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A Systematic Review of Financial Incentives for Dietary Behavior Change

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Abstract

In light of the obesity epidemic, there is growing interest in the use of financial incentives for dietary behavior change. Previous reviews of the literature have focused on randomized, controlled trials and found mixed results. The purpose of this systematic review is to update and expand upon previous reviews by considering a broader range of study designs, including RCTs, quasi-experimental, observational, and simulation studies testing the use of financial incentives to change dietary behavior and to inform both dietetic practice and research. The review was guided by theoretical consideration of the type of incentive used based upon the principles of operant conditioning. There was further examination of whether studies were carried out with an institutional focus and whether incentives took the form of assets or savings. Studies published between 2006 and 2012 were selected for review, and data were extracted regarding study population, intervention design, outcome measures, study duration and follow-up, and key

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findings. Twelve studies meeting selection criteria were reviewed, with eleven finding a positive association between incentives and dietary behavior change in the short-term. All studies pointed to more specific information on the type, timing, and magnitude of incentives needed to motivate individuals to change behavior, the types of incentives and disincentives most likely to affect the behavior of various socioeconomic groups, and promising approaches for potential policy and practice innovations. Limitations of studies are noted, including the lack of theoretical guidance in the selection of incentive structures and the absence of basic experimental data. Future research should consider these factors even as policymakers and practitioners continue to experiment with this potentially useful approach to addressing obesity.

Keywords

Incentives; diet; weight loss; intervention; behavior change

Obesity is a leading cause of morbidity and mortality in the U.S., and its prevalence has increased in recent years.¹⁻⁴ In addition to diabetes,⁵ it is associated with cardiovascular and cerebrovascular disease, hypertension, hyperlipidemia, sleep apnea, and certain cancers.^{2,4} With current estimates standing at 35.7% of the adult population, the need for innovative interventions to address the obesity epidemic has never been greater. Researchers, practitioners, policy makers, and employers have increasingly considered financial incentives in order to influence weight loss and behaviors related to weight management as a potentially cost-effective means of treating or preventing obesity. Beyond weight management and obesity prevention, optimal dietary behavior is also concerned with the intake of healthful, nutritious foods like fresh fruits and vegetables and whole grains. The present paper is an updated review of studies using financial incentives to change a broad range of dietary behaviors that dietitians address every day in their vital roles as health promotion and disease prevention specialists.

Previous reviews of the literature^{6,7} on financial incentives for dietary behavior change have reported mixed results, finding incentives to be generally effective, but the effects are relatively short-lived, with study participants typically returning to their baseline weight or behaviors when incentives are removed. Some have suggested that a financial motivation may actually undermine long-term weight maintenance.⁸ Wall et al.⁶ reviewed randomized, controlled trials (RCTs) testing the effectiveness of monetary incentives for dietary behavior change. Of the four RCTs examined by Wall and colleagues, all showed a positive short-term effect for the incentive group on food purchases, consumption, and weight loss compared to controls. The types of incentive varied, including coupons for fruits and vegetables at farmers' markets, price reductions on low-fat snacks at vending machines, provision of free food, and direct cash payments.⁹⁻¹³ Limitations of these studies included small sample sizes and limited follow-up. The studies that tested weight loss interventions showed reversion to baseline weight and lack of effect after incentives were removed.⁹⁻¹¹ The small number of studies reviewed also made it impossible to answer questions about differential effects by socioeconomic status (SES) or racial/ethnic group and the optimal level of incentive needed for behavior change.⁶

Paul-Ebhohimhen and Avenell⁷ conducted a systematic review with meta-analysis focused on financial incentives for treatments of obesity and overweight only. Again, only RCTs were included in the review, with nine studies identified, seven of which were included in the meta-analysis. Incentives took the form of either direct payments or deposit contracts requiring that behavioral or weight loss goals be met in order for participants to receive refunds on money committed for the purposes of the study. The meta-analysis showed no significant effect of incentives on weight loss outcomes at 12 and 18 months and weight regain at 30 months, but did find modest trends in sub-analyses for incentives: in amounts greater than 1.2% of personal disposable income; for behavior change vs. weight loss; for group-based performance vs. individual performance; and delivered by non-psychologists vs. psychologists. As with the Wall et al.⁶ review, data were insufficient to determine a differential impact of incentives for racial/ethnic minority or lower SES populations. In contrast to Wall et al.,⁶ the review by Paul-Ebhohimhen and Avenell⁷ offers suggestions regarding the optimal magnitude of incentives. They suggested that discrete choice experiments were necessary to determine exactly what amount of monetary incentive would be sufficient to motivate study participants. Estimates from such experiments also could be included in cost-effectiveness analyses, which were missing from nearly all studies reviewed. Paul-Ebhohimhen and Avenell⁷ also recommended that researchers in this area provide justification for their choice of incentive and that incentives be used as adjuvant to therapy rather than as a stand-in for therapeutic intervention.

