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Evaluation of the effectiveness of behavioural economic incentive programmes for the promotion of a healthy diet and physical activity: a protocol for a systematic review and network meta-analysis

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ABSTRACT

Introduction Obesity and being overweight are major risk factors for metabolic syndrome and non-communicable diseases. Despite the recommendation that a healthy diet and physical activity can reduce the severity of these diseases, many fail to adhere to these measures. From a behavioural economic perspective, adherence to such measures can be encouraged through financial incentives. However, additional related behavioural economic approaches may improve the effectiveness of an incentive programme. As such, we have developed a protocol for a systematic review and network meta-analysis to summarise the current evidence from financial incentive programmes with and without behavioural economic insights for promoting healthy diet and physical activity.

Methods and analysis Previous systematic reviews, meta-analyses and individual studies were identified from Medline and Scopus in June 2020 and will be updated until December 2020. Individual studies will be selected and data extracted by two reviewers. Disagreement will be resolved by consensus or adjudicated by a third reviewer. A descriptive analysis will summarise the effectiveness of behavioural economic incentive programmes for promoting healthy diet and physical activity. Moreover, individual studies will be pooled using network meta-analyses where possible. I^2 statistics and Cochran's Q test will be used to assess heterogeneity. Risk of bias and publication bias, if appropriate, will be evaluated, as well as the overall strength of the evidence.

Ethics and dissemination Ethics approval for a systematic review and meta-analysis is not required. The findings will be published in a peer-reviewed journal.

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Strength and limitations of this study

- To our knowledge, this is the first systematic review and meta-analysis that has evaluated the effectiveness of behavioural economic incentive programmes related to standard financial/price incentive for the promotion of a healthy diet and physical activity.
- Behavioural economic incentive programmes in this study consists of deposit contracts, lottery-based incentives, regret lotteries and group-based payments.
- We will assess the effect of behavioural economic incentives on surrogate outcomes, but might not be able to assess the clinical disease outcomes due to insufficient data.
- We have considered financial incentive programmes, which focused only on healthy diet and physical activity.
- There may be studies avaiable published in other languages, which we could not translate.

INTRODUCTION

Obesity and being overweight have become a global epidemic and significant public health concern. Increasing obesity prevalence worldwide has more than tripled in men and more than doubled in women from 1975 to 2014,[1] with associated health concerns particularly in many developing countries, and especially in urban areas.[2] Obesity and overweight are substantially burden causing metabolic syndrome[3 4] and non-communicable diseases such as diabetes, hypertension and cardiovascular diseases.[2 5]

Nevertheless, obesity and being overweight are preventable through appropriate interventions and WHO provides recommendations for both individual and societal approaches.[2] At an individual level, WHO recommends reduced fat and sugar consumption, increased fruit and vegetable intake as well as whole grains, nuts and legumes, in

addition to regular physical activity, which is 60 min per day for children and 150 min per week for adults.[2]

Despite these recommendations, unhealthy dietary behaviours[6] and insufficient physical activity are increasingly common.[7] Interventions to promote healthier diet and regular physical activity at both individual and population levels have mostly focused on legislation (such as banning partially hydrogenated oils and advertisement of alcohol, etc), taxes (such as sugar and alcohol tax) and subsidies (on low-fat products, fruit and vegetables) as well as knowledge and information provision.[8–11] Nevertheless, only a small number of countries have had some success in the recommended interventions to control obesity since 1980.[12] As such, there is opportunity to improve interventions to promote improved diet and physical activity outcomes, particularly through the use of behavioural economics.[13 14]

Behavioural economics is a field that integrates insights and methods from psychology and economics to understand human decision making.[15–17] It has gained increased attention in promoting healthy behaviours, such as healthy food choice,[18–20] physical activity,[20 21] smoking cessation[20 22 23] and reduced alcohol consumption.[20 24] While conventional economics assumes rational informed decision making, yet in reality, irrational health behaviours including overeating and sedentary lifestyle are common.[16 25 26] In contrast, behavioural economic accounts for irrational behaviours or bias in explaining and predicting behaviour,[16 26] including decision making, which contradicts recommended healthy behaviours.[16 25 27 28] The rationale for such decisions commonly results from the time lapse between the cost and benefits of an action, especially if the benefit and the costs are significantly separated in time, a phenomenon known as 'present bias'.[27]

