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Incentive-based interventions for increasing physical activity and fitness (Protocol)

O'Malley GC, Baker PRA, Francis DP, Perry I, Foster C



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[Intervention Protocol]

Incentive-based interventions for increasing physical activity and fitness

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ABSTRACT

This is the protocol for a review and there is no abstract. The objectives are as follows:

The main aim of the review is to determine the effectiveness of using incentive-based approaches (IBAs) (financial and non-financial) to increase physical activity in community-dwelling children and adults.

A secondary objective will be to address the use of incentives to improve cardiovascular and metabolic fitness.

A final objective will be to explore:

- whether there are any adverse effects associated with the use of IBAs for increasing physical activity;
- whether there are any differential effects of IBAs within and between study populations by age, gender, education, inequalities and health status; and
- whether the use of disincentive/aversive approaches leads to a reduction in sedentary behaviour.

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BACKGROUND

The World Health Organization (WHO) has recommended a shift of focus from the treatment of illness to one whereby health is promoted. Such a paradigm shift emphasises the need to modify health risk factors including smoking, unhealthy diet and physical inactivity (WHO 2002; WHO 2005). Improving participation in health-enhancing physical activity is of huge importance, as participation in such activity is associated with the prevention of many chronic diseases, including type 2 diabetes, cardiovascular disease, coronary heart disease and some cancers (Bauman 2004; Penedo 2005). Exploring the relationship between physical activity and cardiometabolic health has been the aim of two previous Cochrane reviews (Jolliffe 2001; Thomas 2006).

The reported global prevalence of 'some but insufficient physical activity' of 41% is estimated to be associated with 1.9 million deaths, 19 million Daily Adjusted Life Years (DALYs) and approximately 22% of coronary heart disease prevalence globally (WHO 2002). In the United States, less than 5% of the population are reported to engage in recommended levels of physical activity (Troiano 2008), and inadequate physical activity is the fourth leading attributable risk of death (Danaei 2009). Physical inactivity is therefore, not only a major public health burden, but also a significant economic encumbrance (Scarborough 2011). A previous Cochrane review has explored the effectiveness of interventions used to promote physical activity in adults, and observed the use of strategies such as financial incentives in primary studies to modify physical activity behaviour (Foster 2005). Examples of such incentives include free access to private fitness facilities, personal training, supervised exercise sessions and subsidised public transport (Ogilvie 2008). Studies using such incentive-based approaches (IBAs) to increase physical activity behaviour have drawn from research in areas of behaviour modification such as drug misuse (Olmstead 2007; Sindelar 2007), and have been used in behavioural interventions, as part of a suite of strategies, to encourage behaviour change. The commercial world has adopted and refined these principles to make product choice more attractive (Blythman 2004). The repackaging of these approaches in "nudge" theory has awakened interest in utilising the processes of choice architecture "that alters people's behaviour in a predictable way, without forbidding any options or significantly changing their economic incentives" (Thaler 2008). Governments and policy makers have adopted these principles and are currently investigating their application across different policy areas. Nudge type strategies are composed of elements from a number of different psychological theories of behaviour change (social cognitive theory, transtheoretical model and the health belief model). The efficacy of such approaches remains unknown and our review will quantify if these approaches have any impact in physical activity interventions.

Description of the condition

This review will evaluate studies that report on the effectiveness of IBAs to increase physical activity. Physical activity is any bodily movement produced by skeletal muscles which results in increased energy expenditure (Caspersen 1985). Physical activity is associated with indices of health-related physical fitness such as cardiorespiratory fitness, muscle strength, bone strength, balance, co-ordination, flexibility, metabolic
and psychological profile (Bailey 1999; Deforche 2003; Faigenbaum 1999; Katzmarzyk 1998; Malina 2001; Miller 2010; Pate 1990). Although increasing physical activity levels is a cornerstone of obesity prevention and management, it is clear that independent of any effect on body weight, the physical and psychological benefits justify the promotion of physical activity in all humans.

It is recommended that adults engage in a weekly target of 150 minutes of moderate intensity cardiorespiratory exercise training (Garber 2011). In children (5 to 17 years of age) the current recommendations are to accumulate an average of at least 60 minutes per day, and up to several hours, of at least moderate intensity physical activity (Janssen 2010). It is reported that in general, physical activity decreases with age, particularly in females, and that activity level is influenced by biological factors (Rowland 1998), physical limitations (O'Malley 2010), time spent in sedentary pursuits, peer-group activity and individual motivation (Haerens 2009).

Description of the intervention

We will use the socioecological framework to guide our definition of where IBAs can be delivered (Sallis 1999). The socioecological framework describes the interaction between policy, the environment and individual level factors upon physical activity behaviour. Our definition of IBAs reflects these different levels of influence on behaviour. IBAs will include strategies that offer financial or non-financial rewards and incentives at the time of, or after the adoption of physical activity. IBAs can act at an organisational level (e.g. within a workplace), or at an individual level (e.g. payment or rewards for being active for the individual, or payment of healthcare professionals to deliver activity interventions). We will take into account the timing that the IBA is applied, given the negligible benefit that is reported with the provision of tax rebates to those of lower socioeconomic status (Spence 2010). As such, we will consider IBAs that are provided before or after initiating physical activity.

It is hypothesised that by applying IBAs, an increased awareness of the health-promoting physical activity message may ensue, in tandem with improvements of knowledge regarding the benefits of activity, increases in the motivation to be active, as well as improved attitudes and beliefs related to becoming physically active. Such developments might improve participation in physical activity and reduce sedentary behaviour in an effort to take advantage of the IBA, while facilitating improved levels of physical fitness and reductions in morbidity and mortality.