Building upon the critique of a lack of justification for the type of incentive used in these studies, a more recent review by Burns et al.¹⁴ is explicitly theoretical in its orientation. The authors classified the 27 studies in their systematic review using a taxonomy informed by the principles of operant conditioning.¹⁵ In general, the theory proposes that behaviors that elicit rewards are repeated (reinforcement), while behaviors that elicit punishments are not. Aspects of operant conditioning also are included in contemporary theories of behavior change concerned with reward, contingency management, and outcome expectations. Since most incentive schemes involve reinforcement, the authors focus on only this portion of the theory. Reinforcement can be classified as either positive (reward) or negative (removal of noxious stimuli). It can also vary by the schedule of reinforcement, which in this context generally includes either fixed-ratio (consequence after every *n*th behavior) or variable-ratio (unpredictable schedule of consequences that occur on average every *n*th time) schedules.¹⁵ The authors also note that the short-lived effects in several of the studies previously reviewed could be explained theoretically by the concept of *extinction*,^{15,16} or the cessation of behavior once reinforcement is removed.¹⁴ They suggest that habituation, or a decrease in responsiveness to rewarding stimuli, is a potential mechanism by which extinction occurs in the context of obesity interventions.¹⁴ Their broader discussion of the role of motivation also highlighted the tension between extrinsic motivation (e.g., external rewards like financial incentives) and intrinsic, autonomous motivation in line with the principles of self-determination theory.^{17,18} Where self-determination theory suggests that human beings have fundamental needs for competence and autonomy, the authors suggest that monetary incentives could help to spur those who are not intrinsically motivated but could nonetheless benefit from dietary behavior change and weight loss interventions. In other words,

incentives may act as a catalyst for the initiation of behavior change that may then become more intrinsically motivating once individuals begin to engage in the behavior.

This review expands this list of considerations to include the institutional vs. individual administration of incentives. Individuals interact with incentives put in place by institutions on a daily basis, and their ubiquity may mitigate the need for strong intrinsic motivation. For instance, the federal tax code has been used to incentivize everything from home purchases to energy-efficient appliances to retirement savings. Additional prominent institutions with which individuals come into regular contact include schools and employment settings. Dietitians also recognize the importance of institutional contexts for shaping the dietary choices that individuals make. An incentive administered within the context of institutions may have additional motivational power because of the social norms attached to institutions, and this may further account for the relative success of group-based interventions noted in previous reviews of this area. To the extent that incentives can be “institutionalized,” they may exploit social and psychological forces related to what researchers in behavioral economics call *default options*.¹⁹ Individuals very often rely on the perceived expertise of the designers of choices and then have a strong tendency towards inertia once an option has been chosen. This places dietetic practitioners with responsibility for food service management and other institutionally-based nutritional services in a unique position to shape the environments in which dietary choices are made, including administering incentives.

Purpose of Current Review

As Wall et al.⁶ and Paul-Ebhohimen et al.⁷ note, randomized, controlled studies of financial incentives and dietary behavior change in adults have been inconclusive, often with limited follow-up and only short-term effects. Additionally, the use of incentives for dietary behavior change has been examined in fields other than health, and through means other than RCTs. The purpose of the current review is both to update and expand upon previous reviews, including new developments in economics, policy, and study design for dietary behavior change. The objective is to provide updated information on RCT, observational, and simulation studies examining the use of financial incentives (e.g., direct cash payment, taxes, subsidies, coupons) to influence dietary behavior and anthropometric outcomes among community-dwelling adults. Updated information on how incentives are being tested and their effect on dietary behavior will inform future interventions.

METHODS

This systematic review of published reports of randomized controlled trials, observational and simulation studies of financial incentives for dietary behavior change, including interventions for weight loss, was conducted based upon established protocols for such reviews, particularly those established by Cochrane Reviews and the PRISMA statement.^{20,21}

Search strategy

A primary purpose of this review was to update and expand the review conducted by Wall et al. and to cover a broader range of study type and outcome than the more recent reviews by

Paul-Ebhohimen et al.⁷ and Burns et al.¹⁴ All of the health-related databases identified by Wall et al.⁶ were searched: PubMed, EMBASE, CINAHL, and Cochrane. Studies published between January 1, 2006 and April 30, 2012 were reviewed in order to include studies published since the Wall et al. review and to provide some overlap with the latter part of that review's study period to account for studies in press. To expand the search beyond strictly medical databases, the behaviorally-focused Family and Society and PsycINFO databases, and economics databases Econlit and BusinessSource Complete were included. In addition to the incentive and dietary outcome terms used by Wall et al.,⁶ MeSH terms and terms appearing in titles and abstracts related to *free food*, *insurance*, *reimbursement*, and *contracts* were searched. Also included was a third branch of search terms related only to financial terms, such as money, cash, dollar, finance, monetary, payment, asset, saving, and *financial management*. For dietary outcomes, the terms cholesterol, food supply, food legislation, food policy, and *risk reduction* were added to the terms from Wall et al.⁶ To limit the search to dietary behavior, terms related to *tube feedings*, *food processing*, *delay discounting*, and *willingness to pay* were excluded from the search criteria. A graphical representation of the search strategy is shown in Table 1.

In addition to the search of electronic databases, a bibliography search was conducted for all included studies, additional studies from authors who had published in this area were searched, and authors of unpublished work were contacted to determine if published versions of their studies had appeared.

Selection Criteria

Studies were included according to the following criteria: English language; United States-based samples; community-based (i.e., not residing in institutional settings) adult participants (18+); RCT, observational study, or simulation; financial incentive central to study; comparison with another intervention or control; effect of incentive analyzed independently; and anthropometric or dietary behavior outcomes.

