Incentives to increase physical activity and reduce sedentary behaviour

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Incentives to increase physical activity and reduce sedentary behaviour

by

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Incentives to increase physical activity and reduce sedentary behaviour

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LIST OF PUBLICATIONS AND CONFERENCE PRESENTATIONS ASSOCIATED WITH THESIS

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***** denotes presenting author

ABSTRACT

Physical inactivity and engagement in high volumes of sedentary behaviour represent key contributions to disease burden globally. Effective initiatives to increase physical activity levels and reduce sedentary time are required. Incentive-based programs represent a promising approach to encourage health-promoting behaviours. While empirical evidence on the effectiveness to promote certain behaviours is growing there remain key gaps. For example, there is limited research regarding process analysis and economic evaluations of such programs. Furthermore, very few studies have explored incentive use for reducing sedentary behaviour. Incentive-based programs are increasingly being used by health insurers to promote health behaviours in the general population, however literature is limited in regard to how programs might best be tailored to populations most at-risk of poor health outcomes, such as socioeconomically disadvantaged groups.

In this thesis, four inter-related studies were conducted to examine the potential of incentive-based programs to encourage both an increase in physical activity and a reduction in sedentary behaviours in middle-aged adults (40-65 years). The first two studies focused on a previous incentive-based intervention (Active Choices IncEntiVE study; ACHIEVE) which was implemented in partnership with a private health insurer in Victoria, Australia. The process analysis (Study 1, presented in Chapter 3) of the ACHIEVE study allowed us to understand, importantly, from the participants' perspective, what 'worked' within the study, what did not work, and how the program could be improved. This guided the development of subsequent studies included in this thesis. The economic evaluation (Study 2, Chapter 4) enabled determination of the within trial cost-efficacy credentials of the ACHIEVE program

as well as the modelling of its long-term cost-effectiveness if it was scaled-up to all eligible Australians. The final two studies explored how to best tailor incentive-based programs for populations most at-risk of poor health outcomes due to physical inactivity and high levels of sedentary behaviour. A qualitative study (Study 3, Chapter 5) was conducted with socioeconomically disadvantaged middle-aged adults to explore perceptions of potential incentive-based program components and the needs and preferences of this group. The final study (Study 4, Chapter 6) aimed to confirm these findings quantitatively by engaging with a separate sample of adults of the same demographic who completed a discrete-choice experiment online.

The process evaluation (Study 1) of the ACHIEVE incentive-based study demonstrated that overall, the program was liked by participants and that embedding incentive strategies into a multi-component approach (particularly self-monitoring strategies) was perceived as effective. The importance of individually tailoring the program was outlined by participants, with text messages perceived as the least liked component of the program due to their 'impersonal nature' and lack of personalised support. Although overall the study was effective in increasing participants' physical activity and reducing their sedentary behaviour, sitting goals were reported as more difficult to achieve than physical activity goals. This was due to a variety of barriers including the perception that sitting was perceived in many instances 'unavoidable', particularly in workplace settings. Additional research is required in this space, particularly in terms of considering how to effect environmental changes to promote healthy behaviours.

The analyses of the economic evaluation (Study 2) suggested that the ACHIEVE study and similar incentive-based programs to increase physical activity and reduce sitting time are likely to represent good value for money, measured against the commonly accepted willingness-to-pay threshold in Australia. To our knowledge this is the first economic evaluation of incentive-based programs that targets a reduction in sitting.

The qualitative study in this thesis (Study 3) demonstrated that incentive-based programs to increase physical activity and reduce sedentary behaviour are an appealing approach among socioeconomically disadvantaged population groups. When evaluating program components, small, frequent, cash or shopping vouchers were reported as the most appealing elements. However, a unique finding was 'experience-based' rewards as a desirable incentive type. In addition, most participants expressed that they would be willing to be involved in an incentive-based program indefinitely, or for as long as it continued to meet their needs and hold their interest. The majority expressed the view that programs should be open to everyone, however there were some concerns about these programs being offered to those who were already active. The most appealing funding body to support these programs was the government, due to more 'trust' in programs funded by the government when compared with private enterprise. A social aspect to these programs was also particularly important to this cohort. Despite overall appeal, due to the wide variety of barriers to behaviour change reported, this study suggested that individual tailoring is likely to be essential when targeting programs to at-risk population groups.

The discrete-choice experiment in this thesis (Study 4) expanded on the qualitative study by quantitively exploring the appeal of incentive-based program components in a socioeconomically disadvantaged population group. When evaluating incentive type, there was no significant preference for cash rewards when compared to rewards tailored to personal interest, shopping vouchers or experience-based rewards for physical activity programs. The same trend was observed for sitting programs with the exception of cash rewards being preferred over experience-based rewards. In regard to incentive magnitude the highest value (AUD50) was preferred over the lower values for both physical activity and sitting programs. Indefinite/long-term programs were more appealing than those of shorter duration for physical activity programs. When considering sitting programs, there was no significant difference between preference for indefinitely/long term and 12-month or 6-month programs; however, 3-month programs were less appealing. This suggests that reward type and ideal program duration for participation may vary depending on target behaviour. When considering access to both physical activity and sitting programs there was no significant difference in the appeal of programs offering open access to all and those offering access only to people who were not already active. In regard to physical activity programs targeting to people with increased health risks was viewed as more appealing than open access programs, however there was no significant difference between these two options for sitting programs. This result highlights the different perceptions on who should have access may depend on health behaviour being targeted. There was no significant difference in preferences of programs to be funded by a combination of funding bodies when compared to government-only funded programs for both physical activity and siting programs. However, health insurer and private/sponsor funded program were less appealing than government funded programs for both health behaviours.

This thesis has contributed to the limited evidence base examining incentive-based programs to encourage an increase in physical activity and a reduction of sedentary behaviours. It has increased our understanding of appeal of these programs among middle-aged adults and those experiencing socioeconomic disadvantage; has evaluated the economic credentials of an incentive-based program; and explored and quantified the appeal of incentive-based program components to inform the development of interventions for an at-risk target group. Given the continued high prevalence of physical inactivity and sedentary lifestyles and associated disease risk, it is vital that novel intervention strategies (such as incentives) be explored and evaluated to encourage healthy behaviour change. It is also important that programs aim to move beyond using these strategies within affluent population groups (such as only being offered to those with private health insurance) and aim to resource health programs with a focus on equity. This means more in-depth studies that open a dialogue with at-risk populations about current barriers to increasing physical activity and reducing sedentary behaviour; the appeal of new, innovative programs; and how these programs could be best tailored to meet their differential needs.

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ACHIEVE:	Active Choices IncEntiVE study
AUD:	Australian dollar
AIHW:	Australian Institute of Health Welfare
BMI:	Body mass index
COREQ:	COnsolidated criteria for REporting Qualitative research
GDP:	Gross domestic product
GMHBA:	Geelong Medical and Hospital Benefits Association
HALYs:	Health-adjusted life years
MET(s):	Metabolic equivalent(s)
ICER:	Incremental cost-effectiveness ratio
IPAN:	Institute for Physical Activity and Nutrition
IT:	Information technology
IPAQ-L:	International Physical Activity Questionnaire Long version
PA:	Physical activity
SB:	Sedentary behaviour
WTP:	Willingness to pay

CHAPTER 1: INTRODUCTION

1.1. Physical activity

Physical activity is defined as any bodily movement that expends energy (1). Evidence suggests that regular physical activity is associated with considerable health-related benefits such as reduced risk of cardiovascular disease, type 2 diabetes, obesity and various forms of cancer (2). The Australian Physical Activity Guidelines recommend that adults should be active on most, if not all days of the week, for maximal health benefits. The recommended accumulation is between 150 to 300 minutes per week of moderate intensity physical activity or 75 to 150 minutes per week of vigorous intensity activity, or an equivalent combination of both, as well as muscle strengthening activities on at least two days, each week (3). Physical activity can be accumulated in various domains including domestic (household), transport-related, occupational and recreational (leisure-time) (3).

Physical inactivity is defined as participation in insufficient amounts of moderate to vigorous physical activity according to physical activity guidelines (4). According to the Australian Institute of Health Welfare (AIHW) report (2017) on the impact of physical inactivity as a risk factor for chronic conditions, the seven diseases most closely associated to physical inactivity are type 2 diabetes, bowel and uterine cancer, dementia, breast cancer, coronary heart disease and stroke (descending order) (5). In Australia, more than half (55%) of the adult population in 2017 to 2018 did not meet physical activity guidelines with an estimation of over 16,000 individuals dying prematurely due to physical inactivity annually (6-8). In fact, despite the increased focus on and understanding of the benefits of physical activity amongst researchers and in the public, insufficient activity has increased in high income countries over time (9). In addition to poorer health outcomes, a systematic review investigating the economic impact of physical inactivity outlined an estimate of attributable annual healthcare costs ranging from A$681.1 million to A$850 million for the Australian population (10).

1.1. Sedentary behaviour

Sedentary behaviour differs from physical inactivity and is defined as any sitting or reclining activity that is performed at or below the energy expenditure rate of 1.5 metabolic equivalents (4, 11). Sedentary behaviour can be categorised into domains such as occupational (sitting at a computer), transport-related (driving a car) and leisure-time (watching television, reading) (12, 13). Studies have identified sedentary behaviour as an independent risk factor for premature mortality, with particular links to increased risk of chronic health conditions such as type 2 diabetes, obesity, cardiovascular disease, high blood pressure, metabolic syndrome and abnormal glucose metabolism (14, 15). It is important to note that there has been some debate in the literature about the ability of moderate to vigorous physical activity to attenuate the health risks of high volumes of sedentary time (e.g., 16). It is therefore suggested that both the reduction of sedentary behaviour and the increase in physical activity should be targeted simultaneously in public health strategies.

Australian guidelines have placed increasing emphasis on encouraging individuals to minimise the amount of overall sedentary time and to interrupt prolonged sitting time frequently (3). Despite improved understanding of health risks associated with sedentary time, the prevalence of sedentary behaviours is high in developed countries. The Australian population specifically has been found to engage in sedentary behaviour for on average 50% to 70% of their waking hours (8 to 12 hours per day) (17). Among the key causes of high sedentariness are environmental factors. The modern workforce now consists of a high percentage of desk-based jobs, thereby limiting opportunities for physical activity throughout the day (18). Watching television is the most prominent leisure time sedentary activity across all adult age groups. Older age groups in particular were found to watch the most television, whereas computer use was more concentrated in younger adults (Figure 1.1; (7)) .

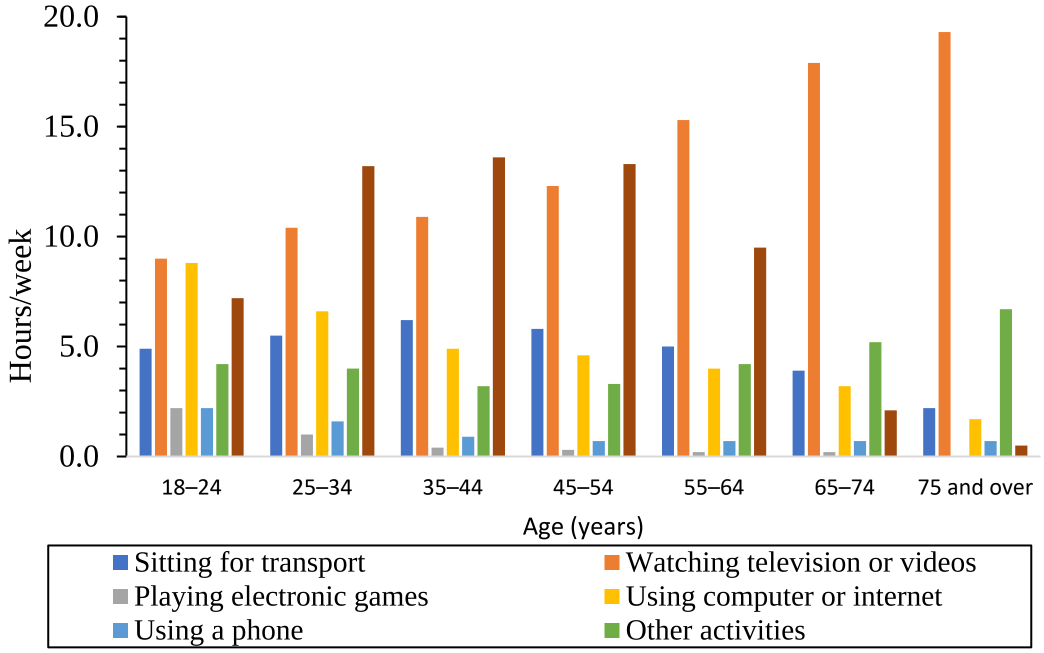

Figure 1.1. Average time spent in different forms of sedentary behaviour

Source: data from Australian Health Survey: 2011-12

Recent studies have also proposed a new approach to the classification and analysis of sedentary behaviour with a particular focus on the risks associated with depression (19). This research highlights the potentially important differences between passive sedentary behaviour (e.g., television viewing) increasing the risk of depression, whereas mentally active sedentary behaviours (e.g., reading) have been found to be a protective factor against depression onset (19). This is an important development which highlights the need to assess context and type of sedentary behaviour being assessed.

1.2. Socioeconomically disadvantaged populations

There are inequities in health across the socioeconomic spectrum (20). Socioeconomically disadvantaged individuals (e.g., those with low levels of education, low occupational status, low income, or living in a socioeconomically disadvantaged neighbourhood) are disproportionately affected by obesity and chronic diseases (e.g., type 2 diabetes, depression) linked to inactive lifestyles (5, 21). Research has identified that socioeconomically disadvantaged individuals are at greater risk of being physically inactive (22, 23). In addition, socioeconomically disadvantaged population groups are more likely to engage in higher levels of leisure-time sitting and television viewing (24-26). In Australia, the rates of disease burden due to physical inactivity is 1.7 times higher in the lowest socioeconomic group when compared to the highest socioeconomic group (5). A pattern of decreasing burden with increasing socioeconomic position has also been identified (5). Therefore, physical activity programs and interventions targeting those of low socioeconomic position are quintessential in contributing to a reduction in health inequalities.

1.3. Intervention approaches

A large number of interventions have been trialled in efforts to promote physical activity and reduce sedentary behaviour in the general population. Intervention approaches include informational (point-of-choice prompts), behavioural (individually-adapted health behaviour change programs), social (school/work-based physical education, social support in communities) environmental (increased access to physical activity-friendly environments) and policy (information outreach activities) (27). One approach that shows promise in promoting physical activity - including amongst individuals of low socioeconomic position - involves behavioural incentives.

1.3.1 Incentive-based intervention strategies

Incentive-based intervention strategies hold particular promise in promoting the formation of healthy behaviours. The rationale behind such an approach is based in numerous behavioural economic theories. One of these is operant conditioning, in which the frequency of a target behaviour is hypothesised to be manipulated through consequences of that behaviour (28, 29). In theory, repetition of association between the target behaviour and an incentive should lead to rational addiction and consequent habit formation. Although physical activity and reducing sedentary behaviours provide long-term health rewards, many individuals are ‘present biased’ – that is, they tend to value immediate, rather than distant future rewards for their behaviour, even if the latter are larger and more beneficial (28, 30). Therefore by receiving rewards soon after the desired healthy behaviour, as opposed to health benefits that may not be realised for years, individuals may be more likely to modify their behaviour and hopefully with time form a new healthy habit (30).

There are a number of important components to consider when developing incentive interventions to change health behaviours (31). One of the first is whether a financial (e.g., cash, gift vouchers, discounts) or non-financial (e.g., affirmation, competition) incentive is likely to be more effective. Another is the magnitude or total value of incentive required to motivate the individual to achieve the desired behaviour change (31). This may vary according to socioeconomic circumstances.

The direction and certainty of incentives must also be considered. Positive reinforcement of a desired behaviour every time it is enacted (assured incentives) is likely to be beneficial in terms of creating a stronger positive association with the behaviour in a shorter period of time. However, another technique has been the administration of rewards based on a lottery schedule. For example, some studies have supplied individuals with the eligibility to draw from a prize pool each time a desired behaviour is exhibited. The rationale behind framing an incentive in this way is to play on individual's 'anticipated regret' in regard to what could have been if they were adherent (32). Similarly, a 'reset' escalating reinforcement schedule plays into this notion of regret; if a participant does not achieve their goal, their reward rate will return to baseline and therefore their overall maximum possible gain is reduced by their lack of adherence. Another format that has shown promise is a 'buy in' or 'deposit contract' approach (28, 33, 34). This involves individuals investing their own money or being allocated a maximum earning at the beginning of the intervention and 'losing' a portion of this investment every time a goal is not achieved. This schedule therefore relies on the notion that individuals will be more motivated based on the theory of loss aversion (28).

Another component for consideration when formulating an incentive-based program is the scheduling of rewards. Incentives could be issued only for fixed optimal target behaviour patterns throughout the intervention (e.g., meeting physical activity guidelines each week) or a contingency management approach could be administered. The latter involves changing criterion to induce small but immediate changes in behaviour and therefore has the potential to gradually ‘shape’ behaviour towards an optimal goal (35). Despite participants achieving targeted behaviours faster when the optimal behaviour is required from the beginning of the intervention, contingency management approaches are likely to have more realistic potential for long-term maintenance of behaviour change (31, 36). This is due to contingency management-based approaches being more likely to increase an individual’s self-efficacy by helping them achieve realistic incremental goals regularly and therefore enhancing their perceived capability and control over health.

There are some concerns about the use of incentives to increase healthy behaviours. The first relates to ethical issues about rewarding individuals (particularly financially) for behaviours that they should arguably already be participating in for their own health and wellbeing. In addition, there have been some concerns that incentive schemes may lead to the widening of existing inequalities (37). Incentive programs assume a level of autonomy over behaviours, however, socioeconomically disadvantaged individuals, for example, are likely to have additional barriers to healthy behaviour change (e.g., environmental/social barriers, financial constraints) (e.g., 38), when compared with more advantaged individuals. This therefore highlights the importance of targeted incentive programs, that effectively address differential barriers to participation, as opposed to universal schemes in which rewards are more easily accessed by those who are already advantaged (37).

There have also been some concerns that programs which incentivise behaviours and then remove rewards may decrease an individual's intrinsic motivation, and subsequently the desired behaviours may in fact fall below baseline due to temporary presence then removal of an extrinsic reward (39). In a review of psychological literature, strong evidence for an undermining effect (or 'crowding out') of rewards on intrinsic motivation was found when motivation for the task was initially high (40). However, for health-related behaviours, where baseline levels of the incentivised behaviour were already low, these effects were not observed (40). One possible explanation for this is that by offering incentives to those who initially have high levels of intrinsic motivation, it may change the focus of the motivation for those people (from being intrinsically motivated to then being more extrinsically motivated), which then leads to lower motivation once the incentive is removed. Therefore, targeting individuals with little interest in the health-related behaviour prior to intervention (e.g., those not sufficiently active) may be less likely to have a negative effect.

In summary, there are many approaches by which incentive-based programs can be administered. Form, magnitude, direction, certainty and scheduling are all important incentive components that need to be selected in a way most appropriate to the target population and target activity.

1.4. Thesis outline

Given the promise of incentive strategies to encourage healthy behaviour change, the purpose of this thesis is to examine the potential of incentive-based programs increase physical activity and reduce sedentary behaviour in both the general population and in socioeconomically disadvantaged population groups.

The next chapter (Chapter 2) presents an overview and critique of existing literature relevant to the research topic of incentive-based interventions to increase physical activity, incentive-based interventions to reduce sedentary behaviour and current approaches for healthy behaviour change to in socioeconomically disadvantaged population groups. The aims of this thesis are also presented in this chapter.

Four studies were conducted as part of this thesis and are presented in the four subsequent chapters. Chapter 3 and Chapter 4 focus on evaluating a previous incentive-based program to increase physical activity and reduce sedentary behaviour in the general population. These analyses include a process analysis (Chapter 3; Study 1) and an economic evaluation (Chapter 4; Study 2).

Chapter 4 and Chapter 5, expand on this by exploring the appeal of incentive-based program components amongst socioeconomically disadvantaged population groups. This includes a qualitative analysis (Chapter 4; Study 3) and a discrete-choice experiment (Chapter 6; Study 4).

Chapter 7 provides an overview of thesis findings, their relationship to previous work and their implications for public health. This chapter also outlines the limitations and strengths of this thesis and recommendations for future research.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

An early scope of the literature identified several published systematic reviews on financial incentives to increase physical activity (e.g., 41, 42). However, few studies were identified relating to incentive-based approaches for sedentary behaviour or studies specifically focusing on the use of incentives with socioeconomically disadvantaged adults. So as to not duplicate the literature of the physical activity incentive-based reviews and due to the limited studies identified regarding sedentary behaviour and socioeconomically disadvantage population groups a systematic review of these topics was not considered suitable for this thesis.

This chapter therefore includes a narrative review on the research areas outlined below:

- Incentive-based programs to encourage physical activity in adults
- Incentive-based programs to reduce sedentary behaviour in adults
- Intervention strategies to reduce sedentary behaviour
- Incentive-based programs focused specifically on socioeconomically disadvantaged adults
- Interventions which have explored socioeconomic characteristics as a moderating factor in the effect of incentive-based programs to encourage healthy behaviour change

This chapter also provides an overview of economic evaluations of interventions to increase physical activity and reduce sedentary behaviour with the purpose of providing information on the methodology of these analyses.

2.2. Incentive-based programs to increase physical activity

2.2.1 Aim

The aim of this review was to investigate the impact of incentive-based programs or interventions on physical activity or physical fitness among adults in the general population.

2.2.2 Methodology

Search terms

A detailed search for research articles was conducted in March 2016 and updated in July 2020. Included in the search were the terms physical activity, exercise, fitness, incentive, reward and reinforcement. Search strategy combinations included ("physical* activ*" OR exercise* OR fitness*) AND (incentiv* OR reward* OR reinforc*). Electronic databases used were Ebscohost (Academic Search, AgeLine, Global Health, Health Source, MEDLINE, SPORTDiscuss), Scopus and Google Scholar. No limitations were placed on the date of publication. Reference lists of relevant studies were further examined.

Inclusion/exclusion criteria

Outlined below are the inclusion/exclusion criteria which guided this review.

Inclusion criteria:

- Observational (e.g., cohort studies) and intervention (e.g., randomised controlled trials and non-randomised controlled trials) studies
- Adult participants (18 years and older)
- Studies which outline incentive administration (e.g., cash reward, lottery draw)
- Studies with an indicator or physical activity (e.g., vigorous aerobic exercise, step-

count) or physical fitness (e.g., direct behavioural criteria) as an outcome measure.

- Incentive administration consequential to behaviour change

Exclusion criteria:

- Meta-analyses or review studies
- Studies published in a language other than English
- Studies with a focus on individuals with a serious underlying medical condition
- Studies which only administered incentives as a recruitment strategy

2.2.3 Overview of studies

Details of the studies included in this review are summarised in Appendix A. The majority of these were intervention studies however observational studies were also included (43-47). Most of studies identified were conducted since 2005. All studies were conducted in a single country, the majority of which were in the United States (28, 35, 43, 45-70). However, there were also studies included from Australia (71), England (72), Ireland (73, 74), Pakistan (75) and South Africa (44). Settings included universities (28, 35, 49, 52, 54-56, 58, 59, 61, 62), workplaces (43, 45-47, 53, 64, 65, 70, 71, 73, 74) and community settings (44, 48, 50, 51, 53, 57, 69, 72). Measures of physical activity included step counts (35, 45, 46, 48, 50, 51, 53, 60, 62-64, 66-68, 70, 74, 75), attendance at fitness centres/programs (43, 44, 49, 54, 55, 58, 59, 61) and monitors of aerobic fitness (28, 47, 52, 56, 63, 65, 66, 69, 71). The most common incentive type was financial incentives (cash, gift voucher, product discounts), the alternatives being personal choice incentives (e.g., 'dinner and a movie if I complete my goal') (56) or academic reward (e.g., extra point on exam/overall course grade) (52). A significant positive association between incentives and increases in physical activity was observed in the majority of studies (28, 35, 43-46, 48-50, 52, 53, 55, 56, 58, 59, 61, 63, 65-70, 72). However, concerns about the maintenance of increased physical activity were identified (28, 53, 55, 57, 60, 64, 70). All these interventions exposed participants to incentives for 12 to 13 weeks (28, 53, 55, 57, 60, 64, 70), highlighting the need for more research to explore the potential impact of program length on maintenance. Another important aspect which - to our knowledge - is yet to be explored, is whether gradual removal of incentives could have a positive impact on program outcomes as opposed to incentives abruptly ceasing at the end of an intervention (as was the case with all the studies assessed).

2.2.4 Observational studies

Observational studies (i.e., that did not involve investigator-driven interventions) examining the effects of incentives on physical activity were identified (43-47). This included retrospective cohort studies (43-46) and a retrospective nested case-control study (47). Although all analyses were retrospective in nature, they varied on many design features that are outlined below.

The studies differed in regard to the sample and setting of the analysis. Samples sizes varied from 320 (46) to 304,054 (44). Studies were based in the United States (43, 45-47) and South Africa (44). Studies retrospectively analysed the impact of incentive-based health programs on employees (43, 45-47) and medical plan members (44). Despite sample differences, all participants were considered to be healthy adults in the general population.

Target behaviours, incentives and measures also varied between the programs analysed. Study goals included increasing utilisation of fitness-centres (43, 44, 47) and local fitness-related activities (44) and increasing step counts per day (45, 46). Measures of goal achievement included self-reported physical activity (43), objectively measured centre attendance (44, 47) and objectively measured step counts via electronic devices (45, 46). Incentives included cash rewards, (43, 45, 47), gift vouchers (46), and discounts on local goods and services (44).

Results from retrospective analyses indicated positive associations of incentive-based programs and increases in physical activity for the majority of the studies. Studies indicated that these associations were particularly strong for those participants who had a low initial baseline level of physical activity (43, 45), although it was reported that it was more difficult to recruit these participants. Follow-up analyses indicated that increases in physical activity also translated to lower rates of hospital admissions and subsequently lower hospital costs (based on the evaluation of admissions and costs in the 2 years post the 3-year observational study of fitness-related activities) (44). When comparing different incentive schedules, tiered incentive schemes (e.g., 40000 steps per quarter received US$100 gift card (tier 1); 6500000 US$125 gift card (tier 2); and 900000 US$150 (tier 3)) worked best in comparison to a static quarterly goal/reward (500000 steps per quarter received a US$100 gift car) (46). The study that demonstrated the least positive results was the nested case-control (47). This program involved providing intervention group members a US$25 incentive for each time they visited a fitness centre a minimum of 10 times. Although the program was initially associated with increased utilisation of fitness centres this this did not translate to long-term maintenance (12-months after enrolment at fitness centre) (47).

Despite the majority of analyses in these observational studies demonstrating an increase in physical activity linked to incentive-based programs, limitations of these studies should be considered. Firstly, retrospective observational studies do not allow for participants to be randomised into groups and therefore causality cannot be determined. In addition, the use of fitness centre ‘attendance’ (44, 47) as a measure of physical activity has been criticised due to validity limitations (e.g., possibility of another individual swiping access card) and the inability to capture the exact nature of the activity (e.g., low intensity vs. high intensity; actual activity duration). Sample limitations include cohorts that were likely to be of a higher socioeconomic status and education status (due to university affiliations) (47) as well as groups that may be more interested in physical activity engagement due to being employees in the health and wellness industry (46). Restricted access to employee demographic and characteristic information in one study also precluded determining whether hard-to-reach employees were included in the cohort (45).

2.2.5 Randomised controlled trials

Samples of randomised controlled trials comprised predominately healthy adults, with a small number focusing on older populations (51, 69) or individuals who were overweight or obese (44, 54, 68). Studies differed in terms of the target behaviours, assessment of behaviour change and magnitude of incentives provided. For example, physical activity as assessed in regards to fitness session/ fitness-centre attendance (54-56, 59, 63), step goals (51, 53, 60, 64, 68, 70, 74, 75), specific exercises to be completed (such as treadmill or cycling) (28), and aerobic exercise in general (52, 66, 69). Physical activity behaviour change was predominantly assessed through the use of pedometers, accelerometers or smartphone applications (51, 53, 59-61, 64, 66, 68, 70, 74, 75) or electronically recorded attendance at fitness programs/ fitness-centres (55, 63). In some studies, these objective measures were combined with self-report (52, 68, 69). The value of incentives received for achieving physical activity goals ranged from US$0.95 per weekly goal achieved (75) to US$500 if participant was the winner of a lottery ‘jackpot’ draw (64).

In addition to target behaviour, assessment of change and magnitude of incentives received, studies also varied in terms of the probability and timing of incentives. Excluding a few studies (52, 56) interventions primarily issued a financial incentive (e.g., cash reward, gift voucher). Some studies included ‘lottery’ schedules in which participants gained eligibility to win cash or gift vouchers on completion of physical activity goals (51, 54, 61, 64). An American study which included a lottery component required participants to deposit US$3.00 prior to the intervention and had the opportunity to win a chance at a cash or voucher valued at US$21 for attending four out of five exercise sessions (61). Results of this study showed that the lottery group had a significantly higher attendance than the control group. The additional personal deposit component in this lottery study may have had a positive influence in comparison to the lottery studies which did not include this feature (51, 54). Another study using an investment strategy included three incentive types; gain, lottery and loss (53). All participants were assigned a goal of 7,000 steps per day. The control group received daily feedback, the gain group received US$1.40 each day the goal was achieved, the lottery group received daily eligibility (valued at ~US$1.40) if the goal was achieved and the loss group (who invested US$42 upfront), lost US$1.40 each time a daily goal was not met (53). The assigned incentive value (US$1.40) was guided by previous literature which explored adherence to remote-monitoring regimens in patients with poorly controlled diabetes. This study found that the lower incentive-arm (US$1.40) improved remote-monitoring rates when compared to the control and had significantly better outcomes once incentives ceased, compared to higher incentives (76). Interestingly results showed financial incentives framed as a loss to be the most effective for physical activity goals. This negative-reinforcement or ‘buy-in’ incentive was also combined with a positive reinforcement in an American study (59). This included positive reinforcement of a new accelerometer bracelet for achieving 200 miles and a program t-shirt for achieving 400 miles. In addition, a loss aversion strategy was also administered where if participants achieved 450 miles, they received a US$25 of a previously invested US$100 which was required to participate in the program (59). However, in this study no difference was found within incentivised and non-incentivised conditions. This result may have been a consequence of combining positive and negative reinforcement, an approach that has not been previously explored.

Studies showed that incentives were more effective in increasing physical activity if the population targeted was previously insufficiently active (52, 58). These studies compared results of participants who regularly attended a gym or were sufficiently active to sedentary cohorts and found that targeting cohorts that were already active were not effective (52, 58). This result may be due to active individuals already being intrinsically motivated and therefore extrinsic motivators such as financial rewards have little effect in boosting activity levels further. Therefore, future programs should focus on incentives targeting sedentary populations in order to promote adoption of physical activity rather than increasing activity in those already active.

Supplementary approaches were used alongside incentives in many of the trials. It has been suggested that for incentives to be useful they should be embedded alongside other successful behavioural change techniques in order to promote increased intrinsic motivation that is sustained after the cessation of incentives (77). The use of accelerometers, pedometers and smartphone applications as measures of physical activity (53, 57, 59, 60, 64, 66, 68-70, 73-75) adds an element of self-monitoring to the incentive-based programs reviewed and this in itself could have increase motivation for behaviour change. Studies (28, 60, 61) also incorporated group sessions within their intervention programs, which may have encouraged behaviour change through peer support, accountability and unity towards a common goal. Reinforcement supplied by significant others (56), peer networks including online message boards (51) and coaching (66) provided by trained paraprofessionals are additional ways in which three randomised controlled trials incorporated social-support components to complement incentive-based programs. Results on the use of multiple behavioural techniques were however varied and therefore further studies should explore varying combinations of these to determine their effectiveness in increasing physical activity.

Limited studies were identified that included an economic evaluation of randomised controlled trials. However, results from a study which did include this, found that despite reduced health care costs, reduced absenteeism, and improved mental wellbeing the intervention was not cost effective from the National Health Services perspective. Results indicated that the intervention had the potential to be cost effective from an employer's perspective however more research was required (74). Limitations of this study included the possibility that incentives were too low to encourage long-term behaviour change (74).

Most studies included in this review found a significant increase in physical activity as a result of an incentive-based intervention when compared to a control group. The studies in which a significant association was not found were noticeably limited by design features, such as only assessing physical activity in working hours (73); setting step goals that were too difficult to achieve (51); assigning incentives that were potentially too low to increase motivation (74, 75); and creating competition between participants for rewards which may have hindered performance (57) .

There were also numerous limitations identified throughout the randomised controlled trials reviewed. These included small sample sizes and samples which were non-representative of the general population (54, 69, 71). In addition, duration of interventions significantly varied (4 weeks to 12 months) and few studies included a follow-up assessment point after incentives had ceased. However, the length of interventions did not seem to be associated with effectiveness. Regardless, the variability across studies in intervention duration and lack of consistent follow-up analyses limit the ability to draw conclusions about optimal intervention dose, the sustainability of behaviour change and the likelihood of healthy habit formation amongst participants.

2.2.6 Non-randomised controlled trials

Non-randomised controlled trials included in this review targeted to healthy adults from the general population (35, 49), older adult populations (50, 72), adults who were overweight or obese (48, 67) and specific sedentary occupations (71). Sample size was extremely varied between these interventions ranging from six individuals (50) to 6,548 participants (48). Duration of interventions varied from one week (35) to 12 months (48). Physical activity was measured in terms of fitness class attendance (72), step goals (35, 48, 50, 67), a suite of physical activity goals (71) and a combination of attendance and reaching specified behavioural criteria (49).

Physical activity behaviour change was assessed objectively using pedometer, accelerometers and smartphone applications (35, 48, 50, 67, 71), by research assistant supervision (49) and self-report (72). Most studies administered an assured financial reward (48-50, 67, 71, 72). Again, as with the randomised controlled trial interventions, the lottery-based schedule study (35) had the poorest result, with only four of the 11 participants in the intervention group increasing their physical activity. However, this conclusion is limited by the small sample size of this study.

