The Effect of Financial Incentives for Patients on Weight Loss: A Meta-analysis

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Abstract

Context: Being overweight (BMI≥25kg/m^2) and obesity (BMI≥30kg/m^2) are common and costly. While reward systems can affect behaviors, it is uncertain whether financial incentives are beneficial in weight loss programs.

Objective: To estimate the effectiveness of financial incentives in weight loss programs.

Data sources: We searched the English-language literature in MEDLINE, EMBASE, CINAHL, the Cochrane Database of Systematic Reviews, and the Cochrane Register of Controlled Clinical Trials) from 1966 to November 2011. Additional studies were identified by searching reference lists of all relevant articles. Search terms included financial, economic, monetary, reward, incentive or reimbursement, and diet, weight loss, obesity or overweight.

Study selection: We included controlled trials evaluating the effect of financial incentives in weight loss programs for overweight individuals. We excluded studies that did not provide weight change over time.

Data extraction: Data were extracted from articles by using predefined data fields, including study quality indicators. We performed subgroup analyses to examine the effect of study duration (at 4 months and 12 months) and a self-set goal versus program fixed goal on the effectiveness of financial incentives on weight loss.

Results: Overall, the results of the meta-analysis show that using financial incentives was associated with higher weight loss (-0.32 SMD, 95%CI (-0.56, -0.08),, random effects model). The benefit of incentives was greater at 4 months (-0.56 SMD, 95%CI (-0.89, -0.23),random effects model) but there was no effect at 12 months. The effect of financial incentives in programs with predetermined, imposed weight loss goals was significant (-0.48 SMD, 95%CI (-0.67, -0.29)) but there was no benefit in studies with self-set weight loss goals.

Conclusions: Our results suggest that financial incentives are beneficial on weight loss both overall, and at 4 months. This benefit appears greater in studies with an imposed weight loss goal compared to self-set goals. These results suggest that financial incentives should be used more widely in weight loss programs. Future studies are needed to determine the best way to administer these financial rewards (e.g., deposit contracting, competitions or lotteries).

Introduction

Overweight is defined by a body mass index (BMI) of above 25kg/m^2, and obesity is a BMI greater than 30 kg/m^2. Overweight is a widespread chronic health problem that affects 68% of the US population, and its prevalence continues to increase.[1] It is a public health priority, because obesity is a driver of health care costs, with an estimated 5-10% of health care costs attributable to overweight- and obesity-related disorders.[2] It diminishes the quality of life, and increases the risk of many serious conditions, such as diabetes, coronary heart disease and premature death.[2]

Behavior changes such as dieting and higher levels of physical activity are difficult to implement, and are even harder to maintain. Many types of interventions for losing weight have been studied, and include individual or group interventions, social support systems, and different types of diets. Researchers have studied behavioral and psychological models for weight loss, some of which involve seemingly successful short-term reward systems. Various financial reward systems have been tested in clinical settings: these include deposit contracts[3-5], reimbursement of payroll deductions, individual or group competitions[6] and lottery systems[5,7]. For example, some studies use a person's inherent over-optimism and over-estimation in predicting weight loss, and require the subject to make a financial investment contingent to this prediction. According to the theory of loss aversion, in which subjects strive to not lose any money, this contingency investment will help motivate subjects to reach their weight goal. The amounts of money used in these studies are generally small or moderate.

The aim of this meta-analysis is to combine evidence to determine whether financial incentives can increase the effectiveness of weight loss programs for people who are overweight. We will also study the effect of time on the use of a financial incentive, and the influence of a self-set goal versus an imposed, fixed goal on the effectiveness of financial incentives.

Method

We conducted a systematic review and meta-analysis of controlled or randomized controlled studies that use financial incentives contingent on weight loss or behaviors associated with weight loss. Inclusion criteria were any controlled studies of overweight adults defined as a BMI >25 kg/m2, that compare intervention groups that used these financial incentives with control groups that do not have financial incentives. We studied the overall weight change in these groups, then performed subgroup analyses of (a) the effect of time, and (b) the way the goal is set (self-set or imposed).

The literature search

We searched electronic databases (MEDLINE, EMBASE, CINAHL, the Cochrane Database of Systematic Reviews, and the Cochrane Register of Controlled Clinical Trials) from 1966 to November 2011 using the terms: “financial”, “monetary”, “incentive” or “reward” and “weight”; “overweight”, “obesity”, “weight loss” or “diet”. We limited our search to human adults, English language, and to randomized controlled trials, clinical trials, comparative studies, controlled studies, or meta-analysis. We searched for MeSH terms: “overweight”, “reimbursement, incentive”, and “employee incentive plans”. Titles and abstracts were screened to retrieve relevant articles for further review. Reference lists of all relevant articles were also screened. We also searched in the databases for authors who have published in this field, cited in systematic reviews.

Study selection

Eligibility was assessed according to inclusion and exclusion criteria based on abstracts for screening, followed by the review of full articles. Several authors were contacted for further information about their data and study design: this allowed us to ascertain that there was no overlap in study populations. Studies that did not provide estimates of weight change over time with distribution characteristics, even after contacting the authors, were excluded from our review. This was the case for four studies.

Data abstraction

Data was abstracted from the selected articles using a predefined coding sheet, converting all weight measures to kilograms where necessary. We coded the study design, baseline participant characteristics, intervention measures for the weight loss programs, duration of intervention and of follow-up period. We also recorded whether the weight loss goal was imposed or self-set, and the type of financial incentive studied. We also collected data on how the financial incentive intervention was designed, and assessed the quality of the studies (intention to treat analysis, concealment of allocation). Some publications reported several studies within a paper, comparing the effect of financial incentives for different weight loss interventions in independent randomized populations. We extracted the data for these subgroups as individual studies in the meta-analysis, while describing the overall study population in the systematic review. This explains the multiple comparison groups for certain publications that appear in the forest plots.

Data analysis

Study data was entered into Review Manager (version 5.1)[8] for analysis. We estimated the effect size of financial incentives by calculating the standardized mean difference for weight change and standard deviation overall. Further subgroup analyses were then performed to take into account the effect of time and of the way of setting the weight loss goal (self-set or imposed

by study protocol) on weight change. Heterogeneity across studies was explored using the I^2 estimate,[9] reporting the results from both a fixed effect model and a random effect model when heterogeneity was high. Potential publication bias is also explored with a funnel plot.

