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# Effectiveness of Monetary Incentives in Modifying Dietary Behavior: A Review of Randomized, Controlled Trials

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*To review research evidence on the effectiveness of monetary incentives in modifying dietary behavior, we conducted a systematic review of randomized, controlled trials (RCTs) identified from electronic bibliographic databases and reference lists of retrieved relevant articles. Studies eligible for inclusion met the following criteria: RCT comparing a form of monetary incentive with a comparative intervention or control; incentives were a central component of the study intervention and their effect was able to be disaggregated from other intervention components; study participants were community-based; and outcome variables included anthropometric or dietary assessment measures. Data were extracted on study populations, setting, interventions, outcome variables, trial duration, and follow-up. Appraisal of trial methodological quality was undertaken based on comparability of baseline characteristics, randomization method, allocation concealment, blinding, follow-up, and use of intention-to-treat analysis. Four RCTs were identified as meeting the inclusion criteria. All four trials demonstrated a positive effect of monetary incentives on food purchases, food consumption, or weight loss. However, the trials had some methodological limitations including small sample sizes and short durations. In addition, no studies to date have assessed effects according to socioeconomic or ethnic group or measured the cost-effectiveness of such schemes. Monetary incentives are a promising strategy to modify dietary behavior, but more research is needed to address the gaps in evidence. In particular, larger, long-term RCTs are needed with population groups at high risk of nutrition-related diseases.*

Key words: diet, incentives, intervention

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## INTRODUCTION

The increasing prevalence, and associated health consequences, of overweight and obesity in developed and developing countries[1-4] has generated interest in determining effective and sustainable population-based strategies to promote healthy eating. Such strategies must acknowledge the wider societal, cultural, and environmental determinants that shape food choices.[5-7] The price of food is one such important determinant.[8,9]

The price of healthy food is perceived to be a key barrier to healthy food choices.[10,11] Naturally, this barrier to dietary change is particularly relevant to socioeconomically disadvantaged groups.[12] Studies in several countries have demonstrated income-related differences in food purchasing patterns, with socioeconomically advantaged groups more likely to have patterns conducive to good health.[13-21] The relatively low cost of energy-dense and nutrient-poor foods such as those high in refined sugars and saturated fats is postulated to be an important mediator of this relationship between socioeconomic status and nutrition-related health.[17,22-24]

Fiscal food policies have been advocated by several key international bodies, including the World Health Organization.[25-27] Fiscal approaches posited include taxing foods based on nutrient content or taxing specific categories of food with low nutritional value, with the aim of creating a price differential favoring healthier food items. Small taxes on foods of low nutritional value such as soft drinks, snack foods, and candy have been implemented within 18 states in the United States.[28,29] In Australia, Canada, France, and the United Kingdom,

differential application of Goods and Services Taxes (GST) or Value Added Taxes (VAT) to food are employed, although the implementation criteria suggest that health benefits are not the primary driver. The impact of such approaches on food purchases and overall sales is not clear, because there is a lack of reported evaluation or research on these established policies.[30,31]

It is intuitive that monetary incentives such as contingent payments, price discounts, or coupons could reduce the economic barrier to making healthier food choices. Incentive schemes have been used successfully to target non-dietary-related behaviors such as increasing physical activity,[32] smoking cessation,[33-36] immunization,[37] and response to mailed questionnaires.[38,39] Price discounts are used frequently by the food industry to increase sales, but very little robust randomized research has investigated how price impacts food sales independently of the other retail activities that generally accompany price reductions.[40] A major retail promotion can increase sales by up to 75%,[41] but it is not known what proportion of this increase comes from the price reduction versus the additional merchandising activities that accompany it. Evidence from a small number of observational studies for the use of incentive strategies in modifying dietary behavior is promising.[42-44]

Characteristics of monetary incentives to influence behavior may be variable. Such characteristics include the form of incentive (e.g., cash, coupon, prize, gift, income enhancement) or disincentive (e.g., tax), the perceived monetary value of the incentive,[38,39] the certainty of incentive or disincentive (e.g., lottery vs. payment), whether receipt of the incentive/disincentive is contingent on attainment of the desired health behavior or outcome,[35,36,48] and the timing of incentive[46] (immediate vs. delayed). It is probable that the form and delivery mechanism of an incentive influences its impact on the desired outcome among different settings and populations.[45-47]

This paper reviews the current evidence from randomized, controlled trials (RCTs) on monetary incentives and their effectiveness in modifying dietary behavior. Questions of interest include: 1) are incentives effective in modifying dietary behavior?; 2) is the effect (if any) of incentives on dietary behavior more/less/equal in different socioeconomic or ethnic groups?; and 3) what level of monetary incentive is needed to effect change?