The provision of financial incentives is an effective tool to encourage healthy behaviours given the current nature of the incentive in relation to the distant health benefit. Financial incentives of monetary value are rewards for achieving the prespecified health goal; alternatively, incentivisation of healthy choices such as price discounts, coupons for healthy food or choices and access to sports facilities before any health goal is met can also be used.[29–31] Incentivisation of healthy behaviours offers experience of healthy choices, while price discounts or free distribution/access to healthy choices help reduce barriers to behavioural change associated with switching costs.[32] Several studies have demonstrated the effectiveness of financial incentive programmes in the promotion of healthy diet and physical activity behaviours.[8 33 34] In addition, the effectiveness of these incentive programmes should be able to improve by behavioural economics.

Financial incentive interventions incorporated other behavioural insights beyond present bias[8 33 35 36] include:

- Deposit contracts are voluntary options for individuals to deposit their own money which will be refunded if they achieve the prespecified health goal, for example, steps per day, weight loss.[37] Some incentive programmes also match rewards when the goal is met.[35] Due to loss aversion[38] programme participants will be more determined to hold to their commitments.
- Lottery-based incentives are rewarded to individuals who achieved the specific goal.[39] Due to overweighting of a small probability of receiving rewards, people tend to be more motivated by an uncertain larger reward than a certain smaller reward because they believe that they will get a larger reward.[40 41]
- Regret lotteries pay only individuals who achieved the goal at the time they win the lottery. However, and importantly, everyone in the programme has a chance to be drawn to get the incentive and is informed when winning the lottery regardless of their goal achievement. This design should induce the regret aversion,[42 43] that is, people do not want to feel regret when they are informed of being drawn for the incentive but are not eligible to get it because they failed to achieve the goal.[35 44 45]
- Group-based payments pay the whole group—all group members—when the group goal is achieved instead of incentivising on individual level.[46] Evidence from a large body of literature on social preferences shows that people do not care only about their own payoffs but also others' payoffs when making decisions.[47 48]

Recent narrative reviews evaluated financial incentive programmes that incorporated behavioural economic insights into the study design for the promotion of healthy diet and physical activity.[8 36] In addition, a meta-analysis by Haff *et al* compared the effectiveness of standard financial and behavioural economic incentive programmes on change in health behaviours (weight loss, smoking cessation and medication adherence). However, this meta-analysis was limited to seven studies which considered standard financial incentives, deposit contracts and regret lotteries.[35] Additional financial incentive programmes that were not considered within the meta-analysis include price incentives, lottery-based incentives and group-based payments.

This systematic review and network meta-analysis protocol will address the following aims. First, comparisons of effectiveness between standard financial, price and behavioural economic incentive programmes using pooled mean differences (MD) of weight change and/or steps per day, relative risks (eg, OR and risk ratios (RR)) of goal achievement, non-communicable diseases and disease complications, should sufficient data be amenable to pooling. Second, evaluations of associations between the effectiveness of financial incentive design features based on a framework by Adams *et al* that considers direction (rewards/penalties), form (cash/non-cash), magnitude (level), target (on effort/outcome), length (for how long) as well as frequency (how often) of incentives,[49] type of other components (eg, text reminder, feedback, education classes, etc) and participant characteristics (eg, female proportion, health condition, etc) using meta-regression analyses.

METHODS AND ANALYSIS

This systematic review and network meta-analysis will be conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols guidelines.[50 51] The review will be conducted between June 2020 and May 2021.

Location of studies

Relevant studies published until June 2020 will be identified from Medline via PubMed and Scopus databases. In addition, reference list of identified studies will also be examined for additional relevant studies. Searches will be updated every 6 months until December 2020 to ensure the most recent studies are included in the final analysis.

Patient and public involvement

No patient involved

Search strategies

The search terms will address the following PICO criteria. See the full search strategy for Medline via PubMed and Scopus in online supplemental materials.

Patients (P)

General population (children and adults) and specific patient cohorts (eg, diabetes, obese, cardiovascular disease, etc) will be considered and therefore unrestricted.

