Evidence-Based and Theoretically-Driven Behaviour Change Interventions for Physical Activity to Enhance Health and Wellbeing

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Abstract

There are high rates of inactivity in UK adults, which can lead to a range of health problems. The main aims of this thesis were: first to review existing behaviour change intervention design, delivery, evaluation, and reporting frameworks to gauge the most effective process and/or combination; second to review the existing literature on physical activity and sedentary behaviour interventions, to see whether they work, what techniques might be effective, and how well they were reported; third to review theories of behaviour (change) in terms of completeness and suitability for physical activity and sedentary behaviour; fourth to test the chosen theory (COM-B model) in terms of the relevant components of the three constructs (Capability, Opportunity, Motivation) and how well they predicted moderate-to-vigorous physical activity (MVPA) and sedentary behaviour (in comparison to the Theory of Planned Behaviour); last to design, implement, and evaluate (including from the deliverers' perspective) a community physical activity programme, with the techniques highlighted in the review included in the content and the behavioural drivers from the theory analysis as secondary outcomes.

The exploration of behaviour change intervention design frameworks concluded by summarising a nine-step process covering the most important elements from needs assessment to dissemination. The systematic review showed physical activity interventions to be effective at changing behaviour and maintaining those changes, and pointed towards behaviour change techniques that were associated with effectiveness. The theory review concluded that the COM-B contained the most comprehensive range of behavioural determinants and was ideally situated within the Behaviour Change Wheel for designing interventions. The COM-B analysis showed a strong prediction of MVPA and highlighted Psychological Capability and Reflective Motivation as important drivers. Sedentary

behaviour was also predicted relatively strongly with Psychological Capability the most important driver. The Active Herts programme was then detailed and evaluated, showing improvements in physical activity, health, life satisfaction, and wellbeing at 3 and 6 months. COM-B measures predicted MVPA more strongly after intervention at 3 and 6 months, than at baseline, and were better at predicting MVPA performance than change over this period. Interviews with the Get Active Specialists delivering the programme reflected positively on the training, materials, and overall programme. Key lessons to take forward were extra support at the start with supervision and engaging referrers, and limiting the length and complexity of outcomes measures. The discussion explored the need to measure long-term outcomes of behaviour change, difficulties in measuring the constructs of the COM-B, the balance between standardisation and tailoring of interventions, and adopting a transdisciplinary approach to programme design.

Publications and presentations

Published papers

Howlett, N., Jones, A., Bain, L., & Chater, A. (2017). How effective is community physical activity promotion in areas of deprivation for inactive adults with cardiovascular disease risk and/or mental health concerns? Study protocol for a pragmatic observational evaluation of the 'Active Herts' physical activity programme. *BMJ Open, 7*(11), e017783.

Howlett, N., Schulz, J., Trivedi, D., Troop, N., & Chater, A. (2017). A prospective study exploring the construct and predictive validity of the COM-B model for physical activity. *Journal of Health Psychology*.

Howlett, N., Trivedi, D., Troop, N. A., & Chater, A. M. (2015a). What are the most effective behaviour change techniques to promote physical activity and/or reduce sedentary behaviour in inactive adults? A systematic review protocol. *BMJ Open, 5*(8), e008573.

Howlett, N., Trivedi, D., Troop, N. A., & Chater, A. M. (2018). Are physical activity interventions for healthy inactive adults effective in promoting behavior change and maintenance, and which behavior change techniques are effective? A systematic review and meta-analysis. *Translational Behavioral Medicine*.

Conference presentations and posters

Chater, A., Howlett, N., Trivedi, D., & Troop, N. (2016). *Effective behaviour change techniques to promote physical activity in inactive adults: Systematic review and meta-analysis. Paper presented at the* European Health Psychology Society and BPS Division of Health Psychology Joint Annual Conference, Aberdeen.

Howlett, N., Schulz, J., Trivedi, D., Troop, N., & Chater, A. (2018). *A prospective study exploring the construct and predictive validity of the COM-B model for physical activity*. Poster presented at the Health Psychology in Public Health Network Annual Conference, Stevenage.

Howlett, N., Trivedi, D., Troop, N., & Chater, A. M. (2015b). *What are the most effective behaviour change techniques to promote physical activity and/or reduce sedentary behaviour in sedentary adults? A systematic review*. Poster presented at the BPS Division of Health Psychology Annual Conference, London.

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Chapter 1

Thesis Overview

Both men and women in the United Kingdom (UK) are at risk of a range of negative health consequences due to inactive and sedentary lifestyles. Interventions aimed at increasing physical activity and/or reducing sedentary behaviour are of paramount importance. However, there are a number of underlying issues with design, delivery, evaluation, and reporting that preclude the best evidence-based approaches reaching the populations that need them most. The aim of this thesis was to design, implement, and evaluate a community-based programme to promote physical activity and reduce sedentary behaviour using the most up-to-date evidence, theory, and reporting guidelines. This chapter provides an overview of the thesis chapters, detailing the key components of each section.

Chapter 2 critically analyses the most influential behaviour change intervention design, delivery, evaluation, and reporting frameworks, in terms of their limitations and overlapping guideline content. These include holistic behaviour change intervention guidance, frameworks that focus only on automatic processes or changing environments, or design or evaluation, and reporting guidelines. This leads to suggestions of how the best parts from these frameworks and guidance may be combined into one larger process containing nine stages of intervention design, delivery, and evaluation: needs assessment; systematic review; behavioural diagnosis; choosing intervention functions, policy categories, and behaviour change techniques (BCTs); training deliverers in an appropriate communication style; feasibility testing; delivery; evaluation; dissemination.

Chapter 3 then details the rates of inactivity (including general physical activity levels, muscle-strengthening, and sporting participation) and sedentary behaviour (such as sitting and screen time) in the general adult population, focused mostly on the UK. This chapter also distinguishes between physical inactivity and sedentary behaviour as separate behaviours, and then highlights the risk factors associated with each independently. Additionally, the national guidelines (or lack of) for each behaviour are summarised.

Study 1 (Chapter 4) then reports a systematic review and meta-analysis of previous interventions from the last 25+ years in inactive adults to explore whether they have been effective in changing behaviour (physical activity and sedentary behaviour) through intervention trials and whether this behaviour change has been maintained. As part of the review, a meta-analysis was conducted on pooled physical activity outcomes to provide an estimate of effectiveness of these interventions not only in changing behaviour but also in maintaining this change. The review also analysed the specific BCTs that have been included in the intervention descriptions to explore whether certain techniques (i.e. action planning) are associated with greater effectiveness. A secondary objective was to review how well the interventions have been reported, with a particular focus on whether fidelity assessment has been reported, i.e. the extent to which interventions are delivered as intended.

Alongside poor quality evidence on effectiveness, and intervention content, there is inconsistency in which theories are applied in the design and evaluation of physical activity interventions, with intervention designers often selecting individual constructs or multiple overlapping theories (Prestwich, Sniehotta, Whittington, Dombrowski, Rogers, & Michie, 2014). Theories such as the Theory of Planned Behaviour (TPB; Ajzen, 1991) have been used to try to understand and change behaviour, but have struggled at times to do either, because the theories do not contain all of the potential drivers for behaviour. Chapter five, therefore, contains an overview of the most relevant theories of behaviour and behaviour change in terms of predicting and changing physical activity and sedentary behaviour. The COM-B (Capability, Opportunity, and Motivation - Behaviour) model (Michie, Van stralen, & West, 2011) has the potential to provide a more comprehensive basis with which to understand specific behaviours in different populations and can be utilised as the centre of the Behaviour Change Wheel (Michie, Atkins, & West, 2014) to design interventions.

Study 2 (Chapter 6) and Study 3 (Chapter 7) then provide a unique analysis of the COM-B model, in relation to moderate-to-vigorous-intensity physical activity (MVPA) and sedentary behaviour (sitting) respectively. As there is no standardised method to measure COM-B, this involved exploring the most suitable indicators with which to represent the three key constructs of the COM-B (Capability, Opportunity, Motivation) and to test the main tenet of the model; namely whether Motivation acts as the central mediator. Further analysis for each of these behaviours then explored the predictive validity of the COM-B and compared it to the most commonly applied model from previous literature, the TPB. This analysis provided both a novel test of the COM-B model and pointed towards key internal and external drivers of physical activity and sedentary behaviour.

The final aim of this thesis was to use the findings from the systematic review and COM-B analysis to design a physical activity programme for inactive community residents in four deprived areas in Hertfordshire. Change over 3 and 6 months in physical activity, sporting participation, and sitting was the primary outcome of the programme. The systematic review (Study 1) provided the most effective BCTs from previous randomised controlled trials (RCT) to increase physical activity in terms of behaviour change and maintenance. The COM-B analysis of physical activity (Study 2) then highlighted the most important drivers of MVPA. Together these findings were used to aid in the design of the programme materials and consultations (BCTs), and the choice of secondary evaluation measures (COM-B related drivers) for the community programme. The programme, called 'Active Herts', was funded by Sport England, Hertfordshire County Council, and local Clinical Commissioning Groups (CCGs).

A mixed-methods evaluation of Active Herts is presented in Study 4 (Chapter 8) and 5 (Chapter 9). Two different delivery models (two areas per delivery model) are evaluated in terms of changes in these outcomes from baseline, to 3 months and 6 months. In two areas (Hertsmere and Stevenage) programme users received a behaviour change technique booklet, regular consultations, a booster phone call, motivational text messages, and signposting to 12 weeks of exercise classes. In another two areas (Watford and Broxbourne) programme users received 12 weeks of free tailored exercise classes, with optional exercise 'buddies' available for additional social support. Study 4 (Chapter 8) presents the methodology (materials, procedures, training of delivery staff, fidelity assessment) of the Active Herts programme and analyses the primary (physical activity, sporting participation, sitting) and secondary outcomes (mental wellbeing, perceptions of health, life satisfaction, self-efficacy, self-monitoring, action planning, intentions, and attitudes). Further analysis explored some of the underlying drivers identified in the COM-B analysis related to MVPA performance (baseline, 3 and 6 months) and change across the programme (baseline to 3 and baseline to 6 months).

Study 5 (Chapter 9) then details interviews conducted with the four Get Active Specialists who delivered the programme in the four target localities. Thematic analysis was utilised to draw out themes relating the specialists' views of the training, delivery, materials, questionnaires, and overall Active Herts programme. These themes were used to improve the delivery and evaluation of the programme and provide key learning for future approaches to physical activity promotion.

The final chapter summarises the main points and findings from each chapter. Implications and future directions from this body of research are then covered including: measuring outcomes beyond behaviour change such as wider health improvement; the challenges in conceptualising and measuring the COM-B constructs; the need for further development of the BCT taxonomy; comparing the effectiveness of interventions designed using different frameworks; the challenges of standardising programme delivery and the balance with tailoring to the individual; transdisciplinary approaches in behavioural science. The REF2021 impact case emerging from this work is then discussed including further impact from the Active Herts programme such as spinout programmes and Sport England literature. This chapter then ends by outlining the future plans of the PhD candidate.

Chapter 2

Behaviour change intervention design, delivery, evaluation, and reporting

Large strides have been made in the last decade in guidance on how to design, deliver, evaluate, and report BCIs. This is likely to increase the chances that current and future BCIs will be effective, acceptable, and reproducible. It is helpful to first consult general guidelines covering the main considerations for BCIs before intervention development begins. There are a number of intervention frameworks which explain how to design and evaluate BCIs, which are explored in this chapter. There also needs to be an analysis of the barriers and facilitators of a behaviour using relevant theory. Models which concentrate on the intervention design phase help elaborate these processes and are covered in detail in this chapter. However, designing an intervention and detailing its content is not enough to ensure effectively delivery. This chapter considers how to best deliver the interventions in terms of communication style. To identify if an intervention has been effective, it is important to draw from a relevant evaluation framework, which goes beyond traditional measures of effectiveness to include concepts such as reach, cost, and fidelity. The reporting of interventions is also essential to support reproduction and understand effectiveness. Guidelines for a range of trial designs and intervention elements are available and should be consulted. This chapter concludes by drawing together these approaches to make suggestions about how to combine the key elements.

2.1. Behaviour change intervention guidance

2.1.1. Medical Research Council (MRC).

One of the most widely used set of guidelines is the Medical Research Council (MRC) guidance on developing and evaluating complex interventions (Craig, Dieppe, Macintyre, Michie, Nazareth, & Petticrew, 2013). These guidelines focus on five key areas related to BCIs: development; piloting/feasibility; evaluation; reporting; implementation. The authors themselves concede that there is often no clear divide between simple and complex interventions (Craig et al., 2013), and so these guidelines should be considered for any BCI even if it is low-intensity or relatively straightforward.

The development stage can be broken down further into three areas. The first is to consult the existing evidence base through a systematic review (and meta-analysis if applicable). This allows intervention designers to understand greater detail about what has been done before and whether changing a particular behaviour in a certain population is feasible and effective. The likelihood is that this would need to be a new piece of research fitting the exact criteria of the new BCI. If there is limited resource then existing reviews can be consulted. The second area is to provide a theoretical basis for the BCI using existing behaviour change theory. An existing theory can be explored in a new way that is relevant for the target population and behaviour both quantitatively (e.g. questionnaires) and/or qualitatively (e.g. interviews or focus groups). The final stage is modelling which involves testing potential design features in a series of smaller experiments aimed at optimisation and/or exploring the potential costs involved with an economic evaluation. This can influence changes to the design or delivery prior to beginning the trial or programme launch. The details on how to do this are however quite vague, but the guidance does suggest Multiphase Optimization Strategy (MOST; Collins, Murphy, Nair, & Strecher, 2005) as one of the approaches that can be used. MOST is a method of optimising behavioural interventions that will be explored in greater detail later in this chapter.

The MRC guidelines highlight feasibility and piloting as a key stage in building complex interventions (Craig et al., 2013). Feasibility testing can tell researchers crucial information on acceptability, recruitment, and retention, and can lead to changes in protocol that increase the likelihood of intervention success. Similarly, piloting can provide important information on potential effect sizes and sample size required and can be utilised to tweak elements of design, delivery, and evaluation. This testing stage will also inform the next evaluation stage where intervention designers are provided with guidance on the choice of design to use depending on the type of intervention in question. Decisions such as whether randomisation or an experimental design is possible are made at this stage. Further considerations include the need for process evaluation to explore factors such as how and/or why the intervention was successful (e.g. mechanisms of change), and the extent of fidelity (e.g. whether the intervention was delivered as intended). Cost-effectiveness is also highlighted as a key part of BCI evaluation so that the level of change can be analysed against the resources needed to achieve it.

Reporting of the primary research is highlighted in the fourth stage of the guidelines. Reporting guidelines in general will be analysed in more detail later in this chapter but the MRC guidelines emphasise Consolidated Standards of Reporting Trials (CONSORT; Boutron, Moher, Altman, Scultz, & Ravaud, 2008) for randomised controlled trials (RCT), Transparent Reporting of Evaluation with Non-randomised Designs (TREND; Desjarlais, Lyles, Crepaz, & TREND, 2004) for non-randomised designs, and Strengthening the Reporting of Observational Studies in Epidemiology (STROBE; von Elm, et al., 2007) for observational designs. A well-reported publication suitable for an academic audience is just one small element of potential dissemination and wider implementation, which is the focus of the final part of the MRC guidance. Implementation, in this context, covers how well the findings are communicated to, and translated by, people working with the target population. Other important elements of this stage are trying to analyse long-term outcomes (e.g. beyond the primary research project) and monitor the outcomes of changes in behaviour (e.g. lower rates of cardiovascular disease from increases in physical activity). This can sometimes be achieved through routinely collected population data such as NHS Digital (https://digital.nhs.uk/).

2.1.2. The National Institute for Health and Clinical Excellence (NICE).

In 2007, NICE published public health guidance on general approaches to behaviour change. This guidance covered BCIs at the individual, community, and population level. The authors were comprised of a programme development team (chaired by Professor Mildred Blaxter), a NICE project team, and several external contractors who completed review work (e.g. a social marketing review by University of Stirling). The guidance states that interventions aimed at one level can affect more than one level of outcomes (e.g. a community-level intervention can produce community-level, individual-level, and/or population benefits; NICE, 2007). The individual-level recommendations highlight a number of optimal intervention techniques that have since been classified as behaviour change techniques (BCT; Michie et al., 2013). These include graded tasks, information about health and emotional consequences, and action planning (referred to as if-then plans; NICE, 2007). The guidance also highlights a number of constructs from social cognition theories such as the Theory of Planned Behaviour (TPB; Ajzen, 1985) and Social Cognitive Theory (SCT:

Bandura, 1989), which are explored in more detail in Chapter 5. These include self-efficacy, intentions/goals, and positive attitudes.

The guidance does however highlight a number of key problems with the evidence base. As of 2007 there was a lack of consistent evidence for the effectiveness and cost-effectiveness of specific BCI approaches (NICE, 2007). The guidance also commented on the multitude of behaviour change theories, with often overlapping constructs which had, to that point, provided little evidence on the mechanisms of change operating in BCIs that were effective. Abraham, Kelly, West, and Michie (2009) later produced a commentary on the guidance, which highlighted that the eight guidance principles mirror quite closely the steps specified in Intervention Mapping (IM: Kok, Schaalma, Ruiter, van Empelen & Brug, 2004). IM will be explored in more detail later in this chapter.

Seven years later, NICE released updated guidance that focused on individual-level BCIs (NICE, 2014). This guidance incorporated several key developments in behavioural science since the previous set of recommendations. The range of recommendations and breadth of targets for the recommendations (e.g. researchers, policy makers) were also more extensive. There is a recognition that the communication skills with which interventions are delivered are equally important, with a person-centred approach highlighted as an example of good practice (NICE, 2014). Recommendation 5 introduces the importance of monitoring and measuring fidelity, so an evaluation can judge whether the intervention was delivered as intended. Related to this, recommendation 14 states that those delivering the intervention should be assessed and receive feedback. This can involve recording sessions and then coding audio for certain delivery components such as BCTs specified in the intervention manual. The guidance mentions the COM-B (Capability, Opportunity, and Motivation – Behaviour; Michie et al., 2011) on multiple occasions as a theoretical model and way of conceptualising the barriers and facilitators in the target population. BCTs are also considered the optimal way of classifying intervention content. Both the COM-B and BCTs will be explored in greater detail later in this chapter.

The authors of the 2014 guidance also outline a number of key considerations and lessons learned going forward. The guidance represents a best-case scenario that might not be achievable in reality due to a range of factors such as funding/resource limitations. The guidance also represents what to do as best practice for BCIs but not how to do it. Further recommendations are that the control arms of BCIs need to be better described in conjunction with intervention manuals being published so that extra detail can be provided that is not allowed in relatively brief journal articles. The authors recommend that information provision to improve knowledge is rarely enough to change behaviour (NICE, 2014). Training programmes for deliverers are also still too often using the stages of change from the Transtheoretical Model (TTM; Prochaska & DiClemente, 1982, 1983), despite little to no supportive evidence. The challenges with this model will be covered more comprehensively in Chapter 5. A final note from the guidance is that there is a paucity of research on the effectiveness of 'choice architecture' interventions, sometimes referred to as 'nudging'. These interventions are covered in the next section in more detail.

2.1.3. Messenger, Incentives, Norms, Defaults, Salience, Priming, Affect, Commitment and Ego (MINDSPACE).

The MINDSPACE approach to behaviour change was favoured by the UK government (Institute of Government, 2010), and primarily aimed at manipulating environments and communications to change subsequent behaviour. Dolan et al. (2012) state that most approaches have traditionally targeted conscious, reflective decision making. The authors make a case for interventions that target more automatic processes to influence behaviour. Despite presenting MINDSPACE as a summary of the literature on this subject, no systematic review was conducted. Dolan et al. (2012) criticises approaches targeting conscious decision making but do not provide systematic evidence for approaches targeting only automatic processes as a counter. Furthermore, the authors acknowledge that this mnemonic was arrived at without expert consensus, and therefore represents the subjective view of the authors (Dolan et al., 2012).

MINDSPACE focuses on 'system 1' of a dual-system approach of cognitive processing (Kahneman, 2002; Stanovich & West, 2002). In this dual-system approach, system 1 is intuitive, fast, and effortless and system 2 is reasoned, slow, and effortful (Kahneman, 2002). Decision-making and perceptions generated from system 1 can result in errors and lead to biased thinking (Kahneman, 2002; Tversky & Kahneman, 1974). By creating a false dichotomy between focusing on either automatic (system 1) or conscious processes (system 2), MINDSPACE falls short of more comprehensive models such as PRIME theory (Plans, Responses, Impulses, Motives, Evaluations; West & Brown, 2013) and the COM-B (Michie et al., 2013). PRIME theory adopts a dual-process approach in which there can be both automatic (i.e. not requiring conscious thought such as habituation) and reflective (i.e. conscious inference and analysis) change processes (West & Brown, 2013). The MINDSPACE approach covers some of what interventions targeting automatic processes might look like but does not detail how to design such interventions. The nine 'effects' from the literature are also incoherent structurally. These effects comprise a mixture of intervention functions (incentives), modes of delivery (messenger), policy categories (defaults), emotions (affect), and BCTs (commitment can be a type of behavioural contract) (Michie et al., 2011). The nine effects are also primarily designed to change momentary point-of-decision 'choices'. Therefore, they are very unlikely to achieve long-term behaviour change maintenance, something partly acknowledged by the authors (Dolan et al., 2012).

2.1.4. Easy, Attractive, Social, Timely (EAST).

Following on from MINDSPACE the Behavioural Insights Team, originally situated in the cabinet office, developed the EAST framework for designing interventions (Service et al., 2014). Whereas MINDSPACE was purely descriptive, EAST provides a more usable framework to design interventions, however, still largely focused on 'choice architecture'. EAST proposes a four-stage process to design interventions which involves defining the outcome (how it is measured, how large a change is sufficient, and for how long), understanding the context in which the intervention will take place, building the intervention, and testing the intervention (Service et al., 2014). The four parts of the EAST acronym come in at the third stage where intervention designers are asked to make the intervention Easy, Attractive, Social, and Timely.

- Easy interventions involve reducing barriers and making messaging simple. A good example of an easy intervention is parkrun which is free and only requires a barcode to be printed one time to participate anywhere in the country. Making interventions easy can also involve using defaults (opting into a scheme automatically), e.g. organ donation (Behavioural Insight Team, 2013) and pension contributions (HMG, 2013).
- Attractive interventions should be attention grabbing and maximise the effect of rewards and sanctions. They should be fun and be seen to be relevant to the target audience.

- Social interventions provide information about social norms, use networks, and commitments to others. They facilitate social interactions and social support.
- Timely interventions help people plan, focus on immediate benefits over costs, and prompt people to perform behaviour at opportune times (Service et al., 2014), highlighting the importance of 'teachable moments' (e.g. Epiphaniou & Ogden, 2010).

The EAST approach also favours testing these interventions with RCTs and refining the materials and approach through an iterative process, much like the MOST approach (Collins et al., 2005). EAST is used in all government-funded intervention work by the Behavioural Science Unit. For policy makers in particular, who are often limited on time, the EAST approach provides an approach more sensible and usable than MINDSPACE to testing interventions that affect choices about behaviour.

2.1.5. Typology of Interventions in Proximal Physical Micro-Environments (TIPPME).

The TIPPME provides systemisation to a set of 'choice architecture' approaches, which up to that point had seen very little work specifying consistent definitions and evaluation criteria (Hollands et al., 2017). This typology is concerned with minor changes in the physical environment that affect selection, purchasing, and consumption of food, tobacco, and alcohol. The TIPPME framework offers intervention designers 18 possible intervention combinations depending on whether the approach alters the location or properties of objects/stimuli, whether the focus is the product itself, related products, or the wider environment, and which type of intervention it is (Availability; Position; Functionality; Presentation; Size; Information; Hollands et al., 2017). For instance, an intervention could change the availability of a product. This typology aims to help interventionalists more systematically classify, describe, report, and design interventions to affect choices. For example, altering the position of unhealthy food products away from the queue where people pay. However, physical activity was not included as one of the target behaviours as it is often not distinct from the environment in which it takes place (Hollands et al., 2017). Physical activity is rarely performed in a fixed place, with the only applicable example being attempts to promote stair use instead of escalators and/or lifts (e.g. Eckhardt, Kerr, & Taylor, 2015).

