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The Utility of Monetary Contingency Contracts for Weight loss:

A Systematic Review and Meta-Analysis

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Abstract

Financial incentives to improve health have received increasing attention, but are subject to ethical concerns. Monetary Contingency Contracts (MCCs), which require individuals to deposit money that is refunded contingent on reaching a goal, are a potential alternative strategy. This review evaluates systematically the evidence for weight loss-related MCCs. Randomized controlled trials testing the effect of weight loss-related MCCs were identified in online databases. Random effects meta-analyses were used to calculate overall effect sizes for weight loss and participant retention. The association between MCC characteristics and weight loss/participant retention effects were calculated using meta-regression. There was a significant small-to-medium effect of MCCs on weight loss during treatment when one outlier study was removed. Group refunds, deposit not paid as lump sum, participant setting own deposit size, and additional behaviour change techniques were associated with greater weight loss during treatment. Post-treatment, there was no significant effect of MCCs on weight loss. There was a significant small-to-medium effect of MCCs on participant retention during treatment. Researcher-set deposits paid as one lump sum, refunds delivered on an all-or-nothing basis and refunds contingent on attendance at classes were associated with greater retention during treatment. Post treatment, there was no significant effect of MCCs on participant retention. The results support the use of MCCs to promote weight loss and participant retention up to the point that the incentive is removed, and identifies the conditions under which MCCs work best.

Key words: Weight loss, Obesity, Incentives, Contracting

The worldwide prevalence of obesity has almost doubled since 2005, with at least 2.8 million adults dying each year as a result of being overweight or obese (World Health Organisation, 2013). Despite the availability of clinical guidelines (e.g., National Institute for Health and Clinical Excellence, 2014) and research reviews on the most effective techniques for weight management (e.g., Dombrowski et al., 2012), the predicted global increase in overweight and obesity (Kelly, Yang, Chen, Reynolds, & He, 2008) suggests that further weight management research is needed.

Financial incentives, in which individuals are offered financial rewards for engaging in health enhancing behaviours, or refraining from health damaging behaviours (e.g., Adams, Giles, McColl, & Sniehotta, 2013; Lynagh, Sanson-Fisher, & Bonevski, 2013; Marteau, Ashcroft, & Oliver, 2009) have received growing attention. This approach has aided treatment compliance (Giuffrida & Torgerson, 1997), preventive health behaviours (Kane, Johnson, Town, & Butler, 2004), dietary behaviour (Wall, Ni Mhurchu, Blakely, Rodgers, & Wilton, 2006), and physical activity, smoking cessation, vaccination and screening attendance (Giles, Robalino, McColl, Sniehotta, & Adams, 2014). However, after incentives are removed they appear less effective (e.g., for smoking: Cahill and Perera (2011); for weight loss: Paul-Ebhohimhen and Avenell (2008). Additionally, the use of personal financial incentives to promote healthy behaviour could be considered 'unfair', rewarding individuals for performing health behaviours others perform without financial payment (Volpp, Pauly, Loewenstein, & Bangsberg, 2009).

A potentially less controversial way of providing personal financial incentives for health behaviour change is to encourage individuals to invest a sum of money that is refunded contingent on the achievement of a specific goal. As long as this approach is voluntary, it may provide a fairer and less coercive form of financial incentive, as it does not involve the offer of external financial gain. It could be argued that offering this type of incentive as an intervention may be less fair for individuals on lower incomes as they may be less able to deposit a sum of money to be used as a reward. However, this could be overcome by setting deposit amounts as a

certain percentage of disposable income, or allowing individuals to set an amount that they feel would be motivating for them, but that would not cause excessive financial deprivation were they to lose it.

In the area of weight management, money is either refunded contingent on the actual amount of weight lost (Colvin, Zopf, & Myers, 1983; Harmatz & Lapuc, 1968), or other weight loss-related outcomes such as attending weigh-ins (Cameron et al., 1990) or completing food diaries (Follick, Fowler, & Brown, 1984). Various terms have been used to describe this technique, including 'monetary contingencies' (Wing, Epstein, Marcus, & Shapira, 1981) and 'contingency contracting' (Mann, 1972). We refer to the term 'Monetary Contingency Contracts' (MCCs) for the purposes of the present review.

The benefits of MCCs in motivating weight loss are supported by theories of learning and behavioural economics. Based on operant conditioning theory (Skinner, 1953), MCCs act as a 'negative reinforcer', reinforcing behaviour by the removal of a negative or aversive stimulus. The payment of the money before the weight loss attempt provides the aversive stimulus (loss of the money), and the successful achievement of weight loss behaviours leading to weight loss results in the removal of this aversive stimulus (the money being returned).

As part of a meta-analysis of financial incentives in the treatment of overweight and obesity Paul-Ebhohimhen and Avenell (2008) found MCCs produced a modest effect (weighted mean difference in weight loss from baseline to 12 months of 0.5kgs compared to no MCCs, based on 7 studies). In a sub group analysis, Paul-Ebhomhimhen and Avenell found a weak trend in favour of refunds based on group performance rather than for individual performance (based on one MCC study). In another sub group analysis, a weak trend was found in favour of rewards for behaviour change rather than for actual weight loss. However, the latter sub group analysis was based on all studies included in Paul-Ebhohimhen and Avenell's review (including two studies testing external financial incentives rather than MCCs) and therefore it is unclear how this trend changes when only MCC-based studies are included. Moreover, we do not know from Paul-

Ebhohimhen and Avenall's review whether the effects of MCCs continue only for as long as the refunds are returned, as the effect on weight during treatment and post treatment is not differentiated between. In a qualitative synthesis of evidence, Burns et al. (2012) suggested weight loss achieved during treatment is not maintained after termination of refunds and MCCs may be more effective when the deposit is particularly large. However, these claims were not examined through meta-analyses.

Paul-Ebhomhimhen and Avenell (2008) and Burns et al. (2012) reviews of financial incentives evaluated the impact of weight loss related MCCs on the outcome of actual weight loss only. However, weight loss may be adversely affected by high dropout in behavioural interventions (Grave et al., 2005; Honas, Early, Frederickson, & O'Brien, 2003; Inelmen et al., 2005). Strategies that increase retention, even if they do not directly improve weight loss, can indirectly improve weight loss if they are paired with other techniques that are effective when used on a longer-term basis. Moreover, Paul-Ebhomhimhen and Avenell (2008) and Burns et al. (2012) reviews have not evaluated statistically how the nature of any additional behaviour change techniques (BCTs)[1], administered alongside the MCC, may influence weight loss or participant retention. It is important to consider whether MCCs are only effective when delivered alongside BCTs because BCTs such as self-monitoring might enhance the effectiveness of MCCs. Indeed, Paul-Ebhohimhen and Avenell (2008) recommend that a financial incentive should be used as part of a broader weight loss intervention, rather than as a treatment itself but did not statistically test this. Considering which BCTs are most likely to complement an MCC would be useful for the design of future MCC studies to maximise weight loss and participant retention.

Aims

As well as being the first review focused specifically on MCCs, the present review aims to extend the previous literature in three key respects. First, it will statistically test a broad range of factors that may influence the effect of MCCs on weight loss: e.g., whether the deposit amount is set by the participant or the researcher; the total number of refunds; whether the deposit was paid

as one lump sum or in instalments throughout the study; and the use of additional BCTs alongside the MCC. This is important because the wide variations in how financial incentives interventions are administered makes it difficult to conclude what type of incentives are effective, for whom and under what conditions (Adams et al., 2013). Second, the present review explores which features of MCCs affect participant retention. Third, the present review extends Paul-Ebhohimhen and Avenell's (2008) review by including studies with any length of follow-up period permitting an examination of MCCs effects over time. Short-term decreases in weight loss can be useful because they are linked with larger improvements in ongoing weight loss (Jeffery, Wing, & Mayer, 1998).

Method

Protocol Registration

Details of the protocol for this systematic review were registered on PROSPERO and can be viewed in the online supplementary materials.

Data Sources and Searches

The electronic databases MEDLINE, PsycINFO, EMBASE, CINAHL and the Cochrane Register of Controlled Trials (CENTRAL) were searched. The search strategy was based around three filters (see search criteria in online supplementary materials). The first two filters were adapted from previous reviews and identified studies using contracts (Bosch-Capblanch, Abba, Prictor, & Garner, 2007) and weight loss interventions (Norris et al., 2005; Shaw, O'Rourke, Del Mar, & Kenardy, 2005). The third filter used previously validated search strategies to identify randomised controlled trials (Eady, Wilczynski, & Haynes, 2008; Higgins & Green, 2011; Scottish Intercollegiate Guidelines Network, 2012). The search was last conducted in January 2014. The reference sections of studies meeting the inclusion criteria were also searched.

Study Selection

To be included in the review, studies had to: 1. involve random assignment of participants to a treatment group who received an intervention and a comparison group who received either a control intervention or no intervention; 2. test the effect of MCCs for weight loss, in which a participant deposits an amount of money, which is returned contingent on weight loss or behaviours associated with weight loss (e.g., attendance at weight loss classes); 3. include a measure of weight loss or associated weight loss behaviour after the money has been returned or forfeited; 4. include only participants aged over 18 years; 5. involve an MCC that was under the control of somebody other than the participant themselves (i.e., not self-reward). Studies were excluded if: 1. The study had a non-human (animal) sample; 2. the paper was an existing review; 3.the paper was an unpublished thesis; 4. the study was not reported in the English language. The titles, abstracts and full-texts were screened by the first author. All full-texts were double-screened by another member of the review team with discrepancies resolved through discussion.

Data Extraction and Quality Assessment

Data extraction was first conducted by the lead author using a standardised, pre-piloted data extraction form, constructed with reference to several weight loss based MCC studies already known to the authors. The Cochrane Collaboration's tool was used to assess risk of bias at both the study and outcome level (Higgins & Green, 2011).Extracted information included details of: BCTs administered alongside the MCC, outcome measures including weight loss in kilograms for the MCC groups and no MCC groups, study setting, sample size and type, intervention duration, value of contingency contracts and size of weight loss goals. BCTs were coded using the CALO-RE taxonomy (Michie et al., 2011). This is a standardised 40-item taxonomy used to classify behaviour change techniques used in physical activity and healthy eating interventions. This taxonomy has been found to have good inter-rater reliability (Michie et al., 2011). Study authors were contacted in the event of missing data. To enhance reliability, all data extraction was checked by another review team member. Discrepancies were resolved through discussion.

Data Synthesis and Analysis

All eligible studies, except two, included actual weight loss as an outcome. Therefore, weight loss was used to calculate effect sizes (Hedges g) across study conditions using Comprehensive Meta-Analysis (Borenstein, Hedges, Higgins, & Rothstein, 2005). For the two studies that did not report actual weight loss, percentage weight loss or percentage overweight was used to calculate the effect size. A total of 16 studies tested the effect of an MCC against no MCC. For 2 studies (both of which tested an MCC against no MCC), a weight loss effect size could not be calculated due to insufficient information in the paper. Therefore, these studies were excluded from weight loss analyses. Therefore, the MCC vs. no MCC analysis for weight loss was based on 14 studies and included 17 comparisons.

The rate of participant retention was determined by calculating the proportion of participants within each group that stayed in the study and were weighed at each weigh-in. Where this was not possible, participant retention was calculated using other information reported in the paper (e.g., the number of participants completing a specific number of the intervention sessions). Participants who dropped out before paying the deposit or before the interventions commenced were not included in this analysis. There was insufficient retention data for 4 studies (3 of which tested an MCC against no MCC). Therefore, the MCC versus no MCC analysis for participant retention was based on 13 studies and included 16 comparisons.

Where studies had multiple comparison groups, to help isolate the effect of MCCs, we selected the group most similar to the MCC condition in terms of the additional intervention components provided alongside the MCC. When this was not possible (i.e., when the MCC group was equally similar to two comparison groups, or a comparison group was equally similar to two MCC groups), we report more than one comparison from the same study with sample sizes divided by the number of comparisons to avoid multiple counting of participants. When there were multiple follow-ups, the effect sizes for each follow-up were combined into a single effect size. None of the studies reported the use of cluster randomisation and so no correction was applied. Heterogeneity between studies was assessed using the I^2-statistic and Q-test. Meta-

regressions were run to identify the MCC characteristics and BCTs most strongly associated with weight loss and retention.

Additional Analyses

Meta-regressions tested the association between methodological quality and weight loss. Chi-square analyses identified potential confounds between each combination of categorical MCC variations (e.g., 'did the researcher set the size of deposit?'; 'did all participants make the same size deposit?'). Pearson's r correlations identified potential confounds between each combination of non-categorical MCC variations (e.g., 'deposit amount'; 'number of refunds'). Point bi-serial correlation identified potential confounds between each combination of categorical versus non-categorical MCC variations.

The Sample-Adjusted Meta-Analytic Deviancy (SAMD) statistic (Huffcutt & Arthur, 1995) identified one outlier. A sensitivity analysis was conducted for weight loss excluding this study (sensitivity analysis 1). Additionally, certain studies recruited all of their participants on the basis of their willingness to invest into a MCC (with participants randomized to the comparison group being refunded soon after the beginning of the study). Such designs, by only recruiting participants willing to pay into such schemes, are more likely to minimize any motivational differences between the MCC and comparison groups as all of the participants were prepared to pay the deposit. Consequently, a second set of sensitivity analyses were conducted with only these studies (Follick et al., 1984; Harmatz & Lapuc, 1968; Jeffery, Bjornson-Benson, Rosenthal, Kurth, & Dunn, 1984; Jeffery, Danaher, Killen, Farquhar, & Kinnier, 1982; Jeffery, Forster, & Snell, 1985; Jeffrey, 1974; Rozensky & Bellack, 1976). Additionally, as there is a possibility that those participants who drop out are those who are least successful in weight loss, to test this, a third set of sensitivity analyses were conducted that included only those studies that used intention to treat analyses (Jeffery et al., 1984; Jeffrey & Christensen, 1975; John et al., 2011; Volpp et al., 2008).

Results

Study Selection

The number of papers considered at each stage of the review is summarized in Figure 1. Thirty-one papers met all inclusion/exclusion criteria, resulting in thirty unique studies.

Study Characteristics

All studies were RCT's, and reported at least one weight loss outcome measure. Three of the 30 unique studies (10%) exclusively used medical/healthcare based samples (patients). All but one of the 30 studies were conducted in the US. The mean deposit amount across all studies was £119.80 and ranged from £13.76 (Hagen, Foreyt, & Durham, 1976) to £480.24 (Jeffery, Thompson, & Wing, 1978). Duration of the refunds ranged from 4 weeks (Romanczyk, Tracey, Wilson, & Thorpe, 1973) to 1 year (Kramer, Jeffery, Snell, & Forster, 1986). Study characteristics are reported in Tables A1 and A2 in online supplementary materials.