Interventions (I) and comparator (C)

will include any type of financial incentive programmes including standard financial, price and behavioural economic incentive programmes, encompassing the following terms: "behavioural economic*", "behavioural economic*", nudg*, incentive*, "deposit contract*", "monetary contingency contract*", "commitment device*", lotter*, "regret theory", "group payment", "group-based payment", "team payment", "team-based payment".

Outcomes (o)

- Behavioural change:
  "health behavior change", diet*, "physical activity", exercis*
- Surrogate outcomes:
  "weight loss", "weight gain", overweight, "goal achievement".
- Long-term clinical outcomes:
  Obesity, "metabolic syndrome", "non-communicable disease*", diabetes, hypertension, "cardiovascular disease*".

Selection of studies

There are a significant number of individual studies, systematic reviews, and meta-analyses evaluating the effectiveness of financial incentives on healthy diet and physical activity. As such, we will implement a dichotomous approach. First, relevant individual studies from the systematic reviews with or without meta-analysis (SRs/MAs) will be selected. Then, relevant individual studies published since the previous SR/MA search date will be added.

Studies published in English and other languages amenable to Google translate will be included according to the following criteria.

Systematic reviews with or without meta-analysis

- SRs/MAs of randomised controlled trials (RCTs) or non-RCTs undertaken in either general population or disease specific patients.
- Published financial incentive programme comparisons (eg, standard monetary (or equivalent) rewards, price incentives, or behavioural economic incentive programmes, or with no incentive) that were implemented on subject/patient levels.
- Assessed any outcome of improved healthy diet and/or physical activity.
- Studies that provided economic incentive for healthcare or intervention providers or any third party will be excluded.

Individual studies in the SRs/MAs and studies published after the search date from published SRs/MAs

- RCTs or non-RCTs of general population or disease specific patients.
- Published any comparisons among standard monetary (or equivalent) rewards, price incentives, deposit contract, lottery-based incentive, regret lottery, group-based payment or no incentive which were implemented on subject/patient levels.
- Assessed any outcome of improved healthy diet and/or physical activity including actual weight, weight change, steps per day, number of physical activity sessions completed, gym visits, goal achievement, non-communicable diseases, disease complications (among disease specific patients).

  Studies will be excluded on the basis of the following criteria: included interventions as gifts of symbolic value as a reward, involved economic incentives for healthcare providers, intervention providers or any third party, and incomplete data for pooling after two attempts to contact the corresponding author.

Two reviewers (SB and OP) will independently select studies by screening titles and abstracts. If a decision can be not made, the full texts will be retrieved and reviewed. Any disagreement will be resolved by consensus or adjudicated by a third reviewer (AT).

Interventions

Interventions of interest include financial incentive programmes for promoting healthy diet and physical activity such as:

- Standard monetary (or equivalent) rewards of a specified amount or with a transferable monetary value to individuals when a specific health goal is achieved.
- Price incentive for healthy options, for example, discount, coupons or free distribution for healthy food and exercise facilities.[52–55]

- A deposit contract that includes a voluntary option for individuals to deposit their own money which will be refunded if they achieve the health goal.[37]
- Lottery-based incentives that include a reward for successful individuals with some of probability.[39]
- Regret lotteries that include payments for only some individuals who achieve the health outcome, although everyone is included in the lottery drawing and informed regardless of their goal achievement.[35 45]
- Group-based payment for all group members when the group goal is achieved.[46 56]

Outcomes of interest

The surrogate outcomes of interest are related to healthy diet and physical activity including:

- Weight: actual weight, weight difference.
- Physical activity: steps per day, number of completed sessions, frequency of gym visit.
- Goal achievement (success or failure).

In addition, we will consider secondary long-term clinical outcomes if data are available including diabetes mellitus, hypertension and cardiovascular diseases.

Data extraction

A standardised data extraction form will be developed. Two reviewers (SB and OP) will independently extract data from published studies. Any difference of extracted results will be discussed and resolved by consensus or adjudicated by a third author (AT).

Data from all included individual studies will be extracted including authors, year of publication, study design, type of participants, country of study, characteristics of study population (eg, percentage female, mean age, etc) financial interventions (type, duration, features, etc), type of other components (eg, text reminder, feedback, education/dietary classes, etc), type of outcomes and data for pooling.

