for meta-analysis. Mahoney 1974 (14) was not included in meta-analysis because the weight-related outcome was 'percentage of subjects maintaining or improving weight' rather than 'weight change'. Wing *et al.* 1981 (15) was not included in meta-analysis primarily because a crossover method was employed in the delivery of refund and there was no control

Table 1 Details of included studies

Study (author and year)	Participants	Interventions	Outcomes	Other observations
Cameron <i>et al.</i> 1990 (19)	<p>Country: Canada</p> <p>Source: local media and telephone screening</p> <p>Age (mean) years: M = 42.4, F = 41.7</p> <p>Sex (n): M = 6, F = 169</p> <p>Weight (mean) kg: M = 99.0, F = 77.7</p> <p>BMI (mean) kg m<sup>-2</sup>: M = 31.7; F = 29.3</p> <p>SES (% employed outside home) M = 81.3, F = 66.9</p> <p>Other</p> <p>Average number of years of education: M = 15.3, F = 13.5</p>	<p>All</p> <p>L = mailed 15 printed lessons on diet, exercise and behaviour; and \$21 refunded for attendance at 1 year follow-up</p> <p>Duration: 15 weeks</p> <p>Groups by assignment</p> <p>(i) Received L after other groups</p> <p>(ii) L only</p> <p>(iii) L + W (weigh ins and face to face consultation as needed) n = 12</p> <p>(iv) L + H (homework – one page record of changes made and weight; telephone consultation as needed) n = 12</p> <p>(v) L + W + D (\$21 deposit refunded for homework and attendance) n = 12</p> <p>(vi) L + H + D n = 10</p> <p>(vii) L + H + W n = 12</p> <p>(viii) L + H + W + D n = 9</p>	<p>Follow-up: 16 months</p> <p>Overall attrition rate (females only): 17.6%</p> <p>Overall dropout rates given but results based only on outcomes from participants meeting the minimum of a set of criteria used to determine active participation in study</p> <p>Outcome</p> <p>1. Weight (and BMI)</p>	<p>Delayed treatment control group 'i' excluded from analysis</p> <p>Main analysis performed for female participants (numbers given for different groups in meta-analysis are for treated females only)</p> <p>Description of results for male participants did not allow for extraction of data on financial incentives</p> <p>There is a possibility that the planned refund for all groups at 1 year affected the role of 'D' as a financial incentive</p> <p>Comparisons for all meta-analyses:</p> <p>a = v vs. iii</p> <p>b = vi vs. iv</p> <p>c = viii vs. vii</p>
Jeffery <i>et al.</i> 1983 (16)	<p>Country: USA</p> <p>Source: ineligible from an existing trial pool</p> <p>Age (mean) years: 52.8 (35–57) years</p> <p>Sex: 100% male</p> <p>Weight (mean) kg: 100.2</p> <p>BMI (mean) kg m<sup>-2</sup>: 31.8</p> <p>SES: (Hollingshead two factor index of social position) = 33.1</p> <p>Others</p> <p>Age of onset (mean) = 26.7 years</p> <p>% with prior weight program experience = 27</p>	<p>All</p> <p>Educational programme on behaviour, diet and exercise; weekly group meetings; calorie and exercise records</p> <p>Duration: 16 weeks</p> <p>Groups assignment by mode of refund (for weight) / initial deposit</p> <p>(i) n = 16: individual/ \$30</p> <p>(ii) n = 15: individual/ \$150</p> <p>(iii) n = 14: individual/ \$300</p> <p>(iv) n = 17: group/ \$30</p> <p>(v) n = 14: group/ \$150</p> <p>(vi) n = 13: group/ \$300</p>	<p>Follow-up: 12 and 24 months</p> <p>Overall attrition rates: 3.4% at 12 months and 1.1% at 24 months</p> <p>Outcomes</p> <p>1. Weight</p> <p>2. % at least achieving contracted goal</p>	<p>Heavier individuals happened to be in groups with larger monetary deposits</p> <p>Results used only for subgroups analysis</p> <p>Comparisons in Fig. 3 (use of financial incentives of 1.2% PDI or more vs. use of financial incentives &lt;1.2% PDI at 12 months)</p> <p>a = ii &amp; iii vs. i</p> <p>b = v &amp; vi vs. iv</p> <p>Comparisons in Fig. 4 (group vs. individual delivery)</p> <p>a = iv vs. i</p> <p>b = v vs. ii</p> <p>c = vi vs. iii</p>