When publications reported several studies within a paper, comparing the effect of financial incentives for different weight loss interventions, we included them separately as independent comparison groups in the meta-analysis.

Results

Literature search

Out of the 19 609 potentially relevant articles about obesity and overweight (see figure 1), 58 articles from Medline, 15 from EMBASE, 24 from CINAHL and 15 from the Cochrane Library were identified as involving some form of financial incentive for weight loss. The investigator screened these titles and abstracts. Of these, 28 articles were selected for full-text retrieval, 22 were included in the systematic review and 13 were included in this systematic review. There were prior review articles on incentives for weight loss which are not reported here, but served to identify relevant authors, and were used for reference list reviews. Two potential studies were identified in this manner, but were not retained in the study: one had incomplete data, and the other was a quasi-experimental design using before-after comparison, but did not include a control group. Overall, there were five articles from our main search that were excluded due to incomplete data, either because weight change was presented as percent weight change, or because of lack of distribution characteristics of the mean weight change estimate. This state of missing data persisted even after contacting the authors for further information.

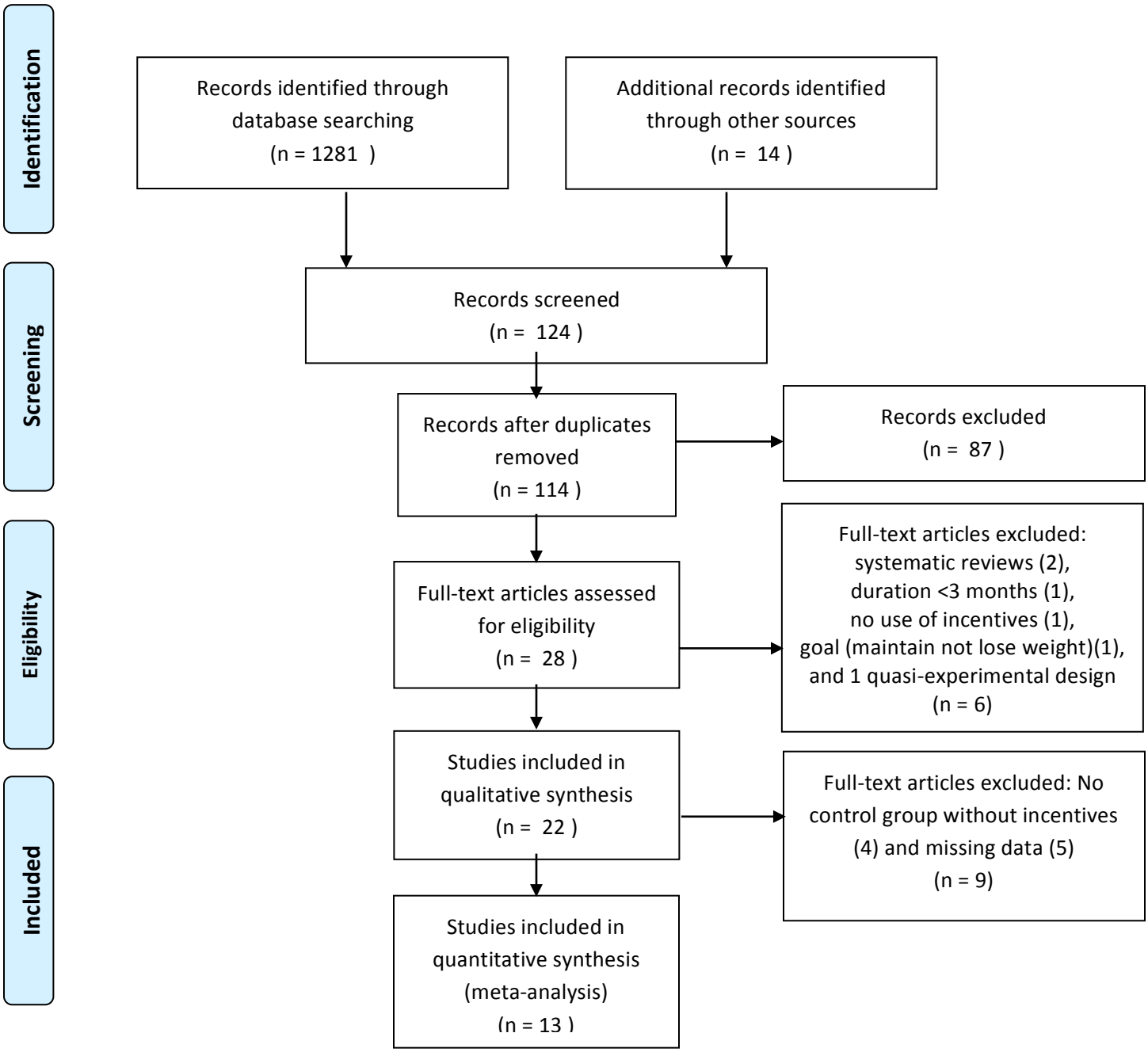

Figure 1. PRISMA flow-diagram of study selection out of 19609 potentially relevant publications

Systematic review

The characteristics of the studies included in the systematic review of the included trials are presented in Table 1. These studies were published between 1978 and 2011, and vary in quality of reporting, and in sample sizes. One author, R. Jeffery, has largely contributed to the literature on weight loss incentives, as he and his collaborators have published nearly half of the studies in our review.[3,7,10-17]

The included studies all used financial incentives, but followed different designs. Although a majority used a deposit contracting system, there were reward systems, lotteries and even group competition for weight loss. The amount of the incentives varied from $100 lottery gains to less than $400 in the deposit contracting design. The incentives were also given for different behaviors, with some programs including attendance for sessions or weigh-ins as a goal, others only focusing on weight change.

The intervention programs for weight loss also varied, with differences in the number of classes, methods and resources used, and in frequency of contacts. Some programs had group sessions, with or without physical activity, coaching, food provision, food diaries, or Internet support. The interval for follow-up ranged from food provision 5/7 days a week, weekly weigh-ins, to nearly 6-month intervals.

Some publications include several independent comparison groups that are relevant to our meta-analysis. We detail the independent comparison groups in the review and integrated those independent groups as separate studies in the meta-analysis (different lines for one author in the forest plots). We verified that none of the subjects were included in more than one of these lines.