Risk of Bias

All studies reported weight loss measured by the researcher rather than relying on self-reported weight. However, no studies reported adequate blinding of participants, intervention deliverer, data collector or statistician. All studies were at unclear risk of selective outcome reporting. Risk of bias is summarized in Table A3 in online supplementary materials. Meta-regressions revealed none of the methodological quality variables were significantly associated with greater weight loss (see online supplementary materials, Table A5).

Syntheses of Weight Loss Results

Overall effect of MCCs on weight loss.

Across all treatment end point and post treatment follow-ups, based on 17 comparisons (from 14 studies), MCCs were ineffective for weight loss compared to a no-MCC comparison condition, $g = 0.20$, $p = .22$; $I^2 = 76.33$; 95% CI [-0.123, 0.532]. The mean overall weight change during treatment in the MCC groups and comparison groups was -4.94 kg (± 2.94 SD) and -3.57 kg (± 3.24 SD) respectively, $g = 0.28$, $p = .13$; $I^2 = 70.08$; 95% CI [-0.081, 0.636]. After

termination of refunds, the mean overall weight change in comparisons that included follow-ups after the treatment endpoint (5 studies) was +3.30 kg (± 2.45 SD) in the MCC groups and +1.35 kg (± 1.44 SD) in the comparison groups, g = 0.02, p = .92; I^2 = 52.96; 95% CI [-0.340, 0.377]. Figure 2 suggests that although the effect either during or after treatment is not significant, whilst refunds are administered (Figure 2a), MCCs may be more effective than a no MCC comparison, with the MCC group losing more weight in almost all comparisons. However, post-treatment (Figure 2b), there is weight gain in both conditions, and so more weight-regain may be associated with the MCC.

MCC factors associated with greater weight loss.

Within-study comparisons.

In the study testing the effect of group-based refunds, the group refunded for average group performance was more effective than the group refunded for individual performance g = 0.44, p < .001; I^2 = 0.00; 95% CI [0.19, 0.68]. However, in the study testing the effect of pair based refunds, the group refunded for individual performance lost more weight than the group refunded for paired performance, g = -0.70, p < .005; I^2 = 0.00; 95% CI [-1.15, -0.26]. . None of the other within study comparisons were significant (see Table 1).

Between-study comparisons: meta-regressions (MCC versus No MCC comparisons).

Weight loss was greater in the comparisons where the deposit was not paid as a lump sum at the start of the intervention (i.e., paid in smaller instalments throughout the intervention period, g = 0.64) than comparisons where the deposit was paid as a lump sum (g = -0.10), g = -0.76, p < .05; 95% CI [-1.36, -0.16]. A marginally significantly larger weight loss effect was obtained in the comparisons where the researcher did not set the deposit amount (g = 0.53) compared to comparisons in which the researcher did set the deposit amount (g = -0.03), g = -0.59, p = .07; 95% CI [-1.22, 0.04]. However, it should be noted that if the researcher set the deposit amount, the deposit was more likely to be paid as a lump sum at the start of the study, therefore suggesting a possible confound. None of the meta-regressions for the other MCC variations produced

significant effects (see Tables 2 and 3). 'Prompt self-monitoring of behaviour' (BCT 16) was the only BCT delivered alongside MCCs that was associated with greater weight loss and the effect was only marginally significant, g = 0.93, p = .06; 95% CI [-0.04, 1.89] (see Table A4 in online supplementary materials). The operationalization of self-monitoring of behaviour included asking participants to record food and calorie intake (Follick et al., 1984; Jeffery et al., 1985) and the use of pre-eating monitoring, in which participants were required to write down their intended food intake immediately prior to eating (Rozensky & Bellack, 1976). Significantly greater weight loss was reported when the MCC-based intervention incorporated more BCTs than the comparison group, g = 0.14, p = .02; 95% CI [0.02, 0.25].

Syntheses of Participant Retention Results

Overall effect of MCCs on participant retention.

Across all treatment end point and post treatment follow-ups, based on 16 comparisons (from 13 studies), MCCs were effective for improving participant retention compared to a no-MCC comparison condition, g = 0.32, p < .05; I^2 = 29.32; 95% CI [0.01, 0.64]. The mean participant retention during treatment in the MCC groups and comparison groups was 85.1% (± 0.14 SD) and 71.7% (± 0.28 SD) respectively, g = 0.41, p < .05; I^2 = 13.65; 95% CI [0.075, 0.746]. After termination of refunds, the mean overall participant retention in comparisons that included follow-ups after the treatment endpoint (4 studies) was 76.9% (± 14.2 SD) in the MCC groups and 75.6% (± 18.7 SD) in the comparison groups, g = 0.01, p = .98; I^2 = 0.00; 95% CI [-0.506, 0.518].

MCC factors associated with greater retention.

Within-study comparisons.

None of the within-study comparisons (Group MCC versus Individual MCC; Pair based MCC versus Individual MCC; Weight loss refunds versus Behaviour change refunds; Smaller versus Larger deposit) for participant retention were significant (see Table 1).

Between-study comparisons: meta-regressions (MCC vs. No MCC comparisons).

Participant retention was higher in the comparisons where the deposit was paid as one lump sum at the start of the study (g = 0.56) compared to where the deposit was paid in smaller instalments throughout the study (g = 0.03), g = 0.61, p < .05; 95% CI [0.03, 1.18]. Participant retention was also higher when the return of all or part of the deposit was not contingent on weight loss (g = 0.71) compared to comparisons in which return was contingent on weight loss (g = -0.01), g = -0.72, p < .01; 95% CI [-1.22, -0.21]; when the refund was offered on an 'all or nothing' basis (g = 0.78) rather than a performance-related basis (g = 0.11), g = -0.69, p < .05; 95% CI [-1.28, -0.10]; when return of all or part of the deposit was contingent on attendance at classes or meetings (g = .72), compared to comparisons when it was not (g = 0.11), g = 0.60, p < .05, 95% CI = [0.03. 1.18]. A marginally significantly larger effect on participant retention was obtained in comparisons in which the researcher set the deposit amount (g = 0.53) than comparisons in which participants set their own deposit amount (g = -0.05), g = 0.58, p = .06; 95% CI [-0.03, 1.12]. None of the meta-regressions for the other MCC variations produced significant effects on participant retention (see Tables 2 and 3) but various BCTs were associated with lower participant retention rates when delivered alongside MCCs: 'prompt review of outcome goals'(BCT 11), g = -1.16, p < .01; 95% CI [-2.02 , -0.30]; 'provide rewards contingent on successful behaviour' (BCT 13), g = -0.72, p < .01; 95% CI [-1.22 , -0.21]; 'prompt self-monitoring of behavioural outcome' (BCT 17), g = -1.16, p < .01; 95% CI [-2.02 , -0.30]; 'provide feedback on performance' (BCT 19), g = -1.16, p < .01; 95% CI [-2.02 , -0.30] (see Table A4 in Online Supplementary Materials). Marginally greater participant retention was reported when the MCC-based intervention incorporated less BCTs than the comparison group, g = -0.11, p = .08; 95% CI [-0.24, 0.01].

Additional Analyses

One study was identified as an outlier (via the SAMD statistic, see Huffcutt & Arthur, 1995) due to an unusually large weight loss effect, with the no MCC group losing significantly

more weight than the MCC group. After removal of this study (sensitivity analysis 1, see 'Additional Analyses' in Method section), there was a significant overall effect of MCCs on weight loss (see online supplementary materials Table A6), g = 0.32, p < .05 but the effect emerged during treatment (g = 0.38, p < .01) not after termination of refunds (g = 0.14, p = .24). The mean overall weight change during treatment in the MCC groups and comparison groups was -5.36kg (±2.91 SD) and -3.48kg (±3.48 SD) respectively. After termination of refunds, the mean overall weight gain in studies that included follow-ups after the post treatment follow-up (4 studies) was 4.21kg (±2.09 SD) and 1.66kg (±1.55 SD) respectively. Additionally, weight loss was significantly greater when the deposit was paid in smaller, frequent amounts throughout the study, the return of all or part of the deposit was contingent on weight loss, rather than on behaviour or attendance at weigh-ins or follow-ups (see online supplementary materials Table A7). In sensitivity analysis 2 (studies in which all conditions were initially asked to pay a deposit), there was no significant main effect of MCCs on weight loss, g = 0.12, p > .05, and no significant effect on weight loss either during treatment (g = .15, p = .67) or after termination of refunds (g = .01, p = .96). However, weight loss was significantly greater when the deposit was paid in smaller, frequent amounts throughout the study (see online supplementary materials Table A7). In studies which conducted intention to treat analyses (sensitivity analysis 3), a significant effect of MCCs on weight loss emerged during treatment, (g = .59, p <.001) but not after termination of refunds (g = .21, p = .18). The results of all sensitivity analyses (including participant retention results) are reported in the online supplementary materials Tables A6 and A7.

The results of the chi-square and correlation analyses to assess whether any of the MCC variations were confounded revealed that several of the MCC variations were confounded. Most notably for the significant weight loss meta-regressions, it was found that if the researcher set the deposit amount, the deposit was more likely to be paid as a lump sum at the start of the study (see online supplementary Tables A8, A9 and A10). Additionally, for the significant participant

retention meta-regressions, most notably it was found that if the deposit was paid as a lump sum, the deposit was more likely to be set by the researcher, return of all or part of the deposit was more likely to be contingent on attendance at classes/meetings, and less likely to be refunded on a performance related basis (see online supplementary materials Tables A11, A12 and A13).

Studies not Included in Meta-Analyses

For five of the included studies, no comparisons were possible for the above analyses. For a summary of these studies, see online supplementary materials.

Discussion

This review aimed to evaluate the efficacy of weight-loss-based MCCs for promoting weight loss and participant retention, and to identify the conditions under which MCCs are most effective. The results suggest MCCs may aid weight loss (following the exclusion of one outlier study) but only while the refund is still available; weight regain is likely after refund termination. There were a number of factors identified as potentially making MCCs more effective for weight loss: refunds contingent on average group performance rather than individual performance; frequent deposits rather than one lump sum; participants were able to choose their own deposit amount; and when the BCT of self-monitoring was employed compared to when this technique was not employed.

During treatment, MCCs were effective in promoting participant retention, particularly when the researcher set the deposit amount, the deposit was paid as a lump sum at the start, rather than in frequent amounts throughout the study, the refund was contingent on attendance at classes or meetings rather than actual weight loss, and was offered on an 'all or nothing' basis. However, again it should be noted that in studies in which the researcher set the deposit amount, the deposit was more likely to be paid as a lump sum at the start. MCCs were less effective for retention when used alongside various BCTs (prompt review of outcome goals, provide rewards contingent on successful behaviour (coded if refunds were contingent on actual weight loss), prompt self-monitoring of behavioural outcome, provide feedback on performance). However, the sub-group

analyses were based on few studies (e.g., only one study tested rewards to groups comprising at least 3 people) and some variables were potentially confounded. For example, the studies in which the researcher set the deposit amount were more likely to request that the deposit was paid as a lump sum at the start. Consequently, the variations of MCCs which may be more effective should be considered in this context; further research is needed.

The finding in the present review that MCCs are only effective for weight loss during treatment, supports Burns et al.'s (2012) narrative review concerning the long term effectiveness of MCCs. While Burns et al. (2012) also concluded that larger deposits may make MCCs more effective, our quantitative review did not support this. Paul-Ebhohimhen and Avenell (2008) and Burns et al. (2012) concluded group-based rewards to be more effective. Unsurprisingly, after identifying the same single study (Jeffery, Gerber, Rosenthal, & Lindquist, 1983), we reached the same conclusion but only when groups comprised of more than two people who were strangers at the outset. An additional study, not included in the earlier reviews, found that pair-based MCCs were not effective for weight loss (Zitter & Fremouw, 1978). In Zitter and Fremouw's (1978) study, however, the pairs of participants were friends joining the program together and anecdotal reports suggested one partner within the pair often convinced the other to deviate from their healthy eating patterns. Additionally, in the present review, we did not find evidence to support Paul-Ebhohimhen and Avenell's finding that rewards for behaviour change or attendance at sessions are more effective in terms of weight loss than rewards for actual weight loss. However, the present review did find rewards for behaviour change or attendance at sessions are more likely to promote participant retention.

Within the study identified as an outlier (Rozensky & Bellack, 1976), the deposit was equivalent to approximately £44 (paid in full at baseline), which was relatively small compared to the other studies included in the meta-analysis. Additionally, whereas other studies with similar deposit sizes tended to offer refunds on few occasions, participants in the Rozensky and Bellack study were weighed and offered refunds each week for seven weeks. Therefore, this likely

resulted in smaller refunds at each 'refund opportunity' compared to other studies. The small size of the deposit may have resulted in this monetary loss being absorbed into the wealth status, with a shifted reference point resulting in subsequent refunds being perceived as small gains. Thus, each refund may have had a less salient reward value, and instead of rewarding successful weight loss, as acknowledged by Rozensky and Bellack, the MCC procedure may have distracted participants from other, more effective components of the weight loss program.

Although it is difficult to compare effects across meta-analyses due to intervention variations such as duration and intensity, the mean difference in weight loss between intervention and comparison groups in the present review (after removal of one outlier) is smaller than that found in meta-analyses of other weight-loss interventions. The mean difference in weight loss during treatment in the present review was 1.88kg whilst other reviews have found mean differences of 3kg for behavioural interventions (Dombrowski et al., 2012) and 3.7kg and 7.8 kg differences for interventions targeted at dietary change alone and diet and exercise change combined respectively (Franz et al., 2007). However, it should be noted that the mean weight loss differences in these previous reviews were calculated approximately 6 months after baseline, compared to a mean of only 3.5 months after baseline in the present review.

We also found evidence that greater weight loss occurs when the deposit is paid in small, frequent deposits rather than as one lump sum at the start of the study. This may be because paying frequent deposits reduces the time interval between paying and forfeiting, increasing the sense of loss compared to those who pay a one-off sum (see John, Loewenstein, & Volpp, 2012).

Weight loss was greater when participants set their own deposit amount rather than the deposit amount being set by the researcher but this difficult to interpret because the studies in which participants were able to set their own deposit amount, were also more likely to be the studies in which the deposit was paid in more frequent amounts throughout the study. MCCs were most effective for weight loss when accompanied by additional BCTs, in particular 'self monitoring of behaviour'. This supports, through meta-analysis, Paul-Ebhohimhen and Avenell's

(2008) suggestion that a financial incentive be used as an 'adjuvant to treatment' rather than as a therapy in itself. The utility of self monitoring, is unsurprising, given its noted efficacy for healthy eating and physical activity (Michie, Abraham, Whittington, McAteer, & Gupta, 2009) and weight loss (Dombrowski et al., 2012).