**Table 1** Continued

Study (author and year)	Participants	Interventions	Outcomes	Other observations
Jeffery et al. 1984 (17)	<p>Country: USA</p> <p>Source: Self-referred through newspapers (SR) and existing trial pool (PS)</p> <p>(A) SR group Numbers: M = 28; F = 31</p> <p>Age (mean) years M = 44.3; F = 44.5</p> <p>Weight (mean) kg M = 105.1; F = 84.0</p> <p>BMI (mean) kg m<sup>-2</sup> M = 32.6; F = 31.5</p> <p>SES (Hollingshead) M = 29.5; F = 43.2</p> <p>(B) PS group Numbers: M = 27; F = 29</p> <p>Age (mean) years M = 52.3; F = 50.3</p> <p>Weight (mean) kg M = 106.5; F = 82.5</p> <p>BMI (mean) kg m<sup>-2</sup> M = 33.0; F = 30.5</p> <p>SES (Hollingshead) M = 28.5; F = 42.3</p>	<p>All</p> <p>\$150 deposit, instructional programme on diet, exercise and behaviour; weekly group meetings; individual weight loss objectives (13.6 kg for men, and 9.1 kg for women)</p> <p>Duration: 16 weeks</p> <p>Groups assignment by recruitment source and pattern of refund (for weight)</p> <p>(i) SR; complete refund at first visit</p> <p>(ii) SR; fixed weekly \$30 refunds</p> <p>(iii) SR; increasing weekly refunds from \$5 to \$75</p> <p>(iv) PS; complete refund at first visit</p> <p>(v) PS; fixed weekly \$30 refunds</p> <p>(vi) PS; increasing weekly refunds from \$5 to \$75</p>	<p>Follow-up: 12 months</p> <p>Overall attrition rate: 2.6%</p> <p>Outcome</p> <p>1. Weight</p>	<p>Female participants were of lower socioeconomic status (higher score on Hollingshead two factor index)</p> <p>Further randomization of willing participants into either of two optional maintenance programmes</p> <p>Success at initial weight loss significantly associated with maintenance programme enrolment</p> <p>Subgroup analysis showed women in intensive maintenance group did better than men</p> <p>Comparisons in meta-analyses</p> <p>a = ii &amp; iii vs. i (males)</p> <p>b = v &amp; vi vs. iv (males)</p> <p>c = ii &amp; iii vs. i (females)</p> <p>d = v &amp; vi vs. iv (females)</p>
Jeffery et al. 1993 (2)	<p>Country: USA</p> <p>Source: newspaper, radio and mailed invitations</p> <p>Age (mean) years: 35.7–38.5</p> <p>Sex: ratios not given</p> <p>Weight (mean) kg: 88.1–92.3</p> <p>BMI (mean) kg m<sup>-2</sup>: 30.8–31.1</p> <p>SES (% non-college graduates) 35.0–58.5%</p> <p>Others</p> <p>Ethnicity (% white): 87.5–97.5</p> <p>% Married: 65.0–75.6</p>	<p>Duration: 78 weeks</p> <p>Groups by assignment</p> <p>(i) n = 40, no treatment control</p> <p>(ii) n = 40, standard behavioural treatment (SBT) with 20 weekly meetings and weigh ins, then</p> <p>monthly meetings and weekly weigh ins till 18 months</p> <p>(iii) SBT and food provision (FP), n = 40</p> <p>(iv) SBT and financial incentives (FI) for weight from \$2.50 to \$25 week<sup>-1</sup>, n = 41</p> <p>(v) SBT and FP and FI, n = 41</p>	<p>Follow-up</p> <p>12/18/30 months</p> <p>Overall attrition rates: 13%/15%/12%</p> <p>Outcomes</p> <p>1. Weight (BMI)</p> <p>2. Perceived barriers to abstinence</p> <p>3. Caloric intake from fat</p> <p>4. Total caloric intake</p> <p>5. Physical activity levels</p>	<p>No contact with any groups between 18 months and final follow-up at 30 months</p> <p>Comparisons in meta-analyses</p> <p>a = iv vs. ii</p> <p>b = v vs. iii</p>

Table 1 Continued

Study (author and year)	Participants	Interventions	Outcomes	Other observations
Jeffery <i>et al.</i> 1998 (3)	<p>Country: USA</p> <p>Source: media</p> <p>Age (mean) years: 40.0–42.6</p> <p>Sex (%female) 79–86</p> <p>Weight (mean) kg: 84.7–87.7</p> <p>BMI (kg m<sup>-2</sup>): 30.6–31.5</p> <p>SES (% college graduates and above)</p> <p>65–83</p> <p>Others</p> <p>Ethnicity (%white): 71–88</p> <p>% Married = 52–68</p> <p>% with prior weight program experience: 45–71</p>	<p>Duration: 24 weeks</p> <p>Groups by assignment</p> <p>(i) n = 40, SBT (S) with diet and exercise, caloric intake diaries and weigh-ins. Progress reviews and group discussions</p> <p>(ii) n = 41, S+ supervised thrice weekly walk sessions (E)</p> <p>(iii) n = 42, S+ E+ personal trainer to remind and walk with participants (T)</p> <p>(iv) n = 37, S+ E+ financial incentive for attendance at exercise sessions from \$1 to \$3 per walk session (I)</p> <p>(v) n = 36, S + E + T + I</p>	<p>Follow-up: 18 months</p> <p>Overall attrition rate: 22%</p> <p>Outcomes</p> <ol style="list-style-type: none"> <li>1. Weight change</li> <li>2. Psychological status</li> <li>3. Caloric intake from fat</li> <li>4. Total caloric intake</li> <li>5. Physical activity levels</li> </ol>	<p>Comparisons in meta-analyses</p> <p>a = iv vs. ii</p> <p>b = v vs. iii</p>
Kramer <i>et al.</i> 1986 (20)	<p>Country: USA</p> <p>Source: newspaper, worksite and another trial pool</p> <p>Age (mean) years: 41.6–45.1</p> <p>Sex (%female): 41–43</p> <p>Weight (mean) kg: 81.2–82.1</p> <p>BMI (mean) kg m<sup>-2</sup>: not given</p> <p>SES: not indicated</p> <p>Other</p> <p>% with prior weight programme experience: 39–52</p>	<p>All</p> <p>prior 16 weeks behavioural treatment with use of financial contingencies across all groups based on average group weight loss</p> <p>Duration: 1 year</p> <p>Groups by assignment</p> <p>(i) n = 28, (control) reminder letter at 6 months, \$100 immediate refund, and \$20 refund at 1 year</p> <p>(ii) n = 29, (skill focused) monthly group meetings, diet and physical activity information, financial contingencies for attendance only</p> <p>(iii) n = 28, (weight focused) monthly group meetings, non-specific subject initiated discussions about maintenance, monthly financial contingencies for attendance and weight maintained – \$10 returned per meeting but withheld if weighing more than post treatment weight</p>	<p>Follow-up: 1 year (this is also the maintenance phase of earlier weight loss treatment).</p> <p>Attrition rate: 2.4%</p> <p>Outcomes</p> <ol style="list-style-type: none"> <li>1. Weight</li> <li>2. % initial weight loss maintained</li> <li>3. % subjects maintaining weight in groups</li> </ol>	<p>Financial incentives used differentially during the maintenance phase. All subjects had had a 16-week intervention with uniform incentive use and only successful losers (≥10% of body weight) during earlier intervention were offered enrolment in this maintenance programme</p> <p>Comparison in main meta-analysis</p> <p>Figs 2 and 3 (use of financial incentives &lt;1.2% PDI vs. no financial incentive at 12 months)</p> <p>a = ii &amp; iii vs. i</p> <p>Comparison in Fig. 4 (reward for weight loss vs. reward for behaviour change at 12 months)</p> <p>a = iii vs. ii</p>