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This review will also consider the negative consequences associated with the use of IBAs. It has been reported that the use of IBAs may have unintended repercussions, such as undermining intrinsic motivation or eroding an individuals' decision-making autonomy (Claassen 2007; Deci 2009). There are additional ethical and moral concerns regarding whether the use of IBAs is coercive or inequitable (Gostin 2007; Halpern 2007); this review will attempt to report on such issues of concern.

The study will encompass any strategy or item that could be deemed as a reward by the study recipient, to facilitate motivating study participants to increase their participation in physical activity. This will include taxation rewards, grant opportunities, subsidies and reduced price opportunities to be active, salary bonuses, direct financial payments, lottery tickets, competition entries and prizes. Similarly we will include disincentives and aversive approaches for sedentary behaviour, such as penalties or increased taxes for undertaking actions which would otherwise lead to sedentary behaviour. Such penalties will include the use of fines where traffic calming strategies are ignored by motorists, or car parking costs. Car-free zones, 30 km/hr speed limits, parking capacity limitations and high taxation of automobile ownership and use have been used in many urban areas to promote and facilitate pedestrian and bicycle traffic.

How the intervention might work

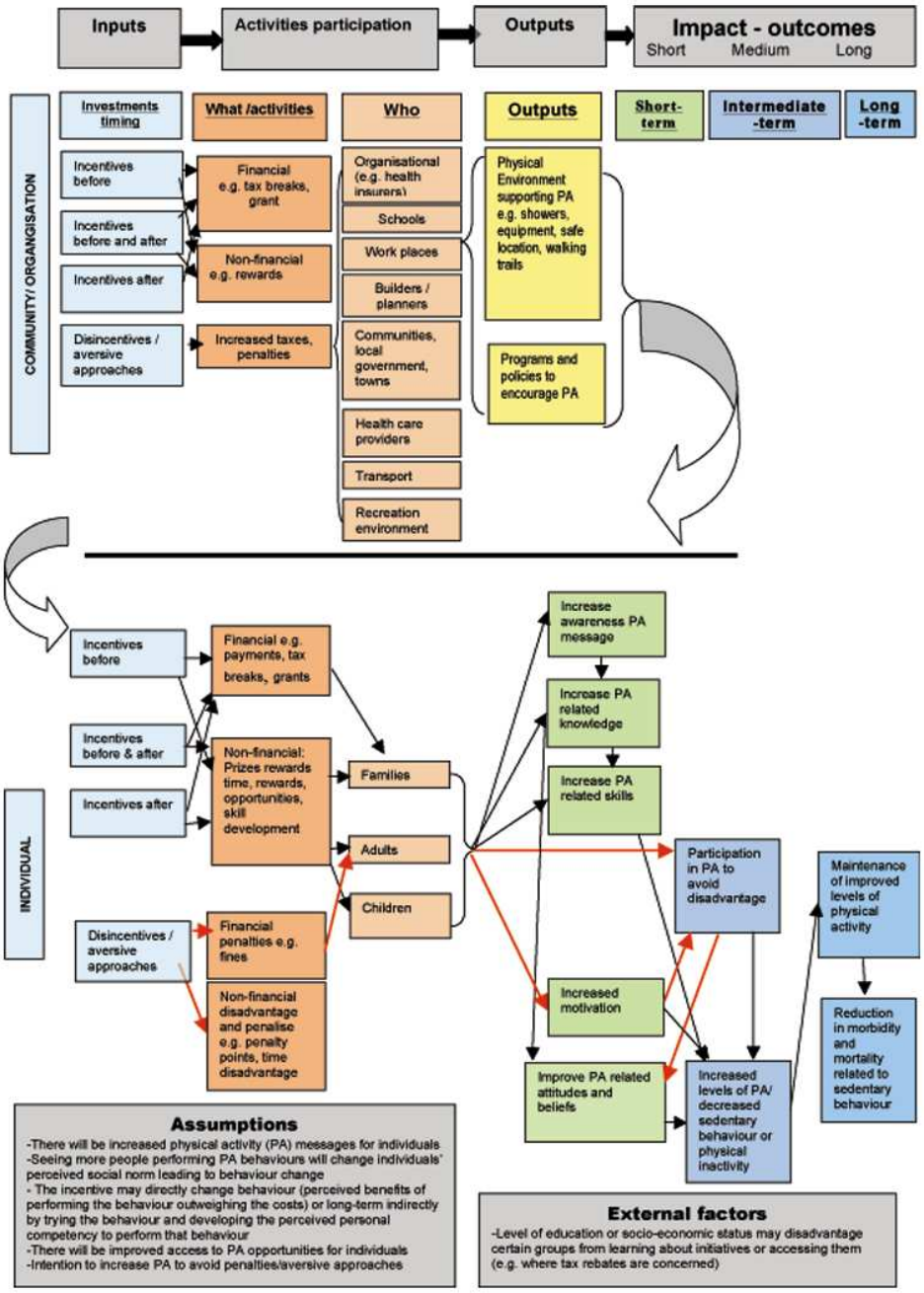
Research on decision-making has found that the desire to avoid regret is a potent force in decision-making (Connolly 2006), as is the incentive value of small rewards and punishments (Ainslie 1975). The theory underpinning how IBAs might work, draws from psychological, ecological and behavioural economics research. It is proposed that individuals consider an IBA with a present bias and may want to do what is in their long-term interest (become more active), but usually succumb to the temptation to be sedentary. People may be more patient in immediate future choices than in distant future choices (Loewenstein 1992; Thaler 1981). As such, an IBA may facilitate an individual to pursue a smaller, more immediate reward (e.g. payment for participating in a work-based exercise class) instead of a more distant but valuable reward, for example, avoiding chronic illness by participating in ongoing physical activity (Berns 2007). Similarly, the use of IBAs facilitates the removal of barriers (cognitive and physical) to participating in physical activity, and such modification of attitudes and motivation may lead to changes in behaviour and action.