2.2. Broad models for BCIs covering development to evaluation

2.2.1. PRECEDE-PROCEED

The PRECEDE-PROCEED model summarises steps to take during any health promotion programme or intervention (Green & Kreuter, 2005). PRECEDE stands for Predisposing, Reinforcing and Enabling Constructs in Educational Diagnosis and Evaluation. PROCEED stands for Policy, Regulatory, and Organizational Constructs in Educational and Environmental Development. The model combines the original PRECEDE methods (Green, 1974), with the later PROCEED (Green & Kreuter, 1991) in combination in an updated model based on social ecological principles. Improvements in or maintenance of quality of life are the end goal of the PRECEDE-PROCEED model, with improvements in health the key precursor (Green & Kreuter, 2005). Health is influenced by genetics, behaviour, and environment, with behaviour and environment the changeable targets of the health programme. These changes can be achieved through educational strategies and policy/regulation that helps to reinforce or enable the target population (Porter, 2016). The model presents a coherent framework but does not offer enough detail on the range of intervention strategies which are heavily weighted towards education. A strength of the model is that it considers health promotion within the system in which the target population and therefore intervention operate (Porter, 2016). This increases the chances of successful implementation, albeit some of the systemic factors may be beyond the scope of the health promotion activities to change.

2.2.2. Intervention Mapping (IM)

The six stages of the IM protocol (Bartholomew, Parcel, & Kok, 1998; Bartholomew Eldredge, Markham, Ruiter, Fernández, Kok, & Parcel, 2016) closely align with the PRECEDE-PROCEED model. IM provides a framework with which to select and apply theories of behaviour and behaviour change (Kok, Schaalma, Ruiter, & van Empelen, 2004). The comprehensive six-stage process involves establishing a logic model of the problem including a needs assessment, identifying programme outcomes and objectives, designing the programme including selecting theory-based methods, programme production including materials and piloting, programme implementation planning, and evaluation (Bartholomew et al., 2016). The key tools for developing the intervention overlap with the MRC guidelines and include systematic reviews, assessment of theory, and collecting new data (e.g. about theory suitability and/or target population).

The authors state that IM provides a more comprehensive programme development phase than the PRECEDE-PROCEED model (Kok et al., 2004). The main objective of IM is to link theory to practice, as a catalyst for more successful implementation. IM prefers that multiple theories are utilised to solve practical problems rather than a single theory (Kok et al., 2004). However, this assumption predated the publication of the COM-B, a much more holistic behaviour-change model (Michie et al., 2011). This assumption is also not necessarily backed by evidence, particularly when changing physical activity, where interventions utilising a single theory are more effective than those containing multiple theories (Gourlan et al., 2016). IM focuses more on intervention design than more holistic models and has similarities to models focused exclusively on intervention design which are reviewed later.

2.2.3. Six-stage development model of evaluating health promotion.

Although this model is referred to as an evaluation framework it actually focuses on a health promotion approach which encompasses intervention design as well as evaluation. The six-stage development model for evaluating health promotion is similar to the social ecological and PRECEDE-PROCEED approaches, in that quality of life and health in terms of functional independence and morbidity are of primary importance (Nutbeam, 1998). A four-tier hierarchal outcome model is suggested with these factors included in the top health and social outcomes tier (Nutbeam, 1998). Changes in behaviour, health services, and environment are seen as intermediate health outcomes in the second tier. The third tier is focussed on health promotion outcomes but lacks coherency, with elements of Capability and Motivation (health literacy), Opportunity (social influence and action), and policy (Nutbeam, 1998). The fourth tier contains similar elements to the intervention functions of the Behaviour Change Wheel (BCW) such as education. The structure of the model lacks a clear path to follow in design and evaluation.

A six-stage evaluation model is then presented, which despite being named an evaluation model, has two stages that are akin to the design element from the BCW and IM. At times, the model appears unrealistic in the breadth and depth of evaluation required, given that most health promotion programmes only assign around 5-10% of funding to this area (Zandniapour & Vicinanza, 2013). The evaluation targets include potentially hard-to-capture elements such as community ownership of programmes, social mobilisation, and organisational practice (Nutbeam, 1998). The fourth stage also mentions real-world testing of the health promotion approach, but this often happens after a trial is conducted. Additionally, Nutbeam (1998) also makes reference to less experimental, more iterative designs which may be more applicable to practice but present problems for reproducibility and replicability. Nutbeam (1998) ends by outlining conditions for success which include reach, implementation, and acceptability which align with elements of the RE-AIM framework (Glasgow, Vogt, & Boles, 1999) presented later.

2.3. Models for intervention design

2.3.1. MOST/SMART for eHealth interventions.

The Multiphase Optimization Strategy (MOST; Collins, Murphy, Nair, & Strecher, 2005) and Sequential Multiple Assignment Randomized Trial (SMART; Collins, Murphy, & Strecher, 2007) have been put forward as complementary methods to achieve more effective interventions through refinement and testing. MOST proposes three phases which screen, refine, and confirm the design and delivery of a BCI. The lack of guidance for the three proposed stages is quite problematic, as there is little to no framework, use of existing literature, and/or application of theory. The model assumes that theoretical considerations, alongside feasibility and implementation issues, have been explored prior to the first screening stage. The first screening stage therefore represents more of a pilot phase because effectiveness is the main outcome (Collins et al., 2007). The authors state that MOST is a perspective rather than a procedure, which allows the potential of a high degree of subjectivity when assessing the value and suitability of intervention components.

The MOST and SMART approaches have been proposed as an ideal way of testing, refining, and delivering electronic BCIs (Collins et al., 2007). One benefit of electronic delivery is that it allows for complex factorial designs where several different versions of an intervention can be tested without huge expense. The SMART procedure is designed to help with the final refining stage of MOST and allows for tailoring of intervention and delivery components, and multiple randomisation stages nested within one trial based on participant behaviour/characteristics (Collins et al., 2007). This is a great way of individualising intervention delivery, but makes data analysis potentially very difficult. Overall the MOST and SMART methods present a useful outline to design and deliver tailored BCIs, which have been tested and refined extensively before a full trial. However, the approach lacks detail on theory, choosing intervention components, and a coherent structure to bring all the elements of intervention design together.

2.3.2. The Behaviour Change Wheel (BCW), COM-B and the TDF.

The BCW is a behaviour change intervention design framework developed from systematic theory and evidence synthesis (Michie et al., 2014; Michie et al., 2011). The BCW provides a more comprehensive and systematic version of the guidance in the first part of the MRC guidelines and steps 2 and 3 of IM, and is most applicable to individual-level interventions (Michie et al., 2011). This process of intervention design contains eight steps, of which four concentrate on behavioural diagnosis which is central to the BCW. These first steps involve defining, selecting, and specifying the target behaviour, before clearly outlining what needs to change (Michie et al., 2014). The authors recommended concentrating intervention effort on changing one (or at most a few) behaviour(s).

The BCW was formulated from summarising 19 previous frameworks involving intervention design principles, including MINDSPACE and IM, alongside taxonomy-based frameworks such as the EPOC taxonomy of interventions (Cochrane Effective Practice and Organisation of Care Group, 2010). One of the key contributions of the BCW was the introduction of a new system of behaviour referred to as the COM-B model (Michie et al., 2011). The COM-B postulates that the motivation to perform (or not) a behaviour must be stronger than the motivation to carry on as before or engage in a competing behaviour. Motivation can be reflective (e.g. intending to change a behaviour) and/or automatic (e.g. habitual enacting of the behaviour), and is influenced by an individual's Capability and Opportunity specific to that behaviour (Michie et al., 2011). Capability can be psychological (e.g. knowledge of the behaviour) and/or physical (e.g. having the skills to perform the behaviour). Opportunity can be social (e.g. having support for the behaviour from friends or family) and/or physical (e.g. living in a location conducive to the behaviour). The COM-B plays a crucial role in determining what needs to be addressed for the person to change their behaviour and was developed around the same time as the second iteration of the Theoretical Domains Framework (TDF; Cane, O'Connor, & Michie, 2012).

The most recent TDF has been mapped on to the COM-B and provides further detail on the behavioural determinants that might encompass Capability, Opportunity, and

Motivation (Cane et al., 2012). The original TDF was formulated by a comprehensive expert consensus group of psychological theorists, health service researchers, and health psychologists (Michie, Johnston, Abraham, Lawton, Parker, & Walker, 2005). Through a multi-stage consensus approach, this group identified and synthesised 33 theories and 128 theoretical constructs into 12 domains: Knowledge; Skills; Social/Professional role & identity; Beliefs about capabilities; Beliefs about consequences; Motivation and goals; Memory, attention and decision processes; Environmental context and resources; Social influences; Emotion regulation; Behavioural regulation; Nature of behaviour (Michie et al., 2005). A further refinement, using a stronger evidence base, was then conducted which produced a final 14-domain framework, containing 84 component constructs. The 2012 TDF, removed the domain Nature of behaviour, added Optimism and Reinforcement domains, and divided the original Motivations and goals domain into separate Intentions and Goals domains.

The revised 14 domains (with number of components per domain in brackets) were: Knowledge (3); Skills (7); Memory, attention and decision processes (5); Behavioural regulation (3); Social influences (11); Environmental context and resources (6); Social/Professional role & identity (9); Beliefs about capabilities (8); Optimism (4); Beliefs about consequences (5); Intentions (3); Goals (6); Reinforcement (7); Emotions (7) (Cane et al., 2012). These 14 domains can be thought of as barriers or facilitators for behaviour. Many studies use the TDF and COM-B to study the target population during the phase of intervention or programme development (in line with step 4 of the BCW). For example, Capability includes the domains of Knowledge, Skills, and Behavioural regulation, Opportunity includes Social influences and Environmental context and resources, and Motivation includes Intentions, Goals, and Optimism (Cane et al., 2012). Recent research examples include studying the barriers and facilitators to managing diabetes in people with severe mental illness (Mulligan et al., 2018) and from the perspective of healthcare professionals caring for these individuals (McBain et al., 2016). Such a wide, evidence-based range of behavioural facilitators and barriers helps intervention designers tailor approaches to the target population and the TDF has recently been featured as a layer within the BCW.

An additional important contribution of the BCW was to outline clearly specified intervention functions and policy categories based on previous frameworks (Michie et al., 2011). Intervention functions include: Education; Persuasion; Incentivisation; Coercion: Training; Restriction; Environmental restructuring; Modelling; Enablement. Policy categories include: Communication/marketing; Guidelines; Fiscal; Regulation; Legislation; Environmental/social planning; Service provision. Once intervention designers have determined what needs to change for the target population, they then map the most appropriate intervention functions and policy categories to influence these changes. Some interventions, particularly at the individual level, may not have the capacity to change policy (e.g. fiscal measures or regulations) and so it may only appropriate to select intervention functions. The penultimate step is to choose behaviour change techniques (BCT) that map onto the specified intervention functions and behaviour constructs. The best way to complete this process is to determine BCTs which are most likely to influence the TDF domains already identified using a published mapping approach (Cane, Richardson, Johnston, Ladha, & Michie, 2015; Michie et al., 2014). BCT taxonomies allow a systematic method of describing interventions in terms of the fine-grain components which are utilised to change behaviour (Michie et al., 2013).

The first iteration of a BCT taxonomy, coded from papers in published systematic reviews, detailed 26 BCTs and included techniques such as ‘provide information on consequences’ and ‘relapse prevention’ (Abraham & Michie, 2008). Further iterations of the BCT taxonomy sought to widen the range of BCTs, improve the reliability of the original taxonomy, and target particular behaviours. This led to refined taxonomies for healthy eating and physical activity (Michie, Ashford, Sniehotta, Dombrowski, Bishop, & French, 2011), smoking cessation (Michie, Hyder, Walia, & West, 2011), alcohol consumption (Michie, Whittington, Hamoudi, Zarnari, Tober, & West, 2012), and condom use (Abraham, Good, Warren, Huedo-Medina, & Johnson, 2011). As an example, the CALO-RE taxonomy increased the original BCT pool from 26 to 40 items, all aimed at changing eating and physical activity behaviour (Michie et al., 2011). CALO-RE retained some of the original BCTs (e.g. provide feedback on performance) and divided other BCTs into more than one that were more specific (e.g. prompt specific goal setting became goal setting behaviour and goal setting outcome). However, when applied to systematic review coding, there was still room for improvement (Martin, Chater, & Lorencatto, 2013).

This taxonomy development work culminated in the publication of a 93-item taxonomy which is applicable to all behaviours (Michie et al., 2013). Despite this being the most comprehensive taxonomy to date, recent research shows that there may be many more techniques still to add, particularly in relation to communication methods such as motivational interviewing. In the current taxonomy intervention/delivery methods such as motivational interviewing are contained within one umbrella BCT (social support [unspecified]). Recent research suggests that motivational interviewing may contain up to 38 BCTs, of which only 16 are considered similar to BCTs from the current taxonomy (Hardcastle, Fortier, Blake, & Hagger, 2017). Other techniques like enhancing positive affect and signposting opportunities are also missing.

The final step in the BCW intervention framework is to determine an appropriate mode of delivery (Michie et al., 2014). The options range from face-to-face to a range of media (e.g. internet, TV, billboard, leaflets). A taxonomy of delivery modes will soon be published that more systematically details different options in this area. The BCW guide book also introduces APEASE as a way of considering the Affordability, Practicability, Effectiveness (including cost), Acceptability, Side effects/safety, and Equity of any decision about intervention components throughout the steps (Michie et al., 2014). The APEASE criteria may also function as part of evaluating any BCI as it overlaps with many evaluation frameworks such as RE-AIM (Glasgow et al., 1999), which will be examined below.

The BCW provides a clear framework to design BCIs but starts with the assumption that a behaviour needs to change, and therefore misses the initial needs/epidemiology/social assessment stage contained within other models such as IM. At the other end of the BCI process, the BCW does not direct intervention designers on evaluation. The importance of a clearly defined system of intervention design cannot be overstated, and the ongoing Human Behaviour Change project will provide intervention designers with key information on ‘what intervention(s) work, compared with what, how well, with what exposure, with what behaviours, for how long, for whom, in what settings and why’ (Michie et al., 2017). The BCW provides intervention designers with step-by-step instructions that can be transparently reported. The development of a comprehensive BCT taxonomy in particular has helped to improve designing and reporting of interventions.

2.4. Delivery method

Alongside the mode of delivery (e.g. printed materials and/or face-to-face consultations), the delivery method or communication style of the intervention deliverer is important. Evidence suggests that client-centred approaches that involve open-ended questions and reflective listening are more effective than traditional advice-giving approaches that are more prescriptive (Rubak, Sandbaek, Lauritzen, & Christesen, 2005). Deliverers can be effectively trained in these types of 'healthy conversation skills' so that client-centred techniques, that allow for more autonomy, are embedded in delivery practices going forward (Lawrence et al., 2016). The most utilised and evaluated of these methods in motivational interviewing (MI), which helps people change their behaviour by exploring and resolving ambivalence (Rollnick & Miller, 1995). MI is effective in changing physical activity in disadvantaged communities, with those attending two or more MI sessions enacting greater change (Hardcastle, Blake, & Hagger, 2012). Meta-analytic evidence also shows that MI is effective in promoting greater physical activity levels in adults with chronic conditions (O'Halloran et al., 2014). Essentially, MI interventions that had greater fidelity were more effective (O'Halloran et al., 2014), highlighting the importance of ensuring appropriate skills of those responsible for intervention delivery.

2.5. Evaluation Frameworks

2.5.1. Reach, Efficacy – Adoption, Implementation, Maintenance (RE-AIM).

RE-AIM is a framework for evaluating health promotion interventions and promotes a broader range of evaluation than just efficacy or effectiveness (Glasgow et al., 1999). The authors argue that too much focus is placed on RCT trials which have unrealistic levels of money and support for resources, which do not reflect real-world service delivery (Glasgow et al., 1999). It is proposed that interventions which initially show low efficacy but have realistic utilisation of resources, such as health professional time, may end up being more translatable in routine practice and therefore more successful eventually. The RE-AIM framework considers evaluation across five domains: Reach; Efficacy; Adoption; Implementation; Maintenance.

- Reach is primarily evaluated at the individual level and assesses how many of the intended recipients participated and how representative of the population they are.
- Efficacy, also at the individual level, is judged both in terms of positive and negative impacts, and recommends a range of outcomes including changes in behaviour and quality of life.

- Adoption is more focussed at the level of the organisation and is comparable to reach. Adoption measures how many intended settings adopted the programme and how representative they are of all that were offered it.
- Implementation, also at the level of organisation, is focussed on the real-world application of a health promotion programme, such as when the programme was tested in practice was it delivered as intended. The recommended time over which to collect this data is 6-12 months.
- The last domain of maintenance operates at both individual and organisational levels. The idea is to assess whether individuals maintain changes in behaviour and whether the programme is adopted over the long term by becoming regular practice/treatment as usual. The recommended time over which to collect this data is at least 24 months.

Cost effectiveness is not explicitly included as its own domain but it is acknowledged that it is unlikely that a programme that was not cost-effective would achieve adequate adoption, implementation, and maintenance (Glasgow et al., 1999). Using these five domains also allows for the plotting of different interventions against each other. The example given by the authors shows a high cost/intensity intervention achieving higher efficacy than a low cost/intensity comparison, but scoring lower on the other four components (Glasgow et al., 1999). Methods of evaluation and subsequent reporting of interventions are critical for evidence synthesis and linking effectiveness with the most 'active' components of different approaches.

2.6. Reporting guidelines

The systemisation of reporting guidelines using expert consensus has been a fundamental breakthrough in research reporting standards. The vast majority of high-quality journals have helped in this transition by making the reporting of studies using appropriate guidelines a mandatory part of submission. This section summarises the most relevant guidelines for reporting behaviour change interventions.

2.6.1. Enhancing the QUAlity and Transparency Of Health Research (EQUATOR).

EQUATOR (n.d.) is an international network collaborating to improve the quality of the reporting of published health research. The network acts as a hub to bring together the latest and most robust reporting guidelines to ensure quality and consistency in reporting. The main resource is the EQUATOR website which contains links to a wide range of guidelines including for RCTs, systematic reviews, observational studies, and qualitative research. The clear and detailed reporting of health research is essential if effective (and ineffective) approaches are to be understood, synthesised in evidence reviews, replicated in other contexts, and scaled up (or avoided).

2.6.2. Consolidated Standards of Reporting Trials (CONSORT).

RCTs are considered the gold standard for evidence-based medicine (Hassan, Noor, Mouaz, & Fares, 2016). CONSORT aims to improve the reporting of RCTs as they are, in most cases, the optimal method for evaluating interventions (Moher et al., 2010). There is a protocol equivalent which is the Standard Protocol Items: Recommendations for Intervention Trials (SPIRIT; Chan et al., 2013). A multitude of reporting in published papers includes only vague details of design (e.g. allocation concealment), outcomes (e.g. selective reporting), and evaluation (e.g. missing data) (Moher et al., 2010). A related tool from Cochrane is the risk of bias (ROB; Higgins et al., 2011) tool which is designed to appraise the extent to which these sorts of factors were either not completed or not reported properly.

The CONSORT checklist has 25 items which must be reported across the title (1 item), introduction (1 item), method (10 items), results (7 items), discussion (3 items), and additional information (3 items). Several of these items have multiple parts. There is also a recently updated CONSORT-SPI specifically for social and psychological (and behavioural) interventions, which extends nine of the original 25 items to be more appropriate for these types of interventions (Montgomery et al., 2018). The one big omission from the original CONSORT was that there was only one item covering intervention description. Item 5 states that authors should report 'The interventions for each group with sufficient details to allow replication, including how and when they were actually administered' (Moher et al., 2010, p. e4). The updated CONSORT-SPI breaks item 5 into fidelity, materials, and allocation but this is still an inadequate level of detail for complex health interventions.

2.6.3. Template for Intervention Description and Replication (TIDieR).

TIDieR (Hoffman et al., 2014) was designed to provide clearer and more detailed information than the relatively sparse requirement from item 5 in CONSORT and item 11 in the closely aligned SPIRIT guidelines. The TIDieR checklist contains 12 items covering the name of the intervention (with clear description of the intervention), why (theory, rationale), what (materials), what (procedure), who provided (delivers), how (mode(s) of delivery), where (setting), when and how much (frequency and dose), tailoring, modifications (from the intended protocol), how well (planned assessment of adherence and fidelity), how well (actual assessment of adherence and fidelity) (Hoffman et al., 2014). The list is primarily used to describe adequate detail of an intervention or health programme prior (protocol) and/or after it is evaluated, and enables replication. Publishing protocols is becoming much more common practice and allows for greater detail in methods to be published alongside the main trial results. This has the potential to prevent things such as incomplete and selective outcome reporting. TIDieR can also be used to summarise information from systematic reviews (Hoffman et al., 2017) to look at the quality of reporting across interventions.

2.6.4. Transparent Reporting of Evaluation with Non-randomised Designs (TREND).

Although RCTs can often represent the gold standard of research evidence, they are not always feasible, practical, or ethical in public health research (Victora, Habicht, & Bryce, 2004). Therefore, other non-randomised designs such as quasi-experimental evaluations can be the best approach and the standard of reporting is still of paramount importance. This is so that public health policy makers and commissioners can still appraise the evidence and evidence synthesis attempts are still useful when incorporating this type of study. TREND (Des Jarlais et al., 2004) is a checklist for the reporting of non-randomised evaluations of behavioural and public health interventions. TREND contains 22 items covering the title and abstract (1 item), introduction (1 item), method (9 items), results (8 items), and discussion (3 items).

2.6.5. Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA (P)).

In addition to the importance of reporting in trials and evaluations of health interventions, the detail given in evidence synthesis such as systematic reviews and meta-analyses is crucial for commissioners, policy makers, and for future intervention design. This led to the PRISMA (Moher, Liberati, Tezlaff, Altman, & the PRISMA Group, 2009). There is also an adapted version for protocols called the PRISMA-P (Shamseer et al., 2015). Publishing protocols for systematic reviews can help to avoid some of the same pitfalls as trials such as selective reporting and including analysis that was completed post-hoc (e.g. subgroup analysis that was not pre-planned) (Moher, Stewart, & Shekelle, 2016). PRISMA contains 27 items covering the title (1 item), abstract (1 item), introduction (2 items), method (12 items), results (7 items), and discussion (3 items), and funding (1 item). Several of these items have multiple parts. PRISMA-P contains 17 items closely aligned to producing a fully PRISMA-compliant published review in the future. Like the CONSORT guidelines, most reputable journals have made submission of reviews and protocols complying with these guidelines a mandatory requirement.

2.7. The way forward

Intervention designers now have a wealth of frameworks, guidelines, and models to use to design, deliver, evaluate, and report BCIs. The MRC guidelines provide an ideal overview of the best approach to complex interventions, from identifying the existing literature all the way to implementation in ‘real-world’ settings. The NICE guidelines provide guidance specific to BCIs at the individual level and highlight the COM-B as a model to conceptualise behaviour and what needs to change. NICE also recommends a person-centred communication style for delivery and specifying intervention content using BCTs. All of the design frameworks specify an assessment such as an epidemiological (PRECEDE-PROCEED; Porter, 2016) or needs assessment (IM; Kok et al., 2004). The BCW has the advantage of having COM-B at the centre and specifies a four-stage behavioural diagnosis, with clear specification of intervention functions and policy categories (Michie et al., 2014). The BCW also has the advantage of linking the TDF and BCTs to elements of the COM-B that warrant changing while also taking in to account aspects of APEASE. Motivational interviewing is an effective delivery style to facilitate changes in physical activity. The RE-AIM evaluation framework is the most comprehensive way to judge the ‘success’ of a BCI (Glasgow et al., 1999). Finally, reporting guidelines should be utilised to clearly lay out the intervention content, with TIDieR (Hoffman et al., 2014) a key tool to enhance reproducibility.

This summary points to a multi-stage intervention process combining what are considered to be the best elements of the guidelines and frameworks. Stage 1 is a needs assessment of the health problem (and wider system issues if applicable) in line with PRECEDE-PROCEED and IM. Stage 2 is a systematic review of the literature to explore how this health problem has been addressed and which approaches are effective (in line with the initial stage of the MRC guidelines). A pre-registered protocol (including initial registration on International Prospective Register of Systematic Reviews; PROSPERO), and full review paper should be published using the PRISMA guidelines (Moher et al., 2009; Shamseer et al., 2014). Stage 3 is a behavioural diagnosis in line with the BCW and COM-B (define the problem in behavioural terms, select target behaviour, specify the target behaviour, identifying what needs to change). The MRC also recommends identifying and developing a theory and therefore overlaps in particular with the fourth part of behavioural diagnosis from the BCW. The COM-B and TDF are the best theories with which to develop a conceptualisation of what needs to change for the target behaviour and population.