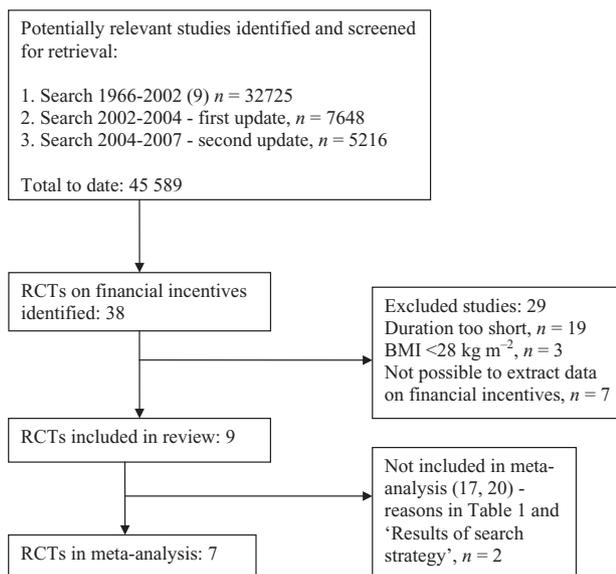
**Table 1** Continued

Study (author and year)	Participants	Interventions	Outcomes	Other observations
Mahoney 1974 (14)	<p>Country: USA                      Source: Newspapers                      Age (mean) years: not given                      Sex (n): M = 3, F = 46                      Groups (numbers) amount overweight</p> <p>i. (n = 11) not given                      ii. (n = 13) 23.4 kg                      iii. (n = 11) 21.5 kg                      iv. (n = 14) 14.0 kg                      BMI (kg m<sup>-2</sup>): not given                      SES: not indicated</p>	<p>All                      \$35 deposit and \$5 for absences; and                      S = self-control program with weekly weigh                      ins and group meetings, and given                      pamphlets on dietary behaviour control                      Duration: 8 weeks                      Groups by assignment                      (i) Delayed treatment control                      (ii) S+ weekly self-reward for weight                      improvement                      (iii) S+ weekly self-reward for habit                      (iv) S only</p>	<p>Follow-up: 12 months                      Attrition rate: not given                      Outcomes                      1. % subjects maintaining or improving                      weight loss</p>	<p>Baseline differences with control group                      being significantly older, and obesity                      having been more chronic in groups 'ii'                      and 'iii'                      Delayed treatment control group 'i'                      excluded from analysis                      No weight change data to allow for                      meta-analysis                      Gift certificates also used but not clear                      how                      Study more directed at determining which                      of reward for weight or for behaviour is the                      more effective</p>
Saccone and Israel 1978 (18)	<p>Country: USA                      Source: unspecified (general                      community)                      Age (range) years: 16–56                      Sex (numbers): M = 1, F = 48                      Weight (mean) kg by groups</p> <p>i. (n = 5) 82.8                      ii. (n = 6) 73.7                      iii. (n = 8) 84.2                      iv. (n = 8) 79.1                      v. (n = 7) 77.5                      vi. (n = 8) 82.0                      vii. (n = 7) 79.6                      BMI (kg m<sup>-2</sup>): not given                      SES: not indicated</p>	<p>All                      Basic program (P) on behaviour, diet and                      exercise                      Duration: 9 weeks                      Groups by assignment                      (i) Delayed treatment control                      (ii) P+ weight monitoring by individual(W)                      (iii) P+ eating behaviour monitoring by                      individual (B)                      (iv) P+ W+ reward by therapist for weight                      at \$1.50 lb<sup>-1</sup> to maximum of \$5 weekly                      (v) P+ B+ reward by therapist for eating                      behaviour change on point scale from \$0                      to \$5 weekly                      (vi) P+ W+ reward by significant other for                      weight loss as in 'iv'                      (vii) P+B+ reward by significant other for                      eating behaviour change as in 'v'</p>	<p>Follow-up: 12 months                      Attrition rate: 19.2%                      Outcomes                      1. Weight</p>	<p>Delayed treatment control group 'i'                      excluded from final analysis                      Comparisons for meta-analysis (Fig. 2)                      and Fig. 3 (use of financial incentives                      &lt;1.2% PDI vs. no incentive at 12 months)                      a = iv &amp; vi vs. ii                      b = v &amp; vii vs. iii                      Comparison in Fig. 4 (reward for weight                      loss vs. reward for behaviour change at                      12 months)                      a = vi vs. vii                      b = iv vs. v</p>