Disincentives and aversive approaches for sedentary behaviour might be used to reduce sedentary behaviour (i.e. congestion or high parking charges to reduce car use and increase walking). Whether an associated increase in physical activity is elicited by reducing sedentary behaviour is not clear (Pate 2008); we will explore if this is the case in the review. To date, researchers propose that by targeting theoretical constructs such as individual behavioural processes, self-efficacy, and social support, a change in the behavioural outcome (i.e. physical activity) may be observed (Lewis 2002). A 2008 Cochrane review investigated the use of incentives for the promotion of smoking cessation and concluded that none of the trials included showed higher quit rates at six months when incentives were used (Cahill 2008). More recently, a large trial conducted by Volpp 2008, showed a positive effect of using personal financial incentives on sustained quitting at 12 months. Regarding physical activity interventions, recent data proposes a promising benefit for the use of IBAs in well-designed studies (Kahn 2002; Lewis 2002; Vandelanotte 2007). Identified studies may use payment or an incentive to encourage study participation and this may have a varying degree of impact, particularly in cohorts at a socioeconomic disadvantage. As such, we will aim to address such issues of inequity and reach.

We have developed a logic model (Figure 1) to show the two levels at which incentive interventions may be directed, i.e. at the community/organisational level, or directly at the individual level where intermediate- and long-term activities are expected to be observed (Foster 2005). The activities participation stage describes the type of IBA that is used, at what time it is applied, in what setting it is used and to what target group it is offered. It is hypothesised that the use of the IBA will lead to a variety of outputs such as changes in the physical environment and the implementation of policies and programmes directed at increasing physical activity. Such outputs will impact upon a variety of outcomes ranging from the short- to the long-term. Such outcomes could include increased awareness of health-promoting initiatives, an increase in knowledge related to the benefits of physical activity, improvements in motivation, increased participation in physical activity and subsequent reductions in morbidity and mortality. We will use the logic model to describe the components of the intervention which may have influenced a change in behaviour (activity level).

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Figure 1. Logic model for IBA used to increase physical activity



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Why it is important to do this review

It is important to increase population levels of physical activity related to lifestyle choices in order to address the increasing burden of chronic diseases (e.g. type 2 diabetes and cardiovascular disease). To date, the use of IBAs in a variety of settings to increase physical activity has been promising (Kahn 2002; Lewis 2002; Vandelanotte 2007). In the absence of a systematic synthesis of the evidence regarding the use of IBAs for the promotion of physical activity, recent national policy has supported their use (e.g. in England, the Step2Get programme) (Healthy Lives 2010). A Cochrane review of community-wide interventions examined only interventions which were multi-strategy in nature (Baker 2011), and thus did not address IBAs as a distinct strategy, which is the focus of this review.

It is currently unknown whether using incentives is more effective in the promotion of sustained physical activity, compared to not using incentives. Promotion with incentives is the focus of our review, however we acknowledge that there are examples of incentives offered to community organisations to encourage specific actions (e.g. subsidies to promote the building and development of public spaces which prioritise walking and cycling). At present we feel these actions lie beyond the scope of our review. In addition, it is unknown whether certain incentives are more effective than others in promoting health-enhancing physical activity and associated measures of fitness. Equally, it is unknown whether disincentives for sedentary behaviour can lead to an increase in physical activity. As such, it is warranted that the evidence to date is synthesised in an effort to guide the implementation of future strategies. Finally, we acknowledge that an incentive may be viewed differently by individuals or groups in various settings and as such, we will identify and explore such issues in the qualitative description of the included studies.

OBJECTIVES

The main aim of the review is to determine the effectiveness of using incentive-based approaches (IBAs) (financial and non-financial) to increase physical activity in community-dwelling children and adults.

A secondary objective will be to address the use of incentives to improve cardiovascular and metabolic fitness.

A final objective will be to explore:

- whether there are any adverse effects associated with the use of IBAs for increasing physical activity;
- whether there are any differential effects of IBAs within and between study populations by age, gender, education, inequalities and health status; and
- whether the use of disincentive/aversive approaches leads to a reduction in sedentary behaviour.

METHODS

Criteria for considering studies for this review

Types of studies

We will include all randomised controlled studies (RCTs) comparing the use of incentives for the promotion of physical activity with a minimum follow-up of 12 weeks in community- dwelling children and adults. Although the inclusion of non-RCTs will increase the susceptibility for bias, we will include non-RCTs and time-series studies with comparator groups because we anticipate that a limited number of RCTs will be available. We will include two component reviews in order to examine the evidence, which pertains to both RCTs and non-RCTs. We will include studies that have compared the use of an incentive to increase physical activity in one group versus the use of no incentive in the other. The intervention component of included studies could be a once off intervention, or an intervention extending over a specified length of time. We will only include studies that measure physical activity levels (using standardised subjective or objective tools) pre- and post-intervention.