Financial incentives could be monetary (e.g., cash) or non-monetary (e.g., voucher or coupon), and dietary behavior change was defined as any attempt to modify the intake of food or nutrients in order to improve health, with or without the intended goal of weight loss. Studies for which financial incentives were used but not central to the intervention, such as incentives for participation or follow-up, were excluded, as were studies with no comparison or control group. Also, studies which did not analyze the effect of financial incentives independently of other interventions, or for which outcomes were not related to dietary behavior change, were not eligible. The geographic criterion of the U.S.-based studies was meant to account for the unique political and regulatory environment of the United States (e.g., compared to Western Europe or the developing world) when considering the applicability of findings and feasibility of implementation for researchers and policymakers. Abstracts qualifying for the above criteria, but that were published as posters or supplements, were excluded from the final selection. The first (JP) and second author (RG) reviewed all abstracts independently and discrepancies regarding the appropriateness of studies for inclusion in the review were discussed and settled through consensus.

Analysis

Figure 1 describes the process by which studies were included in the review. Data from the screened studies was extracted independently (RG) using a standardized form for the following information: study design; study and sample population; number of participants; setting; intervention type and control; outcome measures; baseline and final outcome values; duration of trial; length of follow-up; results of hand searches; and reasons for exclusion, if applicable. Table 2 contains information on all studies included in the review.

RESULTS

Simulation studies

Simulation studies use mathematical models to estimate what the impact of policy or programmatic changes would be on a given outcome, in this case dietary behavior and its health-related outcomes. Such studies offer dietetic practitioners and policymakers information in a timely and efficient manner on the anticipated impact of potential interventions, usually with an analysis of cost-effectiveness. They may also help to narrow down the range of interventions that should be tested through experimental means. Of the three simulation studies identified, two modeled taxes on sugar-sweetened beverages^{22,23} and one modeled voluntary reduction in sodium content by the food industry vs. taxes on sodium (disincentives associated with punishment, or consequences applied to reduce a behavior, in operant theory).²⁴ Both beverage studies found that an increase in price would result in reduced consumption. Specifically, analyzing 20 years of data from the Coronary Artery Risk Development in Young Adults (CARDIA) Study, Duffey et al.²² reported that a 10% increase in the price of soda was associated with a -7.12% (95% confidence interval [CI], -10.71 to -3.52) change in the amount of kilocalories per day (kcal/d) consumed from soda ($p < .001$), and a \$1.00 increase in soda price was associated with a mean (SE) of 124 (38) fewer total kcal/d consumed ($p = .001$). Because there was a strong association between the price of soda and the consumption of pizza in particular, the authors also estimated the effect of increases in pizza prices as well as both soda and pizza prices. A 10% increase in the price of pizza was associated with an -11.5% (95% CI, -17.50 to -5.50) change in kcal/d. A \$1.00 increase in the price of both soda and pizza was associated with a mean (SE) 181 (34) fewer total kcal/d ($p < .001$). Based upon these findings the authors estimate that an 18% soda and pizza tax would result in approximately a 56 kcal/d reduction in total energy intake among young to middle-aged adults, which would translate into approximately a 5 lb reduction in body weight per person per year at the population level and significant reductions in obesity-related risk for chronic disease.²²

Using data from the 2006 Nielsen Homescan panel of household store-bought food and beverage purchases, Finkelstein et al.²³ found that a 20% tax on carbonated sugar-sweetened beverages would reduce consumption by a mean (SE) 4.2 (1.6) kcal/d vs. a 7.8 (2.8) kcal/d reduction from a 40% tax. They estimated that both tax schemes would result in minimal weight loss, with a 20% tax resulting in a mean (SE) .20 (.07) kg/y reduction in weight per person and a 40% tax resulting in a mean (SE) .37 (.13) kg/y reduction. Weight loss from 20% and 40% taxes on all sugar-sweetened beverages were estimated at means (SE) of .32 (.09) and .59 (.16) kg/y per person, respectively. The latter 40% tax would result in mean (SE)

\$2.5 billion (\$77.5 million) in tax revenue. The authors included an analysis that found that such taxes would not be regressive (i.e., disproportionately affect low-income households); however, the primary drivers of the observed effects were middle-income households. Significantly, both of these simulations took into account the economic principle of elasticity, which describes the change in demand for a good when the price changes as well as the other goods that consumers use as substitutes when such changes in price occur. A limitation for both studies was the potential for measurement bias through data collection. In the Duffey et al.²² study, there was a limited selection of qualifying food and beverage groups, as well as a limited range of substitutions. In the Finkelstein et al.²³ study, consumption was limited to store purchases only, and did not account for potential behavior changes in restaurants or in response to shifts in demand. Smith-Spangler et al.²⁴ estimated that a 40% tax on sodium would decrease intake by 6% and decrease mean systolic blood pressure (SBP) by .93 mm Hg among adults aged 40 to 85 years, which would result in 327,892 fewer strokes and 306,137 fewer myocardial infarctions (MIs), an increase of 840,113 life-years, and a cost savings of \$22.4 billion. By contrast, collaboration with the food industry to reduce sodium (modeled on previous experience with such an approach in the United Kingdom) would decrease intake by 9.5% and mean SBP by 1.25 mm Hg, which would result in 513,885 strokes and 480,358 MIs prevented, 1,317,709 life-years preserved, and a savings of \$32.1 billion. Both strategies were found to be preferable to the status quo.