Other publications report the follow-up data of a previously described study. In these cases, we grouped the original publication with the follow-up report, and present them in the same box for clarity. For the meta-analysis, these articles are considered one article (one line in the forest plot) for simplicity and clarity, but also to avoid including a same population twice into the analysis.

Table 1. Characteristics of included trials (qualitative synthesis)

Trial	Trial design	N	Subject characteristics	Intervention	Duration of incentive	Incentive design	Outcome	Follow-up
Jeffery et al,[3] 1978*	Controlled trial	31	Age 24-65y, female 87%	11x1hr weekly group sessions and weigh-ins: behavior principles education	10 weeks	Deposit contract	Imposed	12 weeks
Saccone et al,[18] 1978* **a. Incentives for monitoring eating behavior vs only monitoring eating** **b. Incentives for monitoring weight vs only monitoring weight**	RCT	49	Age 16-56y, female 98%	8x1hr weekly group sessions and weigh-ins: checklist for eating behavior, and all had stimulus-control education	9 weeks	Deposit contract	Self-set	1 year
Castro et al,[19] 1980	RT[§]	46	Age not reported Female 93%	1x2hr session, 8 weekly weigh-ins , 1 group meeting and 1 individual follow-up	8 weeks	Deposit contract	Imposed	16 weeks
Wing et al,[20] 1981	RCT	38	Age 19-65, female 87%	9x1hr weekly meetings, then 7x1hr monthly meetings, food diary	9 months	Deposit contract	Imposed	9 months
Jeffery et al,[13] 1983 **Jeffery et al,[11] 1984 (follow-up)**	RT[§]	89	Age 35-57y, female 0%	Manual, intake and exercise diary, non-mandatory weekly weigh-in.	15 week	Deposit contract	Imposed	1 year (2 year)
Forster et al,[10] 1985	RCT	131	Mean age 37y, female	Weight loss manual, food diary, weigh-ins 2x/month	6 months	Deposit contract	Self-set	6 months
Jeffery et al,[12] 1985A*	RCT	45	Age 34-53y, female 86%	2x/month group meetings: weight-loss manual and food records	6 months	Self-fixed (paycheck)	Self-set	6 months
Jeffery et al,[14] 1985 B	RCT	139	Age not reported Female 52%	16x1hr weekly group counseling sessions	16 weeks	Deposit contract	Imposed	16 weeks

*Included in meta-analysis.

Table 1. Characteristics of included trials (qualitative synthesis), cont'd

Trial	Trial design	N	Subject characteristics	Intervention	Duration of incentive	Incentive design	Outcome	Follow-up
Cameron et al,[21] 1990* **a. LHWD vs LHW** **b. LHD vs LH** **c. LWD vs LW** **(L=lessons, H=homework, W=weight-ins, D=deposit)**	RCT	185	Mean age 42y female 91%	15 lessons, weekly report, weigh-ins at 5 and 10 weeks	15 weeks	Deposit contract	Self-set	12 months
Jeffery et al,[17] 1993* **Jeffery et al,[15] 1995* (follow-up)** **a. Incentive and SBT vs only SBT** **b. Incentive and food provision vs only food provision**	RCT	202	Mean age 37y, female 50%	SBT 1x/week then 1x/month	18 months	Weekly incentive	Self-set	18 months (30 months)
Mavis et al,[22] 1994	RCT	101	Mean age 42y, female	10 1-hr group sessions	14 weeks	Deposit contract	imposed	14 weeks
Jeffery et al,[16] 1998* **a. Incentive for SW vs only SW** **b. Incentive and personal trainer vs only personal trainer**	RCT	196	Mean age 41y, female 83%	SBT, SW or personal trainer	18 months	Incentive for presence	Self-set	18 months
Jeffery et al,[7] 1999*	RCT	809	Mean age 38y, female 80%	Monthly newsletter, gym membership	3 years	Lottery	Self-set	3 years
Hubbert et al,[23] 2003*	Controlled trial (propensity score)	125	Mean age 49y, female 77%	Weekly meetings	12 weeks	50% reimburse-ment of sessions	Imposed	12weeks
Butsch et al,[24] 2007	Sequential control-intervention	401	Mean age 46y, female 84%	Weekly 90-min group sessions	12 weeks	50% reimburse-ment of sessions	Imposed	12 weeks

*Included in meta-analysis. SBT: Standard behavior therapy, SW: supervised walk [§]RT: randomized groups in a study that does not have a control group

We assessed the methodological quality of the studies included in the meta-analysis in more detail in Table 2, reporting whether the participants were randomly assigned to the intervention and control group, the concealment of allocation, the duration of the intervention and whether the authors used an intention to treat analysis. Studies without a control group, even if randomized (RT), were not included in the meta-analysis.

Table 2. Methodological quality of included trials

Trial	CCT or RCT	Allocation concealment	Comments
Jeffery et al,[3] 1978	CCT	-	Control subjects were those who refused a contract
Saccone et al,[18] 1978	RCT	Not reported	
Jeffery et al,[12] 1985a	RCT	Not reported	Early versus delayed treatment
Cameron et al,[21] 1990	RCT	Not reported	Stratified by gender and BMI
Jeffery et al, [17] 1993, Jeffery et al, [15]1995	RCT	Not reported	
Jeffery et al,[16] 1998	RCT	Not reported	
Jeffery et al,[7] 1999	RCT	Not reported	2 intervention groups, one with a $100 monthly lottery reward for returned postcards
Hubbert et al,[23] 2003	CCT	-	Analysis using a propensity score, and cases matched 4 to 1
Volpp et al,[5] 2008	RCT	Yes	Stratified on age and gender, intention to treat analysis
John et al,[4] 2011	RCT	Not reported	Stratification by sex and age
Morgan et al,[6] 2011	RCT	Yes	Intention to treat analysis
Jolly et al,[26] 2011	RCT	Yes	Intention to treat analysis

Meta-analysis

Out of the 22 studies reported in the systematic review, we included 13 publications in the meta-analysis. These actually compare and report 17 studies of independent comparison groups, each of which compared an intervention with incentive (experimental group) to a similar intervention without incentive (control group). One publication is a follow-up report of results of a trial, so both publications appear in the same line in Table 1 (Jeffery et al 1993[17] and 1995[15]). One of the non-randomized studies used a propensity score to match the intervention cases using financial incentives to a control group (ratio of 4 to 1) for the analyses.