Stage 4 continues with the BCW to pick appropriate intervention functions (and policy categories if applicable) and related BCTs to address the change objectives identified in the previous stage (Michie et al., 2014). The design, development, and outcomes should be pre-registered in a published protocol and a trial database (if applicable). Stage 5 involves choosing an appropriate delivery method, such as MI, and training the deliverers in this style. Stage 6 is feasibility testing to explore issues such as acceptability, compliance, recruitment, and delivery in line with the MRC guidelines (Craig et al., 2008). Stage 7 involves delivering the BCI in a full scale trial with a relevant design such as RCT, quasi-experimental, or observational design. Stage 8 is a comprehensive evaluation using a combination of the RE-AIM framework (with aspects of APEASE) and MRC guidelines. RE-AIM examines a range of outcomes (over and above efficacy) and the MRC specifies process evaluation and cost-effectiveness analysis. The final stage 9 is focussed on dissemination through academic channels and through talks and lay summaries to relevant organisations. Reporting in outcome papers should use the respective guidelines and TIDieR should be used for any BCI. Depending on the context of the BCI, a further stage of adoption, rolling out, or scaling up could follow after dissemination of a more research-orientated trial.

The Active Herts programme presented in this thesis managed the majority of these stages, with some steps omitted due to limitations in funding and resources (feasibility testing), and some still to be completed and beyond the scope of this thesis (cost-effectiveness and full external process evaluation). Chapter 3 presents a needs assessment at the national level in terms of physical activity and sedentary behaviour (stage 1). The national level needs assessment also forms part of the behavioural diagnosis by exploring what needs to change. A local level needs assessment is also contained in Study 4 for the areas involved in Active Herts. A systematic review is then presented in Study 1 (stage 2), which includes analysis of the BCTs that are most likely to be effective for increasing physical activity with inactive adults. Study 2 and 3 then identify and develop the COM-B theory and TDF to explore which factors drive physical activity and sitting (stage 3). Appropriate BCTs are chosen from the systematic review and are specified in Study 4 (stage 4).

Training in MI and ongoing fidelity checks are summarised in Study 4 (stage 5). Feasibility (stage 6) was the main stage that was not possible due to pragmatic limitations in funding and timeline. Study 5 does, however, summarise improvements that have been made to the Active Herts programme due to feedback from various stakeholders. The evaluation of Active Herts adopted a pragmatic research perspective, whereby, a mixed-methods approach was seen as best suited to answer the issue of whether the programme worked and how the experience of the deliverers impacted on the programme. The Active Herts programme was delivered (stage 7) and interim two-year outcomes are reported in Study 4 (stage 8). Although the evaluation did not adopt the full RE-AIM framework, this thesis does evaluate the primary and secondary outcomes, and underlying change processes. The outcomes and processes from a COM-B perspective (Study 4) and the views of the Get Active Specialists (Study 5), provide information about what worked well (or not) and why (stage 8). Parallel analysis from colleagues at UEA will provide a multi-layered process evaluation and cost-effectiveness analysis. In terms of dissemination (stage 9), the review protocol (PRISMA-P; Howlett, Trivedi, Troop, & Chater, 2015a), COM-B theory analysis (COM-B, TDF; Howlett, Schulz, Trivedi, Troop, & Chater, 2017), full review (PRISMA, TIDieR, BCTs; Howlett, Trivedi, Troop, & Chater, 2018), and Active Herts protocol (TREND, TIDieR, BCTs, COM-B; Howlett, Jones, Bain, & Chater, 2017), have all been published using the intervention design principles, theory, and appropriate reporting guidelines covered in this chapter.

The next chapter presents an assessment of the estimates of national levels of physical activity and sedentary behaviour (stage 1), the related health risks associated with these levels, and the guidelines currently available.

Chapter 3

Needs Assessment

The UK guidelines for adults recommend at least 150 minutes per week of moderate-intensity physical activity and/or 75 minutes of vigorous-intensity physical activity, in bouts of at least 10 minutes at a time, alongside two or more days per week of muscle strengthening exercises (Bull et al., 2010). The latest guidelines from the United States recommend that adults should do at least 150 to 300 minutes of moderate-intensity physical activity or 75 to 150 minutes of vigorous-intensity physical activity, with anything above 300 minutes of moderate providing additional health benefits (U.S. Department of Health and Human Services, 2018). This chapter summarises estimates of UK (and comparative international) levels of physical activity and sitting, reviews the health risks associated with these behaviours (or lack of), and then explores the national guidelines for both behaviours.

3.1. Estimates of physical activity and sedentary behaviour

In England, 66% of men and 58% of women self-report participating in the recommended weekly levels of 150 minutes of moderate-to-vigorous physical activity (NHS Health and Social Care Information Centre, 2018), which is higher than the overall figures of 50% from the US (Centre for Disease Control and Prevention), and 56% in Australia (Australian Bureau of Statistics, 2015). Men in England also report spending 4.9 hours every day being sedentary during the week and 5.4 hours every day being sedentary during the weekend. This includes activities such as TV watching, other screen time, and reading. The corresponding figures for women are 4.7 and 5.1 hours respectively (Health and Social Care Information Centre, 2014). Objective measurements suggest this may well be an underestimation, with cohort studies showing an average of 10.3 in adults (Henson et al., 2013), and between 10.5 (Chastin et al., 2018) and 11.4 hours a day in older adults (Hajna et al., 2018), all in the UK.

The Active People Survey from Sport England asks specifically about sporting participation and in 2014-15 found that only 36% of adults (41% of men and 31% of women) take part in sport once a week, with the figure decreasing to 18% for sporting participation on three or more occasions. In the four weeks prior to the survey 57% reported no sporting participation. Physical fitness correlates with self-reported physical activity and figures from 2008 show that 32% of men and 60% of women were not fit enough to consistently walk at 3mph on a 5% incline (Health Survey for England, 2008). Only 34% of men and 24% of women meet the guideline of completing two or more days per week of muscle-strengthening exercises, and half of respondents reported none at all in the four weeks prior to the survey (Health Survey for England, 2012).

The vast majority of these data was self-reported (e.g. via questionnaire), which allows for population-level figures to be collected cheaply without much burden on respondents, but also means that it could be an inaccurate reflection of people's actual behaviour. For example, self-reported physical activity can often be over-reported when compared to objective measures such as an accelerometer, by rates of 36-173% (Lee, Macfarlane, Lam, & Stewart, 2011). Also, correlations between physical activity that is self-reported and objectively-measured are in the small-to-moderate range from .09 to .39 when comparing the International Physical Activity Questionnaire (IPAQ) to accelerometers (Lee et al., 2011). The range of correlations is even more inconsistent when using a wider range of comparison measures (-.71 to .96; Prince et al., 2008). Self-report physical activity measures have inherent problems with reporting and recall biases. This inconsistency is reflected in objectively-measured data from 2008 in the UK that shows much lower levels than self-reported participation - just 6% of men and 4% of women performed the recommended amount (Health and Social Care Information Centre, 2014). There is a need to objectively measure population levels of physical activity more often, to provide a more accurate current picture, but these data also have limitations.

Objective measures can capture physical activity using pedometers or accelerometers, activity intensity using heart-rate monitors, or outcomes of physical activity, such fitness using the VO2 max test, but these options also have inherent flaws and rely on people wearing them constantly. Pedometers can vary in accuracy depending on the waist circumference of the person wearing it, do not accurately distinguish between different intensities, and cannot record certain activities such as cycling (Pomeroy et al., 2011). Accelerometers present limitations such as not capturing the increased expenditure of energy for walking or running up an incline or stairs, and also struggle to capture certain activities such as weight lifting and cycling (Trost & O'Neil, 2014). Many objective measures have not been waterproof until relatively recently, which also prevented capture of activities such as swimming. There is no ideal way of measuring physical activity, but streamlining the way in which these data are measured and reported would go a long way to help researchers and policy makers to interpret a range of findings more easily (Autier & Pizot, 2016). Despite the limitations of measurement approaches, much research has sought to explore the potential health and social burden of low levels of physical activity and high levels of sedentary behaviour.

3.2. Physical activity, sedentary behaviour, and health

The WHO (2010) estimate that physical inactivity (defined as an absence of physical activity or exercise) is responsible for 6% of deaths globally, making it the fourth leading risk factor for mortality world-wide. Participating in 150 minutes per week of vigorous-intensity physical activity is related to better survival rates and better physical and cognitive health in older age (Almeida et al., 2014). When compared to subjects who did not participate in physical activity, a lower risk of all-cause mortality has been found for those completing regular vigorous-intensity activity (men, 22%; women 31%) and moderately-intensity activity (men, 19%; women 24%) (Löllgen, Böckenhoff, & Knapp, 2009). This study did not, however, capture and account for the duration of these types of activity, which means the results need to be interpreted with caution. Overall, leisure-time physical activity (from walking through to vigorous intensity) of 92 minutes per week, has been associated with a 14% lower risk of mortality and increased life expectancy of three years compared to no activity (Wen et al., 2011).

Participating in either 3 hours of vigorous-intensity physical activity or 4 hours of moderate-intensity physical activity per week, in leisure time, reduces Cardiovascular Disease (CVD) events and CVD mortality rates in older adults when adjusting for CVD risk factors (Barengo, Antikainen, Borodulin, Harald, & Jousilahti, 2016). In a large review of the health impact of physical activity, it was found that across all studies (applying different inactivity criteria) when compared to people categorised as 'unfit/inactive', 'active/fit' people have a lower risk of the following: all-cause mortality (31%); CVD (33%); Stroke (31%); Hypertension (32%); colon cancer (30%); breast cancer (20%); Type 2 diabetes (40%)

(Rhodes, Janssen, Bredin, Warburton, & Bauman, 2017). When assessing aerobic fitness (e.g. through the VO2 max test) the risk is even lower for all-cause mortality (45%), CVD (50%), Stroke (60%); Hypertension (50%), and Type 2 diabetes (50%) (Rhodes et al., 2017). In addition, exercise designed to promote increased muscle mass and strength also provides risk reductions for mortality and cancer independently of physical activity performance (Stamatakis et al., 2017). There is also strong evidence that exercise is an effective treatment for depression (Schuch et al., 2016). These benefits were equivalent to a five point reduction on the HAM-D (Hamilton, 1967) and six point reduction on the BDI (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). This is in excess of the threshold specified by NICE for reductions of clinical significance (NICE 2009).

The beneficial effects of even modest volumes of physical activity on mortality risk have been demonstrated across epidemiological studies (e.g. Wisloff et al., 2006), systematic reviews (Arem et al., 2015; Hupin et al., 2015), and Randomised Controlled Trials (RCT) (e.g. Foulds, Bredin, Charlesworth, Ivey, & Warburton, 2014). Alongside the negative health outcomes related to low physical activity levels, sedentary behaviour could be an independent risk factor for a range of health problems. Sedentary behaviour is related to obesity even after controlling for levels of leisure-time physical activity and diet (Shields & Tremblay, 2008). Daily sitting time is linked to all-cause mortality (Chau et al., 2013) and risk of mortality through CVD (Katzmarzyk, Church, Craig, & Bouchard, 2009), after factoring in physical activity levels. Higher levels of sedentary behaviour are also predictive of insulin resistance (Helmerhorst, Wijndaele, Brage, Wareham, & Ekelund, 2009) and strongly associated with diabetes (Wilmot et al., 2012). The evidence suggests that maintaining appropriate physical activity levels, and limiting long periods of sitting, has short and long-term health benefits.

3.3. Defining activity, inactivity, and sedentary behaviour

A major issue is that the research presented has categorised activity in myriad ways, particularly the notion of inactivity, sometimes inaccurately referred to as being sedentary. Different questionnaires have a multitude of categories and accelerometers often have different algorithms to calculate activity thresholds. The Chief Medical Officer and Sport England have defined being ‘inactive’ as a person that does not regularly exceed 30 minutes per week of moderate-intensity physical activity (Sport England, 2016). The Health Survey for England also has additional categories of ‘some activity’ (60-149 minutes of moderate-intensity physical activity per week) and ‘low activity’ (30-59 minutes of moderate-intensity physical activity per week). Whereas the Sedentary Behavior Research Network Terminology Consensus Project reached an agreement amongst their expert members that ‘physical inactivity’ is defined as anyone not meeting the current physical activity guidelines (Tremblay et al., 2017).

A more consistent use of labels/categories is needed going forward so that evidence can be synthesised and interpreted more efficiently (Stamakis et al., 2018). There is a growing body of research and expert consensus suggesting that inactivity and sedentary behaviour may be different constructs (Tremblay et al., 2017; van der Ploeg & Hillsdon, 2017). One can be highly active and highly sedentary by spending the vast majority of their awake hours sitting but still complete 150 minutes of moderate activity throughout the week. Sedentary behaviour is defined as ‘any waking behavior characterized by an energy expenditure ≤1.5 metabolic equivalents (METs), while in a sitting, reclining or lying posture’ (Tremblay et al., 2017, p. 9).

Unlike the clearly specified physical activity recommendations, there are no firm guidelines or cut offs for acceptable levels of sedentary behaviour – the only recommendation is that people should minimise extended periods of sitting (NHS, n.d.). A later consensus statement from Public Health England recommended that people who work in jobs that require extended sitting time, should try to total at least two hours of standing and light activity during working hours (Buckley et al., 2015). Although a good start, this does not provide definitive detail on leisure time sedentary behaviour, or the recommended amount of time of not sitting that could mitigate the potential risk factors that have been highlighted. This prevents a clear message being communicated about healthy amounts of sedentary behaviour, in line with the clearly prescribed levels outlined in the physical activity recommendations.

One of the main reasons for the lack of clear sedentary behaviour guidelines is that the strength of research is much more limited compared to that of physical activity. The latest narrative review of sedentary behaviour research and recommendations, urges caution on a number of areas due to the evidence base still being relatively weak (Stamakis et al., 2018). The authors suggest that although progress has been made, there is still inconsistent evidence that sedentary behaviour produces additional health problems over and above inactivity (Stamakis et al., 2018). Sedentary behaviour research also too often uses surrogate and/or self-reported outcomes and has a weak epidemiological base for breaking periods of sitting (Stamakis et al., 2018). This leads the review to conclude that until a stronger evidence base is gathered, quantitative guidelines on sitting would not be appropriate (Stamakis et al., 2018).

3.4. Conclusion

Overall, men in England are both more active and more sedentary than women. Both men and women in England are at risk of a range of negative health consequences due to inactive and sedentary lifestyles. The evidence presented in this chapter shows that the definitions and guidelines for being 'inactive' and 'sedentary', and the measurement and reporting of both physical activity and sedentary behaviour need to be more streamlined. For the rest of this thesis, adults participating in less than the recommended amount of physical activity will be defined as inactive, in line with the latest expert consensus project (Tremblay et al., 2017). The next chapter (Study 1) reviews the literature between 1990 and 2016, to explore the potential effectiveness, key components, and reporting of RCTs of physical activity and sedentary behaviour interventions, using healthy inactive adults. Changing the behaviour of this population is key in preventing future illness, disability, and premature mortality.

Chapter 4

Study 1: A systematic review and meta-analysis of physical activity and sedentary behaviour interventions

This chapter has been published as: Howlett, N., Trivedi, D., Troop, N. A., & Chater, A. M. (2018). Are physical activity interventions for inactive adults effective in promoting behavior change and maintenance, and which behavior change techniques are effective? A systematic review and meta-analysis. *Translational Behavioral Medicine*.

4.1. Introduction

Physical activity has a beneficial effect on the risk factors associated with cardiovascular disease, stroke, type 2 diabetes, and cancer (Rhodes et al., 2017). When compared to individuals who participate in low levels of physical activity, highly active and moderately active people have a reduced risk of all-cause mortality (Löllgen et al., 2009). However, only 66% of men and 58% of women in England, meet the recommended levels of 150 minutes per week of moderate to vigorous physical activity (NHS Health and Social Care Information Centre, 2018). Inactive adults (those not meeting the recommended levels), even if they are currently healthy, are therefore a key target for intervention as they may be at risk of developing ill health without long-term lifestyle change. This review also includes interventions aimed at reducing sedentary behaviour as high levels are associated with a range of risk factors independently of physical activity levels (Chau et al., 2013).

While previous reviews exist for physical activity interventions, they have combined inactive and active populations (Conn, Hafdahl, & Mehr, 2011) or summarised highly heterogeneous samples (e.g. those living with diabetes and pregnant women, Martin et al., 2015), or combined healthy and unhealthy adults (Gardner, Smith, Lorencatto, Hamer, & Biddle. 2015). The importance of physical activity as a primary preventative approach for healthy adults has long been acknowledged (Harris, Caspersen, & Defriese, 1989). Individuals not currently engaging in physical activity, nor presenting with ill-health may not have experienced a ‘teachable moment’ or any cause for concern for their health that would act as a catalyst for change (Epiphaniou & Ogden, 2010; Rosenstock, 1974). Consequently, despite a proliferation in reviews of physical activity interventions, there has been no systematic review of interventions targeting *healthy* and *inactive* adults. The biggest reductions in future health problems are often seen when moving people from inactive to moderately active lifestyles (Rhodes et al., 2017). Therefore, healthy adults, who may not yet be suffering the effects of inactivity, represent a key target population for public health prevention efforts.

Behavioural science highlights the need to draw an important distinction between initial behaviour change and behaviour change maintenance, which is reportedly harder to achieve (Kwasnicka, Dombrowski, White, & Sniehotta, 2016). A number of reviews that have attempted to analyse longer-term outcomes have not specified a minimum post-intervention follow-up period [Martin et al., 2015; Müller-Riemenschneider, Reinhold, Nocon, & Willich, 2008; Orrow, Kinmonth, Sanderson, & Sutton, 2012). Therefore, the majority of reviewed studies, despite being 12 or more months in duration, only captured facilitated behaviour change (i.e. directly after active components are completed). Maintenance is hypothesised to occur at a minimum of 6 months after initial behaviour change (Prochaska & Di Clememte, 1982). Six-month post-intervention outcomes, where no contact with participants is made, are therefore needed to capture behaviour change maintenance. This is not always clear in the literature, with reviews including studies where active components such as motivational newsletters or phone calls, are still occurring during the 'follow-up' period (e.g. Fjeldsoe, Neuhaus, Winkler, & Eakin, 2011; Martin et al., 2015; Murray, Brennan, French, Patterson, Kee, & Hunter, 2017). This review provides a unique contribution in distinguishing clearly between behaviour change and behaviour change maintenance of physical activity/sedentary behaviour interventions.

Another crucial need is to explore the fine-grain detail of intervention content in an attempt to uncover effective elements. As described in Chapter 2, specifying the active components of an intervention is essential for implementing, replicating, and synthesising successful approaches (Michie et al., 2013). The Behaviour Change Technique (BCT) Taxonomy v1 (Michie et al., 2013) includes 93 items that allow the 'active ingredients' of interventions to be systematically described, reviewed, and replicated. Previous reviews have either failed to identify behaviour change techniques (Pavey et al., 2011) or have analysed BCTs using older less comprehensive taxonomies (Greaves et al., 2011; Murray et al., 2017). In previous taxonomies such as the 40-item CALO-RE taxonomy (Michie et al.,

2011) a number of BCTs were missing and many more were not irreducible (i.e. these BCTs were composites and needed to be further broken down into more basic elements; Martin et al., 2013). As such, using this taxonomy is less likely to provide interventionalists with sufficient information for clear replication. This review was the first in the area of physical activity and sedentary behaviour interventions that aimed to investigate behaviour change and maintenance using the 93 item BCT taxonomy V1 (Michie et al., 2013) in healthy inactive adults.

Finally, to enable replication, intervention designers would benefit from the knowledge of factors such as mode of delivery, duration, frequency, and fidelity (an evaluation of the delivery of the intervention as planned). However, this detail is rarely reported. The 'Template for Intervention Description and Replication' (TIDieR; Hoffman et al., 2014) allows for a systematic description of interventions using a 12-item checklist detailing the why, what, who, where, and how of intervention delivery. The current review provides this additional insight, essential for intervention replication. In summary, this review aimed to fill a number of important evidence gaps. This was the first review to synthesise randomised controlled trials (RCTs) of physical activity and sedentary behaviour interventions for healthy inactive adults. It was also the first review to analyse outcomes in this population, representing both behaviour change (post-intervention) and behaviour change maintenance (follow-up after six months). Finally, it was the first review to provide evidence from these interventions using the BCT Taxonomy v1 and analyse the content against items on the TIDieR checklist. We aimed to answer three research questions:

- Are RCTs of interventions aimed at increasing physical activity or reducing sedentary behaviour in healthy inactive adults effective immediately post intervention (behaviour change), and at a minimum of 6 months post-intervention follow-up (behaviour change maintenance)?
- Which behaviour change techniques are associated with effectiveness at post-intervention and follow-up?
- How often is the fidelity of such interventions checked?

4.1. Methods

The protocol was registered with PROSPERO (registration number: CRD42014014321) and a detailed pre-registered protocol was also published (Howlett et al., 2015a). This review is reported according to the PRISMA guidelines including PICO (Participants, Intervention, Comparisons, Outcomes; Moher et al., 2009).

4.1.1. Eligibility Criteria.

Study characteristics:

1) Participants:
   Healthy adults (aged 18 or older) who were inactive defined as less than 150 minutes of moderate or 75 minutes of vigorous-intensity activity per week (Tremblay et al., 2017), or less than 10000 steps per day. Included studies had a minimum of 70% of participants classified as inactive. Healthy was defined as those without serious injury, long-term physical incapacity, or living with or rehabilitating from chronic conditions and risk factors that require medication.
2) Intervention:
   Any intervention evaluated in an RCT with a primary aim (as stated in the full paper and/or study protocol) to increase physical activity and/or reduce sedentary behaviour. We included all settings (e.g. leisure centre, primary care) and delivery formats (e.g. group, individual).
3) Comparator or control:
   Any passive (e.g. usual care) or active (e.g. alternative behavioural approaches) control group.
4) Outcomes:
   Primary outcomes were self-reported or objectively-measured physical activity and/or sedentary behaviour assessed at baseline and/or post intervention (defined as directly after intervention completion), and a minimum of 6 months after intervention completion. Secondary outcomes, where available, were recorded.

4.1.2. Information Sources.

Searches were conducted in August 2016 on the following electronic databases for the period covering 1 January 1990 to August 2016: Applied Social Sciences Index (ASSIA);

British Nursing Index (BNI); Cumulative Index to Nursing and Allied Health Literature (CINAHL); Cochrane Central Register of Controlled Trials (CENTRAL); Cochrane systematic review database; current controlled trials register; Database of Abstracts of Reviews of Effects (DARE); EMBASE; Health Technology Assessment (HTA) database; National Institute of Health Research (NIHR) portfolio; PsycINFO; PubMed; Scopus; SPORTDiscus; System for Information on Grey Literature (SIGLE); Web of Science. In addition, 18 published systematic reviews (Baker, Francis, Soares, Weightman, & Foster, 2011; Bird, Baker, Mutrie, Ogilvie, Sahlqvist, & Powell, 2013; Dombrowski, Sniehotta, Avenell, Johnston, MacLennan, & Araújo-Soares, 2012; Eakin, Lawler, Vandelanotte, & Owen, 2007; Fjeldsoe et al., 2011; Foster, Hillsdon, Thorogood, Kaur, & Wedatilake, 2005; French, Olander, Chisholm, & McSharry, 2014; Hobbs et al., 2013; Malik, Blake, & Suggs, 2014; Martin et al., 2015; Michie, Abraham, Whittington, McAteer, & Gupta, 2009; Müller-Riemenschneider et al., 2008; Ogilvie et al., 2017; Olander, Fletcher, Williams, Atkinson, Turner, & French, 2013; Orrow et al., 2012; Pavey et al., 2011; Prince, Saunders, Gresty, & Reid, 2014; Short, James, Plotnikoff, & Girgis, 2011) were screened to make sure relevant articles were not missed by the electronic searches. Furthermore, we screened the reference lists of all included studies and requested from experts (e.g. members of European Health Psychology Society) in the field any relevant information on published, unpublished, and ongoing research.