Observational studies

There were two observational (i.e., non-experimental) studies that each examined financial incentives for weight loss. In their survey study of insured adults with metabolic syndrome (i.e., elevated blood pressure, elevated waist circumference, and elevated levels of blood glucose and triglycerides, and reduced high-density lipoprotein cholesterol) Arterburn et al.²⁵ found that increasing insurance coverage for weight loss from 10% to 100% resulted in roughly three times the proportion women (14% vs. 47%) and seven times the proportion of men (3% vs. 22%) reporting being “very interested” in program participation, with significant differences in these distributions for women vs. men (10% coverage – $\chi^2 = 8.1$, $p = .045$; 100% coverage – $\chi^2 = 16.9$, $p = .001$). In addition, 57% of men and 76% of women supported specific financial incentives for weight loss within their insurance plan; 41% of the sample said that the incentives would motivate them to lose weight; and the mean financial incentive needed to motivate them to lose 15 pounds was \$591 (median = \$125; range = \$10 to \$9,999), or \$39.40 per pound. Selection bias in the study's small sample size and restriction to one treatment center could limit the external validity of the results. Additionally, the collection survey used by Arterburn and colleagues²⁵ was not validated, which could introduce bias in reporting results.

In an evaluation of a worksite-based weight loss program offering financial incentives across 17 sites, Cawley and Price²⁶ found, on average, a fairly modest impact: 1.4 pounds of weight loss ($p > .05$) for those offered steady quarterly rewards calibrated to percentage of baseline weight lost (fixed ratio positive reinforcement) and 3.6 pounds ($p < .05$) for those who participated in a lottery (variable ratio positive reinforcement) and deposit contract (fixed ratio negative reinforcement) program. They also noted considerable attrition (ranging

from 57.9-76.4%) at the end of the one-year program. The study exhibited some selection bias in the small size of its control group.²⁶

Quasi-experimental studies

Of the three quasi-experimental (i.e., non-randomized intervention) studies, two were by the same group investigating subsidies for fruit and vegetable purchases in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC),^{27,28} and 1 was concerned with enrollment in a university-sponsored weight management program.²⁹ Herman et al.²⁷ showed that 90% of low-income women in the Los Angeles WIC who received \$10/week vouchers for fruit and vegetable purchases (fixed-ratio positive reinforcement) redeemed them at local supermarkets and farmer's markets, and they purchased a wide variety of these foods. There was an additional control condition that received coupons for disposable diapers, but fruit and vegetable purchases were not tracked for this group. The study exhibited some selection bias in that the produce used was not available to all WIC participants or generalizable to all seasons.²⁷ Selection bias could also have influenced the results of the control group, which had lower energy intake than both interventions.²⁷ In a later study of the same program, Herman and colleagues²⁸ demonstrated that fruit and vegetable intake increased as a result of receiving vouchers at farmers markets (1.4 servings per 1,000 kcal, $p < .001$) and supermarkets (.8 servings per 1,000 kcal, $p = .02$), and that increased consumption was maintained 6 months post-intervention (Adjusted $R^2 = .13$, $p < .001$). Both studies used a self-reported tool for measuring nutritional intake, which may have introduced bias in reporting results.^{27,28}

In the study by Butsch et al.,²⁹ participants were offered the possibility of a 50% rebate (\$150) on the upfront cost (\$300) of a university-based weight loss program if they achieved weight loss of 6% of their baseline weight (fixed-ratio negative reinforcement). The potential reimbursement had no significant effect on program enrollment or weight loss, but a trend was observed for an association with the incentive and attendance at classes (68.1% of classes for intervention vs. 59.2% for control; $p = .05$). Attendance was associated with greater weight loss for those attending at least 10 sessions (4.19% of baseline weight vs. 2.25% for those attending < 10 sessions; $p = .007$). The study reported potential selection bias in the requirement of a \$150 enrollment fee, a barrier for lower income groups.²⁹ Butsch and colleagues²⁹ also noted the possibility for motivation bias through voluntary participation, where incentives may have motivated some participants more than others both before and during the intervention.

Randomized studies

A single study by Finkelstein and colleagues³⁰ used a randomized design with no control group to examine incentives for weight loss at various levels with measurements at baseline, 3, and 6 months (fixed-ratio positive reinforcement). The first group (back-loaded) received no cash incentive at 3 months and \$14 per percentage of weight loss from baseline at 6 months. The second group (front-loaded) received \$14 per percentage of weight loss at 3 months and no incentive at 6 months. The final group (steady payment) received \$7 per percentage of weight loss at both 3 and 6 months. Overall, the larger \$14 incentive resulted in greater weight loss in the short term (-2.73 pounds weight change at 3 months, $p < .05$),

increased odds of clinically significant (5%) weight loss ($OR = 5.39, p < .05$), and increased odds of program attendance ($OR = 4.30, p < .05$), but there were no significant differences between the groups in long-term (6 months) weight loss. The study experienced high attrition rates, affecting external validity. The authors also note that the details of payment schedules were not clear to some participants, which may have introduced reporting bias.³⁰ Detailed methodologies for randomization, allocation concealment, and blinding were not reported.³⁰

Randomized, controlled trials (RCTs)

There were three RCTs identified, two of which were weight loss interventions by the same group of investigators^{31,32} and one of which was concerned with low-density lipoprotein (LDL) cholesterol reduction. Volpp et al.³² randomized patients at the Philadelphia VA Medical Center with BMIs ranging from 30-40 kg/m² into a monthly weigh-in (control), lottery incentive (variable ratio positive reinforcement), or deposit contract (fixed ratio negative reinforcement) condition, with a goal of 1 pound per week weight loss over 16 weeks. Both incentive groups lost significantly more weight on average than controls (13.1 lb [95% CI, 1.95-16.40] vs. 3.9 lb [95% CI, .20-13.2] for lottery vs. control, $p = .02$; 14.0 lb [95% CI, 3.69-16.43] vs. 3.9 lb for deposit contract vs. control, $p = .006$), and roughly half in both groups met the 16-pound weight loss goal (52.6% [95% CI, 28.9%-75.6%] for lottery vs. 47.4% [95% CI, 24.5%-71.1%] for deposit contract vs. 10.5% [95% CI, 1.3%-33.1%] for control; $p = .01$). However, at a 7-month follow-up, differences in weight loss among the groups were not statistically significant.