The present review suggests that providing refunds contingent on attendance at classes or meetings is more effective for participant retention than providing refunds contingent on actual weight loss. Attending a class or meeting may be seen as an easy route to receive a refund. When refunded for weight loss, participants may be more likely to drop out if they have not achieved their target, as they know they will forfeit their deposit regardless.

MCCs were more effective in promoting participant retention when the researcher set the deposit amount. One possibility is that those who set their own deposit set a lower amount, which causes them to be less motivated to stay in the study. However, our confound analyses suggest studies with participant-set deposit amounts actually had significantly higher mean deposit amounts than the studies with researcher set deposit amounts. 'All or nothing', rather than 'performance-related', refunds also increased participant retention. This seems an unexpected result, as participants receiving performance-related refunds knew they would receive at least some refund if they have lost any weight, so should be more inclined to attend the weigh-in. However, participants who agree to take part in an 'all or nothing' MCC study, may be more motivated at the outset, as in order to receive any of their deposit back, they would have to achieve the full weight loss goal.

For several characteristics of MCCs, we could find very few instances within the included studies (e.g., refunds contingent on group performance, refunds contingent on attendance at classes/meetings) and this can reduce the power of our analyses and threaten the reliability of the conclusions drawn. Therefore, null effects should be interpreted with caution and it would be valuable in future research to manipulate the characteristics of MCCs systematically. A number of limitations should be noted. First, as noted above, the number of studies in the sub-group

analyses were few and some variables were confounded. The lack of studies reduces the power of the analyses as well as the ability of the review to account for potential confounds. Second, the studies were generally of low methodological quality. Third, the search terms used may have missed potentially relevant studies using different terminology. However, the search strategy included two filters from previously published reviews, modified to increase sensitivity, and previously validated filters, to identify randomised controlled trials. Fourth, in the studies that required only the participants in the MCC group to pay a deposit, those in the MCC groups may have been more motivated to lose weight than those in the comparison condition and this may have inflated the effect size estimate. Indeed, in the sensitivity analyses conducted to minimise these motivational differences, the overall weight loss effect size decreased. Fifth, all but one of the studies were conducted in the US, which limits the generalisability of the findings. Finally, within the present review, only two studies reported participants' socioeconomic status or income (John et al., 2011; Volpp et al., 2008). Therefore, it was not possible to conduct analyses on the effect of these factors on weight loss or participant retention. As previous literature has suggested that financial incentives for health behaviour may have a larger effect on economically disadvantaged populations (Lagarde, Haines, & Palmer, 2007; Sutherland, Christianson, & Leatherman, 2008), future research should test whether the impact of socioeconomic status and income level moderates the effects of MCCs on weight loss and retention.

The results suggest MCCs yield a small effect on weight loss (less than 2 kgs over 3.5 months) and are effective only when the refund was still available. Consequently, MCCs may be best viewed as one technique within a larger weight loss package. Given their brief effects, they may need to be paired with BCTs that promote autonomous motivation for weight loss to achieve more sustained weight loss. The subgroup analyses suggested MCCs may be more effective under certain conditions but further research is needed to substantiate this given the relatively small number of studies. As several MCC characteristics were found to be associated with greater weight loss, but less participant retention (i.e., deposit paid in small frequent amounts, participant set deposit sizes, use of additional BCTs), future research should consider how MCCs could be adapted to improve both outcomes.

Footnotes

[1] Behaviour change techniques have been defined as 'a systematic procedure included as an active component of an intervention designed to change behaviour' (Michie & Johnston, 2013, p. 182). Examples include 'self-monitoring of behavioural outcome' whereby the person is asked to keep a record of measures expected to be influenced by the behaviour change (e.g., weight loss) and 'provide instruction on how to perform the behaviour' which involves telling the person how to perform a behaviour (see Michie et al., 2011 for full definitions). Recent acknowledgement of the need to standardise the reporting of the content of the behaviour change interventions has led to the development of taxonomies of behaviour change techniques (BCTs) used in healthy eating and physical activity interventions (Abraham & Michie, 2008; Michie et al., 2011; Michie et al., 2014). These taxonomies provide standardised definitions of BCTs used in such interventions ensuring people use the same labels for the same techniques. Such taxonomies have then been used in statistical reviews to identify which BCTs are most effective in various contexts (e.g., Dombrowski et al., 2012; Prestwich et al., 2014).

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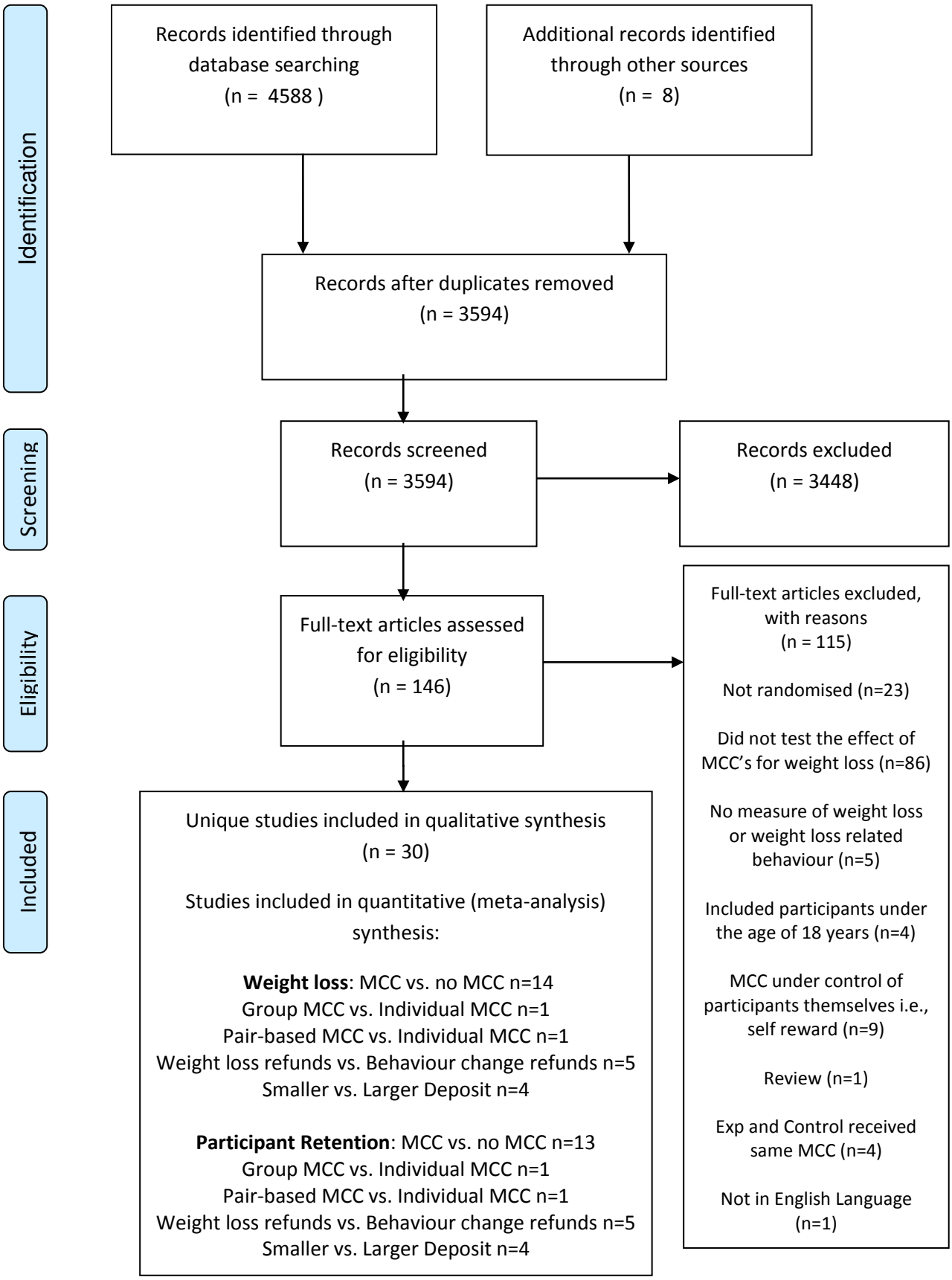
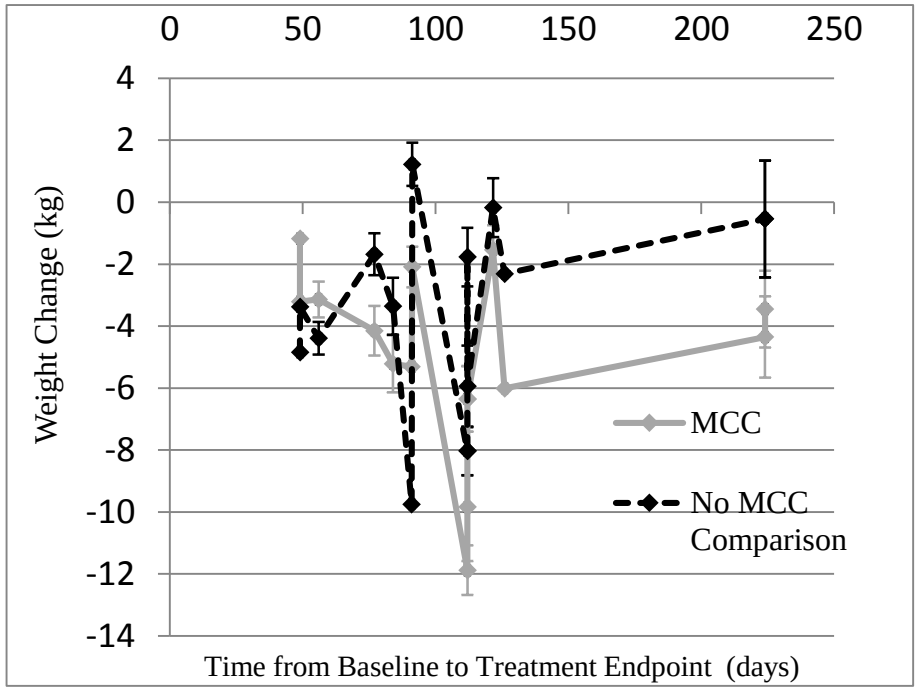


Figure 1. PRISMA flow diagram for study inclusion.



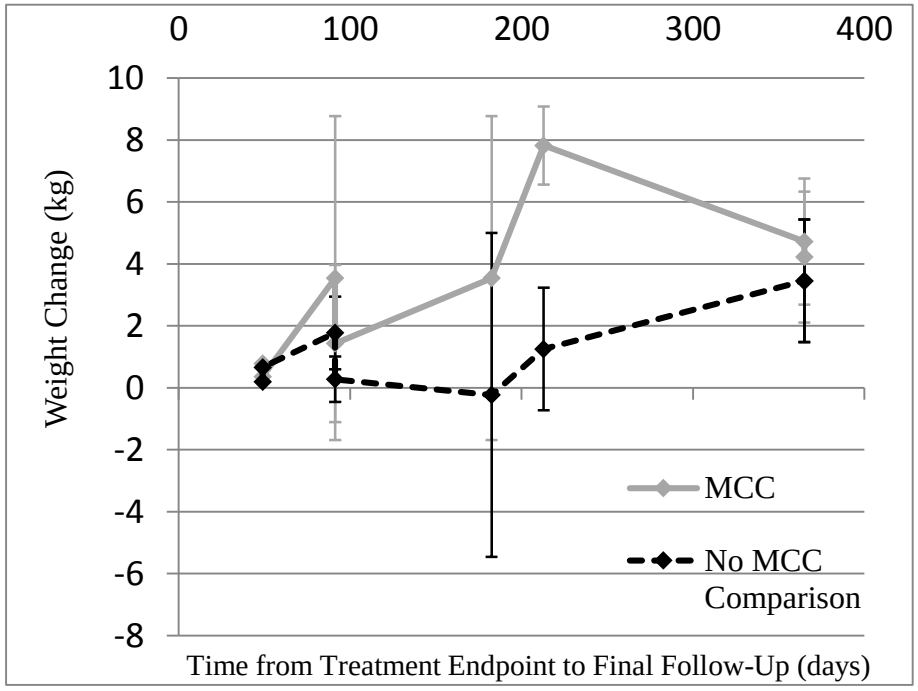


Figure 2(a)

Figure 2(b)

Figure 2. Weight Change During and After Treatment: a. Weight loss for Each MCC vs. no MCC Comparison at Treatment Endpoint (Time is Days from Baseline) b. Weight Loss for MCC vs. no MCC Comparisons After Final Refund (Time is Days Since Final Refund). Where the standard error could not be calculated due to insufficient information in the paper, if possible, the standard error was estimated following guidelines set out in the Cochrane Handbook for Systematic Reviews of Interventions, Section 7.7.3.2. (Higgins & Green. 2011)

Table 1

Within Study Comparisons of MCC Variations

	Comparison	Outcome	Number of Comparisons	Beta	I^2	95% CI	
						Lower Limit	Upper Limit
1	MCC vs no MCC	WL	17	0.204	76.33	-0.123	0.532
		PR	16	0.323*	29.32	0.010	0.637
2	Group MCC vs. Individual MCC	WL	1	0.435***	0.00	0.192	0.678
		PR	1	-0.487	0.00	-1.553	0.579
3	Pair based MCC vs. Individual MCC	WL	1	-0.704*	0.00	-1.151	-0.257
		PR	1	-0.114	0.00	-0.771	0.543
4	Weight loss refunds vs. behaviour change refunds	WL	9	-0.038	0.00	-0.278	0.202
		PR	7	0.221	10.61	-0.146	0.589
5	Smaller vs. Larger deposit	WL	9	-0.011	11.25	-0.195	0.173
		PR	7	0.206	0.00	-0.257	0.668

Note. CI = confidence interval, WL = weight loss, PR = participant retention.

* $p < .05$ ** $p < .01$ *** $p < .001$.