Types of participants

We will include studies that include community-dwelling children (< 18 years) and adults (> 18 years). We will exclude studies in which athletes or sports students participate.

Types of interventions

We will define incentives as 'any strategy that offers financial or non-financial rewards (before, and or after physical activity) in an effort to facilitate motivating the study participants to increase their participation in physical activity'. As IBAs could be applied in a number of settings, we will use the logic model (Figure 1) to classify the type of intervention and at which level (community or individual) it is utilised. In addition, we will include studies testing the use of disincentives or aversive approaches.

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The following are examples of IBAs, which might be utilised in order to increase levels of physical activity, consistent with the logic model to be included in this review.

Community Level

- Financial incentives offered by health insurers or other bodies to employers who provide wellness programmes to employees.
- Grants and support for establishing walking-school buses.

Individual Level

- Tax rebates for individual purchases of exercise equipment or club memberships.
- Time-for-time; prizes; competition entries or bonuses to staff who participate and sustain physical activity via employer provided or after work wellness programmes.
- Academic incentives and credits offered to students who increase their participation in physical activity.
- Subsidies offered to individuals for purchasing a bicycle through, for example, a 'bike-to-work' scheme.

Disincentives or aversive approaches

- City congestion charges; fines to motorists who park or drive in bicycle lanes; increase in fines to motorists who speed in populated areas; the use of penalty points to drivers who disregard cyclist and pedestrian safety; and no-car zones.

Types of outcome measures

We will include studies if physical activity level is either a primary or secondary outcome of interest.

Primary outcomes

The primary outcome will be physical activity level assessed by standardised tools between baseline and follow-up. Studies should employ objective measures of activity such as pedometers and accelerometers (Webber 2008) or subjective measures such as self-report and validated questionnaires (Jeffery 1998).

Secondary outcomes

We will include secondary outcomes of cardiovascular fitness (e.g. risk factors such as blood pressure, blood lipid profile and aerobic capacity); metabolic fitness (e.g. insulin sensitivity and glycaemic control); musculoskeletal fitness (e.g. muscle power, flexibility and the presence of pain); mental health (e.g. symptoms of depression and anxiety); measures of motivation; and quality of life measures.

We will also detail additional outcomes such as financial (e.g. data relating to cost effectiveness, cost per unit change in outcome and cost-benefit analyses) and adverse effects (e.g. perceptions of coercion, undermined intrinsic motivation and data indicating inequity), as well as information detailing the specific psychological theory underpinning the intervention.

Search methods for identification of studies

Electronic searches

We will search relevant multiple databases and websites (as recommended by Armstrong 2008) using a sensitive search strategy developed by GO'M in liaison with the Public Health Group's Trials Search Co-ordinator, and will tailor the MEDLINE strategy for each database during 2012. In the month, prior to submission of our review, we will check all the highest yielding databases for newly published studies. We will handsearch the reference lists of review articles and included studies and contact experts in the field for other potentially eligible studies. We will impose no language or date restrictions in our search. We will search the following databases for material.

Health

Cochrane Public Health Group Register
CENTRAL
MEDLINE
EMBASE
CINAHL
PsycINFO
PUBMED
PEDRO
LILACS
Web of Science
Cochrane Occupational Health Field Register

Business

EMERALD
Business Source premier
EconLit

Architecture, sport, transport and planning

Avery
Compendex
GEOBASE
SPORTDiscus
TRIS

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Social sciences

Sociological abstracts
ASSIA
C2-SPECTR (Campbell collaboration)

Grey literature

HMIC
OpenSIGLE
Index to Theses
ZETOC
In addition, we will search the WHO International Clinical Trials Registry Platform (WHO ICTRP) to identify studies in progress.

Searching other resources

In addition to databases, we will search other resources for published and unpublished studies.

- We will handsearch our top 10 high yielding journals (those which yield the highest numbers of studies that meet the inclusion criteria), such as *The American Journal of Preventative Medicine, Preventative Medicine* and the *ISBNPA Journal,* if these have not already been handsearched by The Cochrane Collaboration.
- We will search reference lists of all papers and relevant systematic reviews that have been identified as meeting the inclusion criteria for the review.
- We will conduct a Google Scholar search for relevant material and search key websites (International Labour Organisation, WHO and International Network of Agencies for Health Technology Assessment).
- We will contact subject experts through the International Society for Physical Activity and Health, HEPA Europe (European network for the promotion of health-enhancing physical activity) and the Active Living Research Organization.

Data collection and analysis

Selection of studies

We will divide the resulting titles from the search by the review authors for initial screening by GO'M and DF. IP, PB, or CF will independently examine the title, keywords and abstract of each report for inclusion in the review. We will import article records from each database into the bibliographic software package Endnote 2010, where we will remove duplicates and select relevant articles. We will undertake an initial screening of titles and abstracts to remove those which are obviously outside the scope of the review. The review authors will be over inclusive at this stage and, if in doubt, we will include a paper. We will obtain the full text for the papers potentially meeting inclusion criteria (based on the title and abstract only), and we will link together multiple publications and reports on the same study. The review authors will not be blinded with respect to authors' name, journal or date of publication during this process. Multiple review authors (GO'M and shared between IP, PB and CF) will screen all the full text papers obtained and will utilise the logic model (Figure 1) to assess whether basic components of the definition of an IBA and permissible study designs are fully met. Where there is a persisting difference of opinion, DF will review the paper in question in order to reach a consensus between the review authors. We will maintain a record of the outcome of the study assessment process for all reviewed material. After the initial selection, GO'M and CF will perform a re-screening of a random 10% of all excluded titles to ensure no suitable titles have been omitted.