Table 1 Continued

Study (author and year)	Participants	Interventions	Outcomes	Other observations
Wing <i>et al.</i> 1981 (15)	<p>Country: USA</p> <p>Source: newspapers</p> <p>Age (mean) years: not given</p> <p>Weight (mean) by groups</p> <p>i = 93.5 kg</p> <p>ii = 88.6 kg</p> <p>BMI (<math>\text{kg m}^{-2}</math>): not given</p> <p>Sex by groups</p> <p>(i) M = 3, F = 17</p> <p>(ii) M = 2, F = 16</p> <p>SES: not indicated</p>	<p>All</p> <p>\$225 deposit (15 checks, each for \$15)</p> <p>Educational programme on behaviour, diet and exercise; weekly (monthly during maintenance) group meetings; self-monitoring diaries and weight charts</p> <p>Duration: 9 months</p> <p>Groups by assignment</p> <p>(i) First 8 checks returned weekly for attendance then remaining 7 returned monthly for weight loss</p> <p>(ii) First 8 checks returned weekly for weight loss and other 7 returned monthly for attendance</p>	<p>Follow-up: 13 months</p> <p>Attrition rate: 57.9%</p> <p>Outcomes</p> <p>1. Weight</p>	<p>Financial refund being in the form of bank checks thought to have negatively influenced the effectiveness of the financial incentive</p> <p>Not included in meta-analysis because of the cross over method employed in the delivery of refund</p>

F, females; M, males; SES, socioeconomic status; BMI, body mass index.



**Figure 1** Flow diagram for locating RCTs for systematic review. RCT, randomized controlled trial.

group to which a possible combination (as performed for some studies) of the two crossover treatment groups could be compared.

Many studies involving financial incentives were not indexed in the databases we searched. Most retrieved studies were the result of hand searching of journals and following reference lists of authors cited for behavioural treatment of obesity or in reviews of effects of financial incentives in a more general health-related behaviour context.

### Quality of included studies

All but two studies stated random allocation without giving description to inform concealment of allocation (16,17). Blinding of outcome assessors was not mentioned in any of the included studies. Dropouts and withdrawals were adequately described in Jeffery *et al.* 1983, Jeffery *et al.* 1984 and Saccone and Israel 1978 (16–18), not mentioned by Mahoney (14), and partially reported in all other studies. No studies were analysed on an intention to treat basis.

### Description of included studies and participants

All nine studies (see Table 1) were trials of behavioural obesity treatments. One study was in Canada (19) and all others in the United States. Two studies were conducted in the 1970s (14,18), four in the 1980s (15–17,20) and three the 1990s (2,3,19).

The source of recruitment of participants was not clear in the study of Saccone and Israel (18). Jeffery *et al.* (16) used an existing pool of volunteers, while Jeffery *et al.* (17) compared participants from an existing pool of volunteers

with those from fresh media recruitment. The remaining studies recruited participants through media advertisements suggesting that the population represented may be individuals with high levels of motivation to lose weight.

Mean age of participants in all studies ranged from 35.7 to 52.8 years, and mean BMI from 29.3 to 31.8 kg m<sup>-2</sup>. None of the studies had values to suggest participants were morbidly obese, and studies generally excluded persons with significant medical conditions.

There were more female participants in all studies except one all-male study (16) with participants recruited from an already existing trial pool of men. Socioeconomic status was not indicated in most studies, but where indicated, female participants were of lower socioeconomic status than male participants (16,17).

Ethnicity was only given in two studies, where percentage of participants who were white in the various groups was given (2,3) and ranged from 71% to about 98%. Smokers were excluded from one study (2). No other studies described the smoking status of participants.

### Description of interventions

In two studies, the financial incentives were freely supplied (2,3). All other studies used financial incentives provided from participants' deposited money. Refunds were made for weight loss or compliance with behaviour change or attendance at sessions. Some studies compared refund for weight change with refund for compliance with behaviour change (14,18,20).

All included studies were coordinated by psychologists, and intervention groups received behavioural, diet and exercise advice. Some groups had other motivators such as provision of food (2) and provision of personal exercise trainers (3). Monitoring varied and could be provided by the participants themselves, psychologist, or another individual. In one study (18), reward by a psychologist was compared with reward by a non-psychologist.