Table 2

Between Study Comparisons - Meta-Regressions: Categorical MCC Variations Regressed on Weight Loss & Participant Retention Effect Sizes

			Number of Comparisons					95% CI	
	Predictor	Outcome	Yes (1)	No (0)	Unclear	Q test	Beta	Lower limit	Upper limit
1	Did the researcher set the deposit amount?	WL	10	7	0	3.339	-0.588	-1.218	0.043
		PR	9	7	0	3.450	0.582	-0.032	1.120
2	Did all participants have the same deposit amount?	WL	9	8	0	1.828	-0.446	-1.093	0.201
		PR	8	8	0	1.878	0.435	-0.187	1.058
3	Was the deposit paid as one lump sum at the start of the study?	WL	10	7	0	6.183*	-0.760*	-1.359	-0.161
		PR	10	6	0	4.309*	0.609*	0.034	1.184
4	Was return of all or part of the deposit contingent on weight loss?	WL	13	4	0	1.663	0.513	-0.267	1.293
		PR	9	7	0	7.731*	-0.715**	-1.219	-0.211
5	Was return of all or part of the deposit contingent on behaviour?	WL	2	15	0	2.081	-0.762	-1.798	0.273
		PR	3	13	0	0.262	0.222	-0.629	1.073
6	Was return of all or part of the deposit contingent on attendance at classes/meetings?	WL	3	14	0	0.001	0.012	-0.876	0.900
		PR	5	11	0	4.203*	0.602*	0.026	1.177

(continued)

Table 2 continued Contracts

	Predictor	Outcome	Number of Comparisons			Q test	Beta	95% CI	
			Yes (1)	No (0)	Unclear			Lower limit	Upper limit
7	Was return of all or part of the deposit contingent on attendance at weigh ins/follow ups?	WL	4	13	0	1.661	-0.513	-1.293	0.267
		PR	3	13	0	0.138	-0.157	-0.987	0.672
8	Was the refund offered on a 'performance related' basis[a]?	WL	15	2	0	0.535	0.380	-0.639	1.399
		PR	11	5	0	5.171*	-0.688*	-1.280	-0.095
9	Was return of the deposit contingent on individual performance?	WL	15	2	0	0.100	-0.168	-1.213	0.876
		PR	16	0	0				
10	Was unreturned deposit money divided between successful participants	WL	8	4	5	0.249	0.247	-0.724	1.218
		PR	8	3	5	0.011	0.049	-0.844	0.941
11	Was unreturned deposit money donated to charity?	WL	4	8	5	0.248	-0.247	-1.218	0.724
		PR	3	8	5	0.011	-0.049	-0.941	0.844
12	Was there any other monetary incentive?	WL	8	9	0	0.033	-0.063	-0.742	0.616
		PR	8	8	0	0.806	-0.297	-0.945	0.351

Note. CI = confidence interval, WL = weight loss, PR = participant retention.

[a] 'Performance based' refunds were coded in studies where, even if participants did not achieve the full overall weight loss goal, they could earn back some of their deposit (e.g., if they could earn part of their refund weekly for achieving smaller weekly goals). This is opposed to 'all or nothing' refunds in which the participant received all of their deposit if they achieved the overall weight loss goal at the end of the study, and none of the deposit if they did not manage to achieve the overall weight loss goal at the end of the study.

*p < .05. **p < .01.

Table 3

Between Study Comparisons - Meta-Regressions: Non-Categorical MCC Variations Regressed on Weight Loss and Participant Retention Effect Sizes

	Predictor	Outcome	Number of Comparison	Q-test	Beta	95% CI	
						Lower Limit	Upper Limit
1	Deposit Size	WL	14	1.618	0.005	-0.002	0.012
		PR	13	2.080	-0.008	-0.019	0.003
2	Number of refunds	WL	17	0.054	0.011	-0.081	0.103
		PR	16	0.744	-0.031	-0.101	0.039
3	Average time interval between refunds	WL	13	0.000	0.000	-0.021	0.021
		PR	11	0.861	0.006	-0.006	0.017
4	Duration of refunds	WL	13	0.937	0.004	-0.005	0.013
		PR	11	0.157	-0.002	-0.011	0.007
5	Percentage of time between baseline and follow up that refunds are offered	WL	16	0.263	0.003	-0.009	0.015
		PR	15	2.661	0.008	-0.002	0.017

Note. CI = confidence interval, WL = weight loss, PR = participant retention.

Online Supplementary Materials

Table A1

Study Characteristics for all included studies

Study	Country	Setting	N	Participants	% male	Mean starting weight (kg)	Duration of intervention component	Follows up after post treatment (for which effect sizes can be calculated)	Deposit Amount (£)[a]	Primary weight loss measure
Ashby & Wilson (1977)	US	Community	75	Recruited through community newspaper	0	At least 6.8 over ideal weight	8 weeks (+ 8 months of maintenance sessions if assigned)	3, 6, 9 and 12 months	142.09	Weight loss
Black et al (1984)	US	Community	47	Recruited through physicians and through community newspaper	8.5	85.7	6 weeks	7 months	15.06, 52.74	Weight loss [b]
Black & Friesen (1983)	US	Community	24	Recruited from the community	0	80.3	4 months	None	39.29	Weight loss [c]
Black & Scherba (1983)	US	Community	14	Recruited through community newspaper	14.3	88	7 weeks	3, 6 and 12 months	78.6	Weight loss
Cameron et al (1990)	US and/or Canada	Community	185	Recruited from community	8.6	79.5	15 weeks	12 months	25.16, 50.31	Weight loss [b]
Colvin et al (1983)	US	Educational + Workplace	23	Medical students and staff	39.1	70.6	11 weeks	6 months	78.6	Weight loss [c]
Follick et al (1984)	US	Workplace	48	Hospital employees	14.6	27.4% overweight	Unclear	1 followup (time scale unclear)	105.47	Percentage overweight [c]

(continued)

Study	Country	Setting	N	Participants	% male	Mean starting weight (kg)	Duration of intervention component	Follows up after post treatment (for which effect sizes can be calculated)	Deposit Amount (£)[a]	Primary weight loss measure
Forster et al (1985)	US	Workplace	131	University employees	17.6	37.8% overweight	6 months	None	188.96	Weight loss [d]
Hagen et al (1976)	US	Educational	42	Recruited through university newspaper	0		6 weeks	None	55.03, 13.76	Weight loss [bc]
Harmatz & Lapuc (1968)	US	Medical	21	Psychiatric inpatients	100	88.6	4 weeks	6 weeks	134.96	Percentage weight loss [c]
Harris & Bruner (1971)	US	Educational	32	University students and staff	18.8	76.5	12 weeks	7 months		Weight loss [c]
Jeffery et al (1984)	US	Community	115	Recruited from a population sample and through a newspaper	48.7	99.1	16 weeks (+ 1 year of maintenance sessions if chosen)	12 months	226.02	Weight loss [c]
Jeffery et al (1982)	US	Community	47	Recruited from community	40	86.3	8 weeks	None	81.12	Weight loss [c]
Jeffery & Forster (1985)	US	Workplace	36	University staff	13.9	81	3 months	None	81.98	Weight loss [c]
Jeffery et al (1983/1984)	US	Community	89	Recruited from population sample ineligible for another study	100	100.2	15 weeks	12 and 24 months	47.16, 235.78, 471.57	Weight loss [be]
Jeffery et al (1978)	US	Community	31	Recruited through community newspaper	12.5	104.6	10 weeks	None	480.24	Weight loss [d]
Jeffrey (1974)	US	Community	62	Recruited from community		42% overweight	7 weeks	6 weeks	111.15	Weight loss [c]

(continued)

Study	Country	Setting	N	Participants	% male	Mean starting weight (kg)	Duration of intervention component	Follows up after post treatment (for which effect sizes can be calculated)	Deposit Amount (£)[a]	Primary weight loss measure
Jeffrey & Christensen (1975)	US	Educational + Workplace	43	Undergraduate students	18.6	77.2	18 weeks (+18 weeks of maintenance sessions if assigned)	None		Weight loss [c]
John et al (2011)	US	Medical	66	Veteran medical centre patients	83.3	104.3	32 weeks	None	90.03	Weight loss [c]
Kingsley & Wilson (1977)	US	Community	78	Recruited through community newspaper	0	At least 6.8 overweight	8 weeks (+ 14 weeks of maintenance sessions if assigned)	3, 6, 9 and 12 months	142.09	Weight loss
Kramer et al (1986)	US	Community	85	Individuals who had lost 10% or more of weight in a previous study	57.6	Between 130% and 150% of ideal weight	1 year (focus on weight maintenance after 15 week treatment)	None	28.56, 171.41	Weight loss [db]
Norton & Powers (1980)	US	Community	45	Recruited from community	6.7	74.1	10 weeks	2, 4 and 8 months	28.5	Weight loss [c]
Perri et al (1984)	US	Community	129	Recruited through community newspaper	12.9	88.4	15 weeks (+ 22 weeks mail and telephone contact if assigned)	3, 6 and 12 months	76.85	Weight loss
Romanczyk et al (1973)	US	Community	102	Recruited through community newspaper	20.5	At least 6.8 overweight	4 weeks	2 and 8 weeks	35.26	Weight loss [d]

(continued)

Study	Country	Setting	N	Participants	% male	Mean starting weight (kg)	Duration of intervention component	Follows up after post treatment (for which effect sizes can be calculated)	Deposit Amount (£)[a]	Primary weight loss measure
Rozensky & Bellack (1976)	US	Workplace	40	Veteran hospital employees	13.5	77.7	7 weeks (+7 weeks mail contact if assigned)	7 weeks	44.03	Weight loss [c]
Vincent et al (1976)	US	Community	34	Recruited through the community	0	51% overweight	13 weeks	None	5% of net monthly income	Weight loss [c]
Volpp et al (2008)	US	Medical	57	Veteran medical centre patients	94.7	107.9	16 weeks	3 months	127.05	Weight loss [c]
Wing et al (1981)	US	Community	38	Recruited from community	13.2	91.2	8 weeks	None	387.52	Weight loss [d]
Wing & Jeffery (1999)	US	Community	166	Recruited through community newspaper (recruited alone or in groups of 4)	49.4	84.9	16 weeks	6 months	46.98	Weight loss [e]
Zitter & Fremouw (1978)	US	Community	56	Recruited through community newspaper	14.3	76	6 weeks	6 weeks and 6 months	60.03	Weight loss [e]

Note. Blank cells indicate data was not reported.

[a] Deposit amount is adjusted for inflation (March 2014). [b] Included in larger deposit vs. smaller deposit within-study analysis. [c] Included in MCC vs. no MCC within-study analysis. [d] Included in Weight loss vs. Behaviour within-study analysis. [e] Included in group rewards vs. Individual rewards within-study analysis.

Table A2

Intervention characteristics for studies included in MCC vs. no MCC analysis

Study	MCC group	MCC group additional intervention	Comparison group	Comparison group intervention	No of refunds	Refunds Contingent on
Black & Friesen (1983)	Minimal intervention deposit condition	Minimal intervention - told to take any action they wished to lose weight whilst eating a well-balanced diet.	Minimal intervention no deposit condition	Same as MCC group	2	Attendance at follow-up weigh-ins
Colvin et al (1983)	Money group	Weight graphs prominently displayed in workplace building for each participant	Social Group	Same as MCC group	9	Weight Loss
Follick et al (1984)	Incentive Group	14 group session behaviour modification program. Topics included: energy-balance model, self-monitoring of calorie intake and expenditure, stimulus control, nutrition education, goal setting, cognitive restructuring, contingency management, exercise and how to enlist support of others in treatment process	Control Group	Same as MCC group	14	Attendance at treatment sessions, return of daily food and calorie intake records
Hagen et al (1976)	Twenty dollar deposit group + Five dollar deposit group	Provided with a self-study weight reduction manual and told they should study the lessons and do the homework at the rate of one lesson per week	No deposit group	Same as MCC group	1	Attendance at at least 10 treatment sessions
Harmatz & Lapuc (1968)	Behaviour Modification Condition	Put on a 1800 calorie a day diet	Diet-only condition	Same as MCC group	6	Weight Loss

(continued)

Table A2 continued

Study	MCC group	MCC group additional intervention	Comparison group	Comparison group intervention	No of refunds	Refunds Contingent on
Harris & Bruner (1971)	Contract	Asked to maintain a nutritionally sensible diet and given instruction for maintaining daily diet records, computing calorie values and noting circumstances surrounding their eating behaviour	Self-control	Same as MCC group + 8 group meetings discussion operant and respondent conditioning, stimulus control, relaxation training techniques and covert conditioning procedures	11	Weight Loss
Jeffery et al (1984)	Constant contact group + Increasing contract group	16 weekly group meetings + manual. Topics covered were: self-monitoring, diet and exercise recommendations, stimulus control, planning ahead, social support, self-motivation, crisis management and weight loss maintenance	Commitment control	Same as MCC group	5	Weight Loss
Jeffery et al (1982)	Mail + contract	8 week group behavioural program emphasising self-observation, stimulus control, eating rate, social support, nutrition, exercise and self-motivation. Weekly homework (eating and exercise diaries) were countersigned by a second person (preferably their spouse) for verification	Mail	Same as MCC group but no requirement for countersigning of homework	9	Return of self-monitoring homework assignments
Jeffery & Forster (1985)	Treatment	6 semi-monthly group meetings + manual. Topics covered were: self-monitoring, diet and exercise recommendations, stimulus control, planning ahead, social support, self-motivation, crisis management and weight loss maintenance	Delayed treatment	None	6	Weight Loss

(continued)

Table A2 continued

Study	MCC group	MCC group additional intervention	Comparison group	Comparison group intervention	No of refunds	Refunds Contingent on
Jeffrey (1974)	External control group	Provision of manual emphasising external control of weight loss with brief instructions on how to record own weight and eating habits, basic nutrition facts, and specific weight control techniques including stimulus control. Weekly meetings with therapist including weigh-in, counting of eating habits and goal setting for following week	Self-control refundable contingency	Same as MCC group except manual emphasised self-control	8	Weight Loss and eating habit improvement
Jeffrey & Christensen (1975)	Behaviour therapy	Participants instructed to monitor their weight and calorie intake, set weight loss goals eating habit change goals. Stimulus control, eating habits and energy expenditure procedures applied in small group sessions, which were faded to phone calls at week 10 and terminated at week 16	Will power	One individual interview in which they were told that most important aspect of losing weight is 'willpower'. Given same materials and instructions for losing weight as MCC group but no group sessions or phone calls	15	Weight loss, attendance of weekly meeting and return of weight graph each week
John et al (2011)	DC1 + DC2	1 hour individual consultation with a dietician on enrolment. Participants given weight loss goal of 24lbs in first 24 weeks. Provided with weight chart depicting daily weight goals to attain to qualify for incentives. Participants weighed themselves each morning and called researcher with weight. Received daily text message indicating if they were on track towards attaining monthly weight loss goal and how much they had earned that day in incentives. attended monthly weigh-ins	Control	1 hour individual consultation with a dietician on enrolment. Participants given weight loss goal of 24lbs in first 24 weeks. Attended monthly weigh-ins.	8	Weight loss
Norton & Powers (1980)	Study completion only	2 weigh ins and 1 group meeting per week providing social reinforcement for weight loss and education in the stimulus control of eating behaviour. Goal setting and self-monitoring of eating and exercise behaviour	No commitment	Same as MCC group	1	Study Completion