In a follow-up to Volpp et al.,³² John et al.³¹ expanded the intervention time to 32 weeks, which included 24 weeks of weight loss with the same 1 pound per week goal and an 8-week maintenance phase. Again, both incentive groups lost more weight than the control group (mean deposit contract groups' weight loss of 8.70 lb vs. 1.17 lb for control; $p = .04$ [95% CI of means, .56-14.50]), but long-term follow-up at 36 weeks post-intervention showed weight regain and no statistically significant differences among the groups. Both the Volpp et al.³² and John et al.³¹ studies were limited by a small sample size and the restriction to one treatment center.

Bloch et al.³³ randomized employees from several industries to a \$100 monetary incentive (fixed ratio positive reinforcement) group, a nurse educator (with classes and telephone follow-up) group, or an online education only (control) group with the goal of a 15% reduction in LDL cholesterol after 6 months. Both the incentive (mean (SD) 17.9 (34.4) mg/dL; 11.3%) and the nurse educator (mean (SD) 17.9 (26.3) mg/dL; 11.5%) groups had comparable reductions in LDL cholesterol at 6 months, and both realized reductions significantly greater than the control group (mean (SD) 5.5 (21.4) mg/dL; 3.5%; $p = .0264$). The study was limited by a small sample size, and did not report detailed methods of randomization, concealment, or blinding in group allocation, intervention, and data analysis.³³

Institutional focus

Of the 12 studies reviewed, only the 3 simulation studies²²⁻²⁴ testing the impact of food and beverage taxes could be considered institutional in their focus. That is, the taxes would affect the purchases of large numbers of people on a regular basis. Results of these studies also suggest a significant, population-level change in dietary behaviors and health-related outcomes (e.g., weight loss and blood pressure) as a result of taxation, though one study²³ showed minimal reductions in consumption and weight loss. The only other studies that approach an institutional focus are the 2 evaluations of the fruit and vegetable vouchers for women in the WIC program.^{27,28} Though the participation of women in the study was voluntary, it is easy to imagine how the provision of such vouchers could be institutionalized across the WIC program, and the results of these studies suggest that this may result in increased consumption in a high-risk population.

Several studies were located in individual workplaces or hospitals,^{26,31-33} but participation was voluntary. This differs in important ways from policies requiring or strongly encouraging participation as a function of institutional membership or employment. Given the heterogeneity of studies in this review, it was not possible to directly compare incentive schemes with a strong institutional focus and those without.

Study Quality

Study quality was determined by the reviewers using an established framework.³⁴ The most common methodological limitations were small sample size and selection bias in participants.^{25-28,32,33} The potential for study-level bias differed by study type. For non-simulation studies, the most commonly reported study-level limitation was external validity due to small sample size or where the sample population came from a single treatment center.^{25-28,32,33} In cases where randomization methodology was reported, the nature of the interventions did not allow participants or coordinators to be blinded beyond the group assignment.³² Additionally, there is the potential for motivation bias in all studies with voluntary participation. Motivation for behavior change differs by individual, and incentives may work to motivate some more than others, both before and during the intervention.²⁹

For outcomes, self-reporting of results could have resulted in reporting bias for Hermann and colleagues^{27,28} and Finkelstein et al.³⁰ Finally, all studies experienced some attrition, but only Cawley and Price²⁶ accounted for potential positive effects of high attrition on outcomes.

DISCUSSION

This review of financial incentives for dietary behavior change identified 12 studies with a wide range of study populations, methods, and behavioral outcomes. In general, financial incentives were found to have a positive short-term effect on dietary behavior, with larger incentives associated with better outcomes. However, as noted in previous reviews, where long-term follow-up was reported, behavior change did not appear to be maintained. Indeed long-term maintenance continues to be a major concern for interventions using financial

incentives, suggesting that further research is needed to develop alternative approaches that can address this limitation.

The expansion of methodological focus beyond RCTs in this area does result in a more balanced assessment of the potential for incentives to impact dietary behavior. For example, simulation studies of the effect of taxes on sugar-sweetened beverages^{22,23} point to some potential promise in this approach at the population level, though the estimated impact ranges from as little as .44 lbs (.20 kg) to as much as 5 lbs (2.27 kg) of weight loss per person per year. This difference in estimates may be accounted for in part by the use of a single year of panel data in the study by Finkelstein et al.²³ compared to the 20 years of data examined by Duffey and colleagues.²² There are limitations to the use of such data for policy and practice, as they only estimate correlations based on extant data and specified models rather than describing actual behavior under experimental conditions. Dietetic practitioners, and particularly dietitians whose professional roles place them in policymaking or advocacy roles may be able to rely on such simulation studies to estimate the impact of taxation policies before they are enacted but should always evaluate their influence in actual practice. Vouchers for fruit and vegetable purchases among low-income women in the WIC program also seem promising in light of findings showing high levels of use and increased fruit and vegetable intake sustained over a 6-month period.^{27,28} It is also noteworthy that receipt of vouchers in the WIC program was not contingent on completing a particular behavior, but rather facilitated the desired behavioral outcome. This may be a crucial feature of financial incentives that could address the problem of maintenance consistent with Burns et al.'s notion of using financial incentives as the catalyst for behavioral change rather than as a reward for behavior.¹⁴ Dietitians may consider advocating for these types of subsidies for low-income households to engage in healthy dietary behaviors.