Duration of use of incentives ranged from 8 weeks (14) to 18 months (2). Wing *et al.* (15) made out contingencies using pre-written cheques from participants and Jeffery *et al.* (2) made cheques out to participants at weekly weigh-ins. All other studies delivered the financial incentive in cash. Jeffery *et al.* (3) did not state the form of the financial incentive. The monetary value of the incentive (total refundable or maximum possible reward) calculated as a percentage of PDI at the year of publication ranged from 0.2% PDI (19) to 10.2% PDI (2), with median at 1.2% PDI (17).

Where the incentive was used for less than or more than a year, further estimation was performed to aid comparisons using simple *pro rata* calculations, and making allowance for situations where the size of the incentive payment changed over time. These additional estimates of the mon-

etary value of financial incentives used then ranged from 0.5% PDI (19) to 8.8% PDI (16), with a median value of 3.1% PDI (15).

The longest reported follow-up period was 30 months in a later publication (21) to Jeffery *et al.* 1993 (2). The lowest recorded overall study rate of attrition was 1.1% at 24 months because of death of one participant (16) while the highest overall attrition rate of 57.9% at 13 months was reported by Wing *et al.* 1981 (15), in which greater attrition (approaching significance  $P < 0.10$ ) was observed when the weight loss contract was in place than when an attendance contract was in place.

### Outcomes and Meta-analyses

Analysis was undertaken at 12-month, 18-month and 30-month follow-up (Fig. 2). No weight change data were available for 24-month analysis.

The use of financial incentives was associated with a WMD weight change at 12 months of  $-0.4$  kg (95% CI  $-1.6$  to  $0.8$  kg), at 18 months of  $-0.7$  kg (95% CI  $-2.5$  to  $1.1$  kg) and at 30 months of  $1.1$  kg (95% CI  $-1.3$  to  $3.4$  kg), compared with groups where financial incentives were not used in treatment (see Fig. 2).

At 1 year, the use of financial incentives of monetary equivalents less than 1.2% of PDI was associated with a WMD for weight change of  $0.0$  kg (95% CI  $-1.5$  to  $1.6$  kg) compared with groups without use of financial incentives (see Fig. 3). The use of monetary amounts equivalent to 1.2% PDI and above, was associated with a WMD change

in weight of  $-1.1$  kg (95% CI  $-3.1$  to  $0.9$  kg) and  $-0.7$  kg (95% CI  $-2.5$  to  $1.1$  kg), compared with not receiving any financial incentive, at 12 months and 18 months respectively. Assuming use of financial incentives for 1 year in all studies, comparison of groups receiving financial incentives equivalent to less than 3.1% PDI to groups not receiving any financial incentive gave a WMD change in weight of  $-0.4$  kg (95% CI  $-1.7$  to  $0.9$  kg), and comparison of groups receiving 3.1% PDI and above to groups not receiving any financial incentive gave a WMD change in weight of  $-0.9$  kg (95% CI  $-2.8$  to  $1.1$  kg).

Comparing groups receiving greater than 1.2% PDI equivalent of money with groups receiving less than 1.2% PDI monetary equivalents gave a WMD for weight change of  $-0.7$  kg (95% CI  $-4.1$  to  $2.7$  kg), which was the same as comparing groups receiving monetary equivalents greater than 3.1% PDI with groups receiving monetary equivalents less than 3.1% PDI (assuming financial incentive use for 1 year in all groups).

At 12 months, treatment with financial incentives for less than 16 weeks (the median intervention period) was associated with a WMD weight change of  $-0.8$  kg (95% CI  $-2.3$  to  $0.7$  kg) compared with treatment without financial incentives (see Fig. 4).

Use of financial incentives for more than 16 weeks was associated with a WMD weight change of  $0.4$  kg (95% CI  $-1.7$  to  $2.5$  kg) compared with no financial incentive. It is worth noting that the financial incentive was usually discontinued after about 16–24 weeks or became less regular in the longer studies.