## METHODS

### Study Selection Criteria

The study design of interest was RCTs in community-based populations. Trials in which participants were hospitalized or living in institutions were excluded. Incentives were defined as monetary or non-monetary rewards in the form of payments, competitions, lotteries, raffles, prizes, coupons for free or reduced priced nutrition items, or the opportunity to avoid disincentives (e.g., taxes).[46,47] For inclusion in the review, incentives were required to be a central component of the study. Thus, research in which incentives were primarily an adjunct to improve recruitment or participation were excluded, as were studies using multi-component interventions, in which it was not possible to assess the independent effect of the incentive. Outcomes of interest comprised food purchases/consumption, weight loss, and anthropometric or dietary measures (e.g., food frequency data).

### Search Strategy

We searched MEDLINE (1966 to April 2005), EMBASE (1980 to 2005), CINAHL (1982 to April 2005), Cochrane Controlled Trials Register/Library (to 2005), and PsycINFO (1972 to April 2005) databases. Key Medical Subject Headings (MeSH) and text words used in the searches incorporated terms related to: 1) incentives/disincentives such as motivation, reward, reinforcement, awards and prizes, taxes, incentives, contest, discount, coupon, token, price, money; 2) other forms of nutrition interventions such as health education, health promotion, food supply/legislation/policy; and 3) nutrition behavior and outcome terms such as food habits, food preferences, health knowledge/attitudes/practice, diet, weight changes/gain/loss, risk reduction, obesity, BMI, skinfold thickness, waist-hip ratio, and glucose/cholesterol. The search strategy is shown in Figure 1 and Table 1. The search was limited to English language publications, human subjects, and RCTs. Handsearching of reference lists of included studies and electronic searches for publications by key authors in this field was also undertaken.

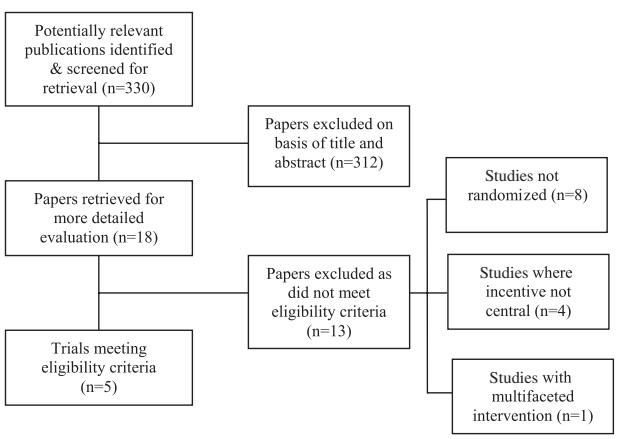


**Figure 1.** Process of study selection of eligible randomized, controlled trials.

**Table 1.** Search Strategy for Medline Database*

| | Search History (Main MESH Headings Only) |
|---|---|
| 1 | Motivation/ |
| 2 | Exp Reward/ |
| 3 | Reinforcement/ |
| 4 | "Awards and Prizes"/ |
| 5 | Taxes/ |
| 6 | Health education/ |
| 7 | Health promotion/ |
| 8 | Dietary services/ |
| 9 | Legislation, food/ |
| 10 | Food supply/ |
| 11 | Nutrition/ |
| 12 | Exp Food/ |
| 13 | Nutrition policy/ |
| 14 | Food preferences/ |
| 16 | Food habits/ |
| 17 | Exp Dietary Fats/ |
| 18 | Risk Reduction Behaviour/ |
| 19 | (reward$ or reinforcement or prize$ or incentive$ or contest$ or win$ or discount$ or moviat$ or disincentive$ or price$ or tax$).tw |
| 20 | (Price$ adj (restrict$ or reduct$ or limit$)).tw |
| 21 | Body mass index/ |
| 22 | Skinfold thickness/ |
| 23 | Overnutrition/ |
| 24 | Waist-Hip Ratio/ |
| 25 | Blood Glucose/ |
| 26 | Exp Diet/ |
| 27 | Exp body weight changes/ or weight gain/ |
| 28 | Health Behaviour/ |
| 29 | Health Knowledge, Attitudes, Practice/ |
| 30 | Obesity.tw |
| 31 | Weight$ adj (gain$ or loss$ or change$).tw |
| | Limited to English language and humans |
| | Filter for controlled/randomised controlled trials |

*Search strategy was modified for other electronic databases.

The titles and abstracts of articles thus identified were screened for relevance to the review topic. Potentially relevant studies were assessed for inclusion against a priori eligibility criteria by the primary reviewer (J.W.). Any potentially contentious studies were appraised by a second reviewer (C.N.M.), with differences in assessment resolved by discussion between the reviewers.

### Data Extraction

A standardized data extraction form was used to elicit relevant information on individual study design methods, results, and quality. The following methodological and outcome variables were extracted: study and sample population, number of participants, setting, intervention type and comparison, outcome measures, baseline and final outcome values, duration of trial, and length of follow-up. Criteria used to assess the methodological quality of trials included assessment of baseline characteristics, randomization, allocation concealment, blinding, follow-up, and intention-to-treat analysis. These data were used to generate summary evidence tables.

### Analysis

A meta-analysis could not be undertaken due to the disparate nature of the study populations and the type of incentives used; therefore, analysis was limited to a descriptive review of studies.