4.1.3. Search Strategy.

Searches included a combination of terms from medical subject headings (MeSH) and keywords in the title, abstract, and text (Appendix A). The search included multiple terms for population (e.g. adult, inactive), intervention (e.g. health promotion, physical activity), comparator (e.g. clinical trial), and outcome themes (e.g. exercise, sedentary behaviour). All terms within each theme were combined with 'OR' and then the four themes were combined with 'AND'.

4.1.4. Study Selection.

Search results were imported into Endnote X7 reference management software and duplicates were removed. Titles and abstracts were screened by NH with a random 10% done independently (NT, first supervisor). Full-texts of potentially relevant studies were assessed independently by two reviewers (NH; NT, first supervisor). Where information was missing or only protocols were available, study authors were contacted for relevant information regarding eligibility criteria. Any disagreements were resolved through discussions with the other reviewers (AC, second supervisor; DT, third supervisor).

4.1.5. Data Extraction.

All data from included studies were extracted into Excel using a pre-piloted data extraction form. Data from each included paper were extracted independently by two reviewers (NH; NT, first supervisor) and included the variables listed in Table 4.1. Ten authors were contacted to request additional outcome data for the meta-analysis and obtained further information from two.

Table 4.1.

Data extraction table including article information, methods, intervention features, and outcomes

Extraction categories	Extraction items
General	author(s); article title; type of publication (e.g. published article); related papers; country of origin; source of funding.
Method	*Design:* aims/objectives of the study; target behaviour(s); study design (including control groups); inclusion and exclusion criteria; recruitment and sampling methods (including unit of randomisation and blinding); unit of allocation; power calculations. *Participants:* population type; inclusion and exclusion criteria; number of participants; age; sex; weight status; ethnicity.
Intervention features	Frequency and length of sessions; intervention duration; intervention setting; intervention provider; delivery format; behaviour change techniques; TIDieR guidelines: theoretical basis.

Outcomes	*Primary outcomes:* unit of measurement; type of measurement (e.g. subjective); follow-up duration, and frequency; mean and standard deviation at baseline, post-intervention, and follow-up; effectiveness at post-intervention and follow-up; effect size; attrition rate. *Secondary outcomes:* adverse effects; effectiveness at post-intervention and follow-up for any of the following (if available): objectively measured health indicators (e.g. BMI), subjective wellbeing (e.g. QOL), self-efficacy and metabolic health (e.g. blood pressure).

4.1.6. Classification of Intervention and Control Condition Content.

Behaviour change techniques were coded as present or absent using the BCT taxonomy v1 for all intervention and active control conditions. Two experienced reviewers (NH; AC, second supervisor) coded all available primary papers, related papers, and protocols for each study independently (as per Martin et al., 2013). The TIDieR checklist describes reporting items that are essential for accurate intervention description and replication. The 12 items on the checklist were coded independently by two reviewers (NH; NT, first supervisor) as either present, absent, unclear, or not applicable. Items 11 and 12 were of particular interest as they cover planned and actual adherence/fidelity assessment respectively. Inter-rater reliability throughout this review was assessed using Krippendorf's α, a reliability coefficient that compares favourably to alternatives (Hayes & Krippendorff, 2007).

4.1.7. Risk of Bias.

Two reviewers (NH; DT, third supervisor) independently assessed risk of bias using the Cochrane tool for assessing risk of bias (ROB, Higgins et al., 2011) in RevMan software. Assessment was performed for the domains of allocation sequence generation and concealment, blinding of participants, personnel and outcome assessors, completeness of outcome data (post-intervention and follow-up), selective reporting of outcomes (if protocol available), and any other potential sources of bias. We assessed ROB as either low, unclear, or high risk.

4.1.8. Quality of the Evidence.

The quality of evidence for primary outcomes was assessed using the Grading of Recommendations Assessment, Development and Evaluation guidelines (GRADE, Guyatt et al., 2011). Assessment was performed for the areas of design, study limitations, consistency, directness, precision, and publication bias. Risk of publication bias was assessed with funnel plots using Stata 14. Grading was assessed for continuous physical activity and sedentary behaviour outcomes at post-intervention and follow-up. Quality of the included studies was judged as high, moderate, low, or very low depending on our confidence that the estimates of the effect were accurate based on the GRADE guidelines (Balshem et al., 2011; Guyatt et al., 2011). RCTs start as high quality but can be downgraded for serious problems on any of the five domains.

4.1.9. Statistical Analysis.

4.1.9.1. Effect sizes**.** As per Cochrane guidelines for the meta-analysis it was assumed that baseline figures were equal between groups based on the RCT design (Higgins, Deeks, & Altman, 2011). Post-intervention and follow-up means, standard deviations, and sample sizes for each condition were analysed to produce standard mean differences (Cohen's *d*), with 95% confidence intervals. This analysis was performed for the studies reporting continuous outcomes (16 out of 26, Aittasalo, Rinne, Pasanen, Kukkoken-Harjula, & Vasankari, 2012; Bélanger-Gravel, Godin, Bilodeau, & Poirer, 2013; Bickmore et al., 2013; Bock, Marcus, Pinot, & Forsyth. 2001; Buman et al., 2001; Chen et al., 1998; Dallow & Anderson, 2003; Hertogh, Vergouwe, Schuit, Peeters, & Monninkhof, 2010; Kolt, Schofield, Kerse, Garrett, & Oliver, 2007; Lewis, Williams, Martinson, Dunsiger, & Marcus, 2013; Napolitano et al., 2006; Nies & Partridge, 2006; Norton, Norton, Lewis, & Dollman, 2011; Opdenacker, Boen, Coorevits, & Delecluse, 2008; Rovniak, Hovell, Wojcik, & Winett, 2005; Van Hoecke, Delecluse, Bogaerts, & Boen, 2014).

4.1.9.2. Synthesis of results. We conducted two meta-analyses using a random effects model in Stata 14 to calculate pooled effect sizes for post-intervention and follow-up physical activity outcomes. Heterogeneity was investigated using Higgins I^2, with heightened levels (over 50% - moderate; over 75% - high) being explored further in subgroup or sensitivity analysis.

4.1.10. Subgroup, Sensitivity, and Additional Analysis.

Pre-planned analysis by subgroups was conducted by type of physical activity measure (self-report vs objective) and targeting single versus multiple behaviours. Sensitivity analysis was completed on the follow-up meta-analysis with and without a study, which produced an effect size different in magnitude from the others. The Cochrane Handbook for Systematic Reviews recommends a minimum of 10 studies in a meta-analysis to conduct meta-regression (see guidance 9.6.4; Higgins & Green, 2011). After meeting this threshold, pre-specified additional analysis was conducted using a set of univariate meta-regression models to examine the association between individual behaviour change techniques (behaviour change techniques had to be present in at least two studies for inclusion), total number of behaviour change techniques, intervention duration, follow-up duration, age, and intervention effectiveness. Pre-specified additional analyses of sedentary behaviour outcomes, mode of delivery, and theoretical basis were not possible due to the small number of studies (sedentary behaviour: $N = 2$) and wide range of approaches across studies respectively. The association between behaviour change techniques and effect size was investigated using regression coefficients (β), with values > .10 in conjunction with an adjusted R^2 of > 10%, indicating an important association (Michie et al., 2009). Due to the large number of univariate meta-regressions there was a risk of false-positive findings. Therefore, we used the Monte Carlo permutation test (10,000 permutations) to calculate adjusted p-values (Higgins & Thompson, 2004).

4.2. Results

4.2.1. Study Selection.

The final review included 26 separate intervention studies (Aittasalo et al., 2012; Annesi, Johnson, Tennant, Porter, & McEwen, 2016: Bélanger-Gravel et al., 2013; Bickmore et al., 2013; Bock, Marcus et al., 2001; Buman et al., 2001; Carels, Darby, Cacciapaglia, & Douglass, 2004; Chen et al., 1998; Dallow & Anderson, 2003; Dzator et al., 2004; Halbert, Silagy, Finucane, Withers, & Hamdorf, 2000; Harland, White, Drinkwater, Chinn, Farr, & Howel, 1999; Hertogh et al., 2010; Jimmy & Martin, 2005; Kolt et al., 2007; Lawton, Rose, Elley, Dowell, Fenton, & Moyes, 2008; Lewis et al., 2013; Marshall, Bauman, Owen, Booth, Crawford, & Marcus, 2004; Mutrie, Carney, Blamey, Crawford, Aitchison, & Whitelaw, 2002; Napolitano et al., 2006; Nies & Partridge, 2006; Norton et al., 2011; Opdenacker et al., 2008;

Rovniak et al., 2005; Steptoe, Doherty, Rink, Kerry, Kendrick, & Hilton, 1999; Van Hoecke et al. 2014) published across 47 papers.

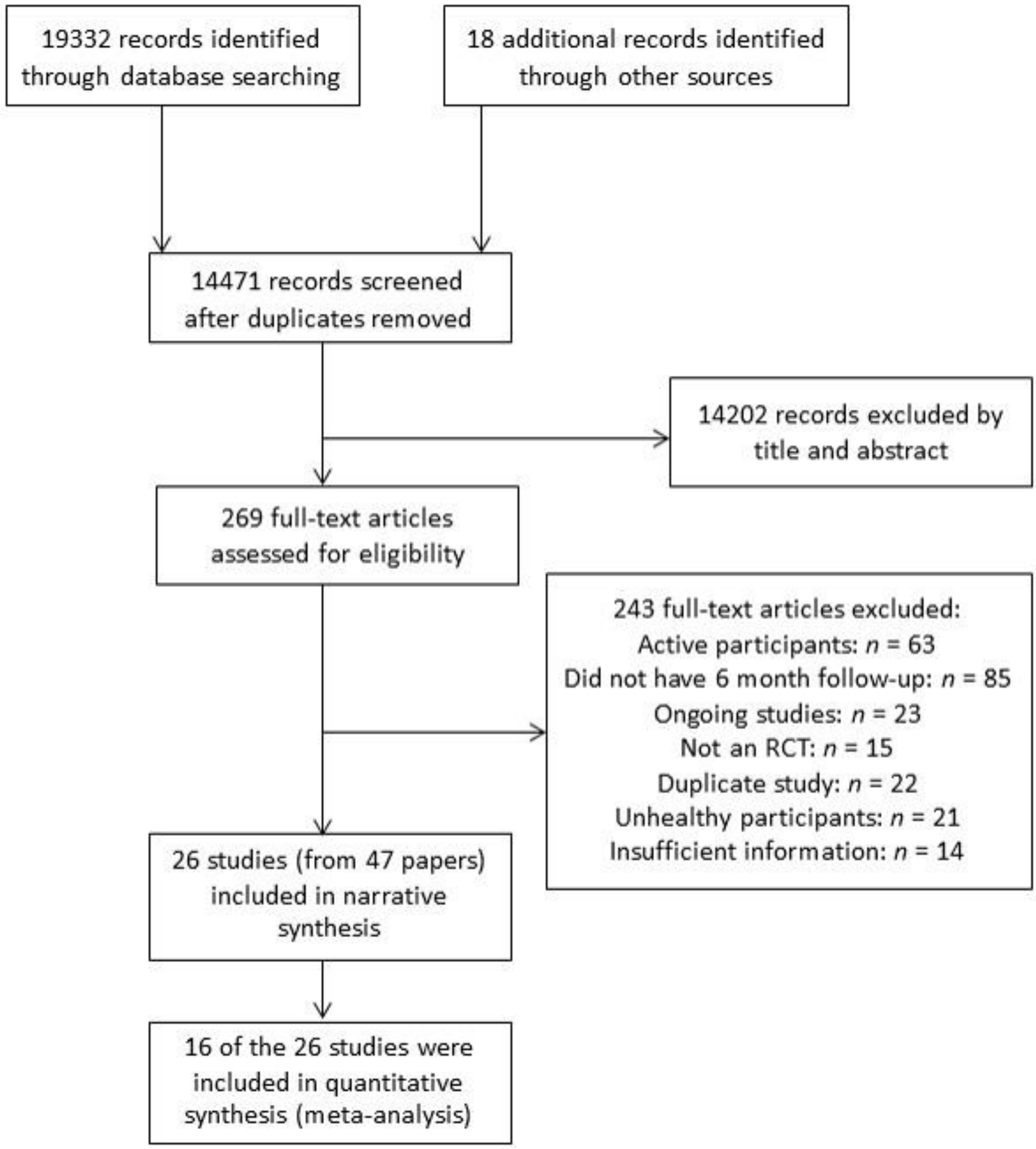

Figure 4.1. PRISMA flowchart

4.2.2. Study and Participant Characteristics.

The country in which the 26 studies were conducted was diverse with the largest number from America (11 studies; Appendix B). The behaviour targeted was physical activity in 20 studies, physical activity and sedentary behaviour in two studies, physical activity and diet in three studies, and physical activity, diet, and smoking in one study. Intervention provider was mixed with the most common involving an instructor or student counsellor (both four studies). Intervention setting was most frequently primary care, an exercise facility/leisure centre, or delivered by post (all five studies). Duration and frequency ranged from receiving a single information pack to 33 individual and group sessions over 14 months. Theoretical basis was highly variable with the Transtheoretical Model (TTM; to be discussed with other theories in Chapter 5) utilised most often (eight studies).

Participants were on average 51.4 years old and mostly women (77%) with an average BMI of 29.2kg/m^2 and 28.9kg/m^2 in intervention and control conditions respectively. Participants in 16/19 studies reporting BMI were overweight. Average sample size was 129 participants for the intervention conditions (3350 total) and 143 for the control conditions (3713 total) at baseline. Only 12 studies reported ethnicity, with nine having a majority of white/Caucasian participants. Average intervention length was 21 weeks (range 0 to 61) and the average length between the intervention finishing and the last follow-up measurement was 41 weeks (range 24 to 121). The attrition rate from baseline to follow-up was 28% in the intervention and 26% in the control conditions. For primary outcomes, 21 studies used a subjective measure, three used a mixture of subjective and objective measures, and two an objective measure only. Both sedentary behaviour measures were self-report.

For secondary outcomes, one study found improvements in physical fitness (post intervention and follow-up), one found post-intervention increases in self-efficacy, one found an intervention effect at follow-up for physical functioning and mental health, and one found an improvement for women only on three subscales of QOL, but a decrease on four other subscales, all at follow-up. Only seven studies reported adverse effects, with three showing some imbalance between groups (two showed increased risk of injury/falls in the intervention condition and one showed more adverse events for controls).

4.2.2.1. Behaviour change techniques. The 26 interventions contained an average of 8.4 behaviour change techniques, with a range between 0-17 and a total of 37 different behaviour change techniques implemented across the interventions (Table 4.2.). The most frequently used behaviour change techniques were ‘Goal setting (behaviour)’ (22 studies) and ‘Social support (unspecified)’ (20 studies). The 19 active control conditions contained an average of 5.1 behaviour change techniques, with a range between 0-15 and a total of 24 behaviour change techniques implemented across the control conditions. The most frequent behaviour change techniques in the active control conditions were ‘Goal setting (behaviour)’ and ‘Information about health consequences’ (both 10 studies). Average inter-rater reliability for the 24 behaviour change techniques coded in more than one study was good (Krippendorf’s α = 0.91, range = 0.58-1.00).

Table 4.2.

BCTs contained in all studies (k = 26) for each condition, with BCTs unique to either condition highlighted in bold italics.

Study ID	Intervention Condition BCTs	Control Condition BCTs
Aittasalo (2012)	***1.1: Goal setting (behaviour)***	No BCTs
	1.2: Problem solving	
	1.4: Action planning	
	2.3: Self-monitoring of behaviour	
	4.1: Instruction on how to perform the behaviour	
	5.1: Information about health consequences	
	7.1: Prompts/cues	
	8.7: Graded tasks	
Annesi (2016)	***1.1: Goal setting (behaviour)***	5.1: Information about health consequences
	1.2: Problem solving	
	1.5: Review behaviour goal	
	1.8: Behavioural contract	
	2.2: Feedback on behaviour	
	3.1: Social support (unspecified)	

	5.1: Information about health consequences ***7.1: Prompts/cues*** ***13.2: Framing/reframing***	
Belanger-Gravel (2013)	1.1: Goal setting (behaviour) ***1.2: Problem solving*** ***1.4: Action planning*** 1.5: Review behaviour goal 2.2: Feedback on behaviour 2.3: Self-monitoring of behaviour 3.1: Social support (unspecified) 5.1: Information about health consequences	1.1: Goal setting (behaviour) 1.5: Review behaviour goal 2.2: Feedback on behaviour 2.3: Self-monitoring of behaviour 3.1: Social support (unspecified) 5.1: Information about health consequences
Bickmore (2013)	***1.1: Goal setting (behaviour)*** ***1.2: Problem solving*** ***1.5: Review behaviour goal*** ***2.2: Feedback on behaviour*** 2.3: Self-monitoring of behaviour ***3.1: Social support (unspecified)*** ***6.1: Demonstration of the behaviour***	2.3: Self-monitoring of behaviour

	9.1: Credible source	
	10.4: Social reward	
Bock (2001)	1.1: Goal setting (behaviour)	1.1: Goal setting (behaviour)
	1.4: Action planning	***1.2: Problem solving***
	2.2: Feedback on behaviour	***4.1: Instruction on how to perform the behaviour***
	3.1: Social support (unspecified)	***5.1: Information about health consequences***
	4.2: Information about antecedents	***9.1: Credible source***
	6.2: Social comparison	10.9: Self-reward
	9.2: Pros and cons	
	10.4: Social reward	
	10.9: Self-reward	
Buman (2011)	***1.1: Goal setting (behaviour)***	2.3: Self-monitoring of behaviour
	1.2: Problem solving	3.1: Social support (unspecified)
	1.4: Action planning	***5.1: Information about health consequences***
	2.3: Self-monitoring of behaviour	8.1: Behavioural practice/rehearsal
	3.1: Social support (unspecified)	
	4.1: Instruction on how to perform the behaviour	
	6.2: Social comparison	

	8.1: Behavioural practice/rehearsal	
Carels (2004)	1.1: Goal setting (behaviour) 1.2: Problem solving 2.3: Self-monitoring of behaviour 2.4: Self-monitoring of outcome(s) of behaviour ***2.5: Monitoring of outcome(s) of behaviour without feedback*** ***11.2: Reduce negative emotions*** ***12.6: Body changes***	1.1: Goal setting (behaviour) 1.2: Problem solving 2.3: Self-monitoring of behaviour 2.4: Self-monitoring of outcome(s) of behaviour
Chen (1998)	***1.1: Goal setting (behaviour)*** ***1.2: Problem solving*** ***1.5: Review behaviour goal*** ***2.2: Feedback on behaviour*** ***3.1: Social support (unspecified)*** 4.1: Instruction on how to perform the behaviour 5.1: Information about health consequences ***9.1: Credible source*** ***15.4: Self-talk***	4.1: Instruction on how to perform the behaviour 5.1: Information about health consequences

Dallow (2003)	1.1: Goal setting (behaviour)	1.1: Goal setting (behaviour)
	1.2: Problem solving	1.4: Action planning
	1.4: Action planning	***2.3: Self-monitoring of behaviour***
	3.1: Social support (unspecified)	3.1: Social support (unspecified)
	4.1: Instruction on how to perform the behaviour	4.1: Instruction on how to perform the behaviour
	5.1: Information about health consequences	8.1: Behavioural practice/rehearsal
	6.1: Demonstration of the behaviour	8.7: Graded tasks
	8.1: Behavioural practice/rehearsal	
	8.7: Graded tasks	
	9.1: Credible source	
	10.9: Self-reward	
	14.7: Reward incompatible behaviour	
Dzator (2004)	1.1: Goal setting (behaviour)	1.1: Goal setting (behaviour)
	1.2: Problem solving	1.2: Problem solving
	1.4: Action planning	1.4: Action planning
	1.5: Review behaviour goal	1.5: Review behaviour goal
	2.2: Feedback on behaviour	***2.1: Monitoring of behaviour by others without feedback***
	2.3: Self-monitoring of behaviour	2.3: Self-monitoring of behaviour

	3.1: Social support (unspecified)	3.1: Social support (unspecified)
	4.1: Instruction on how to perform the behaviour	4.1: Instruction on how to perform the behaviour
	5.1: Information about health consequences	5.1: Information about health consequences
	6.1: Demonstration of the behaviour	8.2: Behaviour substitution
	8.1: Behavioural practice/rehearsal	9.1: Credible source
	8.2: Behaviour substitution	9.2: Pros and cons
	9.1: Credible source	10.4: Social reward
	9.2: Pros and cons	10.9: Self-reward
	10.4: Social reward	11.2: Reduce negative emotions
	10.9: Self-reward	
	11.2: Reduce negative emotions	
Halbert (2000)	***1.1: Goal setting (behaviour)***	No BCTs
	1.2: Problem solving	
	1.4: Action planning	
	1.5: Review behaviour goal	
	2.2: Feedback on behaviour	
	2.3: Self-monitoring of behaviour	
	2.6: Biofeedback	
	4.1: Instruction on how to perform the behaviour	

	5.1: Information about health consequences	
	8.1: Behavioural practice/rehearsal	
	8.7: Graded tasks	
	9.1: Credible source	
Harland (2005)	***1.7: Review outcome goal(s)***	2.2: Feedback on behaviour
	2.2: Feedback on behaviour	2.6: Biofeedback
	2.6: Biofeedback	2.7: Feedback on outcome(s) of behaviour
	2.7: Feedback on outcome(s) of behaviour	5.1: Information about health consequences
	3.1: Social support (unspecified)	
	5.1: Information about health consequences	
	8.1: Behavioural practice/rehearsal	
Hertogh (2010)	***1.1: Goal setting (behaviour)***	No BCTs
	1.4: Action planning	
	2.3: Self-monitoring of behaviour	
	2.4: Self-monitoring of outcome(s) of behaviour	
	2.6: Biofeedback	
	4.1: Instruction on how to perform the behaviour	
	6.1: Demonstration of the behaviour	

	8.1: Behavioural practice/rehearsal ***8.7: Graded tasks*** ***9.1: Credible source***	
Jimmy (2005)	1.1: Goal setting (behaviour) ***1.2: Problem solving*** 1.4: Action planning 2.2: Feedback on behaviour ***3.1: Social support (unspecified)*** 4.1: Instruction on how to perform the behaviour 5.1: Information about health consequences 9.1: Credible source ***9.2: Pros and cons***	1.1: Goal setting (behaviour) 1.4: Action planning 2.2: Feedback on behaviour 4.1: Instruction on how to perform the behaviour 5.1: Information about health consequences 9.1: Credible source
Kolt (2006)	***1.1: Goal setting (behaviour)*** ***1.2: Problem solving*** ***1.4: Action planning*** ***1.5: Review behaviour goal*** ***2.3: Self-monitoring of behaviour,*** ***3.1: Social support (unspecified)***	No BCTs

	4.1: Instruction on how to perform the behaviour	
	5.1: Information about health consequences	
	7.1: Prompts/cues	
	8.1: Behavioural practice/rehearsal	
	8.7: Graded tasks	
	9.1: Credible source	
	9.2: Pros and cons	
	10.4: Social reward	
	10.9: Self-reward	
	13.3: Incompatible beliefs	
Lawton (2008)	***1.1: Goal setting (behaviour)***	No BCTs
	1.2: Problem solving	
	1.4: Action planning	
	1.5: Review behaviour goal	
	2.3: Self-monitoring of behaviour	
	2.6: Biofeedback	
	2.7: Feedback on outcome(s) of behaviour	
	3.1: Social support (unspecified)	
	5.1: Information about health consequences	

	7.1: Prompts/cues	
	9.1: Credible source	
Lewis (2013)	***1.1: Goal setting (behaviour)***	2.3: Self-monitoring of behaviour
	1.2: Problem solving	***11.2: Reduce negative emotions***
	1.4: Action planning	
	2.2: Feedback on behaviour	
	2.3: Self-monitoring of behaviour	
	3.1: Social support (unspecified)	
	4.1: Instruction on how to perform the behaviour	
	4.2: Information about antecedents	
	5.1: Information about health consequences	
	6.2: Social comparison	
	9.2: Pros and cons	
	10.9: Self-reward	
Marshall (2004)[a]	No BCTs reported	No BCTs
Mutrie (2002)	***2.3: Self-monitoring of behaviour***	No BCTs