Altogether, 11 of the 13 publications were randomized controlled studies. In these 13 articles, there were 1603 subjects, aged 24 to 65 years old. Sixty-seven percent of the participants were women, in spite of one study on a solely male population[6] and another with 97% of men.[5] The BMI ranged from 26.1[7] to 40.5 kg/m^2.[6,7] The duration of the follow-up in these studies varied from 3 months to 3 years, and the duration of the incentives intervention ranged from 9 weeks to 3 years.

Overall, the use of financial incentive was associated with a standardized weighted mean difference (SMD) effect on weight loss of -0.50 (95%CI -0.61 to -0.40) with a fixed effects model, which has some heterogeneity, with I^2=74% (Table 3). This result does not take into account the duration of follow-up or the duration of the intervention. Using a random effects model shows that this overall result is still statistically significant (SMD=-0.32, 95%CI of -0.56 to -0.08) (Table 3). The forest plots of all results can be found in the appendix. The funnel plot of the randomized effects model did not reveal any obvious publication bias (see appendix 6).

Table 3. Overall effect of financial incentives on weight loss, and subgroup analyses

Outcome	Number of studies (groups* included)	Experimental n	Control n	Heterogeneity of pooled effects (I^2)	Standard Mean Difference
Overall effect	12 (5)	686	917	74%	-0.50 (-0.61, -0.40) fixed -0.32 (-0.56, -0.08) random
Subgroup analyses					
4 months	6 (1)	281	319	67%	-0.65 (-0.82, -0.47) fixed -0.56 (-0.89, -0.23) random
12 months	6 (4)	475	652	72%	-0.54 (-0.66, -0.41) fixed -0.27 (-0.57, 0.03) random
Imposed goal	6 (1)	229	254	0%	-0.48 (-0.67, -0.29)
Self-set goal	6 (4)	457	663	84%	-0.51 (-0.64, -0.39) fixed -0.19 (-0.56, 0.18) random

*independent comparison groups

We analyzed the effect size when taking into account the time of weight measurement from the start of the intervention. The results of weight loss change after 4 months based on five different studies show a statistically significant effect size of -0.65 (95%CI -0.82 to -0.47) using a fixed effects model (I^2=67%) (Table 3), and an effect size of -0.56 (95%CI -0.89 to -0.23) with a random effects model (Table 3). The results at 12 months also showed a statistically significant effect size, with both a fixed effect model (SMD= -0.54, 95%CI (-0.66 to -0.41), I^2=72%) and a random effects model (SMD= -0.27, 95%CI (-0.57 to -0.03)) (Table 3).

We also analyzed the effect of financial incentives in studies that allowed patients to set their own weight loss goal. Six of the 12 studies used fixed weight loss goals, and six offered participants the choice of their goals. We included the study with group competition in the imposed goal study, because even if the investigators did not predefine the goal, it was imposed on a given individual by the performance of others, which means that the goal is not self-set. We found an effect size of -0.56 (95%CI of -0.67 to -0.29), using a fixed effects size model for the fixed weight programs (Table 1), with an I^2 statistic of 0. The self-set goal subgroup had high heterogeneity, with an I^2 statistic of 84%. The use of incentives in the random effects model, however, does not show statistical significance (Table 1). So we see that financial incentives have a positive effect when the study design includes a fixed weight loss goal.

Discussion

Our systematic review of 10 independent studies involving financial incentives for weight loss revealed different types of education programs to implement healthier behaviors. Some of these use incentives for food, either in quality or caloric content, for promotion of physical activities, for attendance at these educational sessions or weigh-ins, and some studies use financial incentives to drive weight loss. The amount of money offered does not need to be very high to achieve a result in terms of weight change.[27]

The quality and generalizability of the studies were assessed and verified wherever possible. We included one small study that was not randomized. One researcher conducted multiple studies, and we verified that all his studies were independent, conducted on different populations by contacting the author (Jeffery, RW). Ten of the 12 studies were conducted in North America (one in Australia, one in England), which may limit generalizability. We excluded two studies from the meta-analysis due to missing information, which remained unavailable even after contacting the authors. Attrition rates were reported in most of the studies, but not compared in this current report, since there is such great variation in the duration of the intervention and the follow-up.

The meta-analysis results are supportive of the use of financial incentives for weight loss programs. We see that there is an overall statistically significant benefit of financial incentives in weight loss programs, if we compare the last reported result of all studies without taking into account the duration of the intervention or time of follow-up. We studied the effects of financial incentives of the results reported after 3 to 4 months of study duration, and found that financial incentives are associated with a better outcome. This benefit persists, although to a lesser degree if we look at the studies that report results at 12 months. It is important to note that we only took into consideration the weight change reported at various time intervals, and that the financial incentives were often not maintained for the whole length of follow-up in these trials[15]. This can diminish the apparent effectiveness of financial incentives over time, and shows that people tend to revert to their previous behaviors if there is no support or supplementary motivation. The one study that maintained an intervention during the time of follow-up was one by Jeffery et al,[7] which had lasted three years. The study by Jolly et al[26] found that those who maintain their wish to lose weight and remain in the program at the end of one year are associated with a significant weight loss, whereas those who change plans or lose motivation gain weight. Further studies need to be carried out to confirm the results of this study.

Subgroup analysis of the approach to setting the weight loss goal showed interesting results. Financial incentives are more effective in studies that have a predetermined weight loss goal than in those where participants set their own goal, which could be free choice or a choice among several options for weight loss goals. These preset goals can be a fixed weight in absolute numbers, or a percentage of the initial body weight. Our findings suggest that self-determined weight loss goal programs may not benefit from financial incentives as much, with a

significant result only in the fixed effects model. This may however be due to the small size of the studies included, or to the high heterogeneity in this subgroup. Interestingly, studies have shown that participants overestimate the weight they will lose (overestimation), which is why reaching that goal may be particularly difficult, independent of the presence of financial incentives. Another possible explanation for this difference between self-set or preset goals is that participants perceive an externally set goal as a feasible goal that all other participants are striving to reach, which can increase both the self-confidence and social support, through the group session, and may thus help improve the self-efficacy in reaching that goal.