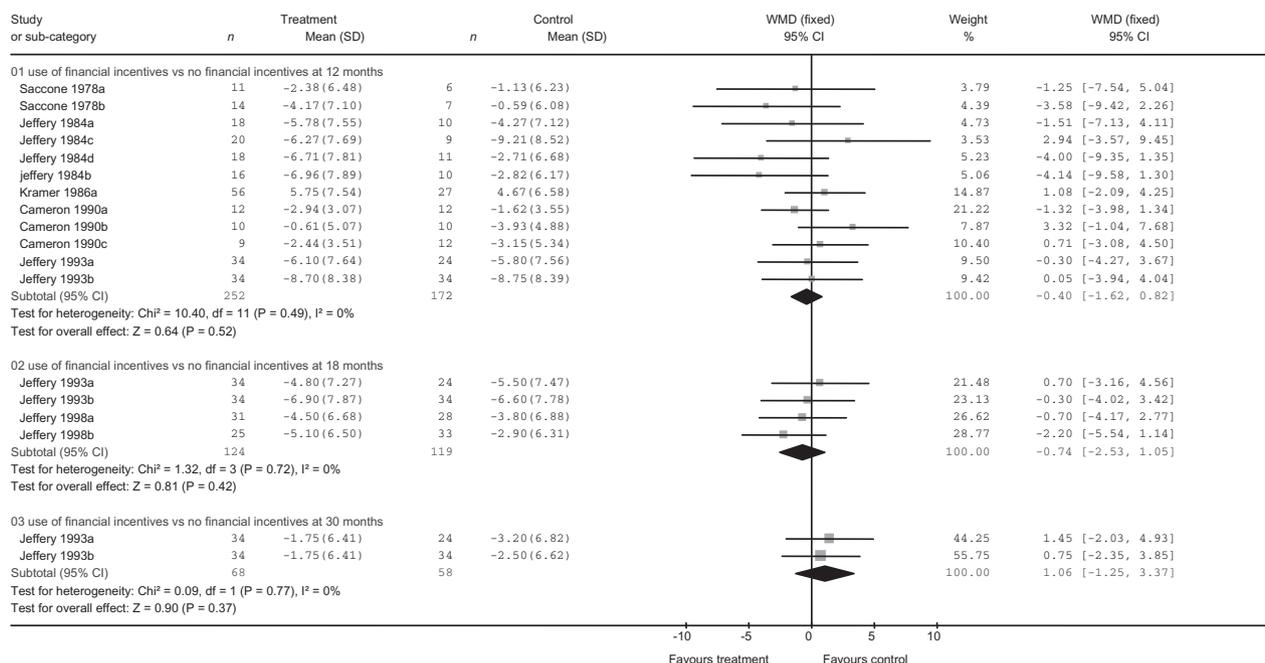
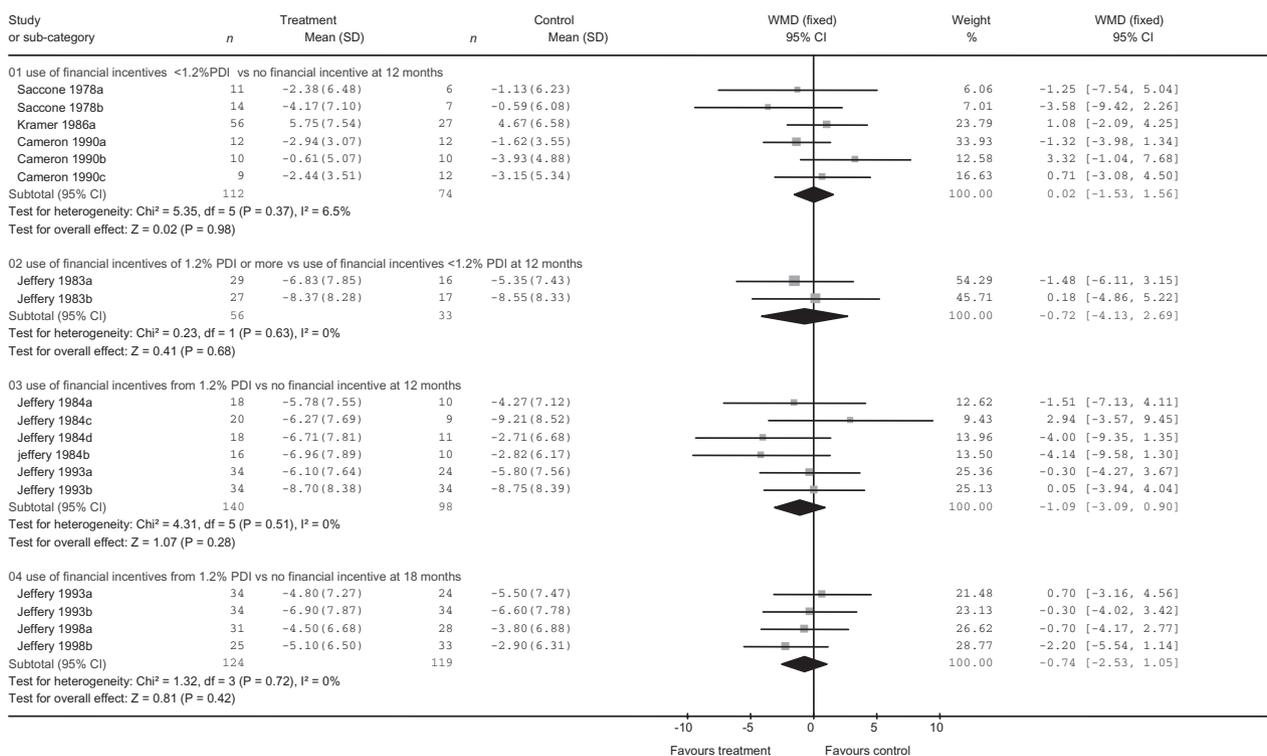
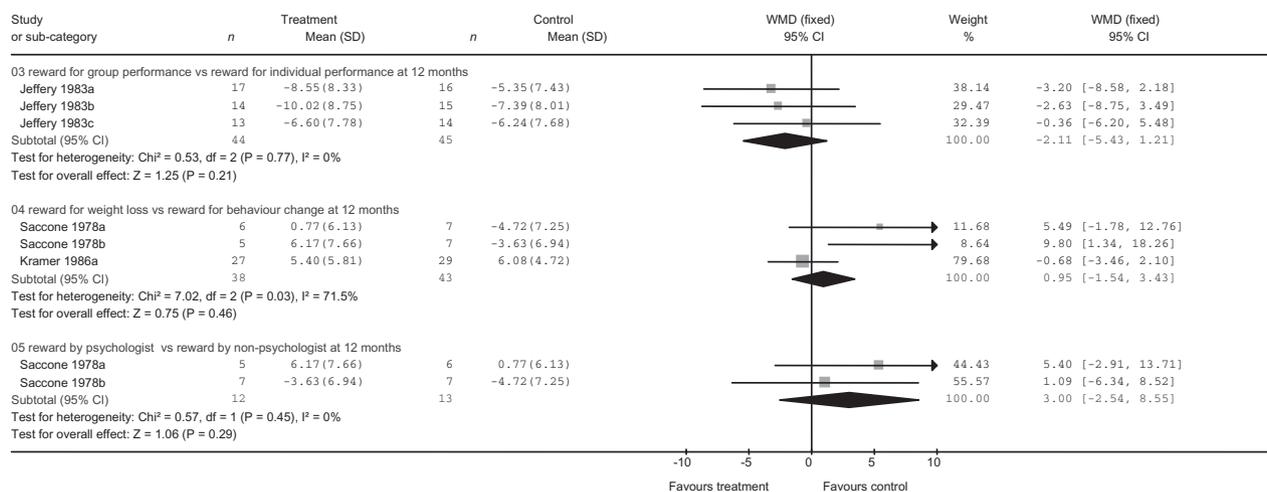