	4.1: Instruction on how to perform the behaviour ***9.2: Pros and cons***	
Napolitano (2006)	***1.3: Goal setting (outcome)*** ***3.1: Social support (unspecified)*** ***4.2: Information about antecedents*** ***9.2: Pros and cons***	No BCTs
Nies (2006)	1.1: Goal setting (behaviour) ***1.2: Problem solving*** 1.4: Action planning ***3.1: Social support (unspecified)*** ***4.2: Information about antecedents*** 5.1: Information about health consequences	1.1: Goal setting (behaviour) 1.4: Action planning 5.1: Information about health consequences
Norton (2011)	1.1: Goal setting (behaviour) 1.2: Problem solving 1.4: Action planning ***2.1: Monitoring of behaviour by others without feedback*** 2.3: Self-monitoring of behaviour	1.1: Goal setting (behaviour) 1.2: Problem solving 1.4: Action planning 2.3: Self-monitoring of behaviour 3.1: Social support (unspecified)

	2.6: Biofeedback	4.1: Instruction on how to perform the behaviour
	3.1: Social support (unspecified)	4.2: Information about antecedents
	4.1: Instruction on how to perform the behaviour	5.1: Information about health consequences
	4.2: Information about antecedents	8.7: Graded tasks
	5.1: Information about health consequences	
	6.1: Demonstration of the behaviour	
	8.1: Behavioural practice/rehearsal	
	8.7: Graded tasks	
	9.1: Credible source	
Odenpacker	1.1: Goal setting (behaviour)	1.1: Goal setting (behaviour)
(2008)	***1.2: Problem solving***	***1.4: Action planning***
	2.3: Self-monitoring of behaviour	4.1: Instruction on how to perform the behaviour
	2.6: Biofeedback	6.1: Demonstration of the behaviour
	3.1: Social support (unspecified)	8.1: Behavioural practice/rehearsal
	4.1: Instruction on how to perform the behaviour	***8.7: Graded tasks***
	6.1: Demonstration of the behaviour	9.1: Credible source
	8.1: Behavioural practice/rehearsal	
	9.1: Credible source	

Rovniak (2005)	1.1: Goal setting (behaviour)	1.1: Goal setting (behaviour)
	1.2: Problem solving	1.2: Problem solving
	1.4: Action planning	1.5: Review behaviour goal
	1.5: Review behaviour goal	2.2: Feedback on behaviour
	2.2: Feedback on behaviour	2.3: Self-monitoring of behaviour
	2.3: Self-monitoring of behaviour	3.1: Social support (unspecified)
	3.1: Social support (unspecified)	4.1: Instruction on how to perform the behaviour
	4.1: Instruction on how to perform the behaviour	5.1: Information about health consequences
	5.1: Information about health consequences	7.1: Prompts/cues
	6.1: Demonstration of the behaviour	8.7: Graded tasks
	6.2: Social comparison	
	7.1: Prompts/cues	
	8.1: Behavioural practice/rehearsal	
	8.7: Graded tasks	
Steptoe (1999)	***1.1: Goal setting (behaviour)***	3.1: Social support (unspecified)
	1.4: Action planning	
	2.3: Self-monitoring of behaviour	
	3.1: Social support (unspecified)	
	5.1: Information about health consequences	

	9.1: Credible source	
	10.3: Non-specific reward	
Van Hoecke (2014)	***1.1: Goal setting (behaviour)***	3.1: Social support (unspecified)
	1.2: Problem solving	8.1: Behavioural practice/rehearsal
	1.4: Action planning	9.1: Credible source
	1.5: Review behaviour goal	
	2.2: Feedback on behaviour	
	3.1: Social support (unspecified)	
	4.1: Instruction on how to perform the behaviour	
	8.1: Behavioural practice/rehearsal	
	8.7: Graded tasks	
	9.1: Credible source	
	10.4: Social reward	

Notes: [a] No BCTs were explicitly described in this paper but participants were given stage of change booklets targeted at their motivational readiness for physical activity. Therefore, the intervention was very likely to contain BCTs that were not reported.

4.2.2.2. TIDieR checklist. Reporting in the 26 intervention conditions was adequate for 69% of items (Table 4.3.). For the 19 active control conditions reporting was adequate for 54% of items. For intervention and control conditions, a brief description (item 1 – 92% for intervention; 89% for control), mode of delivery, (item 6 – 100% for intervention; 79% for control) and procedure (item 4 – 88% for intervention; 84% for control) were the most well reported. Where the intervention was delivered (item 7 – 47% for intervention; 50% for control) and how and by whom fidelity or adherence was assessed (item 11 – 36% for intervention; 19% for control) were the items with the most inadequate reporting in both conditions. Average inter-rater reliability for the TIDieR items was good (Krippendorf's α = 0.75).

Table 4.3.

Coding for the 12 TIDieR items for individual studies, divided into intervention and active control conditions.

Study	Condition	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12
Aittasalo (2012)	Intervention (step)	yes	yes	yes	yes	no	yes	yes	yes	yes	n/a	yes	yes
Annesi (2016)	Intervention (Coach)	yes	yes	yes	yes	yes	yes	no	yes	unclear	n/a	yes	unclear
	Control (Comparison)	yes	yes	yes	yes	yes	yes	n/a	yes	unclear	n/a	no	no
Belanger-Gravel (2013)	Intervention (CA + II)	yes	yes	unclear	yes	no	yes	no	yes	yes	n/a	no	no
	Control (CA)	yes	yes	unclear	yes	no	unclear	no	yes	no	n/a	no	no
Bickmore (2013)	Intervention (ECA)	yes	yes	yes	yes	n/a	yes	yes	yes	yes	n/a	yes	yes
	Control (pedometer)	yes	no	yes	yes	n/a	yes	yes	yes	n/a	n/a	no	unclear
Bock (2001)	Intervention (IT)	yes	yes	yes	yes	yes	yes	n/a	yes	yes	n/a	no	no
	Control (ST)	yes	yes	yes	yes	n/a	yes	n/a	yes	n/a	n/a	no	no
Buman (2011)	Intervention (active)	yes	yes	no	yes	yes	yes	yes	unclear	n/a	n/a	yes	no
	Control (community)	yes	yes	yes	yes	yes	yes	yes	unclear	n/a	n/a	yes	no
Carels (2004)	Intervention (lifestyle +)	yes	unclear	unclear	unclear	unclear	yes	no	yes	n/a	n/a	unclear	yes
	Control (lifestyle)	yes	no	unclear	unclear	unclear	yes	no	yes	n/a	n/a	unclear	yes
Chen (1998)	Intervention (behav)	yes	yes	yes	yes	yes	yes	n/a	yes	yes	n/a	yes	yes
	Control (educational)	yes	no	yes	yes	yes	yes	n/a	unclear	n/a	n/a	no	no
Dallow (2003)	Intervention (lifestyle)	yes	yes	yes	yes	no	yes	yes	yes	n/a	n/a	unclear	no

	Control (usual care)	yes	yes	unclear	unclear	no	yes	yes	unclear	no	n/a	unclear	no
Dzator (2004)	Intervention (high level)	yes	yes	yes	yes	yes	yes	no	yes	n/a	n/a	no	yes
Halbert (2000)	Intervention	yes	no	yes	yes	yes	yes	yes	yes	yes	n/a	unclear	yes
	Control (nutrition)	yes	no	yes	yes	yes	yes	yes	yes	unclear	n/a	n/a	n/a
Harland (2005)	Intervention (group 4)	yes	unclear	yes	yes	unclear	yes	yes	yes	n/a	n/a	no	yes
	Control	yes	no	yes	yes	no	yes	yes	yes	n/a	n/a	no	n/a
Hertogh (2010)	Intervention	yes	no	n/a	yes	yes	yes	yes	yes	n/a	n/a	unclear	no
	Control	yes	no	unclear	yes	n/a	unclear	n/a	unclear	n/a	n/a	no	no
Jimmy (2005)	Intervention (advice)	yes	unclear	yes	yes	yes	yes	unclear	yes	yes	n/a	yes	yes
	Control (feedback)	yes	unclear	yes	yes	yes	unclear	unclear	unclear	n/a	n/a	n/a	n/a
Kolt (2006)	Intervention	yes	yes	yes	yes	unclear	yes	n/a	yes	yes	n/a	no	no
Lawton (2008)	Intervention	yes	yes	yes	yes	unclear	yes	yes	yes	unclear	n/a	no	no
Lewis (2013)	Intervention (print)	yes	yes	yes	yes	yes	yes	n/a	yes	yes	n/a	no	no
	Control (contact arm)	yes	yes	yes	yes	n/a	yes	n/a	yes	n/a	n/a	no	no
Marshall (2004)	Intervention	yes	unclear	yes	unclear	n/a	yes	n/a	yes	n/a	n/a	yes	yes
Mutrie (2002)	Intervention (print)	yes	yes	yes	yes	no	yes	n/a	yes	n/a	n/a	no	no
Napolitano (2006)	Intervention (CTM)	yes	unclear	unclear	unclear	n/a	yes	n/a	unclear	n/a	n/a	yes	unclear
Nies (2006)	Intervention (couns)	unclear	yes	n/a	yes	yes	yes	n/a	yes	n/a	n/a	no	no
	Control (video)	unclear	no	yes	yes	no	yes	no	yes	n/a	n/a	no	no
Norton (2011)	Intervention (group)	unclear	yes	yes	yes	unclear	yes	no	yes	unclear	n/a	yes	yes
	Control (pedometer)	unclear	yes	yes	yes	no	yes	yes	yes	n/a	n/a	yes	yes

Odenpacker (2008)	Intervention (lifestyle)	yes	yes	yes	yes	yes	yes	unclear	yes	yes	n/a	unclear	unclear
	Control (structured)	yes	yes	no	yes	yes	yes	yes	yes	yes	n/a	unclear	unclear
Rovniak (2005)	Intervention (high)	yes	yes	unclear	yes	no	yes	no	yes	unclear	n/a	yes	yes
	Control (low)	yes	yes	unclear	yes	no	yes	no	yes	unclear	n/a	yes	yes
Steptoe (1999)	Intervention	yes	yes	no	unclear	yes	yes	no	yes	unclear	n/a	no	yes
	Control	yes	n/a	no	unclear	no	unclear	no	no	unclear	n/a	no	no
Van Hoecke (2014)	Intervention (coach)	yes	yes	unclear	yes	yes	yes	no	yes	yes	n/a	no	no
	Control (refer)	yes	yes	yes	yes	yes	yes	no	yes	n/a	n/a	no	no

Note: Yes – clear description of item; No – no description or minimal description of item; Unclear – unclear description of item; n/a – the design of the study voided the relevance of this item.

4.2.3. Risk of Bias within Studies.

Nineteen studies were judged to be at high risk of bias on at least one domain (Figure 4.2.). The domain judged as having the lowest risk of bias was completeness of outcome reporting (low risk in 15/26 studies for follow-up outcomes and 12/21 studies for post-intervention outcomes). Random sequence allocation was reported adequately in 12 studies. For the remaining indicators the number of studies assessed as low risk was poor. The risk of bias domains that were judged to have a large number of high risk studies were selective reporting (11 studies) and ‘other’ (10 studies). The majority of the judgements in the ‘other’ domain were caused by low sample sizes and/or high attrition rates at follow-up. Overall the risk of bias rating across all domains was mostly unclear (60%). Good inter-rater agreement was achieved across the eight main domains (Krippendorf’s $\alpha = 0.81$).

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data post-intervention (attrition bias)	Incomplete outcome data follow-up (attrition bias)	Selective reporting (reporting bias)	Other bias
Aittasalo 2012	+	?	?	?	+	+	?	?
Annesi (2016)	?	?	+	?	?	+	?	?
Belanger-Gravel 2013	+	?	−	?	+	+	?	?
Bickmore 2013	?	?	?	+	+	+	?	−
Bock 2001	?	?	?	?	?	?	?	?
Buman 2011	?	?	?	?	+	+	?	−
Carels 2004	?	?	?	?	?	?	−	−
Chen 1998	?	?	?	?	−	?	?	−
Dallow 2003	?	?	?	?	?	?	?	−
Dzator 2004	+	?	?	?	+	+	?	−
Halbert 2007	?	?	?	?	+	+	−	?
Harland 1999	+	?	?	?	+	+	−	?
Hertogh 2010	?	?	?	?	?	?	−	?
Jimmy 2005	?	+	?	?	?	+	−	−
Kolt 2007	+	?	?	+	?	?	+	?
Lawton 2009	+	+	?	+	?	+	+	?
Lewis 2013	+	+	−	+	+	+	−	?
Marshall 2004	?	?	?	+	?	+	?	?
Mutrie 2002	+	?	?	+	?	?	−	?
Napolitano 2006	?	?	?	+	+	+	−	?
Nies 2006	?	?	?	?	+	+	−	?
Norton 2011	+	?	−	?	?	?	−	−
Opdenacker 2008	+	?	−	−	+	+	?	?
Rovniak 2005	+	?	?	−	?	?	?	−
Steptoe 1999	+	+	−	?	?	?	−	−
Van Hoecke 2014	?	?	?	?	+	?	+	?

Figure 4.2. Summary of risk of bias in individual studies

4.2.4. Intervention Effects on Main Outcomes.

4.2.4.1. Physical activity. Five studies had more than one intervention group. In each instance the most intensive intervention group was compared with controls. Five studies reported baseline and follow-up outcomes only. Of the 21 studies that reported physical activity outcomes post-intervention, 13 studies showed a significant effect in favour of the intervention, two showed a significant effect in favour of the intervention on a sub-scale of the main outcome, and the remaining six showed no effect. At follow-up 11 studies showed a significant effect in favour of the intervention, two showing a significant effect in favour of the intervention on sub-scales of the main outcome, and 13 showed no effect.

Three studies provided sufficient non-continuous data (percentage of participants classified as active). Only one of these studies showed a difference in favour of the intervention at follow-up. Fourteen studies provided sufficient continuous data (e.g. minutes per week/day of walking or moderate/vigorous activity) to pool for the post-intervention meta-analysis and 16 for the follow-up meta-analysis. Post-intervention, intervention participants engaged in significantly more physical activity than control participants (d = 0.32 (95% confidence interval 0.16 to 0.48), Figure 4.3), representing a relatively small effect, with a moderate to high level of heterogeneity (I^2 = 69%). The effective interventions showed post-intervention improvements ranging from 31-247 minutes per week of physical activity and 606-1849 steps per day.

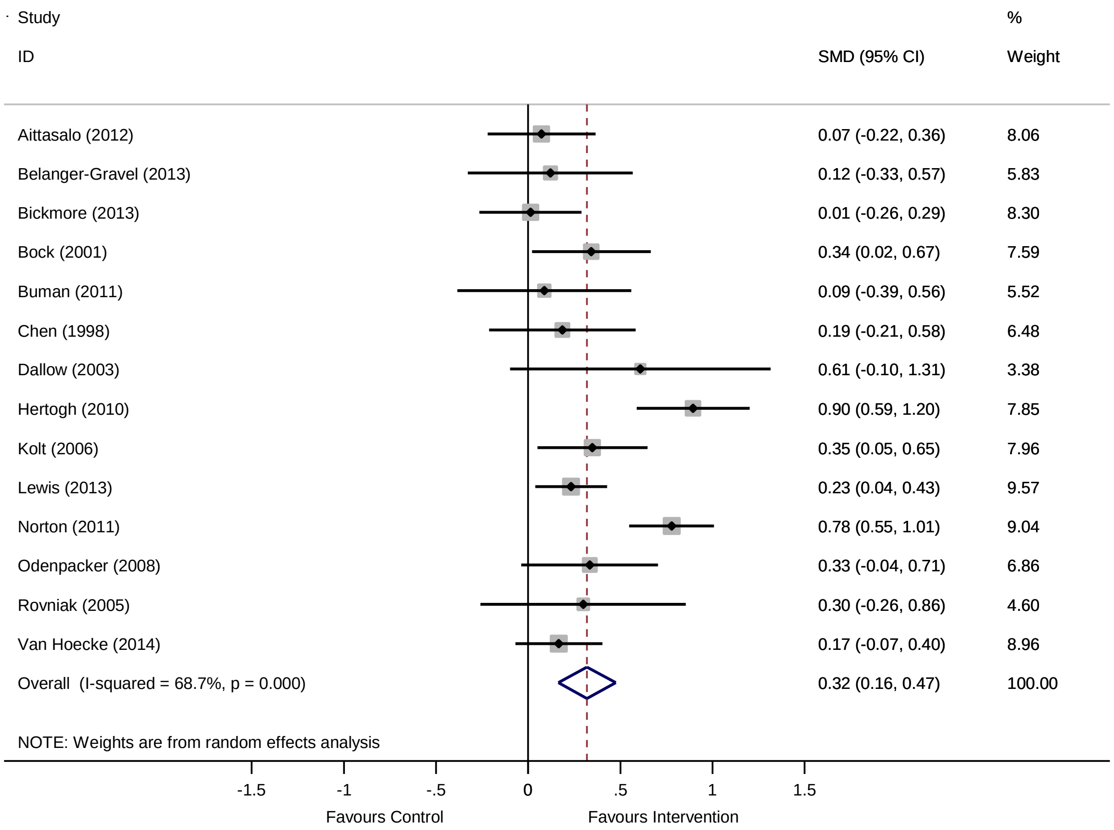

Figure 4.3. Post-intervention physical activity forest plot.

At follow-up, intervention participants still engaged in significantly more physical activity but the effect was smaller (d = 0.21 (0.12 to 0.30), Figure 4.4), with very low heterogeneity (I^2 = 3%). The effective interventions showed improvements at follow-up ranging from 5-95 minutes per week of physical activity and 421-1370 steps per day.

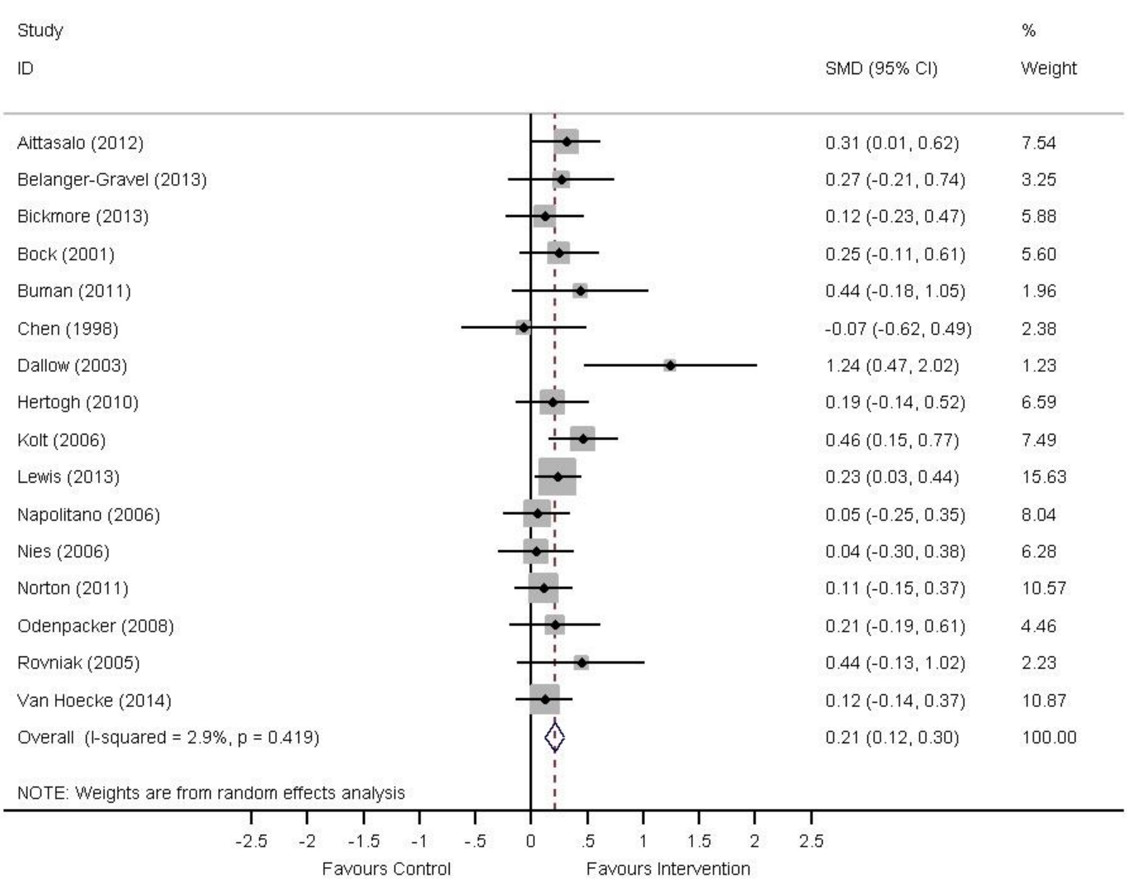

Figure 4.4. Follow-up physical activity forest plot.

4.2.4.2. Sedentary behaviour. Of the two studies that reported sedentary behaviour outcomes (both sitting time) only one reported group differences, showing no intervention effect at post intervention or follow-up (see Figures 3.5 & 3.6).

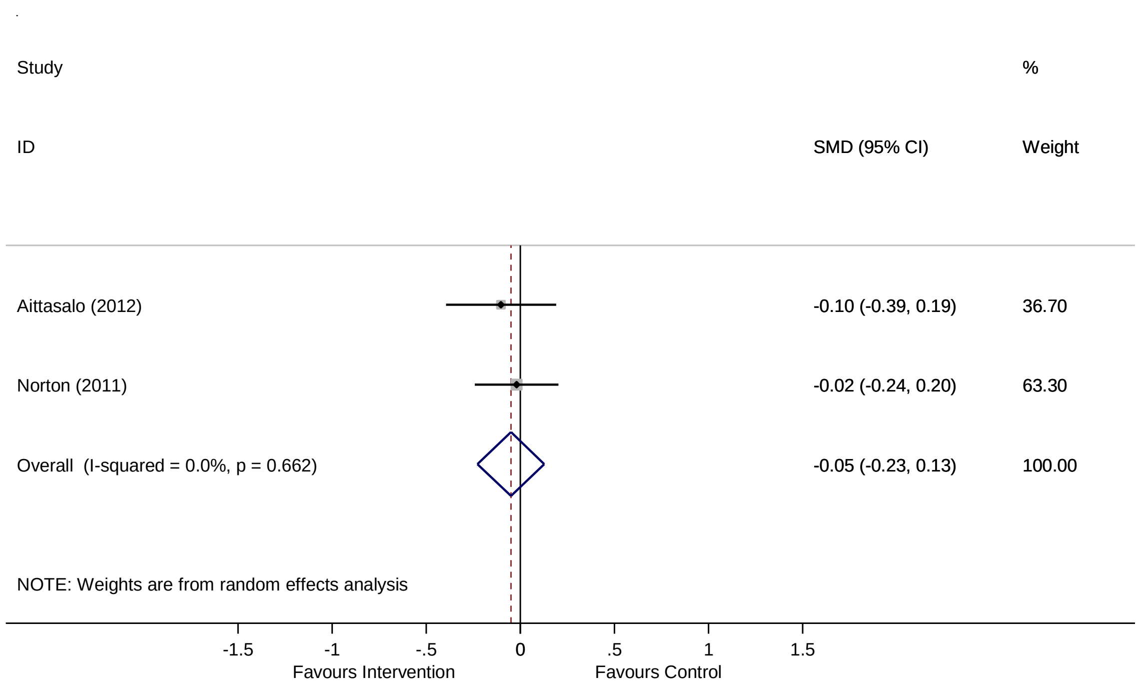

Figure 4.5. Post-intervention sedentary behaviour forest plot.