Findings related to taxation and subsidies highlight another strength of the expanded focus of this review: the ability to comment on socioeconomic differences where other reviews of RCTs have failed to find sufficient information. Though clearly a preliminary conclusion requiring further research, the study by Finkelstein and colleagues²³ suggests that beverage taxes would have the most impact on the dietary behavior and health-related outcomes of middle-income households, with both higher- and lower-income households largely unaffected by such policies. Importantly, simulation analyses also suggest that such taxes would not be regressive in nature.²³ In addition, it would appear that subsidizing healthy behavior (e.g., fruit and vegetable consumption) in low-income households is preferable to taxation as a disincentive for unhealthy food choices.^{23,27,28} Given the limited food budgets of low-income households, such subsidies could result in the substitution of healthier foods for unhealthy options within the market basket. This review also made it possible to begin to quantify the range at which incentives may be motivating to individuals involved in dietary behavior change programs. For example, employees do not seem sufficiently motivated by a partial refund on weight management program fees in exchange for weight loss,²⁹ but they are interested in full insurance coverage for weight management and would be motivated by a roughly \$40 per pound incentive to lose weight.²⁵ This is useful information for dietetic professionals, who may consider advocating for full health insurance coverage of evidence-based weight management programs and can use \$40 as a reasonable estimate of the optimal

magnitude of an incentive. The use of evidence-based, and often dietitian-assisted, weight management in the studies reviewed highlights the need to attend to the detrimental unintended consequences of providing incentives for weight loss in particular, including unhealthy or potentially dangerous forms of weight loss. For this reason, dietetic professionals are essential members of any team that is interested in implementing an intervention using incentives to change dietary behavior. Employees who received a \$100 incentive to engage in lifestyle modification to reduce LDL cholesterol were as successful as those in a more intensive nurse educator intervention.³³ Though the authors do not report on the cost-effectiveness of these two strategies, the latter is certainly more intensive in terms of time and labor. Long-term outcomes of this intervention were not reported, however, making further research on its efficacy necessary. Simulation studies also suggested that a substantial tax (10% to 40%) would be necessary to influence dietary behaviors related to sugar-sweetened beverages and sodium in food.²²⁻²⁴ Additional research is needed to determine more exact estimates of the amount of incentive that individuals will find motivating and the cost-effectiveness of strategies that involve financial incentives versus usual care or standard approaches (e.g., education or counseling). More research is also needed to determine how, if at all, financial incentives might be integrated into existing nutrition counseling approaches.

There are, of course, limitations inherent to a review that considers such a broad set of study methods, settings, and samples. With respect to operant conditioning, we were not able to provide any direct comparison of the various types and schedules of reinforcement and punishment reflected in this review. Lack of randomization and absence of a control or comparison group in the studies that were not RCTs also limits the internal validity of results obtained from studies with observational or quasi-experimental designs. However, the increased external validity of some of these studies did allow for novel information on incentives that may not have been revealed in a review that focused more narrowly on a single design. For example, the modest weight loss and relatively high levels of attrition in employment settings after one year of follow-up alerts researchers and policymakers to the challenges inherent in the broad application of incentives for weight loss in particular.²⁶

Future research

The research agenda in the area of financial incentives for dietary behavior change is in need of both greater precision and innovation. As observed by Wall et al.,⁶ more experiments are necessary prior to fielding large, expensive RCTs. Discrete choice experiments that ask participants to state their preferences among a pre-determined set of choices are just one type of such experimentation. Experiments also should account for the mental shortcuts and errors in judgment and decision-making that have been described by behavioral economics.³⁵ This is especially relevant in the context of dietary choices, where the value placed on a healthy food option may change as the time to consumption grows nearer (e.g., impulsive, immediate consumption of foods high in fat or sugar without consideration of long-term health consequences).³⁶ On the other hand, planned purchases for a household's weekly consumption (e.g., grocery shopping) may rely on more rational motivations and planned behavior. Dietetic practitioners who develop nutrition plans with patients encounter these same phenomena in their interactions with clients. It may be useful to explore

experiments informed by both the rational choice model and behavioral economics to determine: a) what type of incentives are motivating, b) on what schedule, c) at what level, d) for what populations, and e) for which set of behavioral outcomes. These types of experiments could provide dietitians with valuable information on how best to counsel clients based on their stated preferences and their actual behaviors.

Policy implications

This review also calls for appropriate expectations on the part of policymakers for what incentives alone can do to change behaviors as complex as those related to dietary choices. As the emphasis on choice architecture in behavioral economics suggests,¹⁹ incentives are but one tool in the toolboxes of major institutions. Individuals and households must also be “nudged” by social norms, meaningful feedback, and proper allowance for lapses in their decision-making. Institutions like government, schools, employers, and even industry, can put in place structures that support people in making healthy choices for themselves and their families. Incentives can be effective in eliciting initial motivation, but a broader institutional focus is necessary for sustaining behavioral change, particularly for the most vulnerable populations.