(continued)

Study	MCC group	MCC group additional intervention	Comparison group	Comparison group intervention	No of refunds	Refunds Contingent on
Rozensky & Bellack (1976)	External control	Provision of treatment manual covering establishment of negative energy balance, stimulus control and self-monitoring. Mailed monitoring records to therapist each morning. Received weekly general diet information and comments about previous weeks monitoring records. Weekly weight checks.	Self-control	Same as MCC group except did not attend weekly weight checks	7	Weight loss
Vincent et al (1976)	Deposit	10 group treatment sessions with emphasis on identifying and modifying environmental cues associated with problematic eating. Participants instructed to self-monitor weight, calorie intake and exercise and provided with an exercise plan.	No Deposit	Same as MCC group	1	Attendance at sessions, completion of self-monitoring forms and habit change exercises
Volpp et al (2008)	Deposit contract intervention + Lottery intervention	1 hour individual consultation with a dietician on enrolment. Participants given weight loss goal of 16 lbs in 16 weeks. Provided with weight chart depicting daily weight goals to attain to qualify for incentives. Participants weighed themselves each morning and called researcher with weight. Received daily text message indicating if they were on track towards attaining monthly weight loss goal and how much they had earned that day in incentives. attended monthly weigh-ins	Control intervention	1 hour individual consultation with a dietician on enrolment. Participants given weight loss goal of 16lbs in 16 weeks. Attended monthly weigh-ins.	4	Weight Loss

Table A3

Risk of bias for included studies

Study	Informed consent obtained	Baseline Group differences	Prevention of contamination	Concealment of allocation	Differences between completers and non completers	Use of intention to treat analysis	Incomplete outcome data addressed
Ashby & Wilson (1977)	No	None	No	No	Not tested	No	No
Black et al (1984)	No	None	No	No	Not tested	Unclear	Unclear
Black & Friesen (1983)	Yes	None	No	No	Not tested	No	Unclear
Black & Scherba (1983)	No	None	No	No	Not tested	No	No
Cameron et al (1990)	Yes	None	No	No	Not tested	No	No
Colvin et al (1983)	No	Not tested	No	No	Not tested	No	No
Follick et al (1984)	No	Not tested	No	No	Not tested	No	No
Forster et al (1985)	No	None	No	No	Differences detected	Yes	No
Hagen et al (1976)	No	None	Yes	No	Differences detected	No	No
Harmatz & Lapuc (1971)	No	None	No	No	Not tested	Unclear	Unclear

(continued)

Study	Informed consent obtained	Baseline Group differences	Prevention of contamination	Concealment of allocation	Differences between completers and non completers	Use of intention to treat analysis	Incomplete outcome data addressed
Harris & Bruner (1971)	No	Not tested	No	No	Not tested	No	No
Jeffery et al (1984)	No	Unclear	No	No	Not tested	Yes	Yes
Jeffery et al (1982)	No	None	No	No	Not tested	No	No
Jeffery et al (1985)	No	None	No	No	Not tested	Unclear	No
Jeffery et al (1983/84)	Yes	Differences controlled for	No	No	Not tested	Yes	Yes
Jeffery et al (1978)	No	None	No	No	Not tested	Yes	No
Jeffrey (1974)	No	None	No	No	Not tested	Unclear	Unclear
Jeffrey & Christensen (1975)	No	Not tested	No	No	Not tested	Yes	Yes
John et al (2011)	Yes	Differences controlled for	No	No	Not tested	Yes	Yes
Kingsley & Wilson (1977)	No	No differences	No	No	Not tested	No	No
Kramer et al (1986)	Unclear	None	No	No	Unclear	Yes	Yes

(continued)

Study	Informed consent obtained	Baseline Group differences	Prevention of contamination	Concealment of allocation	Differences between completers and non completers	Use of intention to treat analysis	Incomplete outcome data addressed
Norton & Powers (1980)	No	Not tested	No	No	Not tested	No	Unclear
Perri et al (1984)	No	None	No	No	No differences	No	No
Romancyzk et al (1973)	No	None	No	No	Not tested	No	No
Rozensky & Bellack (1976)	No	None	No	No	Not tested	No	No
Vincent et al (1976)	No	None	No	No	Differences detected	No	No
Volpp et al (2008)	Yes	None	No	Yes	Not tested	Yes	Yes
Wing & Jeffery (1999)	Yes	Differences detected	No	No	Not tested	Yes	Yes
Wing et al (1981)	No	None	Yes	No	Not tested	Yes	Yes
Zitter & Fremouw (1978)	No	None	No	No	Not tested	No	No

(continued)

Table A4

Meta-regressions: BCTs regressed on weight loss and participant retention effect sizes

BCT[a]	Outcome	Number of Comparisons			Q test	beta	95% CI	
		MCC group only (1)	Both groups or neither (0)	Comparison group only (-1)			Lower limit	Upper limit
1	WL	1	16	0	0.081	-0.206	-1.628	1.215
	PR	1	15	0	0.001	-0.022	-1.347	1.302
2	WL	0	17	0				
	PR	0	16	0				
3	WL	1	16	0	1.030	0.733	-0.683	2.149
	PR	1	15	0	0.369	-0.483	-2.042	1.076
4	WL	0	16	0				
	PR	0	16	0				
5	WL	1	16	0	1.030	0.733	-0.683	2.147
	PR	1	15	0	0.369	-0.483	-2.042	1.076
6	WL	3	14	0	1.734	0.570	-0.278	1.418
	PR	3	13	0	0.002	-0.023	-0.957	0.911
7	WL	0	17	0				
	PR	0	16	0				
8	WL	1	15	1	1.347	0.562	-0.387	1.511
	PR	1	14	1	0.162	0.216	-0.834	1.266
9	WL	2	15	0	2.413	0.787	-0.206	1.780
	PR	2	14	0	1.609	-0.690	-1.756	0.376
10	WL	0	17	0				
	PR	0	16	0				

BCT[a]	Outcome	Number of Comparisons			Q test	beta	95% CI	
		MCC group only (1)	Both groups or neither (0)	Comparison group only (-1)			Lower limit	Upper limit
11	WL	3	14	0	0.999	0.443	-0.426	1.312
	PR	3	13	0	6.936*	-1.159**	-2.022	-0.297
12	WL	1	16	0	0.581	-0.543	-1.938	0.852
	PR	1	15	0	0.287	0.306	-0.814	1.426
13	WL	12	5	0	2.418	0.566	-0.147	1.278
	PR	9	7	0	7.731*	-0.715**	-1.219	-0.211
14	WL	0	17	0				
	PR	0	16	0				
15	WL	0	17	0				
	PR	0	16	0				
16	WL	2	15	0	3.564	0.929	-0.036	1.893
	PR	2	14	0	0.001	-0.020	-1.243	1.202
17	WL	3	14	0	0.999	0.443	-0.426	1.312
	PR	3	13	0	6.936*	-1.159**	-2.022	-0.297
18	WL	0	17	0				
	PR	0	16	0				
19	WL	3	14	0	0.999	0.443	-0.426	1.312
	PR	3	13	0	6.936*	-1.159**	-2.022	-0.297
20	WL	0	17	0				
	PR	0	16	0				
21	WL	2	15	0	0.249	0.266	-0.778	1.310
	PR	2	14	0	0.181	-0.225	-1.262	0.812

(continued)

BCT[a]	Outcome	Number of Comparisons			Q test	beta	95% CI	
		MCC group only (1)	Both groups or neither (0)	Comparison group only (-1)			Lower limit	Upper limit
22	WL	0	17	0				
	PR	0	16	0				
23	WL	1	16	0	0.003	-0.041	-1.503	1.421
	PR	1	15	0	0.273	-0.272	-1.294	0.749
24	WL	1	16	0	2.096	1.007	-0.356	2.369
	PR	1	15	0	0.444	0.627	-1.217	2.471
25	WL	2	15	0	0.249	0.266	-0.778	1.310
	PR	2	14	0	0.181	-0.225	-1.262	0.812
26	WL	0	17	0				
	PR	0	16	0				
27	WL	1	16	0	1.030	0.733	-0.683	2.149
	PR	1	15	0	0.369	-0.483	-2.041	1.076
28	WL	0	16	1	0.003	0.041	-1.421	1.504
	PR	0	15	1	0.273	0.272	-0.749	1.294
29	WL	1	16	0	2.096	1.007	-0.356	2.369
	PR	1	15	0	0.444	0.627	-1.217	2.471
30 – 39[b]	WL	0	17	0				
	PR	0	16	0				
40	WL	15	2	0	0.243	0.258	-0.768	1.284
	PR	14	2	0	0.001	0.013	-0.882	0.909

Note. CI = confidence interval, WL = weight loss, PR = participant retention.
[a] For details of BCTs see: Michie et al (2011). [b] BCTs 30 through to 39 were all delivered in either both groups or neither in all studies
* $p < .05$. ** $p < .01$.

Table A5

Between Study Comparisons - Meta-Regressions: Risk of Bias Variables Regressed on Weight Loss Effect Sizes

	Predictor	Number of Comparisons		Q test	Beta	95% CI	
		Yes (1)	No (0)			Lower limit	Upper limit
1	Was informed consent obtained?	5	12	0.411	0.240	-0.493	0.972
2	Were baseline group differences checked for (and controlled for if found)?	11	6	0.204	-0.163	-0.868	0.543
3	Was there adequate prevention of contamination between conditions?	0	17				
4	Was there adequate concealment of allocation?	2	15	0.154	0.208	-0.831	1.247
5	Were differences between completers and non-completers detected?	1	16	0.581	-0.543	-1.938	0.852
6	Was intention to treat analysis used?	7	10	2.142	0.484	-0.164	1.132
7	Was incomplete outcome data adequately addressed?	7	10	2.142	0.484	-0.164	1.132

Note. CI = confidence interval

Table A6

Sensitivity Analyses - Overall Effect of MCCs on weight loss and participant retention effect sizes

	Sensitivity Analysis 1[a]	Sensitivity Analysis 2 [b]	Sensitivity Analysis 3 [c]
Outcome	Beta	Beta	Beta
Weight Loss	0.315*	0.118	0.396**
Participant Retention	N/A	0.670*	-0.238

[a] One outlier (Rozensky et al) removed
[b] Studies in which all conditions were initially asked to pay a deposit
[c] Studies in which intention to treat analyses were used * p <.05 **p < .01

Table A7

Sensitivity Analyses –MCC Variations Regressed on Weight Loss Effect Sizes

			Sensitivity Analysis 1[a]	Sensitivity Analysis 2 [b]	Sensitivity Analysis 3 [c]
	Predictor	Outcome	Beta	Beta	Beta
1	Did the researcher set the deposit amount?	WL	-0.393	-1.181	-0.231
		PR	N/A	-0.283	
2	Was the deposit paid as one lump sum at the start of the study?	WL	-0.557*	-1.607*	-0.040
		PR	N/A	-0.283	0.124
3	Was return of all or part of the deposit contingent on weight loss?	WL	0.629*	0.523	
		PR	N/A	-0.447	
4	Was return of all or part of the deposit contingent on weight maintenance?	WL			
		PR	N/A		
6	Was return of all or part of the deposit contingent on behaviour?	WL	-0.855*		
		PR	N/A	-0.319	
7	Was return of all or part of the deposit contingent on attendance at classes/meetings?	WL	-0.141		0.552
		PR	N/A	0.562	0.124

Table A7 continued

	Predictor	Outcome	Sensitivity Analysis 1 [a] Beta	Sensitivity Analysis 2 [b] Beta	Sensitivity Analysis 3 [c] Beta
8	Was return of all or part of the deposit contingent on attendance at weigh ins/follow-ups?	WL	-0.626*	-0.741	
		PR	N/A	-1.406	
9	Was the refund offered on a 'performance related' basis?	WL	0.509		
		PR	N/A	-0.767	
10	Was return of the deposit contingent on individual performance?	WL	-0.019	-0.328	0.231
		PR	N/A		
11	Was unreturned deposit money used to cover research costs?	WL			
		PR	N/A		
12	Was unreturned deposit money divided between successful participants	WL	0.490	0.318	-0.479
		PR	N/A	1.256	-0.124
13	Was unreturned deposit money donated to charity?	WL	-0.490	-0.318	0.479
		PR	N/A	-1.256	0.124
14	Was there any other monetary incentive?	WL	0.204	-0.410	0.040
		PR	N/A	-0.126	-0.124

	Predictor	Outcome	Sensitivity Analysis 1 [a] Beta	Sensitivity Analysis 2 [b] Beta	Sensitivity Analysis 3 [c] Beta
15	Deposit Size	WL	0.001	0.006	-0.002
		PR	N/A	-0.001	0.005
16	Number of refunds	WL	0.012	-0.087	0.058
		PR	N/A	-0.047	0.001
17	Average time interval between refunds	WL	-0.005	0.014	-0.023
		PR	N/A	0.167	-0.005
18	Duration of refunds	WL	0.001	0.011	0.001
		PR	N/A	0.022	-0.003
19	Percentage of time between baseline and final follow-up that refunds are offered	WL	0.001	0.002	0.005
		PR	N/A	0.016	-0.003

Note. WL = weight loss, PR = participant retention. Blank cells indicate no variation in moderator.

[a] One outlier (Rozensky et al) removed
[b] Studies in which all conditions were initially asked to pay a deposit
[c] Studies in which intention to treat analyses were used

Table A8

Results of Chi-squared analyses to test whether categorical MCC variations are confounded for weight loss

		1	2	3	4	5	6	7	8	9	10	11	12
1	Did the researcher set the deposit amount?			χ^2 (1) = 13.39***[a]	χ^2 (1) = 4.50*[a]								χ^2 (1) = 7.14**[b]
2	Did all participants have the same deposit amount?												χ^2 (1) = 4.74*[b]
3	Was the deposit paid as one lump sum at the start of the study?										χ^2 (1) = 4.29*[b]	χ^2 (1) = 4.29*[a]	
4	Was return of all or part of the deposit contingent on weight loss?					χ^2 (1) = 7.37**[b]			χ^2 (1) = 7.37**[a]				
5	Was return of all or part of the deposit contingent on behaviour?										χ^2 (1) = 4.80*[a]	χ^2 (1) = 4.80*[a]	

Table A8 continued

		1	2	3	4	5	6	7	8	9	10	11	12
6	Was return of all or part of the deposit contingent on attendance at classes/meetings?												
7	Was return of all or part of the deposit contingent on attendance at weigh ins/follow-ups?											(continued)	
8	Was the refund offered on a 'performance related' basis?												
9	Was the deposit contingent on individual performance?												
10	Was unreturned deposit money divided between successful participants											χ^2 (1)= 12.0**[b]	χ^2 (1) = 12.0**[a]
11	Was unreturned deposit money donated to charity?												χ^2 (1) = 12.0**[b]

		1	2	3	4	5	6	7	8	9	10	11	12
12	Was there any other monetary incentive?												