Various reward schedules were used in these studies. One of which was the administration of a contingency management reward schedule. This involved incremental changes in the behaviours required to receive rewards, thereby encouraging gradual increases in physical activity towards the target behaviour. This type of scheduling theoretically holds great potential, due to the ability to increase individuals' self-efficacy and perception of their control over their health. Despite this, incorporating this approach showed the least promising results of the non-randomised controlled trial interventions (35). Another non-randomised controlled trial intervention that used this approach also incorporated a post-intervention follow-up assessment after incentives were withdrawn (49). All participants in this study significantly increased exercise during intervention, moving from an inactive level at baseline to achieving three 30-minute sessions per week. Participants were also found to maintain some physical activity gains in the follow-up assessment however this was shortly after the intervention had ceased (2 weeks).

Adapting goals to the contextual needs of participants was also a strategy explored (67, 68). This approach included researchers setting daily dependent on participant's baseline measures and by examining contextual information (e.g., daily stress, busyness, weather, perceived self-efficacy) (67). Results of this study were promising, with participants increasing their daily steps by an average 2,650 (p<0.001) and reporting enjoying variable goals each day. Another study included participants in the design of physical activity goals prior to the intervention (71). Due a focus on a unique occupation in this study (truck drivers), participants were asked to join group sessions (3-4 participants) to discuss where positive physical activity choices could be incorporated into their daily shift routines. These then informed the final suite of behavioural goals developed by the researchers. Results of this study indicated non-significant increases in physical activity, however again the sample size of this study was small (n=19).

There were strengths and limitations in the methodologies of most of the non-randomised controlled trial interventions included in this review. The use of lab-based attendance as a measure of physical activity is a particularly limiting approach as it does not consider an individual's physical activity outside of the lab (49). In addition, the application of a one-week intervention and a one-week follow-up period (35) is likely to be insufficient time to establish behaviour change and observe lasting impacts. A study including a process evaluation questionnaire (72) identified that some participants rated the required activities to achieve incentives as too difficult. Similarly, although two thirds of participants another study (48) reported appreciating the health benefits of the intervention (e.g., weight loss), one third did not like the program, with some participants reporting that they felt coerced to take part. Numerous strengths however could be considered for inclusion in future studies. These include the use of an internet-based intervention, thereby eliminating location as a barrier (48, 50). In addition, process evaluation questionnaires which offer an avenue for participants to voice their likes and dislikes could be beneficial in informing future programs of consumers' perceived effectiveness, acceptability, suitability and implementation of varying components of previous intervention programs administered.

2.2.7 Summary

Incentive-based programs offer potential to increase physical activity, however current research remains limited and inconsistent in terms of methodology and results. It was clear from the literature - and aligning with behavioural economic theory - that interventions targeting individuals who are not sufficiently active were more effective. However, there remains insufficient evidence and lack of consensus about incentive form, magnitude, timing of administration of incentive, scheduling of rewarded behaviours and the overall duration of intervention required in order to ensure sustainable behaviour change. In addition, no study included a comprehensive cost-effectiveness analysis. The economic credentials of interventions should be considered in future research, in order to determine whether the cost of an intervention is justified by the benefits, and therefore inform feasibility of population roll-out. By gaining consensus on these components, there is potential for effective incentive-based programs to be administered and population health to be improved.

2.3. Incentive-based programs to reduce sedentary behaviour

2.3.1 Aim

The aim of this review was to investigate the impact of incentive-based programs or interventions on sedentary behaviour or sitting time among adults in the general population.

2.3.2 Methodology

Search terms

A detailed search for research articles was conducted both in March 2016 and updated in July 2020. Included in the search were the terms sedentary, sitting, incentive, reward and reinforcement. Search strategy combinations included (sedentary OR sitting) AND (incentiv* OR reward* OR reinforc*). Electronic databases used were Ebscohost (Academic Search, AgeLine, Global Health, Health Source, MEDLINE, SPORTDiscuss), Scopus and Google Scholar. Reference lists of relevant studies were further examined.

Inclusion/exclusion criteria

Outlined below are the inclusion/exclusion criteria which guided this review.

<u>Inclusion criteria:</u>

- Observational (e.g., cohort studies) and intervention (e.g., randomised controlled trials and non-randomised controlled trials) studies
- Adult participants (18 years and older)
- Studies which outline incentive administration (e.g., cash reward, lottery draw)
- Studies with an indicator or sedentary behaviour (e.g., sitting time/day) as an outcome measure.
- Incentive administration consequential to behaviour change

<u>Exclusion criteria:</u>

- Meta-analyses or review studies
- Studies published in a language other than English

- Studies with a focus on individuals with a serious underlying medical condition
- Studies which only administered incentives as a recruitment strategy

2.3.3 Incentive-based programs to reduce sedentary behaviour

Very few studies were identified in this review which explored the effectiveness of incentive-based programs to encourage reduction of sedentary behaviour. The studies that were identified were randomised controlled trials conducted with 204 (78) and 212 (66) healthy, sedentary adult participants in community settings in the United States.

Studies had similar, yet different design features. Each included a combination of different target behaviours related to diet, physical activity and sedentary behaviour. One study evaluated combining target behaviours into one of four treatment groups (e.g., Group one: increase fruit and vegetable consumption and physical activity; group two: decrease fat and sedentary leisure time; group three: decrease fat and increase physical activity; and group four: increase fruit and vegetable consumption and decrease sedentary leisure time) (78). Another explored incentivising behaviour change simultaneously (moderate-to-vigorous physical activity, sedentary behaviour and diet targets) or sequentially (moderate-to-vigorous physical activity after diet and sedentary behaviour targets). Intervention lengths varied from a three weeks (78) to a nine month intervention (66). Financial incentives contingent on behaviour targets were included in both studies with maximum values ranging from US$60 (66) to US$175 (78). Studies included supplementary components in the form of coaching and mobile technology support.

Results from these studies in regard to reducing sedentary behaviour time were promising. Improvements were observed in the combined increase of fruit and vegetable consumption/decrease of sedentary leisure time treatment group (78). This group improved significantly more than the other three treatment groups ($p<.001$). Specifically, sedentary leisure time in this group was reduced by, on average, over two hours a day, compared to baseline measures (baseline: 219 mins/day; end of program: 89 mins/day) (78). Participants also maintained substantial improvements in the five month follow-up (125.7mins/day) (78). Similarly, another study reported large, improvements in both the simultaneous and sequential intervention groups when compared to the control (66). Specifically, sedentary leisure time decreased by ~170 minutes per day at the end of the 9-month intervention (66). These preliminary results hold promise that the combination of coaching supported by mobile technology and financial incentives can encourage the reduction and maintenance of healthy behaviour change in sedentary adults.

2.4. Effective non-incentive-based approaches for reducing sedentary behaviour

Clearly there is a dearth of studies trailing incentives to reduce sedentary behaviours. However, in recent years there has been increasing interest among researchers and health practitioners in exploring ways to encourage individuals to decrease detrimental sedentary habits using a range of other intervention approaches (79). This section will therefore provide a brief summary of examples of broader effective approaches for reducing sedentary behaviour among adults, despite the lack of an incentive component.

2.4.1 Setting

A recent review exploring the effectiveness of interventions targeting sedentary behaviour, found that the greatest reduction of sedentary behaviour (in adults) in was from environmental interventions (79). Aligning with this, the majority of adult interventions within this area have been administered in a workplace setting (e.g., 80, 81-83). Despite research being warranted within this environment due to the highly sedentary trends of many workplaces, the homogeneity of research settings is of concern. One randomised controlled trial was identified which investigated the effects of an intervention targeted at reducing sedentary behaviour in all domains of life (84). However, observed decreased in sitting time within this study were not significant.

2.4.2 Prompting programs

Prompting technology to reduce sedentary behaviour was an intervention strategy identified within the literature (e.g., 80, 85, 86). One study which used this approach aimed to increase workday activity by interrupting prolonged occupational sitting time (80). This study used prompts delivered through work computers to encourage participants to introduce short bursts of physical activity throughout the day. The rationale was that prompts not only interrupted established habits but also re-engaged individuals in conscious decision-making about their health behaviours (80). Self-report measures indicated that the e-health intervention was an effective mechanism for increasing work-related energy expenditure and reducing prolonged sitting (80). Another study also found prompts delivered through work computers to be a feasible, low cost approach to breaking up sitting time, however low self-efficacy and the desire to conform to cultural norms were highlighted as barriers to behaviour change (86). A systematic review of the literature found that computer prompted reminders alone were not effective in reducing sedentary behaviour in the workplace, however when combined with education or information sessions results were promising (87).

2.4.3 Standing/active workstations

Another approach to reduce sedentary behaviour time was the passive inclusion of standing or active workstations. A systematic review on workstations' influence on sedentary time, highlighted that this simple change to the environment had the potential to effectively reduce occupational sedentary time, without compromising work performance (81). However, more research is needed (specifically, large and long-term randomised controlled trials) in order to determine the sustainability of this behaviour change and the long-term impact on health and work-related outcomes (81).

2.4.4 Multicomponent programs

A multicomponent intervention strategy has also been used to reduce sedentary behaviour. Several studies have indicated strong success and acceptance of multicomponent interventions in the reduction of sedentary time (82, 88-90). A randomised controlled pilot which aimed to reduce both workplace and leisure sedentary time in overweight and obese participants, using hourly screen-delivered prompts to break up sitting time at work, and daily text messages during transportation, home and leisure time (82). Participants were found to reduce their sitting time and increase both standing and stepping in the intervention period. Further studies (88-90) have shown that substantial reductions in sitting time were achievable through the use of integrated individual, environmental and organisational elements (88) and a theory-based internet delivered program, including a portable pedal machine at work and a pedometer for 12 weeks (89). A systematic review found that multi-component interventions reported the greatest reductions in workplace sedentary behaviour (91).

2.4.5 Summary

In recent years there has been an increasing focus in the health research literature on approaches for reducing individuals' sedentary time. Most of the research among adults has targeted workplace settings. Prompting systems, active workstations and multicomponent interventions were all well received and widely accepted by participants. However, there is still a need for the effectiveness of these program components to be explored within population-based studies and subgroups most at risk.

2.5. Effectiveness of incentive-based programs for promoting healthy behaviour change across the socioeconomic spectrum

Considering the evident health inequities across the socioeconomic spectrum (20), it is important that interventions are assessed across different socioeconomic groups, especially those most at risk of developing chronic diseases. However, considering the limited research examining incentives for promoting increased physical activity behaviour, very few studies have explored the impact of such approaches across varying socioeconomic groups, and no study has assessed the differential impact across socioeconomic groups of incentives for reducing sedentary behaviours.

Socioeconomically disadvantaged populations are likely to have differential barriers that impact their ability to achieve recommended levels of physical activity and sedentary behaviour, when compared to more advantaged groups (38, 92, 93). It has been suggested that incentive-based interventions are in fact likely to be more appropriate and appealing to individuals experiencing socioeconomic disadvantage (94, 95). This is due to the ability of such interventions to address barriers that are salient within these groups such as insufficient financial resources to participate in leisure time physical activity programs (38). However there appears relatively little empirical evidence to support this notion.

This section examines the limited evidence of the effectiveness of incentive-based interventions for promoting healthy behaviour change in low socioeconomic populations. Studies identified in the review (Section 2.2) of incentive-based interventions to increase physical activity that specifically targeted socioeconomically disadvantaged groups are expanded on in more detail in this section. In addition, this section will also provide a brief summary of studies which have explored the differential impact of incentive-based programs for healthy behaviour change (e.g., smoking cessation, weight loss, medication adherence) across socioeconomic groups. This knowledge will inform the formation of future interventions by establishing the potential differential responses to incentive-based interventions across socioeconomic groups, and outlining components that might be particularly effective and appealing when tailoring programs to at-risk groups.

2.5.1 Incentive-based programs specifically targeting socioeconomically disadvantaged groups

To our knowledge, only one study has examined the effectiveness of incentive-based intervention programs on behaviour change specifically within socioeconomically disadvantaged populations. This study (72) implemented a ‘healthy passport’ intervention program amongst older adults (50+) (n=186) in a deprived multi-ethnic district in the England. This study evaluated the effectiveness of incentives on health promotion activities including physical activity. Over six months, participants were offered various activities (e.g., cycle sessions, walk sessions) for which they could receive points that could be exchanged for rewards. When participants achieved 15 points they were eligible to receive slippers, a 10 percent discount pass for activities at local leisure centre or a meal at the local café. When participants achieved 30 points, they were eligible for a £20 gift voucher.

Significant improvements were found in terms of physical activity. Specifically, the frequency of physical activity was at first low for the older people in the intervention (70s), but by the time they had achieved 15 points (the first reward threshold) the number of days they participated in 30 minutes of exercise had significantly increased ($F=5.35$ (df 1, 53), $p<0.05$) (72). However, after this timepoint their physical activity increased no further. In the evaluation questionnaire when participants were asked (in an open-ended question) what they thought they had changed as a result of the program 33% of respondents reported more walking or physical activity (72). When evaluating adherence and behaviour change, enjoyment of the incentive scheme, support from peer group organisers, level of understanding and barriers (such as mobility) were all influencers (72). Notable positive outcomes from the evaluation questionnaires included the use of an incentive scheme and likeability of the program overall (72). In addition, when asked if they would be willing to be involved in an extended or related intervention to improve their health, reduce isolation, and improve social engagement, 96% of respondents reported ‘yes’ (72).

2.5.2 Differential impact of incentive-based programs across socioeconomic groups

A meta-analysis (96) has produced some insights on the roles of demographic characteristics in financial incentive-based approaches to changing health behaviours (e.g., smoking cessation, weight loss, medication adherence). This analysis included seven randomised controlled trials with available participant-level data published between 2006 and 2014 (96). While physical activity was not specifically assessed, weight loss related behaviours were. Conditional payment, deposit contract and lottery incentive structures were all included. Participant characteristics included gender, age, race, education and household income. Results found no significant links between financial incentives and income, education, age, gender or race. However, when further adjusting for incentive structure, significant race differences in behaviour change were identified and lower income participants had greater odds of behaviour change when compared with higher-income participants (96). This study highlights the potential differences between population groups in regard to the structure of incentives and their impact on effectiveness. Such findings suggest a need to consider differential participant characteristics when implementing an incentive-based intervention to achieve behaviour change.

An additional systematic review and meta-analysis examined financial incentives for changing habitual health-related behaviours and included a focus on the influence of recipients' deprivation level (97). Health-related behaviours included smoking cessation, healthy eating and physical activity. Participants 'deprivation level' was classified as either, 'high' or 'other' based on the particular measure used in the studies evaluated (e.g., income, employment, education, ethnicity). Results showed that at six and 12 months from the start of the intervention, the effect of incentives across health-related behaviours was greater for participants identified as ‘highly deprived’ when compared to ‘less deprived’ participants; although most did not reach statistical significance. Regardless, this empirical evidence suggests the potential role of participants’ socioeconomic characteristics in the moderation of the impact of financial incentives on health-related behaviour.

2.5.3 Summary

Despite some promising results that incentive-based programs may be effective in promoting healthy behaviour change in socioeconomically disadvantaged populations, the evidence in this area is limited. More research is needed to determine the needs and preferences of at-risk disadvantaged populations in order to appropriately tailor interventions.

2.6. Economic evaluations of interventions to increase physical activity and reduce sedentary behaviour

Given the lack of literature specific to economic evaluations of incentive-based programs to increase physical activity and reduce sedentary behaviour, this section aims to provide an overview of economic evaluations of studies to increase physical activity and reduce sedentary behaviour without an incentive component. The purpose of this section is to provide information on the methodology of these analyses.

A recent systematic review (98) , covering literature from 2009-2017, explored the methods used in economic evaluations of targeted physical activity and sedentary behaviour interventions. A total of 15 economic evaluations (17 publications) were included. Studies were from four countries; United Kingdom (n=8), New Zealand (n=3), the United States (n=2) and the Netherlands (n=2). Targeted participant groups included older adults, individuals with pre-existing conditions or medical diagnosis, specified age groups, females, and specific ethnic groups. Intervention settings included primary care or community and the home. No studies were identified which targeted sedentary behaviour as a risk factor independent of physical activity (98).

The methodology of these studies varied. Most studies were single trial-based economic evaluations (n=10), which compared costs and consequences of groups during the intervention and follow-up period but not beyond. Five studies were model-based which extrapolated trial effectiveness estimate over the lifetime of the cohort. However, the assumptions which informed analyses varied greatly. Two thirds of the studies (n=11) reported one type of evaluation; a cost utility analysis (n = 5) or cost-effectiveness analysis (n = 6). The remainder included both a cost utility and cost effectiveness analysis (n=2) and a cost-consequence analysis in addition to cost utility analysis (n=2). No studies included in this review conducted a cost-benefit analysis, despite this approach being established in the literature as preferrable over a cost-utility analysis (99).

The most common analysis perspective employed was a health sector perspective (n =7), followed by a societal perspective (n=3), payer perspective (n=1), multi-agency public sector perspective (n=1) or a combination of different perspectives (n=3). Two studies did not report their analysis perspective. The most common type of cost reported was the intervention costs, followed by healthcare costs. Outcomes used in the reporting of incremental cost-effectiveness ratios varied, however the most common was ‘cost per short-term QALY gain’. All model-based studies assessed long-term gain as QALYs gained as a result of not developing health conditions (e.g., type 2 diabetes, coronary heart disease) or experiencing premature mortality.

2.6.1 Summary

Results from this review (98) highlight the heterogeneity in the methodology of economic evaluations in this field as well as the scarcity of economic evaluations for targeted sedentary behaviour interventions.

2.7. Thesis aims

In light of the literature review above, this thesis will provide insights into the perceived effectiveness and cost-effectiveness of an incentive-based intervention which aimed to promote both increased physical activity and reduced sedentary behaviour in the general population. It will then qualitatively and quantitatively explore how incentive-based programs could be tailored to meet the differential needs of socioeconomically disadvantaged population groups. Specific aims and associated chapters are outlined below.

- Study 1 (Chapter 3) aim: To evaluate the appeal, acceptability and perceived effectiveness of an incentive-based intervention (ACHIEVE) to increase physical activity and reduce sedentary behaviour in the general population.
- Study 2 (Chapter 4) aim: To evaluate the cost-effectiveness of an incentive-based intervention (ACHIEVE) to increased physical activity and reduced sedentary behaviour in the general population.

- Study 3 (Chapter 5) aim: To qualitatively evaluate the appeal of incentive-based program components to increase physical activity and reduce sedentary behaviour in a socioeconomically disadvantaged population group.

- Study 4 (Chapter 6) aim: To quantitatively evaluate the appeal of incentive-based program components to increase physical activity and reduce sedentary behaviour in a socioeconomically disadvantaged population group

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CHAPTER 3: A PROCESS EVALUATION OF AN INCENTIVE-BASED PROGRAM TO INCREASE PHYSICAL ACTIVITY AND REDUCE SEDENTARY BEHAVIOUR[1]

3.1. Introduction

The previous chapter highlighted that although incentive use is increasing, particularly as an approach to encourage an increase in physical activity, very few studies have moved beyond evaluated outcome variables. Process evaluations are essential to aid an understanding of how the program was received and the relationship between program components and outcomes (100). Regardless of the effectiveness of a program it is important to conduct a process evaluation to inform future research and programs. The Medical Research Council's guidelines on process evaluation of complex interventions list core components as (1) Implementation: what is implemented, and how?; (2) Mechanisms of impact: how does the delivered intervention produce change?; and (3) Context: how does context affect

[1] Note: elements of this chapter have been published in Ball K, Hunter RF, Maple JL, Moodie M, Salmon J, Ong KL, Stephens LD, Jackson M, Crawford D. Can an incentive-based intervention increase physical activity and reduce sitting among adults? the ACHIEVE (Active Choices IncEntiVE) feasibility study. International Journal of Behavioral Nutrition and Physical Activity. 2017 Dec 1;14(1):35.

implementation and outcomes (101). The current study focuses on implementation factors and mechanisms of impact (e.g., participant responses to and interactions with the intervention). Assessment of contextual factors was beyond the scope of this analysis due to resource limitations.

Of the existing incentive-based studies targeting physical activity or nutrition, only two were identified which included a process evaluation. One of which was study conducted in a multi-ethnic metropolitan borough in England (72) and targeted older residents (50+ years) in this area. Participants were recruited through a variety of community-based approaches, the most successful being local older people's groups and clubs. The study used financial incentives that were awarded when participants accrued enough points for completing specified healthy behaviours. Each participant received a booklet (the 'passport') that outlined tasks and reward requirements. Physical activity focused behaviours included attending an extend class (i.e., gentle exercises designed to improve mental and physical health), cycle training, family bike riding session and walking with a 'health walk leader'. Significant improvements were identified in relation to exercise, diet and the uptake of influenza vaccines and eyesight tests. The program evaluation found that barriers to program success identified by participants included finding assigned activities too difficult, poor understanding of activities, difficulty arranging transport and mobility problems. Positive outcomes were associated with participants who reported liking the 'passport' format of the incentive-based intervention.

An American study also evaluated participants' perceived effectiveness of a large-scale internet-mediated walking program (48). Participants in this study were recruited through Blue Care Network of Michigan. The focus was on individuals with a BMI of ≥ 30kg/m² who were participating in an internet-mediated walking program as part of an optional wellness program. The program included the use of pedometers, goal setting through step-counts and web-based feedback. The incentive component was eligibility for enhanced benefits such as reduced deductibles and co-payments. These benefits amounted to approximately 20% of savings in out-of-pocket expenses which, for some families, was a saving of GBP 2,000. Therefore, incentives for participating in the program and meeting step-count goals could be substantial. Despite impressive rates of program enrolment and adherence, the program evaluation identified that one-third of survey respondents reported disliking the program and some participants outlining financial incentives as coercive. Two-thirds however reported that appreciating the health benefits they gained from the program and preliminary data suggested long-term effects for individuals who participated for a full year maintaining step-counts substantially higher than established goals.

Process evaluations were an essential component of both of these studies by establishing the strengths and weaknesses of the incentive-based design and implementation. Intervention studies including thorough process evaluations are needed to; 1) determine the appeal, acceptability, perceived effectiveness of program components; 2) inform the formation of future programs.

3.2. Aim

The aim of this study is to evaluate the appeal, acceptability and perceived effectiveness of the incentive-based intervention for participants. The Active Choices

IncEntiVE (ACHIEVE) study was an intervention to test the feasibility, effectiveness and cost-effectiveness of using incentives to increase physical activity and reduce sedentary behaviour in inactive adults. The main outcomes for the ACHIEVE study are published (102), with some elements of this process evaluation included in this publication.

3.3. Methods

A mixed methods approach was chosen in order to provide both quantitative analysis as well as rich qualitative insights into the appeal, acceptability and perceived effectiveness of the ACHIEVE study. The methods and procedures are described below.

3.3.1 Ethics and consent to participate

Ethical approval for the ACHIEVE study was obtained from Deakin University Human Research Ethics Committee (HEAG-H 179_2014). All participants signed a consent form prior to the intervention. Modification for the student researcher (JLM) to access data for the process evaluation was approved on third of May 2016.

3.3.2 The ACHIEVE study

The ACHIEVE study was designed prior to the commencement of PhD candidature, however all analyses included in this chapter were led by the candidate. Details of the ACHIEVE study have been previously published (102). Briefly, the study explored the perceived feasibility of an incentive-based program to increase physical activity and reduce sedentary behaviour among adults aged 40-65 years, since this life stage is characterised by high levels of inactivity and increased risk of chronic disease (6, 7). Key features of the study relevant to the process evaluation are described below.

Participants

A total of 82 participants were recruited to the ACHIEVE study through the utilisation of the Geelong Medical and Hospital Benefits Association (GMHBA) member database. Two participants withdrew during the program resulting in a final sample size of 80 (35 men and 45 women). GMHBA is a leading not-for-profit insurance fund in Victoria, Australia, with a socio-demographically diverse membership. To be included in the study, participants had to meet the following criteria; 1) aged between 40 and 65 years; 2) living 25kms from Deakin University's Burwood campus; 3) not meeting Australian government physical activity guidelines; and 4) spending more than three quarters of the day sitting, on most days (3). More information on participant demographics is outlined in Table 3.1 below.

Table 3.1. Participant demographic information

Five-year age and gender groups	Age count
Female	45
40-45	9
46-50	11
51-55	12
56-60	7
61-65	6
Male	35
40-45	13
46-50	8
51-55	5
56-60	5
61-65	4

Intervention and procedures

The ACHIEVE study was a 16-week intervention conducted from June 2015 to November 2015. Within this period participants were encouraged to increase their physical activity to 150 minutes per week and reduce their sitting time by 150 minutes per week in progressive increments. Physical activity goals were chosen to align with recommended guidelines (3). Sedentary behaviour goals were chosen by the research team as an initial feasible target and to match the physical activity goal which made for a simpler message for participants to remember. Physical activity and sedentary behaviour were measured pre and post intervention using the International Physical Activity Question Long Version (IPAQ-L), which is a 27-item self-report measure that assesses duration and frequency of physical activity in the last 7 days.

Participants received daily points, with one point per minute allocated for engaging in moderate to vigorous intensity physical activity (capped at 30 minutes per day) and one point per minute reduction in sedentary behaviour from baseline measure (capped at 30 minutes per day), with the overall goal of at least 30 minutes per day of activity and 30 minutes per day reduction in sedentary behaviour. Weekly targets were provided to participants and points were accrued over fortnightly periods. Participants received corresponding rewards at two weeks post-baseline, four weeks, and then monthly (see Table 3.2 below). Fitbit data were used to facilitate the distribution of incentives. More information regarding incentives and complementary components of the ACHIEVE study are described below. Participants' perceptions of these components were assessed in the process evaluation.

Incentives

Incentives included clothing, recipe books, and Coles/Myers vouchers (of A$10, A$40 and A$50). There was also a raffle for the final incentives (1 of 4 Apple iPad Minis), which was drawn once all participants had completed the 16-week intervention. The incentive schedule is outlined in Table 3.2. Eligibility for incentives was determined once every two weeks. Participants were required to sync their provided Fitbit via their mobile phone in order to upload their behaviour data onto the ACHIEVE website. The total cost of incentives provided in the study was A$7,519.

Table 3.2. Incentive schedule and dollar value (AUD) (Source: Ball et al., 2017)

	First 2 weeks	Second 2 weeks (Month 1)	Month 2	Month 3	Month 4
For increased physical activity: one point/minute, capped at 30 minutes/day (total possible 210 points/week)	For achieving 200 PA points per fortnight (100 mins PA/week) Women's scarf $7.50 Men's cap $10.50	For achieving 200 PA points per fortnight (100 mins PA/week) $10 supermarket voucher	For achieving 240 PA points per fortnight (120 mins PA/week) Heart Foundation classic or barbeque cookbook $17.00 or $20.00	For achieving 300 PA points per fortnight (150 mins PA/week) points $50 supermarket voucher	For maintaining 300 PA points per fortnight (150 mins PA/week) Chance to win one of four Apple iPad Minis
For reduced sedentary behaviour: one point/minute reduction from baseline, capped at 30 minutes/day (total possible 210 points/week)	For achieving 200 SB points (100 mins reduction/week) $10 supermarket voucher	For achieving 200 SB points (100 mins reduction/week) Heart Foundation shirt $18.00	For achieving 240 SB points (120 mins reduction/week) $40 Supermarket voucher	For achieving 300 SB points (150 mins reduction/week) Heart Foundation hooded jacket $38.00	For maintaining 300 SB points (150 mins reduction/week) Chance to win one of four Apple iPad Minis
Total value for participants	$17.50 ($8.25/week) for women $20.50 (10.20/week) for men	$28.00 ($14.00/week)	Average $14.30/week	$80.00 ($22.00/week)	

Abbreviations: PA physical activity; SB sedentary behaviour

Complementary intervention components

The main intervention component was the administration of incentives subject to meeting the behavioural criteria discussed above. However, since the literature suggests that incentives are more likely to be successful when incorporated into a broader range of behaviour change strategies (77, 80), a variety of complementary intervention components were also administered.

Motivational interview

Motivational interviews have been identified in the literature as an effective approach for supporting behaviour change (103, 104). This intervention component provided interpersonal social support and also the opportunity to facilitate participants in generating their own goals. Interviews took place by telephone at a prearranged time around four days after the participant's baseline measurement appointment. Interviews were conducted by one of two research staff and took approximately 20 minutes. Participants were provided with information on physical activity and sedentary behaviour guidelines. They were also asked to discuss what they believed would be the benefits of making changes to their current activity habits. Interviewers explored tailored strategies to help participants achieve their goals. On conclusion of the interview, participants were instructed that they could begin the intervention program.

Text messages

Prompting techniques have been identified as a successful approach in physical activity behaviour change interventions (105). Participants in the ACHIEVE study received weekly text messages (n=16) via Telstra short messaging services throughout the intervention period. These were designed to provide encouragement and strategies for behaviour change success. The library of text messages is provided in Appendix B. Messages were based on control theory principles (31). Self-regulation techniques were a particular focus, with several text messages prompting goal-setting and intention formation (e.g., ‘Have you reviewed your physical activity and reduced sitting goals? Try setting a new goal to walk 30 mins more or sit 30 mins less.’). Messages were also sent for administrative purposes (reminders to participants to weigh themselves, complete blood pressure measures or complete evaluation surveys) (n=7-10 depending on participant actions, e.g., second reminder to send weight reading).

Fitbit

A Fitbit One device (valued at A$129) was given to each participant to measure their physical activity and sedentary behaviour. Participants were advised that regular syncs via their mobile telephone or computer were essential, in order to upload their data to the ACHIEVE website to calculate eligibility for incentives. Participants were also required to place the device on ‘sleep mode’ each night to ensure only awake sedentary time was recorded. The device was administered as a monitoring component, however participants had access to their data and were therefore able to track their progress. This form of self-regulation again aligns with control theory principles (31) and complemented the main incentive intervention component. Participants were entitled to keep the device upon the completion of the intervention.

3.3.3 Data collection

Pre and post-study surveys

The effectiveness of the ACHIEVE study was assessed through pre- and post-study surveys (Appendix C). The pre-study survey was completed online by participants at baseline. The same questions were presented in each survey to assist in determining outcome effects (self-reported physical activity and sedentary behaviour). The post-study survey was administered online after the participants had completed the 16-week intervention period. This included an additional section about participants' experience with the ACHIEVE study for process evaluation purposes. The complete process evaluation measures are provided in Appendix C. Questions assessed participants' overall experience with the program as well as experiences with specific study components (incentives, motivational interview, text messages, Fitbit, and program length). Questions covered appeal, usability, helpful experiences and room for improvements. Since the questions were highly specific to the intervention program and content, they were developed by the research team for this study. Both Likert-type scale and open-ended questions were included.

3.3.4 Data analysis

Descriptive statistics were analysed using Stata 14 (Statscorp) (106). This included calculating percentages of the Likert-type scale questions to determine the degree to which the sample agreed or disagreed with the statements presented.

For the qualitative analysis, NVivo 10 software (QSR International) (107) was used to organise the data and methods for thematic analysis were informed by previously published guidelines (108). Firstly, the open-ended responses were read multiple times by the student researcher (JLM) with initial themes identified in each. Following this, major categories were created by combining similar codes and subcategories (e.g., injury, sickness and fatigue). Once reviewed, themes were linked with direct quotes. Consistent with the view that prevalence does not necessarily indicate the importance of a theme (108), inclusion in analysis was determined based on the extent to which the theme expanded on the knowledge required to answer the research question, rather than occurrence with the data. The mixed methods approach allowed quantitative analysis of exact numbers of respondents who agreed or disagreed with statements about the program and the ability to confirm this and expand on reasons why through qualitative analysis.

3.4. Results

3.4.1 Overview

Seventy-four participants completed the post-study survey (92.5%). For context, the main outcome results (reported elsewhere (102)) indicated that overall participants increased their leisure-time physical activity by 252.5 minutes per week; increased their transport-related physical activity by 178.5 minutes per week; and reduced their sitting time by 3.1 hours per day (all $p<0.001$) between baseline and follow-up. As previously mentioned, these outcomes were assessed using the IPAQ-L and despite being a validated measure, it is important to note that some over-reporting may have occurred. In regard to incentives achieved, two-thirds of the sample qualified for the first physical activity incentive (100 mins physical activity/per week) only one third qualified for the last incentive (102). In comparison, achieving sitting incentives appeared more difficult, with 43% of participants qualifying for the first incentive (100 mins reduced sitting time/week) and only 20% for the last incentive (102).

Overall, the results of the process analysis indicated that the majority of participants reported liking the incentives and finding the intervention easy to both understand and monitor progress. Quantitative survey responses are presented in Table 3.3 and Qualitative themes in Figure 3.1.