There are limitations to the meta-analysis we performed. First, sample sizes were sometimes very small in the articles, particularly in the older studies. It is therefore almost certain that those studies lack statistical power to show the desired effect. Second, the studies do have considerable heterogeneity in population characteristics such as gender, the type and length of educational programs, and in the type and amount of financial incentives. Third, we wanted to perform a subgroup analysis concerning the type of financial incentive, but the available studies were too varied in their interventions to be able to draw any conclusion from our dataset.

Conclusion

Our meta-analysis shows that financial incentives can improve the effect of weight loss programs, particularly when the duration of the study is shorter, although our results were significant up to one year's duration. We also found a positive impact of financial incentives in programs that provide preset weight loss goals, as opposed to those who allow the participant to choose the amount of weight they wish to lose. Further studies are needed to determine which population could benefit the most from financial incentives: gender, age, and income could all serve as independent variables for these future studies.

The use of financial incentives for implementing and maintaining a behavioral change such as weight loss may be generalizable to outcomes other than weight loss. We are currently conducting a meta-analysis, which includes other health behaviors such as smoking cessation or drug adherence. This hopefully will provide some more answers as we try to identify the optimal model for financial incentives for chronic disease management.

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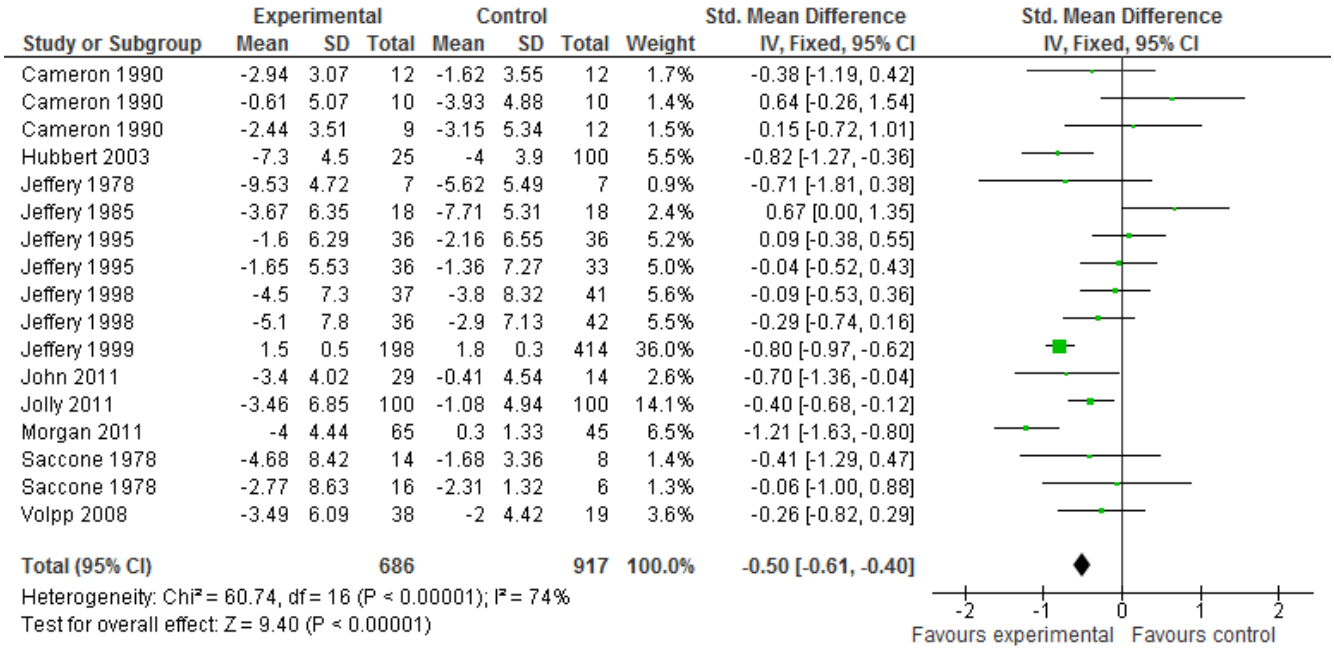
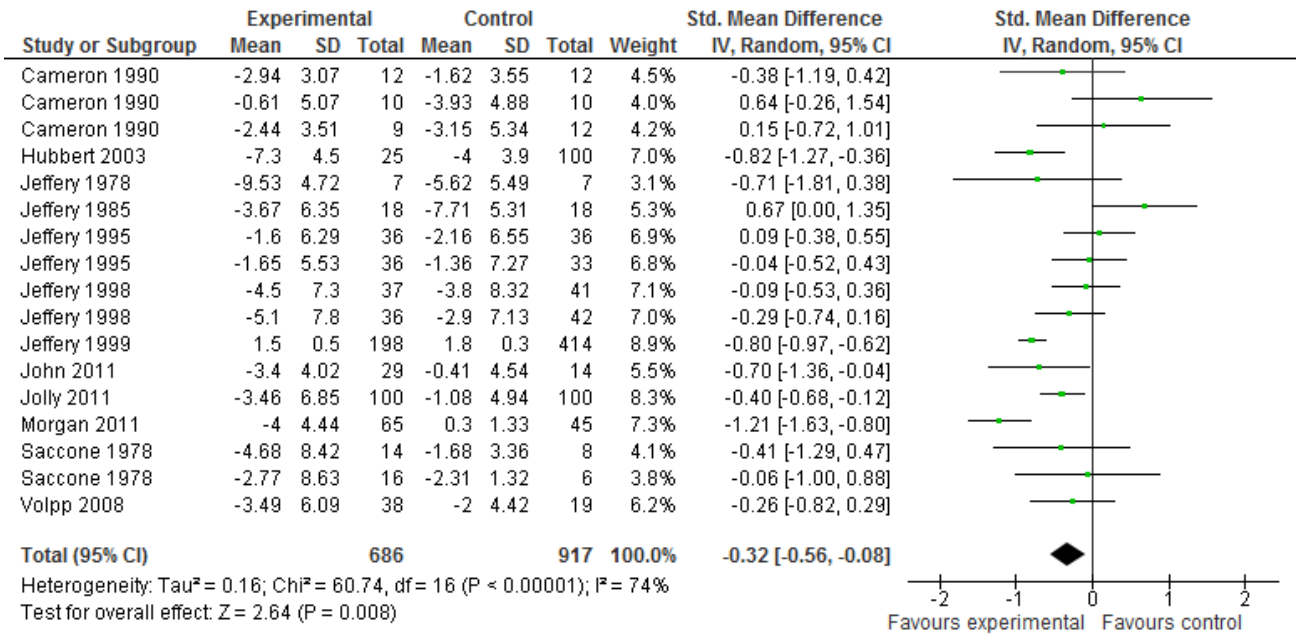
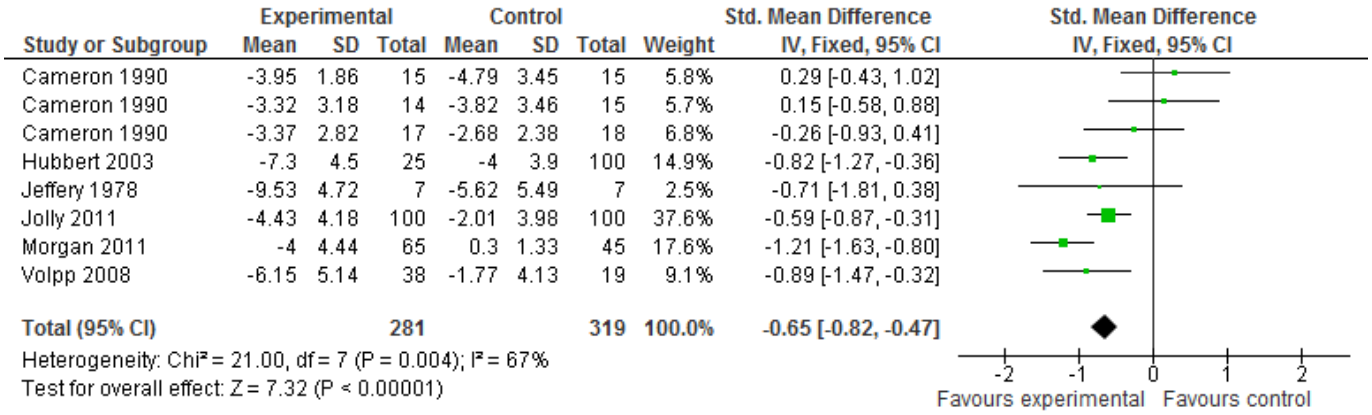
Appendices