## RESULTS

### Study Selection

The literature search yielded 330 references. Of these, 312 were excluded on the basis of title and abstract. A further 13 were excluded for failing to meet our eligibility criteria: eight studies were not RCTs[42-44,49-53]; four did not use incentives as the central component[54-57]; and in one the incentives were part of a multifaceted intervention that did not allow analysis of the impact of incentives in isolation.[58] The final pool of five articles reported results from four independent studies.[59-63]

### Description of Included Studies and Interventions

Details of the studies included in the review are shown in Table 2. All four studies were based in the United States, with publication dates ranging from 1993 to 2001. They ranged in aims and settings from increasing consumption of fruit and vegetables via farmers' markets[60] to increasing low-fat food choices in school and workplace vending machines[59] to promoting weight loss in the community.[61,62] The type of incentive varied between studies, from price decreases on low-fat snacks in vending machines[59] to farmers' market coupons for fruit and vegetables[60] to a range of financial rewards or free food provision.[61-63] The goal of the incentives was either to facilitate the adoption of the desired behavior/outcome by reducing a financial barrier (e.g., farmers' market coupons,[60] price discounts,[59] or free food[61-63]) or to reward the adoption or maintenance of a behavior/outcome (e.g., payment contingent on weight loss[61-63]).

All four studies reviewed found a positive effect of incentives on healthy eating or weight loss compared with the control condition. Jeffery et al.[61,62] examined weight loss in 202 overweight adults randomized to no treatment (control), standard behavioral treatment (SBT), SBT plus free food, SBT plus monetary incentives, or

SBT plus free food and incentives for 18 months. All groups were evaluated at 6, 12, and 18 months. The key outcome of interest was mean body mass index (BMI). Controls could do whatever they wished to lose weight on their own, but received no active intervention. SBT comprised group behavioral counseling weekly for the first 20 weeks and then monthly, with weekly weigh-in sessions. SBT participants were given individualized goals for weight loss, calorie intake, and exercise. The free food group received SBT, meal plans, and free prepackaged meals for five breakfasts and dinners each week. The incentives group received SBT and a weekly cash payment. The level of the cash incentive (range $2.50 to $25/week) was contingent on the amount of weight lost in relation to an individualized weight loss goal. The fifth group received a combination of SBT, meal plans, and free prepackaged meals plus monetary incentives. All intervention groups showed greater weight loss compared with the control group. Differences between intervention groups were small but favored groups with free food provision. At 18 months, reduction in mean BMI for the control group was 0.21 $kg/m^2$, 1.75 $kg/m^2$ for SBT, 2.49 $kg/m^2$ for SBT plus food provision, 1.49 $kg/m^2$ for SBT plus incentives, and 2.31 $kg/m^2$ for participants receiving SBT plus food provision plus incentives (Table 2).[61] Attendance at treatment sessions and completion of self-monitoring food diaries were also greater in the two food-provision groups than in the SBT or SBT plus incentives groups.[61]

An ancillary study followed up 177 (88%) of the participants at 30 months (12 months after completion of the active interventions),[62] and the effect of food provision did not persist at 30 months. Weight changes observed from baseline to 30 months (12 months after active intervention completion) were a 0.6-kg gain (SD = 5.3) in the control group, a 1.4-kg loss (SD = 7.2) in the SBT group, a 2.2-kg loss (SD = 6.6) in the SBT plus food group, a 1.6-kg loss (SD = 5.5) in the SBT plus incentives group, and a 1.6-kg loss (SD = 6.3) in the SBT plus food plus incentives combined group (treatment effect vs. control $F(4,157) = 0.87$; $P > 0.45$) (Table 2). All active treatment groups gained weight gradually after 6 months, with a convergence in mean weight loss toward the control group once formal treatment was withdrawn at 18 months.[62]

Possible mechanisms by which food provision exerted beneficial effects in the active treatment period were explored in a further study by Wing et al.[63] Overweight adults (N = 163) were randomized to receive SBT (group 1), SBT plus structured meal plans (food types, portion sizes) and grocery lists (group 2), SBT plus meal plans and partially funded food (group 3), or SBT plus meal plans and free food (group 4). Weight losses (mean ± SD) from baseline to 6 months were: 8.0 ± 6.2, 12.0 ± 7.2, 11.7 ± 5.4, and 11.4 ± 6.5 kg for groups 1 to 4, respectively. The overall treatment effect on weight loss was statistically significant ($F(3,143) = 30.4$; $P < 0.03$; no measure of precision reported). Weight loss among the SBT-only group was significantly less than that for all other treatment groups, which did not significantly differ from each other at 6 or 12 months follow-up. Notably, the level of weight loss in the food provision groups did not differ significantly from those receiving SBT plus structured meal plans and grocery lists, suggesting that no further benefit was derived from food provision.[63]