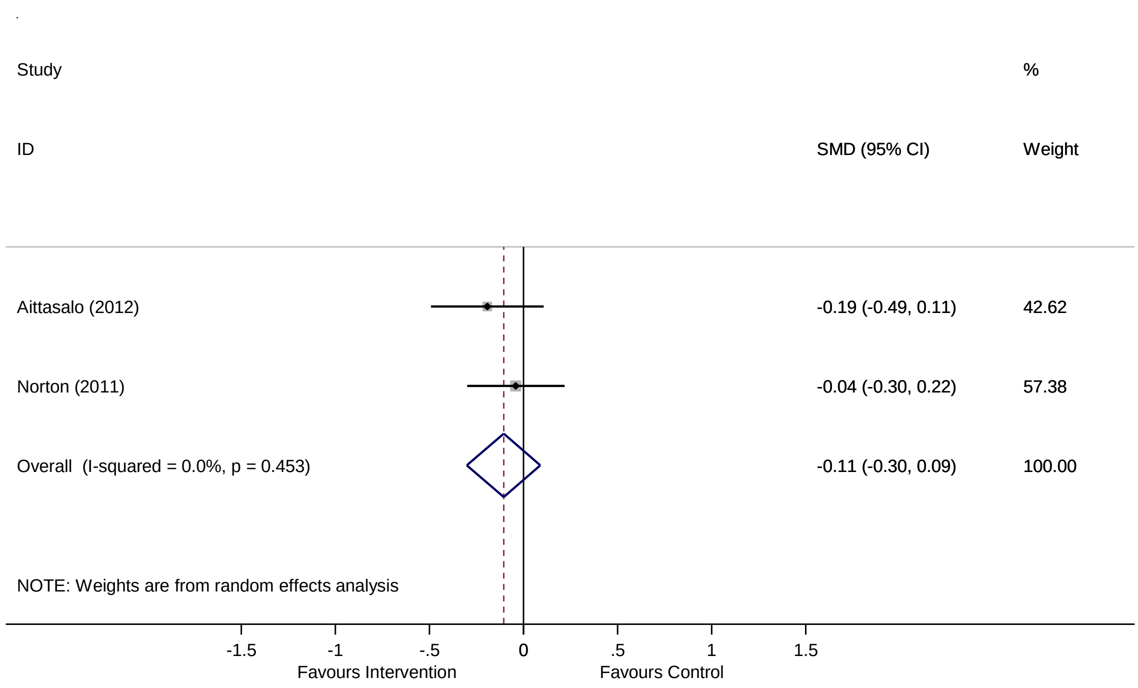

Figure 4.6. Follow-up sedentary behaviour forest plot.

4.2.5. Quality of Evidence across Studies.

Using the GRADE criteria (Balshem et al., 2011; Guyatt et al., 2011) the post-intervention physical activity outcome was downgraded two levels to low quality, because there was a high level of heterogeneity (serious inconsistency) and suspicion of publication bias based on the funnel plot (Table 4.4).

Table 4.4.

GRADE summary of quality of evidence for the four main outcomes.

Quality assessment							**№ of patients**		**Effect**	**Quality**	**Importance**
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**physical activity/sedentary behaviour interventions**	**controls**	**Absolute (95% CI)**		
Physical activity post-intervention (assessed with: minutes of walking, moderate, or vigorous activity per week; steps per day)											
14	randomised trials	not serious	serious [1]	not serious	not serious	publication bias strongly suspected [2]	1127	1219	SMD **0.32 higher** (0.16 higher to 0.48 higher)	⊕⊕◯◯ LOW [1,2]	IMPORTANT
Sedentary behaviour post-intervention (assessed with: minutes per day or week of sitting)											
2	randomised trials	serious [3]	not serious	not serious	not serious [4]	none	211	303	SMD **0.05 fewer** (0.23 fewer to 0.13 more)	⊕⊕⊕◯ MODERATE [3,4]	IMPORTANT
Physical activity at follow-up (follow up: range 24 weeks to 124 weeks; assessed with: minutes of walking, moderate, or vigorous activity per week; steps per day)											
16	randomised trials	not serious	not serious	not serious	not serious	none	1069	1121	SMD **0.21 higher** (0.12 higher to 0.3 higher)	⊕⊕⊕⊕ HIGH	CRITICAL
Sedentary behaviour at follow-up (follow up: range 24 weeks to 46 weeks; assessed with: minutes per day or week of sitting)											
2	randomised trials	serious [3]	not serious	not serious	not serious [4]	none	184	227	SMD **0.11 fewer** (0.3 fewer to 0.09 more)	⊕⊕⊕◯ MODERATE [3,4]	IMPORTANT

Notes: [1] Moderate to High level of heterogeneity, z = 4.03, $p < .001$. $I^2 = 69\%$; [2] Uneven funnel plot suggesting that the overall effect is heavily influenced by two high powered, highly significant studies; [3] Inconsistent risk of bias between the two studies. One study showed high risk of bias for blinding participants and reporting bias (inconsistent reporting of outcomes); [4] Relatively small sample size based on only two studies. Although rated as moderate quality overall this outcome needs to be interpreted cautiously.

The follow-up physical activity outcome was judged to be high quality evidence, with no obvious problems across the five domains. The post-intervention and follow-up sedentary behaviour outcomes were both downgraded one level to moderate quality based on the fact that one of the two studies showed high risk of bias (serious inconsistency).

4.2.6. Subgroup and Sensitivity Analysis.

One study showed an effect size that was markedly different from the other studies at follow-up. Removing this study did not have any impact on the pooled effect or heterogeneity levels.

The 10 studies using self-report measures had a significant, small-to-medium effect size post intervention (d = 0.39 (95% confidence interval 0.19 to 0.59); I^2 = 72%) whereas the four studies using objective measures showed a small, non-significant effect size (d = 0.14 (-0.01 to 0.30); I^2 = 0%). The 12 studies using self-report measures also had a small but significant effect size at follow-up (d = 0.23 (0.12 to 0.35); I^2 = 24%) whereas the four studies using objective measures had a small non-significant effect size (d = 0.16 (-0.02 to 0.33); I^2 = 0%).

The 12 studies targeting only physical activity had a small significant effect size post intervention (d = 0.29 (0.15 to 0.43); I^2 = 52%) whereas the two studies targeting multiple behaviours had a small-to-medium, but non-significant effect size (d = 0.43 (-0.26 to 1.12); I^2 = 93%). The 14 studies targeting only physical activity showed a small significant effect size at follow-up (d = 0.22 (0.11 to 0.32); I^2 = 10%) whereas the two studies targeting multiple behaviours showed a small non-significant effect size (d = 0.19 (-0.00 to 0.39); I^2 = 0%).

4.2.7. Meta-Regression.

All covariates (intervention duration, follow-up duration, number of behaviour change techniques, age of participants, 20 individual behaviour change techniques) were entered into univariate models to calculate the percentage of among-study heterogeneity (adjusted R^2) explained by the covariate and the strength of the association between the covariate and effectiveness (β). Studies that included the behaviour change techniques ‘Biofeedback’, ‘Demonstration of the behaviour’, ‘Behaviour practice/rehearsal’, and ‘Graded tasks’ showed larger effect sizes at post-intervention than studies that did not (see Table 4.5). The large R^2 for the BCT ‘Biofeedback’ was due to the 95% confidence intervals from each subgroup (present vs absent) not overlapping. Studies that included the behaviour change techniques ‘Problem solving’, ‘Review behaviour goal’, and ‘Feedback on behaviour’ showed a smaller effect size at post-intervention than studies that did not.

Table 4.5.

Univariate meta-regression analyses for each BCT for post-intervention physical activity outcomes.

						Univariate model		
Model	**Covariate**	**Classification**	***k***	**Effect size (95% CI)**	**I^2**	**β (95% CI)**	**P-value[a]**	**Adjusted R^2**
0	None	Overall	14	0.32 (0.16, 0.48)	69%	-	-	-
1	Number of BCTs	Range: 4-16	14			0.043 (-0.019, 0.106)	.410	15%
2	Duration of intervention	Range: 7-52 weeks	14			0.001 (-0.004, 0.019)	.504	6%
3	Duration of follow-up	Range: 24-121 weeks	14			-0.000 (-0.007, 0.007)	1.000	10%
4	Age of participants	Range: 36-74 years	14			-0.005 (-0.018, 0.007)	.882	1%
5	1.1. Goal setting (behaviour)[b]	Yes	14	-	-	-	-	-
		No	0					
6	1.2. Problem solving	Yes	12	0.27 (0.12, 0.41)	59%	-0.360 (-0.794, 0.074)	.532	21%
		No	2	0.62 (0.08, 1.16)	83%			
7	1.4. Action planning	Yes	11	0.36 (0.18, 0.54)	72%	0.197 (-0.210, 0.604)	.972	3%
		No	3	0.14 (-0.05, 0.34)	0%			

8	1.5. Review behaviour goal(s)	Yes	6	0.17 (0.04, 0.31)	0%	-0.240 (-0.563, 0.082)	.644	18%
		No	8	0.42 (0.19, 0.65)	77%			
9	2.2. Feedback on behaviour	Yes	7	0.19 (0.08, 0.30)	0%	-0.274 (-0.577, 0.028)	.363	30%
		No	7	0.45 (0.19, 0.72)	71%			
10	2.3. Self-monitoring of behaviour	Yes	10	0.33 (0.13, 0.54)	77%	0.055 (-0.339, 0.450)	1.000	9%
		No	4	0.24 (0.08, 0.41)	0%			
11	2.6. Biofeedback	Yes	3	0.69 (0.40, 0.98)	65%	0.529 (0.318, 0.740)	.059	100%
		No	11	0.20 (0.10, 0.29)	0%			
12	3.1. Social support (unspecified)	Yes	12	0.29 (0.15, 0.44)	56%	-0.189 (-0.657, 0.279)	.993	4%
		No	2	0.48 (-0.32, 1.29)	93%			
13	4.1. Instruction on how to perform the behaviour	Yes	11	0.36 (0.18, 0.55)	71%	0.208 (-0.198, 0.614)	.952	4%
		No	3	0.32 (-0.06, 0.36)	14%			
14	4.2. Information about antecedents	Yes	3	0.45 (0.09, 0.81)	85%	0.181 (-0.201, 0.563)	.977	2%
		No	11	0.27 (0.10, 0.44)	59%			
15	5.1. Information about health consequences	Yes	8	0.33 (0.12, 0.53)	66%	0.016 (-0.336, 0.369)	1.000	11%
		No	6	0.31 (0.05, 0.57)	76%			

16	6.1. Demonstration of the behaviour	Yes	6	0.49 (0.17, 0.82)	80%	0.298 (-0.011, 0.606)	.391	31%
		No	8	0.21 (0.11, 0.31)	0%			
17	6.2. Social comparison	Yes	4	0.25 (0.10, 0.40)	0%	-0.103 (-0.492, 0.287)	1.000	8%
		No	10	0.35 (0.13, 0.56)	77%			
18	7.1. Prompts/cues	Yes	3	0.22 (0.02, 0.41)	0%	-0.113 (-0.540, 0.314)	1.000	6%
		No	11	0.34 (0.15, 0.53)	74%			
19	8.1. Behavioural practice/rehearsal	Yes	8	0.45 (0.22, 0.68)	72%	0.295 (-0.003, 0.594)	.382	34%
		No	6	0.17 (0.05, 0.29)	0%			
20	8.7. Graded tasks	Yes	7	0.45 (0.08, 0.31)	0%	0.256 (-0.060, 0.573)	.631	19%
		No	7	0.20 (0.18, 0.72)	79%			
21	9.1. Credible source	Yes	8	0.41 (0.16, 0.65)	79%	0.214 (-0.120, 0.548)	.867	9%
		No	6	0.20 (0.07, 0.33)	0%			
22	9.2. Pros and cons	Yes	3	0.28 (0.14, 0.43)	0%	-0.023 (-0.428, 0.384)	1.000	12%
		No	11	0.32 (0.11, 0.53)	75%			
23	10.4. Social reward	Yes	4	0.20 (0.05, 0.35)	15%	-0.160 (-0.518, 0.197)	.985	2%
		No	10	0.37 (0.16, 0.58)	73%			

24	10.9. Self-reward	Yes	4	0.30 (0.15, 0.44)	0%	0.029 (-0.361, 0.419)	1.000	13%
		No	10	0.31 (0.09, 0.53)	77%			

Note: [a]From Monte Carlo permutation test for single covariate meta-regressions (10,000 permutations), [b]Dropped from the Monte Carlo simulation due to collinearity, *k* = number of studies

At follow-up there was minimal heterogeneity (3%). Therefore, subgroup analyses were utilised with a criterion of a difference in Cohen's *d* of > .10 defined as meaningful, consistent with the meta-regression. Studies that included 'Action planning', 'Instruction on how to perform the behaviour', 'Prompts/cues', 'Behaviour practice/rehearsal', 'Graded tasks', and 'Self-reward' showed larger effect sizes at follow-up than studies that did not (Table 4.6). Studies that included 'Information about antecedents' had a smaller effect size at follow-up than studies that did not.

Table 4.6.

Subgroup analyses for each BCT for follow-up physical activity outcomes.

Covariate	**Classification**	***k***	**Effect size (95% CI)**	I^2
None	Overall	16	0.21 (0.12, 0.30)	3%
1.3. Goal setting (behaviour)[a]	Yes	15	-	-
	No	1		
1.4. Problem solving	Yes	13	0.23 (0.12, 0.34)	16%
	No	3	0.15 (-0.04, 0.34)	0%
1.4. Action planning	Yes	12	0.25 (0.14, 0.35)	14%
	No	4	0.09 (-0.10, 0.28)	0%
1.5. Review behaviour goal(s)	Yes	6	0.21 (0.09, 0.32)	0%
	No	10	0.22 (0.07, 0.37)	14%
2.2. Feedback on behaviour	Yes	7	0.19 (0.07, 0.32)	0%
	No	9	0.24 (0.09, 0.40)	38%
2.3. Self-monitoring of behaviour	Yes	10	0.25 (0.14, 0.35)	0%
	No	6	0.16 (-0.05, 0.37)	47%
2.6. Biofeedback	Yes	3	0.15 (-0.03, 0.34)	0%
	No	13	0.23 (0.12, 0.34)	19%

3.1. Social support (unspecified)	Yes	14	0.21 (0.11, 0.31)	13%
	No	2	0.26 (0.03, 0.48)	0%
4.1. Instruction on how to perform the behaviour	Yes	11	0.25 (0.14, 0.37)	21%
	No	5	0.13 (-0.03, 0.28)	0%
4.2. Information about antecedents	Yes	5	0.15 (0.03, 0.27)	0%
	No	11	0.27 (0.14, 0.40)	17%
5.1. Information about health consequences	Yes	10	0.24 (0.10, 0.38)	36%
	No	6	0.18 (0.04, 0.32)	0%
6.1. Demonstration of the behaviour	Yes	6	0.25 (0.04, 0.46)	40%
	No	10	0.21 (0.11, 0.31)	0%
6.2. Social comparison	Yes	4	0.27 (0.10, 0.44)	0%
	No	12	0.19 (0.08, 0.31)	21%
7.1. Prompts/cues	Yes	3	0.40 (0.19, 0.60)	0%
	No	13	0.17 (0.08, 0.26)	0%
8.1. Behavioural practice/rehearsal	Yes	8	0.29 (0.12, 0.45)	38%
	No	8	0.18 (0.06, 0.29)	0%
8.7. Graded tasks	Yes	7	0.29 (0.12, 0.47)	45%
	No	9	0.17 (0.05, 0.28)	0%
9.1. Credible source	Yes	8	0.22 (0.06, 0.38)	40%
	No	8	0.21 (0.10, 0.33)	0%
9.2. Pros and cons	Yes	4	0.24 (0.09, 0.40)	15%
	No	12	0.19 (0.08, 0.30)	5%
10.4. Social reward	Yes	4	0.23 (0.07, 0.39)	9%
	No	12	0.20 (0.10, 0.31)	9%

10.9. Self-reward	Yes	4	0.40 (0.13, 0.67)	57%
	No	12	0.20 (0.05, 0.26)	0%

Note: [a]Subgroup analysis was not possible due to all but one study including this BCT, *k* = number of studies

4.2.6. Updated meta-regression.

By the time this review was published advances in analysis methods had suggested that a slightly modified approach to exploring the association between BCTs and intervention effectiveness would be more appropriate (Garnett et al., 2018; Samdal, Eide, Barth, Williams, & Meland, 2017). The change was to enter BCTs into the regression analysis that appeared uniquely in the intervention condition and not in the active control condition as well. The meta-regression analysis for post-intervention and subgroup analysis at follow-up were, therefore, re-run with these parameters. The results for the post-intervention meta-regression remained largely the same. Interventions that included the BCTs 'Biofeedback', 'Demonstration of behaviour' and 'Behavioural practice/rehearsal' still showed larger effect sizes than those that did not. Also, interventions that included the BCTs 'Problem solving', 'Review behaviour goal', and 'Feedback on behaviour' still showed a smaller effect size at post-intervention than studies that did not. There were only two changes (see table 4.7). 'Graded tasks', despite meeting the criteria that (β) with values > .10 in conjunction with an adjusted R^2 of > 10% was potentially important, showed a much less meaningful difference in effect size (.45 vs .20 effect sizes previously). The other change was that 'Credible Source' showed an association with intervention effectiveness (9% variance explained previously).

Table 4.7.

Revised meta-regression results at post-intervention

8.7. Graded tasks	Yes	7	0.37 (0.02, 0.71)	83%	0.256 (-0.060, 0.573)	.631	11%
	No	7	0.30 (0.12, 0.48)	62%			
9.1. Credible source	Yes	6	0.47 (0.15, 0.78)	82%	0.214 (-0.120, 0.548)	.867	24%
	No	8	0.21 (0.10, 0.31)	0%			

For the follow-up subgroup analysis there was more change than at post-intervention (See table 4.8.). Studies that included the BCTs ‘Action planning’ and ‘Self-reward’ were still associated with effectiveness. The BCTs ‘Instruction on how to perform the behaviour’ (.25 vs .13 effect sizes previously), ‘Behaviour practice/rehearsal’ (.29 vs .18 effect sizes previously), and ‘Graded tasks’ (.29 vs .17 effect sizes previously) were no longer associated with effectiveness based on the criteria of a difference in effect size of > .10. The changes were, however, all marginal. The BCT ‘Information about antecedents’ was no longer associated with lower effects sizes (.15 vs .27 effect sizes previously), but again the change was marginal. The BCT ‘Self-monitoring of behaviour’ was associated with higher effect sizes (.25 vs .16 effect sizes previously), but again this change was marginal. The one large change was for the BCT ‘Information about health consequences’ which was strongly associated with effectiveness (.24 vs .18 effect sizes previously).

Table 4.8.

Revised follow-up subgroup analysis

2.3. Self-monitoring of behaviour	Yes	4	0.31 (0.14, 0.47)	0%
	No	12	0.18 (0.07, 0.28)	8%
4.1. Instruction on how to perform the behaviour	Yes	10	0.26 (0.14, 0.38)	0%
	No	6	0.17 (0.04, 0.30)	16%
4.2. Information about antecedents	Yes	4	0.16 (0.02, 0.30)	0%
	No	12	0.24 (0.13, 0.36)	16%
5.1. Information about health consequences	Yes	4	0.41 (0.16, 0.66)	56%
	No	12	0.15 (0.04, 0.25)	0%
8.1. Behavioural practice/rehearsal	Yes	4	0.26 (0.08, 0.44)	15%
	No	12	0.19 (0.09, 0.30)	5%
8.7. Graded tasks	Yes	4	0.26 (0.11, 0.41)	4%
	No	12	0.19 (0.08, 0.30)	6%

4.3. Discussion

This review showed that interventions aiming to increase physical activity in healthy inactive adults are effective in promoting behaviour change and behaviour change maintenance. The two eligible interventions measuring sedentary behaviour were not effective at either. The quality of the evidence was high for follow-up physical activity outcomes, moderate for both sedentary behaviour outcomes, and low for post-intervention physical activity outcomes. The majority of ROB ratings were judged as unclear, reflecting a problem with poor reporting of details essential for judgements of study quality. Problems with inadequate reporting extended to the TIDieR coding, with reporting of active control conditions a serious problem for replication. Items 11 and 12 of the TIDieR guidelines combine adherence and fidelity, and therefore even for studies that did contain this information, it was focused on attendance and engagement, and not on the delivery of content as planned. In fact, only one study assessed the fidelity of intervention content and delivery. This is of real concern for future research, as without the knowledge or measurement of fidelity, details of the effectiveness of interventions must be taken with caution, as an intervention deemed non-effective may actually not have been delivered as planned. The behaviour change technique taxonomy coding provided a detailed summary of intervention components and showed the potential for a number of techniques to be associated with intervention effectiveness.

Using subgroup analysis the studies classified as using objective measurements all utilised pedometers, and overall were found to be ineffective. This may be due to over-estimation in self-report measures (Lee, et al., 2011), pedometers not accurately distinguishing between intensities of activity or capturing activities such as cycling (Pomeroy et al.,2011), or reliability issues when compared with accelerometers (Trost & O'Neil, 2014). Lastly, only one of the four studies stated that pedometers were sealed. Pedometers could therefore have been used for the unintended purpose of self-monitoring behaviour, particularly in one study where self-monitoring was not a stated part of the intervention or control group. It is unfortunately beyond the scope of this review to analyse why this difference has occurred.

4.3.1. Comparison with Other Studies.

This is the first review to analyse only studies with a minimum of 6 months post-intervention follow-up. Exploring maintenance of behaviour change after a significant period of time in which no intervention contact has been made with participants, is essential to investigate whether positive behavioural changes can be sustained (Glasgow et al., 1999). Previous reviews of physical activity interventions have found similar effect sizes for post-intervention physical activity outcomes (Michie et al., 2009; Orrow et al., 2012; Rhodes et al., 2017). Two previous reviews of long-term effectiveness in physical activity outcomes have not truly captured follow-up outcomes because the majority of the studies only measured outcomes until the end of an active intervention period (Müller-Riemenschneider et al., 2008; Orrow et al., 2012). The same issue was found in one previous review which highlighted long-term outcomes for sedentary behaviour in 16 studies (Martin et al., 2015).

This review was also consistent with previous ones in finding that combined physical activity and sedentary behaviour interventions are ineffective in changing sitting time (Martin et al., 2015; Prince et al., 2014). Both previous reviews found only four very small RCTs of sedentary behaviour interventions, none of which collected any follow-up outcomes (Martin et al., 2015; Prince et al., 2014). Unsurprisingly, the present review found no interventions targeting only sedentary behaviour from 26 years of literature that fit our criteria. This highlights a need for more interventions to assess the maintenance of changes in sedentary behaviour, and to include measures other than sitting time. The BCT analysis was consistent with a previous review of interventions targeting obese adults (using an older taxonomy), which showed that demonstrating the behaviour, using prompts and cues, prompting behavioural practice, setting graded tasks, and rewarding progress were associated with effectiveness (Olander et al., 2013). This review did not, however, find that interventions containing self-monitoring were more effective, contrasting it with previous reviews using much more heterogeneous samples (Martin et al., 2015; Michie et al., 2009).

4.3.2. Implications for Research and Practice.

Despite physical activity interventions showing statistically significant effectiveness at both time points, the effect sizes could not be translated into meaningful units to judge potential clinical significance. This reflects a common pattern from other reviews of physical activity interventions (e.g. Michie et al., 2009; Foster et al., 2005) that cannot quantify overall improvements for practitioners and policy makers in a more useable manner (e.g. minutes per day of moderate physical activity), because physical activity is measured in such diverse ways. This problem has led to a recent call for the measurement of physical activity to be more standardised so that data can be pooled more meaningfully to further knowledge (Autier & Pizot, 2016). However, two previous reviews showed that effect sizes of d = .19 and d = .18 equated to increases of 15 and 73 minutes of physical activity per week and 496 and 620 steps per day respectively, dependent on baseline activity levels (Chase, 2016; Conn et al., 2011). Given that the interventions in this review were in people with low levels of baseline activity and effect sizes were somewhat larger, the increases may have been greater, particularly at post-intervention.

Previous research has shown that for overweight adults, experiencing health events or 'teachable moments', such as a doctor recommendation about health can be the catalyst for long-term changes in diet and physical activity (Epiphaniou & Ogden, 2010). The interventions highlighted in this review were for healthy inactive adults, who were overall in the overweight category across the included studies. This represents an ideal population to intervene with by, for instance, an intervention delivered through primary care, to lessen the risk of developing serious health conditions. This review aids commissioners, practitioners, officers, and policy makers in the design of future physical activity interventions for this population by showing that the inclusion of heart rate monitors to track exertion during exercise, providing a demonstration of the behaviour, prompting practice of the behaviour (often in supervised exercise classes), and increasing the intensity and duration of exercise in progressive stages, may be effective in producing changes in physical activity – the last two may also produce changes that can be maintained over longer periods. In addition, including detailed plans to perform the behaviour, providing instruction on how to perform the behaviour, encouraging the use of prompts/cues as a reminder to exercise, rewarding oneself for making efforts to increase physical activity, and providing information about the health consequences of inactivity, may lead to sustained improvements in physical activity.