Table 3.3. Responses (%) to program component questions (n=74)

Program components	Likert-type response percentages (%)				
Incentive	**Strongly agree**	**Agree**	**Neither agree or disagree**	**Disagree**	**Strongly disagree**
I liked the type of incentives	20	49	26	4	1
The incentive point motivated me to be more active	24	34	24	15	3
Incentive points motivated me to reduce my sitting time	26	24	30	19	1
It was easy to check how many points I had	30	38	11	16	5
It was easy for me to understand the points I needed to achieve incentives	34	31	14	15	7
I found it hard to do enough physical activity to achieve the incentives	7	23	23	32	15
I found it hard to reduce my sitting time enough to achieve the incentives	18	31	18	26	8
Continuing to receive incentives would motivate me to be more active in the future	27	42	20	7	4
Continuing to receive incentives would motivate me to sit less in the future	26	36	19	14	5
Overall, the incentives were helpful	32	41	11	12	4

Interview	**Strongly agree**	**Agree**	**Neither agree or disagree**	**Disagree**	**Strongly disagree**
The interview motivated me to change my physical activity habits during the ACHIEVE program	26	54	16	4	0
I already knew the information (e.g., 30min/daily) provided in the interview	23	59	8	9	0
Overall, the interview at the start of the ACHIEVE program was helpful	31	54	14	1	0
Fitbit	**Strongly agree**	**Agree**	**Neither agree or disagree**	**Disagree**	**Strongly disagree**
The Fitbit motivate me to be more active	68	30	1	1	0
The Fitbit motivated me to reduce my sitting time	36	36	12	14	1
The Fitbit was easy to use	51	39	5	4	0
I found it easy to track my activity online	54	42	3	1	0
Overall, the Fitbit was helpful	59	38	1	1	0
Text message	**Strongly agree**	**Agree**	**Neither agree or disagree**	**Disagree**	**Strongly disagree**
The weekly text message motivated me to be more active	8	36	31	20	4
The weekly text message motivated me to sit less	8	35	34	18	5
I always read the text messages	45	50	1	4	0
Overall, the weekly text messages were helpful	11	50	20	16	3

Program length	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
The length of the ACHIEVE program (4 months) was appropriate	35	46	12	7	0
Program component questions			**Answer options (% endorsing)**		
	Interview	**Fitbit**	**Text messages**	**Incentives**	
What do you believe was the most helpful component of the ACHIEVE program for you?	8	81	0	11	
	1-4 months	**4-8 months**	**12-18 months**	**18-24 months**	**>24 months**
After the end of this 4-month program, how long do you think that further incentives would continue to motivate you?	41	16	22	4	18
	Yes	**No**			
Overall, would you say that the ACHIEVE program has made a difference to your physical activity habits?	96	4			
Overall, would you say that the ACHIEVE program has made a difference to your sitting time?	65	35			
Would you be willing to use a Fitbit to track activity for one year?	95	5			

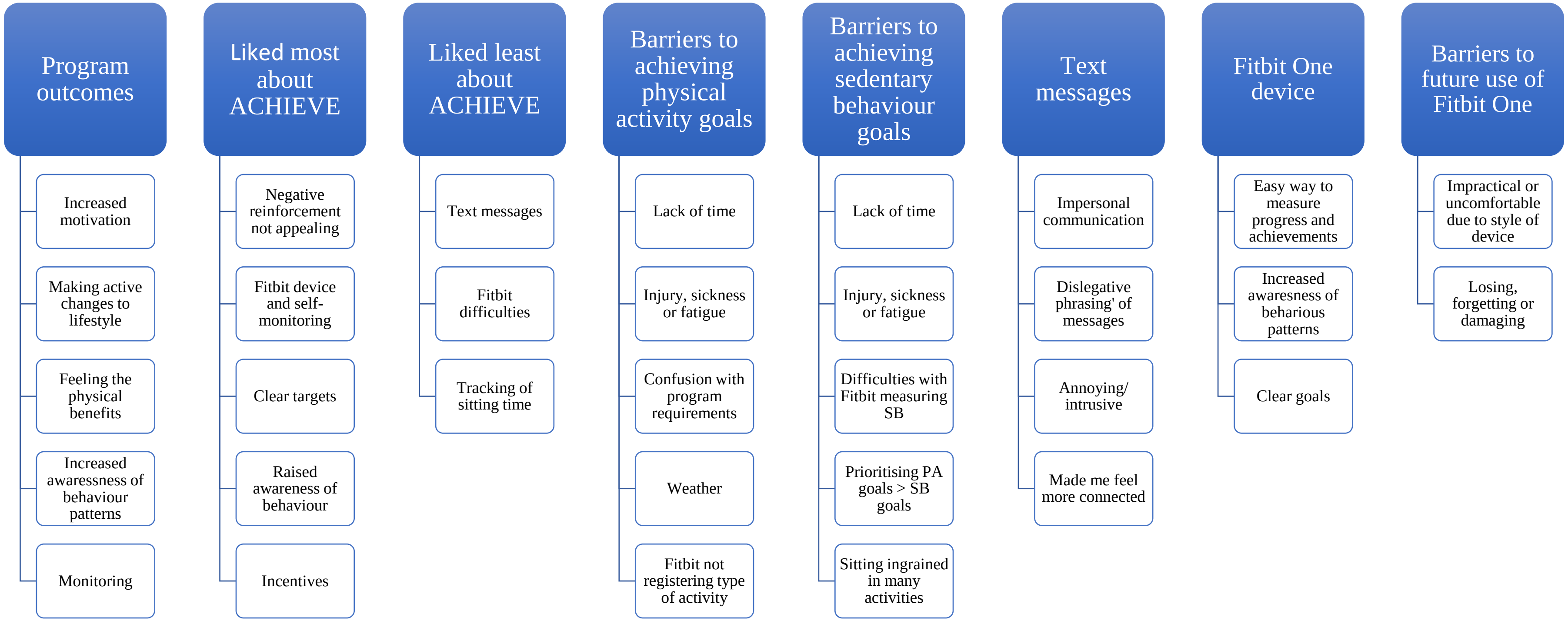


Figure 3.1. Qualitative themes

3.4.2 Incentives

As shown in Table 3.3, the majority of participants (69%) reported liking the types of incentives offered. More than half also agreed that the incentive points motivated them to be more active (58%) and half agreed they motivated them to reduce their sitting time (50%). The program usability was perceived favourably, with most reporting that checking points was easy to do (68%), and that it was easy to understand the points needed to achieve incentives (65%). The majority also reported that continuing to receive incentives would motivate them to be more active (69%) and sit less (62%) in the future. Overall incentives were perceived as helpful by most respondents (73%).

Just under one third (30%) of participants suggested they found it difficult to participate in enough physical activity to achieve incentives. Qualitative data expanded on reasons for this. The most commonly mentioned barrier was the lack of time to accomplish these goals. Participants discussed long hours in work or study environments that required them to be based at a desk with limited opportunities for physical activity throughout the day. Following work, for some participants, family commitments such as supervising children or preparing meals were a higher priority than exercising.

> *When working I cannot just stop what I am doing and leave to exercise… By the time I get dinner ready and our two children in bed it is dark and I am not going to go walking by myself at night time.* – ID96, Female

Close to one quarter of participants reported injury, sickness or fatigue as reducing their ability to achieve physical activity goals. Another barrier reported participants was confusion with program requirements. While the quantitative findings showed that most participants found the requirements easy to understand, several respondents reported qualitatively that they struggled with these. This finding suggests that more discussion in the initial baseline meeting or provision of more detailed information was necessary on how points were calculated and how to effectively sync data.

> *The Fitbit start/end days could not be set up to correlate with the study incentive periods… Initially I didn't realise they didn't correlation and ended up missing out...* – ID62, Female

> *I had no idea what I had to do to achieve the incentives other than it was something about accumulating active minutes…* – ID168, Male

Weather conditions were also reported by a few participants as a barrier. Similarly, the Fitbit device not registering the participant's preferred type of activity (e.g., swimming, martial arts) deterred some.

Responses suggested that sitting time was harder to shift than physical inactivity through the use of incentives, with about half of the participants reporting difficulty in achieving sitting goals. Similar themes to those for physical activity emerged (lack of time; injury, sickness and fatigue; weather conditions) regarding the reasons participants found it hard to reduce their sitting in order to achieve the incentives.

Just under half of participants stated that sitting was especially ingrained in many activities which made it difficult to reduce this time. This was particularly so for work environments as well as meals, relaxation and travel time.

Considering that my work is 100% in front of the computer it was really hard to achieve target without affecting my workload. – ID185, Male

Office job requires sitting at desk. Regular meals also require sitting. Rest and relaxation also requires some sitting. Overall limited opportunities to reduce sitting time. – ID26, Male

An additional theme also discussed by a few participants was the preference to prioritise physical activity goals rather than reduce sitting.

I wasn't focusing on sitting less as much as walking more to achieve 10,000 steps a day. –ID176, Female

A couple of participants reported that despite their efforts to reduce sitting time they did not see any change in what was recorded and that this disappointment contributed to a discontinuation in trying to achieve the incentive goals.

I thought I did reduce my sitting time until I checked the times, was extremely disheartened so didn't really try to cut sitting time as a goal. – ID108, Female

3.4.3 Text messages

Just under half (45%) of participants reported that the text messages motivated them to be more active and around the same number (43%) agreed that they motivated them to sit less. The vast majority (95%) reported that they always read the messages and just under two-thirds reported the messages to be helpful (61%).

In regard to the qualitative data, a few participants reported that the text messages were the program component that they liked least about the ACHIEVE study.

Reasons for this included dislike for impersonal communication, negative phrasing of particular messages and finding them to be annoying or intrusive.

> *The text messages were mechanical and lifeless.* – ID64, Female

On the other hand, a few participants reported liking the text message component as it made them feel more connected to the study.

> *Interaction with text… also kept me connected with the people behind the study and this gave me a sense of being supported and recognized by others…* – ID65, Female

3.4.4 Motivational interview

Despite the fact that most participants reported that they already knew the information provided during the motivational interviews (82%), the majority reported that the interview motivated them to change their physical activity habits (80%) during the program and most agreed that overall, the interview was helpful (85%).

3.4.5 Fitbit

The vast majority of participants (97%) reported that overall, the Fitbit was helpful. In fact, around 81% of respondents reported this as the most useful component of the ACHIEVE study. Most participants responded that the Fitbit was useful in motivating them to be more active (98%), and in motivating them to reduce their sitting time (72%). The Fitbit was reported as generally being easy to use (90%) and easy to track activity online (95%).

The qualitative data also showed that the Fitbit was perceived very favourably when participants were asked to discuss what they liked most about the ACHIEVE program. Reasons for this included that it provided an easy way to measure progress and achievements, clear goals, and awareness of poor behaviour patterns. These were all seen as motivating factors to make healthier choices.

> *The Fitbit gave me lots of information to develop my strategies to becoming fitter.* – ID65, Female

However, despite overwhelming likeability for the Fitbit, numerous participants discussed that they did not believe the Fitbit was accurately portraying reality and being confused as to how the Fitbit was in fact measuring sitting time.

> *I felt that each week I spent less time sitting than the week before but the Fitbit recorded that I was sitting more.* – ID79, Female

When asked if there was anything that would prevent participants from wearing the Fitbit for a year, a number of common themes were evident. These included losing, forgetting or damaging the device as well as impracticality of wearing the device at all times. Another common theme was dissatisfaction about the style of the Fitbit One (which clips onto clothing) which was selected for the study, with many participants reporting that they thought a wristband design would reduce the difficulties experienced in the program and increase long-term usability.

> *Fitbit one, attached to clothes, is too easy to forget and leave behind when changing. Wrist band would be much more reliable.* – ID26, Male

Regardless of these limitations, most (95%) said they would use the Fitbit to track physical activity for one year.

3.4.6 Length of the program

When asked how long they believed that the provision of further incentives would continue to motivate them, the most selected option was a further one to four months (41%), which was the shortest duration option provided, followed by 12 to 18 months (22%). The selection of shortest duration may have been a reflection of participants already believing that the 4-month period assigned to the program was appropriate, with the majority of participants agreeing with this statement (81%).

3.4.7 Program effects on physical activity and sitting time

Participants were asked to report whether they perceived that the ACHIEVE program made a difference to their physical activity and sedentary behaviour (Table 3.3). Overall, most participants agreed that the program improved their physical activity levels (96%). The majority, although a smaller number, also reported that the program improved their sitting time (65%). When asked how the program had made a difference, participants reported that they had made active changes within their lifestyle as a result of the program. These ranged from incidental changes in their work life such as walking whilst on the phone, to maintaining a habit of a minimum 30 minutes of exercise each day. Participants also reported feeling the physical benefits as a result of the program. This included improved fitness, mental health, gradual weight reduction, increased energy, muscle definition, decreased aches and pains and overall feeling ‘healthier’.

> *I loved the energy it gave me and that was very rewarding. I got muscles in places I hadn't had them in years and that was a good feeling. I felt like I was reversing the ageing I have done over the past 8 years.* – ID100, Female

> *…feel so much healthier, my fitness has improved dramatically. I no longer puff and pant just walking to the kitchen, I can easily walk up and down the stair in my home and try to do it at least 10 times a day! I feel great and my mind has improved and I am thinking so much more clearly, I feel like my life is starting over.* – ID66, Female

Goal setting, self-monitoring and increased awareness were all themes that emerged in qualitative responses discussing the factors that led to changes in both physical activity and sedentary behaviour as a result of the ACHIEVE program. Participants reported that having set targets such as 10,000 steps per day increased their motivation to maintain healthy habits. Participants also expressed that being able to track their progress throughout the day helped facilitate these changes. Some reported that knowing others were monitoring their progress motivated them to make changes and in turn form healthy habits. Participants reported that before the program they did not realise how inactive they were, and how much more was required of them to reach health recommendations.

> *It has made me aware how little time we spend being active. Also it is not possible to just go along your daily routine and accumulate 10,000 steps. One really needs to put some effort into it.* – ID36, Male

3.5. Discussion

Despite increasing evidence to support the use of incentive strategies for healthy behaviour change (77, 109), relatively little research has explored participants' perspectives of the appeal, acceptability and perceived effectiveness of incentive-based interventions to increase physical activity and even less to reduce sedentary behaviour. In addition to evaluating intervention outcome variables, it is essential that process evaluations are conducted in order to facilitate improvements in future programs.

In the current study, all individual components as well as the overall program were perceived favourably by the majority of participants. This is a promising finding as likability has been identified as an important correlate associated with positive outcomes in incentive-based programs which include physical activity measures (72). Participants reported that tasks and requirements were easy to understand in the present study. This finding contrasts with that of previous incentive studies where a lack of understanding of the tasks was perceived as a barrier to program success (72). Participants overwhelmingly perceived a positive difference to their physical activity, and amongst a smaller majority, to their sedentary behaviour as result of the ACHIEVE study. These findings are consistent with those of other studies showing incentives can have a positive impact on physical activity (48). The present results are encouraging as not only do they expand on previous process evaluations in the physical activity domain but they also provide preliminary data on the perceived effectiveness of incentive-based programs for the reduction of sedentary behaviour.

3.5.1 Incentives

Acceptability and usability of the incentive component of the ACHIEVE study was high. The majority of participants agreed that continuing incentives would motivate them to be more active and reduce their sedentary behaviour in the future. However, survey responses also indicated that almost all participants thought the program length was suitable (16-weeks). More research is needed to explore the optimal length of incentive programs, with particular attention to the effectiveness of program components.

3.5.2 Complementary components: Text messages and motivational interviews

Overall, the majority of participants reported both the text messages and motivational interview to be helpful. Most participants reported that despite already knowing the information provided in the interviews, this procedure still motivated them to change their health behaviours. The reach of the text messages was high with most participants reporting that they always read the messages they received. Evidence supports the efficacy of text message-based interventions for health promoting behaviours (e.g. smoking cessation, physical activity) (110), with preliminary evidence suggesting that these effects can be maintained long-term (111). However, over half of the participants in this study did not believe these messages motivated them to change their behaviour. In fact, text messages were most commonly reported as the least liked component of the ACHIEVE study. One prominent reason outlined in the qualitative data was due to their impersonal nature of the communication. This aligns with previous meta-analysis findings, with individual tailoring and personalisation being associated with significantly greater efficacy in text message-based interventions for health promotion (110). Therefore, tailoring the content of text messaging to be more personal is a recommended strategy for improved acceptability in future research.

3.5.3 Complementary component: Fitbit

The Fitbit was overwhelmingly reported as the most helpful component of the program. Despite the fact that the Fitbit was not provided as an 'incentive' per se, based on goal achievement, it clearly did serve as a perceived incentive for participation among participants. Perceived Fitbit usability was also high with most participants agreeing that it was easy to use and to track activity online. The majority of participants also reported that they would happily continue to use their Fitbit to track their physical activity. Self-monitoring is a well-established effective strategy in many physical activity interventions (52). These results therefore further support that Fitbits are a likable and easy to use program component of incentive-based interventions.

3.5.4 Difficulty achieving outlined goals

Around one quarter of participants agreed that it was difficult to do enough physical activity to achieve incentives. This was even more evident in regard to reducing sitting time, with almost half the participants reporting difficulty meeting sitting targets. Multi-component goal setting interventions are well-established as an effective method for encouraging physical activity across various population groups and settings (112). Participants in the present study reported that having clear goals and the Fitbit to track progress towards these were major motivating factors.

Consistent with previous literature (13) the commonly reported barriers to achieving incentives included lack of time and work or study environments restricting opportunities. In particular, the goals for reducing sedentary time were reported as unrealistic, with many participants believing that sitting was simply ingrained in daily activities, and in some instances unavoidable. This aligns with previous sedentary behaviour literature where participants reported due to the strong association of sitting with daily activities such as eating, reading, socialising and television viewing, sedentary behaviour had become ingrained in their lifestyle and was therefore difficult to change (113). Participants in the current study endorsed this view by expressing that the perceived impracticality of reducing sedentary behaviour led some to simply abandon these goals altogether and instead focusing solely on increasing physical activity, due to the belief that this was more achievable. These results indicate that a focus on more realistic goals and information about how to reduce sedentary behaviour at home, work and in the community may be necessary. In addition, looking into ways in which social norms can be shifted, particularly workplace attitudes towards sitting is likely to be beneficial to employee's health (e.g., managers encouraging employees to break up sitting time every 30 minutes).

Evidence on the independent health risks of engaging in prolonged periods of sitting is still relatively newly established, and therefore the general population may not be as familiar with these risks or as motivated for change. It is therefore important to raise public awareness around the issue. Given that workplace physical activity programs have shown promise in reducing sedentary behaviour (114), targeting managers and leaders may be one approach to creating an environment that is more accommodating and accepting of workers aiming to reduce their sedentary behaviour.

Some participants questioned the reliability of the Fitbit One for was monitoring sedentary behaviour. A number of participants reported that they believed they were making active changes to replace sitting time and were then disheartened by the fact that they were not seeing any recorded improvements. This may be due to unrealistic perceptions of actual behaviour and expectations. An additional explanation may have been participants' failure to comply with the instruction to place the Fitbit into sleep mode each night. Failure to do so would mean sleep would not have been recorded separately to (awake) sedentary time, which would skew data towards higher recorded sitting levels and make incentives more difficult to achieve. It is not possible to determine this from our data; however future studies could assess participants' compliance to this recommendation. There is also the possibility that the device simply did not accurately capture sedentary changes. The Fitbit One has been established as a valid measure of moderate to vigorous physical activity (115) however there is limited research on accuracy of this device to measure sedentary behaviour (116). Alternative devices such as ActivPal and LUMOback have been found to be valid measures of sedentary behaviour (115, 117) and should be considered in future interventions. However, overall, more research is needed to compare the validity of wearable devices to capture sedentary behaviour.

3.5.5 Limitations

It is important to acknowledge the limitations of the initial trial when considering the findings of this process evaluation. These limitations have been published in the elsewhere (102), however, briefly, the pre-post-test design and the use of self-report outcome measures (IPAQ-L) are notable. Future studies should consider the implementation of a randomised controlled trial, with objective measures of behaviour change. In addition, recruitment from the GHMBA member database could be seen as a limiting factor. Whilst GMHBA membership has been identified as socio-demographically diverse, it is likely to have missed the most socioeconomically disadvantaged population groups which typically are less likely to have private health insurance. It is recommended that in future studies, a range of recruitment strategies be used, such as flyers/posters in local community health centres, media advertisements, recruitment from workplaces and other community organisations, and recruitment via social media.

Self-report methods are associated with recall difficulty, error in judgment and reporting socially desirable responses (e.g., participants over-reporting likeability of intervention components). However, the constructs assessed in this process evaluation are perceptions and by their nature subjective and difficult to assess in other ways.

In addition, although the evaluation of the present study provided useful insights into participants' perceptions of, and interactions with, program components, due to resource restrictions it was not a comprehensive process evaluation (101) and therefore there are some aspects of (e.g., contextual factors) that are not captured here.

3.5.6 Strengths

The mixed method design of this process analysis is a strength of the study. Through the use of mixed methods, we gained not only quantifiable data but also qualitative insights that are useful for investigating an area in which little is known (118). The appeal, acceptability and perceived effectiveness of incentive use for promoting physical activity and particularly, for reducing sedentary time have not been well established in the literature to date. This method allowed for components of the program to be rated on consistent scales by all participants and the reasoning related to these ratings explained in open-ended questions. In addition, examining different components of the ACHIEVE study also provided the opportunity to highlight specific intervention features that worked best or could be improved. These insights will be valuable in the construction of future incentive-based programs.

3.5.7 Conclusions/future research

The findings of the present study have potential implications for future research of incentive-based interventions to both increase physical activity and reduce sedentary behaviour. The study provided support for incentive-use and provided further evidence for the importance of embedding this strategy in a broader program (112). In addition, although all complementary components were received favourably, future studies should consider improvements regarding individual tailoring of text messages (110) and ensuring accurate measurement of sedentary behaviour using the Fitbit device. Lastly, this present study highlighted the difficulty of achieving behaviour change goals, particularly in regard to sedentary behaviour. Exploring additional strategies such as targeting workplace managers to encourage behaviour change and inform provided by general practitioners to reduce sedentary behaviour should be a direction of future research.

An element which was not explored in this study is cost-effectiveness. Establishing the cost-effectiveness of implementing such incentive-based programs is important for helping determine their value for money and helping build a case for community roll-out and assisting in advocating for implementation to a variety of stakeholders (e.g., health insurance companies, policy makers). The next chapter reports on the cost-effectiveness of the ACHIEVE program.

CHAPTER 4: ECONOMIC EVALUATION OF AN INCENTIVE-BASED PROGRAM TO INCREASE PHYSICAL ACTIVITY AND REDUCE SEDENTARY BEHAVIOUR IN MIDDLE-AGED ADULTS[2]

4.1. Manuscript

This chapter has been submitted as a manuscript to BMC Public Health and is currently under review. The content in this chapter is identical to the manuscript submitted to the journal, however to align with the formatting of this thesis headings, table and figure numbers and in-text referencing have been adjusted.

4.2. Abstract

Background: Incentive-based programs represent a promising approach for health insurers to encourage health-promoting behaviours. However, little is known about the economic credentials of such programs. This study aimed to determine the cost-effectiveness of the ACHIEVE (Active CHoices IncEntiVE) program designed to incentivise increased physical activity and reduced sedentary behaviour in middle-aged adults.

[2] The ACHIEVE study was designed prior to the commencement of PhD candidature, however all analyses included in this chapter were led by the candidate.

Methods: A within-trial cost-efficacy analysis and an analysis of the long-term cost-effectiveness of the intervention scaled up to the Australian population was modelled from a health sector perspective. Pathway analysis was used to determine the resource use associated with the intervention, with costs expressed in Australian dollars (AUD) for the 2015 reference year. In the scale-up analyses, the 16-week intervention was modelled for roll-out across Australia over a 1-year time horizon targeting people with private health insurance who are insufficiently active and highly sedentary. Improved health related quality of life quantified in Health-Adjusted Life Years (HALYs) (based on the health impacts of increased metabolic equivalent (MET) minutes and reduced body mass index (BMI) and cost-offsets (resulting from reductions in obesity and physical inactivity-related diseases) were tracked until the cohort reached age 100 years or death. A 3% discount rate was used and all outcomes were expressed in 2010 values. Simulation modelling techniques were used to present 95% uncertainty intervals (UI) around all outputs.

Results: The ACHIEVE intervention cost A$77,432. The cost per participant recruited was A$944. The incremental cost-effectiveness ratio (ICER) for MET increase per person per week was A$0.61; minute of sedentary time reduced per participant per day was A$5.15 and BMI unit loss per participant was A$763. If scaled-up to all eligible Australians, approximately 265,095 participants would be recruited to the program at an intervention cost of A$107.4 million. Health care cost savings were A$33.4 million. Total HALYs gained were 2,709. The mean ICER was estimated at A$27,297 per HALY gained which is considered cost-effective in the Australian setting.

Conclusion: The study findings suggest that financial incentives to promote physical activity and reducing sedentary behaviour are likely to be cost-effective.

4.3. Background

Physical inactivity is a key public health concern in many countries (119). Currently in Australia more than half (55%) of the adult population do not meet physical activity recommendations, with an estimated 16,000 deaths annually caused by ill health attributable to physical inactivity (6, 8). In addition, Australian adults engage in sedentary behaviour 50 to 70% of their waking hours – or 8 to 12 hours per day – with the most prevalent activity being watching television (7, 17). There is therefore a need for innovative programs to encourage increased physical activity and decreased sedentary behaviour.

The ACHIEVE (Active CHoices IncEntiVE) study is an incentive-based program that aimed to encourage an increase in physical activity and reduction of sedentary time in Australian middle-aged adults (102). Full details are described elsewhere (102). In brief, middle-aged (40-65 years) adults who were insufficiently active and highly sedentary were recruited via a health insurance body to take part in a 16-week trial. They received incentives (e.g., supermarket vouchers, clothing and cookbooks) for achieving weekly physical activity and reduced sitting time goals, calculated using their baseline behaviour. The program also involved a motivational interview, weekly text messages and Fitbits distributed to participants to monitor their progress. As a result of the intervention, participants' mean leisure-time physical activity increased by 252 minutes per week; mean transport-related physical activity increased by 178.5 minutes per week; and mean sitting time decreased by 3.1 hours/day (all $p < 0.001$). These changes were assessed by the International Physical

Activity Questionnaire Long version (IPAQ-L) pre and post intervention analyses, which has been established as an acceptable measurement of both physical activity (120) and sedentary behaviour (121). Only leisure-time and transport-related physical activity was reported upon in the outcome paper (102). This was due to the other physical activity domains (e.g., work-related and domestic-related) being much less discretionary (i.e., people have much less choice/control over them. Furthermore, BMI and systolic blood pressure decreased significantly in both men and women, whilst diastolic blood pressure decreased in men (102).

The ACHIEVE program demonstrated promising results using an incentive strategy, however in order to determine the value for money of the program, it is essential that its economic credentials are also assessed. To date only two studies have assessed the cost-effectiveness of incentive strategies to increase physical activity in adults (122, 123) and both showed potential for cost-effectiveness. To our knowledge, no studies have assessed the cost-effectiveness of using incentives specifically to reduce sedentary behaviour. The aim of this study is to examine the economic credentials of the ACHIEVE program, by assessing its short term cost-efficacy in a within-trial analysis, and its potential for cost-effectiveness by modelling the long term health benefits and health care cost-savings resulting from improved physical activity levels and reduced BMI.

4.4. Methods

4.4.1 Overview

The study draws on the efficacy data from the ACHIEVE study conducted in 2015 (102). Both a within-trial cost-efficacy analysis and an evaluation reporting the potential cost-effectiveness if the intervention was scaled up and rolled out to all eligible participants throughout Australia, have been undertaken. Results of the cost-efficacy analysis are reported as incremental cost-effectiveness ratios (ICER) calculated as cost ($A) per metabolic equivalents (METS) increased, sitting time reduced, and body mass index (BMI) unit reduced. The cost-effectiveness analysis reports ICERs as the cost per health adjusted life year (HALYs) gained.

4.4.2 The ACHIEVE study

Details of the ACHIEVE study have been previously published (102). Key features of the study relevant to the economic evaluation are described here.

Recruitment

Participants were recruited to the ACHIEVE study through Geelong Medical and Hospital Benefits Association (GMHBA), a not-for-profit health insurance fund in Victoria, Australia. Study recruitment was facilitated through invitations to participate distributed via e-mail to potentially eligible members (n= 1,544) based on GMHBA client database information. The study was targeted at adults aged 40-65 years, as this is the life stage characterised by declining levels of physical activity and increased risk of chronic disease onset (6, 7). Eligibility criteria included living within 25km of the study site (for pragmatic reasons), not meeting current physical activity guidelines (i.e. undertaking less than 150 minutes/week of moderate-vigorous physical activity) and spending more than three quarters of the day sitting on most days of the week (3). A total of 36 men and 46 women were recruited to the program.

The Intervention

Over a 16-week period, participants were encouraged to increase their physical activity to 150 minutes/week and reduce their sitting time by 150 minutes/week in progressive increments. An incentive point-based scheme was administered with participants receiving one point per minute of physical activity increased (capped at 30 minutes per day) and one point per minute of sitting time reduced in comparison to their baseline measures. Weekly physical activity behavioural goals included achieving 100 minutes/week (for the first four weeks); 120 minutes/week (month 2); and 150 minutes/week (month 3 & 4). Weekly sitting time goals included achieving a 100 minute reduction/week (for the first four weeks); 120 minute reduction/week (month 2); and 150 minutes reduction/week (month 3 & 4). If goals were met (and sufficient points were accrued), participants received the corresponding weekly reward. Rewards ranged in value from A$7 to A$50 and included clothing, supermarket vouchers and cookbooks. A lottery schedule incentive was also offered in the final week that gave eligible participants a chance to win one of four iPad mini devices (valued at approximately A$450). The main incentive component was supplemented by additional support through a motivational interview at intervention commencement plus weekly motivational text messages. Text message content aimed to encourage and provide strategies to increase physical activity and reduce sedentary behaviour. Activity was monitored for incentive distribution by Fitbit devices that participants retained at the conclusion of the program.

Measures

A pre-post intervention design was employed with measurements at baseline and post-intervention (16-weeks). Physical activity and sedentary behaviour were measured using the IPAQ-L, which is a 27-item self-report measure that assesses duration and frequency of physical activity in the last 7 days. The domains include job-related, transport, domestic and leisure-time physical activity as well as time spent sitting. Categories are also broken down into walking (for 10 minutes or more) and cycling for transport, and moderate-intensity and vigorous intensity for leisure time physical activity.

BMI (kg/m^2) was calculated from height (objectively measured by researchers at baseline) and weight (objectively measured by researchers at baseline and by participants post-intervention using Wi-Fi scales provided by researchers and retained by participants). Systolic and diastolic blood pressure were also measured at baseline and immediately post-intervention, via readings on an Omron blood pressure monitor provided to participants.

For the purpose of this economic evaluation, the main outcome measures of interest were the mean differences between baseline and post-intervention (16 weeks) IPAQ-L scores for leisure-time and transport physical activity, and sitting time, and BMI.

4.4.3 Within-trial cost-efficacy analysis

Assessments of benefits

Results from the paired t-tests that change from baseline in BMI (kg/m^2) and sitting time (minutes/day) as reported in the ACHIEVE outcomes paper were used in this analysis (102). In addition, participant physical activity reported in the IPAQ-L questionnaire was used to calculate METS. METS refer to the intensity assigned to an activity, such as light (<3 METS), moderate (3-6 METS) and vigorous (>6 METS) (11). In accordance with the protocol for scoring the IPAQ-L (124), one extreme outlier of leisure time physical activity was truncated to 21 hours (i.e. 3 hours/day). STATA was used to run paired t-tests for pre-post METS.

Assessment of costs

A health sector perspective was adopted for the economic evaluation. Pathway analysis was conducted to identify component activities and associated resource utilisation and costs entailed in the implementation and monitoring of the ACHIEVE intervention. Records kept by the project manager were used to ascertain cost components and unit costs. Cost items included website design, participant recruitment, program administration, motivational text messages, website monitoring, incentives, and postage. Research costs associated with the intervention (e.g., the project manager’s time spent recruiting research assistants, working on ethics applications, and outcome measurement) were excluded in the base case analysis, but were included in the scenario analysis. Where the project manager’s records did not include the required details for the costing, unit cost estimates were made using credible sources such as Australian Bureau of Statistics average weekly earnings (125) and variability around these estimates were incorporated in the uncertainty analysis. The reference year for the within trial cost-efficacy analysis is 2015, the year that the ACHIEVE study was undertaken.

The ACHIEVE within-trial cost components are reported in Appendix 1.

4.4.4 Scaled-up cost-effectiveness analysis

Recruitment

A long-term cost-effectiveness analysis was undertaken which extended the analysis population to the relevant Australian population and the time horizon to over the lifetime of the eligible population (until death or age 100 years). Aligning with previous literature, the intervention was assessed as operating in 'steady state' (i.e., working at its full effectiveness potential) and was measured against a 'do nothing' comparator (126). The intervention timeframe remained 16-weeks (as in the initial ACHIEVE trial) and was delivered to eligible participants over the course of one year. Eight private health insurers were identified to deliver the incentive program, representing approximately 93% of the Australian private health insurer market share (127). Eligibility for service provider inclusion was having equal or higher health insurance market share than the original trial insurer (GMHBA, who has approximately 2.1% of the market share) (127).

The eligible population represented the 2010 Australian population aged 40-65 years adjusted to include those with private health insurance (128) (approximately 56% of the population) who were insufficiently active (approximately 58%) based on the 2011-12 Australian health survey (7). The uptake of the scaled up intervention was informed by uptake of the ACHIEVE study (approximately 12%) (102). The impact of a higher uptake rate was tested in the sensitivity analyses. This was informed by uptake rates in a similar study (70) (sedentary adult population who were provided with step count goals and used the IPAQ-L for outcome measurement) which reported an uptake rate of 37%. However, due to the age restrictions of this study (40-65 year olds) a lower uptake rate of 30% was used (Table 4.1).

Benefit analysis

The change in METS and BMI as a result of the intervention were used to estimate the long-term health impact of the intervention compared to a ‘do nothing’ comparator. A previously developed and validated multi-state life table Markov model - The ACE-Obesity Policy model - was used in the analysis (129). Details of the model have been previously published and a brief description follows (129, 130). The model simulates the effects of the intervention-related changes to the distribution of BMI and physical activity levels (measured in METS) in the intervention population on the incidence of nine diseases causally related to BMI (breast cancer, colorectal cancer, endometrial cancer, kidney cancer, type 2 diabetes, hypertensive heart disease, ischaemic heart disease, stroke and osteoarthritis of the hip and knee), and five diseases causally related to physical inactivity (breast cancer, colorectal cancer, type 2 diabetes, ischaemic heart disease and stroke) (129). Reduced incidence of diseases resulted in reductions in the prevalence and disease-related mortality and morbidity, thereby improving long term health outcomes (reported as HALYs) and producing healthcare cost-savings (129, 130) .

The short-term impact of the intervention was assessed over the 16-week intervention period. There was no maintenance measurement in the ACHIEVE study and therefore it is unknown how long the intervention effects were maintained. In the base case scale up analysis it was assumed that there would be no intervention effect remaining after five years. Due to the lack of current literature on maintenance effects once incentives are removed, this assumption was informed by a meta-analysis which found that participants in exercise and diet programs maintain weight loss for an average of 6 months followed by weight regain at a rate of 0.03

BMI-points per month until, at approximately 5.5 years post-intervention, no effect remains (131). Variations in this assumption with intervention effect being maintained over the lifetime and for one year were tested in sensitivity analyses (Table 4.1).

Cost analysis

Modifications were made to the costing of the intervention in the ACHIEVE trial to enhance the feasibility of scale-up and to reflect the intervention's likely implementation under non-research conditions. It was assumed home-visits for initial baseline measurement would not be undertaken as this is a research related activity and therefore travel costs were excluded. It was assumed that Fitbits would be distributed via post and these costs were included in the scale up analysis. The wifi-scales that were distributed in the ACHIEVE study were excluded in the scale up analysis as they are only required to measure the outcome of the study. Personnel costs included the cost of website development as in the ACHIEVE study, a cost assumed to accrue to each of the health insurers. In the base case scale up analysis, it was assumed that each of the insurers would require two full time staff to recruit and administer the program. The impact of lower staff wage rates was tested in the sensitivity analyses. Additional hourly staff costs for the preparation and mail out of the incentives were also included (assuming 10 incentives could be prepared and mailed out each hour). The cost of the incentives and the number of incentives per participant were taken from the ACHIEVE study.