French et al.[59] examined the effects of price reduction and point-of-purchase promotion of low-fat snacks on the sales of low-fat and regular vending machine snacks at 12 workplaces and 12 schools over a 12-month period. Using a two (setting: workplace, school) by four (pricing: equal between low-fat and regular snacks and low-fat snack price reduction by 10%, 25%, and 50%) by three (promotion: none, labeling of low-fat snacks, and labeling of low-fat snacks plus vending machine signs) factorial design, each site was randomly allocated a sequence of 12 intervention arms. Each arm was implemented in all machines at the site for a 4-week period. Price reductions were associated with significant increases in the percentage of low-fat snack sales ($F(3,66) = 156.89$; $P < 0.01$). The percentage of low-fat snack sales increased by 9%, 39%, and 93%, respectively, when prices were reduced by 10%, 25%, and 50%.[59] Price reductions of 25% and 50% were associated with significant increases in the absolute number of low-fat snacks sold relative to the 10% price reduction and equal price conditions. Price reduction had a statistically significant effect on sales volumes ($F(3,66) = 11.01$; $P < 0.001$). Mean total sales volumes were significantly greater in the 50% price reduction condition compared with the three other conditions.[59] Vending machine profits were not shown to differ significantly by price conditions, with profits of $494, $466, $442, $480 for equal price and 10%, 25%, and 50% for price reduction conditions, respectively.[59]

Provision of farmers' market coupons to 564 low-income women significantly increased self-reported fruit and vegetable consumption. Study participants were recruited from two existing community nutrition programs that served low-income women and children primarily through the provision of regular food packages, coupons for fruits and vegetables, and education. Participants were assigned to one of four intervention arms: 1) education on fruit and vegetables (tailored to action stage of change); 2) coupons (value $20); 3) combination of coupons plus education; or 4) no intervention (control). Groups 1 and 3 were randomly assigned; assignment to the no-intervention or coupon-only groups was contin-

**Table 2.** Summary of Studies Included in a Review of Randomized, Controlled Trials on the Effectiveness of Monetary Incentives in Modifying Dietary Behavior

| Study | Population | Intervention |
|---|---|---|
| Jeffery original study 1993[61] and follow-up at 30 months in 1995[62] | 202 participants (101 males and 101 females) living in US communities (two centers) recruited through newspaper advertisements<br>Eligibility criteria: 25–44 years of age, 14–32 kg overweight, non-smokers, free of serious disease, able to exercise, not taking any medications, not on special diets or allergic to any foods, less than 3 alcoholic drinks per day<br>Study participants were predominantly white, 35–40 years of age, and relatively well-educated | Five intervention arms (20% randomly assigned to each arm, no power calculation reported):<br>1) Control: no intervention<br>2) SBT: weekly group sessions for 20 wks, followed by monthly sessions and weekly weigh-ins for 18 months; assigned calorie goal, food intake record, dietary advice, and exercise goals given<br>3) SBT plus food provision (5 breakfasts and dinners/wk) calorie controlled, food provided free of charge<br>4) SBT plus incentives (payments of up to $25/wk for reaching weight loss goals and maintaining)<br>5) SBT plus food provision plus incentives<br>8 months of intervention, 12 months of follow-up post intervention |
| Wing, 1996[63] | 168 females living in US communities recruited through newspaper advertisements<br>Eligibility criteria: 15–55 years, 30–70 lb overweight, not pregnant or planning to become pregnant in next 18 months, free of medical conditions that would preclude participation in diet and exercise program | Four intervention arms:<br>1) SBT—weekly group sessions of 20 people for 26 wks<br>2) SBT plus structured meal plans and grocery lists<br>3) SBT plus structured meal plans and grocery lists plus food provision where participants required to share food costs (contributing fixed amount of $25 per week)<br>4) SBT plus structured meal plans and grocery lists plus food provided free of charge |
| French, 2001[59] | Unit of observation was vending machine sales; sites were selected from a convenience sample of customers of a large vending machine service company in the midwestern US; sites were selected for geographic and demographic diversity<br>12 schools and 12 worksites in the US in the Minneapolis-St. Paul, Minnesota area selected for demographic and geographic diversity | Four levels of pricing (equal, 10% reduction, 25% reduction, 50% reduction) × 3 levels of promotion (none, label only, label plus sign) × 2 settings (workplace or school); the 12 treatment conditions were implemented at each of the 24 sites in a randomly assigned sequence; each treatment condition remained in effect in all vending machines at given site for a 4-week period<br>Vending machines at 12 school and 12 worksites stocked with low-fat snacks (17% of the machine inventory); prices on the low-fat snacks were reduced relative to the higher fat snacks<br>12 months of intervention |
| Anderson, 2001[60] | 669 low-income females recruited from two nutrition assistance programs (WIC and CSFP) in communities in the US (a Michigan farmers' market)<br>564 participants completed the pretest; 455 completed the post-test<br>Participants completing the post-test were: 43% African-American, 49% Causian, and 7.3% other; their mean age was 29.5 years and 49% had high school education or less | Four study arms:<br>1) Nutrition education only<br>2) Farmers' market coupons ($20 coupon plus either $5 cash if CSFP participant or $10 cash if WIC participant)<br>3) Nutrition education plus coupons<br>4) No intervention<br>Nutrition education was based on stage of change; key components included health, seasonality, storage, buying power, and fruit and vegetable preparation |