Figure 2 Weight change in studies comparing use of financial incentives vs. no financial incentive. WMD, weighted mean difference.



**Figure 3** Effects of use of financial incentives compared by percentage PDI, and compared without financial incentives. PDI, personal disposable income; WMD, weighted mean difference.



**Figure 4** Comparisons of different methods delivering reward using financial incentives. WMD, weighted mean difference.

In conducting the planned sub-analysis of effect of use of financial incentives by source of money used as incentives, we had insufficient data to allow us to compare both the freely supplied incentive groups and the groups receiving refunded deposits (see ‘description of interventions’ above) at the same time. We have therefore conducted and reported these analyses separately at 18 months and 12 months respectively, as follows. WMD

weight change was  $-0.7$  kg (95% CI  $-2.5$  to  $1.1$  kg) at 18 months comparing groups with freely supplied financial incentives with control or comparison groups not receiving financial incentives. Comparing groups with the financial incentives provided by participants as refundable deposits with no financial incentive control groups gave a WMD weight change of  $-0.5$  kg (95% CI  $-1.8$  to  $0.9$  kg) at 12 months.

Comparison of groups rewarded for weight loss vs. groups rewarded for behaviour change or attendance at sessions was associated with a WMD weight change of 1.0 kg (95% CI -1.5 to 3.4 kg) (fixed effects), and 3.9 kg (95% CI -2.6 to 10.5 kg) (random effects). Comparing groups rewarded by non-psychologists (e.g. family member) to groups rewarded by psychologists, the WMD weight change was 3.0 kg (95% CI -8.6 to 2.5 kg). A final comparison of groups with rewards based on group performance to groups with rewards based on individual performance gave a WMD weight change of -2.1 kg (95% CI -5.4 to 1.2 kg).

Subgroup analysis of ethnic groups at high risk of metabolic syndrome and of participants from lower socioeconomic groups was not performed because of insufficient data.

## Discussion

We found we needed to hand search the literature as many studies were not indexed as RCTs of obesity interventions in electronic databases. Although no language limitations were placed, all our studies were in English including a study with a French translation (19). This might be because such studies were not indexed in our databases. All studies in this review were conducted in North America which might limit the generalizability.

We excluded non-randomized or quasi-randomized studies or studies where it was not possible to isolate the effects of financial incentives from other components of the intervention. Many studies did not provide important participant characteristics, leading to our inability to conduct the pre-planned subgroup comparisons of ethnic groups at higher risk for the metabolic syndrome. Inadequate reporting was also found in a review of randomized trials in diet and exercise for weight loss (22). Concern has been expressed over the under-representation of vulnerable population groups in studies involving the use of economic incentives for conditions requiring sustained behaviour change, compared with studies involving simple preventive care (such as immunization) (6). The implication of the above, especially in view of recent evidence indicating that patient-specific subgroups within the same socioeconomic income bracket may respond differently to varying levels of treatment modifiers (23), is that we have very limited evidence of the impact of financial incentives on socioeconomically and ethnically diverse populations that could be aimed at meeting equity in health care (7). This is particularly important as obesity in developed countries has a higher prevalence among the lower socioeconomic groups, and is reported to be more resilient to diet-induced weight loss and maintenance among black than white ethnic groups (24,25).

Sample sizes were not justified and most studies had very small sample sizes (implying low statistical power) and/or employed multiple factorial combinations with small samples. It is clear that future studies need to be more explicit on randomization procedure and blinding and conduct intention to treat analyses in keeping with the CONSORT statement (26).