Conclusion

Results from a diverse set of studies suggest that certain types of financial incentives for dietary behavior change may be appropriate for addressing the epidemic of obesity and healthful dietary behavior when properly administered, but the issue of behavioral maintenance persists as an unresolved weakness of this approach. Further tests of theoretically-driven interventions are necessary alongside innovations in the type and administration of incentives for this complex set of behaviors. Dietetic practitioners have been key collaborators in past research efforts, and their considerable expertise in nutritional counseling will be necessary for the design and testing of additional interventions. Future research should be informed not only by theories of motivation, but also both rational choice and behavioral economic principles and economic models that consider substitution and cost-effectiveness. Experiments that can determine the optimal timing, amount, and type of incentives should provide policymakers and dietetic practitioners clearer guidelines for their use.

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Figure 1.

Process of review and selection for eligible randomized controlled trials, observational, quasi-experimental, randomized, and simulation studies to include in systematic review of financial incentives for behavior dietary change.

Table 1

Search strategy adapted from Wall et al.⁶ to include additional financial and dietary terms for systematic review of financial incentives for dietary behavior change^a

Incentives		Dietary Outcomes/ Measures		Financial		“food security”	Limits/ Filters
<u>MeSH</u>		<u>MeSH</u>		<u>Title and Abstract</u>		“food insecurity”	English
Reward		Diet				“feeding tube”	2006-2012
Motivation		Eating		Money*			RCT
Awards		Feeding		Monies		“feeding tubes”	Simulation
and prizes		behavior		Cash*			Observational
Gift giving	A N D	Food	A N D	Dollar*	N O T	“tube feeding”	Adults
		Weight		Financ*			US
		reduction		Monetar*		“tube feedings”	
		programs		Pay*			
		Weight loss		Asset*		“food processing”	
		Overweight		Saving*			
OR		OR		“Financial Management”		“delay discounting”	
<u>Title</u>		<u>Title</u>				“willingness to pay”	
Motiv*		Diet*					
Incentiv*		Food*					
Award*		Eat*					
Reward*		Feed*					
Gift*		Weight*					
Rebat*		Overweight*					
Prize*		Obes*					
Tax*		Meal*					
Reinforc*		Nutrit*					
Contest*		BMI					
Discount*		Skinfold					
Coupon*		thickness					
Token*		Waist-hip					
Price*		ratio*					
Lotter*		Glucose					
Free food*		cholesterol					
Raffle*		Risk reduc*					
Contract*		Food supply					
Reimburs*		Food					
Insurance*		legislati*					
		Food polic*					

^aSearch strategy was modified for individual databases.

Table 2

Description of studies using financial incentives to influence dietary behavior change by methodological type (simulation, observational, quasi-experimental, randomized studies and randomized, controlled trials).

Study Type	Authors	Population	Study Design	Outcome Measures & Final Values	Trial Duration & Follow-Up	Key Findings
Simulation Study	Smith-Spangler et al., 2010 ²⁴	US adults 40-85 years	Markov model of incidence, prevalence, mortality, and direct costs associated with five health states (well, MI ^a stroke, history of MI/stroke, dead). Used United Kingdom sodium tax estimates (40% tax increase led to 6% decrease in intake) and measured 2 relationships between sodium intake and blood pressure	A 40% tax decreases sodium intake by 6% and SBP ^b by .93 mm Hg ^c averts 327,892 strokes and 306,137 MIs, and results in increase of 840,113 life-years and \$22 billion medical savings. Collaboration with food industry decreases sodium intake by 9.5% and SBP by 1.25 mm Hg, averts 513,885 strokes and 480,358 MIs, and results in increase of 1.32 million life-years and \$32 billion in medical savings.	N/A	Strategies to reduce sodium intake, such as collaboration with industry and a sodium tax, are likely to reduce stroke and MI incidence in US, increase years of life and results in medical cost savings.
	Duffey et al., 2010 ²²	Sample of 5115 adult participants aged 18-30 from the CARDIA study	Baseline survey for self-reported health behaviors & biometrics; follow ups at 2, 5, 7, 10, 15, and 20 years (using survey data from 1985-86, 1992-93, 2005-2006); Food price data from Council for Community and Economic Research. Modeled price elasticity and dietary associations using 2-step marginal effect and least squares regression models	10% increase in the price of soda associated with -7.12% (95% CI, -10.71 to -3.52) change in kcal/d ^e consumed from soda ($p < .001$); \$1.00 increase in soda price associated with M (SE) ^f 124 (38) fewer total kcal/d consumed ($p = .001$), 2.34 (.85) lb ^g lower body weight ($p = .006$), .42 (.10) lower HOMA-IR ^h ($p < .001$); 10% increase in the price of pizza associated with -11.5% (95% CI, -17.50 to -5.50) change in kcal/d; \$1.00 in pizza associated with M (SE) of 58 (19) fewer total kcal/d $p = .002$; \$1.00 increase in both soda and pizza associated with M (SE) 181 (34) fewer total kcal/d $p < .001$; 18% tax would result in 56 kcal/d reduction in total energy intake among young to middle-aged adults, a 5 lb reduction in body weight per person per year at population level and significant reductions in obesity-related risk for chronic disease	N/A	Price increases for soda and pizza foods associated with decreased consumption, modest weight loss, and better health outcomes
	Finkelstein et al., 2010 ²³	Sample of households from 2006 Nielson Homescan panel, limited data to household purchases of beverages	Calculated mean daily kilocalories purchased per household and household member, percentage of households purchasing each type of beverage, and average price per kilocalories. Analysis with multivariate regression and 2-part marginal effects models to predict effects of 20% and 40% price increases on household beverage purchases	Tax on carbonated and SSBs ⁱ - 20%: M (SE) reduction of 4.2 (1.6) kcal/d and .20 (.07) kg/y ^k weight loss; 40%: 7.8 (2.8) kcal/d and .37 (.13) kg/y weight loss. Tax on all beverages- 20%: M (SE) 7.0 (1.9) kcal/d and .32 (.09) kg/y weight loss; 40%: 12.4 (3.4) kcal/d and .59 (.16) kg/y weight loss; 40% tax on SSBs only: tax revenue of M (SE) \$2.5 billion (\$77.5 million); tax not regressive; results strongest for middle income households	N/A	Large taxes have ability to decrease consumption of SSBs and generate revenue