4.3.3. Strengths and Limitations.

This review is the first to investigate physical activity interventions specifically with healthy inactive adults, to draw a distinction between outcomes of behaviour change and behaviour change maintenance, and to use the latest taxonomy to analyse BCTs in relation to these two outcomes. The strengths of this review include the comprehensive terms and databases searched, the RCT design of the studies included, the quality assessment using GRADE, and the pre-registration and published protocol. In addition, this is the first review to incorporate coding of TIDieR guidelines against published physical activity intervention descriptions, which highlighted key characteristics such as dose and frequency of intervention contacts. This fine-grained detail is important in contributing to ongoing efforts such as the Human Behaviour Change Project that aim to build an ontology of behaviour change which will allow intervention designers to answer what works, with what behaviours, for who, and why (Michie et al., 2017).

Due to the limitations of reviewing BCTs pre-chosen by other researchers, or perhaps not reported within manuscripts, this review could not comment on the remaining techniques from the BCT taxonomy v1. Also, despite reaching the minimum threshold of 10, the small number of studies included in the meta-analysis seriously limited the power of the meta-regression and subgroup analysis. More studies would be needed to provide stronger evidence for the overall effects of the interventions and the true effects of individual BCTs, particularly the large post-intervention effect found for 'Biofeedback'. Also, although every effort was made to include only healthy inactive adults some of the studies only provided basic baseline data on which to make this decision. Furthermore, only English Language studies were included and, for resource reasons only 10% of the initial titles and abstracts were double-screened.

4.3.4. Conclusions.

The population highlighted in this review overall were inactive, overweight, and not reported to have any serious health conditions. This population is crucial in targeting individuals that may be at the tipping point of developing chronic health problems without sustained behaviour change. Physical activity interventions are effective in changing physical activity and maintaining these changes, with the evidence for maintenance effects being of greater quality. There is no evidence to date that longer-term changes in sedentary behaviour can be achieved by intervening with this population.

Overall reporting of behavioural interventions is in need of improvement. Adoption of the TIDieR guidelines, particularly details of fidelity assessment, and structuring the description of content using the BCT taxonomy v1, would vastly improve the ability of researchers, practitioners, and policy makers to interpret and replicate effective interventions. Standardisation of physical activity measurement would also be hugely beneficial for the translation of evidence synthesis into practical recommendations for practitioners and policy makers. This review provides those working across the spectrum of physical activity promotion with key information on how to commission, design, and implement physical activity interventions for adults who are at heightened risk of ill health due to inactivity.

Chapter 5

Theories of behaviour (change) for physical activity and sedentary behaviour

Study 1 evaluated physical activity and sedentary behaviour intervention effectiveness for behaviour change and behaviour change maintenance, and then looked at the BCTs associated with effectiveness for physical activity at two time points (post-intervention and six months later). When developing interventions, it is important to consider and consult theory and relevant frameworks. A comprehensive review of behaviour change theories already exists (Michie, West, Campbell, Brown, & Gainforth, 2014). The purpose of this chapter was to review only the most commonly used theories of behaviour (change) for physical activity and sedentary behaviour and their potential to guide intervention design, including the constructs, structure, predictive validity, and effectiveness.

5.1. The Transtheoretical Model

The reason for starting with the Transtheoretical Model (TTM; Prochaska & DiClemente, 1982, 1983) is that it is a model which Sport England still utilise to understand and conceptualise physical activity (Sport England, 2016). The TTM (Prochaska & DiClemente, 1982, 1983) was formulated from a synthesis of 18 different therapeutic approaches, and proposes five stages of change, which are precontemplation, contemplation, preparation, action, and maintenance. The Sport England literature referred to the five stages as 'not on my radar', 'thinking about it', 'planning to do something soon', 'getting started', and 'sticking with it' (Sport England, 2016). The first three stages are motivational (i.e. building an intention to act) and the last two are volitional (i.e. taking action). According to the TTM, someone in the precomtemplation stage is not intending to change for at least the next 6 months. A comtemplator is someone who is considering changing in the next 1-6 months. Someone in the preparation stage is intending to change within the next month and is preparing for this change. In the action stage, an individual would have enacted change for a period of up to six months, and someone in the maintenance stage would have successfully changed their behaviour for in excess of six months. These stages are predominantly at the level of individual processes and were originally conceptualised on the basis of addictive behaviour. Figure 5.1 provides a summary of the stages but movement forward and backward is often not linear (Sutton, 1996), which is one of the criticisms that will be covered later.

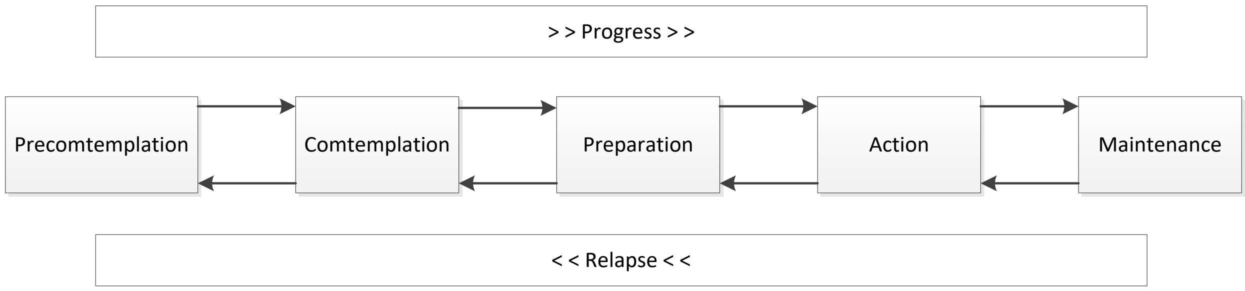

Figure 5.1. The Transtheoretical Model structure (Prochaska & DiClemente, 1982, 1983).

The TTM model also theorises ten cognitive and behavioural processes of change (Cognitive - consciousness raising, self-liberation, social liberation, self-reevaluation, environmental re-evaluation, and dramatic relief; behavioural - counterconditioning, stimulus control, reinforcement management, and helping relationships). These processes help progress the individual from one stage to the next, with particular processes more prevalent at different stages. Prochaska and DiClemente (1983) provided an example of smokers where consciousness raising (increased awareness and information processing) is most important in the contemplation stage. Other processes such as self-liberation (belief in one's ability to change and commitment to act) and reinforcement management (reward or punishment for engaging or not in the healthy behaviour), are more prevalent at the action stage (Prochaska & DiClemente, 1983). Two additional variables (decisional balance and self-efficacy/temptations) are concurrently involved at all stages. Decisional balance is the appraisal of the pros and cons of changing behaviour at any given time. Self-efficacy is the belief that the individual can perform the new behaviour, use the processes of change, and avoid triggers that are a catalyst for relapse (temptation).

The TTM (particularly the stages of change component) is popular with those working in practice, public health, and policy because it allows the conceptualisation of where a person might be on their journey towards changing their behaviour. By assigning discrete stages to people, interventions can, in theory, be tailored to the individual. However, the TTM does not explain why people may be at each stage and in reality it has not shown consistent success as a theoretical basis of behaviour change interventions

(Bridle et al., 2005), has been inconsistently applied in interventions, with only certain elements of the model involved (Hutchinson, Breckon, & Johnston, 2008), and suffers from a number of internal and external validity problems (Bunton, Baldwin, Flynn, & Whitelaw, 2000). In a systematic review, Bridle et al. (2005) found that only 11 (26%) out of 42 comparisons between a TTM-based intervention and control, showed the TTM-based condition to be more effective in changing a range of health behaviours. In the six physical activity interventions included in this review, only one showed greater effectiveness for the TTM-based intervention. Additionally, of the 18 comparisons using stage progression as the outcome, only six (33%) showed the TTM intervention to be more effective.

In a further systematic review of interventions to reduce sitting time, seven studies used the TTM as the basis of the intervention, and only two were shown to be effective compared to controls in reducing sitting (Gardner et al., 2016). One of the issues in TTM interventions, as with many other interventions that are referred to as 'theory-based', is that intervention designers have often only picked certain elements of the theory (mainly the stages of change) and neglected the full model. Hutchinson et al. (2008) conducted a review of 24 TTM-based intervention studies and found that only seven (29%) of the 24 studies utilised all four core components (five stages, 10 processes, self-efficacy, and decisional balance). Although all of the 23 studies used the stages of change, only 71% used the processes of change, 63% used decisional balance, and only 33% adopted the self-efficacy/temptation part of the TTM (Hutchinson et al., 2008). This prevents the full model from showing how behaviour change could occur. Other theories such as Social Cognitive Theory (Bandura, 1989, 2004) were also mixed in to the design of interventions which negates the ability to truly test the model, even when the core components are included.

The TTM has many conceptual flaws, which were detailed in an editorial calling for the model to be abandoned (West, 2005). One of the main criticisms was that the model promotes the movement of individuals through stages as an outcome, potentially at the expense of changes in actual behaviour, which are much more strongly shown as beneficial by evidence (West, 2005). Furthermore, Bridle et al. (2005) stated that the TTM does not accurately explain the barriers to stage progression and/or make predictions about how these barriers are surpassed. There is also evidence that specifying discrete stages may not be the best conceptualisation of behaviour change, with stages being unstable and individuals often in more than one stage, which do not necessarily have to be in sequential order (Littell & Girvin, 2002). Even the stages themselves fail to provide an explanation of why an individual might be in that stage, particularly why some people have not contemplated changing unhealthy behaviour at all (Bunton et al., 2000). Progression through stages is not always linear and in some instances is not needed at all, with Sutton (1996) providing an example of smokers who quit immediately and never smoke again.

A final criticism, which will re-appear throughout this chapter regarding the limitations of theories of behaviour (and behaviour change), is that the TTM is focused only on the internal cognitive mechanisms of the individual. The large influence that the physical and social environment can play in shaping performance of behaviour and behaviour change attempts is not included (Bunton et al. 2000). The focus on the individual, separated from wider community and society level determinants, limits the external validity of the model (Bunton et al. 2000). Despite the lack of supporting evidence, leading health organisations are still using the TTM to conceptualise behaviour change (Sport England, 2016). The enduring popularity of the TTM is at odds with the evidence of its effectiveness and validity, which suggests it is not a good theoretical basis to intervene to increase physical activity or reduce sitting (or change behaviour in general). It could, however, provide those working with individuals, a snap shot of whether behaviour change may, or may not, be on their agenda, allowing them to then draw on other theoretical approaches which may be able to better support behaviour change

5.2. The Theory of Planned Behaviour

An alternative to a stage-based theory is a continuum model where predictors of behaviour are combined in one prediction model and therefore model fit and variance in subsequent behaviour can be tested. The most ubiquitous continuum model is the Theory of Planned Behaviour (TPB; Ajzen, 1985, 1991), which evolved from the Theory of Reasoned Action (TRA; Fishbein & Ajzen, 1975). The TRA proposed that an intention to perform a behaviour was the most important factor in predicting behaviour, and that intentions were influenced by attitudes towards that behaviour and subjective norms. A positive attitude towards the required behaviour is more likely to form a solid intention to act, and attitudes are comprised of behavioural beliefs and outcome expectancies about whether performing the behaviour is beneficial or not. Also, if an individual is surrounded by social influences who look at the behaviour favourably, this can positively affect the intentions of the individual. Subjective norms are comprised of normative beliefs about whether important others approve of the behaviour and how much they are inclined to align their actions to the views of these important others.

Although useful, the TRA struggled to predict behaviours that were not perceived to be under the direct control of the individual. As a consequence, the TRA was modified to include perceived behavioural control (PBC) as an additional influence on intentions, and as a direct influence on behaviour (Ajzen, 1991). PBC is comprised of the control beliefs of the individual regarding the degree to which they see barriers or facilitators to performing the behaviour. The updated theory stated that only if an individual perceives themselves to be able to perform an action will they manufacture an intention to enact it. An individual also has to have the actual ability to perform the action, as perception is often not enough on its own. The TPB model (see Figure 5.2) presents intentions as a full mediator of the effect of attitudes and subjective norms on behaviour, and a partial mediator of the effect of perceived behavioural control on behaviour.

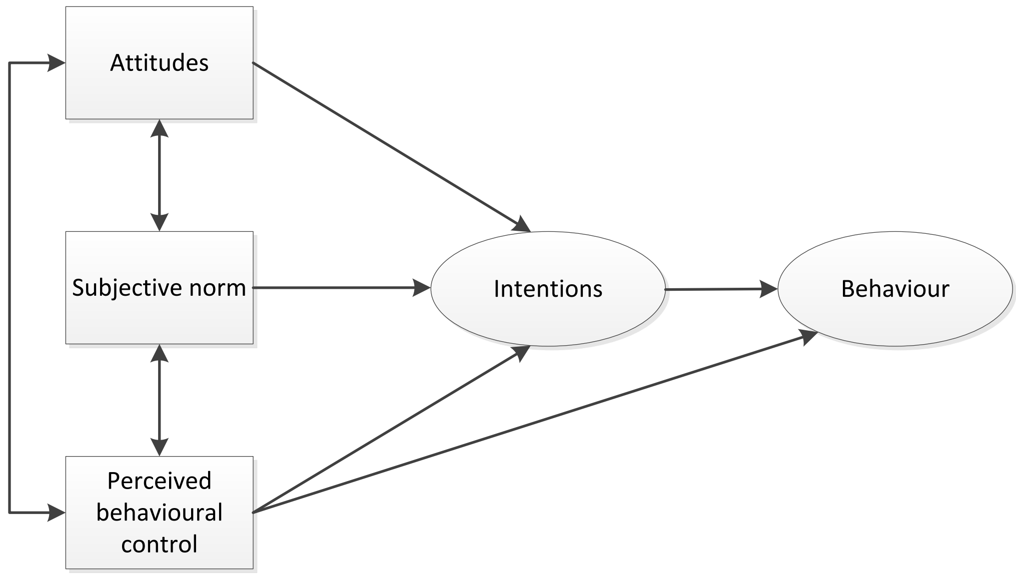

Figure 5.2. Structural path model of the Theory of Planned Behaviour (Azjen, 1985, 1991).

In two separate meta-analyses, totalling in excess of 300 studies, the TPB model was shown to predict between 24-27% variance in physical activity (Hagger, Chatzisarantis, & Biddle, 2002; McEachan, Conner, Taylor, & Lawton, 2011), with physical activity better predicted in student samples than in adults and adolescents (McEachan et al., 2011). The TPB also predicts greater variance in physical activity with shorter timespans between the measurement of antecedent variables (e.g. attitudes or intentions) and physical activity

(McEachan et al., 2011). Plotnikoff, Lubans, Trinh, and Craig (2012) conducted a longitudinal test of the TPB and found, in a Canadian sample of 1427 adults, that baseline TPB variables predicted only 13% of the variance in physical activity 15 years later, even when past physical activity was included in the model. Also, the TPB predicts more variance in behaviour, when physical activity is measured by self-report compared to objective measurements (McEachan et al., 2011), perhaps suggesting that perceptions of cognitions such as PBC and intentions are more closely linked to subjective perceptions of activity levels.

PBC and attitudes have been shown to be the strongest predictors of intention, although past behaviour becomes the strongest when added to the original TPB (Hagger et al., 2002; McEachan et al., 2011). Subjective norms are consistently the weakest predictor of intentions (Hagger et al., 2002; McEachan et al., 2011). Past behaviour and PBC are also the strongest predictors of behaviour, with the addition of past behaviour dramatically reducing the effect of intentions on behaviour (Hagger et al., 2002). Therefore, the hypothesised relationships in this model are mostly supported by research and the TPB shows predictive validity for physical activity under certain circumstances (self-reported physical activity in the short term). However, meta-analytic data do not support the causal mechanisms proposed by the model, particularly in relation to physical activity.

In a meta-analysis of 47 experimental tests, Webb and Sheeran (2006) found that a medium-to-large change in intention led to a small-to-medium change across a range of behaviours. Of the five studies attempting to change physical activity, all produced a significant increase in intentions but none resulted in a significant change in behaviour. In addition, intentions to be active at the beginning of an intervention did not predict physical activity performance or change over the following 12 months (Hardeman, Kinmouth, Michie, & Sutton, 2011). Furthermore, analysis has highlighted a significant gulf between intentions and behaviour with only 54% of individual intentions being translated into action in physical activity across studies (Rhodes & de Bruijn, 2013). The ‘gap’ between intentions and behaviour has long been highlighted as an issue, with planning, maintenance self-efficacy, and action control shown to be significant mediators (Sniehotta, Scholz, & Schwarzer, 2005). Specific plans in the form of implementation intentions also increase the likelihood that behavioural goals will be achieved (Gollwitzer & Sheeran, 2006). These additional post-intention constructs have led to more complex models such as the Health Action Process Approach (Schwarzer, 1992, 2008) which will be discussed in more detail shortly.

For sedentary behaviour the TPB can provide strong explanatory power. Rhodes and Dean (2009) tested the predictive validity of the TPB in samples of Canadian community adults and undergraduates on four different sedentary behaviours. The variance explained ranged from 25% (for student's reading/music and computer use) to 60% (for community adult's computer use). Further research has also highlighted that the TPB may be better at predicting non-volitional (at work) than volitional (leisure) sedentary behaviour, with weekday sedentary behaviour at work (43%) more strongly predicted than at leisure time (8%; Prapavessis, Gaston, & DeJesus, 2015). The variance explained in overall sedentary behaviour was 20%. A recent review of interventions designed to lessen sitting time also showed that only one of the three TPB-based interventions was effective (Gardner et al., 2016). The TPB may not be the best theoretical basis to produce meaningful change in physical activity and sedentary behaviour, because the full spectrum of potential influences are not included and using it as a basis for intervention does not often change either behaviour.

These inherent problems with the TPB led to a call for the model to be 'retired' (Sniehotta, Presseau, & Araújo-Soares, 2014). Sniehotta et al's. (2014) commentary stated that the TPB omits key unconscious processes such as habits (Gardner, De Bruijn, & Lally, 2011), emotions (Conner, Gaston, Sheeran, & Germain, 2013), and identity (Connor & Armitage, 1998), and conscious behaviour regulation processes such as planning (Rhodes & Dickau, 2012), all of which influence behavioural performance. Additionally, demographic factors such as age, SES, and physical and mental health often play a role over and above the specified constructs of the TPB (Sniehotta et al., 2013), as does the surrounding environment (Rhodes & Dickau, 2012). Overall the TPB was a useful conceptualisation of human behaviour that contributed significant knowledge to both researchers and practitioners, but a wider range of potential influences need highlighting, particularly to address the gap between intentions and behaviour (Rhodes & de Bruijn, 2013; Sniehotta et al., 2004).

5.3. Social Cognitive Theory

Social Cognitive Theory (SCT; Bandura, 1989, 2004) contains similar constructs to the TPB, with self-efficacy, outcome expectations (social, physical, and self-evaluative), socio-structural factors, and goals being the key determinants of behaviour. Self-efficacy is a belief in one's ability to perform a desired behaviour in the face of obstacles and overlaps considerably with perceived behavioural control (Ajzen, 2002). Outcome expectancies are similar to attitudes in being evaluations of the usefulness of the behaviour. Socio-structural factors include social facilitators such as the behaviour being acceptable among important others, and thus overlaps somewhat with subjective norms. SCT does, however, broaden facilitating factors by allowing for a wider range of facilitators and impediments from both the physical and social environment. Goals can be either short or long term and therefore cover the intentions aspect of the TPB. In the model outlined in Figure 5.3 self-efficacy affects behaviour both directly and indirectly through the other three constructs. Outcome expectations have a direct effect on behaviour and indirect effect through goals, whereas socio-structural factors have only an indirect effect on behaviour through goals. Goals subsequently have a direct effect on behaviour (Bandura, 2004).

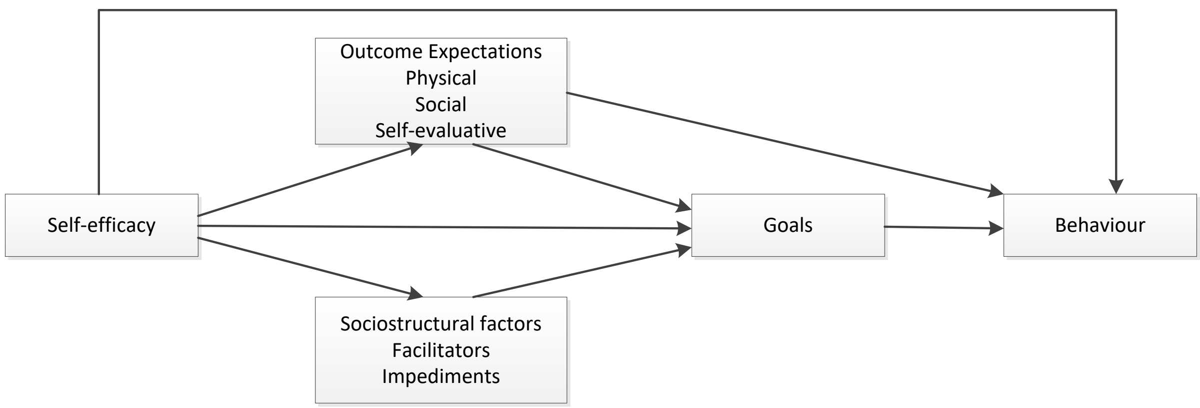

Figure 5.3. Structural path model of Social Cognitive Theory (Bandura, 1989, 2004).

A systematic review and meta-analysis explored the causal structure and predictive validity of SCT for physical activity, and found that of the three constructs postulated to have a direct effect on behaviour, self-efficacy and goals, were reliably associated with physical activity but outcome expectations were not (Young, Plotnikoff, Collins, Callister, & Morgan, 2014). SCT as a model predicted on average 31% of the variance in physical activity, with studies using older samples and being of higher quality producing increases in the variance explained (Young et al., 2014). Even though self-efficacy is the main construct affecting behaviour in SCT, interventions designed to change self-efficacy for physical activity only have a small effect (Ashford, Edmunds, & French, 2010). Furthermore, interventions designed to change intentions to be active (represented by goals in SCT) and the performance of physical activity, are effective in changing intentions but only have a small effect on increasing physical activity (Rhodes & Dickau, 2012). Despite difficulties with interventions targeting key theoretical constructs, a meta-analysis of randomised controlled trials (RCT) that utilised SCT to change physical activity were shown to be effective (average effect size d = .42 for SCT vs d = .26 for the TPB; Gourlan et al., 2016).

A recent review showed that three out of four interventions based on SCT, designed to change sitting time, were effective (Gardner et al., 2016). Overall SCT includes a wider range of potential physical and social facilitators and impediments than the TPB, explains a greater variance of physical activity, and achieves larger effect sizes as a theoretical basis for designing interventions. Despite these strengths, SCT does not account for the problem of translating goals into action or maintenance of behaviour change. Much research has suggested that developing short-term plans is relatively easy but does not lead to behaviour or long-term behaviour change (e.g. Rhodes & Dickau, 2012). For a model to be effective, the inclusion of factors which sustain enacted plans and behaviour change is necessary.

5.4. The Health Action Process Approach

Social cognitive continuum models such as the TPB have limitations, such as assuming the same predictors and linear associations between the predictors for every population and behaviour, and do not account for changes in cognitive appraisal and the arrival of barriers in the change process (Schwarzer, 2008). The TPB and SCT also propose that intentions or goals are the direct precursor to behaviour and therefore do not address the difficulties of translating intentions into action. The Health Action Process Approach (HAPA; Schwarzer, 1992, 2008) was proposed as a stage theory which improved on the explanatory value of the TTM and aimed to plug the intention-behaviour gap, from the TPB and SCT, with post-intentional influences and mediators. The HAPA separates behaviour change into a motivational stage, where intentions are formulated and post-intentional volitional stage where behaviour is enacted. Action self-efficacy, outcome expectancies, and risk perceptions, are proposed as the factors that influence intentions in the motivational stage (Schwarzer, 2008). Perceiving there to be some risk of performing a current unhealthy behaviour or of not performing a healthy behaviour, in combination with the belief that changing behaviour will be beneficial, is hypothesised to be more likely to engender intentions to change. Self-efficacy is divided into a number of types in this model with action self-efficacy being most important in developing an intention; this form of self-efficacy is a belief in oneself to perform a behaviour. The HAPA improves on the structure of the TTM by including processes of change in an integrated model (Figure 5.4).