To maintain consistency with the inputs of the ACE-Obesity Policy model, the analysis was undertaken for the 2010 cost year. Costs taken from the ACHIEVE study were adjusted to 2010 values using the gross domestic product (GDP) price index reported by the Australian

Institute for Health and Welfare (132). All costs and benefits were assessed over a lifetime horizon (up to 100 years or death) and were discounted at a 3% annual rate (133) .

Sensitivity analyses

Sensitivity analyses were undertaken to assess the impact of key variables or assumptions on the ICER results. Analyses were undertaken with varying assumptions related to the duration of intervention effect, staff wage rates and the intervention uptake rate (Table 4.1).

Table 4.1. Sensitivity analyses

Scenario	Description
Scenario 1	Within-trial analysis including research costs.
Scenario 2	Scale up analysis where the intervention effect was assumed to be maintained over the lifetime of the population.
Scenario 3	Scale-up analysis where the intervention effect was assumed to be maintained for one year.
Scenario 4	The Scale-up base case analysis used average staff costs for ‘Financial and insurance services’. This scenario assumed a lower wage rate using the average salary for ‘Administrative and Support Services’ (125).
Scenario 5	Uptake rate was assumed to be 30%. This was informed by a study with similar study design which had an uptake rate of 37% (70), adjusted to reflect the age restrictions in the ACHIEVE study.

Uncertainty analysis

Resource use for several cost items from the ACHIEVE study was estimated retrospectively by the project administrator, therefore variability of +/- 20% in the values was incorporated using a Pert distribution (134). Monte-Carlo simulation using the add-in tool Ersatz (EpiGear, Version 1.35) (134) was used to undertake uncertainty analyses to test the robustness of the results taking into consideration the variability around model input parameters. All results are presented with 95% uncertainty intervals (the range within which the true value lies with 95% certainty). Two thousand iterations of the model were conducted; for each iteration, values were randomly chosen from the specified distribution for each input variable (Appendix 1).

Assessment of Cost-effectiveness

Whilst a willingness to pay (WTP) threshold is not explicit in Australia, a commonly used threshold to determine value for money in the Australian context is A$50,000 per HALY gained (130, 135-137). The intervention was considered cost-effective if the resulting ICERs were below this threshold.

4.5. Results

4.5.1 Within-trial cost-efficacy analysis

The total ACHIEVE intervention cost approximately A$77,432 and A$110,644 when research costs were included. The base case cost per participant recruited was A$944. The ICER per BMI unit lost per participant was A$763; MET reduction per participant per week was A$0.61 and minute of sedentary time reduced per participant per day was A$5.15. As costs reflect ICER per MET increase per person per week, whereas sitting time is ICER per reduction of minutes per person per day, it was not possible to directly compare these results. ICER results when research costs were included are shown in Table 4.2.

Table 4.2. Within-trial analysis results

	Total intervention cost (A$2015)	Cost per person (A$2015)	ICER per BMI unit loss per person (A$2015)	ICER per MET increase per person per week (A$2015)	ICER per reduction in sitting time (minutes) per person per day (A$2015)
Within-trial analysis base case	77432 (71289; 83628)	944 (869; 1020)	763 (607; 946)	0.61 (0.45; 0.82)	5.15 (4.12; 6.31)
Within-trial analysis scenario 1 – including research costs	110644 (105743; 115468)	1349 (1290; 1408)	1090 (878; 1329)	0.87 (0.64; 1.16)	7.36 (5.98; 8.97)

4.5.2 Scale up cost-effectiveness analyses

If the incentive program was rolled out nationally, a total of 131,623 males and 133,472 females were estimated to be eligible (approximately 3.7% of Australians aged 40-65 years in 2010 (128)). The scale up base case and all scale up scenarios modelled were found to be cost-effective (ICER less than A$50,000 per HALY gained), with the exception of scale up scenario 3, where the effect was assumed to be only maintained for one year (Table 4.3 and Figure 4.2 below). Approximately 60% of iterations modelled for the scale up base case fell below the cost-effectiveness threshold (Figure 4.1). Scale up scenario 2 demonstrated that if the intervention effects were maintained over the lifetime then the program would be dominant, indicating the intervention it is both cost-saving and health promoting.

Table 4.3. Scale-up cost-effectiveness results

	Total intervention cost (A$2010)	Health care cost savings (cost offsets, A$2010)	Total HALYs gained	Total ICER	Proportion of iterations that were cost-effective (<A$50,000 per HALY gained)
Scale-up base case	107355577 (56075749; 174774252)	33399577 (5581663; 115828487)	2709 (453; 9518)	27297 (dominant; 234905)	60%
Scenario 2 – Lifetime effect	107110520 (56712591; 172073021)	388571651 (66607772; 1310538331)	31830 (5419; 108338)	dominant (dominant; 7322)	100%
Scenario 3 – Effect maintained for 1 year	105771678 (55934827; 169479941)	14862624 (48448335; 2631784)	1217 (215; 3884)	74683 (12054; 520362)	24%
Scenario 4 – Lower costs	103707187 (54356276; 167050251)	33566209 (5759678; 113317956)	2725 (459; 9544)	25742 (dominant; 221992)	61%
Scenario 5 – 30% uptake	261364128 (207614656; 321623049)	82032666 (14128156; 263626923	6685 (1108; 21152)	26827 (dominant; 222625)	59%

Values are mean (95% confidence interval); dominant: the intervention is both cost-saving and improves health.

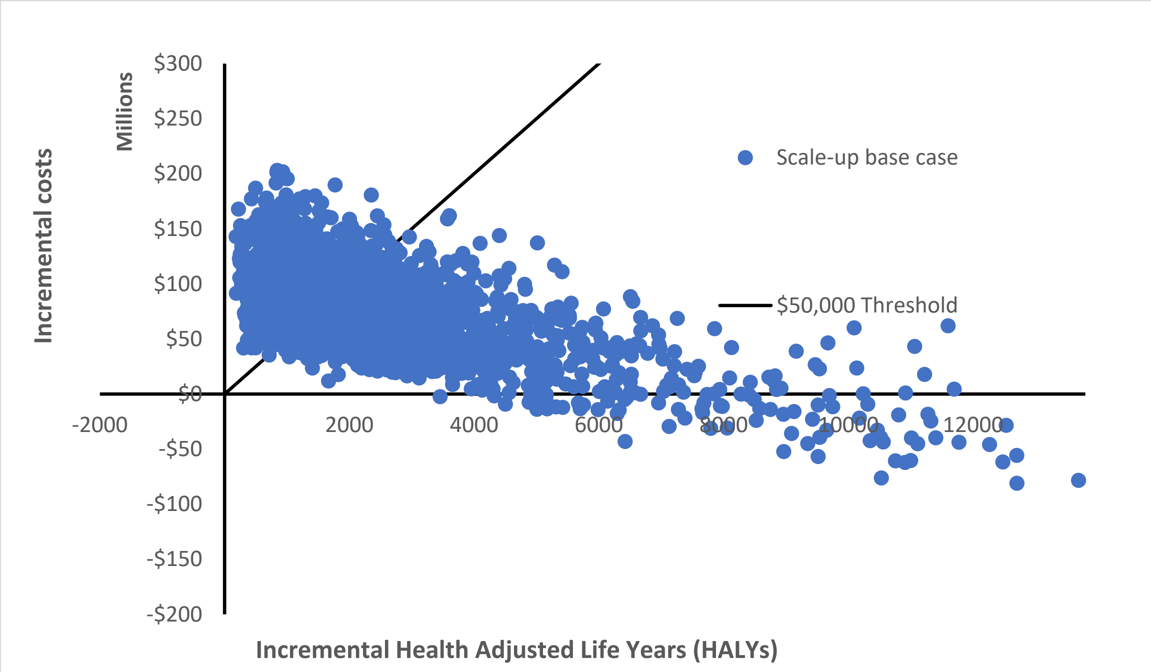


Figure 4.1. Scale up base case cost-effectiveness plane

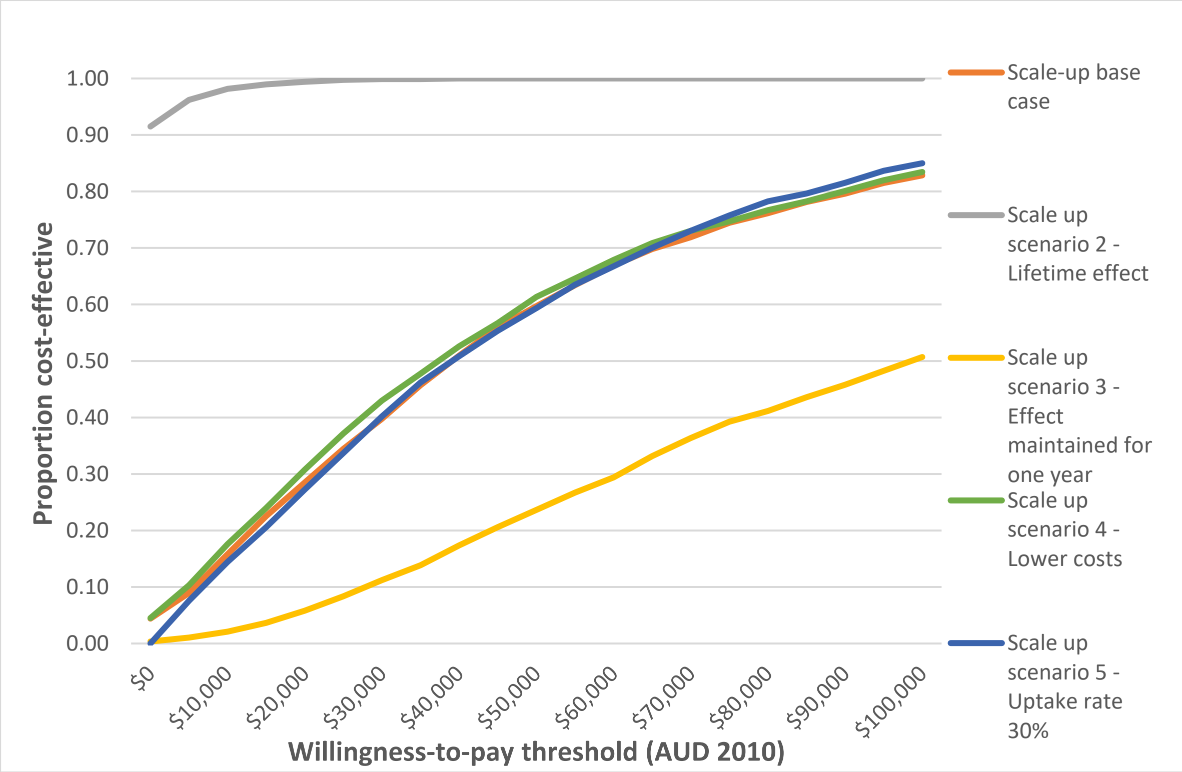


Figure 4.2. Cost-effectiveness acceptability curve

4.6. Discussion

The ACHIEVE intervention cost per participant recruited was A$944. The ICER for MET increase per person per week was A$0.61; minute of sedentary time reduced per participant per day was A$5.15 and BMI unit lost per participant was A$763. The ACHIEVE program showed the potential to be cost-effective if scaled up across the country. The long-term cost-effectiveness analysis showed that if the ACHIEVE program was scaled up to all eligible individuals across Australia, 265,095 adults aged 40 to 65 years would be recruited and the program would have the potential to be cost-effective (ICER: A$27,297). However, sensitivity analyses demonstrated that if program benefits were only maintained for one year, the intervention would not be cost-effective. To address this uncertainty, future research should prioritise collecting long-term data to estimate the longer term effectiveness and cost-effective of incentive based behaviour change programs. Other sensitivity analyses (lower staff costs, increased uptake rate) produced similar mean ICERs to the base case and were all below the cost-effectiveness threshold. Due to the high variability in effectiveness and the costs of the scaled up intervention, between 24-61% of the iterations modelled were predicted to be cost-effective. These analyses suggest that ACHIEVE and similar incentive-based programs to increase physical activity and reduce sitting time are likely to represent good value for money if the intervention effect lasts longer than one year.

Only two previous studies have evaluated the cost-effectiveness of incentive-based programs for increasing physical activity. Participants in those studies included employees in workplaces in Ireland (122) and physically inactive members of the public in a London borough (123). Incentives used in those studies included various products from local businesses (122) and free leisure centre memberships (123). Physical activity was monitored by self-report point systems for physical activity minutes (122) and attendance at local leisure centres (123). Costs were assessed from both healthcare provider (122, 123) and an employer perspective (122). Both of these studies demonstrated potential for cost-effectiveness; however, the results were limited by wide confidence intervals (122) and a lack of assurance around sustainability of benefits (123). Similar issues were observed in the current study. Confidence intervals of modelled scenarios were wide and in most instances crossing the threshold of cost-effectiveness (ICER >50,000).

The provision of membership rewards by health insurance providers is becoming more common in Australia and internationally. Traditionally, these incentives were a marketing strategy offered to increase the appeal of initiating membership by providing discounted access to health-related products and services such as gym memberships, Fitbits and exercise equipment. However, in recent years, private health insurance providers have increasingly rewarded members for *maintaining* a healthy lifestyle (138-140). Although these programs intuitively appear beneficial from a public health stance, it is essential that they are evaluated on their economic credentials to inform resource allocation and service design. An intervention based on the notion of encouraging maintenance of a healthy lifestyle was modelled in the ACE-obesity policy study, which assessed financial incentives for weight loss by private health insurers (136). The intervention targeted adults (18+) who were overweight or obese and had extras/ancillary cover. Members received financial incentives from their health insurance if weight loss/maintenance goals were met ($200 cash payment per year). This was offered alongside an initial one-year weight loss program. Results from that study indicated good value for money from a societal perspective (141). However, it was not found to produce a positive return on investment to the private health insurer.

4.6.1 Limitations

The methods used in the initial ACHIEVE trial restricted the scope of this economic evaluation. Firstly, given the lack of a control group, it is difficult to assess whether the effectiveness of the intervention is specific to certain characteristics of those who chose to participate and how well the effectiveness is generalizable to the whole eligible population. The procedure for collecting demographic information in recruitment screening did not allow for this information to be linked with outcome data. Having more individualised data would have provided insight into the differential engagement and appeal of this type of intervention based on population characteristics. In addition, the measurement of the two primary behavioural outcomes was via self-report. Although the IPAQ-L is widely used as a measure of physical activity and sitting time, data collected via the IPAQ-L can be subject to recall difficulties and bias, and is susceptible to over-reporting. However, main outcomes also report improvements in measured BMI and blood pressure consistent with these self-report physical activity changes.

Another limitation was the sample of the initial ACHIEVE trial. Although GMHBA has a membership that is socio-demographically diverse (102), it is likely that individuals of a low socioeconomic position were underrepresented. An alternative would be to consider providing such programs as part of the publicly funded Medicare system in Australia. Improving health equity by broadening the scope of these programs beyond individuals within the population who hold private health insurance would undoubtedly increase the societal benefits, but also the costs of the intervention (141). Therefore, exploring this approach in varying population groups should be a focus of future programs and corresponding economic evaluations.

The study is also limited by the lack of literature examining the maintenance effects of incentive-based programs. Currently there is limited evidence on the sustained effects of incentive-based physical activity or sedentary behaviour programs once incentives are removed. As BMI was an outcome variable in the initial trial, the use a meta-analysis which examined weight loss maintenance resulting from weight loss programs (131) was considered appropriate to guide our base case model assumptions. However, the sensitivity analyses demonstrated that the results of the cost-effectiveness analysis were highly dependent on assumptions related to how long the intervention effects were maintained.

There were also limitations related to the ACE-Obesity Policy model’s ability to fully capture the benefits of the ACHIEVE study. The model was unable to estimate the health benefits of reduced sitting time and therefore these benefits were not included in cost-effectiveness analyses. Future model developments should focus on incorporating sedentary behaviour as an independent risk factor for long term chronic disease to allow better estimation of the economic credentials of interventions that target this important risk factor.

4.6.2 Strengths

Despite these limitations, a key strength of the current study is that we were able to supplement the within-trial analysis results with modelled long-term results which can estimate whether the ACHIEVE study represents good value for money. In addition, the modelling was based on a pilot study led by a health insurer in a real-life Australian setting.

To our knowledge no economic evaluations of incentive programs to reduce sedentary behaviour have been conducted and therefore our within-trial results represent an important contribution to the literature.

4.6.3 Conclusions/future research

This study outlined both the economic credentials of the ACHIEVE study and modelled the program to all eligible Australians to highlight the potential long-term cost-effectiveness of this incentive program. Incentives are often used simply as a marketing strategy, however there is real potential for their use as a cost-effective health promoting intervention. Potential challenges for future programs may include the ability to design programs that encourage maintenance beyond the duration of the intervention and ensuring uptake and investment in these programs by health insurance providers (due to concerns of positive returns on investment). Future research should aim to collect long-term effectiveness data to improve accuracy of cost-effectiveness evaluations to inform resource allocation decisions. Exploring this approach in varying population groups should also be considered in future programs and economic evaluations.

CHAPTER 5: EXPLORING THE APPEAL OF INCENTIVE-BASED PROGRAM COMPONENTS TO INCREASE PHYSICAL ACTIVITY AND REDUCE SITTING TIME AMONG SOCIOECONOMICALLY DISADVANTAGED ADULTS: A QUALITATIVE STUDY

5.1. Introduction

As discussed in Chapter 1, socioeconomically disadvantaged populations are disproportionately affected by obesity and chronic diseases linked to inactive lifestyles (142). This has been established across multiple different markers of socioeconomic disadvantage, including income, education level, occupational status and neighbourhood level disadvantage (21, 143). Research has also identified that socioeconomically disadvantaged populations are at greater risk of physically inactivity (22, 23). In addition, individuals who are socioeconomically disadvantaged are more likely to engage in higher levels of leisure-time sitting and television viewing (21, 24). Socioeconomically disadvantaged populations are likely to have additional barriers that impact their ability to achieve optimal levels of physical activity and sedentary behaviour, compared to more advantaged groups. Such barriers identified in the literature include negative early life and family physical activity experiences, lack of time due to work commitments, neighbourhood-level barriers, poor health, inconvenient access and low personal functioning (92, 93).

As discussed in previous chapters, incentive use has shown promise in encouraging an increase in physical activity and a reduction in sedentary behaviour. It has been suggested that incentive-based interventions may be particularly appropriate for and appealing to socioeconomically disadvantaged populations (72, 95). However, given the very few studies (72, 95-97) identified in the literature that have explored incentive-use in socioeconomically disadvantaged populations, more research is necessary to determine the appeal and effectiveness of this approach.

Important incentive components to consider when administering financial incentives to change health behaviours have been outlined in the literature (31). These include incentive type, magnitude, direction (positive or negative reinforcement), certainty and scheduling of administration. Considering the many ways in which incentive-based programs can be designed and administered, these components need to be selected in a way that is most appropriate to the target population and target activity. Therefore, the aim of this study was to gather in-depth information from socioeconomically disadvantaged individuals to provide insights into the appeal of incentive-based program components to increase physical activity and reduce sedentary behaviour.

5.2. Methods

A qualitative methodology was chosen to provide rich insights into the appeal of incentive-based program components to increase physical activity and reduce sitting time. This was determined as the most suitable approach as qualitative research is useful for gaining detailed insights and context into areas which are under researched or poorly understood (118). The study is reported based on the principles of the consolidated criteria for reporting qualitative research (COREQ) guidelines (144). The methods and procedures are described below.

5.2.1 Ethics

Ethical approval for this study was obtained from Deakin University Human Research Ethics Committee (HEAG-H 05_2018) on the 16th of February 2018. Informed consent was obtained from all participants prior to conducting the interviews.

5.2.2 Participants and recruitment

The criterion for inclusion in this study was persons aged 40-65 years, as this is a life stage characterised by declining levels of physical activity and increased risk of chronic disease onset (24, 142). Eligibility criteria also involved being insufficiently active (not currently engaging in 150 minutes of moderate physical activity or alternatively 75 minutes of vigorous activity per week), participating in high volumes of sedentary time (of the hours awake each day, spending more than 7 hours sitting) and being socioeconomically disadvantaged. The sedentary behaviour threshold was based on literature which suggests that more than 7 hours sitting per day significantly increases all-cause mortality risk when the effects of physical activity are taken into account (145). In this study, low income was used as the marker of socioeconomic disadvantage, and this was determined by reporting either a net weekly household income of less than A$1,600; or main income from a pension or welfare benefit; or being a Health Care Card holder. In Australia, eligibility for access to a Health Care Card is based on specific payments or supplements already received from the government (e.g., JobSeeker payment) (146). Basing low income eligibility on any of these three criteria meant participants were not required to report their specific income. Participants were also required to speak and read English in order to ensure informed consent and for sound communication within interviews. Participants were informed that the researcher conducting the study was a PhD student with an interest in health promotion and that the findings of the study would be included in her thesis.

Participants were recruited for interviews via a paid advertisement run through social media forums (Facebook and Instagram). Examples of the advertisements are presented in Appendix D. Using setting options provided by Facebook the advertisements were targeted to users aged 40-65 years. These were also posted publicly on the Deakin University's Institute for Physical Activity and Nutrition (IPAN) Facebook page. Multiple images middle-aged adults engaging in light physical activity (e.g., walking a dog) were chosen for inclusion in advertisements and these were rotated in different iterations to try to capture the attention of a wider spread of the public. Partway through recruitment images were changed to exclusively males engaging in light physical activity (e.g., middle-aged male walking a dog), as the recruited sample at this time point was heavily skewed towards female participants. The number of participants required for this study was not predetermined due to the exploratory qualitative nature of the research. Recruitment ceased once saturation (i.e., no new themes were identified in the data) was achieved. This was determined by the research journal kept by the student researcher which was referred to following each interview.

Initially once potential participants responded to the advertisement, the student researcher (JLM) emailed screening questions for the potential participant to complete. Eligible participants were then sent a plain language statement and consent form that they were required to sign and return prior to the commencement of the scheduled interview. However, due to very few responses to screening via this approach, an online survey was designed which enabled screening questions and a plain language statement and consent form content to linked to the advertisement (Appendix E). Responses to the online survey were monitored by the student research (JLM) who then contacted eligible participants to arrange an interview time.

5.2.3 Interview procedures

Semi-structured, one-on-one interviews were conducted via telephone by the student researcher who had previous experience in conducting interviews and had attended training sessions in qualitative research. Interviews were conducted for a five-month period from 9th of May 2018 to 9th of October 2018. An interview schedule (Appendix F) was developed and pilot-tested with two participants of similar age and socioeconomic position as the target group. The development of the interview schedule was partially informed by published literature outlining important components to consider in financial incentive interventions to change health behaviours (31). This provided guidance for ensuring specific incentive components (e.g., direction, form, magnitude, schedule) were explored with participants. In addition, general information on participant's thoughts on their current physical activity and sitting habits as well as the acceptability of using incentive strategies to encourage an increase in physical activity and reduction in sitting time were also explored. Each interview ran for approximately 30 minutes. Consecutive sampling was administered in which the researcher conducted the interview, evaluated the preliminary findings and fine-tuned the questions for the next participant if needed. Participants received a $20 Coles supermarket/Myer department store gift voucher to reimburse their time. It was anticipated that this was unlikely to be coercive as the compensation offered represents a relatively small monetary value and was in line with that offered in other studies on similar topics (92). Participants were informed that they could request a copy of the study findings from the research team when they were available (approximately 3 months after completion of the study).

5.2.4 Analysis

With participant’s consent, each interview was audio-recorded and later transcribed. Following each interview, the interviewer/student researcher (JLM) kept a research journal which included comprehensive notes including proposed preliminary codes and key themes summarised at the conclusion of all interviews. To further ensure the reliability of coding and themes, investigator triangulation was administered where two researchers (JLM, MT) independently coded a sub-sample of transcripts (N=2) (14). Researchers then met in person to discuss the coding process and resolve any discrepancies.

Nvivo 10 software (QSR international) (107) was used to organise content and facilitate a thematic analysis based on published guidelines (108). The methodology for this analysis was a hybrid of inductive and deductive in that it the interview schedule was guided by themes in previously published literature (31) however, new themes that occurred in the data were also included in analysis. Firstly, transcripts were read multiple times by the student researcher (JLM) (Phase 1) and then content coded into sub-categories using Nvivo (Phase 2). Following this, major categories were created by combining similar codes and sub-categories (e.g., (incentive amount, reward frequency, support components etc.) (Phase 3). Candidate (i.e., preliminary) themes were identified and reviewed through linking common ideas (categories/sub-themes) (Phase 4) and once a thematic map was deemed satisfactory through a consensus by the researchers (JLM, MT), key themes were defined and named (Phase 5). In the analysis and write-up of the findings (Phase 6), themes were then linked with direct quotes along with the participant's demographic information (sex and age). Consistent with the published view (108) that prevalence of a theme does not necessarily indicate importance, inclusion in this analysis was based on the extent to which a theme expanded on understanding to address the research aims, as opposed to simply occurrence in the data.

5.3. Findings

5.3.1 Overview

Twenty participants were included in this study (8 males, 12 females). Age ranged from 42 to 64 years. An overall summary of general results is provided below, followed by more detailed discussion of each of the key themes that emerged from the interviews.

In general, almost all participants expressed an interest in taking part in an incentive program that aimed to increase their physical activity and reduce their sitting time. Cash rewards and gift vouchers were the most desired incentives. The types of vouchers participants preferred ranged in categories across grocery, sporting goods and experiences (e.g., movie tickets). However, most participants reported that it would be integral to the success of the program to tailor these rewards to the interests of participants. Most participants indicated an appropriate reward magnitude of around A$10 to A$20 per week with some participants expressing a lower amount would be necessary to incentivise a reduction in sitting. Some participants however expressed that the value would not matter to them but rather that the social contact gained from engagement with the program would be the strongest incentive. Small frequent rewards were favoured over larger one-off rewards, although the latter still appealed to some. Participants expressed the view that these programs would be seen as more acceptable if funded by the government; however most believed this would not be possible. Alternative suggestions were for such incentive programs to be funded by sporting brands, supermarkets or health insurers who have a transparent partnership with the program.

Supplementing these programs with additional support elements was a strong theme. These support avenues included social platforms (e.g., online discussion boards), links to credible educational health resources, transport services, carer services (e.g., for dependents with mental health issues) and self-monitoring technologies. When discussing ideal length of time for these programs, a strong theme was that participants would be willing to be involved long-term if the program continued to meet their needs and held their interest. As illustrated in Figure 5.1, nine major themes, including 28 subthemes were identified.

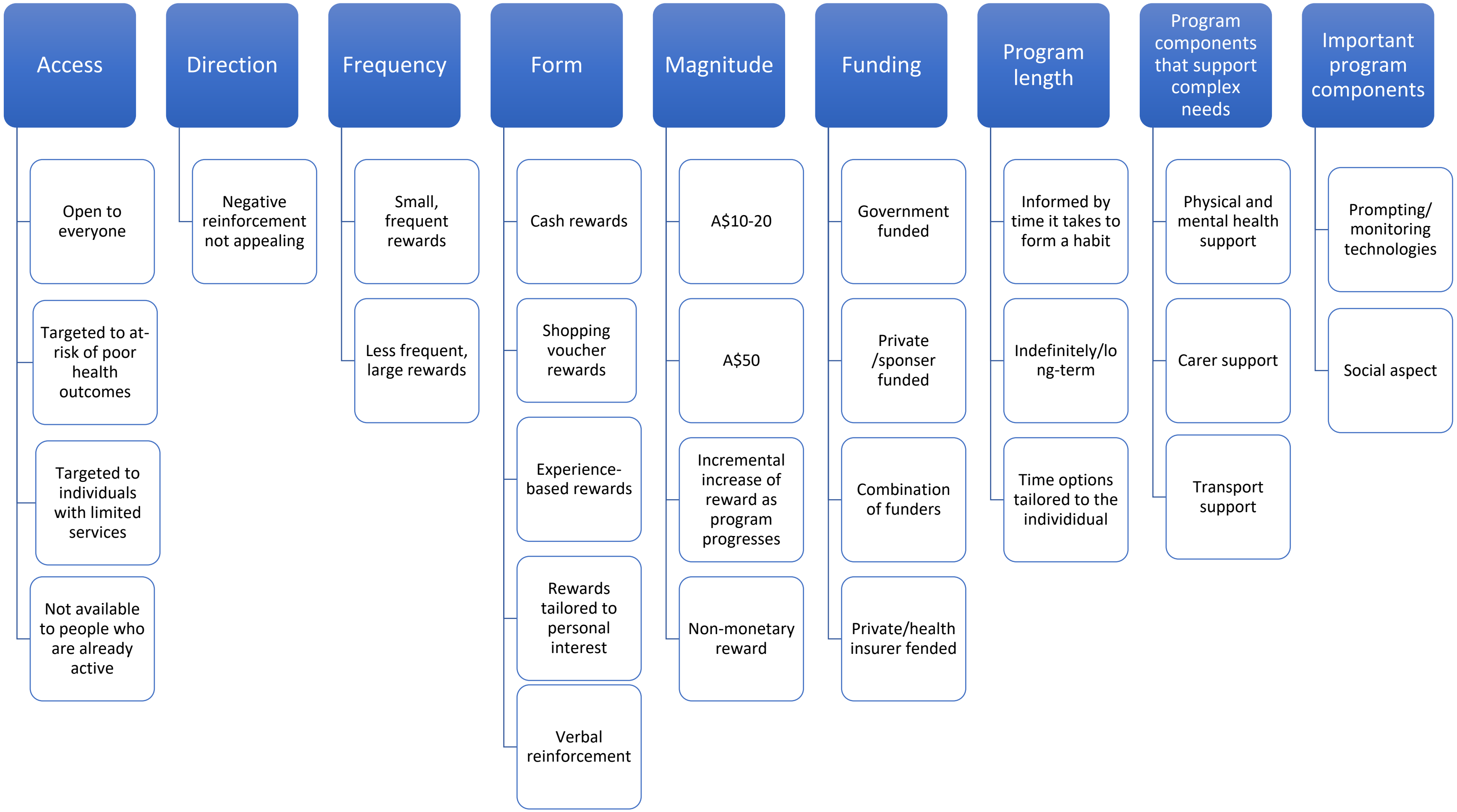


Figure 5.1. Themes identified in interview discussing incentive-based programs to increase physical activity and reduce sitting time

5.3.2 Incentive program components

These themes refer to participants' thoughts on specific features of incentive programs.

Access

Access refers to the population groups who would have the opportunity to be involved in programs that incentivise increasing physical activity and reducing sitting time.

Open to everyone

The importance of programs being available to everyone was a very strong theme discussed by most participants. The majority of participants believed it would be unethical for programs to be set up any other way. A few participants expanded on this idea, expressing that if an individual signed up for this type of program, they would have their reasons for doing so which should not be denied simply because they were not part of the intended target population.

> *I think everyone should have equal access to everything… even people who are already doing exercise if they are going to the extent to join the program… those people probably… need it in other ways so therefore* have *other risk factors.* – Female, age not specified.

Targeted to people most at-risk of poor health outcomes

A few participants however did believe that access should be restricted to people who were most at-risk of poor health outcomes. This was particularly discussed in regard to the idea that some populations would benefit from increasing motivation through incentive use more than others.

> *It should probably be targeted… Obviously there are people who are gonna need this sort of motivation and encouragement more than others.* – Male, 42

Some participants believed that this could be achieved fairly by strategically targeting at-risk population groups first and then expanding the program more broadly.

> *I suppose that everybody should have access to the program but perhaps you could have a sliding scale in terms of risk.* – Female, 61

Population groups with limited services

Older people and rural populations were also discussed by a few participants as potential beneficial recipients of targeted programs, particularly due to the unique needs of these populations such as social and physical isolation and therefore limited appropriate services.

> *I think it would be more useful in older people. The more older people become… that's when you start to stay home more. Everything starts to have a more aggressive effect.* – Female, 61

Not available to people who are already active

A few participants expressed that these programs should not be offered to/available for population groups that are already active, due the belief that it was not necessary to encourage this cohort if they were already partaking in the behaviour that would be incentivised. Some expanded on this to say that if these programs were not restricted it would likely be perceived as a waste of funding.

> *If it's government funded… it's not really a wise use of funds…people who are already active.* – Male, 42

Direction

Direction refers to how rewards should be framed (i.e., positive or negative reinforcement) to facilitate behaviour change.

Negative reinforcement not appealing

Some participants discussed that they would probably think more about their activity if they were losing money, rather than gaining money as a reward. However, this would not be a program they would join.

Some participants elaborated on this idea suggesting that to penalise people for not meeting behavioural goals would be unethical and stigmatising and could perhaps even be damaging to a person's mental health.

…punishing people who are probably sedentary for a reason… is probably going to play into you know internalised stigma and stuff already… I can't see anyone voluntarily joining up for that. – Female, age not specified

Frequency

Frequency refers to how often participants believed rewards would need to be administered in order for incentive programs to be effective.

Small, frequent rewards

Although participants believed that frequency of rewards would depend on the individual, a strong theme was that frequent rewards would be preferrable – especially in the beginning of programs- even if this meant the rewards magnitude was smaller. This was due to ensuring behaviour goals were front of mind to enable habits to be formed. Weekly to monthly rewards were seen as the most appropriate frequency of reward distribution.

Less frequent, large rewards

Some participants did however report that they would consider being involved in a program that rewarded them less frequently if the magnitude of the reward was worth the wait or personalised in some way.

If you know in the long run you can get something really, really special…I would like to accumulate and get the larger reward… certain things that you really would like. – Female, 60

Form

Form of incentive refers to what participants believed would be most appropriate (e.g., cash, voucher etc) to reward individuals who met their behavioural goals in these programs.

Cash rewards

Preferring cash rewards was a strong theme as most participants believed that the freedom for individuals to spend their reward on whatever they pleased rather than be restricted to designated stores or items would be the most effective way to appeal to everyone.

> *Well cash is usually a big motivator… Cash, I mean is sort of a commodity that anybody could use anywhere.* – Female, 56

Shopping vouchers

Vouchers, in varying forms, were also discussed as a potential effective reward. The majority of participants reported that supermarket or petrol vouchers would be a good way to reward individuals with something that would help with everyday family costs.

> *For a lot of people even like Woolworths vouchers… somewhere where everyone shops and... that you know helps your family.* – Female, 43

Some participants also suggested rewarding individuals with exercise-oriented rewards such as a voucher to purchase sports clothing or footwear. Participants thought that this would be a great way to both incentivise the program and also the continuation of these health behaviours.