From our results, a very weak trend for more positive effects tended to be seen with the use of amounts equivalent to 1.2% PDI and above. The choice of the amount, frequency or method of administration of the financial incentives was not justified in any study. This lack of justification of the financial incentives with the targeted population was similarly reported by Kane *et al.* (6). Wing *et al.* (15) involved the use of pre-written cheques equivalent to 2.3% PDI and reported high attrition rates (57.9% at 13 months) and uncertainty as to whether the attrition was due to the contracting procedure or the length of contracting period. The above, compounded by the lack of cost-effectiveness calculations in any study, also observed by Kane *et al.* (6), poses a limitation in our being able to inform on the cost-effectiveness of the use of financial incentives in behavioural obesity treatments (there was no reported use of financial incentives with pharmacological or surgical obesity treatments). Future studies should be informed by discrete choice experiments to estimate money or equivalents that can serve as motivation for use as rewards and include cost-effectiveness data. A more recent study shows that the trend is now to include financial incentives as part of a multi-component intervention (27) as recommended (28).

One excluded study (29) used a financial contract independently as a treatment condition rather than as an adjuvant treatment or motivator. The authors reported a very high attrition rate (58%) in a first experiment, and total decline by all assigned to that condition in the second experiment, the typical reason being financial. It is recommended that a financial incentive should not be used as a therapy in itself but as adjuvant to treatments.

The follow-up period for future studies should be long enough to allow for long-term effects of treatment to be studied. Most of our excluded studies were rejected on this premise. It is important to note the trend towards a reversal of effects observed in groups with 30-month follow-up data (collected 12 months after all treatment was stopped in these groups) (2) in view of arguments over the sustained effectiveness of treatments following withdrawal of extrinsic motivators for long-term lifestyle changes (6). One study tried to address this by providing an intrinsic angle (i.e. self-administered rewards) to the extrinsic use of financial incentives (14), although we were unable to determine the effect of this because of lack of weight data for a meta-analysis.

Although no statistically significant differences were observed in meta-analysis, the CIs for some comparisons

were wide enough to include clinically important weight differences (of approximately 5% weight loss) in 1 year. For example, a very weak trend was observed in favour of reward for behaviour change than reward for weight. The study by Mahoney (14) (not included in meta-analysis for reasons discussed under 'results of search strategy' above) reported percentage of subjects maintaining or improving weight loss to be highest in the group rewarded for behaviour change (70%), followed by the group rewarded for weight (40%), and least in the self-monitoring only (no-reward) group (37.5%). Wing *et al.* (15) reported no difference in the effect of financial incentives between contracting for weight loss and contracting for attendance (no group was rewarded for behaviour change). Other very weak trends from meta-analysis were in favour of rewards based on group rather than individual performance, which may have relevance to commercial groups, and rewards delivered by non-psychologists rather than by psychologists. Further RCTs informed by qualitative research or a theoretical framework, such as discrete choice experiments, could help establish the roles of these attributes to the design of obesity treatments using financial incentives, as is recommended in the design and evaluation of complex interventions (30).

Although possible interactions exist between other motivators used in some studies (e.g. personal trainers and food provision) and financial incentives, we are unable to account for the effect(s) in this review. This observation of the potential for confounding by other intervention components with economic incentive use on consumers' preventive behaviour was also documented by Kane *et al.* (6). Even though we found a very weak trend for more effect to be observed when a behaviour change contingency was in place than a weight change contingency, it is more challenging to objectively measure behaviour change (usually self-reported) than to measure weight change in everyday practice. There is also difficulty in explaining the motivational aspect of contingency management when both target behaviour and consequences or reward comes from the same patient as noted by Foreyt *et al.* (31), i.e. should the source of the financial reward for obesity treatments come from or outside the patients' pockets? Our review incorporated both studies with financial incentives freely supplied to participants and studies with financial incentives provided by participants, and this appeared not to have led to any significant differences in effectiveness in the population represented (interpreted with caution as we acknowledge the limitation in using results of sub-analysis conducted at different time frames for these groups as discussed earlier). How the source of financial incentives used as rewards in obesity treatment might impact on participants from lower socioeconomic groups or those who may be less motivated than those represented here remains to be explored.

Although this review is limited by the sample sizes of the individual studies, and generalizability because all trials

were from North America, there were very weak trends in favour of the use of financial incentives under certain situations when compared with others. Other similar and less focused systematic reviews have reported significantly greater effectiveness when financial incentives are used in patient treatment and preventive behaviour than when not used (6–8). It is reported that financial incentives tend to be more effective than other methods of improving compliance (7). We found that some studies involved the use of other motivators, e.g. food provision or use of personal trainers, but made no attempt to compare the use of financial incentives with any of these motivators because unlike financial incentives, no other motivator was delivered contingent on participants' performance.

Giuffrida and Torgersen (7) reported that financial incentives were more cost-effective than alternative interventions in achieving greater compliance in a dental health screening and referral programme, and are likely to be cost-effective in situations where substantial treatment benefits accrue to society. In view of the externalities to obesity treatments (such as current attributable costs to the National Health Service in the UK) (32), a study of the long-term cost-effectiveness of financial incentives in obesity treatments compared with current practice or other intervention(s) is recommended. Future studies should be informed by qualitative research and discrete choice experiments to measure attributes such as amount, frequency and method of administration of financial (or other) incentives that can serve as sufficient motivation for use as rewards.

## Conflict of Interest Statement

No conflict of interest was declared.

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