Appendix 1a. Overall effect of financial incentives on weight loss (fixed effects model)



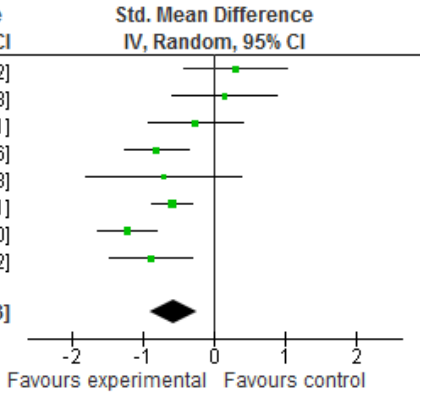
Appendix 1b. Overall effect of financial incentives on weight loss (random effects model)



Appendix 2a. Effect of financial incentives on weight loss at 4 months (fixed effects model)

Study or Subgroup	Experimental Mean	SD	Total	Control Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Cameron 1990	-3.95	1.86	15	-4.79	3.45	15	10.5%	0.29 [-0.43, 1.02]
Cameron 1990	-3.32	3.18	14	-3.82	3.46	15	10.4%	0.15 [-0.58, 0.88]
Cameron 1990	-3.37	2.82	17	-2.68	2.38	18	11.3%	-0.26 [-0.93, 0.41]
Hubbert 2003	-7.3	4.5	25	-4	3.9	100	15.0%	-0.82 [-1.27, -0.36]
Jeffery 1978	-9.53	4.72	7	-5.62	5.49	7	6.4%	-0.71 [-1.81, 0.38]
Jolly 2011	-4.43	4.18	100	-2.01	3.98	100	18.0%	-0.59 [-0.87, -0.31]
Morgan 2011	-4	4.44	65	0.3	1.33	45	15.7%	-1.21 [-1.63, -0.80]
Volpp 2008	-6.15	5.14	38	-1.77	4.13	19	12.8%	-0.89 [-1.47, -0.32]
Total (95% CI)			**281**			**319**	**100.0%**	**-0.56 [-0.89, -0.23]**

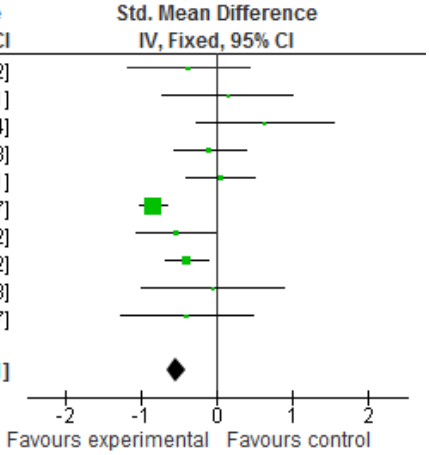
Heterogeneity: Tau² = 0.14; Chi² = 21.00, df = 7 (P = 0.004); I² = 67%
Test for overall effect: Z = 3.30 (P = 0.0010)



Appendix 2b. Effect of financial incentives on weight loss at 4 months (random effects model)

Study or Subgroup	Experimental Mean	SD	Total	Control Mean	SD	Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
Cameron 1990	-2.94	3.07	12	-1.62	3.55	12	2.4%	-0.38 [-1.19, 0.42]
Cameron 1990	-2.44	3.51	9	-3.15	5.34	12	2.1%	0.15 [-0.72, 1.01]
Cameron 1990	-0.61	5.07	10	-3.93	4.88	10	1.9%	0.64 [-0.26, 1.54]
Jeffery 1993	-5.59	6.17	35	-4.96	6.37	32	6.7%	-0.10 [-0.58, 0.38]
Jeffery 1993	-8.85	7.5	37	-9.23	6.6	36	7.4%	0.05 [-0.41, 0.51]
Jeffery 1999	0.4	0.3	198	0.6	0.2	414	50.2%	-0.84 [-1.02, -0.67]
John 2011	-3.9	6	44	-0.54	6.26	22	5.7%	-0.55 [-1.07, -0.02]
Jolly 2011	-3.46	6.85	100	-1.08	4.94	100	19.8%	-0.40 [-0.68, -0.12]
Saccone 1978	-2.77	8.63	16	-2.31	1.32	6	1.8%	-0.06 [-1.00, 0.88]
Saccone 1978	-4.68	8.42	14	-1.68	3.36	8	2.0%	-0.41 [-1.29, 0.47]
Total (95% CI)			**475**			**652**	**100.0%**	**-0.54 [-0.66, -0.41]**