CSFP, Commodity Supplemental Food Program; F&V, fruits and vegetables; SBT, standard behavioral therapy; WIC, Women, Infants, and Children program.

| Outcome Measures/Study Length | Main Findings |
|---|---|
| At 6, 12, and 18 months:<br>1) Weight loss (anthropometric measures BMI, skinfolds)<br>2) Food diaries: daily caloric intake for first 20 wks then 1 wk per month<br>3) Exercise recall: distances walked/cycled<br>4) Perceived barriers to adherence (15-item questionnaire)<br>5) Eating behavior inventory<br>6) Nutritional knowledge<br>7) Attendance at group treatment/weigh-ins<br>At 30 months:<br>Weight loss (anthropometric measures BMI, skinfolds)<br>Study length: 30 months | Mean BMI change from baseline by intervention group:<br><br>6 mo / 12 mo / 18 mo<br>Control: −0.4 / −0.5 / −0.21<br>SBT: −2.7 / −1.95 / −1.75<br>SBT + FP: −2.83 / −3.2 / −2.49<br>SBT + I: −3.8 / −1.85 / −1.49<br>SBT + I + FP: −3.87 / −2.97 / —<br><br>The effect of food provision (FP) did not persist when participants were assessed at 30 months (12 months post completion of the active intervention, i.e. no ongoing provision of food) |
| At baseline and at end of week 26:<br>1) BMI (kg/m$^2$)<br>2) Barriers to adherence<br>3) Dietary intake (block food frequency questionnaire)<br>4) Food stored at home<br>5) Eating patterns<br>6) Diet, exercise and weight loss knowledge<br>7) Physical activity (Paffenbarger Physical Activity Recall)<br>Study length: 12 months | At 26 weeks ($n$ = 148):<br>Weight loss for group 1 (8.0 ± 6.2 kg) was significantly less than for groups 2–4 (12.0 ± 7.2, 11.7 ± 5.4, 11.4 ± 6.5 kg, respectively) ($F(1, 140) = 8.97$; $P < 0.003$); however, there was no significant difference between treatment groups 2–4, suggesting that providing food (free or with payment) did not further increase weight loss over that attained by provision of meal plans and grocery lists<br>At 1 year follow-up ($n$ = 146):<br>The average weight loss from baseline to one year was 3.3, 6.9, 7.5, and 6.6 kg for groups 1–4, respectively; again, significantly poorer long-term weight losses were seen in group 1 than in the remaining treatment groups ($P < 0.02$), however, groups 2–4 did not differ from each other |
| 1) The unit of analysis was sales per site (pooled across all machines at the site)<br>2) Percentage of low-fat snacks sold under each price reduction condition<br>3) Snack sales volumes<br>4) Average monthly profits per machine<br>Study length: 12 months | Price reduction of low-fat items was associated with significant increase in percentage of these items purchased; items reduced by 10%, 25%, and 50% resulted in an increased percentage of low-fat snack sales of 9%, 39%, and 93%, respectively (measures of precision not reported)<br><br>Participants receiving coupons were more likely to have reported visiting the farmers market during the intervention (OR = 69.9; $P < 0.001$, no measure of precision reported)<br>Coupons were found to significantly increase self-reported consumption of fruit and vegetables |
| Self-administered questionnaires pre- and post-intervention assessing attitudes about fruit and vegetable consumption and intake of F&V<br>Records of redemption of coupons by farmers, indicative of client use<br>Study length: 2 months | |

gent on the timing of the client's appointment and the community program. Cash incentives of between $5 and $10 were provided for participation in data collection for those in groups 2 and 3. Pre- and post-intervention self-administered questionnaires assessed intervention effects on attitudes to fruit and vegetable consumption and self-reported intake of fruit and vegetables. Receipt of coupons was associated with a significantly increased likelihood of reporting attendance at a farmers' market (odds ratio [OR] = 69.91; $P < 0.001$; confidence interval [CI] not reported) and significant positive changes in self-reported fruit and vegetable consumption ($F(3,441) = 6.33$; effect size = 0.04 [the percent of variance in multivariate outcomes explained by each factor]; $P < 0.01$) and significant positive effects on the belief that vegetables are more costly than other foods (directional $t$ test = 2.23; $P < 0.05$; CI not reported) (Table 2).[60]

### Quality

Study quality was assessed against the stated criteria, however, no attempt was made to assign a formal rating. A number of methodological limitations common to the reviewed studies were identified (Table 3). Most of the studies had small samples, particularly given the large number of intervention groups in most of them,[59,61-63] and none reported prior power calculations to justify the sample size. The methods of randomization, allocation concealment, blinding of delivery of interventions, and blinding of data collection/analysis were not explicitly reported in any of the published articles. Measures of precision (e.g., 95% confidence intervals or standard deviations) were not reported for relevant analyses in Jeffery et al.[61] or Anderson et al.,[60] and were only shown graphically in French et al.[59] Additional data and information on these methodological processes were not able to be sourced from the listed corresponding authors upon request.[59-61] In general, attrition in the reviewed studies was low.