> *Often I think ah I should really go and buy some… runners…things to wear sort of when you're out and about going for a walk and you know, clothes that are a bit more appropriate to wear if you get a bit of a sweat up*. – Female, 58

Experience-based rewards

Another strong theme was the suggestion of rewarding individuals with 'experience' rewards such as movie tickets, restaurant voucher or ferry rides to local attractions. Around half of the participants believed that these rewards were more likely to be appreciated because they were tangible experiences that could be directly linked to the program, rather than cash that could be mindlessly spent.

> *Maybe points towards a restaurant voucher. Something that you could go along and go out for lunch… points for maybe some sort of organisation that's sort of has an exciting activity… so it measures… I don't think for myself, just $10 to spend [somewhere] is something I would go for*. – Female, 62

> *Movie tickets… and you think well… you know the kids will think of that's a night out and that we don't have to pay for… Yeah you'd just put 20 bucks in your purse and just spend it you know*. – Female, 58

Tailored to participant

Another strong theme was the idea that these rewards should be tailored to the individual's interests, ideals or even location. Most participants believed that this would be integral to the success of the program.

> *I feel it should sort of vary according to what the individual sort of needs. You know, some people might want petrol vouchers… Some people might want food, things like that.* – Male, 52

> *I think you know just saying "here, a voucher for Toys 'r' Us" probably won't do anything cause I don't want my kids doing stuff like that anyway.* – Male, 43

Verbal reinforcement

A few participants expressed that material or monetary rewards would not appeal to them and that simply verbal congratulations and engagement with others would be the main motivator to change their behaviour.

> *A card saying, "Hey congratulations, I know you did this in a day, we're really proud of you." I think that's all it would take.* – Female, 62

Length of program

Length of program refers to how long participants believed incentive schemes should run in order to be effective.

Indefinitely/long-term

A very strong theme was the idea that participants would prefer to be involved in programs indefinitely, as long as the program was able to hold their interests and they were satisfied with the rewards they received.

> *If I was happy with the rewards, and the way it was going, I'd like it to be ongoing*. – Female, 56

Informed by amount of time it takes to form a habit

Other program durations discussed varied from one month to a year. However, it was stressed by many participants that the design of these programs would need to consider the minimum amount of time it takes for a habit to form in order to ensure behaviour was sustained once the program ceased.

> *I think if you are trying to change people's behaviour it would have to be at least 3 months for it to become a routine type thing, so people don't just fall back.* – Female, 56

Time options tailored to the individual

Having various program length options or the ability to extend the program was also discussed as a potential way to tailor the program to individual needs or varying levels of motivation.

Funding

Funding refers to organisations participants believed should fund these programs.

Government funded

Many participants believed that government funded programs are often more highly trusted as opposed to those funded by private organisations that are likely to have ulterior motives. However, participants expressed that they thought gaining this funding from the government was likely to be difficult.

> *Oh in an ideal world the government… but I don't think that would happen necessarily.* – Female, 43

Some also held strong ethical concerns about government-funded programs. This was discussed in the sense that others may hold the belief that we should not be paying people to be active, or that these funds may divert from other more prevalent health concerns.

> *…the kind of story they would run, what we pay lazy people to get out of their chair. I think they would have a little political debate about that.* – Female, 48

> *… the government… are they taking money from where it could be… going to, say actual health issues or something like that? That would be the concern.* – Female, 62

Combination of funders

A way to overcome this was the idea of partnership funding between private organisations with transparent motivations paired with government funding. These included grocery or sporting companies supplying gift vouchers.

Private/health insurer funded

Participants also believed that this funding responsibility could alternatively fall on private health insurers as many felt they often paid a large amount for this cover and it would be good to "receive something in return." Some also stated that it would clearly benefit health insurers to invest in these programs as healthier clients would mean less costly claims.

> *I think maybe some of the health funds could be making a bit of a contribution… because they take our money.* – Female, 58

> *I think the idea that, you know… when you don't look after your health, it's a cost to the nation, when you don't look after your health it's a cost to your insurance. So between the government and insurance companies, the idea that they might see a cost saving.* – Female, 61

There were however some ethical concerns with restricting access to only those who could afford private health cover.

> *I was thinking private health insurance. But no one has private health insurance.* – Female, 44

Magnitude

Magnitude refers to the value of the incentive needed to encourage individuals to increase their physical activity and reduce sitting time.

A$10-20 per week

The strongest theme in regard to incentive magnitude was the notion that a relatively small amount would be enough – specifically in the range of A$10-20 per week. This was for both programs that aimed to increase participants' physical activity as well as to reduce sitting time. In some instances, participants believed that lower incentives would be effective to encourage reduced sitting due to this behaviour being perceived as easier to change.

A$50

A couple participants discussed finding it particularly hard to find the motivation to exercise and therefore would need a larger incentive to consider participation in physical activity. They expressed that if the incentive amount was high enough to feel as though they were really losing out on something by not attempting to change their behaviour, they would likely give it a go. The amount for these participants was around A50 per week.

Incremental increase of rewards as program progresses

A couple participants discussed incrementally increasing reward magnitude as the program progresses. This was discussed as a potential strategy for increasing motivation as behavioural goals became more difficult and to reward participants for long-term engagement with the program.

Non-monetary rewards

A few participants expressed the view that the magnitude of the reward would not be important to them and rather that engagement with program organisers and recognition through verbal congratulations or small gifts of recognition would be the most valuable incentive.

This was highlighted by one woman who lived rurally and experienced social isolation. She stated that this factor had severely impacted her mental health and therefore her motivation to engage in physical activity. She reinforced that simply knowing someone cared whether she exercised or not and feeling accountable due to frequent interactions with program designers would encourage her greatly.

> *[The] value of the thing at the end, it's that someone was connected with you when you trying to do it. I mean we're I'm at, there's no people, you know? It could be just a motivational quote or something like that. So, an e-mail with saying… something inspirational. For me, I would say, "Okay, I'll do something today," it's a kind of reminder – Female, 62*

Program components that support complex needs

This theme refers to supplementary program components that should be considered to ensure participants were adequately supported to change and sustain healthy behaviours (e.g., career and transport services).

Physical and mental health support

Participants discussed individual physical and mental health concerns that restricted their ability to change their current behaviour. The ability for a program to address and support these individual barriers was seen as integral to success (e.g., tailoring programs to ensure those with chronic pain could achieve behavioural goals).

> *I guess the linking it with some things like chronic pain because that's the reason people aren't moving. There may be lots of different reasons why people aren't moving and we have to find what they are instead of just looking at it in an isolated sort of way… like is someone has depression then okay, we will look at something to deal with that. Or if it's chronic pain, looking at how they could be assisted with that. – Male 46*

Carer responsibilities

A few participants indicated that certain factors in their life restricted their ability to leave home to partake in physical activity. These included being a full-time carer for family members. Participants explained that it would be impossible for them to meet behavioural goals set out by these incentive programs without other support services to assist.

> *I'm caring for somebody else with a mental illness…having things at home you can't leave.. for whatever reason… Female, age not specified*

Transport support

Another factor that restricted participants' ability to partake in physical activity was transport difficulties. A couple participants explained that they would be happy to exercise more often however they did not have access to appropriate transport or if they it was often more infrequent than they would like. This was therefore outlined as an important support service that would help overcome barriers to regular physical activity.

> *Addressing those things umm maybe transports an issue for people…you know a lot of people have various health related mobility issues umm and you know they might be in pain when they move… you know you need to sort of consider those things. – Female, age not specified.*

> *I definitely think there should be other support. Like for me, going to the pool more regularly would be so much more helpful if there was a regular way to get a lift to it. – Male, 46*

Program design features

Program format refers to program design features that participants believed would increase the likelihood of changing their behaviour.

Prompting/monitoring technologies

Prompting /monitoring technologies were a strong theme when discussing program design features. These technologies were discussed for both increasing physical activity and reducing sitting time.

A couple of participants discussed having used tracking technologies, or knowing of someone else who had, and the impact these had on increasing motivation. This was due to the ability to set measurable and achievable goals and to monitor your progress towards these.

> *…the most valuable thing that I ever got was a Fitbit. Which means that I can keep track of my activity and the fact that I'm actually trying to do something. I mean I've gone through times where I might be doing three or four thousand steps in a day which is very, very poor. But I keep trying to aim for the 10. If I can get the 10, then I'm happy with myself… was probably the most valuable thing that I've ever been given because that gives you the ability to gauge it and to see what you're actually doing or not doing because sometimes you don't realize that you just–you're not doing things. – Female, 60*

> *when you're working on the computer, after 20 minutes, you have an alarm sound and it tells you you've got to for ten-minute walk or a break. Those sort of things really help. – Female, 62*

Several participants also discussed using these devices with family members and that the social features of these technologies can also be motivating.

> *There, and the ability to kind of go, I can look in the FitBit app, and then just hit "Friends." It's not really interesting in that whole…"Let me challenge everybody else," I'm not really interested in that. But, the ability to see her,*

because I care about her, and see where she's at… Just seeing that we're both up there at, you know, 50-, 60-something, 70,000 [steps per week] which we're getting close to ten a day… trying to hit that average goal, I think, has been something that we both kind of took on as a bit of a challenge. And inadvertently, it's been... I think it's been helpful. – Male, 43

Social features

The importance of social interaction was a strong theme discussed by more than half of the participants in the study. Various formats of interaction were discussed, from attending walking programs with others, to engaging in forums online. Some discussed the importance of social features in terms of accountability.

> *I need motivation. I probably – if I had someone that I went with that'd probably be you know motivate each other to do that sort of thing. But yeah when I'm going out If I'm going out on my own I'm just like mmmnn I can't be bothered you know?* – Female, 58

> *So I want to bother because suddenly I've got an accountability partner.* – Female, 62

Participants also discussed the potential for increased sustainability/maintenance if they were to make social connections during the program.

> *That's where that type of aspect might be a good way of keeping people active because you've made a new friendship. You've got someone else who also wants to walk.* – Female, 60

networking to get other people doing it with you. Because I find that that's actually very motivational as well. To walk with friends once a week. That day I always loved going out and that having someone else with like mindedness can make a huge difference. – Female, 60

In some instances, the social aspect was the primary motivation for being participating in these programs.

It's the support network that's important. – Female, 62

help each other out. You know, give each other advice and support because there would be no point in doing all this, honestly - Female, 44

5.4. Discussion

This study examined the appeal of program components for incentive-based programs which aim to increase physical activity and reduce sedentary behaviour in socioeconomically disadvantaged adults. This study extends on existing evidence by examining preferences relating to specific incentive program components using a published framework (31); and focusing on a target group at risk of inactivity/sedentary lifestyles and associated disease. Results showed that overall participants believed that incentive-based programs were an acceptable and appealing approach to increase their physical activity and reduce their sitting time.

Aligning with existing behaviour change literature (147), the most salient theme was the ability for these programs to be tailored to the unique needs of individuals. External barriers which would need to be addressed included location/social isolation of rural participants, full-time carer responsibilities, transport difficulties, mental health conditions and limited physical ability due to injury/disability/chronic conditions. Therefore, when designing such programs, it will be essential that program designers have an in depth understanding of the individuals taking part, and that strategies are put in place to best support participants and facilitate successful engagement.

Aligning with the existing literature, small, frequent rewards were the most desired (28). Preferences for type of reward were also consistent with those reported in previous studies, with cash and shopping vouchers perceived most favourably (50, 69). A unique finding however was the desire for 'experience-based' rewards, which included movie vouchers, ferry rides and trips to local attractions. These suggestions were all experiences that could be shared with family members. Participants discussed that being rewarded with a memorable experience that could be shared with family would improve their efforts and therefore effectiveness of the program in comparison to cash that may be spent mindlessly. Given the overarching desire for programs to be tailored to the individual, these incentives (cash, voucher or experience-based rewards) may be best prescribed at the beginning of the program based on participant preference.

Another novel finding was the desire for a strong social element as part of an incentive-based program. Walking programs have been previously shown to be well-accepted and efficacious in increasing physical activity amongst older adults (51) and those with obesity (48), and such programs were described by participants in the current study to be appealing due to the social interaction they provide. Participants believed this would help them initiate new health behaviours, maintain these behaviours and increase enjoyment in physical activity. This differs from results of the process evaluation based on incentive-based programs in the general population (Chapter 3), which suggested that participants preferred to participant in physical activity individually. However, this finding supports a previous systematic review and meta-analysis which found that the main feature distinguishing effective physical activity intervention amongst disadvantaged women was the inclusion of a group (social) element (148). This highlights the importance of developing targeted programs to support behaviour change, specific to the needs and interests of the target population.

Another interesting finding was the difference in the value of incentive participants believed would be needed to change sedentary behaviour as opposed to physical activity. Some participants reported that the amount needed was like to be less to incentivise sedentary behaviour due to the perception that it would be "easier" to sit less than exercise more. This contrasts intervention outcome results, such as the ACHIEVE study (102), where incentive goals for sitting were found to be harder to achieve than physical activity goals. It is likely that the discrepancy comes from participants in this qualitative study holding this belief, but when put into practice, such as in the ACHIEVE study, participants found it much more difficult to reduce sitting (which is ingrained in so many daily activities) than perhaps expected. This highlights the importance of future intervention including realistic and achievable goals (based on previous research), to avoid participants being discouraged by the outcomes achieved.

Many participants expressed that it was important for program durations to be long enough to facilitate lasting behaviour change. Literature suggests that engaging in a new behaviour for two to three months as a guideline may help to increase the likelihood that the behaviour change becomes ‘second nature’(149). This minimum amount of time aligned closely with the beliefs of participants in the current study (~three months). Of the few incentive-based physical activity intervention which did include follow up period post-intervention, some reported maintained behaviour change post-intervention (49), however, the majority did not (53, 57, 60, 64). Comparisons however are limited by vast differences in sample size (ranging from 7-286; program length (4wk-13wks); and follow-up durations (2wks-13wks). It is important that more studies are conducted with extended post-intervention follow-up evaluations to determine whether program length is a moderator for behaviour change maintenance.

Participants reported the appeal of a multicomponent design approach. This aligns with the literature, which suggests that incentives are more likely to be successful when incorporated into a broader range of behaviour change strategies (77, 80). Factors such as social support and self-monitoring technology were particularly important to participants of the current study. Ensuring the inclusion of these components is therefore recommended in future incentive-based programs with socioeconomically disadvantaged groups.

5.4.1 Limitations

Several limitations of this study should be acknowledged. Firstly, during the interviews there is the possibility of socially desirable responses (e.g., reporting a desire to exercise more and overstating the appeal of these programs and likelihood of being involved). However, most individuals provided detailed descriptions of their opinions and did not seem to hesitate to discuss reservations with program components. Secondly, socioeconomic position was screened using an income-based measure. Other proxies such as area-based disadvantage (commonly linked to lower leisure-time physical activity) (24) or education level (the most accepted/widely used proxy) were not considered. However, an income-based indicator was specially chosen due to the financial component inherent in most incentive-based programs. There was also a low response rate of males, and recruitment methods had to be modified to attract more male participants. However, ultimately 40% of the sample and rich insights were gained from both sexes.

5.4.2 Strengths

A major strength of the current study was the qualitative design, which provides detailed insights that would not be possible through a quantitative approach. Socioeconomically disadvantaged population groups were an important group for this research given their increased risk of physical inactivity and sedentary behaviour. Therefore, this study was able to provide key insights into the acceptability of incentive-based program components and the differential needs of this population group. In addition, since the interviews were conducted via telephone, this enabled participants to potentially speak more openly about complex barriers, which may not have been discussed in face-to-face situations. Literature supports the validity of telephone interviews, in addition to providing flexibility that enables the recruitment of individuals where a face-to-face format would not be possible (e.g., from rural locations) (150). Another major strength was investigating participants' preferences in regard to an incentive-based program to reduce sedentary behaviours. This is an under-researched area and therefore this study contributes to a major gap in the literature.

5.4.3 Conclusions/future research

Previous literature has suggested that incentive-use for health behaviour change is appealing amongst different population groups (72, 95). This study confirmed this idea and extended this evidence base by specifically focusing on incentive-based programs that aim to increase physical activity and reduce sitting time. This study was able to provide valuable insights into the acceptability of specific program components and suggestions on how to adequately support the differential needs of socioeconomically disadvantaged adults, a population group at high risk of physical inactivity and high levels of sedentary behaviours. Key recommendations from this study include: ensuring programs are tailored to personal preferences and barriers; are of an appropriate length for habit formation and maintenance; and are supported by additional components (e.g., social support, self-monitoring technologies).

The key findings from the current study will be used to inform the development of future studies, including the study outlined in the following chapter (Chapter 6), which explored the appeal of program components quantitatively through a discrete-choice experiment.

CHAPTER 6: EXPLORING THE APPEAL OF INCENTIVE-BASED PROGRAM COMPONENTS TO INCREASE PHYSICAL ACTIVITY AND REDUCE SITTING TIME AMONG SOCIOECONOMICALLY DISADVANTAGED ADULTS: A DISCRETE CHOICE EXPERIMENT

6.1. Introduction

The acceptability and appeal of incentive-based programs to encourage healthy behaviour change shows promise (109). A critical review found that incentive programs were likely to be considered acceptable if they benefitted recipients and the wider society; were considered fair; and were delivered to individuals deemed appropriate (109). However few studies have evaluated specific incentive program components and to our knowledge none have focused on the differential needs and preferences of at-risk population groups.

Only one study has been identified in the literature which used a discrete choice experiment to explore the acceptability of financial incentive program components for encouraging health behaviours (151). Participants of this study were UK residents who were adult members of a market research panel selected using quota sampling (151). Health behaviours examined included promoting physical activity as well as attendance for vaccination, attendance for disease screenings and smoking cessation. Attributes examined included type of incentive (none, cash, shopping vouchers or lottery tickets); value of incentives (a continuous variable); schedule of incentives (same value each week, or value increases as behaviour change is sustained); additional health information provided (none, written information, face-to-face discussion, or both); and recipients of the program (all eligible individuals, people living in low-income households, or pregnant women). Results of this study indicated that cash or shopping voucher incentives were preferred as much as or more than no incentives in all cases (151). Programs with lower value incentives (as opposed to higher values) and open access (as opposed to targeted population approaches) were preferred (151). Preferences for additional information alongside incentives depended on the health behaviour being targeted (151). These are important findings indicating preferences of incentive-use to promote healthy behaviours in the UK. The current study will expand on these findings using a discrete choice experiment to evaluate other important program attributes (e.g., program lengths, preferred funding support); preferences of an at-risk population group (socioeconomically disadvantaged); and an unexplored target health behaviour (sitting time).

The previous chapter (Chapter 5) provided insight from a qualitative study into the appeal of incentive-based program component to increase physical activity and reduce sedentary behaviour amongst individuals who are socioeconomically disadvantaged. Themes highlighted differences in incentive program components including desired program length (ranging from long enough to form a habit to indefinite/long-term); incentive type (cash, vouchers, experience-based rewards); required magnitude of rewards to motivate behaviour change (ranging from non-monetary rewards to A$50 per week); support components (transport, carer and physical/mental ability supports); supplementary program components (electronic devices, social components) and desired funding bodies (government, private/sponsor, combination of funders).

The aim of the present study is to extend these findings by quantitatively investigating the appeal of incentive-based program components to increase physical activity and reduce sitting time among socioeconomically disadvantaged adults. The specific program components examined include incentive form (type), value (magnitude), program length, access and funding. These components were chosen due to the variation in opinions and preferences reported in the previous qualitative study (Chapter 5).

6.2. Methods

6.2.1 Ethics

Ethics approval was obtained from Deakin University Human Research Ethics Committee (HEAG-H 100-2019) on the 8^{th} of June 2019. All participants provide informed consent prior to commencement of the study.

6.2.2 Overview

A discrete choice experiment is a quantitative technique to explore individual preferences. This technique is frequently used in social sciences where revealed preferences are difficult to collect (152). Discrete choice experiments present hypothetical interventions, products or services according to their key characteristics or ‘attributes’ (incentive form; value etc) and ‘levels’ (cash rewards, shopping vouchers; A$5-A$50 per/week equivalent). Participants are then asked to review scenarios and selected the option they prefer. This allows for relative preferences for attribute levels to be determined.

The key stages for developing a discrete-choice experiments are outlined in Figure 6.1. (153). These stages will be discussed in more detail below.

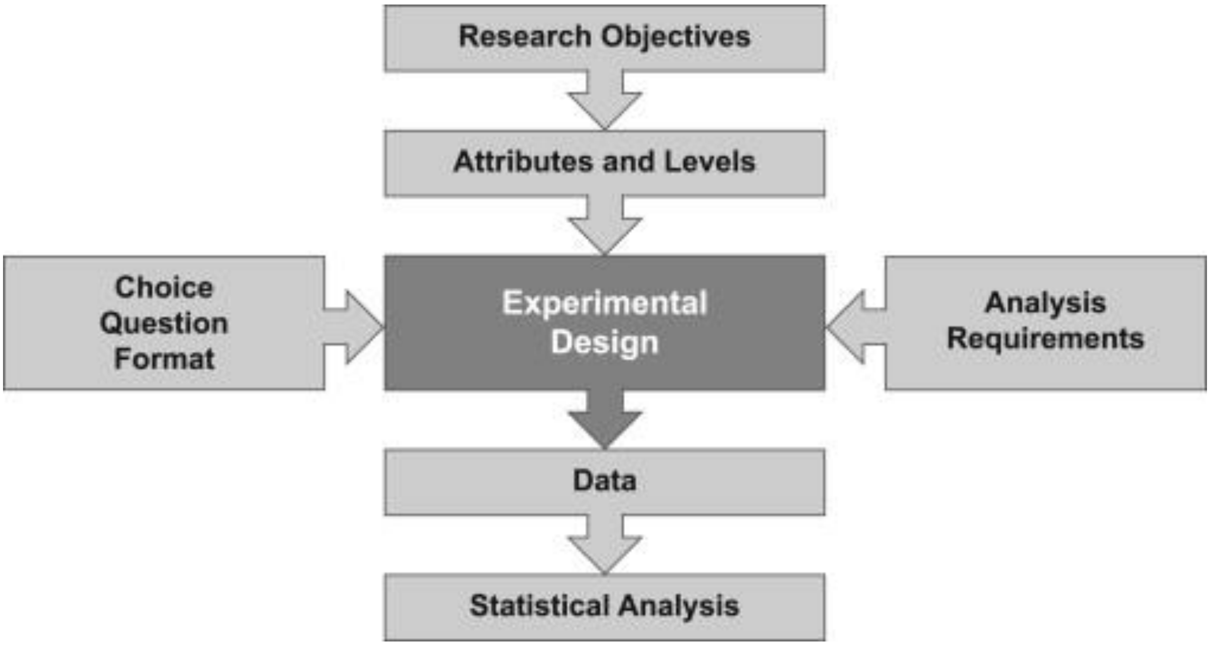


Figure 6.1. Key stages for developing a discrete-choice experiment

Source: Johnson FR, Lancsar E, Marshall D, Kilambi V, Mühlbacher A, Regier DA, et al. Constructing experimental designs for discrete-choice experiments: report of the ISPOR conjoint analysis experimental design good research practices task force. Value Health. 2013;16(1):3-13.

6.2.3 Identification of attributes and levels

The development of the discrete choice experiment was informed by the previous qualitative study (Chapter 5). This involved the translation of themes into attributes and levels of the discrete choice experiment (See Table 6.1). Reference categories were informed by participant responses in this qualitative research as to what were the most appealing components (cash rewards; open to everyone; long-term program; government funded) and previous literature (109). However, the ‘value’ category reference was set to the highest ordinal category as although A$10 was outlined as an appealing level of reward by the majority of participants in the previous qualitative research, having a higher value may intuitively encourage higher participant engagement.

Table 6.1. Discrete-choice attributes and levels

Attribute	Type	Value	Length	Access	Funding
(Reference category)	Cash rewards	$50 per week	Indefinite/ long-term	Open to everyone	Government funded
Level 3	Shopping voucher rewards	$20 per week	12 month program	Not available to people who are already active	Combination of funders
Level 2	Experienc e-based rewards	$10 per week	6 month program	Targeted to people who are most at risk of poor health outcomes	Sponsor/ private funded
Level 1	Rewards tailored to personal interests	$5 per week	3 month program	Targeted to people with limited access to health services	Health insurer funded

6.2.4 Experimental design

The experimental design of the discrete choice experiment was developed through Ngene choicemetrics software (154). The combination of attributes and levels are outlined in Table 6.1. For each participant to analyse all unique combinations of each attribute level would be unrealistic. Therefore, consistent with previous literature, an efficient design was generated using the Ngene software (154) in order to reduce number of choice sets required to a minimum while still maintaining the ability to estimate main effects and minimise standard errors (151). This generated 24 pairs of experiment choice sets for each of the two behaviours (physical activity, sedentary behaviour). The 24 choice sets for each behaviour were then randomly divided in three blocks of eight for each behaviour. Participants were then randomly assigned to one of these blocks for physical activity programs and for reduced sitting programs (16 choice sets in total).

Each choice set was combined with a fourth ‘opt-out’ option. Literature suggests that not including an opt-out or ‘status quo’ alternative when this reflects the reality is problematic, as it may force participants into a choice between unappealing options, none of which they may chosen in practice (155). Therefore a ‘none of these programs appeal to me’ option was included in the choice sets, reflecting reality in which participants may chose not to be involved in a health promoting program at all.

All choice sets in this experiment were ‘forced’, meaning participants were required to make a selection between the three program options and the opt-out option in each choice set before they could move on to the next.

6.2.5 Participants and recruitment

As there remains no consensus on the minimum sample size required for a discrete choice experiment (156), a sample size of 100 was deemed appropriate for modelling stated preference data. This was informed by the research team’s experience with DCEs, studies with similar design characteristics (e.g., 157), and previous literature (158).

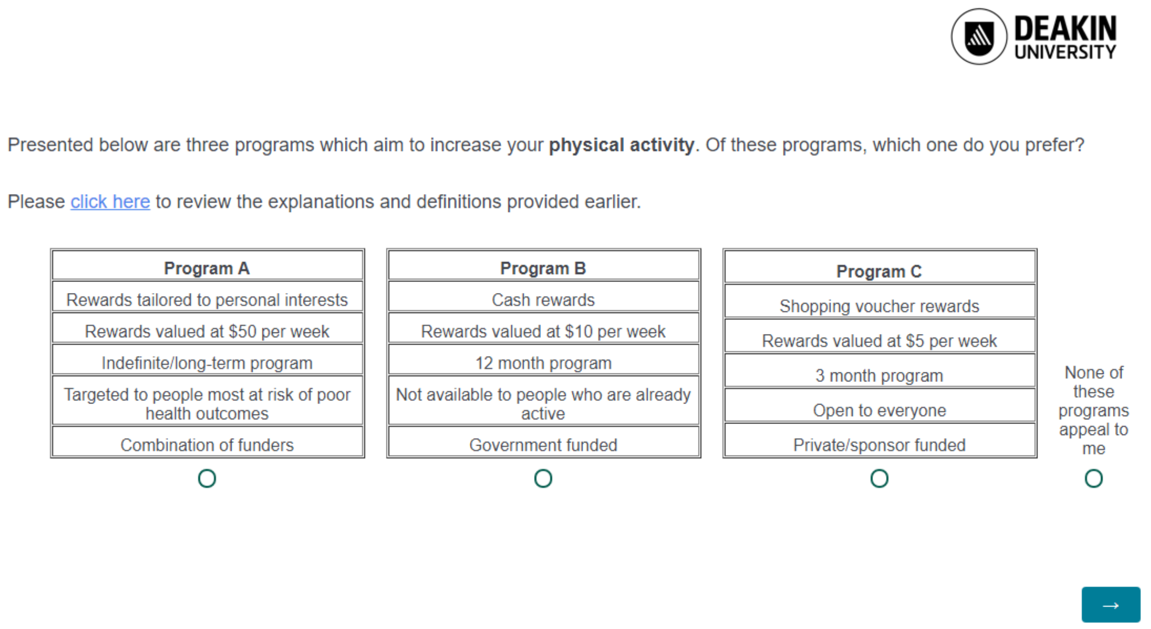
The eligibility criteria for this study included being aged 40-65 years, classified as insufficiently active (not currently engaging in 150 minutes of moderate physical activity or alternatively 75 minutes of vigorous activity per week), regularly engaging in long periods of sitting (sitting for more than 7hrs per day) and experiencing socioeconomic disadvantage (determined by a net weekly household income less than A$1,600; or deriving main income from a pension or welfare benefit; or holding a Health Care Card). Eligibility for access to a Health Care Card is based on specific payments or supplements already received from the government (146). The sedentary cut-point was based on the Australian Physical Activity Guidelines (3) and literature which suggests that more than seven hours sitting per day significantly increases all-cause mortality risk when the effects of physical activity are taken into account (145).

Participants were recruited for an online survey via a paid advertisement run through social media forums (Facebook and Instagram) (see Appendix G for example of advertisement content). The advertisement was also posted on the Deakin University's Institute for Physical Activity and Nutrition (IPAN) Twitter page. Images were rotated to try and capture the attention of the public. A direct link to the online survey was displayed in this advertisement. This enabled participants to read about the study, self-screen the eligibility criteria and complete an online consent form prior to beginning the survey. All participants who opted-in (by providing their email address) were placed in a draw to win one of four A$50 Woolworths supermarket vouchers as compensation for their time.

This recruitment strategy was impacted by the coronavirus pandemic. The advertisement was initially launched in March 2020 but required to be paused due to low engagement after the first coronavirus lockdown announcement shortly thereafter. The advertisement was relaunched four weeks later, and engagement significantly increased. In addition, near the end of the recruitment phase male targeted images were to specifically boost engagement of men.

6.2.6 Discrete choice experiment

An online survey was constructed using Qualtrics (159). This online format was chosen due to ease of use and the ability to involve participants located more broadly. Online discrete choice experiments have been found to be just as effective as face-to-face discrete choice experiments (160). Participants were presented with choice sets and required to select the option that appealed most to them (example choice set represented in Figure 6.2). Prior to the discrete choice experiment, participants were provided with instructions for completion plus attributes and levels described in more detail which they could refer to via a hyperlink at any time throughout the experiment (descriptions outlined in Appendix H).



DEAKIN UNIVERSITY

Presented below are three programs which aim to increase your **physical activity**. Of these programs, which one do you prefer?

Please click here to review the explanations and definitions provided earlier.

Program A	Program B	Program C	
Rewards tailored to personal interests	Cash rewards	Shopping voucher rewards	
Rewards valued at $50 per week	Rewards valued at $10 per week	Rewards valued at $5 per week	
Indefinite/long-term program	12 month program	3 month program	
Targeted to people most at risk of poor health outcomes	Not available to people who are already active	Open to everyone	None of these programs appeal to me
Combination of funders	Government funded	Private/sponsor funded	

→

Figure 6.2. Example choice set

6.2.7 Additional participant information

Participants were asked to complete some questions about themselves to provide descriptive context. These included demographic information, including date of birth, sex, postcode and whether they had dependent children living at home. In addition, although participants were screened as insufficiently active and sedentary, they were also asked to complete the Active Australia physical activity questions (161), and IPAQ-L sitting questions (120), and two open ended questions about barriers to changing their current physical activity and sitting behaviours. This information was used to provide context and to ascertain whether there were any particular barriers that might prevent behaviour change. Participants were also asked to complete a useability question, which asked “Are you having any difficulties completing this questionnaire?” with response options Yes/No. If ‘yes’ was selected participants were asked to expand on this with an open-ended response. This data was used as a means to identify any design errors and to determine ease of completing the discrete choice experiment. The online Qualtrics questionnaire (including the discrete-choice experiment) took approximately 20 minutes to complete.

6.2.8 Analysis

Statistical analyses were conducted using Stata 16 (106). Data were analysed using a random utility theory framework and conditional logit regression. This approach enabled the determination of the utility that participants placed on attribute levels when compared to the reference category. Conditional logit models are deemed appropriate when choice among alternatives is modelled as a function of the characteristics of alternatives rather than the characteristics of the individual making the choice (162).

Presented in the results is each attribute level represented by a coefficient value when compared to the reference category (indicating relative preference). For example, a positive coefficient value indicates that the attribute level (e.g., experience-based reward) was preferred relative to the reference category (e.g., cash reward) and a negative coefficient indicates a relative preference for the reference category. P-values were used to determine statistical significance in differences ($p<0.05$).

6.3. Results

6.3.1 Participant characteristics

One hundred and one participants completed the discrete choice experiment and were included in this analysis. Most participants were female (80.2%) and were located in either the state of Victoria (34.7%), New South Wales (28.7%) or Queensland (17.8%). The majority of the participants were not parents or guardians of children living in their household (70.3%) (see Table 6.2 for participant characteristics).

Table 6.2. Participant characteristics

Characteristic	Level	Study sample, n(%); n=101)
Age	40-44	17(16.8)
	45-49	14(13.9)
	50-54	13(12.9)
	55-59	21(20.8)
	60-64	29(28.7)
	65-69	7(6.9)
Location in states of Australia	New South Wales	29(28.7)
	Northern Territory	1(1.0)
	Queensland	18(17.8)
	South Australia	10(9.9)
	Tasmania	1(1.0)
	Victoria	35(34.7)
	Western Australia	7(6.9)
	Not specified	1(1.0)
Sex	Female	81(80.2)
	Male	19(18.8)
	Not specified	1(1.0)
Parent/guardian to children living in household	No	71(70.3)
	Yes	30(29.7)

6.3.2 Barriers to being more active and sitting less

When asked about factors that made it more difficult to be as active as participants would like, the most frequent responses were lack of motivation; being overweight/obese; occupation; lack of funds; chronic condition/injury and subsequent pain and fatigue; mental health issues; sedentary hobbies/lack of interest in physical activities; and the impact of coronavirus (See Table 6.3 for examples of verbatim responses). When asked about factors that made it more difficult to decrease sitting time, the most frequent responses were lack of motivation; occupation and commute; chronic conditions and subsequent pain and fatigue;

mental health issues; sedentary hobbies/lack of interest in physical activities; boredom/filling time and impact of coronavirus (see Table 6.4 for examples of verbatim responses).