Note. Only significant results are presented.

[a] Relationship is positive, [b] Relationship is negative.

* p < .05, ** p < .01, *** p < .001

Table A9

Results of correlation analyses *(Pearson's r) to test whether non*-categorical MCC variations are confounded for weight loss

		1	2	3	4	5
1	Deposit Amount		-.19	-.35	-.01	-.64*
2	Number of refunds			-.63*	.07	.01
3	Average time interval between refunds				.29	.35
4	Duration of refunds					.52
5	Percentage of time between baseline and follow-up that refunds were offered					

* $p < .05$

Table A10

Results of correlation analyses (Point Biserial) to test whether categorical and non-categorical MCC variations are confounded for weight loss

		Deposit amount	Number of refunds	Average time interval between refunds	Duration of refunds	Percentage of time between baseline and follow-up that refunds are offered
1	Did the researcher set the deposit amount?	.12	-.19	-.09	-.60*	-.27
2	Did all participants have the same deposit amount?	.12	.01	.09	-.60*	-.40
3	Was the deposit paid as one lump sum at the start of the study?	.14	.17	.09	-.33	-.11
4	Was return of all or part of the deposit contingent on weight loss?	.35	.10	-.53	-.18	-.51*
5	Was return of all or part of the deposit contingent on behaviour?	-.16	-.22	-.19	-.25	.40
6	Was return of all or part of the deposit contingent on attendance at classes/meetings?	-.03	.36	-.19	.04	.40
7	Was return of all or part of the deposit contingent on attendance at weigh ins/follow-ups?	-.33	.04	.32	-.22	.06
8	Was the refund offered on a 'performance related' basis?	.37	.57*	-.91**	-.00	-.40
9	Was the deposit contingent on individual performance?	-.86*	.22	.00		.54**

10	Was unreturned deposit money divided between successful participants	-.02	-.06	.34	.30	.34
11	Was unreturned deposit money donated to charity?	.02	.06	-.34	-.30	.34
12	Was there any other monetary incentive?	-.31	.15	-.09	.42	.07

* $p < .05$, ** $p < .01$

Table A11

Results of Chi-squared analyses to test whether categorical MCC variations are confounded for participant retention

		1	2	3	4	5	6	7	8	9	10	11
1	Did the researcher set the deposit amount?			χ^2 (1) = 13.39***[a]	χ^2 (1) = 6.80**[a]	χ^2 (1) = 8.33**[b]			χ^2 (1) = 4.96*[b]			χ^2 (1) = 5.13*[b]
2	Did all participants have the same deposit amount?				χ^2 (1) = 4.90*[a]	χ^2 (1) = 5.13*[b]						
3	Was the deposit paid as one lump sum at the start of the study?					χ^2 (1) = 6.49*[b]	χ^2 (1) = 3.86*[a]		χ^2 (1) = 3.86*[b]			
4	Was return of all or part of the deposit contingent on weight loss?						χ^2 (1) = 5.20*[b]	χ^2 (1) = 4.41*[b]	χ^2 (1) = 10.12**[a]			χ^2 (1) = 7.14**[a]
5	Was return of all or part of the deposit contingent on behaviour?									χ^2 (1) = 7.20**[b]	χ^2 (1) = 7.2**0[a]	χ^2 (1) = 4.10*[b]
6	Was return of all or part of the deposit contingent on attendance at classes/meetings?											

(continued)

		1	2	3	4	5	6	7	8	9	10	11
7	Was return contingent on attendance at weigh-ins											
8	Was the refund offered on a 'performance related' basis?											χ^2 (1) = 7.97**[a]
9	Was unreturned deposit money divided between successful participants										χ^2 (1) = 12.0**[b]	χ^2 (1) = 12.0**[a]
10	Was unreturned deposit money donated to charity?											χ^2 (1) = 12.0**[b]
11	Was there any other monetary incentive?											

Note. Only significant results are presented.

[a] Relationship is positive, [b] Relationship is negative

* p < .05, ** p < .01, *** p < .001

Table A12

Results of correlation analyses (Pearson's r) to test whether non-categorical MCC variations are confounded for participant retention

		1	2	3	4	5
1	Deposit Amount		.51	-.28	.21	-.33
2	Number of refunds			-.68*	.03	-.18
3	Average time interval between refunds				.24	.34
4	Duration of refunds					.51
5	Percentage of time between baseline and follow-up that refunds were offered					

* $p < .05$

Table A13

Results of correlation analyses (Point Biserial) to test whether categorical and non-categorical MCC variations are confounded for participant retention

		Deposit amount	Number of refunds	Average time interval between refunds	Duration of refunds	Percentage of time between baseline and follow-up that refunds are offered
1	Did the researcher set the deposit amount?	-.67*	-.33	.17	-.56	.18
2	Did all participants have the same deposit amount?	-.67*	-.18	.17	-.56	.09
3	Was the deposit paid as one lump sum at the start of the study?	-.68*	-.03	.04	-.46	.28
4	Was return of all or part of the deposit contingent on weight loss?	.54	.43	-.52	.25	-.58*
5	Was return of all or part of the deposit contingent on behaviour?	-.24	-.28	-.21	-.30	.31
6	Was return of all or part of the deposit contingent on attendance at classes/meetings?	-.25	.01	-.21	.01	.44
7	Was return of all or part of the deposit contingent on attendance at weigh ins/follow-ups?	-.17	.11	.32	-.30	-.10
8	Was the refund offered on a 'performance related' basis?	.77**	.77**	-.92**	.04	-.44

10	Was unreturned deposit money divided between successful participants	.18	-.06	-.54	.29	-.45
11	Was unreturned deposit money donated to charity?	-.18	.06	-.54	-.29	.45
12	Was there any other monetary incentive?	.66*	.32	-.17	.35	-.32

* $p < .05$, ** $p < .01$

Table A14

Weight Loss Effect Sizes (Hedges g) for MCC vs. No MCC Comparisons

Study name	Subgroup within study	Hedges's g	Lower limit	Upper limit	p-Value
Black & Friesen 1983	Deposit Condition vs. No Deposit Condition	0.043	-0.551	0.637	0.887
Colvin et al 1983	Money Group vs. Social Group	0.166	-0.585	0.917	0.665
Follick et al 1984	Incentive vs. Control	0.096	-0.594	0.786	0.785
Harmatz & Lapuc 1968	Behaviour Modification vs. Diet Only	1.529	0.727	2.331	0.000
Harris & Bruner 1971	Contract vs. Self Control	0.011	-0.642	0.664	0.974
Jeffery & Christiansen 1975	Behaviour Therapy vs. Willpower	0.896	0.157	1.635	0.017
Jeffery et al 1982	Mail plus Contract vs. Mail	-0.686	-1.593	0.221	0.138
Jeffery et al 1984	Constant Contract vs. Control	0.188	-0.196	0.572	0.337
Jeffery et al 1984	Increasing Contract vs. Control	0.555	-0.180	1.290	0.139
Jeffery et al 1985	Treatment vs. Delayed Treatment (3months)	1.152	0.441	1.863	0.002
Jeffrey 1974	External Control vs. Self-Control Non-Refundable	-0.225	-0.876	0.426	0.498
John et al 2011	Deposit Contract 1 vs. Control	0.600	-0.121	1.321	0.103
John et al 2011	Deposit Contract 2 vs. Control	0.476	-0.239	1.191	0.192
Rozensky & Bellack	External control vs self control	-1.601	-2.201	-1.001	0.000
Vincent et al	Deposit vs no deposit	-0.305	-0.942	0.332	0.348
Volpp et al 2008	Deposit Contract vs Lottery	0.169	-0.368	0.706	0.537
Volpp et al 2008	Deposit Contract vs. Control	0.641	-0.112	1.394	0.095
		0.204	-0.123	0.532	0.222

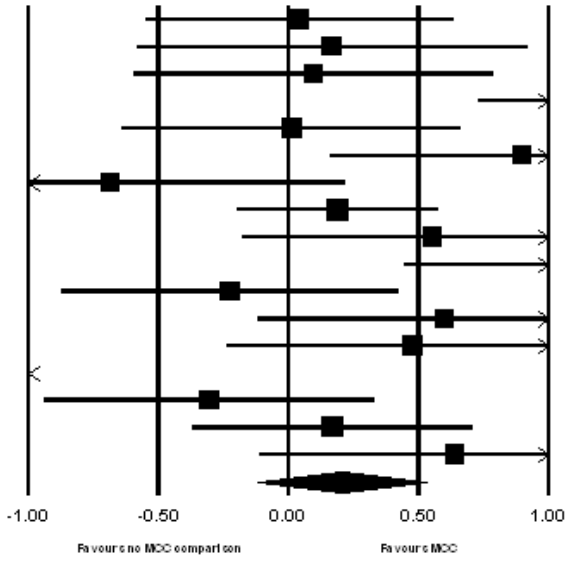


Table A15

Weight Loss Effect Sizes (Hedges g) for Group vs. Individual Refunds Comparisons

Study name	Subgroup within study	Hedges's g	Variance	Lower limit	Upper limit	p-Value
Jeffery et al 1983/1984	Group vs. Individual	0.435	0.015	0.192	0.678	0.000
		0.435	0.015	0.192	0.678	0.000

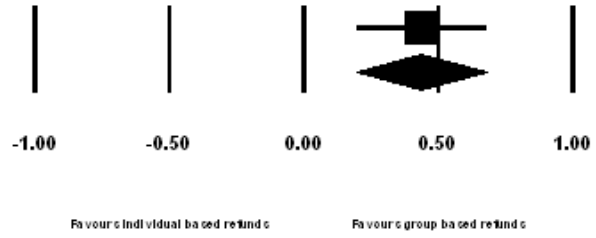


Table A16

Weight Loss Effect Sizes (Hedges g) for Pair vs. Individual Refunds Comparisons

Study name	Subgroup within study	Hedges's g	Variance	Lower limit	Upper limit	p-Value
Zitter	Partner vs individual	-0.704	0.052	-1.151	-0.257	0.002
		-0.704	0.052	-1.151	-0.257	0.002

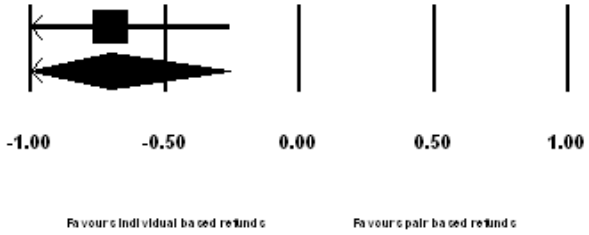


Table A17

Weight Loss Effect Sizes (Hedges g) for Rewards for Weight Loss vs. Rewards for Behaviour Comparisons

Study name	Subgroup within study	Statistics for each study				
		Hedges's g	Variance	Lower limit	Upper limit	p-Value
Forster et al 1985_Go GR_men	Forster - GO vs. GR - Men	-0.749	0.387	-1.968	0.470	0.229
Forster et al 1985_Go GR_women	Forster - GO vs. GR - Women	-0.050	0.096	-0.658	0.558	0.872
Forster et al 1985_So SR_ women	Forster - SO vs SR - Women	-0.097	0.091	-0.687	0.493	0.747
Forster et al 1985_So SR_men	Forster - SO vs SR - Men	-0.556	0.526	-1.977	0.865	0.443
Jeffery 1978_attendance	weight contract vs attendance contract	0.251	0.392	-0.976	1.478	0.688
Jeffery 1978_calorie	weight contract vs calorie contract	0.049	0.307	-1.037	1.135	0.930
Kramer et al 1986	Weight Focus vs. Skills Focus	0.127	0.069	-0.387	0.641	0.628
Romanczyk et al 1973	Group 7 vs. Group 6	-0.093	0.096	-0.701	0.515	0.764
Wing et al 1981	WL-A vs. A-WL (during treatment)	0.037	0.101	-0.586	0.660	0.907
		-0.038	0.015	-0.278	0.202	0.756

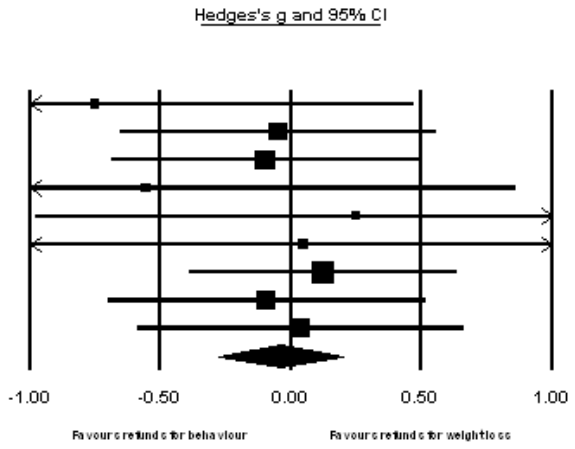


Table A18

Weight Loss Effect Sizes (Hedges g) for Rewards for Larger vs. Smaller Deposits Comparisons

Study name	Hedges's g	Variance	Lower limit	Upper limit	Z-Value	p-Value
Black 1984	-0.132	0.102	-0.759	0.495	-0.413	0.680
Cameron LHWD v LHW	-0.223	0.075	-0.758	0.312	-0.817	0.414
Cameron LHD v LH	-0.304	0.078	-0.851	0.243	-1.090	0.276
Cameron LWD v LW	0.310	0.065	-0.190	0.810	1.216	0.224
Jeffery 1983/1984 - 300 v 150	0.081	0.116	-0.585	0.747	0.238	0.812
Jeffery 1983/1984 - 300 v 30	-0.077	0.105	-0.712	0.558	-0.238	0.812
Jeffery 1983/1984 - 150 v 30	0.239	0.041	-0.157	0.635	1.183	0.237
Kramer -WF v C	-0.117	0.103	-0.746	0.512	-0.364	0.715
Kramer - SF v C	-0.257	0.103	-0.886	0.372	-0.801	0.423
	-0.011	0.009	-0.195	0.173	-0.115	0.909