Further methodological limitations unique to the individual studies reviewed are summarized in Table 3 and discussed herein. In Anderson et al.,[60] the coupons-only group was recruited from a different center than the other study groups, and the no-intervention and coupon-only intervention groups were not randomized, contributing to differential baseline characteristics and selection bias. Furthermore, there was systematic disparity in the amounts of cash (ranging from $5 to $10) received by participants for participation in data collection between study centers and in the timing of when the cash incentives were received between study groups.[60] There were significant differences between completers and non-completers, with completers more likely to have transportation to the market, to have more education, to not be pregnant, to have received farmers' market coupons in previous years, and to believe it to be less of a bother to prepare fruits and vegetables. Results in this study were primarily based on self-reported dietary change and thus may be subject to measurement and reporting biases. Because the outcome measure was the change in low-fat snack vending machine sales in the study by French et al.,[59] it was not possible to determine if increases in sales represented substitution of a regular snack with a low-fat snack, new customer sales, or increases in the number of purchases by existing customers.

Jeffery et al.[61] restricted the analysis to those who completed all assessment sessions (n = 160 or 79%), so this was not an intention-to-treat analysis, which would have created a positive bias in reported results. Sample size was relatively small given five intervention arms, and it is likely that the sample size was not adequate to detect differences between intervention groups. The authors postulate that the level of incentive (up to $25/week) may have been insufficient to favor weight loss behaviors. Thus, it would have been useful to report the socioeconomic status of participants and the mean level of contingent payment received per week.[61]

## DISCUSSION

This review describes the evidence from published RCTs on the impact of monetary incentives on the modification of dietary behavior. There are only a small number of studies addressing this issue using an RCT design. The reviewed studies suggest that incentives have a positive effect on both food purchasing patterns and weight loss. The evidence in support of sustained positive effects is more tenuous. The small number of relevant studies precludes conclusions regarding the optimal characteristics level or form of an incentive to achieve effect, particularly in diverse populations of variable age, socioeconomic status, education level, or ethnicity, or among a broad range of settings (e.g., supermarkets, schools, workplaces). Only one study described evidence of a dose-response relationship according to the magnitude of price reduction.[59] Furthermore, to date, there have been no studies exploring whether there is a differential effect of incentives according to socioeconomic or ethnic group, or measuring the cost-effectiveness of such schemes.

This review provides a useful synthesis of RCT evidence on the effect of monetary incentives on dietary behavior and facilitates identification of future research opportunities. However, some important caveats must be acknowledged when interpreting our findings. While a comprehensive search of electronic databases and published literature was undertaken, we found only a small number of published RCTs in this area, and these were of

variable quality. The included trials also exhibited considerable heterogeneity of study populations, settings, types of incentives, and reported outcome measures, thus precluding the pooling of data for a meta-analysis and hampering the ability to draw comparisons. The review is also likely to be subject to some publication bias since positive study findings are more likely to be published.

The four trials reviewed had some methodological limitations. Short study durations limit the ability to demonstrate that behavior change or weight loss was sustained. The maximum intervention period was 18 months, with only one study incorporating a follow-up assessment at 30 months (12 months post intervention).[62] In addition, it was not possible to determine the potential for widespread application of incentive-based dietary interventions because none of the trials explicitly measured cost-effectiveness of the interventions or evaluated the potential impact on the wider food industry. Some of the trials were relatively small, particularly given the number of intervention groups involved. The trials by Jeffery et al.[61,62] only included 40 or 41 participants in each intervention group, and this sample size may not have been adequate to detect significant differences between intervention groups. These studies were included in the review principally because they included a monetary incentive arm. However, the free food provision arms are not directly comparable to other forms of monetary incentives considered in this review. While providing prepackaged food free of charge reduces the economic barrier of food cost, it has additional effects such as providing meal structure through fixed food availability, meal plans, and portion control, and has a convenience/labor-saving component.[63] All of the trials included in the review were carried out in the United States, so the findings may not be generalizable to countries with different socioeconomic, sociocultural, and political environments. Finally, no studies examined whether there were differential effects of incentive-based interventions on dietary behavior in population subgroups by socioeconomic status or ethnic group.

Incentives that reduce economic barriers, such as differential price structures, are likely to have greater utility in encouraging healthy food choices at the population level, more so than more individually focused incentives in the form of contingent payments, coupons, or food provision. Population-based strategies aim to create environments that favor healthier choices for whole populations, and are often considered to be wider reaching and more sustainable than individually focused interventions.[64,65]

In general, the key findings of this review support those of similar reviews of incentive-based interventions across a wider scope of health outcomes and study methodologies.[46,47] Kane et al.[46,47] undertook a structured review of economic incentives in health, examining 47 studies of varying methodologies (observational and RCTs). Overall, their review reports a positive effect of incentives 73% of the time. Twenty-three of the 47 studies considered outcomes that required sustained behavior changes such as increasing exercise, quitting smoking, and losing weight. Incentives varied in form ranging from lotteries, gifts, cash incentives, and coupons to those involving active reinforcement or the opportunity to avoid negative consequences. The review concluded that economic incentives appear to be effective in the short term for simple, well-defined, finite outcomes, but further clarity is needed to determine the characteristics of incentives to sustain long-term behavior modification. Giuffrida and Torgerson[47] conducted a systemic review of 11 RCTs, and found that financial incentives promoted patient compliance better than other intervention strategies or control conditions in 10 of the 11 studies.