Table 6.3. Examples of verbatim responses when participants were asked about barriers to physical activity

Motivation	"I don't have any motivation to do anything" – Participant 29, Female, 61
Overweight/obese	"Judgement towards an overweight body. Access to fitness gear for fat body and the costs associated. I couldn't tell you the amount of times I've looked for comfy workout clothes that will hold up to movement and minimise discomfort only to find that it is very difficult" – Participant 28, Female 41 "I'm also overweight, which has a lot to do with the pain in my legs I think" Participant 38, Female 56
Occupation	"I have an administration job which involves sitting down using a computer" – Participant 36, Female 48
Lack of funds	"Lack of funds to maybe pursue physical activities I would find more interesting than just walking, or in a group setting or as part of a weight loss program or similar for mentoring and support" – Participant 93, Female 58 "Lack of finances to be able to afford not only a gym membership but a specialist fitness plan" – Participant 58, Female 52
Chronic condition/injury (pain and fatigue)	"A back problem which makes it very painful to walk for more than 5 minutes, often." Participant 93, Female 48 "I have multiple chronic health & autoimmune conditions that have affected my balance and coordination, moderate breathing issues & suffer from extreme fatigue & flare ups if I don't continually pace myself in short bursts" – Participant 7, Female 55
Mental health issues	"I suffer from depression and find it hard to get motivated. I tend to hide from the world too much so don't even walk" – Participant 82, Female 44
Weather	"Hot humid weather outsides makes for a really uncomfortable exercise experience as in walking jogging or sport" – Participant 3, Female 63 "Too cold to exercise outside" – Participant 89, male 51
Sedentary hobbies/lack of interest in physical activities	"I love reading, so my interests are naturally more sedentary. I spend many hours reading newspapers, articles on the internet, researching interests, watching documentaries and TV programs. I don't "like" to be physically active, but I know I "should" be" – Participant 22, Female 59
Coronavirus	"Coronavirus. I am a member of a gym that is closed and I can't attend classes. My unit is too small to do online classes. Isolation prevents leaving" – Participant 19, Female 46 "Fear of coronavirus is keeping me at home. I'm over 60 and have chronic health problems so I figure I am at increased risk of severe disease if I catch it" – Participant 23, Female 61

Table 6.4. Examples of verbatim responses when participants were asked about barriers to reducing sitting time

Motivation	"I feel tired or lazy" – Participant 12, Female 49 "No motivation. No incentive" – Participant 47, Female 42
Occupation and commute	"Traffic! My last job took an hour each way to work, then at work the job is sedentary. Interestingly the company was huge on OH&S for the blue-collar workers, admin staff not at all. Companies need to be more flexible in their work stations etc" – Participant 9, Female 61
Chronic condition/injury (pain and fatigue)	"I become extremely lightheaded & cannot breather the longer I stand on my feet. I have had falls because of it. My pain levels also increase" – Participant 7, Female 55 "The arthritis in my back. Standing or walking for any length of time (even cleaning toilets and bathroom sinks, and doing dishes) causes a lot of pain" – Participant 36, Female 48
Mental health issues	"My own feelings of self-worth, that I'm worth the time and effort of moving more" – Participant 28, Female 41 "I also have social phobia so it is difficult to do things with others, but an incentive programme and extra funds may even help with this is I was able to establish relationships with others due to the programme which could be ongoing and lead to more" – Participant 93, Female 58
Sedentary hobbies/lack of interest in physical activities	"Most hobbies involve sitting (reading, embroidery, watching tv)" – Participant 65, Female 42 "There is very little in the way of exercise that I find intrinsically interesting" – Participant 22, Female 59
Boredom/ filling time	"Unsure how to fill time" – Participant 11, Male 47 "Boredom/loneliness its either sit or lay watching tv" – Participant 32, Female 59
Coronavirus	"Covid! Since working from home I've put on 5kg as I sit down all day now." – Participant 35, Female 62 "Can't go anywhere due to coronavirus lockdown, self-isolating" – Participant 40, Female 67

6.3.3 Difficulties completing questionnaire

Thirteen (12.9%) participants expressed difficulties completing the discrete choice questionnaire. Reason for difficulties included program combinations being hard to understand; and overlap/similarity in options. Others discussed perceived limitations of these programs in their open-ended responses. These included monitoring concerns; fairness/effectiveness of access options; lack of trust in government programs; and other factors influencing participation (poverty, isolation, mental health issues).

6.3.4 Participant behaviour

The majority of participants had not engaged in any moderate physical activity (n=88; 87.1%) or vigorous physical activity (n=87; 86.1%) in the last week. Most participants also had not engaged in any gardening/ yard work (n=69; 68.3%). The most frequent intensity of activity reported was walking with the almost 40% of participants (n=38; 37.6%) reporting that they walked for up to an hour in the last week and about a quarter (n=25; 24.8%) for 1+ to 2 hours (see Table 6.5). Participants sat slightly less on the weekend (50% more than 8 hours) than weekdays (61% more than 8 hours) (see Table 6.6)

Table 6.5. Participant responses (n=) to total physical activity time in the last week

	Vigorous physical activity (n=101)	Walking (n=101)	Yard work/ Gardening (n=100)	Moderate physical activity (n=101)
Not at all in the last week	87	21	69	88
1min to 1hr	11	38	16	8
1+ to 2hrs	3	25	7	2
2+ to 3hrs	-	8	3	1
3+ to 4hrs	-	2	2	1
4+ to 5hrs	-	2	0	1
More than 5	-	5	3	-

Note: One participant response has been removed from yard work/ gardening analysis due to reporting error

Table 6.6. Participant responses (n=) to total sitting time on weekend and weekdays

	Total sitting time weekday (n=96)	Total sitting time weekend day (n=100)
2 to 4hrs	5	6
4+ to 6	14	22
6+ to 8	18	22
8+ to 10	25	23
10+ to 12	20	11
12+ to 14	8	10
14+ to 16	5	4
More than 16hrs	1	2

Note: Some participant data has been removed from this analysis due to reporting errors

6.3.5 Discrete choice experiment

Incentive-based physical activity program components

Seventy of the 101 participants completed the discrete choice experiment without opting out (through selection of 'none of these programs appeal to me') of any of the physical activity program choice sets presented to them. The balance of 31 participants opted out of one or more choice sets, with three participants opting out of all eight choice sets (see Table 6.7 for breakdown of number of choice sets opted out on).

The stated preference weights for attributes of an incentive-based program to increase physical activity in the sample are presented in Table 6.8. There was no statistically significant difference preference in the incentive types when compared to the cash reference category. All lower incentive values per week were less appealing than the reference category of A$50/per week. Program lengths of 3 months and 6 months were less appealing than the reference category of an indefinite/long-term program. However, the 12-month length showed no significant difference in preference compared with the reference category. Similarly, programs not being available to those who were already active showed no difference to the reference category of programs being open to everyone. Targeting programs to those with increased health-risks was preferred when compared to the reference category of open to everyone, whilst targeting programs to those with limited services was less appealing than the reference category. A program funded by a combination of funding bodies showed no significant difference when compared to the reference category of a government funded program. However, health-insurer funded and private/sponsor funded programs were less appealing.

Table 6.7. Number of choice sets participants opted out on when presented with incentive-based physical activity programs

Number of choice sets opt-out on	0	1	2	3	4	5	6	7	8	Total
Participants	70	13	7	4	2	2	0	0	3	101

Table 6.8. Stated preference weights for attributes of incentive-based programs to increase physical activity (n=101)

Attribute	Attribute level	Coefficient	(95% CI)	P Value
Incentive type	Cash (reference)			
	Shopping vouchers	-0.17	(-0.44, 0.09)	0.198
	Experience-based	-0.20	(-0.51,0.11)	0.202
	Tailored to interests	0.25	(-0.06, 0.55)	0.116
Incentive value	$50 equivalent/week (reference)			
	$20 equivalent/week	-0.36	(-1.41, -.68)	<0.05
	$10 equivalent/week	-0.78	(-1.07, -0.49)	<0.05
	$5 equivalent/week	-1.05	(-1.42, -0.68)	<0.05
Program length	Indefinitely/long-term (reference)			
	12 months	-0.25	(-0.52, 0.02)	0.07
	6 months	-0.35	(-0.62, -0.09)	<0.05
	3 months	-0.44	(-0.74, -0.15)	<0.05
Program access	Open to everyone (reference)			
	Not available to those who are already active	0.07	(-0.21, 0.34)	0.641
	Targeted to those with increased health-risks	0.32	(0.01, 0.62)	<0.05
	Targeted to those with limited services	-0.35	(-0.65, -0.05)	<0.05
Funding	Government funded (reference)			
	Combination of funders	-0.21	(-.45, 0.02)	0.08
	Health insurance funded	-1.01	(-1.35, -0.68)	<0.05
	Private/sponsor funded	-0.43	(-0.69, -0.17)	<0.05

Data are dummy coded conditional logit model coefficients and 95% CI. Preference weights indicate utilities for a given attribute level.

The opt-out option is included in this model.

Incentive-based reduced sitting time program components

Sixty-seven participants completed the discrete choice experiment without opting out of any of the physical activity program choice sets presented to them. Three participants opted-out of all eight choice sets (see Table 6.9 for breakdown of number of choice sets opted out on).

The stated preference weights for attributes of an incentive-based program to reduce sitting time in the sample are presented in Table 6.10. There was no statistically significant difference in preference of shopping vouchers or rewards tailored to interests when compared to the reference cash category. However, experience-based rewards were less appealing than the reference cash category. There was no statistically significant difference in preference between the value of A$20 equivalent/week and the reference category of A$50/per week. Values A$5/per week and A$10/per week were however less appealing than the A$50/per week reference category. None of the access attributes showed a statistically significant preference when compared with the reference category of sitting programs being open to everyone. A program funded by a combination of funding bodies showed no significant difference when compared to the reference category of a government funded program. However, health-insurer funded, and private/sponsor funded were less appealing.

Table 6.9. Number of choice sets participants opted out when presented with incentive-based sitting programs

Number of choice sets opt-out on	0	1	2	3	4	5	6	7	8	Total
Participants	67	10	8	5	2	3	2	1	3	101

Table 6.10. Stated preference weights for attributes of incentive-based programs to reduce sitting time (n=101)

Attribute	Attribute level	Coefficient	(95% CI)	P Value
Incentive type	Cash (reference)			
	Shopping voucher	-0.18	(-0.40, 0.05)	0.125
	Experience-based	-0.35	(-0.64, -0.05)	<0.05
	Tailored to interests	-0.16	(-0.44, 0.11)	0.253
Incentive value	$50 equivalent/week (reference)			
	$20 equivalent/week	-0.13	(-0.34, 0.89)	0.250
	$10 equivalent/week	-0.30	(-0.57, -0.02)	<0.05
	$5 equivalent/week	-1.00	(-1.36, -0.66)	<0.05
Program length	Indefinitely/long-term (reference)			
	12 months	-0.16	-0.37, 0.05)	0.143
	6 months	-0.21	(-0.48, 0.05)	0.107
	3 months	-0.29	(-0.55, -0.02)	<0.05
Program access	Open to everyone (reference)			
	Not available to those who are already active	0.00	(-0.32, 0.32)	0.988
	Targeted to those with increased health-risks	0.10	(-0.22, 0.41)	0.553
	Targeted to those with limited services	-0.20	(-0.50, 0.12)	0.235
Funding	Government funded (reference)			
	Combination of funders	-0.21	(-0.46, 0.04)	0.105
	Health insurance funded	-0.62	(-0.93, -0.31)	<0.05
	Private/sponsor funded	-0.49	(-0.79, -0.20)	<0.05

Data are dummy coded conditional logit model coefficients and 95% CI. Preference weights indicate utilities for a given attribute level.

The opt-out option is included in this model.

6.4. Discussion

This study investigated attributes of incentive-based programs to increase physical activity and reduce sitting amongst a sample of middle-aged adults, who were insufficiently active and experiencing socioeconomic disadvantage. The results of this study will inform future interventions targeting this population group at heightened risk of physical inactivity and predominately sedentary lifestyles. Incentive-based programs are already receiving attention in the community (for example, several health insurance funds in Australia and internationally offer such programs to their clients), but the evidence base about the most appealing attributes of such programs remains limited. This study therefore adds to that evidence base to inform more effective interventions for groups at high risk of inactivity.

When considering incentive-based programs to increase physical activity, interestingly participants did not show a significant preference for the reference cash reward category over the shopping voucher rewards; rewards tailored to personal experience; or experience-based rewards. Cash and shopping voucher rewards have been represented in previous discrete choice experiments as preferred over no incentive (151), however these results provided an expand range of ideas on what could constitute an appealing reward for increasing physical activity. In the previous qualitative study (Chapter 5), tailoring rewards to personal interests and providing participants with experience-based rewards (e.g., movie tickets) were considered by participants as appealing, and the present study suggests that they may be just as appealing as cash. When considering incentive type for programs to reduce sitting time, the same trend was observed, with shopping vouchers and rewards tailored to personal interest having no greater or lesser appeal when compared to cash rewards.

However, the reference base cash category was preferred over experience-based rewards for sitting programs, indicating the potential difference in reward preference depended on the health behaviour being targeted.

When considering the value of these incentives, the reference category of equivalent to A$50 per week was more appealing than the A$20, A$10 and A$5 categories for both physical activity and sitting time. This contrasts findings from the previously published study which demonstrated a preference for lower value incentives for physical activity (151). However, the previously published study (151) aimed to capture the entire UK population using quota sampling, and this may have led to differential reported preferences when compared to the socioeconomically disadvantaged group recruited in the present study. Similarly, in the qualitative study within this thesis (Chapter 5), the most frequently reported amount encourage behaviour change was ~A$10 per week. This may have been the result of the interview format of this study where participants may have felt reluctant to voice the preference for a higher amount and instead responded in a way they perceived more appropriate. In addition, qualitative results in the previous chapter (Chapter 5) suggested that incentives to reduce sitting time may not need as high of a reward value to change behaviour and therefore a lower value may be seen as more appropriate; however, the larger reward was still reported as the most appealing in the present study.

The program length reference category of indefinitely/long term was preferred of program lengths of 12 months, 6 months, and 3 months. This supports the qualitative research in the previous chapter (Chapter 5) in which participants indicated that they would be willing to be involved in these programs for as long as they were meeting their needs and maintaining their interest. Results were different when considering sitting time programs. There was no significant difference between the reference category of indefinitely/long-term when compared with 6-month programs, however 3-month programs were less appealing. This suggests that perhaps participants would consider shorter programs lengths for sitting programs, as long as they were at least greater than 3-month programs, which appeared be too short to be appealing. The majority of incentive-based physical activity programs identified in the literature (Section 2.2.) had intervention duration of ~12-24 weeks (e.g., 51, 53, 57, 64, 73). However, there was a vast range of intervention lengths (ranging from 1 week (35) to 2 years (46), which did not appear to impact effectiveness. Regardless, this finding adds to the literature by outlining participant preferences.

In terms of access, there was no significant difference in programs not being offered to people who were already active when compared to open-access programs for both physical activity and sitting time programs. In regard to physical activity programs, targeting programs to people with increased health risks was more appealing than the reference category of open-access programs. However, there was no significant difference between this attribute and the reference category for the sitting time programs. Targeting programs to those with limited access to services was less appealing than offering open-access programs for both health behaviours. Overall, these results differed from the previously published study (151), in which open-access programs were preferred for all health behaviours (including physical activity). This result highlights the different perceptions on access depending on the health behaviour being targeted (physical activity v sedentary behaviour), and the potential for a difference in access preferences among at-risk population groups as opposed to the general population.

Assessing the appeal of funding bodies was a novel inclusion in this study. There was no significant difference in preferences for programs funded by a combination of funding bodies when compared to the reference category of government funded programs for both physical activity and sitting time programs. Health-insurer and private/sponsor funded programs were less appealing that government funded programs for both behaviours. This is consistent with qualitative results in the previous chapter (Chapter 5) where participants expressed that there is often more trust in government-funded programs and health-insurer funded programs are not as appealing due to not having the funds to pay for health insurance to begin with. Open-ended questions in the current study also support this, with participant queries on access to health insurer-funded programs reported in open-ended questions.

6.4.1 Limitations

A limitation of this study is that comparisons can only be made between attributes and the selected reference category. However, reference categories were informed by the qualitative study in the previous chapter (Chapter 5) and previous literature (109) and therefore are believed to be appropriate for this analysis. In addition, this study does not analyse potential interaction effects of demographic characteristics (e.g., choices influenced by sex, age etc.). However, this study was limited by a homogenous sample (40-65 years, insufficiently active, socioeconomically disadvantaged). Larger studies exploring preferences which are stratified by sociodemographic characteristics is advised for future studies.

6.4.2 Strengths

A major strength of this study is the discrete-choice methodology. This allows for relative comparisons between attribute levels and reference categories. To our knowledge, only one other study has used this methodology to explore incentive-use for health behaviours (including physical activity) (151). The current study expands on the literature by focusing primarily on preferences of a socioeconomically disadvantaged population and exploring incentive-use for sitting time reduction.

General guidelines advising on best practice state the importance of qualitative research methods in the design of discrete choice experiment surveys (163, 164) . This study was informed by the qualitative study presented in the previous chapter (Chapter 5) and therefore is a major strength of this study.

Another strength was including an opt-out option in all choice sets, representing a more realistic real-world setting where participants are not forced to be involved in programs with unappealing attributes. This approach is often avoided due to concerns of participants consistently choosing the opt-out option. However, this was not the outcome of this study with only three participants (2.9% of the sample) opting out of all choice sets.

6.4.3 Conclusions/future research

Given the increased use of incentive-based programs to encourage behaviour change, more evidence is required to explore the appeal of program attributes and the potential differential preferences and needs of at-risk population groups. This study expanded on previous literature using a novel quantitative approach, however research including a larger sample size to allow for more in-depth analysis is recommended for future research.

CHAPTER 7: GENERAL DISCUSSION

7.1. Introduction

In this thesis, four inter-related studies were conducted to examine the potential of incentive-based programs to encourage both an increase in physical activity and a reduction to sedentary behaviour. The first two studies focused on a previous incentive-based intervention (ACHIEVE) which was implemented in partnership with a private health insurer in Victoria, Australia. The process analysis of the ACHIEVE study allowed us to understand from the participants' perspective, what 'worked' within the study, what did not work, what could be improved. This guided the development of subsequent studies. The economic evaluation enabled determination of the within trial cost-effectiveness credentials of the ACHIEVE program as well as the modelling of the long-term effectiveness if the program was scaled-up to all eligible Australians. The final two studies explored how to best tailor incentive-based programs for populations most at-risk of poor health outcomes due to physical inactivity and high levels of sedentary behaviour. A qualitative study was conducted with socioeconomically disadvantaged middle-aged adults to explore perceptions of potential incentive-based program components and the needs and preferences of this group. The final study aimed to quantify these findings by engaging with a separate sample of adults of the same demographic who completed a discrete-choice experiment online. This involved participants choosing the most appealing hypothetical incentive-based program, based on a range of attributes, informed by learnings of the previous study.

Collectively the findings presented in this thesis contribute to the evidence base necessary to inform the development of interventions using incentive-based strategies to encourage healthy behaviour change, particularly those focused on the promotion of active lifestyles in middle-aged adults and socioeconomically disadvantaged populations. An extensive discussion of the specific findings and issues has been presented within each of the previous chapters. This final chapter will provide an overview of thesis findings, their relationship to previous work and their implications for public health. This chapter will also outline the limitations and strengths of this thesis and recommendations for future research.

7.2. Overview of key findings

7.2.1 Aim 1: To evaluate the appeal, acceptability and perceived effectiveness of an incentive-based intervention (ACHIEVE) to increase physical activity and reduce sedentary behaviour in the general population.

The first study of this thesis (Chapter 3), a process evaluation was conducted to examining the perceived effectiveness of the ACHIEVE study. The use of incentives, although increasing in popularity, is still relatively unexplored in regard to process evaluations and importantly, participants' perceptions of program components.

Likability

A promising finding of this study was that individual components as well as the overall program were perceived favourably by the majority of participants. Likability has been identified as an important correlate associated with program outcomes (72), and this was the case in regard to the main outcomes measure reported in the ACHIEVE study and by the participants themselves.

Text messages

Although almost all participants reported reading the text messages they received in the program, over half believed they did not motivate them to change their behaviour and many reported them as the least liked component of the ACHIEVE study. Prompting techniques have been reported as an effective strategy for behaviour change (105), however in this instance were not perceived as effective by participants. Major concerns raised by participants about this particular component was the ‘impersonal nature’ of this form of communication. Individual tailoring and personalisation of text messages has been associated with increased efficacy for health promotion interventions (110). Therefore, tailoring content of prompting messages is advised for future research.

Self-monitoring & multi-component approach

Also reinforcing results of existing literature were findings regarding the effectiveness of self-monitoring strategies (52) and multi-component goal setting interventions (112) to encourage behaviour change. Incorporating a Fitbit was particularly liked by participants as it increased their understanding of their actual behaviour, assisted them to set goals and in turn helped them to achieve what was required of them to receive incentives. Participants also reported lasting behaviour change as a result of embedding these components into the program, reporting that they were still making incidental active choices, setting goals and monitoring activity post-intervention.

Effectiveness to reduce sitting

A unique contribution of this study to the literature was the exploration of the perception of incentive-based intervention components for incentivising reduced sitting. Overall, participants reported that it was much more difficult for them to achieve sitting goals compared to physical activity goals and some participants reported prioritising physical activity goals or abandoning sitting goals completely. There were a variety of different reasons reported in regard to barriers to reducing sitting, however the most prominent was that sitting was perceived as embedded in everyday practices, particularly in workplaces and study environments. Findings regarding the challenges of reducing sitting may also relate to the likelihood that the general population may not be as familiar with the health risks associated with prolonged sitting or as motivated to change this behaviour relative to physical activity, which has been a well-promoted health behaviour for decades. Although overall the study was in fact successful in reducing the overall sitting time of ACHIEVE participants, this result suggests that additional work is needed in this space, particularly in terms of considering how to effect environmental changes to accommodate healthy behaviour change.

7.2.2 Aim 2: To evaluate the cost-effectiveness of an incentive-based intervention (ACHIEVE) to increased physical activity and reduced sedentary behaviour in the general population.

The second study of this thesis (Chapter 4) outlined the cost-benefits of the ACHIEVE study. Again, although incentive-based programs are increasingly used in the public health sector, the economic credentials of these programs have been relatively unexplored.

Cost-benefits

The analyses presented in this study suggest that the ACHIEVE study and similar incentive-based programs to increase physical activity and reduce sitting time are likely to represent good value for money, measured against commonly accepted willingness-to-pay thresholds in Australia. These findings were consistent with the limited literature in this area. There were two studies identified that evaluated the cost-effectiveness of incentive-based programs to increase physical activity in the United Kingdom (122, 123). Although these studies differed in design elements, both studies demonstrated potential for cost-effectiveness. The economic evaluation in this thesis also aligned with the limitations of these previous studies with wide confidence intervals and lack of certainty around the sustainability of benefits.

Although the findings are similar to those of the previous studies, the economic study presented in this thesis also offered a unique contribution to the literature. This study included both a within-trial cost efficacy and long-term cost effectiveness of an incentive-based study to increase physical activity and reduce sedentary. To our knowledge this is the first economic evaluation of incentive-based programs targeting a reduction in sitting. This is an important health behaviour, which is rarely targeted in public health promotion programs, despite independent health risks. This study outlines the potential cost-benefits of targeting this health behaviour through incentive-based programs.

7.2.3 Aim 3: To qualitatively evaluate the appeal of incentive-based program components to increase physical activity and reduce sedentary behaviour in a socioeconomically disadvantaged population group.

The third study of this thesis (Chapter 5) explored how to best tailor incentive-based programs to at-risk population groups by qualitatively evaluating the appeal of program components in a socioeconomically disadvantaged group. Overall, the results of this study demonstrated that incentive-based programs were perceived as both acceptable and appealing as a strategy to increase physical activity and reduce sedentary behaviour.

Barriers to behaviour change

In the process evaluation of an incentive-based program in the general population in the first study of this thesis (Chapter 3), the identified barriers to behaviour change were primarily lack of time; injury, illness or sickness; and for sitting behaviours, that workplace/study environments made it difficult to achieve goals. However, in this study amongst a socioeconomically disadvantaged population group, there were a wide variety of barriers reported. These included, but were not limited to, location/social isolation, full-timer carer responsibilities, transportation difficulties, mental health conditions, and limited physical ability due to injury, disability, or chronic condition. As previously discussed, individual tailoring is an established effective strategy for behaviour change (110, 147), and this can include tailoring to capability or other personal circumstances. This study suggests that tailoring is likely to be essential when targeting programs to at-risk population group with a variety of differential needs.

Incentive type, magnitude, frequency

When exploring the magnitude (value), type and frequency of rewards, this study aligned with previous literature (28, 50, 69) with small, frequent, cash or shopping voucher rewards being overwhelmingly reported as the most appealing approach. However, a unique finding was that 'experience-based' rewards were viewed as a desirable incentive type. This new finding suggests that this population group may also be interested to programs with unique incentive types outside of those traditionally offered in incentive-based programs to date.

Program length

The investigation of desired program length was a novel inclusion in this study. When discussing the length of the program overwhelmingly this population group reported that they would be willing to engage in an incentive-based program indefinitely, or for as long as it continued to meet their needs and hold their interest. This finding differed from the process analysis of the first study (Chapter 3) in which participants who were not selected on the basis of disadvantage, selected the shortest duration option (an additional 1- 4 months) that they would be willing to continue engaging in the ACHIEVE program. There is literature to suggest that incentive-based programs may in fact be more appealing to socioeconomic disadvantaged groups (94, 95) and this finding appears to support this.

Access/ program recipients

Consistent with previous literature (109), the majority of participants expressed that these programs should be open to everyone. However, some did voice concerns about these programs being offered to individuals who were already active. A few participants discussed that offering these programs to those at-risk of poor health behaviours first and then eventually scaling them to the general population may be a good alternative approach.

Funding

The most appealing funding body to support these kinds of programs was the government. Participants expressed that overall people were more likely to have trust in the 'intentions' of a program when it was government funded. Some discussed that it may be difficult to secure government funding to 'pay' people to change their behaviour, and it therefore a partnership between government and private enterprise with a transparent reason for investment (e.g., Coles supermarkets supplying incentive gift vouchers, and therefore more people shop at Coles) would also be acceptable.

Social aspect

Another unique finding within this thesis was that amongst a socioeconomically disadvantaged sample, there was evidence of a strong desire for a social component to be incorporated into incentive-based programs. In the process evaluation, the general population discussed that having a program that they could do individually and in their own time, was a particularly liked component of the ACHIEVE study. However, in contrast, participants from the disadvantaged cohort discussed a preference for programs with other people with whom they could build relationships.

They discussed that this would likely assist initiation, maintenance and enjoyment of physical activity. Other evidence also attests to the importance of social components within physical activity programs for disadvantaged groups (92, 148). In addition, text messages were perceived as the least appealing component of the ACHIEVE study (Chapter 3); however, some participants in the disadvantaged cohort (Chapter 5) reported that text messaging would appeal to them as it would give them an interaction with the program organisers and remind them that they were accountable because ‘somebody cared’ about whether they were attempting to change their behaviour. Collectively these findings suggest the importance of social components amongst socioeconomically disadvantaged groups. This potentially reflects the unique barriers to behaviour change reported by this cohort (e.g., isolation) and highlights the differential needs that should be considered when targeting this population.

Incentive-use based on targeted health behaviour (physical activity vs. sedentary behaviour)

This qualitative study suggested that participants often found it more difficult to conceptualise the use of incentives to change their sedentary behaviour than their physical activity. Even when asked specifically about incentive-based sedentary behaviour programs, participants would often revert back to discussing physical activity programs. This suggests that some participants may not have a strong understanding of ‘sedentary behaviour’ and its differentiation from physical inactivity and conceptualised it merely as a ‘lack of physical activity’. In addition, incentive-based programs are increasingly being used to encourage physical activity through a variety of well publicised health reward programs (138-140) and therefore their use for this target behaviour may be more familiar. Of those who did describe incentive-use for sedentary behaviour programs, some participants believed that reducing sitting would be easier than engaging in more physical activity and therefore a lower incentive value would be needed. In other instances, participants believed sitting time was often unavoidable (due to work requirements) and therefore these programs would not be effective.

7.2.4 Aim 4: To quantitatively evaluate the appeal of incentive-based program components to increase physical activity and reduce sedentary behaviour in a socioeconomically disadvantaged population group

The fourth and final study of this thesis (Chapter 6) used a discrete choice experiment to quantitatively explore the appeal of incentive-based program components in an at-risk socioeconomically disadvantaged population group. This study was unique in its methodology and exploration of incentive-use within this population group, setting and the inclusion of sitting time as a target behaviour. This study was informed by the study presented in Chapter 5 and enabled us to expand on these findings.

Incentive type

When evaluating types of incentives for encouraging physical activity, interestingly there was no significant preference for cash rewards when compared to rewards tailored to personal interest, shopping vouchers or experience-based rewards. Previous literature has shown that cash and shopping vouchers are preferred over no incentive being received (109), however this study expands on these findings and shows that options outside of the traditional ‘financial rewards’ may also be appealing. This reinforces findings in the qualitative study of the importance to participants that programs are tailored to their interests and also that experience-based rewards are appealing. The same trend was observed for types of incentives for encouraging a reduction in sitting time, with the exception of the cash rewards being preferred over experience-based rewards. This may indicate a difference in reward appeal depending on the target behaviour.

Incentive magnitude

The higher reference category of A$50 per week was more appealing than the lower values for both physical activity and sitting programs. This differs from both a previous discrete-choice experiment conducted in the UK, in which participants reported a preference for lower value incentives for promoting physical activity (109), and the qualitative study presented in this thesis (Chapter 5) in which A$10 was the most commonly reported value. There are numerous reasons why this finding may have differed from previous findings. The previously published discrete-choice study (109) aimed to capture the entire population using quota sampling, and this may have led to differential reported preferences when compared to the socioeconomically disadvantaged group recruited in the present study.

In addition, a reporting bias may have been at play in the qualitative study (Chapter 5) where participants stated a value less than in fact preferred.

Program length

Exploring preferred program length was a novel inclusion in this study. Indefinite/long-term programs were more appealing than the shorter length categories for physical activity programs. When considering sitting programs there was no significant difference between preferences for the reference category of indefinitely/long term and either 12 months or 6 months; however, 3-month programs were less appealing. This suggests that duration of participation may vary depending on the target behaviour.

Access/program recipients

When considering access to both physical activity and sitting programs, there were no significant differences in the appeal of programs offering open access to all, and those offering access only to people who were not already active. In regard to physical activity programs, targeting programs to people with increased health risks was viewed as more appealing than open-access programs. This finding contrasts with previous literature, where there was a universal, and strong preference for incentives to be offered to all eligible participants rather than targeted approaches (109); as was also the case with the findings of the qualitative study within this thesis. There was, however, no significant difference between preferences for targeting programs to people with increased health risks and the reference category for the sitting programs. This result highlights the different perceptions around who should have program access depending on the health behaviour being targeted.

Funding

Assessing the appeal of different funding bodies was a novel inclusion in this study. There was no significant difference in preferences for programs funded by a combination of funding bodies when compared to government-only funded programs for both physical activity and sitting time programs. This supported the findings in the qualitative study where participants discussed that as long as the government was included in the combination of funders, programs would still be seen as ‘trustworthy’ and acceptable. Health-insurer and private/sponsor funded programs were less appealing than government funded programs for both health behaviours. This too was consistent with the qualitative study where participants expressed that there is often more trust in government-funded programs, and that participants in this cohort were less likely that the general population to have a health-insurance fund and therefore this access option was less appealing.

7.3. Significance and implications for policy makers and future research

Our findings from the evaluation of the ACHIEVE study have highlighted that incentive-based interventions and corresponding program components are perceived overall by participants as effective to encourage behaviour change and have the potential to be a cost-effective strategy in the general population. As discussed, incentive strategies are increasingly being used to encourage behaviour change through a variety of health reward programs (138-140). The findings of this thesis contribute to the literature by examining incentive-based programs in depth and highlighting the potential to policy makers of their cost-benefits. This should encourage the consideration of similar programs for future healthy behaviour change initiatives.

This thesis has also moved beyond the typical sample that these incentives are currently administered (to affluent population groups, typically in a health insurance setting) and explored how they could be best administered to at-risk population groups. Importantly, differential preferences (long-term programs, social components) and needs (variety of supports to address unique barriers) were identified as particularly important amongst socioeconomically disadvantaged groups. Having a focus on equity in future program implementation is encouraged, and this thesis highlights the need for policy makers to ensure an emphasis on individual tailoring to at-risk population groups in order to be effective.

Although targeting multiple health behaviours is a common strategy in health promotion, the findings of this thesis would suggest the need to consider behaviour specific intervention strategies for physical activity and sedentary behaviour. In almost all instances (with the exception of funding support), preferences on program components differed depending on the healthy behaviour being targeted. Therefore, designing specific intervention strategies dependent on target behaviour is likely to improve program outcomes.

Using four inter-related studies, this thesis has presented the data needed to inform the development of an incentive-based physical activity and/or sedentary behaviour intervention for socioeconomically disadvantaged population groups. It is necessary now to test this methodology in a rigorous randomised controlled trial with long-term follow up, including measures to facilitate a process analysis and economic evaluation. If positive findings are reported, the step thereafter would be the conduct of a widespread dissemination/implementation trial with industry partners (e.g., Government/ health insurance companies).

7.4. Limitations

When examining the findings of this thesis, it is important to acknowledge the limitations. Firstly, the inclusion of the IPAQ-L self-report measure in the ACHIEVE study led to some difficulties when evaluating the program due to over-reporting by participants. Truncation strategies were used to address this issue. Although the IPAQ-L is a validated measure of physical activity, its inclusion did make the economic evaluation in particular more difficult to complete retrospectively. Future studies could utilise ActiGraph accelerometers and activPAL inclinometers for assessing physical activity and sitting time, respectively, as these have been shown to be reliable, objective measures (117, 165).

The data available for this thesis from the ACHIEVE study limited both the process analysis (Chapter 3) and economic study (Chapter 4). Due to the restricted information included in the initial pre-post intervention surveys, process analysis components such as fidelity and maintenance were not able to be included in this study. Similarly, the process for collecting demographic information within the ACHIEVE study meant it was not able to be linked to outcome data. More individualised data would have enabled more insight into the differential engagement with the program based on population characteristics. It is recommended that future studies consider the potential for both a comprehensive process analysis and prospective economic evaluation when considering the information collected in pre-post surveys.