Quality and risk of bias assessment

The quality assessment will be performed separately by SB and OP. Any disagreement will be resolved by the third reviewer (AT).

For randomised trials, the Cochrane risk-of-bias tool for randomised trials (RoB V.2)[57] will evaluate five bias domains: bias arising from the randomisation process, bias due to deviations from intended interventions, bias due to missing outcome data, bias in measurement of the outcome, and bias in selection of the reported result. Several questions will be evaluated against each domain; overall judgement will indicate either low or high risk of bias or some concerns.

For non-randomised studies, Risk of Bias In Non-randomised Studies-of Interventions[58] will evaluate bias that may arise due to the non- randomised trial design which may influence the intervention comparative effectiveness estimates. This approach considers seven domains of bias: bias due to confounding, selection bias, bias in classification of interventions, bias due to deviations from intended interventions, bias due to missing outcome data, bias in measurement of the outcome, bias in selection of the reported result. Note that the last four domains of bias are identical with the domains in RoB V.2. The judgement for each domain, in addition to the overall judgement, can be either low, moderate, serious or critical risk of bias or insufficient information.

Statistical analysis

Direct meta-analysis

The effectiveness of different financial incentive programmes will be compared directly and pooled for each outcome of interest, if there is a minimum of two studies for each comparison. Effect sizes such as MD, and OR or RR will be estimated for continuous outcomes (eg, weight difference, steps per day) and dichotomous outcomes (eg, goal achievement, non-communicable disease status), respectively. These will be pooled across studies using a random-effect model if heterogeneity is present, otherwise a fixed-effect model will be applied.

Heterogeneity will be assessed using Cochrane's Q test and I^2 statistics[59–61] and regarded as present if $p < 0.10$ or $I^2 \geq 25\%$. Source of heterogeneity will be explored by fitting covariables (eg, magnitude, frequency of incentive, length of incentive programme, a reminder system (eg, text reminders or phone call about goal, feedback), supporting components (eg, education/dietary classes, counselling programmes, information booklet/brochure), female proportion, health condition of participants, etc) individually in a meta-regression model and subgroup analysis will be performed accordingly.

Publication bias will be assessed using a funnel plot and Egger test. If asymmetry is present, a contour enhanced funnel plot will be constructed to identify the cause of publication bias.

Network meta-analysis

Interventions will be numerically coded as 1, 2, 3, 4, 5, 6 and 7 for no financial incentive, standard financial incentive, price incentive, a deposit contract, lottery-based incentive, regret lottery, group-based payment, respectively. A network map consisting of nodes and edges will be constructed with nodes weighted by number of studies for the corresponding comparison.[62]

To assess relative treatment effects (ie, MDs, ln(ORs) or ln(RRs)), a network meta-analysis will be applied using a two-stage meta-analysis approach separately for each outcome.[63] First, a binary or linear regression will be applied to estimate relative treatment effects and variance–covariance using no incentive as the reference. Second, a multivariate meta-analysis with a consistency model will pool relative treatment effects across studies.[64] Mixed relative treatment comparisons between all financial incentive programmes will be estimated.

The probability of being the best financial incentive programme will be estimated using surface under the cumulative ranking curve method with appropriate ranking of interventions. In addition, differences between

direct and indirect estimates for each comparison (inconsistency assumption) will be evaluated by a design-by-treatment interaction model.[63]

All analyses will be stratified by age, that is, child or adult status, then they will be performed using STATA software V.16.1; a p<0.05 will be considered statistically significant, except for the presence of heterogeneity where p<0.10 will be used.

ETHICS AND DISSEMINATION

Ethics approval for systematic review and meta-analysis is not required.

We will disseminate our findings through peer-reviewed publication, academic conference presentations and teaching materials.

If amendments to this protocol are required following its publication, we will provide the date, description of the change(s) and rationale for the change(s) of each amendment in resulting publications from this protocol.

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Contributors SB is the principal investigator with overall responsibility for protocol development, together with OP and AT. SB wrote the protocol and registered the protocol at PROSPERO. SB and OP performed study searches and preliminary selection. AT designed review methods, data analysis plan, wrote and critically appraised the review protocol. BO, GM, JA and AT wrote and critically appraised the review protocol. All authors read and approved the final version of the manuscript.

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