Overall, even when considering a broader scope of health behaviors, there remains a paucity of studies analyzing cost-effectiveness,[46] the potential differential effect of incentives on low-income populations, and sustainability of behavior changes.[45,46]

The RCT evidence from French et al.[59] on pricing strategies is consistent with a number of observational studies employing pre-test/post-test study designs undertaken by the same authors.[42-44] Across a variety of community settings and targeted food types, positive effects of relative price reductions for healthy food on nutrition knowledge and changes in healthy food choices have been reported. A 50% reduction in the price of low-fat vending machine items significantly increased the proportion of these items purchased from 25.7% to 45.8%, returning to 22.8% on withdrawal of the discount.[42] In an office cafeteria setting, fruit and salad purchases increased 3-fold during a 3-week intervention combining an increase in the number of fruit choices and a 50% discount on both fruit and salads (comparative to baseline and withdrawal of the price reduction).[52] Similarly, 50% price reductions on fruit, baby carrots, and salads in two secondary school cafeterias were associated with a 4-fold increase in sales of fruit and a 2-fold increase in sales of baby carrots during the 3-week price reduction period (compared with baseline and withdrawal of price reduction).[43]

The impact of lowered prices, health information, and their combination on the purchase of targeted healthy food items were compared in a restaurant setting over a 14-week period by Horgen and Brownell[44] using an pre-/post-test design with six periods: 1) an initial baseline, 2) a price-decreased intervention, 3) an interim baseline, 4) a health information intervention, 5) a combination of price decreases and health message interven-

**Table 3.** Quality Assessment of Studies Included in a Review of Randomized, Controlled Trials on the Effectiveness of Monetary Incentives to Modify Dietary Behavior

| | Quality | | |
|---|---|---|---|
| **Author** | **Baseline Characteristics** | **Randomization** | **Allocation Concealment** |
| Jeffery original study 1993[61] and follow-up at 30 months in 1995[62] | 25–44 years of age, mean age 37.5 yrs; mean BMI 31; 14–32 kg overweight; mean weight at entry 89.8 kg<br>Across all groups, an average of 42% of participants did not graduate from college<br>No significant differences detected between groups indicating randomization was effective in producing comparable treatment groups | Randomized, stratified by gender and center (2 study centers); method of randomization not described | Not specified |
| Wing, 1996[63] | Average age 41.3 ± 7.4 yrs; BMI 32.2 ± 2.3 kg/m$^2$<br>Baseline characteristics of participants post-randomization were similar with the exception of those in the free food arm (group 4), who were marginally less likely to have attended college or beyond (46% vs. 56%, 59%, and 65% for study groups 3, 2, and 1, respectively) | Method of randomization not described | Not specified |
| French, 2001[59] | Not described | Sequence of treatment conditions randomly assigned<br>Method of randomization not described. | Not specified |
| Anderson, 2001[60] | Pre-existing differences between the WIC and CSFP groups on eight variables: attitudes toward F&V, F&V intake, household size, number of children, age, smoking status, whether women were in paid employment, whether women were pregnant or lactating | Study not fully randomized; WIC participants were randomly assigned in April–May to either coupons and education or education only; the no-intervention group was not randomly assigned and recruited from WIC in June; the coupon-only group was not randomly assigned and recruited from CSFP in June | Not specified |

CSFP, Commodity Supplemental Food Program; F&V, fruits and vegetables; WIC, Women, Infants, and Children program.