Data extraction and management

Two review authors (GO'M and either DF, IP, PB or CF), will independently complete a data extraction form for each study, tailored to the requirements of this review. GO'M, DF and CF will pilot the data extraction form to assess its ability to capture study data and inform assessment of study quality. We will resolve any problems identified through discussion and we will revise the form, as required. Where studies report more than one endpoint per outcome, we will extract the primary endpoint identified by the authors. Where the review authors do not identify a primary endpoint, we will rank the measures by effect size and extract the median measure (Curran 2007). Should there be relevant study reports in languages that cannot be translated by the review team, GO'M will complete the data extraction form in conjunction with a translator.

We will extract relevant data from all full text studies meeting the inclusion criteria and assess them for study implementation and fidelity using the quality assessment criteria that corresponds to the RE-AIM public health intervention evaluation framework. These include: 'reach', or the number and representativeness of programme participants; 'efficacy/effect' of the intervention on important positive or negative outcomes; 'adoption', or number and representativeness of settings and intervention agents; 'implementation', or consistency, quality and resources required in programme delivery; and 'maintenance', the institutionalisation of the intervention into routine practices or policy. We will use a check list to ensure inclusion of data relevant for health equity (Morris 2009). In addition, we will assemble multiple reports and publications of the same study and compare them for completeness and possible contradictions. We will mark on the logic model (Figure 1) the specific components present in the primary paper and companion publications to assist in the categorisation of studies and interpretation of results, where heterogeneity is present. We will manage numerical data for analysis that is extracted from the included studies, in a Microsoft Excel spreadsheet.

GO'M and IP will cross-check the completed data extraction forms

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for consistency and should any discrepancy arise, we will seek consensus through discussion. GO'M will file and store all copies of studies undergoing data extraction and completed data extraction sheets (including printed versions of electronic forms) in a filing cabinet for auditing and checking purposes. We will transfer data for collation from our data extraction sheets to RevMan 5.1 (RevMan 2011); IP will independently check the accuracy of this procedure. Where necessary, we will contact study authors to provide data that may be missing from the study reports or to resolve any uncertainty about reported information. We will record any study that undergoes the data extraction process and is subsequently rejected from the review summary in the 'Characteristics of excluded studies' with a rationale for non-inclusion. In addition, we will also present relevant information on all included studies in the 'Characteristics of included studies' table.

Using the location of the intervention, we will categorise the studies as occurring in low-, middle- and high-income countries, as determined by the World Bank classification.

We will review all papers and reports of included studies to identify whether any description of costs or resources were made by the authors. Information extracted will include descriptors of cost to deliver the intervention over the time specified. Where possible, we will separate the cost of the intervention from the cost of the evaluation and research components. Where the results are presented at a population level, we will calculate the cost per person. We will identify and include in kind support. We will also extract general statements (e.g. "low cost intervention") made by the authors, where no expression of monetary value is made.

Assessment of risk of bias in included studies

GO'M and PB will assess the risk of bias. We will assess the studies meeting the inclusion criteria using the Cochrane 'Risk of bias' tool (sequence generation; allocation concealment; blinding of participants and personnel; blinding of outcome assessors; incomplete outcome data; selective outcome reporting; and other sources of bias) (Higgins 2011a). Analysis of non-RCTs will follow the guidance provided in the Effective Practice and Organisation of Care (EPOC) 'Risk of bias' documentation and we will develop a risk of bias table (EPOC 2009). We will judge studies to be at 'low', 'medium', or 'high' risk of bias given overall consideration of the study design, size, and the potential impact of the identified weaknesses. Where there is disagreement between review authors in risk of bias assessment, DF will appraise the study independently and we will resolve discrepancies by consensus between all review authors.

Measures of treatment effect

We will analyse studies with continuous outcome measures using the mean and standard deviation (SD). If not possible, we will report only the point estimate with confidence intervals (CIs) and P values. We will express the effect sizes for dichotomous outcomes as risk ratios (RRs) in the first instance. For continuous outcomes, we will use weighted mean differences (WMDs) between the post-intervention values of the intervention and control groups to analyse the size of the effects of the interventions.

Unit of analysis issues

If a study has more than two arms that are relevant for inclusion in the review, we will examine the overall effects of the intervention versus control by pooling the intervention arms into one group to create a single pair-wise comparison. For continuous outcomes, we will calculate and weight the mean and SDs according to the overall numbers within each arm using the formulae in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011b). For dichotomous outcomes, we will calculate odds ratios (ORs) with 95% CIs, and we will use the number of participants in each arm that are reported as an event (categorised at a pre-determined level) or no event (for example, not active).

This approach is more appropriate than comparing the effects of (one intervention arm versus control) and (the second intervention arm versus control), within a meta-analysis, as the same participants cannot be included twice in the comparison and effect calculations. Where appropriate, we will calculate individual study effects and then the pooled effect sizes as ORs with 95% CIs using a random-effects model. We will calculate any missing 95% CIs using approaches outlined by (Deeks 2011).

We will re-analyse, if possible, studies which randomise or allocate by clusters but do not account for clustering during analysis. Where the population reporting attainment of a physical activity level is stated as a percentage of the population meeting a specified attainment level, we will consider the analysis as being at the same level as allocation for each cluster. Alternatively, if appropriate, we will employ statistical methods that allow analysis at the level of the individual while accounting for the clustering in the data. If successful, effect estimates and their standard errors (SEs) from correct analyses of cluster-randomised trials may be meta-analysed using the generic inverse-variance method in RevMan 5.1 (RevMan 2011).