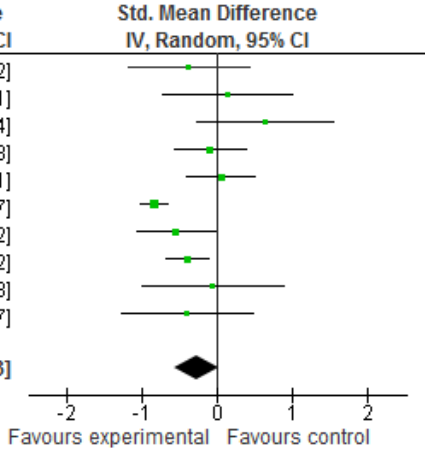
Heterogeneity: Chi² = 32.25, df = 9 (P = 0.0002); I² = 72%
Test for overall effect: Z = 8.48 (P < 0.00001)



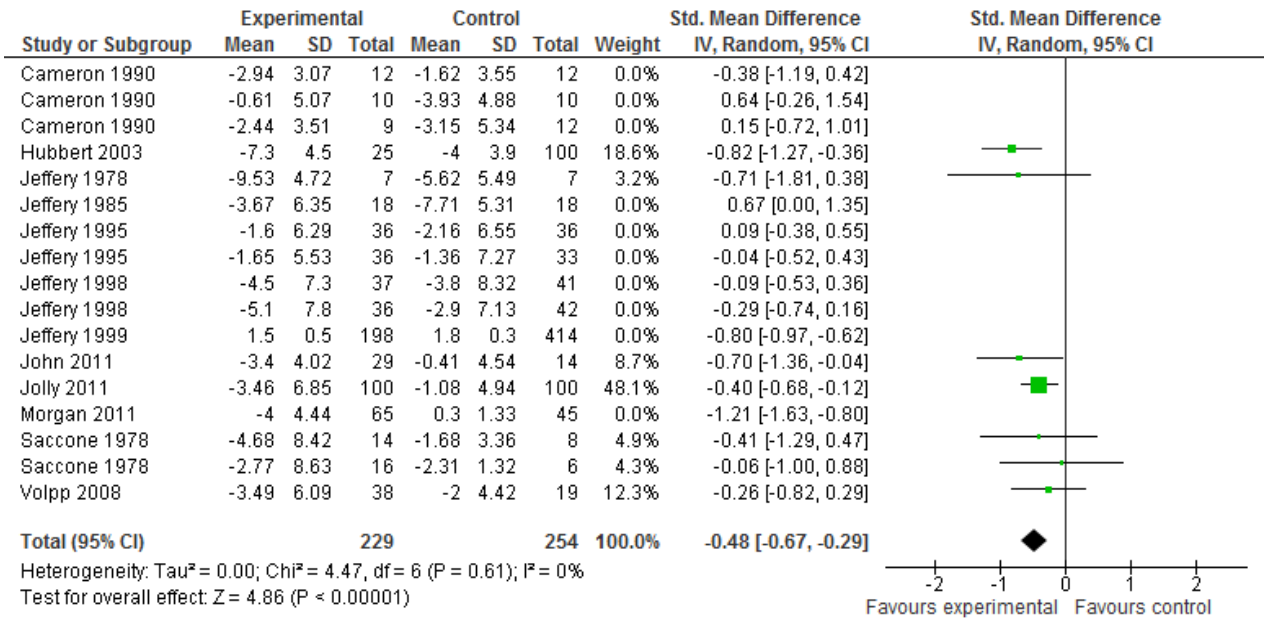
Appendix 3a. Effect of financial incentives on weight loss at 12 months (fixed effects model)

Study or Subgroup	Experimental Mean	SD	Total	Control Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Cameron 1990	-2.94	3.07	12	-1.62	3.55	12	7.5%	-0.38 [-1.19, 0.42]
Cameron 1990	-2.44	3.51	9	-3.15	5.34	12	7.0%	0.15 [-0.72, 1.01]
Cameron 1990	-0.61	5.07	10	-3.93	4.88	10	6.6%	0.64 [-0.26, 1.54]
Jeffery 1993	-5.59	6.17	35	-4.96	6.37	32	11.8%	-0.10 [-0.58, 0.38]
Jeffery 1993	-8.85	7.5	37	-9.23	6.6	36	12.1%	0.05 [-0.41, 0.51]
Jeffery 1999	0.4	0.3	198	0.6	0.2	414	16.0%	-0.84 [-1.02, -0.67]
John 2011	-3.9	6	44	-0.54	6.26	22	11.2%	-0.55 [-1.07, -0.02]
Jolly 2011	-3.46	6.85	100	-1.08	4.94	100	14.7%	-0.40 [-0.68, -0.12]
Saccone 1978	-2.77	8.63	16	-2.31	1.32	6	6.3%	-0.06 [-1.00, 0.88]
Saccone 1978	-4.68	8.42	14	-1.68	3.36	8	6.8%	-0.41 [-1.29, 0.47]
Total (95% CI)			**475**			**652**	**100.0%**	**-0.27 [-0.57, 0.03]**