Study Type	Authors	Population	Study Design	Outcome Measures & Final Values	Trial Duration & Follow-Up	Key Findings
Observational Study	Arterburn et al., 2008 ²⁵	Insured adults ages 18-79; continuous enrollment in Group health for at least 2 years; (BMI ¹ 25); meeting 3/5 clinical criteria for metabolic syndrome	Survey participants were asked about the acceptability of 5 weight loss programs with different financial incentives and insurance coverage options within a health maintenance organization	Increase in insurance coverage from 10-100%; "very interested" 3-fold increase in women (14% vs. 47%) & 7 fold increase in men (3% vs. 22%), with significant differences in these distributions for women vs. men (100% coverage - $\chi^2 = 8.1, p = .045$; 100% coverage - $\chi^2 = 16.9, p = .001$); 57% men & 76% women supported a health plan-sponsored weight loss program with financial incentives; 41% stated the program would motivate them to lose weight; mean financial incentive for 15 lb weight loss was \$591 (median = \$125; range = \$10 to \$9,999), or \$39.40/lb	One week notice of survey w/\$2 incentive, follow up calls (up to 15 calls), 22-item, 15 minute survey; no follow-up	Authors conclude that providing full coverage and financial incentives for weight management programs increases participant interest in programs
	Cawley et al., 2009 ²⁶	Employed adults enrolled in 1 of 17 employer-contracted weight loss programs nationwide, BMI>25	Participants enrolled in 3 incentive programs: 1)Standard incentives: employees pay no fee and receive quarterly payments determined by percent of baseline weight lost 2)Modified incentives: quarterly lottery and monthly deposit contract, refunded if 5% weight loss achieved in 1 year 3)No incentives for weight loss, \$20 for 1 year's participation in program	1.4 lbs of weight loss ($p > .05$) for standard incentives and 3.6 lbs ($p < .05$) for those who participated in lottery and deposit contract program; considerable attrition (ranging from 57.9-76.4%) at the end of the one-year program.	1 year with quarterly measurements; no follow-up	Financial incentives associated with modest short-term weight loss
Quasi- experimental Study	Herman et al., 2006 ²⁷	Low income women participating in WIC ^m program in Los Angeles, CA	Two intervention groups received \$10/wk in vouchers for produce in different units depending on purchase site: 1)Supermarket (\$10 units) 2)Year-round farmer's market (\$2 units) Control group received \$13/mo voucher for non-food purchases.	90% redemption rate for both intervention groups (control rates not tracked); top purchased items showed wide variety of nutrient-rich fruit/vegetable purchases	6 months; follow-up at 14 months	Low-income women used produce vouchers almost fully; purchased wide variety of fruit and vegetables
	Herman et al., 2008 ²⁸	Low income women participating in WIC program in Los Angeles, CA	After 2 month monitoring period to collect baseline data, two intervention groups received \$10/wk in vouchers for produce in different units depending on purchase site: 1)Supermarket (\$10 units) 2)Year-round farmer's market (\$2 units) Control group received \$13/mo voucher for non-food purchases. Produce consumption and BMI assessed through self reporting and "multiple pass method" during 4 separate interviews of all participants	Fruit and vegetable intake increased as a result of vouchers at farmers markets (1.4 servings per 1,000 kcal, $n, p < .001$) and supermarkets (.8 servings per 1,000 kcal, $p = .02$); increases sustained for intervention group at 6 month follow up ($R^2 = .13, p < .001$)	14 months; follow up at 2 months post-partum and 6 months post intervention	Low income women increased fruit and vegetable intake when produce vouchers were included in the WIC package
	Butsch et al., 2007 ²⁹	Adults (aged 19+) inquiring	Control (24 weeks): standard response that reimbursement	Potential reimbursement had no significant effect on program enrollment (24.5% for	Control: 24 weeks Intervention: 44	No significant difference in

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Study Type	Authors	Population	Study Design	Outcome Measures & Final Values	Trial Duration & Follow-Up	Key Findings
nurse educator 3)online access to educational materials (control) nurse educator 3)online access to educational materials (control)						

Notes:

^aMI = myocardial infarction

^bSBP = systolic blood pressure

^cmm Hg = millimeters of mercury

^d95% CI = 95% confidence interval

^ekcal/d = kilocalories per day

^fM = mean

^gSE = standard error

^hlb = pound

ⁱHOMA-IR = Homeostasis Model of Assessment Insulin Resistance score

^jSSBs = sugar-sweetened beverages

^kkg/y = kilograms per year

^lBMI = body mass index

^mWIC = Women, Infants, and Children

ⁿkcal = kilocalories

^oLDL-C = low-density lipoprotein-cholesterol

^pCHD = coronary heart disease