Dealing with missing data

We will contact the authors of potentially included studies if missing data are unclear or data have not been fully reported. We will capture missing data in the data extraction process and report it in the risk of bias table.

Assessment of heterogeneity

We will initially assess the differences between included studies. We will use the logic model (Figure 1) in the categorisation of the type of intervention strategies included, participants and outcomes. We will quantify and evaluate the amount of heterogeneity to

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determine whether the observed variation in the study results are compatible with the variation expected by chance alone (Higgins 2003). We will assess heterogeneity through examination of the forest plots and quantify it using the I^2 statistic. We will perform a sensitivity analysis to investigate heterogeneous results.

Assessment of reporting biases

PB will plot trial effect against SE using funnel plots (Sterne 2011). Given that asymmetry could be caused by a relationship between effect size and sample size, or by publication bias (Egger 1998), we will examine any observed effect for clinical heterogeneity and we may carry out additional sensitivity tests.

Data synthesis

We will report continuous outcomes on the original scale, where possible. If the outcomes are to be combined from different scales we will standardise these as required for the analysis. We will only undertake a meta-analysis when data are clinically homogeneous. We will follow Chapter 9: 'Analysing data and undertaking meta-analyses' in the *Cochrane Handbook for Systematic Reviews of Interventions* (Deeks 2011). GO'M, DF and CF will perform statistical analyses using RevMan 5.1, if all available data are sufficiently similar, and of sufficient quality (RevMan 2011). We will use a random-effects model to incorporate heterogeneity among studies that cannot be explained, to ensure it is clear that this model does not remove the need to try to explain causes of heterogeneity. We will not combine evidence from differing study designs and outcome types in the same forest plot (Christensen 2009).

In the situation where it is not appropriate to conduct a meta-analysis, we will develop a table with effect sizes of each study. In addition, we will present the median effect size and its range for each outcome. We will conduct a narrative synthesis of the results as a means of considering the included interventions and the body of evidence identified through the review process.

Subgroup analysis and investigation of heterogeneity

We will make an assessment whether to pool RRs by measuring the effectiveness of incentive-based intervention compared to no intervention on physical activity, following initial assessments of methodological heterogeneity. Where sufficient data are available, GO'M, DF and CF will perform additional subgroup analyses to compare outcomes by: types of study designs; group effects for people who share a common social, cultural, or health status characteristic (age, gender, ethnicity); reach of intervention; and intensity of intervention (derived from use of the logic model and process evaluations). The subgroup analysis will also explore whether there is any evidence of differential effects of the intervention by socioeconomic and demographic group. Where appropriate, we will assess subgroup heterogeneity through examination of the forest plots and quantification using the I^2 statistic.

Sensitivity analysis

We will carry out sensitivity analysis to explore the impact of risk of bias on study findings by repeating the meta-analysis that excludes studies that are assessed as having a high risk of bias.

Summary of findings

GO'M and PB will prepare a summary of findings table for the primary outcomes related to physical activity and sedentary behaviour using GRADE profiler (Schunemann 2011). We will summarise the quality of evidence by applying the principles of the GRADE framework and following the recommendations and worksheets of EPOC for creating summary of findings tables (EPOC 2011). We will use four levels of quality (high, moderate, low and very low) to describe the body of evidence. We will create the table using the measures for the primary outcomes identified as being most important, most reliable and the most predominant. We will assess the quality of evidence for each outcome across studies. Non-randomised studies will start at low quality; however given the a priori expectation that the highest quality of evidence is likely to come from large, controlled before and after studies of communities, we will not further down-grade such studies if we identify deficiencies in randomisation. We will assess the magnitude of the effect, sample size, representativeness of the population cohorts, and the validity of the measures used to determine whether it is appropriate to upgrade or downgrade the quality of a finding. We will also consider information from process and evaluation reports of the intervention. The primary determinant for upgrading or downgrading the evidence will be whether the issues identified are likely to affect the outcome based on the logic model and the GRADE criteria.

The summary of findings table will contain illustrative comparisons of the effect of the intervention upon population levels of primary outcomes using three scenarios of physical activity levels and intervention approaches that are indicative of low-, middle- and high-income countries. If necessary, we will adjust the illustrations for any corresponding equity gradient that may be apparent, such as the staircase effect (Tugwell 2006). This may identify an increasing gap and decreasing effectiveness by advantaged and disadvantaged populations across relevant components of the intervention. We will quality assess the prevalence data used in the comparison using the framework of Loney 2000. We will minimise multiple reporting of measurement instruments for physical activity and sedentary behaviour that cannot be combined, to ensure the size of the table is proportionate to the quantity of meaningful findings. We will base the selection of measurement instruments upon known validity aspects of the instruments and the prevalence of their use in the primary studies. Interpretation of the findings will emphasise potential population and health policy significances, rather than solely clinical significance. In the event that meta-analysis is not appropriate, we will prepare an alternative

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summary of findings table using narrative analysis of the included studies.