The inability to determine the sustainability of effects in the economic evaluation was also a limitation of this thesis. To our knowledge, there is limited research exploring the sustainability of physical activity beyond the trial time horizon and none regarding the reduction of sitting time once incentives are removed. In order to address this issue, modelled scenarios for the economic evaluation were informed by results of weight loss programs. However longitudinal studies should be encouraged to explore the sustainability and subsequent effectiveness of incentive-based programs for these target behaviours.

The ACE-obesity model used to estimate the cost benefits of the ACHIEVE program did not capture the health benefits of reducing sitting independent of increases in physical activity. This may have led to underreporting of the cost benefits of the ACHIEVE study. It is encouraged that future models incorporate sedentary behaviour and its unique health benefits in order to enable a comprehensive economic evaluation for this target behaviour.

There were also several limitations in the methodology and recruitment of the studies which aimed to explore incentive-based program components in socioeconomic disadvantaged population groups (Chapters 5 and 6). As is the case with all self-report studies, there is the potential for bias due to social desirability in responses. Regardless, in-depth interviews are still seen as the most informative approach to gaining rich insight into an unexplored research topic (118). The income measure as a marker for socioeconomic disadvantage may also be seen as a limitation of the qualitative and discrete-choice questionnaire, however this was intentionally chosen due to the focus on financial incentives. The sample of these studies was also limited by the low response rate of males. This was addressed by tailoring social media advertisements part-way through recruitment, which proved successful in achieving increased engagement from male participants. However, it should be noted for future research that this hard-to-reach cohort will require tailored strategies to achieve a balanced sex representation.

7.5. Strengths

A major strength of this thesis was the multi-method approach which enabled incentive-based programs to promote an increase physical activity and a reduction in sedentary behaviour to be evaluated in a variety of different ways and amongst two different population groups. The mixed method process evaluation of the ACHIEVE study enable the program to be rated on consistent and validated scales and to then be expanded upon in open-ended questions. The economic evaluation of the ACHIEVE study provided valuable within-trial cost-efficacy analysis and modelled the long-term results to determine the potential for cost-effectiveness if scaled up to the wider population. Qualitative methods were then used to explore perceptions of incentive-based program components in a socioeconomically disadvantaged cohort allowing in-depth knowledge to be gained in an unexplored area. These qualitative results then informed the construction of the discrete-choice experiment; a unique and novel approach to quantifying the appeal of incentive-based program components.

Despite the coronavirus pandemic resulting in a pause in recruitment for a few weeks during the final study, online recruitment strategies were effective for recruiting a socioeconomically disadvantaged sample for both the qualitative study and the final discrete choice experiment. This high-risk and hard to reach target group were recruited well through social media advertisements. This format also enabled flexibility in advertising. For example, as discussed previously, in both studies when a sex imbalance was noticed in the participants being recruited, the wording of the advertisements and the images used could be easily changed to boost this demographic component. Using this mode of advertising and offering a small incentive to reward people for their time seems to be particularly effective in this population group and should be considered for future research in this area.

All studies included in this thesis contributed novel and relevant evidence to the field. Moving beyond the primary effectiveness evaluations and ensuring both process analysis and economic evaluations of community-based programs is essential. To date, very few economic evaluations have been conducted on incentive-based programs for promoting physical activity and none have been identified specifically for reducing sedentary behaviour. Considering the significant rise in incentive-based programs in the general population through health reward programs (138-140), it is important that these programs are being evaluated to ensure they are being rolled out as intended, meeting the needs of the consumer and are a cost-effective strategy to ensure best use of resources. In addition, as socioeconomically disadvantaged populations are at increased risk of poor health outcomes due to physical inactivity and high levels of sedentary behaviour, they are an important target group for research. Prior to this thesis, little was known about the differential needs or preferences of incentive-based program components among this high-risk population.

7.6. Unanswered questions for future research

Although this thesis made novel contributions to the literature regarding incentive-use to increase physical activity and reduce sedentary behaviour, some important questions still remain.

Firstly, targeting sedentary behaviour through incentive-based programs, although explored in depth in this thesis, still needs further exploration. This thesis highlighted that program component preferences varied depending on the target behaviour. Therefore, designing specific intervention strategies dependent on target behaviour is likely to improve program outcomes. In addition, this thesis highlighted that participants often had difficulty conceptualising incentive-use as a successful strategy to reduce their sedentary behaviour. Many participants perceived that sitting was simply 'unavoidable' due to the nature of the tasks they engaged with (e.g., work environments). It is important that future research explores this further and places emphasis on incentive-based programs being accompanied by changes in participants environments to so that a reduction in sedentary time is perceived as more achievable.

Another important unanswered research question is identifying additional components that are necessary to best support socioeconomically disadvantaged individuals to be able to engage in these programs effectively. This thesis highlighted that although this cohort was eager – perhaps more so than the general population – to engage in incentive-based health promotion programs, they also experienced more barriers that hindered potential participation or success. These included access difficulties, isolation, unique carer responsibilities, limited physical ability and mental health issues. To ensure equity, it is essential that these programs be tailored effectively to the needs of this population group, however more research is needed to inform how best to do so.

Finally, although incentive-based programs show promise in promoting an increase in physical activity, there remains a gap in the literature their ability to promote behaviour change over the longer term. It is important that future research in this area include extended follow-up periods to evaluate the sustainability of this approach for both physical activity and sedentary behaviour.

7.7. Conclusions

This thesis has contributed to the limited evidence base examining incentive-based programs to encourage an increase in physical activity and a reduction of sedentary behaviours. It has increased our understanding of appeal of these programs among middle-aged adults and those experiencing socioeconomic disadvantage; has evaluated the economic credentials of incentive-based programs; and quantitatively explored the appeal of program components to inform the development of interventions for an at-risk target group. It is integral that novel intervention strategies (such as incentives) be explored and evaluated to encourage healthy behaviour change. It is also important that programs aim to move beyond using these strategies within affluent population groups (such as only being offered to those with private health insurance) and aim to resource health programs with a focus on equity. This means more in-depth studies that open a dialogue with at-risk populations about current barriers to increasing physical activity and reducing sedentary behaviour; the appeal of new, innovative programs; and how these programs could be best tailored to meet their differential needs.

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Appendix A. Summary of studies exploring incentives to increase physical activity

Author (year), Country	Aim	Method	Participants	Study design	Key outcomes
Crespin, Abraham & Rotham., (2016) United States	Exploring the effect of participation in a financial incentive-based wellness program on exercise.	2-year retrospective analysis of the effects of the Fitness Rewards Program. US$20 credit received each month that a participant utilized a fitness centre on least 8 occasions. Baseline, 1-year and 2-year physical activity assessed.	n= 2,972 Fitness Rewards Program eligible university employees. 35% participated in the Fitness Rewards Program.	Observational retrospective longitudinal cohort analysis. Self-reported exercise days.	The incentive program resulted in an increase of 0.59 vigorous exercise days per week and 0.43 strength-building days per week. Increases persisted 2 years later. Employees who were less frequent exercises were least likely to participate in the program. However, less frequent exercisers who did participant reported the largest increases in exercise.
Patel et al., (2011) South Africa	Examining the changes in participation in fitness-related activities and hospital claims	5-year retrospective analysis of gym visits and participation documented fitness-related activities (1-3 years), probability of	n=304,054 adult members of medical plan (n=192,467 registered for	Observational retrospective longitudinal cohort analysis. Objectively measured changes in electronically recorded gym visits,	Members of the incentivised program increased participation of fitness-related activities. Associations with a lower probability of hospital admission and lower hospital costs in the following 2 year were observed.

	over 5 years amongst members of an incentivised health promotion program offered by a private health insurer.	hospital admissions and associated costs of admission (4-5 years). Participation in wellness activities rewarded with points which resulting in discounts between 20-40% on goods and services.	the health promotion program and n= 111,587 members not in the program)	registrations for fitness-related activities and measures of association between changes in behaviour and subsequent probability and costs of hospital admissions.	Two additional gym visits per week lowered the odds of hospital admissions by 13%.
Holland et al., (2008) England	Evaluating the effectiveness of incentives and peer-group organisers in the outcomes of a healthy improvement program.	6-month intervention available to people aged 50+. Health promotion activities (including physical activities) were provided, and points (for prizes) administered upon completion. Rewards received once 15 points	n= 186 completed initial questionnaire. Average age ~71.3 years. Participants located in multi-ethnic district. 83% female.	Non-randomised controlled trial. Three waves of data collection; monitoring questionnaire at registration, questionnaire on achieving 15 points and 30 points. Measured through self-report ‘passport’ format.	The intervention resulted in an increase in the number of days participants in their 60s=70s engaged in at least 30 minutes of physical activity. Positive process evaluation outcomes included participants reporting liking incentives and the format of the program.

		(slippers) and 30 (£20 gift voucher) points were achieved.			
Zulman et al., (2013) United States	Evaluating the large-scale implementation of an incentivised internet-mediated walking program and examining program acceptance, adherence and impact.	1-year guided step-count goal program including web-based feedback. Participants received benefits (~20% savings in out-of-pocket expenses) for uploading data at least once every 30 days and for walking an average of 5,000 daily steps in each quarter. A qualitative component was also administered to gain information on effectiveness and transferability of	n= 6,548, obese adults.	Non-randomised controlled trial. Mixed-methods evaluation. Objectively measured step counts through the use of pedometers.	Participation in the program resulted in step counts substantially higher than baseline measures. Results indicated that of the participants who uploaded data for 75% of the program an average of 7,500 steps per day was observed. Acceptance and participation rates indicate that this program format shows promise for promoting physical activity amongst obese adults.

		implementation strategies.			
Washington, Banna & Gibson, (2014) United States.	Exploring the preliminary efficacy of prize-based contingency management to increase activity levels.	Participants wore a Fitbit for 3 weeks. In the initial baseline participants earned prizes for wearing the tracking device. During intervention period, prize draw criteria for each participant was calculated using percentiles schedules.	n= 11 university students.	Non-randomised controlled trial. Objectively monitored step counts through the use of Fitbits.	Results indicated that n=4 participants increased step counts as a result of the incentive program.
Irons et al., (2013) United States	Exploring the effects of contingency management to induce physical activity by providing monetary payments using a	The baseline period included all participants having access to treadmill and free weights in a lab-based setting for a range of 6-12 days). In the 4-week	n= 7 physical inactive students. Average age ~20.14 years. 6 female.	Non-randomised controlled trial. Quantitative physical fitness analysis instruments and measures.	All participants increased their physical activity levels from inactive at baseline to participating in three 30-minute sessions per week during the intervention period. Maintained some gains at follow-up.

	multiple baseline, changing-criterion procedure.	intervention period participants were rewarded for attending 3 exercise sessions per week. Participants could earn vouchers valued up to US$10 (US$2 for attendance, US$8 for meeting behavioural criteria) for each session they attended. Behavioural criteria included week 1: 5 minutes on treadmill for first session, 10 and 15 minutes for subsequent sessions; week 2: 20 minutes on treadmill for first session 25 and 30 minutes for subsequent sessions;			

		week 3 and 4: reach and maintain target heart rate (50-85%) within 30-minute session. Follow-up was conducted 2-weeks post intervention.			
Kurti & Dallery, (2013) United States	Exploring the effects of an internet-based intervention to increase walking.	- Study 1: Participants were rewarded for meeting escalating step-count goals on at least 3 days during consecutive 5-day blocks. Participants received reward value corresponding to goals: 2,000 - 2,999 steps per day for 3 days during a block = US$2.00 3,000 to 3,999 steps	Study 1: N= 6. 5 women. Study 2: N = 6 5 women	Non-randomised controlled trial. Objectively monitored step counts through the use of Fitbits.	Study 1: The incentive intervention resulted in participant increasing step counts by 182% and 87% of step goals were achieved. Study 2: The intervention resulted in participants increasing steps by 108% and 52% of step goals were achieved.

		per day for 3 days = US$3.00 Participants also received $3.00 for progression to the next step-count goal. The intervention ceased when participants achieved 10,000 steps per day on at least 3 days (of the 5-day blocks) or alternatively once 2 months had passed. Study 2: Goals were set using the same format however participants did not receive rewards.			
Hunter et al., (2013)	Investigating the effectiveness of financial incentives	12-week intervention. Incentive group: Physical activity	N= 199 incentive group. N= 207	Two-arm quasi-experimental design. Objectively measured	The incentive program did not result in increases in physical activity when compared to the self-

Ireland	to increase PA in the workplace.	monitored using a loyalty card and points were accrued to receive financial incentives (retail vouchers). Comparison: loyalty cards were used to self-monitor physical activity however participants did not receive rewards.	comparison group. Average age ~43.32 years. 67% female.	physical activity using novel tracking system.	monitoring only program.
Kullgren et al., (2014) United States	Examining the effects of a program involving financial incentives and peer networks. with the aim to promote walking.	24-week trial (16-week intervention, 8-week follow-up) Participants received daily step count goals and weekly feedback. - Incentive group: access into a lottery with potential to received up to US$200 each week.	N= 92 older adults. Average age ~71.9 years. 70% female. 93% Caucasian. 83% at least bachelor's degree.	Mixed methods randomised controlled trial. Objectively measured step goals through the use of pedometer.	The intervention did not result in any differences in number of days step goals were achieved for the financial incentive, peer network and combined group when compared with the comparison group. Follow-up indicated that the number of days step goals were achieved was lower in the peer network group but not in the financial incentive or combined groups when compared to the comparison.

		- Comparison: weekly feedback only. - Peer network: opportunity to engage with other participants online. - Combined: both interventions.	74% retired.		
Noland, (1989) United States	Assessing the effects of self-monitoring and reinforcement on exercise adherence.	18-week intervention. Participants received exercise instructions and asked to complete these activities in their own time. Three conditions; self-monitoring; reinforcement supplied by another person & control.	n=77 (n=35 moderately fit (recruited from adult fitness program group), n= 42 sedentary (recruited from campus newsletter)	Randomised controlled trial. Objectively measured physiological parameters, cardiorespiratory fitness and body density.	The incentive group resulted in an 11% improvement in predicted max V02 and a 9 bpm improvement in exercise heart rate. The self-monitoring group resulted in an 7.8% improvement in predicted max V02 and a 5 bpm improvement in exercise heart rate. The control group resulted in an 5.3% improvement in predicted max V02 and a 6 bpm improvement in exercise heart rate. T-test results indicated that the incentive group and the self-monitoring group significantly improved on these variables however the control group did not.

					The intervention did not impact adherence of participants who exercised regularly prior to the program.
Patel et al., (2016). United States.	Examining the effectiveness of 3 methods to frame financial incentives to increase physical activity.	26 weeks (13-week intervention, 13-week follow up) Daily step goal of 7,000. - Control: daily feedback - Gain incentive group: US$1.40 received each day goal was achieved - Lottery incentive group: daily eligibility (value ~US$1.40) when step goal was met. - Loss incentive group: US$42 was allocated each month and US$1.40 was deducted	N= 281 overweight or obese employees. Average age ~39.7 years. 78% female.	Randomised controlled trial. Objectively measured step counts through use of accelerometers.	In adjusted analyses, the loss-incentive group was the only group with a significantly higher proportion of participant-days when step goals were achieved relative to the control (0.16; $p<0.001$). However, mean daily step counts were not significant. Adjusted, differences in mean daily steps were not significant. Follow-up assessments indicated a decrease in daily step counts for all groups and no differences from the control group were observed.

		each day step goal was not met. - 13-week follow up post-intervention with daily performance feedback but no incentives.			
Finkelstein et al., (2008) United States	Examining whether financial incentives for walking could increase physical activity.	4-week intervention. - Control group: fixed payment of US$75 - Intervention group: fixed payment of US$50 and up to US$25 more per week subject to number of weekly aerobic minutes achieved.	n=51 sedentary older adults. Average age ~60 years. 75% female. 94% Caucasian. 75% minimum of college degree education. 40% household income greater than US$50,000.	Randomised controlled trial. Objectively measured aerobic minutes through use of pedometers.	The intervention group engaged in 4.1 hours of aerobic minutes per week, on average in comparison to the control group who engaged in 2.3 per week, on average. On average, the intervention group achieved US$17.5 of additional weekly payments.

Wing et al., (1996) United States	Examining the effects of a personal trainer and financial incentives on exercise adherence.	24-week intervention. Weekly group meetings and supervised training sessions. Two conditions; - Study 1: contact and sessions with personal trainer. - Study 2: lottery incentive based on attendance to ‘special walk session (US$50 gift voucher). Last group session draw for US$2,000 travel certificate. Both studies had a comparison control group.	Study 1: n= 35 overweight women (n= 19 personal trainer, n= 16 control) Study 2 N= 37 overweight women (n= 21 incentive, n= 16 control)	Randomised controlled trial. Objectively measured attendance.	Intervention group did not result in a statistically significant improvement in exercise adherence when compared to control group.
Pope & Harvey-Berino, (2013)	Examining the viability of monetary	12-week intervention. identical escalating fitness-centre	n= 117 university students (n= 78	Randomised controlled trial.	On average 63% of incentive group participants achieved weekly fitness-centre attendance goals compared to 13% of control group participants.

United States	incentives to increase fitness-centre use.	attendance goals were assigned to all groups ranging from 2 visits in week 1 and 2 to 5 visits in weeks 8-12. - Control: assigned weekly fitness centre attendance goals however no rewards received. - Intervention group: assigned weekly fitness centre attendance goals and rewards increased with a reset contingency. In week one participants could receive $US5 for each 30-minute attendance and this amount increased by US$0.25 as number of visits increased.	incentive, n= 39 control) Average age ~18 years. 63% female. 85% Caucasian.	Fitness-centre use monitored objectively through electronic ID cards.	Attendance goals achieved significant decreased over the course of the intervention.

		Rewards were only received in the overall weekly attendance goal was achieved and if the goal was not met the reward reset to the base amount.			
Strohacker et al., (2015) United States	Exploring the feasibility of small incentives to improve exercise-related energy expenditure.	10-week intervention. - Control: no incentive - Incentive group: Instructed to exercise at campus fitness centre and goal of 30 minutes moderate-intensity aerobic exercise on 5 days was assigned. Potential to earn US$5.00 per week.	n= 22 sedentary or low activity level university students (n= 11 incentive, n= 11 control) 69% female.	Randomised controlled trial. Caloric expenditure expended through moderate-intensity treadmill or cycling exercise objectively monitored.	Greater exercise-related caloric expenditure was observed in the incentive group relative to the control. Mean caloric expenditure appeared to diminish in both conditions over time.
DeVahl, King & Williamson, (2005)	Exploring whether a greater academic incentive would	12-week intervention. Two condition with different reward	n= 210 university students	Randomised controlled trial.	Those within the greater reward group showed more compliance in a voluntary exercise program and had better health outcomes.

United States	improve effectiveness and student adherence to an exercise program aimed to decrease body fat.	structures; -1: Single exam bonus group (greatest % body fat loss award 1 bonus point). -2: Course grade bonus group (bonus points would be added to overall course grade).		Body fat % loss objectively measured to represent exercise program engagement.	
Andrade et al., (2014) United States	Evaluated a reinforcement-thinning schedule for maintaining high activity levels.	12-week intervention. Participants were assigned the goal of >10,000 steps per day which was monitored via pedometers. Initially all participants rewarded for each day this goal was achieved. Participants were then randomised into a monitoring-only	n= 61 sedentary adults included randomisation phase. Average age ~48 years. 90% female. 82% Caucasian.	Randomised controlled trial. Objectively measured step counts through the use of pedometers.	Participants in the monitoring plus reward thinning group gr reinforcement thinning condition who met walking goals was 83% (mean percentage) compared to 55% for the monitoring only group (*p* < .001). No group differences remained at the 24-week follow-up assessment.

		group, or a monitoring and reinforcement thinning group. Rewards included eligibility into a draw with a 50% chance to win prizes ranging from $1 to $100 in value.			
Charness & Gneezy, (2009) United States	Exploring the effects of incentives to encourage the gym attendance.	- Study 1: Eight-week baseline measure followed by a 7-week intervention period. Three conditions; control, US$25 attend gym once a week, US$25 to attend gym once a week plus an additional US$100 for gym attendance of at least 8 times in	Study 1 N= 120 university students Study 2 N= 168 university students	Randomised controlled trial. Objectively monitored gym attendance.	Study 1: Results indicated an increase in the average attendance rate of the one-time group from 0.70 visits per week at baseline to 0.76 at the end of the intervention. The eight-time group reported an average attendance rate increase from 0.64 visits per week at baseline to 1.24 at the end of the intervention. A decrease was observed in the average attendance rate for the control group from 0.59 visits per week at baseline to 0.56 at the end of the intervention.

		following four weeks. - Study 2: Twelve-week baseline period followed by a 13-week intervention period. Three conditions; control, attend gym once during one month period, attend gym eight times during intervention period. All participants received US$75 for initial meeting and US$50 for subsequent meetings.			Study 2: Results indicated an increase in the average attendance rate of the one-time group from 0.63 visits per week at baseline to 0.87 at the end of the intervention. The eight-time group reported an average attendance rate increase from 0.53 visits per week at baseline to 1.46 at the end of the intervention. The average attendance rate also increased for the control group from 0.81 visits per week at baseline to 1.10 at the end of the intervention.
Fennell et al., (2016) United States	Comparing the effectiveness of a non-incentivised reward system with an incentivised reward system using combined	Two 12-week interventions completed by each participant; - 1: Exercise intervention with no rewards.	n=15 sedentary faculty and staff at a university. Average age ~48.7 years.	Longitudinal randomised controlled study Objectively measured physical activity using accelerometers	Results indicated no differences in physical activity or health-related variables between the incentivised and non-incentivised interventions.

	positive and negative rewards on physical activity, attendance and health and performance outcomes.	- 2: Same exercise intervention completed one year later with incentivised component (positive and negative reinforcements)	86% female.		
Patel et al., (2016) United States	Comparing the effectiveness of different combinations of social comparison feedback and financial incentives to increase physical activity.	- 26 weeks participants received weekly feedback on team performance based on either the 50th percentile or the 75th percentile. - 13 weeks participants received weekly lottery-based financial incentive (US$35 – US$350) and feedback on team performance based on either the 50th percentile or the 75th percentile.	n= 286 Average age ~41.3 years. 80.1% female.	Randomised trial Objectively measured step goal using smartphone-based accelerometer	Social comparison to median performance plus rewards was the most effective scheme for encouraging physical activity. No differences observed in follow-up period.

		Weekly eligibility for rewards if average step count per team member was at least 7000 steps. - Final 13 weeks participants received feedback on performance with no reward scheme.			
Epstein et al., (1980) United States	Exploring the effects of contracting and lottery procedures on exercise attendance.	5-week exercise program. - Contract groups (n=3): deposit US$5 receive US$1 back for every week 4/5 sessions attended and achieved either 1 mile or 2-mile goal depending on group - Lottery group (n=1): US$3 deposit, chance in lottery (value	n= 37 female students	Randomised controlled trial. Objectively measured attendance.	A significant intervention effect $F(2, 33) = 3.38$ $p<0.025$) All contracting groups and the lottery group attended the exercise sessions significantly more than the control group.

		US$21) received for 4/5 sessions attended on a given week and achieved 1-mile goal - Control group (n=1): no incentive for attendance, no deposits, asked to run 1 mile per day			
Patel et al., (2016) United States	To compare the effectiveness of individual versus team-based financial incentives to increase physical activity.	13-week intervention and 13-week follow-up period. - Control group: daily feedback on performance towards achieving a 7000 step goal. - Three financial incentive groups: all received daily feedback on step goal and a draw held every second day with one	n= 304 adult employees from health insurance organisation.	Randomised controlled trial. Objectively measured mean proportion of participants-days achieving 7000 step goal via smartphone.	Average proportion for meeting 7000 step count goal was significantly higher for the combined incentive group (0.35) when compared to the control (0.18). No significant differences observed between the individual incentive group or the team incentive group when compared to the control. The combined incentive group also met the step goal at a rate significantly higher than the team incentive (0.17) but not the individual incentive group. No differences were observed in follow-up period.

		team selected as winner. Participant eligible in each group as follows: Individual incentive: US$50 if participant met step count goal. Team incentive: US$50 if all four team members met step count goal Combined incentive: US$20 individual met step count goal and an additional US$10 if team members also met step count goal.			
Hunter et al., (2018) Ireland	Evaluating the effectiveness and cost-effectiveness of a loyalty scheme based intervention involving rewards	6-month intervention. Clusters (n=37) were randomly assigned to either an intervention	n= 853 18-65 years employees with no medical contraindication	A cluster randomised wait-list controlled trial, researchers masked to allocation.	Intervention group had significantly lower mean step count per day when compared to the control group (-336, 95%, $p = 0{\cdot}02$).

	for increasing physical activity in public sector employees	group or placed on a wait list (1:1). Intervention group: administration of points (1 point for 1 minute of activity). Points could be exchanged for retail vouchers.	s to physical activity	Objectively measured step counts via pedometer.	Low incentive value may have limited results.
Patel et al., (2018) United States	Evaluating the effect of lottery-based financial incentives in increasing physical activity.	13-weeks with receiving rewards, 13-weeks feedback only. Participants were assigned a step count goal of 7000 steps per day which they could track via their smartphone. Daily feedback was received. Randomly assigned to 1 of 3 groups:.	n= 209 adult university employees with a body mass index of ≥27.	Randomised controlled trial. Objectively measured mean proportion of participant days step goals were met via smartphone.	In adjusted analyses, the combined lottery group was the only group with a significantly higher mean proportion of participant days step count goals were met when compared to the control group. A significant decline was observed in the jackpot group (0.13) when compared to the control. No differences were observed in follow-up period.

		- Higher frequency, smaller reward group: 1 in 4 chance of winning US$5 - Jackpot reward group: 1 in 400 chance of winning US$500 - Combined lottery group: 18% chance of US$5 and 1% chance of US$50.			
Galárraga et al., (2020) United States	Pilot testing two low-cost incentive programs to promote physical activity among low-active adults in a community setting.	12-month intervention. Three groups: - Control - Small financial incentive group: cash incentives US$1/day - Charitable donations group: US$1/day Eligibility for rewards based on I on	n=75 insufficiently active, otherwise healthy adults.	Randomised controlled trials. Objectively measured physical activity via attendance at YMCA.	The small financial incentive group had a significant median attendance rate of 19.24 additional visits when compared to the control group. The charitable donations group had a marginally significant median attendance rate of 11.88 additional visits when compared to the control group.

		attendance at YMCA facility.			
Losina et al., (2017) United States	Examining the feasibility of a workplace program that uses individual and team-based financial incentives to increase physical activity among sedentary hospital employees.	2 pre-intervention weeks, 24-week intervention. Participants created or were placed in teams of 3 and were required to wear a Fitbit to monitor activity. Eligibility for US$10 if participants increased their moderate-to-vigorous physical activity by 10% each week or for meeting physical activity guidelines.	n=292 sedentary hospital employees. Average age 38 years, 83% female.	Intervention with no control arm. Objectively measured proportion of participants meeting weekly physical moderate-to-vigorous goals or meeting physical activity guidelines via Fitbit Flex.	86% of participants achieved their moderate-to-vigorous physical activity goals or achieved physical activity guidelines for a minimum of 6 weeks. 52% of participants met achieved their moderate-to-vigorous physical activity goals or achieved physical activity guideline for a minimum of 12 weeks.
Spring et al., (2018) United States	Examining whether a multicomponent intervention integrating	9-month intervention. Randomly assigned to either: - Intervention group	N=212 adults with low fruit and vegetable and high	Randomised controlled trial. Objectively measured	Both the simultaneous and sequential groups achieved improvements substantially higher when compared to the control group for variables. Participants achieved

	mHealth, modest incentives, and remote coaching could sustainably improve diet and activity.	targeting moderate-to-vigorous activity simultaneously with diet and activity targets. - Intervention group targeting moderate-to-vigorous physical activity sequentially after other diet and activity targets. - Control group targeting stress and sleep contact control. Weekly reward value of US$5 for 12 weeks.	saturated fat intakes, low moderate-to-vigorous physical activity and high sedentary screen time.	activity via a smartphone app and accelerometer.	all diet and physical activity guideline levels as a result of the intervention. Specifically, fruit and vegetables servings increased by 6.5 servings per day, moderate-to-physical-activity increased by 24.7 minutes per day, sedentary leisure time decreased by 170.5 minutes per day, and saturated fat intake decreased by 3.6%.
Hooker et al., (2018) United States	Examining the effects of an employer-based monetary incentive program on membership termination and	12-month period. - Incentive group members received a US$25 reward for each time they visited the fitness centre at minimum of 10 times	n=1122 members of a university-based fitness centre.	Retrospective nested case-control study. Objectively measured activity via attendance.	On average the incentive group reported visiting the fitness centre significantly more times per month (5.3) when compared to the control (4.3). However, the incentive group were more likely to terminate their membership after one year (38%) when compared to

	usage at a fitness centre.	per month. - Control group members did not receive rewards.			the control group (31%).
Memon, Masood, Awan & Waqas, (2018) Pakistan	Examining the efficacy of an incentive-based approach combined with a smartphone application in promoting physical activity and weight loss among female medical students.	5-week intervention. - Incentive group: received weekly rewards based on step counts: a) PKR100 (USD0.95) for 7500-9999 step count for ≥4 days per week; b) PKR200 (USD1.9) for ≥10000 step count for ≥4 days per week; c) PKR300 (USD2.85) for ≥12000 step count for ≥4 days per week. - Control group did not received rewards.	n=58 female medical students.	Randomised controlled trial. Objectively measured steps/day via smartphone Moves application.	Incentive group did not achieve more physical activity or weight loss when compared to the control.

Korinek et al., (2018) United States	Evaluating an adaptive step goal plus reward intervention grounded in social cognitive theory delivered via a smartphone application.	14-week intervention. Daily step count goals and points were received via an app based on an algorithm as a result of each participant's baseline measures. Goals differed for each person each day e.g., if persons perceived self-efficacy for any given day was low then a doable goal of just reaching their baseline median may be assigned if high then an 'ambitious' goal of 2x baseline may be set). Daily points ranged from 100-500 per day and each time a participant	n= 20 generally healthy, insufficiently active, overweight (BMI 25-45 kg/m^2) adults aged 40-65. 90% female.	System identification experimental design with no control. Objectively measured steps/day via smartphone application.	The intervention did not significantly increase physical activity. However, significant weight loss was reported at the end of the intervention. Process evaluation results indicated that application satisfaction was high and that participants appreciated receiving a different goal each day.

		accumulated 2500 points they received a US$5 gift card. Self-report measured were also collected twice per day.			
Gilson et al., (2017) Australia	Examining the extent to which an m-Health financial incentives program could facilitate physical activity and health dietary choices in Australian truck drivers.	20-week program. Drivers and researchers collaborated to identify where physical activity and dietary changes could be included into shift routines. An action plan could then be personalised to each participant by choosing from the compiled resource pack. Divers accrued points based on the number of weekly	n=19 male truck drivers Mean age 47.5; BMI 31.2 kg/m^2.	Pre-post test design. Objectively measured activity tracker and self-reported health behaviours via a smartphone application.	Increases were observed in the average amount physical activity time during the work hours; however these were not statistically significantly (+7 mins/day). The majority of participants reported positive changes for various health behaviours.

		behavioural goals achieved and these points could be exchanged for rewards. Regular feedback and guidance was provided. At the end of the intervention drivers were informed of total points and monetary reward achieved (e.g., 200 points accumulated = AU$200 voucher).			
Adams et al., (2017) United States	Comparing adaptive vs. static goal setting and immediate vs. delayed, non-contingent financial rewards for increasing free-	4-month intervention. Randomised into one of four groups: - Immediate rewards and daily adaptive step goals; - Immediate rewards and static goals; - Delayed non-	n= 96 insufficiently active and overweight/obese (mean BMI = 34 kg/m^2). Mean age 41; 77% female.	2 x 2 factorial randomised controlled trial. Objectively measured steps/day via a Fitbit Zip.	On average participants from all groups significantly increased their step count by 2389 per day from baseline to the end of the intervention. The static goal group reported a larger increase in step count (2630 steps/day) when compared to the adaptive goal group (2149). The immediate reward group reported a larger improvement (2762) when compared to the delayed reward group (2016). The delayed reward group

	living physical activity.	continent rewards with daily adaptive step goals; - Delayed non-contingent rewards with daily static step goals. Participants also received feedback based on reward group they were assigned to. Reward values were as follows: - Immediate reward group: one point each day they met step count goal; one point equalled US$1. - Delayed reward group: Increasing magnitude of monthly incentives (month one =US$5, month two and 3 =			however had a slower decrease in daily step counts from the start of the intervention to the end when compared to static goals group (less than half the rate). As a result, the adaptive goals group showed better improvements by the end of the study period.

		US$10; month 4 =US$20). Reward types were selected by participants from a list of retail or charity options.			
Mason et al., (2018) United States	Exploring the efficacy of an incentivised workplace physical activity intervention, particularly among the least active employees.	6-week intervention. 1- week follow up. Participants were grouped by pre-intervention daily step counts into four groups: 1: <6,000 2: 6000 to 7999 3: 8000 to 9999 4: ≥10 000 Participants were set a 10,000/day step goal. Incentives were administered in a tiered format at the	n= 6246 university employees.	Retrospective cohort design. Objectively measured steps/day via commercial grade physical activity monitors of participants' choice.	A 60% increase was observed in participants achieving ≥10 000 steps per day. Significant step count increases were observed in groups 1, 2, and 3 (46%, 24%, and 11%, respectively). These results were partially maintained in groups 1 and 2 in the follow-up period. No increases were observed during the intervention for group 4. This group was also found to have significantly decreased their step counts in the follow-up period.

		end of the intervention ranging from based step count average categories of 6000-7999; 8000- 9999; and ≥10 000. Incentive values ranged from US$10.50 (6000-7999 steps/day) to US$29 (≥10000 steps/day). 1-week follow up post-intervention.			
Norman et al., (2016) United States	Investigating the use of two incentive designs to reward employees for achieving step goals.	2-year program. Each benefit year had a different incentive design: - First year: incentive step count goal was 500000 per quarter resulting in a US$100 gift card reward.	n=320 benefit-eligible employees at American Specialty Health aged 18-65 years.	Retrospective design. Objectively measured steps/day via ActiPed wireless step tracker.	Daily step count averages were higher in second year (tiered) (3573, p<0.001) compared to the same employees in first year (fixed goal) (2817, p< 0.001).

		- Second year: a 3-tier threshold for receiving rewards was administered. If participants achieved 400000 steps in the first quarter they received US$100 gift cared (tier 1); US650000 in a quarter they received US$125 gift card (tier 2); and 900000 per quarter they received US$150 (tier 3).			