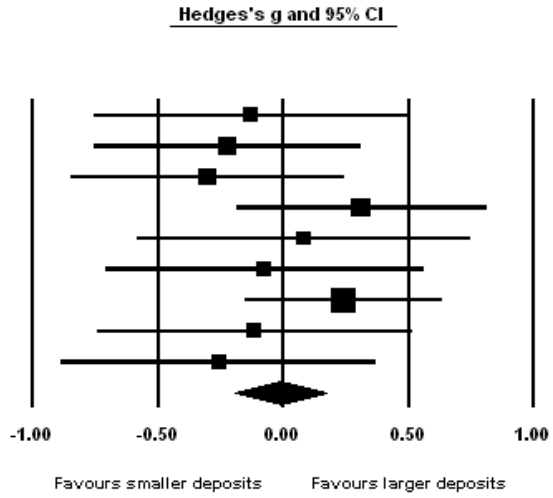


Table A19

Participant Retention Effect Sizes (Hedges g) for MCC vs. No MCC Comparisons

Study name	Subgroup within study	Hedges's g	Variance	Lower limit	Upper limit	p-Value
Black & Friesen 1983	Deposit Condition vs. No Deposit Condition	0.585	0.217	-0.328	1.498	0.209
Colvin et al 1983	Money Group vs. Social Group	0.081	0.100	-0.540	0.702	0.798
Follick et al 1984	Incentive vs. Control	0.907	0.125	0.215	1.599	0.010
Hagen et al 1976_20	$20 vs. $0	1.672	0.477	0.318	3.026	0.016
Hagen et al 1976_5	$5 vs. $0	0.463	0.256	-0.529	1.455	0.360
Harris & Bruner 1971	Contract vs. Self Control	0.301	0.287	-0.750	1.352	0.574
Jeffery & Christiansen 1975	Behaviour Therapy vs. Willpower	-0.139	0.477	-1.493	1.215	0.841
Jeffery et al 1982	Mail plus Contract vs. Mail	-0.583	0.438	-1.880	0.714	0.378
Jeffery et al 1985	Treatment vs. Delayed Treatment (3 months)	0.930	0.733	-0.748	2.608	0.277
John et al 2011_DC1	Deposit Contract 1 vs. Control	0.000	0.918	-1.878	1.878	1.000
John et al 2011_DC1	Deposit Contract 2 vs. Control	-0.835	0.701	-2.475	0.805	0.318
Norton & Powers 1980	Study Completion Only vs. No Commitment	1.709	0.629	0.155	3.263	0.031
Rozensky et al	external control vs self control	0.000	0.305	-1.082	1.082	1.000
Vincent et al	Deposit vs no deposit	0.600	0.159	-0.182	1.382	0.133
Volpp et al 2008_con	Deposit Contract vs. Control	-0.902	0.308	-1.990	0.186	0.104
Volpp et al 2008_lott	Deposit Contract vs. Lottery	0.191	0.169	-0.615	0.997	0.642
		0.323	0.026	0.010	0.637	0.043

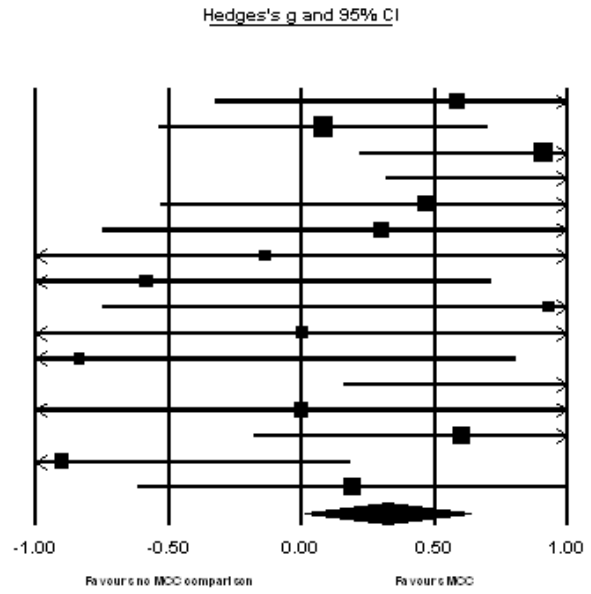


Table A20

Participant Retention Effect Sizes (Hedges g) for Group vs. Individual Rewards Comparisons

Study name	Subgroup within study	Hedges's g	Variance	Lower limit	Upper limit	p-Value
Jeffery et al 1983/1984	Group vs. Individual	-0.487	0.296	-1.553	0.579	0.371
		-0.487	0.296	-1.553	0.579	0.371

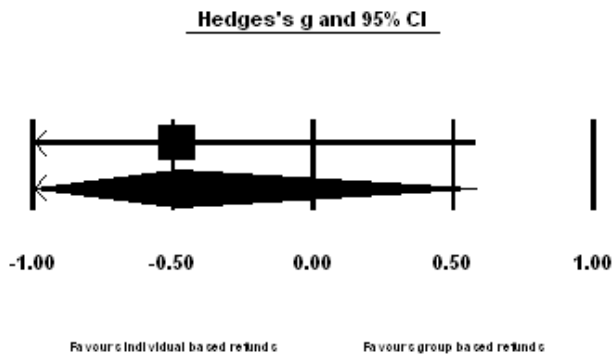


Table A21

Participant Retention Effect Sizes (Hedges g) for Pair vs. Individual Rewards Comparisons

Study name	Subgroup within study	Hedges's g	Variance	Lower limit	Upper limit	p-Value
Zitter	partner vs individual	-0.114	0.112	-0.771	0.543	0.734
		-0.114	0.112	-0.771	0.543	0.734

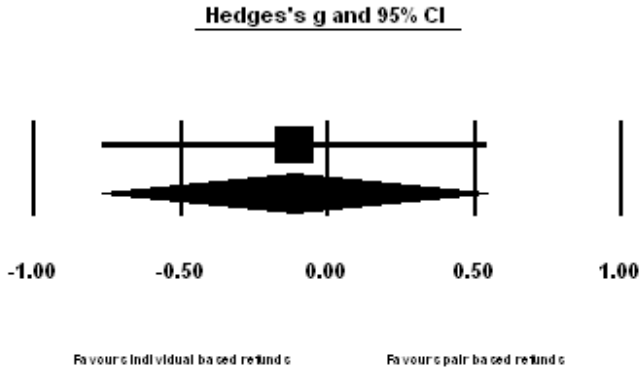


Table A22

Participant Retention Effect Sizes (Hedges g) for Rewards for Weight Loss vs. Rewards for Behaviour Comparisons

Study name	Subgroup within study	Hedges's g	Variance	Lower limit	Upper limit	p-Value
Forster et al 1985_GO	GO vs. GR	0.069	0.123	-0.619	0.757	0.844
Forster et al 1986_SO	SO vs. SR	0.239	0.102	-0.386	0.864	0.454
Jeffery 1978_attendance	weight contract vs attendance contract	0.236	0.806	-1.524	1.996	0.793
Jeffery 1978_calorie	weight contract vs calorie contract	0.183	0.814	-1.585	1.951	0.839
Kramer et al 1986	Weight Focus vs. Skills Focus	-0.611	0.812	-2.377	1.155	0.498
Romanczyk et al 1973	Group 7 vs. Group 6	0.875	0.119	0.199	1.551	0.011
Wing et al 1981	WL-A vs. A-WL (during treatment)	-0.509	0.256	-1.501	0.483	0.314
		0.221	0.035	-0.146	0.589	0.238

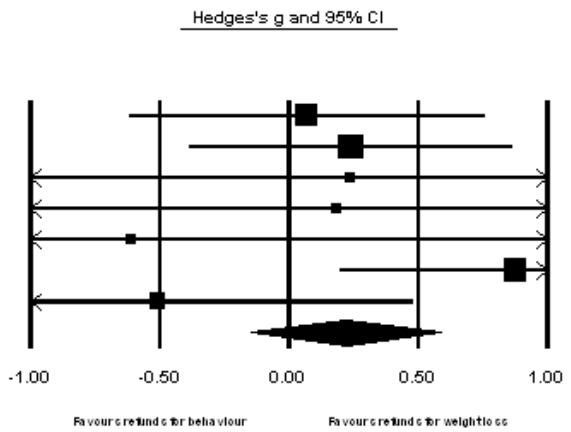
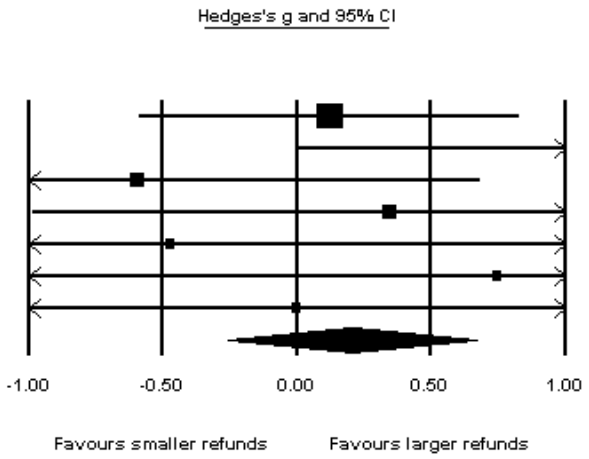


Table A23

Participant Retention Effect Sizes (Hedges g) for Rewards for Larger vs. Smaller Deposits Comparisons

Study name	Subgroup within study	Hedges's g	Variance	Lower limit	Upper limit	Z-Value	p-Value
Black et al 1984	BP vs. MI1	0.123	0.131	-0.587	0.833	0.340	0.734
Hagen et al 1976	$20 vs. $5	1.223	0.394	-0.008	2.454	1.947	0.051
Jeffery et al 1983/1984	$150 vs. $30	-0.591	0.425	-1.869	0.687	-0.906	0.365
Jeffery et al 1983/1984	$300 vs. $150	0.345	0.461	-0.986	1.676	0.508	0.611
Jeffery et al 1983/1984	$300 vs. $30	-0.471	0.899	-2.329	1.387	-0.497	0.619
Kramer et al 1986	Skills Focus vs Control	0.748	0.908	-1.120	2.616	0.785	0.433
Kramer et al 1986	Weight Focus vs. Control	0.000	0.945	-1.905	1.905	0.000	1.000
		0.206	0.056	-0.257	0.668	0.872	0.383



Monetary Contingency Contracts

Medline Search Criteria

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2 agreement*.mp.

3 (concord* or negotiat*).mp.

4 (goal* adj setting).mp.

5 (behavio?ral adj3 contract*).mp.

6 (contingen* adj3 (contract* or intervention or reinforc*)).mp.

7 participa* deposit*.mp.

8 ((refund* or reward* or incentive* or penalt* or punish*) adj5 (contingen* or contract* or agree* or concord*)).mp.

9 monetary deposit*.mp.

10 ((monetary or payment* or voucher* or token*) adj3 contingen*).mp.

11 pledg*.mp.

12 reward/

13 goals/

14 1 OR 2 OR 3 OR ...13

15 obes*.mp.

16 weight gain*.mp.

17 weight loss.mp.

18 body mass index.mp.

19 adipos*.mp.

20 overweight.mp.

21 over weight.mp.

22 overload syndrom*.mp.

23 overeat*.mp.

24 over eat*.mp.

25 overfeed*.mp.

26 over feed*.mp.

27 weight cycling.mp.

28 weight reduc*.mp.

29 weight losing.mp.

30 weight maint*.mp.

31 weight decreas*.mp.

32 weight watch*.mp.

33 weight control*.mp.

34 obesity/

35 weight gain/

36 weight loss/

37 body mass index/

38 body weight/

39 15 OR 16 OR ...38

40 randomized controlled trial.pt.

41 controlled clinical trial.pt.

42 randomized.ab.

43 placebo.ab.

44 drug therapy.fs.

45 randomly.ab.

46 trial.ab.

47 groups.ab.

48 40 or 41 or 47

49 exp animals/ not humans.sh.

50 48 not 49

51 14 AND 39 AND 50

Monetary Contingency Contracts

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7 participa* deposit*.mp.
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adj5 (contingen* or contract* or agree* or concord*)).mp.
9 monetary deposit*.mp.
10 ((monetary or payment* or voucher* or token*) adj3 contingen*).mp.
11 pledg*.mp.
12 rewards/
13 incentives/
14 reinforcement/
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18 weight loss.mp.
19 body mass index.mp.
20 adipos*.mp.
21 overweight.mp.
22 over weight.mp.
23 overload syndrom*.mp.
24 overeat*.mp.
25 over eat*.mp.
26 overfeed*.mp.
27 over feed*.mp.

28 weight cycling.mp.

29 weight reduc*.mp.

30 weight losing.mp.

31 weight maint*.mp.

32 weight decreas*.mp.

33 weight watch*.mp.

34 weight control*.mp.

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36 weight gain/

37 weight loss/

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39 body weight/

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42 random*.tw.

43 exp treatment

44 41 OR 42 OR 43

45 15 AND 40 AND 44

Embase Search Criteria

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4 (goal* adj setting).mp.

5 (behavio?ral adj3 contract*).mp.

6 (contingen* adj3 (contract* or intervention or reinforc*)).mp.

7 participa* deposit*.mp.

8 ((refund* or reward* or incentive* or penalt* or punish*) adj5 (contingen* or contract* or agree*

or concord*)).mp.

9 monetary deposit*.mp.

10 ((monetary or payment* or voucher* or token*) adj3 contingen*).mp.

11 pledg*.mp.

12 reward/

13 incentives/

14 reinforcement/

15 1 OR 2 OR ...14

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17 weight gain*.mp.

18 weight loss.mp.

19 body mass index.mp.

20 adipos*.mp.

21 overweight.mp.

22 over weight.mp.

23 overload syndrom*.mp.

24 overeat*.mp.

25 over eat*.mp.

26 overfeed*.mp.

27 over feed*.mp.

28 weight cycling.mp.

29 weight reduc*.mp.

30 weight losing.mp.

31 weight maint*.mp.

32 weight decreas*.mp.

33 weight watch*.mp.

34 weight control*.mp.

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36 weight gain/

37 weight reduction/

38 body mass/

39 body weight/

40 16 OR 17 OR ...39

41 clinical trial/

42 randomized controlled trial/

43 randomization/

44 single blind procedure/

45 double blind procedure/

46 crossover procedure/

47 placebo/

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49 rct.tw.

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53 (allocated adj2 random).tw.

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55 double blind*.tw.