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* *Indicates the major publication for the study*

APPENDICES

Appendix 1. Medline Search Strategy

Database: Ovid MEDLINE(R) <1948 to April Week 4 2011>
Unless otherwise stated, search terms are free text terms; MeSH = Medical subject heading (Medline medical index term); exp = exploded MeSH; tw = text word; pt = publication type; sh = MeSH; adj = adjacent; ti=title.
The same search terms were used in each database and amended if required by the database format
Search Strategy:

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1 incentiv*.ab,ti. (12977)
2 competit* entr*.ab,ti. (17)
3 contest*1.ab,ti. (1297)
4 ((provi* or access or free or offer* or supply or supplies or opportunit* or entic*) adj5 (reward* or lottery)).ab,ti. (996)
5 prize*.ab,ti. (3971)
6 voucher*1.ab,ti. (633)
7 financial assist*.ab,ti. (482)
8 Financial Support/ (2651)
9 monetary support.ab,ti. (15)
10 (subsidy or subsidies).ab,ti. (1776)
11 ((provi* or access or free or offer* or supply or supplies or opportunit* or entic*) adj5 member*).ab,ti. (4207)
12 loan*.ab,ti. (1355)
13 ((contingent or cash) adj payment*).ab,ti. (90)
14 deposit contract*.ab,ti. (9)
15 exp Employee Incentive Plans/ (1439)
16 "employee incentive* plan*".ab,ti. (3)
17 payment*.ab,ti. (14659)
18 "health facilit*".ab,ti. (4021)
19 Health Facilities/ (10291)

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20 ((provi* or access or free or offer* or supply or supplies or opportunit* or entic*) adj5 grant*1).ab,ti. (426)
21 Financing, Government/ (16758)
22 Public Assistance/ (2273)
23 Government Programs/ (2846)
24 "congestion charge*".ab,ti. (2)
25 bonus*.ab,ti. (819)
26 ((provi* or access or free or offer* or supply or supplies or opportunit* or entic*) adj5 (bike* or bicycle* or shower or facility or facilities or gym* or leisure* or club* or room* or space* or equipment* or locker* or game*1 or lane* or trail* or tour* or fitness class*2 or exercise class*2 or aerobic class*2 or spin class*2 or recreation*)).ab,ti. (16087)
27 rebate*.ab,ti. (218)
28 credit*.ab,ti. (5087)
29 (free adj3 (health or medical*)).ab,ti. (1546)
30 rent*.ab,ti. (1802)
31 (free adj3 (breakfast* or meal* or lunch* or food or snack* or dinner*)).ab,ti. (1394)
32 or/1-31 (102004)
33 Sedentary Lifestyle/ and (decreas* or reduc* or discourag*).ab,ti. (195)
34 (sedent* adj5 (decreas* or reduc* or discourag*)).ab,ti. (502)
35 ((inactive or inactivity) adj5 (decreas* or reduc* or discourag*)).ab,ti. (1441)
36 (desk adj5 (job* or bound)).ab,ti. (15)
37 ((sit or sitting) adj5 (decreas* or reduc* or discourag*)).ab,ti. (728)
38 (VDU or "visual display unit").ab,ti. (244)
39 "visual display screen".ab,ti. (4)
40 ((computer* or screen* or tv* or television*) adj5 (decreas* or reduc* or discourag*)).ab,ti. (6636)
41 Video Games/ and (decreas* or reduc* or discourag*).ab,ti. (187)
42 (("video Game*" or electronic game*) adj5 (decreas* or reduc* or discourag*)).ab,ti. (32)
43 exp exercise/ and (increas* or sustain* or encourag* or motivat* or promot* or improv*).ab,ti. (29857)
44 exp running/ and (increas* or sustain* or encourag* or motivat* or promot* or improv*).ab,ti. (4823)
45 walking/ and (increas* or sustain* or encourag* or motivat* or promot* or improv*).ab,ti. (6712)
46 physical fitness/ and (increas* or sustain* or encourag* or motivat* or promot* or improv*).ab,ti. (7324)
47 swimming/ and (increas* or sustain* or encourag* or motivat* or promot* or improv*).ab,ti. (4567)
48 gardening/ and (increas* or sustain* or encourag* or motivat* or promot* or improv*).ab,ti. (90)
49 exp "physical education and training"/ and (increas* or sustain* or encourag* or motivat* or promot* or improv*).ab,ti. (4814)
50 dancing/ and (increas* or sustain* or encourag* or motivat* or promot* or improv*).ab,ti. (365)
51 exp sports/ and (increas* or sustain* or encourag* or motivat* or promot* or improv*).ab,ti. (35066)
52 yoga/ and (increas* or sustain* or encourag* or motivat* or promot* or improv*).ab,ti. (412)
53 fitness center/ and (increas* or sustain* or encourag* or motivat* or promot* or improv*).ab,ti. (102)
54 recreation/ and (increas* or sustain* or encourag* or motivat* or promot* or improv*).ab,ti. (1010)
55 "play and playthings"/ and (increas* or sustain* or encourag* or motivat* or promot* or improv*).ab,ti. (1270)
56 motor activity/ and (increas* or sustain* or encourag* or motivat* or promot* or improv*).ab,ti. (26339)
57 exp Health Promotion/ and (exp exercise/ or exp running/ or walking/ or physical fitness/ or swimming/ or gardening/ or exp "physical education and training"/ or dancing/ or exp sports/ or yoga/ or fitness center/ or recreation/ or "play and playthings"/ or motor activity/) (4746)
58 exp Health Promotion/ and (physical activ* or exercis* or aerobic activ* or moderate activ* or vigourous activ* or moderate exercis* or vigourous exercise* or recreation* or active travel* or active transport* or active commut* or alternative transport* or alternative travel* or fitness or aerobic class* or exercise class* or sport*).ab,ti. (5006)
59 exp Motivation/ and (exp exercise/ or exp running/ or walking/ or physical fitness/ or swimming/ or gardening/ or exp "physical education and training"/ or dancing/ or exp sports/ or yoga/ or fitness center/ or recreation/ or "play and playthings"/ or motor activity/) (8533)
60 exp Motivation/ and (physical activ* or exercis* or aerobic activ* or moderate activ* or vigourous activ* or moderate exercis* or vigourous exercise* or recreation* or active travel* or active transport* or active commut* or alternative transport* or alternative travel* or fitness or aerobic class* or exercise class* or sport*).ab,ti. (3537)
61 ((physical activ* or aerobic activ* or moderate activ* or vigorous activ*) adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (7348)