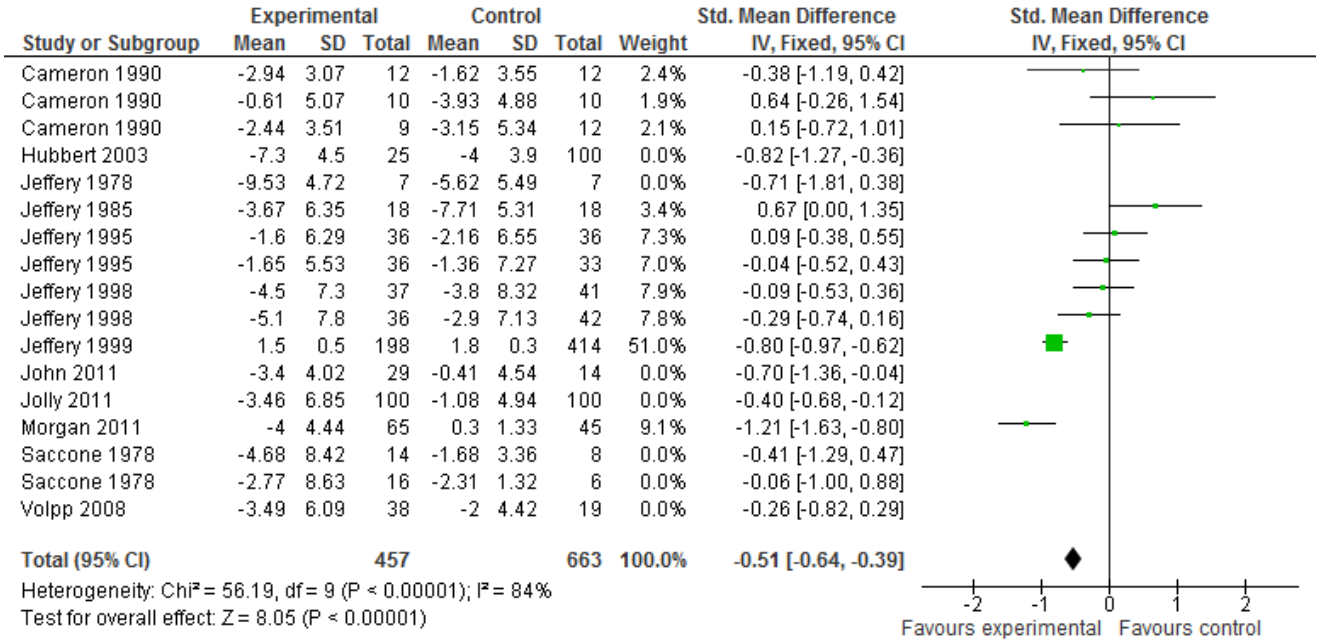
Heterogeneity: Tau² = 0.14; Chi² = 32.25, df = 9 (P = 0.0002); I² = 72%
Test for overall effect: Z = 1.77 (P = 0.08)



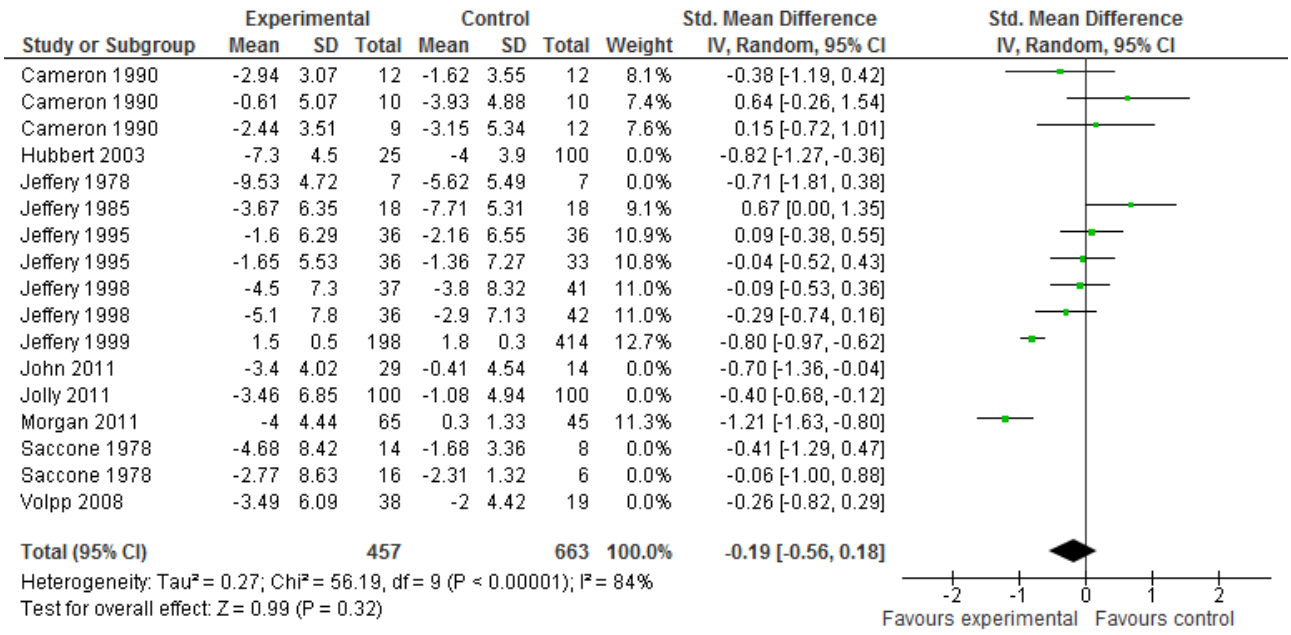
Appendix 3b. Effect of financial incentives on weight loss at 12 months (random effects model)



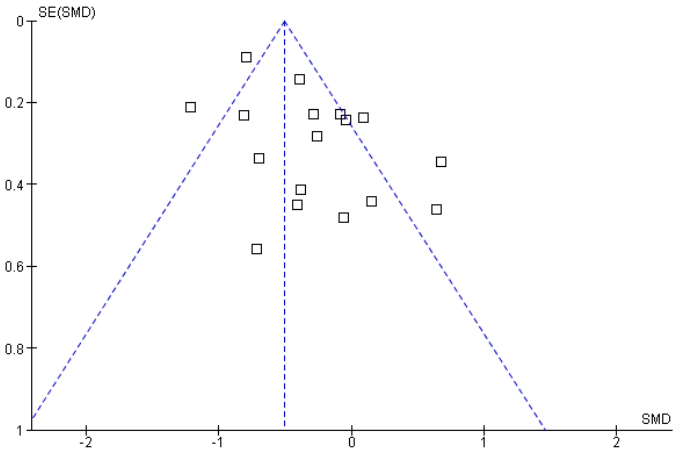
Appendix 4.Effect of financial incentives for fixed weight loss goals, using a imposed effects model (subgroup analysis)



Appendix 5a. Effect of financial incentive for self-set weight loss goals, using a fixed effects model (subgroup analysis)



Appendix 5a. Effect of financial incentives for self-set weight loss goals, using a random effect model (subgroup analysis)



Appendix 6. Funnel plot of overall effect of financial incentives on weight loss (fixed effects model)