| Quality | | |
|---|---|---|
| **Blinding** | **Follow-up** | **Intention-to-treat** |
| Participants and study staff delivering intervention not blinded<br>Not specified if data collection or analysis was blinded | Attrition low, with 85%–89% of participants attending 6-, 12-, and 18-month assessments.<br>Attrition by treatment group:<br>Group 1: 70%<br>Group 2: 65%<br>Group 3: 90%<br>Group 4: 85%<br>Group 5: 83% | Incomplete data were analyzed in two ways: first, analysis was restricted to subjects who attended all sessions; second, they included all subjects who were present at the 18-month follow-up and interpolated missing data from adjacent values; the results of these two approaches were very similar, so they based reported results on complete cases only (not intention-to-treat) |
| Blinding to staff implementing the intervention not possible; not specified if data collection or analysis was blinded | Attrition was low at 26 weeks, with 91% ($n$ = 148 of 163) of participants completing assessments; no significant difference in the proportion of completers was seen by treatment group<br>At one year, data were obtained for 146 (90%) participants. | At 26 weeks:<br>Not explicitly stated.<br>At 1 year:<br>Two participants were excluded from the analysis, one who became pregnant and one who had major surgery; the remaining 144 subjects were evenly distributed among the four treatment groups |
| Blinding to staff implementing the intervention not possible; not specified if data collection or analysis was blinded | Two sources of missing data described:<br>1) Data not available from one school site that discontinued participation in the study after 3 months; a new similar school was recruited to take part<br>2) Data missing in two site-treatment condition combinations (out of total of 288) | Regression imputation used to address missing data from the two site-treatment condition combinations; based on both fixed and random effects, data was predicted for the two missing cells<br>Reported results are based on the original unbalanced data, however, as the estimates were very similar to the imputed data |
| Participants and study staff delivering intervention were not blinded<br>Variations in the timing and amount of cash incentives paid for data collection; pattern of incentives was based on budgetary reasons and staff recommendations whereby CSFP participants given $20 in coupons and $5 cash, whereas WIC participants given $20 coupons and $10 cash; the authors note that these variations could have differentially influenced outcomes<br>Blinding of data collection and analysis not specified | Attrition 19.3%, with 455 of 564 participants completing the post test; compared with participants who did not return, those completing the post test were significantly more likely to have transportation to the farmers' market, have a higher education, not be pregnant, have received farmers' market coupons in the past and believe it to less of a bother to prepare F&V<br>Redemption of coupon data was available for 94% of participants | Not specified |

tion, and 6) a final baseline. Price decreases of approximately 20% to 30% were associated with significantly increased sales of some targeted healthy food items above the initial baseline compared with control items.[44] While these findings are promising, they are derived from non-randomized studies, so it is possible (although unlikely) that the effects reported were due to variables other than the intervention.

The small number of RCTs with a focus on dietary outcomes identified in this review prohibited consideration of the effect of the incentive characteristics. Two modeling approaches have suggested that disincentives in the form of food taxes may be regressive. That is, an increase in the price of food disproportionately burdens those who are socioeconomically disadvantaged. This may arise because the proportion of the total budget allocated to food tends to decrease with increasing income, and there is evidence that those on lower incomes are more price sensitive.[66-68] Conversely, subsidies on healthier foods could favor socioeconomically disadvantaged populations. However, since the findings were derived from modeling studies rather than actual evaluated interventions, they cannot be considered conclusive.

### Policy Implications

Modification of dietary behavior at the population level necessitates a multifaceted approach of which incentive-based strategies are a potentially valuable component.[29,69] Parallels have been drawn between the use of incentive-based strategies in effective tobacco control and methods to improve diet and physical activity.[70,71] However, there are well-documented differences that limit the validity of such comparisons, including the fact that food is a basic need, the diversity of food products and producers, the importance of public health institutions working collaboratively with the food industry,[41] and the relative price inelasticity of demand of most food in contrast to alcohol and tobacco products.[66] Fiscal food policies such as subsidies and taxes to influence food purchasing behavior have been advocated by several key bodies, including the UK House of Commons' Health Select Committee[72] and the World Health Organization.[73] Commonly suggested fiscal approaches include: taxes on specific foods[74,75]; exemption from a goods and service tax (GST) or value added tax (VAT)[74,75]; a voucher system targeted to high-risk groups,[53] and the provision of incentives to the food industry for the production and marketing of healthier food products.[22,25] Considerable challenges with implementation and sustainability of incentive-based policies may be anticipated. Contributing to such challenges are the complexity of the food industry, the feasibility and sustainability of a funding mechanism to lower prices of healthier foods, and the need for substantial commitment to such a policy from central governments and the food industry. Targeted subsidies and taxation of foods are likely to meet with opposition from the food industry,[68] potentially limiting implementation. It is important that any adoption of fiscal food policies minimizes, or at the very least does not exacerbate, existing inequalities in nutrition-related health determinants and outcomes.

### Future Research

A number of research imperatives are highlighted in this review. There is a clear need for further RCTs to measure the effectiveness of pricing strategies for dietary modification, particularly for socioeconomically disadvantaged and ethnically diverse populations, who typically experience higher rates of nutrition-related diseases. Future RCTs should explicitly assess the cost-effectiveness of incentive-based interventions and should be of sufficient size and duration to assess adoption and maintenance of healthier dietary behaviors. Trials assessing the effects of varying levels of price differentials on healthy food choices also merit further attention. Trials should ideally be guided by the CONSORT statement[77] when reporting findings to better facilitate assessment of trial quality and data required for meta-analysis.

## CONCLUSIONS

In conclusion, RCT research evidence to date suggests that monetary incentives are a promising strategy to encourage healthier food choices and to modify dietary behavior. However, there are no data available on the impact of incentives on the dietary behavior of socioeconomically and ethnically diverse populations, on the form and level of incentive necessary to effect sustained dietary change, or on the cost-effectiveness of incentive strategies. Further research using robust, randomized trial designs is needed to address the remaining evidence gaps.

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