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62 ((physical exercis* or aerobic exercis* or moderate exercis* or vigorous exercis*) adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (1635)
63 (fitness adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (3821)
64 (aerobic capacity adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (528)
65 ((leisure or fitness) adj5 (centre* or center* or facilit*) adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (45)
66 ((walk* or run* or jog*) adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (9834)
67 ((gym* or sport* or aqua* or keep fit* or yoga* or pilates*) adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (2996)
68 (play* adj3 (ground* or equipment* or game* or place* or park* or leisure* or time* or break* or outdoor* or activ*) adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (685)
69 ((resistance train* or physical train* or exercise train* or strength train* or resilience train*) adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (3105)
70 ((bike or bikes or biking or bicycl*) adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (706)
71 ((cycle or cycling) adj5 (school* or work or workplace or commut* or travel* or equipment or facilit* or rack*1 or store*1 or storing or park* or friendly or infrastructure) adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (129)
72 ((swim or swimming or swims) adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (1671)
73 ((exercise class* or aerobic class* or fitness class*) adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (20)
74 ((rollerblad* or rollerskat* or skate or skates or skating) adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (81)
75 (physical exert* adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (64)
76 weightlifting.ab,ti. (229)
77 (active adj (travel* or transport* or commut*) adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (215)
78 ((multimodal transportation or alternative transport* or alternative travel*) adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (7)
79 (stair* adj5 (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (320)
80 ((pedestrianis* or pedestrianiz*) and (increas* or sustain* or encourag* or motivat* or promot* or improv*)).ab,ti. (3)
81 or/33-80 (121672)
82 32 and 81 (1470)

83 (Effects of a personal trainer and financial incentives on exercise adherence in overweight women in a behavioral weight loss program).ti. (1)[HEM1]
84 82 and 83 (1)
85 (personal trainers and financial incentives to increase exercise in a behavioral weight-loss program).m˙titl. (1)
86 82 and 85 (1)
87 (Promoting physical activity in a socially and economically deprived community: a 12 month randomized control trial of fitness assessment and exercise consultation).m˙titl. (1)
88 82 and 87 (0)
89 Project GRAD: two-year outcomes of a randomized controlled physical activity intervention among young adults.m˙titl. (1)
90 82 and 89 (0)
91 Does primary care referral to an exercise programme increase physical activity one year later?.m˙titl. (1)
92 82 and 91 (0)
93 Effects of physical activity counseling in primary care the Activity Counseling Trial a randomized controlled trial.m˙titl. (1)
94 82 and 93 (0)
95 Randomised controlled trial to examine the effects of a GP exercise referral programme in Hailsham, East Sussex, on modifiable coronary heart disease risk factors.m˙titl. (1)
96 82 and 95 (0)
97 Randomized controlled trial to evaluate the effect of a physical actvity intervention program based on behavioral studies.m˙titl. (0)
98 Effects of nurse counseling on walking for exercise in elderly primary care patients.m˙titl. (1)
99 82 and 98 (0)

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100 (Academic incentives for students can increase participation in and effectiveness of a physical activity program).m˙titl. (1)
101 82 and 100 (1)
102 Interventions for promoting physical activity.m˙titl. (5)
103 82 and 102 (0)
104 Effectiveness of an Incentive-Based Online Physical Activity Intervention on Employee Health Status.m˙titl. (1)
105 82 and 104 (1)
106 A randomized study of financial incentives to increase physical activity among sedentary older adults.m˙titl. (1)
107 82 and 106 (1)
108 Effects of an incentive-based online physical activity intervention on health care costs.m˙titl. (1)
109 82 and 108 (1)
110 from 82 keep 30,38,63 (3)

HISTORY

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CONTRIBUTIONS OF AUTHORS

Draft the protocol: GO'M and CF were responsible for the primary conceptualisation of the review. The draft of the protocol was written in accordance with a project plan by GO'M, DF, PB and CF. GO'M led the development of the writing of the protocol.

Study selection: titles from the search will be divided amongst the review authors for initial screening. All authors will independently examine the title, keywords and abstract of each report for inclusion in the review.

Extract data from studies: GO'M and shared between DF, IP, PB and CF will independently complete a data extraction form.

Assess the risk of bias: GO'M and PB.

Enter data into RevMan 5.1: GO'M.

Carry out the analysis: GO'M, DF and CF will perform statistical analyses using RevMan 5.1.

Interpret the analysis: GO'M with input from DF, IP, PB and CF.

Draft the final review: GO'M with input from DF, IP, PB and CF.

Disagreement resolution: DF will appraise risk of bias independently if disagreements arise.

Update the review: GO'M will undertake necessary future updates of the review.

DECLARATIONS OF INTEREST

None to declare.

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