Appendix B. Text messages sent to ACHIEVE participants

Deakin visit

A reminder for your appointment at Deakin University tomorrow at <<time>>. Pls let us know if you are unable to make this appointment. Thx. ACHIEVE team.

Home visit

A reminder we are visiting your home tomorrow at <<time>>. Pls let us know if you are unable to make this appointment. Thx. ACHIEVE team.

Week 1

ACHIEVE team here. Welcome to ACHIEVE! Today's the day to start towards your goals for being more active, and sitting less. Remember your Fitbit!

Week 2

It's the ACHIEVE team. Regular physical activity lowers your risk of heart disease, T2 diabetes, some cancers & more. We'll help you get active!

Week 3

Breaking physical activity into smaller sessions can help you fit it in - try 10 mins three times a day. The ACHIEVE team

Week 4

Spending most of your time sitting increases risk of obesity, heart disease, T2 diabetes and more. Try to break up long periods of sitting. The ACHIEVE team

Week 5

Do you know how you are going to be active tomorrow? Think ahead about how you will achieve your activity goals this week. The ACHIEVE team

Week 6

Have you reviewed your physical activity & reduced sitting goals? Try setting a new goal to walk 30 mins more or sit 30 mins less today. ACHIEVE team

Week 7

Have you thought about how you will reach your reduced sitting time goal this week? Plan ahead how you'll cut down sitting time. ACHIEVE team

Week 8

Well done! You are half-way through the ACHIEVE program. Congratulations and stick with it! The ACHIEVE team

Week 8 Weight

Now you are half way through the ACHIEVE study we need to your measure your weight again on the scales provided and email to us at achieve@deakin.edu.au

Week 9

Physical activity tips: make physical activity appointments in your diary; take spare walking shoes everywhere; always take the stairs.ACHIEVE team

Week 10

Sync your Fitbit at least 1 x week to keep track of your activity and keep moving ☺ The ACHIEVE team.

Week 11

Tips for sitting less: stand when you're on the phone; cut out 1-2 TV shows; set 'standing' reminders thru the day; hold 'walking meetings'. ACHIEVE team

Week 12

Ever thought about joining a walking group? Great for motivation & meeting new people. Check out walking.heartfoundation.org.au. ACHIEVE team

Week 13

Brisk walking is one of the simplest and cheapest forms of activity you can do almost anywhere - all you need are comfy shoes. ACHIEVE team

Week 14

Find activities you like so you will stick to them - consider tennis, bowling, golf, an exercise class (lots on YouTube!), or dancing (even in the loungeroom!)

Week 15

Don't let bad weather stop you being active - take protective clothing, or have a back-up activity planned. ACHIEVE team

Week 16

SMS 1: Congratulations, you've reached the final week of ACHIEVE! We'll be in touch! Keep your Fitbit as our gift to help you maintain a more active lifestyle

SMS 2: Remember to keep going for the final week and please remember to keep syncing your Fitbit so we get your final weeks points :) Thanks. The ACHIEVE Team

Other

Week 8 Weight:

Now you are half way through the ACHIEVE study we need to your measure your weight again on the scales provided and email it through to us. Thanks.

Week 8 Weight Reminder:

Reminder to please email your Weight from our ACHIEVE scales. Note, the information doesn't automatically send each time you weigh. Refer Video on ACHIEVE site

URGENT:Reminder to please email your Weight from our ACHIEVE scales. Note, the information doesn't automatically send each time you weigh.

achieve@deakin.edu.au

URGENT:Reminder to please email your weight from your ACHIEVE scales to achieve@deakin.edu.au. This is an important component of the study. Thanks. ACHIEVE team

WK 17 weight SMS

SMS1:

Now you have finished Wk16 of the ACHIEVE study please measure your weight again on the scales provided and email to us at achieve@deakin.edu.au

SMS2:

Please make sure you sync your Fitbit today for you final reading for the ACHIEVE study

Start of study BP and website reminder

Hi. ACHIEVE reminder to please send back your Blood Pressure Monitor and record sheet. Also, please check you have registered on the ACHIEVE website. Thanks :)

End of study Weight First reminder

Hi. ACHIEVE study reminder to please send us your final weight for the end of the study. Thanks again for your participation. Concerns? achieve@deakin.edu.au

Weight Second reminder

ACHIEVE Reminder to please send us your end of study weight. This is a really important part of the

study. Thanks. The ACHIEVE team.

End of study Survey first reminder

Hi. An important reminder to please complete your ACHIEVE post survey using the link sent via

email. Concerns? achieve@deakin.edu.au

End of study Survey Second reminder

Follow up reminder to please complete your ACHIEVE post survey using the link sent via

email. Concerns? achieve@deakin.edu.au

End of study BP return first reminder

Hi. ACHIEVE study reminder to please send back your Blood Pressure monitor as soon as possible. Thanks again for your participation. Concerns? achieve@deakin.edu.au

Reminder to do final Sync of Fitbit

Hi xx, Could you please sync your Fitbit one final time so we can get your final weeks data. This is important for the study. Thanks. The ACHIEVE team.

Appendix C. ACHIEVE post-test survey

Thank you for your participation in the ACHIEVE study. We appreciate your time and effort.

We now ask that you please complete the following survey. It should take no more than 30 minutes to complete, depending on your answers.

The first half of the survey will ask you about the time you spent being physically active in the last 7 days.

The second half of the survey will ask about your experience with the ACHIEVE study.

The first section of the survey is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. DO NOT include unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family. We ask about these later in the survey.

Do you currently have a job or do any unpaid work outside your home?

- o Yes
- o No

The next questions are about ALL the physical activity you did in the last 7 days **as part of your paid or unpaid work**. This does not include traveling to and from work.

During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging,

heavy construction, or climbing up stairs **as part of your work**? Think about only those physical activities that

you did for at least 10 minutes at a time. *(Vigorous physical activities refer to activities that take hard physical* *effort and make you breathe much harder than normal).*

- No vigorous job related physical activity
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

How much time did you **usually** spend on one of those days doing **vigorous** physical activities as part of your work?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes

options.

___ Hours per day

___Minutes per day

Again, thinking about only those physical activities that you did for at least 10 minutes at a time. During the **last**

7 days, on how many days did you do **moderate** physical activities like carrying light loads **as part of your work**?

Please DO NOT include walking. (Moderate activities refer to activities that take moderate physical effort and

make you breathe somewhat harder than normal)

- No moderate job related physical activity
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

How much time did you **usually** spend on one of those days doing **moderate** physical activities as part of your work?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes options.

___Hours

___Minutes

During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time as part of your work?

Please DO NOT count any walking you did to travel to or from work.

- No job related walking
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

How much time did you usually spend on one of those days **walking** as part of your work?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes options.

___Hours per day

___Minutes per day

These questions are about how you travelled from place to place, including to places like work, stores/shops, movies, and so on.

During the **last 7 days**, on how many days did you **travel in a motor vehicle** like a train, bus, car, or tram?

- No traveling in a motor vehicle
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

How much time did you usually spend on one of those days **traveling** on a train, bus, car, tram, or other kind of motor vehicle?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes options.

___Hours per day

___Minutes per day

Now thinking only about the **bicycling** and **walking** you might have done to travel to and from work, to do errands, or to go **from place to place**.

During the **last 7 days**, on how many days did you **bicycle** for at least 10 minutes at a time to go **from place to place**?

- No bicycling from place to place
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

How much time did you usually spend on one of those days to **bicycle** from **place to place**?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes options.

___Hours per day

___Minutes per day

During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes options.

- No walking from place to place
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

How much me did you usually spend on one of those days **walking** from **place to place**?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes options.

___Hours per day

___Minutes per day

This section is about some of the physical activities you might have done in the **last 7 days** in, and around, your home, like housework, gardening, yard work, general maintenance work, and caring for your family.

Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**,

on how many days did you do **vigorous** physical activities like heavy lifting, chopping wood, shovelling snow, or

digging **in the garden or yard**? *(Remembering, vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal)*

- No vigorous activity in garden or yard
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

How much time did you usually spend on one of those days doing **vigorous** physical activities in the garden or yard?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes options.

___Hours per day

___Minutes per day

Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, sweeping, washing windows, and raking **in the garden or yard**? *(Remembering, moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal)*

- No moderate activity in garden or yard
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

How much time did you usually spend on one of those days doing **moderate** physical activities **in the garden or yard**?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes options.

___Hours per day

___Minutes per day

Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, washing windows, scrubbing floors and sweeping **inside your home**?

- No moderate activity inside your home
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

How much time did you usually spend on one of those days doing **moderate** physical activities inside your home?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes options.

___Hours per day

___Minutes per day

This section is about all the physical activities that you did in the **last 7 days** solely for recreation, sport, exercise or leisure. Please DO NOT include any activities you have already mentioned.

Not counting any walking you have already mentioned, during the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time in **your leisure time**?

- No walking in leisure time
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days

- 6 days
- 7 days

How much time did you usually spend on one of those days walking in your leisure time?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes options.

___Hours per day

___Minutes per day

Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like aerobics, running, fast bicycling, or fast swimming in your leisure time? *(Remembering, vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal)*

- No vigorous activity in leisure time
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

How much time did you usually spend on one of those days doing **vigorous** physical activities in your leisure time?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes options.

___Hours per day

___Minutes per day

Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis in **your leisure time**? *(Remembering, moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal)*

- No moderate activity in leisure time
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

How much time did you usually spend on one of those days doing **moderate** physical activities in your leisure time?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes options.

___Hours per day

___Minutes per day

The last questions in this section are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

During the last **7 days**, how much time did you usually spend **sitting** on a **weekday**?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes options.

___Hours per day

___Minutes per day

During the **last 7 days**, how much time did you usually spend **sitting** on a **weekend day**?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes options.

___Hours per day

___Minutes per day

In the times you spent sitting, we are interested in finding out the types of activities you did.

Of your total sitting time, during the last 7 days, how much time did you usually spend sitting watching TV on a **weekday**?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes

options.

___Hours

___Minutes

Of your total sitting time, during the last 7 days, how much time did you usually spend sitting watching TV on a **weekend day**?

E.g., if you did 45 minutes, enter zero hours, 45 minutes.

Please fill in both hours and minutes, even if one of these is zero, and use arrows to scroll through minutes options.

___Hours per day

___Minutes per day

This section of the survey will ask about your experience with the ACHIEVE study.

The following questions relate to the interview you had at the start of the ACHIEVE program.

The interview motivated me to change my physical activity habits during the ACHIEVE program.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

I already knew about the information (e.g., 30min/daily) provided in the interview.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

Overall, the interview at the start of the ACHIEVE program was helpful.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

The following questions relate to the length of the ACHIEVE program.

The length of the ACHIEVE program (4 months) was appropriate.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

If you did not think the **length of the ACHIEVE program** was appropriate, how long would you like a program like this one to last?

- Less than 4 months
- 4 to 8 months
- 8 to 12 months
- 12 to 18 months
- 18 to 24 months
- Longer than 24 months (2 years)

The following questions relate to the text messages.

The weekly text message motivated me to be **more active**.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

The weekly text message motivated me to **sit less**.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

I always read the text messages.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

Overall, the weekly text messages were helpful.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

The following questions relate to the Fitbit.

The Fitbit motivated me to be more **active**.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

The Fitbit motivated me to reduce my **sitting time**.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

The Fitbit was easy to use.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

I found it easy to track my activity online.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

Overall, using the Fitbit was helpful.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

The following questions relate to the incentives.

I liked the **types** of incentives offered.

- Strongly Agree
- Agree
- Neither

- Agree nor Disagree
- Disagree
- Strongly Disagree

The incentive points motivated me to be **more active**.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

The incentive points motivated me to reduce my **sitting time**.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

It was easy to check how many points I had.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

It was easy for me to understand the points I needed to achieve incentives.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

I found it hard to do enough **physical activity** to achieve the incentives.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

Why did you find it hard to do enough **physical activity** to achieve the incentives?

I found it hard to reduce my **sitting time** enough to achieve the incentives.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

Why did you find it hard to reduce your **sitting time** enough to achieve the incentives?

Continuing to receive incentives would motivate me to be **more active** in the future.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

Continuing to receive incentives would motivate me to **sit less** in the future.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

After the end of this 4-month program, how long do you think that further incentives would continue to motivate you?

- A further 1-4 months
- 4-8 months
- 8-12 months
- 12-18 months
- 18-24 months
- more than 24 months (2 years)

Overall, the incentives were helpful.

- Strongly Agree
- Agree
- Neither
- Agree nor Disagree
- Disagree
- Strongly Disagree

Would you be willing to use a Fitbit to track your physical activity for 1 year?

- Yes
- No

What, if anything, would **prevent** you from wearing the Fitbit for a year?

What do you believe was the **most helpful** component of the ACHIEVE program for you?

- The interview

- Using the Fitbit
- Receiving text messages
- Receiving incentives

What did you like **most** about the ACHIEVE program?

What did you like **least** about the ACHIEVE program?

Overall, would you say that the ACHIEVE program has **made a difference** to your **physical activity** habits?

- Yes
- No

Please explain: why or why not?

Overall, would you say that the ACHIEVE program has **made a difference** to **your sitting time**?

- Yes
- No

Please explain: why or why not?

Appendix D. Social media advertisement content for qualitative study

Advertisement 1 (email contact):

TELL US WHAT YOU THINK AND EARN $$

Do you find it difficult to be physically active and to reduce your sitting each day? Would you be more likely to exercise if you were rewarded for your efforts? If you're between 40-65 years, email us now and be part of our new study! All eligible participants receive a $20 Coles Myer voucher simply for telling us what you think.

Advertisement 2 (link to online self-screening):

TELL US WHAT YOU THINK AND EARN $$

Do you find it difficult to be physically active and to reduce your sitting each day? Would you be more likely to exercise if you were rewarded for your efforts? If you're between 40-65 years, click below to be part of our new study! All eligible participants receive a $20 Coles Myer voucher simply for telling us what you think.

https://deakinsurveys.au1.qualtrics.com/jfe/form/SV_6x1MzZ5pbFDryqp

Additional images:

Appendix E. Online Qualtrics survey for recruitment for qualitative study

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Start of Block: WELCOMEBLOCK

WELCOME Thank you for your interest in our study - your opinion on this topic is very important to us!

This study aims to explore how incentives (e.g., cash rewards, vouchers, discounts) might be used to help encourage people to be more physically active or sit less.

The study involves one phone interview to discuss your views on this topic. All participants will receive a $20 Coles group/ Myer voucher as a token of our appreciation.

End of Block: WELCOMEBLOCK

Start of Block: SCREENINGBLOCK

INTRO +AGE Please complete the following questions to determine your eligibility for this study.

Are you aged between 40 - 65 years?

○ Yes (1)

○ No (2)

Skip To: PA1 If Please complete the following questions to determine your eligibility for this study. Are you age... = Yes

Skip To: End of Block If Please complete the following questions to determine your eligibility for this study. Are you age... = No

PA1 Do you do MORE THAN 150 minutes per week of physical activity that increases your heart rate and makes you feel warmer?

○ Yes (1)

○ No (2)

Skip To: End of Block If Do you do MORE THAN 150 minutes per week of physical activity that increases your heart rate and... = Yes

Skip To: PA2 If Do you do MORE THAN 150 minutes per week of physical activity that increases your heart rate and... = No

PA2 Do you do MORE THAN 75 minutes per week of vigorous physical activity (like running, fast cycling or swimming) that makes you huff and puff each week?

○ Yes (1)

○ No (2)

Skip To: ST If Do you do MORE THAN 75 minutes per week of vigorous physical activity (like running, fast cycling... = No

Skip To: End of Block If Do you do MORE THAN 75 minutes per week of vigorous physical activity (like running, fast cycling... = Yes

ST Of the hours that you are awake each day, do you spend MORE THAN 7 hours sitting?

○ Yes (1)

○ No (2)

Skip To: End of Block If Of the hours that you are awake each day, do you spend MORE THAN 7 hours sitting? = No

Skip To: INCOME If Of the hours that you are awake each day, do you spend MORE THAN 7 hours sitting? = Yes

INCOME Is your net (after tax) weekly household income less than $1,600; OR does your main income come from a pension or welfare benefit; OR are you a health care card holder?

○ Yes - one of more of these apply to me (1)

○ No - none of these apply to me (2)

Skip To: End of Block If Is your net (after tax) weekly household income less than $1,600; OR does your main income come f... = Yes - one of more of these apply to me

End of Block: SCREENINGBLOCK

Start of Block: PLSCFBLOCK

Display This Question:

If Is your net (after tax) weekly household income less than $1,600; OR does your main income come f... = Yes - one of more of these apply to me

PLSCF You are eligible for participation in our study! Please find all study details below.

1. Your Consent

This Plain Language Statement contains detailed information about the research project. Its purpose is to explain to you as openly and clearly as possible all the procedures involved in this project so that you can make a fully informed decision whether you are going to participate.

Please read this Plain Language Statement carefully. Feel free to ask questions about any information in the document. You may also wish to discuss the project with others. Please feel free to do this.

Once you understand what the project is about and if you agree to take part in it, you will be asked to sign the Consent Form. By signing the Consent Form, you indicate that you understand the information and that you give your consent to participate in the project.

2. Purpose

The purpose of this study is to explore opinions on the use of incentives (e.g., cash rewards, vouchers, discounts on goods) to increase physical activity and reduce sitting time. We are interested in hearing your thoughts on your current physical activity and sitting habits as well as discussing the use of incentive programs to increase physical activity and reduce sitting time.

3. Procedures

If you are eligible for this study you will be contacted via telephone for a one-to-one interview to discuss your thoughts on your physical activity and sitting habits, how acceptable you feel incentives are to increase physical activity and reduce sitting time and thoughts on different incentive components in more detail. The interview will take approximately 30 minutes. The study researcher will conduct the interview which will be audio recorded.

4. Possible benefits

This project will provide valuable insight on the use of incentives to increase physical activity and reduce sitting time. A summary of the findings will be available to participants on request.

5. Possible risks

We do not anticipate any possible risks as a result of participation in this study.

6. Privacy, confidentiality and disclosure of information

The interview will be conducted via telephone with a study researcher and will be audio recorded and transcribed. However all transcribed data will be given a code and will not contain any identifying information.

Any information we collect in recruitment that can identify you will remain confidential. Hard copy interview transcripts will be stored in locked cabinets and only labelled with a unique identification number. Audio recordings and other digital information will be stored on a password-protected computer and only accessible by researchers involved in this projected.

7. Results of the project

The findings of this study will be published in scientific journals and presented at national and/or international conferences. They may also appear in newsletters accessible on the Deakin University website. These results will also be included in the student researcher's thesis.

The findings will be presented in summary form of all participants. Individual quotes may be used; however no names or identifying details will be included in any publication or presentation.

You may request a copy of the published study findings from the study researchers when they are available (approximately 3 months after completion of the study).

8. Participation is voluntary

Participation in this study is entirely voluntary. If you decide to take part and later change your mind, you are free to withdraw from the project at any stage without providing a reason and without consequence.

If you decide to withdraw from this study at any point please contact project staff on jmaple@deakin.edu.au or return the Withdrawal of Consent Form attached.

9. Reimbursement for your time

Upon the completion of the study you will be sent a $20 Coles group -Myer gift voucher for your participation.

10. Ethical guidelines

The ethics aspect of this research project have been approved by the Human Research Ethics Committee of Deakin University.

11. Complaints

If you have any complaints about any aspect of the project, the way it is being conducted or any questions about your rights as a research participant, then you may contact: The Manager, Ethics and Biosafety, Deakin University, 221 Burwood Highway, Burwood Victoria 3125, Telephone: 9251 7129, research-ethics@deakin.edu.au Please quote project number [HEAG-H 05_2018]. 12.

Further information, queries or any problems

If you require any further information or have any queries or problems regarding the study please contact

Jaimie-Lee Maple

Deakin University School of Exercise and Nutrition Sciences

221 Burwood Highway, Burwood, 3125

Email: jmaple@deakin.edu.au

Phone: +61 3 9244 6397

If you are happy to proceed please select the consent option below and then select the forward arrow.

○ I have read and understand the purpose of this survey. I freely agree to participate in this study according to the conditions explained above. (1)

End of Block: PLSCFBLOCK

Start of Block: CONTACTBLOCK

CONTACT Thank you for agreeing to be a participant in our study. Please provide the email address that we can contact you on to arrange your phone interview.

○ Email (1) ____

○ Phone number (2) ____

End of Block: CONTACTBLOCK

Start of Block: THANKYOUNOTELIGIBLEBLOCK

Display This Question:

If Please complete the following questions to determine your eligibility for this study. Are you age... = No

Or Do you do MORE THAN 150 minutes per week of physical activity that increases your heart rate and... = No

Or Of the hours that you are awake each day, do you spend MORE THAN 7 hours sitting? = No

Or Is your net (after tax) weekly household income less than $1,600; OR does your main income come f... = No - none of these apply to me

Or Do you do MORE THAN 150 minutes per week of physical activity that increases your heart rate and... = Yes

Or Do you do MORE THAN 75 minutes per week of vigorous physical activity (like running, fast cycling... = Yes

TYNE Thank you for your interest in our study. Unfortunately, you do not qualify for our study at this time.

Skip To: End of Survey If Thank you for your interest in our study. Unfortunately, you do not qualify for our study at this...() Is Displayed

End of Block: THANKYOUNOTELIGIBLEBLOCK

Appendix F. Interview schedule for qualitative study

Qualitative research: Views on incentive-based programs to increase activity and reduce sitting

Participant number:

Phone Number:

Interview introduction

Introduction to the researcher

I am Jaimie-Lee Maple and I am a PhD student at Deakin University with an interest in health promotion.

Introduction to the research

Today I'd like to discuss with you some ways that have been used to try and encourage people to be more active and spend less time sitting down. One of the ways this can be done is by offering people incentives, or rewards. This is similar to when stores give people reward points for shopping there regularly – it's possible to give people points to reward them for being more active or sitting less.

Ethical Issues

- Before we begin I'd like to remind you that this session will be audio recorded with your permission

- All data from this interview will remain confidential and any information used will be not be identifiable

- Also a reminder that you are free to withdraw from this research at any time

Interview questions		**Notes**
Section one: Thoughts on physical activity/sitting time.		
When discussing physical activity I am talking about any body movement that works your muscles, increases your heart rate, makes you feel warmer or makes you huff and puff. This could include walking, running, playing sports, swimming, yoga etc.		
1.	**How much physical activity do you do on a usual day?** Does this differ on weekdays vs weekends?	
2.	**Do you think you spend enough time being active?** Why/why not?	
I'd like you to think about sitting time in general, so this could include at work, for transport, meal times, watching tv, smartphone use, reading etc		

3.	**How much time do you think you would spend sitting down on a usual day?** Does this differ on weekdays vs weekends?	
4.	**How do you feel about the amount of time you spend sitting each day?** Why?	
Section two: Incentives in general		
I would now like to discuss your opinion on using incentives to encourage people to be more active and sit less. Incentives can be anything from cash rewards, vouchers, clothing items, discounts on goods or healthcare services etc… that could be used to reward people for being more active or sitting less.		
5.	**What do you think about the idea of giving people incentives to help them be more active or sit less?** Why do you think that?	

6.	**Do you think some types of incentives would be more appropriate than others?** Why? Prompts (if necessary) o Vouchers more so than cash o Discounts more than clothing	
7.	**If you could design the best incentive program that would help you get active, what would it be?** Prompts (if necessary) o What types of rewards o What would you have to do to receive them	
8.	**If you could design the best incentive program that would help you to sit less, what would it be?** Prompts (if necessary) o What types of rewards o What would you have to do to receive	
9.	**Are there particular sitting activities that you think should be targeted with incentives?** Why?	

	Prompts (if necessary) ○ TV viewing ○ Smartphone use ○ Leisure-time computer or tablet use ○ Workplace sitting ○ Travelling/commuting (in a car/public transport)	
10.	**Do you think these incentive programs would help people to be more active and sit less?** Why/why not?	
11.	**What is the minimum incentive amount that you would need to be active (say 30mins) on most days?** Prompts (if necessary) ○ $5 per week ○ $10 per month	
12.	**What is the minimum incentive amount that you would need to sit less each day?** Prompts (if necessary) ○ Same as activity? ○ Different? Why?	

13.	**Do you think the incentive amount would influence how acceptable other people find them?** Why?	
14.	**Who do you think should pay for incentives to help get people active?** Prompts (if necessary) ○ Govt funded (tax payers) ○ Health insurers ○ Community organisations ○ Other – who?	
15.	**Do you think who funded incentive programs would influence how acceptable other people find them?** Why?	

16.	**Do you think everyone should have access to these programs or are there certain groups of people that you think should or should not be provided with incentives?** Prompts (if necessary) ○ People of higher incomes ○ People who are already active	
17.	**What do you think would be the benefits of these incentive programs?** Prompts (if necessary) ○ Reduced burden of disease ○ Healthier individuals	
18.	**What do you think would be the disadvantages of these incentive programs?** Prompts (if necessary) ○ Ethical concerns ○ Expense ○ Unfair to people who are already active	
Section three: Incentive components		

I would now like to ask your opinion on different components of incentive programs.		
19.	**If you were in one of these programs what types of incentives would appeal to you?** Why? Prompts (if necessary) ○ Supermarket vouchers ○ Discounts on health care ○ Cash ○ Clothing items	
20.	**How often do you think you would need to be rewarded in order to be stay motivated?** Prompts (if necessary) ○ Weekly ○ Fortnightly ○ Monthly	

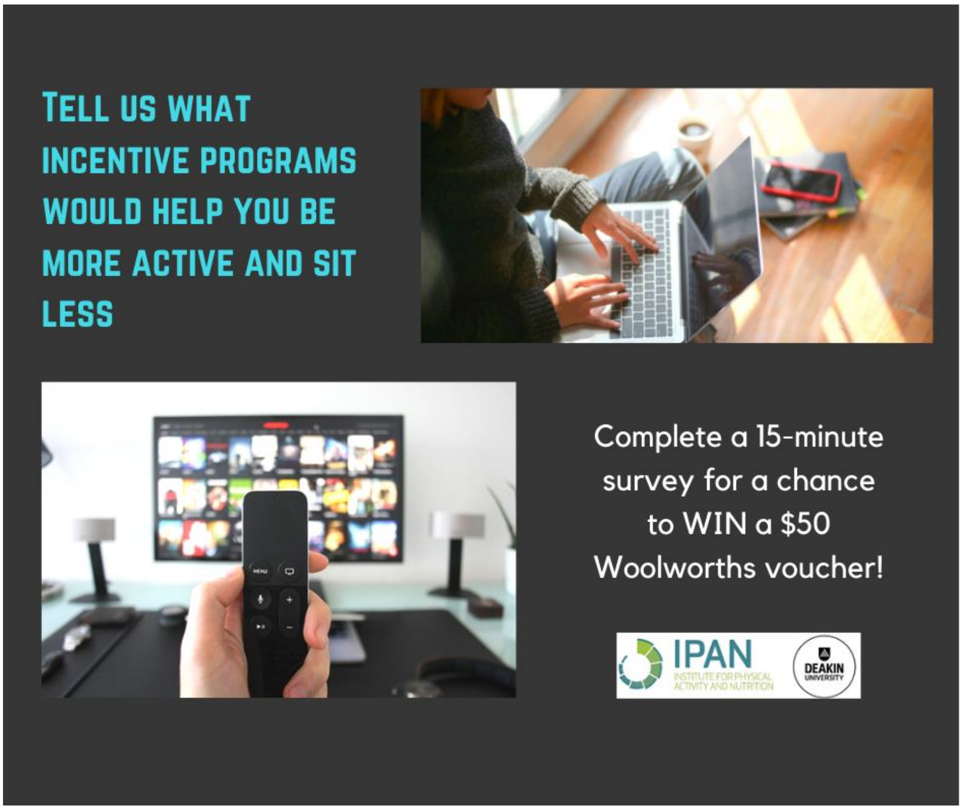
21.	**Let's imagine there was one program that rewarded you with $1 each time you were active/or sat less. In another program you had to pay $1 and lost it if you weren't active/or reduced your sitting when you planned to. Which of these do you think would be better at helping you to change your behaviour?** Why?	
22.	**Say there was one program with small, regular rewards every time you were more active/or sat less. In another program there was a larger, one off reward when an overall goal was achieved (say 30mins most days /week for 3 consistent weeks). Which of these do you think would be better at helping you to change your behaviour?** Why?	
23.	**How long do you think you would be willing to be involved in an incentive program?** Why?	

24.	**Do you think you would continue to be more active once the incentive program was completed?** Why/why not?	
25.	**Do you think you would continue to sit less once the incentive program was completed?** Why/why not?	
26.	**Do you think incentive programs alone would help you be more active and sit less or do you think they should include other components?** Prompts (if necessary) ○ Use of additional written information ○ Face-to-face discussions ○ Prompting services ○ Monitoring devices	

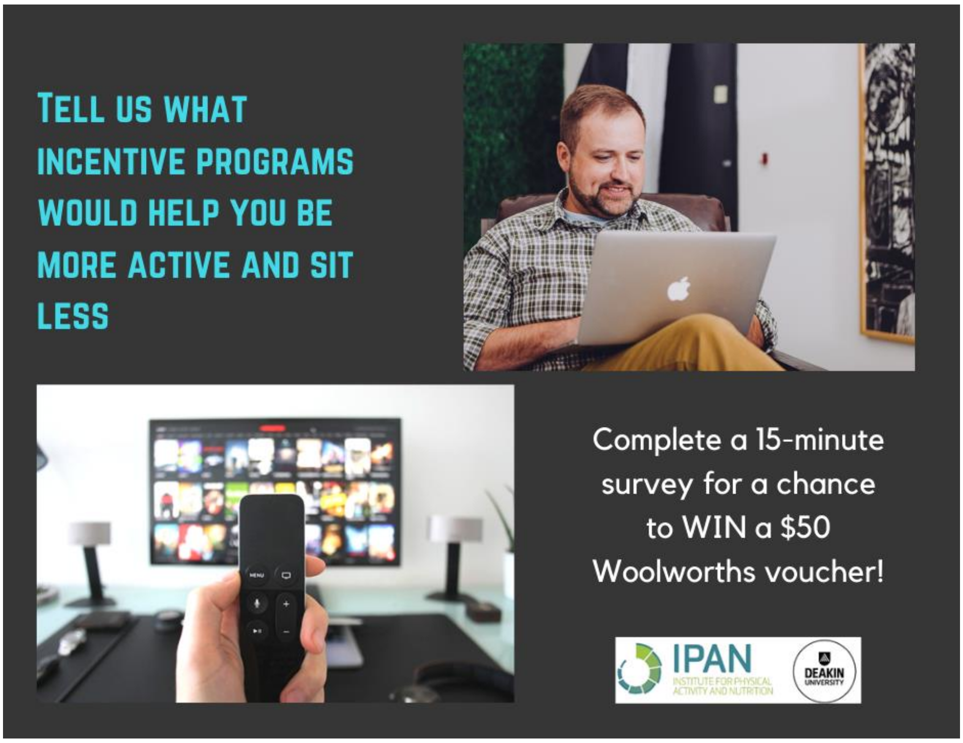
- We have now reached the end of the interview
- Do you have any questions or other thoughts/information you would like to add before we finish?

- I will send you through an email just to confirm some final details for our records as well as your address so we can post you out the gift voucher
- Thank you so much for your time

Appendix G. Social media advertisement content for discrete choice experiment



Male targeted:



Appendix H. Description of attributes and levels outlined to participants for discrete choice experiment

Incentive program design

In the next section, you will be presented with some possible programs to consider.

The first eight questions will include programs that aim to encourage you to increase your physical activity. The goal of these programs is for you to meet physical activity guidelines (~150 minutes per week) by the conclusion of the program.

The second eight questions will include programs that aim to encourage you to reduce your sitting time. The goal of these programs is for you to form a habit of sitting for shorter durations by the conclusion of the program.

You will be asked to consider each possible program and choose the one you prefer.

Each program design will include the following components: length, access, value, funding and form. Please consider the following explanations and definitions of each component when answering the questions.

Length

The component "length" describes how long you are involved in the program. In this questionnaire, the length options will be defined as follows:

<u>3 months</u>

A 3 month program

<u>6 months</u>

A 6 month program

<u>12 months</u>

A 12 month program

<u>Indefinitely/long term</u>

You can be involved for as long as you like.

Access

The component “access” describes who can/cannot participate in the program. In this questionnaire, access options will be defined as follows:

<u>Open to everyone</u>

The program is open to everyone with no restrictions.

<u>Not available to people who are already active</u>

The program is not available to you if you are already meeting physical activity guidelines as you are classified as not needing extra motivation/incentives.

<u>Targeted to people most at risk of poor health outcomes</u>

The program is available to you if you are at "high-risk" of poor health outcomes due to physical inactivity and long durations of sitting.

<u>Targeted to people with limited services (e.g., rural/older populations)</u>

The program is available to you if you are in a population group who is in need of more support to improve your health behaviours.

Value

The component “value” describes the amount of the reward you would receive per week for meeting your behavioural goals. In this questionnaire, value options will be defined as follows:

<u>$5 per week</u>

You receive a small reward equivalent to $5 per week

<u>$10 per week</u>

<u>You</u> receive a reward equivalent to $10 per week per week

<u>$20 per week</u>

You receive a reward equivalent to $20 per week

$50 per week

You receive a large reward equivalent to $50 per week

Funding

The component "funding" describes the most acceptable option for providing financial support for the program. In this questionnaire, funding options will be defined as follows:

Government

The program would be funded by the government.

Combination of funders (e.g., government & sponsor)

This program would be funded by a combination of different funding bodies.

Private/sponsor (e.g., Rebel Sports, workplaces)

The program would be funded by private company/sponsors who have a transparent relationship with the program. For example, this could include companies such as Rebel Sport, who might provide funding to support more people being active which could result in more people shopping at their business. It could also include workplaces providing funding so their employees are more active and therefore are more productive at work.

Health insurers

The program would be provided by health insurers, who would benefit from more active and hence healthier clients.

Form

The component "form" describes the type of reward you would receive if you meet your weekly behaviour goals. In this questionnaire, form options will be defined as follows:

Cash rewards

You would receive money

Shopping vouchers

You would receive shopping vouchers

Tailored to your personal interests

You would have the ability to negotiate and tailor the rewards you received

Experiences (e.g., community cooking classes, movies tickets)

You would receive rewards for experiences/activities, such as cooking classes, movie tickets or day trips to local attractions.