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60 case study/

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62 abstract report/ or letter/

63 60 OR 61 OR 62

64 59 NOT 63

65 15 AND 40 AND 64

CINAHL Search Criteria

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3	TX concord*
4	TX negotiat*
5	TX "goal* setting"
6	TX behavio#ral N3 contract*
7	TX contingen* N3 (contract* or intervention or reinforc*)
8	TX "participa* deposit*"
9	TX (refund* or reward* or incentive* or penalt* or punish*) N5 (contingen* or contract* or agree* or concord*)
10	TX "monetary deposit*"
11	TX ((monetary or payment* or voucher* or token*) N3 contingen*)
12	TX pledg*
13	(MH "Reward")
14	(MH "Reinforcement (Psychology)")
15	1 OR 2 OR ...14
16	TX obes*
17	TX "weight gain*"
18	TX "weight loss"
19	TX "body mass index"
20	TX adipos*
21	TX overweight
22	TX "over weight"
23	TX "overload syndrom*"
24	TX overeat
25	TX "over eat"
26	TX overfeed
27	TX "over feed"

28 TX "weight cycling"

29 TX "weight reduc*"

30 TX "weight losing"

31 TX "weight maint*"

32 TX "weight decreas*"

33 TX "weight watch*"

34 TX "weight control*"

35 (MH "Obesity")

36 (MH "Weight Gain")

37 (MH "Weight Loss")

38 (MH "Body Mass Index")

39 (MH "Body Weight")

40 16 OR 17 OR ...39

41 TX allocat* random*

42 (MH "Quantitative Studies")

43 (MH "placebos")

44 TX placebo

45 TX random* allocat*

46 (MH "random assignment")

47 TX randomi* control* trial*

48 TX ((singl* n1 blind*) or (singl* n1 mask*))

49 TX ((doubl* n1 blind*) or (doubl* n1 mask*))

50 TX ((tripl* n1 blind*) or (tripl* n1 mask*))

51 TX ((trebl* n1 blind*) or (trebl* n1 mask*))

52 TX clinic* n1 trial*

53 PT clinical trial

54 (MH "clinical trials+")

55 41 OR 42 OR ...54

56 15 AND 40 AND 55

Cochrane Central Register of Controlled Trials Search Criteria

1 contract*
2 agreement*
3 concord*
4 negotiat*
5 "goal setting"
6 behavioural NEAR/3 contract*
7 participa* NEXT deposit*
8 contingen* NEAR/3 contract*
9 contingen* NEAR/3 intervention
10 contingen* NEAR/3 reinforc*
11 refund* NEAR/5 contingen*
12 reward* NEAR/5 contingen*
13 incentive* NEAR/5 contingen*
14 penalt* NEAR/5 contingen*
15 punish* NEAR/5 contingen*
16 refund* NEAR/5 contract*
17 refund* NEAR/5 agree*
18 refund* NEAR/5 concord*
19 reward* NEAR/5 contract*
20 reward* NEAR/5 agree*
21 reward* NEAR/5 concord*
22 incentive* NEAR/5 contract*
23 incentive* NEAR/5 agree*
24 incentive* NEAR/5 concord*
25 penalt* NEAR/5 contract*
26 penalt* NEAR/5 agree*
27 penalt* NEAR/5 concord*
28 punish* NEAR/5 contract*

29 punish* NEAR/5 agree*

30 punish* NEAR/5 concord*

31 monetary NEXT deposit*

32 monetary NEAR/3 contingen*

33 payment* NEAR/3 contingen*

34 voucher* NEAR/3 contingen*

35 token* NEAR/3 contingen*

36 pledge*

37 **Reinforcement (psychology)**

38 **goals**

39 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35 OR #36 OR #37 OR #38

40 obes*

41 "weight gain"

42 "weight loss"

43 "body mass index"

44 adipos*

45 overweight

46 "over weight"

47 overload NEXT syndrom*

48 overeat

49 "over eat"

50 overfeed

51 "over feed"

52 "weight cycling"

53 weight NEXT reduc*

54 "weight losing"

55 weight NEXT maint*

56 weight NEXT decreas*

57 weight NEXT watch*

58 weight NEXT control*

59 **obesity**

60 **body weight changes**

61 **body mass index**

62 #40 OR #41 OR #42 OR #43 OR #44 OR #45 OR #46 OR #47 OR #48 OR #49 OR #50 OR #51 OR #52 OR #53 OR #54 OR #55 OR #56 OR #57 OR #58 OR #59 OR #61

63 #39 AND #62

Summary of studies not included in meta-analyses

Black et al, 1993

All participants paid $50 deposit and the only difference between groups was that one group was refunded for successful compliance with a weight loss-related behaviour change contract goal, and the other for completing and implementing at least one weight loss-related problem solving form each week. Results revealed that the group rewarded for completing problem solving forms lost significantly more weight at post treatment (7 weeks) and at 3 and 6 month follow-ups. The authors do not report the number of participants dropping out of each condition.

Ashby, 1997

After attending 8 weekly sessions of group behavioural self-control treatment, 75 obese women were randomised to biweekly structured behavioural booster sessions, monthly structured behavioural booster sessions biweekly unstructured nonspecific booster sessions, monthly unstructured non-specific booster sessions (all intended to promote weight loss maintenance), or a control group with no booster sessions. Participants paid $55 deposit and were rewarded for attending 7 of the 8 treatment sessions, and all but one of their maintenance sessions. Results showed that although all groups continued to lose weight during maintenance period, there was no significant benefit of providing booster sessions. Of the 80 participants, 4 failed to meet the attendance requirement and so were considered 'drop outs'. Both were from the biweekly structured behavioural booster session condition.

Kingsley and Wilson, 1977

Seventy-eight women were assigned to group behavioural treatment, individual behavioural treatment or social pressure treatment for 8 weekly sessions. Following this, half of each group were randomised to 4 additional booster sessions, or weigh ins only over the following 12 months. Participants paid $55 deposit, and were rewarded for attending 7 of the 8 treatment sessions, and all four of their booster sessions or weigh ins. Results showed that during

treatment, both behavioural treatment conditions were significantly more successful than the social pressure treatment condition. At 12 month follow-up, the group behavioural treatment was significantly superior to the individual treatment condition. Booster sessions were significantly superior to weigh-ins only at 3 month follow-up, marginally significantly superior at 6 month follow-up, whereas no differences were found at 9 or 12 month follow-up. Overall 6 participants did not meet the attendance requirement, and the authors report that attrition did not significantly differ between groups at any time point in the study.

Perri et al, 1984

One hundred and twenty-nine participants were randomised to non behavioural therapy, behaviour therapy or behaviour therapy plus relapse prevention training for 15 weekly sessions. Following this, half of each group were randomised to post treatment contact by mail and telephone or no post treatment contact. Participants paid $51 deposit. Behaviour therapy groups were rewarded for attendance and completion of written monitoring assignments whilst the non behaviour therapy group were rewarded for attendance only. Results revealed no significant difference in weight loss between groups at post treatment follow-up. Post treatment contact was significantly effective for participants who previously received non behavioural therapy or behavioural therapy plus relapse prevention training, but not for participants who received behaviour therapy. Twenty-eight participants dropped out during the treatment phase and rates of attrition did not differ significantly between groups. During the 12 month follow-up period, a further 6 participants dropped out.

Wing and Jeffery, 1999

One hundred and sixty six participants were recruited either alone or with 3 friends, and randomly assigned to standard behavioural treatment or standard behavioural treatment plus social support strategies for 16 weeks. All participants paid $50 pre treatment deposit. Participants in standard behavioural treatment only group were rewarded for attending follow-up assessments. Participants in the standard behavioural treatment plus social support strategies

group worked in teams of 4 and participated in treatments designed to increase social support, including a competition for a jackpot of $25 of each participants deposit for the team retaining the most weight loss in full from month 4 to 7. They were also rewarded $25 of their deposit for attendance at follow-up assessments. Results showed that participants recruited with friends experienced significantly more weight loss during the 16 week treatment phase than those recruited alone. Participants recruited with friends and receiving the social support intervention had significantly less attrition and significantly more weight loss maintenance over a 6 month follow-up period.

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Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4-6
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5-6
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	6
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6-7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Online Supplementary Materials page 38-44
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6-7 +29
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8, 26-28, Online Supplementary

			Materials page 1-8
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	7-8
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	7-8

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	Online Supplementary Materials page 9-11
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	9
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	29
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Online Supplementary Materials page 1-8
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	10, Online Supplementary Materials page 9-11
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Online Supplementary Materials pages 28-37

Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	25-30, Online Supplementary Materials pages 12-14
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	10, Online Supplementary Materials page 9-11
Additional analysis	23	13-15	15-16, Online Supplementary Materials page 16-27
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	15-18
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	18-19
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	19
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	1

Prospero Review Protocol

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Review question(s)

How effective are monetary contingency contracts for weight loss and under what conditions (circumstances) are they most effective?

How effective are monetary contingency contracts for participant retention and under what conditions (circumstances) are they most effective?

Searches

We will search the following electronic bibliographic databases: PsycINFO, MEDLINE, EMBASE, CINAHL and Cochrane Central Register of Controlled Trials (CENTRAL). The search terms will be adapted for each database searched (please see attached search strategy). For each database, a contingency contract filter, a weight loss filter and a controlled trial filter (except for CENTRAL) will be used. The contingency contract filter and weight loss filter are adapted from published Cochrane reviews on these topics. Database-specific filters for controlled trials will be utilised where possible. There will be no date restrictions. The references sections of studies meeting the inclusion criteria will also be searched.

Types of study to be included

Inclusion: Randomised Controlled trials

Exclusion: All other study designs.

Condition or domain being studied

Obesity arises from excessive weight gain caused by a sustained positive energy balance which causes excess energy to be stored as fat. The rising incidence of overweight and obesity is a serious concern, as obesity is associated with increased risk of mortality due to direct associations with diseases such as diabetes and heart disease.

Participants/ population

Inclusion: Adults.

Exclusion: Children and adolescents (under 18 years of age) and non-humans.

Intervention(s), exposure(s)

Studies will be included if they test the effect of Monetary Contingency Contracts for weight loss, in which a participant deposits an amount of money or a personal item, which is returned contingent on weight loss (individual or group) or weight loss associated behaviour (e.g., attendance at weight loss classes, attendance at weigh in, increase in physical activity, improvement of diet). Studies will not be included if the Monetary Contingency Contract is under the control of the participant themselves (i.e., self-reward), or if all groups receive the same Monetary Contingency Contract Intervention

Comparator(s)/ control

Each study must include a comparison group who received either a control intervention or no intervention.

Context

Not applicable - there is no specific inclusion/exclusion criterion linked to setting.

Outcome(s)

Primary outcomes

Each eligible study will have to have taken a measure of weight loss or associated weight loss behaviour (e.g., attendance at weight loss classes, attendance at weigh in, increase in physical activity, improvement of diet).

Outcome Measures: Measure of weight loss or associated weight loss behaviour (e.g., attendance at weight loss classes, attendance at weigh in, increase in physical activity, improvement of diet).

Participant Retention (i.e., number or proportion of participants being weighed at each time point).

Changes in weight from baseline to each reported follow-up

Secondary outcomes

Refunds contingent on individual or group based performance; refunds contingent on weight loss, associated behaviour change, attendance at classes/meetings, attendance at weigh ins/follow ups; deposit amount; did participants have same deposit amount; was the deposit paid as one lump sum or in installments; refund offered on 'all or nothing' or 'performance related' basis, was forfeited deposit money divided between successful participants, donated to charity, used for research purposes; was there any other monetary incentive; number of refunds; average time interval between refunds; duration of refunds; percentage of time between baseline and follow up that refunds were offered; additional behaviour change techniques delivered alongside MCC.

Data extraction, (selection and coding)

The main review author will independently screen the titles and abstracts according to the inclusion and exclusion criteria. The full texts of these potentially eligible studies will be retrieved and screened by the main review author. In any cases of doubt, the inclusion/exclusion of the full text will be discussed with another review team member. A standardised, pre-piloted form will be used to extract data from the included studies. The main author will independently extract data from all included studies. Additionally, all included studies will be divided between three review team members (not the main author) who will interdependently extract data from these studies. This data extraction will then be compared to that carried out by the main review author, and any discrepancies will be discussed to reach agreement. Extracted information will include details of: study setting, sample size and details, details of the intervention and comparison conditions including intervention duration and behavior change techniques employed, outcome measures and risk of bias. Study authors will be contacted in the event of missing data.

Risk of bias (quality) assessment

Risk of bias will be assessed using the 'Risk of bias tool' from the Cochrane Collaboration Handbook (Chapter 8, section 8.5).

Strategy for data synthesis

Weight loss will be used to calculate effect sizes (Hedges g) across study conditions using the 'Comprehensive Meta-Analysis' software.

The rate of participant retention will be determined by calculating the proportion of participants within each group that stayed in the study and were weighed at each follow up. Participants who dropped out before paying the deposit or before the interventions commenced will not be included in this analysis.

Where studies have multiple comparison groups, we will select the group most similar to the MCC condition in terms of the additional intervention components provided alongside the MCC in the MCC group, in order to more clearly isolate the effect of the MCC. When this is not possible (i.e., when the MCC group is equally similar to two comparison groups, or a comparison group is equally similar to two MCC groups), we will report more than one comparison from the same study. When this results in a certain group being used in more than one comparison, the number of participants for this group will be divided by the number of comparisons before it is entered into the meta-analyses to avoid multiple counting of participants. When there is multiple follow-ups post intervention, the effect sizes for each follow-up will be combined into a single effect size for that comparison. The amount of heterogeneity between studies will be assessed using an I2-statistic and a Q-test. Meta-regressions will be conducted to identify the characteristics of MCCs and the additional BCTs most strongly associated with weight loss and/or participant retention.

In order to assess whether methodological quality of the studies had an effect on weight loss results, meta-regressions will be conducted to investigate whether any of the methodological quality variables are significantly associated with greater weight loss. Additionally, to assess whether any of the MCC variations were confounded, Chi-square analyses will be conducted between each combination of MCC variation pairs. For example, to assess whether the variable 'did the researcher set the deposit amount?' was confounded with the variable 'did all participants have the same deposit amount?'.

The Sample-Adjusted Meta-Analytic Deviancy (SAMD) statistic (Huffcutt & Arthur, 1995) will be used to identify outliers and if any are identified, a sensitivity analysis will be conducted excluding these studies.

Analysis of subgroups or subsets

The following within study sub group analyses will be performed:

i) Groups refunded for individual performance versus groups refunded for group performance

ii) Groups refunded for weight loss versus groups refunded for weight loss associated behaviour

Dissemination plans

The results will be written up and submitted for publication in a peer-reviewed journal. The results will also be presented at relevant academic conferences (e.g., UKSBM).

Anticipated or actual start date

05 December 2011

Anticipated completion date

01 July 2014

Conflicts of interest

None known

Language

English

Country

England

Subject index terms status

Subject indexing assigned by CRD

Subject index terms

Behavior Therapy; Food Habits; Humans; Motivation; Obesity; Reward; Weight Loss

Stage of review

Completed but not published

Date of registration in PROSPERO

28 March 2012

Date of publication of this revision

11 July 2014

Stage of review at time of this submission	Started	Completed
Preliminary searches	No	Yes
Piloting of the study selection process	No	Yes
Formal screening of search results against eligibility criteria	No	Yes
Data extraction	No	Yes
Risk of bias (quality) assessment	No	Yes
Data analysis	No	Yes