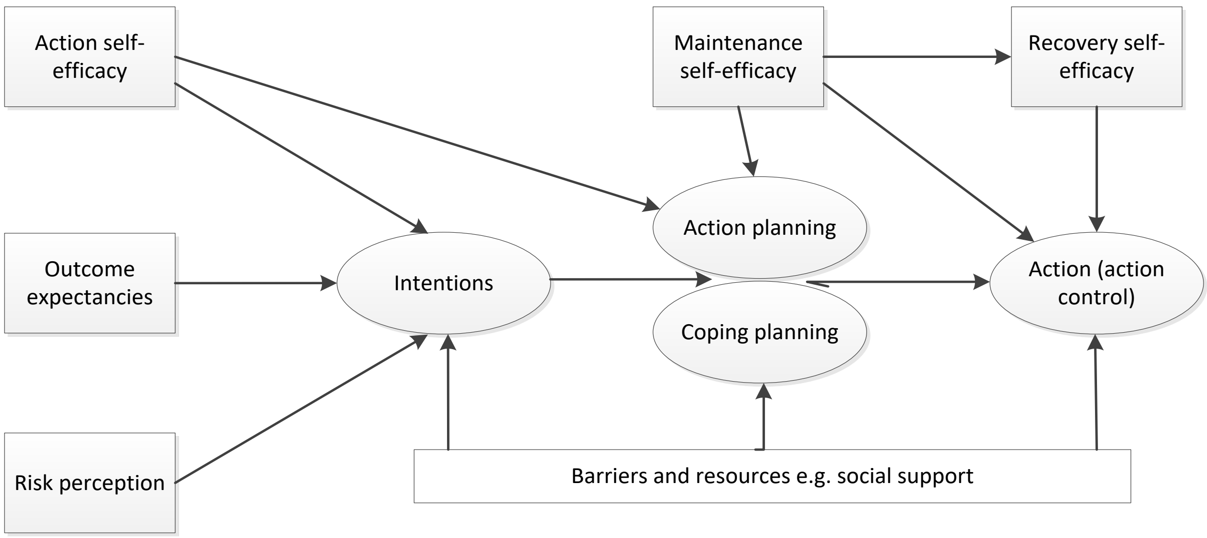

Figure 5.4. Structural path model of the Health Action Process Approach (Schwarzer, Lippke, & Luszczynska, 2011).

Once an intention is formed there are two proposed mediators of the translation of intentions into behaviour, which are action planning and coping planning (Schwarzer, 2008). Action planning is a fully specified plan involving the when, how, and where of behavioural performance (Gollwitzer, 1999), and has been shown in a meta-analysis to more effectively translate intentions into action (Gollwitzer & Sheeran, 2006). Coping planning involves the anticipation of barriers and how these might be overcome so that intentions can still be fulfilled. The HAPA suggests that during enactment of behaviour, maintenance self-efficacy plays an important role by giving an individual confidence in their ability to persist with a behaviour (e.g. physical activity) in the face of challenges both within the person (e.g. tiredness), and from the external environment (e.g. bad weather) (Schwarzer, 2008). Newer versions of the model also specify barriers and resources that can help facilitate the change process, with social support being a key factor (Schwarzer et al., 2011). The final type of self-efficacy proposed is recovery self-efficacy which plays an important role in helping people re-start a healthy behaviour after a lapse or forced interruption in performance (i.e. injury).

The theorised relationships in the HAPA have been tested in a variety of contexts and populations. Parschau et al. (2014) tested the predictive validity of the HAPA in a sample of obese adults and found it predicted 30% of the variance in intentions to be active and 18% of the variance in physical activity. It was also found that action self-efficacy, outcome expectancies, and social support were related to intention, and that recovery self-efficacy and social support were associated with physical activity (Parschau et al., 2014). This supports some of the hypothesised relationships from the HAPA but not all. This inconsistency in support for some of the factors contained in the HAPA is prevalent throughout the literature.

A review of the current evidence on theories which address the intention-behaviour gap, found only 12 studies which tested the specified mechanisms of the HAPA in relation to physical activity, of which only three experimentally tested the full model (Rhodes & Yao, 2015). The majority of studies supported the proposed effect of action self-efficacy and outcome expectancies on physical activity, but not risk perceptions. Furthermore, maintenance self-efficacy appeared to be the most consistent predictor of physical activity from the volitional stage of the model, with the potential for coping planning to be important, but only three studies analysed this (two were found to support the inclusion of this factor) (Rhodes & Yao, 2015). Of the three intervention studies, two showed increases in the HAPA-related intervention versus control conditions. However, all three studies only attempted to change action and coping planning, without addressing maintenance and recovery self-efficacy.

A modified version of the HAPA for sedentary behaviour was also recently tested, with habit strength as an additional predictor of sedentary behaviour (Maher & Conroy, 2016). Action self-efficacy was a significant predictor of intentions and planning (but outcome expectancies and risk perceptions were not). Planning was then a predictor of objectively-measured (ActivPAL3 activity monitor) sedentary behaviour on a daily basis (Maher & Conroy, 2016). Habit strength independently predicted sedentary behaviour and was the strongest predictor, with the overall model predicting 14% of the variance in sedentary behaviour (9% from habits and 5% from planning; Maher & Conroy, 2016). Much like the studies in physical activity, this study did not address maintenance and recovery self-efficacy.

The HAPA is an improvement on the TTM as it specifies only a pre and post-intentional stage instead of dividing the motivation part into smaller arbitrary stages that are often not distinct from each other. It also proposes potential barriers and the types of self-efficacy needed to overcome them, answering previous criticism of the TTM (Bunton et al., 2000; Littel & Girvin, 2002). The HAPA also improves on the TPB by suggesting processes that mediate the intention-behaviour gap and how relapse can be overcome. Nevertheless, the HAPA seems to explain a similar amount of variance in physical activity as the TPB and SCT, and has not been empirically tested as a basis for interventions in randomised controlled trials very often. Even when it has, the interventions have only partially tested the model, the results have been mixed for behaviour change, and some of the proposed mechanisms of change have not been supported (Rhodes & Yao, 2015). A final issue is that the HAPA mostly focuses on motivation and does not cover other internal (e.g. knowledge, health status) and unconscious (e.g. identity, emotions, impulses) processes.

5.5. The Motivation-Opportunities-Ability Model

The TPB, SCT, HAPA, and to a lesser degree TTM are all focused on the factors involved in forming motivation (e.g. intentions/goals) and how this then stimulates action. None of the four models include any factor covering physical ability to perform a behaviour and habit (aside from the TTM with counter-conditioning and stimulus control). The Motivation-Opportunities-Ability Model (MOA; Ölander & Thøgersen, 1995) goes some way to addressing these omissions by introducing a novel key construct in Ability, and a more elaborate Opportunity construct than the TPB (which only specifies subjective norms and not environment). The MOA model focuses on engagement in pro-environmental behaviour but could be applied to a number of other health behaviours. The Motivation construct is based on the TRA and therefore includes intentions, social norms, and attitudes (which are a function of beliefs about the behaviour and evaluations of possible outcomes). The Ability construct is comprised of habits (how much the behaviour has become routine) and knowledge (knowing how to perform the behaviour), and can both directly affect behaviour and moderate the motivation-behaviour relationship.

The Opportunity construct represents objective conditions which can facilitate behavioural performance (e.g. availability of exercise facilities). Although not defined by specific components, the Opportunity construct concentrates on the practical facilitators which make the translation of motivation into action most likely. This includes both limiting potential barriers and providing the right tools (appropriate exercise equipment for physical activity) to perform the desired behaviour. Performance of the behaviour can then have a reciprocal influence on Ability and beliefs. For instance, starting an exercise programme may be perceived as very difficult and will initially cause muscles to ache. When the behaviour is performed several times this will strengthen habits and task knowledge and be perceived as more manageable, building more positive beliefs about outcomes.

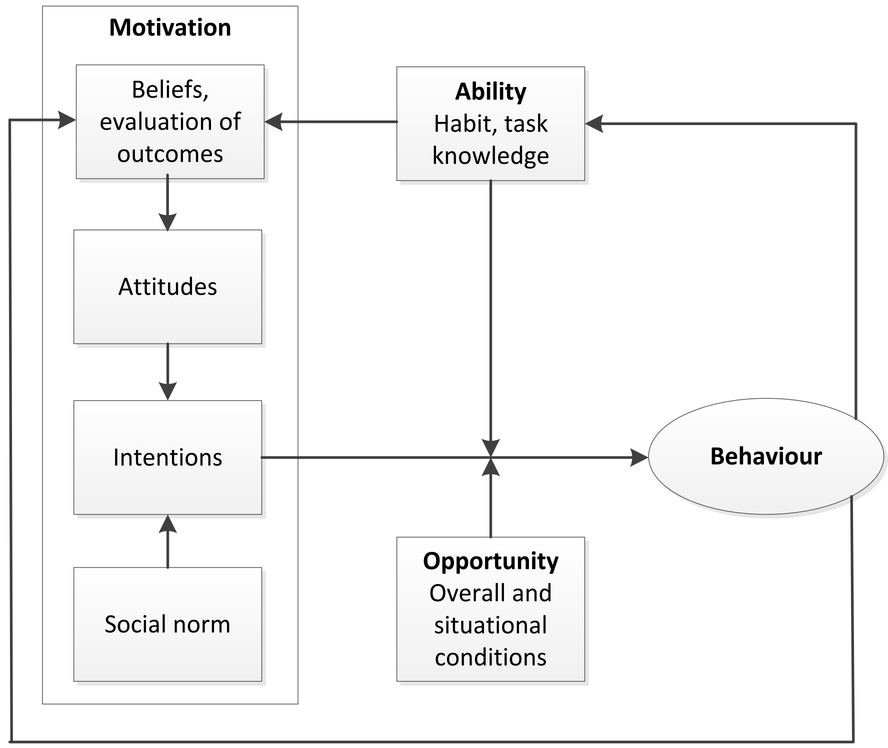

Figure 5.5. The Motivation-Opportunities-Ability model structure (Ölander & Thøgersen, 1995).

The MOA model improves on previous continuum models by adding a wider range of drivers of behaviours. However, much like the TPB, the social norm construct is still too narrow to capture the range of social influences (e.g. injunctive norms, moral norms, descriptive norms, social support). A recent review of models that attempted to address the often poor relationship between intention and behaviour, found no observational or experimental tests of the Motivation-Opportunities-Ability model for physical activity (Rhodes & Yao, 2015). Therefore, to date it is not possible to tell how well it predicts different behaviours, or whether targeting the constructs specified in the model in an intervention produces meaningful changes in behaviour in a controlled trial. The model is, however, a closely aligned pre-cursor to the COM-B model of behaviour (Michie et al., 2011), which replaces Ability with Capability and adds a number of components that specify Opportunity (Cane et al., 2012). The COM-B model will be explored in greater detail in the next two chapters (Study 2 and 3).

5.6. The Social Ecology Model of Behaviour Change

The final consideration that previous models have not alluded to, is the importance of the wider social ecological context in which a behaviour change intervention is implemented. The Social Ecology Model (Panter-Brick, Clarke, Lomas, Pinder, & Lindsay, 2006) of behaviour change proposes a familiar set of psychosocial antecedents of intentions and behaviour change. However, the model also focuses on the social ecology in which the behaviour is performed and suggests that interventions have to be not just acceptable but compelling to be effective. Based on the work of Fishbein (2000), the Social Ecology Model suggests that attitudes, social norms, and self-efficacy influence intention, which is the main precursor to behaviour change. For intentions to be translated into behaviour (change) two key considerations are postulated. The main one is that the social ecology needs to be factored into intervention design and implementation. Social ecology refers to the social and physical settings, and the relationship between the individual and external factors (Panter-Brick et al., 2006). This includes the skills and abilities of the individual, local and wider investments (financial, political, and community-based), and real constraints such as time and money. In this way the social ecological model is aligned closely with the Dahlgren-Whitehead rainbow model which emphasises the individual at the centre of a wider system, including lifestyle factors, social and community networks, living and working conditions, and socio-economic, cultural, and environmental conditions (Dahlgren & Whitehead, 1991).

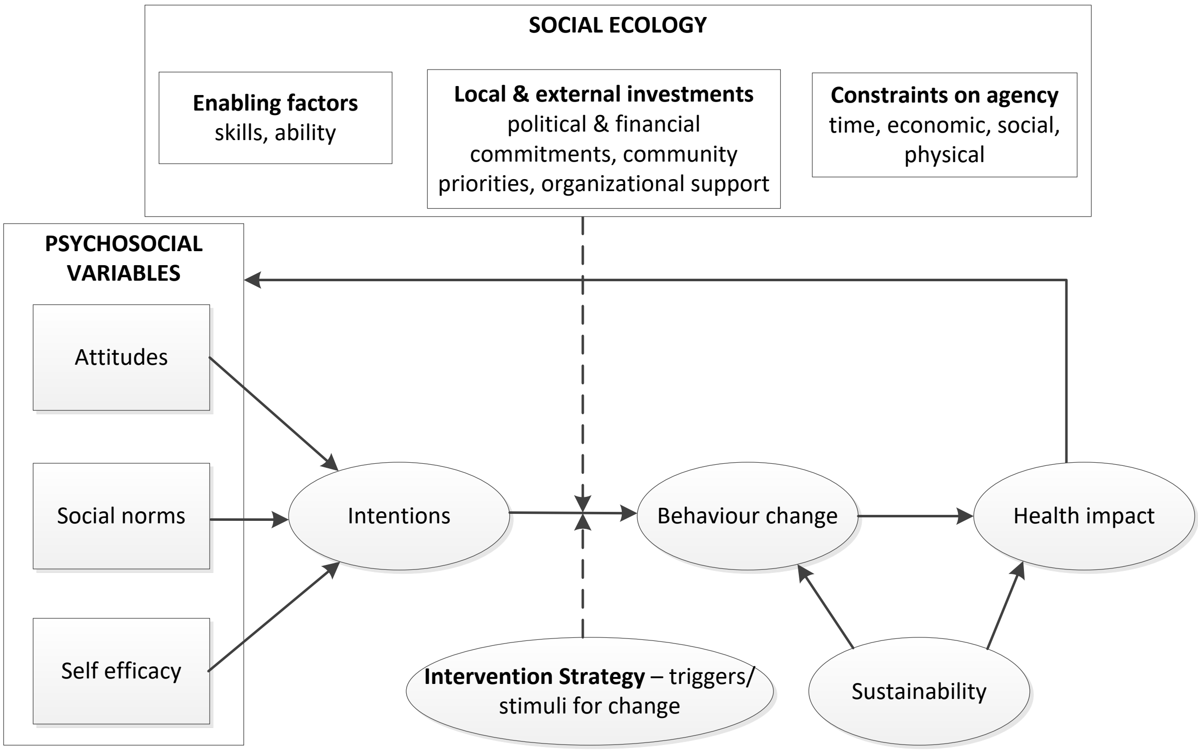

Figure 5.6. The Social Ecological Model for Behaviour Change model structure (Panter-Brick et al., 2006).

The Social Ecology Model also suggests that the intervention strategy acts as a catalyst for change and that making messages and approaches as compelling as possible for the target audience, will help convert intentions into behaviour change. Compelling in this context refers to both how entertaining and thought provoking the strategy is and how well it is housed within the social and physical community setting (Panter-Brick et al., 2006). Unlike many previous models the Social Ecology Model posits an additional stage, drawing a distinction between behaviour change and health impact. The first does not always equal the second, and health impact needs to be both objectively measured and perceived as true by the local community in question.

Evidence of effectiveness can also be shown through sustainability of behaviour change and health impact, and with how the health impact feeds back into changes in the psychosocial variables such as self-efficacy and attitudes (Panter-Brick et al., 2006). In support of a social ecology perspective, a review of theories of behaviour change maintenance highlighted environment and social influences as a key theme from previous research (Kwasnicka, Dombrowski, White, & Sniehotta, 2016). However, like many behaviour change theories the Social Ecology Model has not been tested extensively to ascertain how well it predicts behaviour change, and how effective interventions that target the key processes proposed by the model are compared to alternatives or controls.

5.7. In summary

This review of behaviour change theories relevant to physical activity has shown that categorising someone as belonging to a stage of change can be useful, but the journey through stages is hard to define and predict. Intention-based models have helped explain and change physical activity but it is often challenging converting these good intentions into lasting physical activity change, with many potential moderators. The wider health impact of behaviour change is important to consider, and interventions should ideally understand the social and physical barriers and facilitators affecting the target behaviour. Any model needs to consider a wide range of internal and external determinants, with appropriate intervention strategies and policy changes to enable behaviour change. The next two chapters analyse the COM-B model (Capability, Opportunity, Motivation – Behaviour; Michie et al., 2011) in relation to physical activity (Study 2) and sitting behaviours (Study 3), and compare the predictive validity of this model with the TPB.

Chapter 6

Study 2: Examining the COM-B model for physical activity

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6.1. Introduction

Previous chapters have outlined a clear need for effective, replicable, and scalable physical activity interventions. However, interventions to change health behaviours have often suffered from a poor description of their content and implementation (i.e. the how, what, and where; Hoffmann et al., 2014), the specific behaviour change techniques (BCTs) utilised (Michie et al., 2013), and the underlying theoretical basis (Michie, Fixen, Grimshaw, & Eccles, 2009). Without a sound theoretical basis which both predicts physical activity levels and provides a rationale for the design of physical activity interventions, as well as criteria for its success, it is difficult to evaluate empirical evidence and replicate. A review of healthy eating and physical activity interventions found that only 56% reported using any theory at all, 24% measured pre-post changes in theoretical constructs, and just 5% targeted all theoretical constructs with specific intervention techniques (Prestwich et al., 2014).

A range of psychological models were presented in the previous chapter and many of them have been used to explain individual differences in physical activity. The most commonly used model has been the Theory of Planned Behaviour (TPB; Ajzen, 1991). The TPB predicts between 24-27% of variance in physical activity performance (McEachan et al., 2011) and meta-analytic analysis does not, however, provide strong evidence for the causal link between changes in intention and behaviour suggested by the TPB and other models (Webb & Sheeran, 2006). One of the reasons is that they omit important influences on physical activity such as self-regulation and affect (Rhodes & Dickau, 2012), as well as wider aspects such as physical capability and environmental opportunity. As yet, the usefulness of these models to serve as a framework for designing physical activity interventions is limited.

In providing a more clearly defined systematic approach to designing behaviour change interventions, Michie et al. (2011) reviewed existing frameworks and found that none combined comprehensiveness, coherence, and a clear link to a model of behaviour change. The previous frameworks were, therefore, synthesised into the Behaviour Change Wheel (BCW), which allows systematic development of behaviour change interventions (Michie et al., 2011; Michie et al., 2014). At the centre of the BCW is the COM-B model of behaviour. The COM-B specifies Capability (physical and psychological), Opportunity (social and physical), and Motivation (reflective and automatic), as the drivers of behaviour. The model also posits that both Capability and Opportunity influence Motivation making it the central mediator of the model. Capability and Opportunity, therefore, affect behaviour through an indirect as well as a direct path.

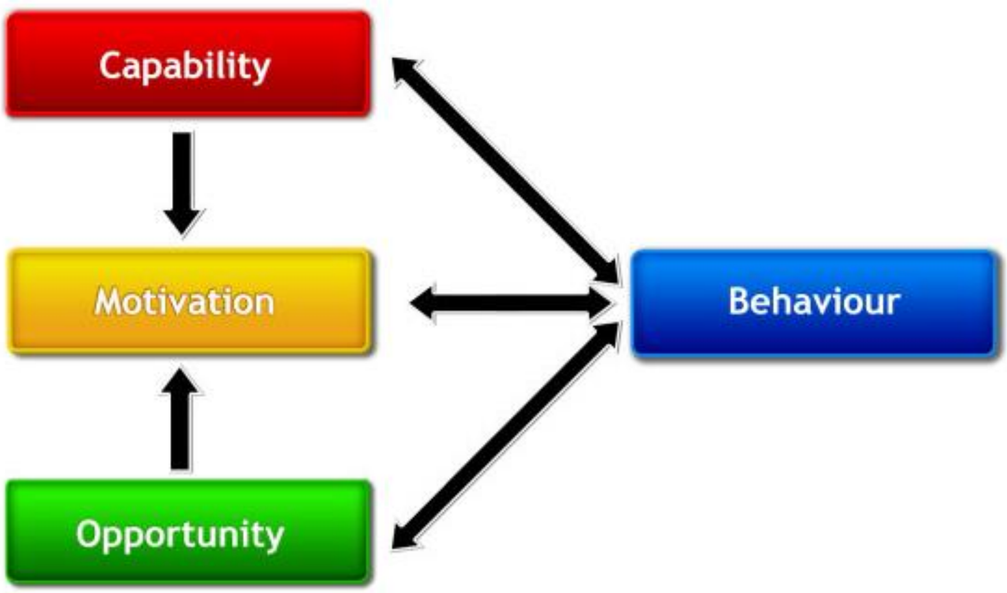

Figure 6.1. The COM-B model of Behaviour (Michie et al., 2011).

In summarising theories of behaviour that often contain overlapping constructs, 112 theoretical constructs were synthesised, leading to the current Theoretical Domains Framework (TDF), consisting of 14 domains (Cane et al., 2012). The TDF covers the spectrum of behavioural determinants and can be directly mapped on to the COM-B (see Table 3 in Cane et al., 2012). These include constructs aligned to those mentioned previously in earlier theories such as the TPB (i.e. beliefs about capabilities = perceived behavioural control/self-efficacy). Each domain can be further specified by a number of core components. For instance, the behavioural regulation domain contains self-monitoring, breaking habit, and action planning components (Cane et al., 2012). However, the relevance of these TDF components depends on the target behaviour as well as on its target population. For instance, organisational commitment is a component of the social/professional role domain. This would not be relevant for leisure time physical activity. The comprehensive coverage of the TDF allows researchers to analyse the most important domains specific to their populations and behaviours of interest. This allows a crucial step forward in predicting, and ultimately changing, physical activity by providing a much wider range of determinants than previous models have afforded.

This study explores the usefulness of the TDF for empirically identifying measures that are appropriate to represent the key drivers, Capability, Opportunity, and Motivation which, according to the COM-B, can be expected to influence levels of physical activity (Michie et al., 2011). This study is a first step towards the development of a measurement model in the area of adult physical activity. The three constructs of the COM-B represent theoretical or latent variables which require an operationalization resulting in a measurement model. A measurement model displays the relationship between the selected measures for each construct and can be examined for its goodness of fit. This study opted for a formative rather than a reflective measurement model (Perron & Gillespie, 2015). In a formative model, the content of a construct is defined by its empirical indicators (i.e. the actual measures). Crucially, this implies that its content can change with different measures being selected. By contrast, in a reflective model the constructs are assumed to exist as latent variables and to influence the selected measures serving as empirical indicators (Bollen & Lennox, 1991; Bollen & Diamantopoulos, 2015).

There have been two COM-B-related questionnaires developed for physical activity, but both have serious limitations. Taylor, Lawton, and Conner (2013) developed a questionnaire based on a previous version of the TDF which contained 11 domains (but only seven of the 14 current TDF domains), asking three questions for each domain. Some domains had low internal consistency (e.g. beliefs about capabilities, knowledge) and the predictive validity of the measure was not tested. Taylor et al. (2016) also developed a COM-B questionnaire for children, which was brief, not mapped onto the TDF domains, and only captured narrow elements of the three COM-B constructs. This study only tested predictive validity in terms of BMI and only the Capability measure showed a relationship with lower BMI.

The constructs of the COM-B depend on the population and behaviour in question, and so cannot be assumed to represent unique entities that are quantifiable by a set of standard measures. Rather, their content can vary considerably between studies and so they have been conceptualized by domains from the TDF, each with its own range of potential components. The COM-B constructs are, therefore, more appropriately defined as an index, where each of the selected measures contributes to its formation according to its weight (Diamantopoulos & Winklhofer, 2001). Because a formative measurement model rests on the assumption that the selection of indicators for defining a construct is valid, it is important to evaluate whether their links (i.e. weights) with the corresponding construct are each statistically reliable and of notable size. The recent combination of Partial Least Squares (PLS) with Structural Equation Modelling (SEM; Hair Jr, Hult, Ringle, & Sarstedt, 2013; Henseler, Hubona, & Ray, 2016) provides an ideal statistical framework for such an exploration as it allows researchers not only to evaluate a proposed formative measurement model of the COM-B, but also the predictive validity of the constructs with respect to physical activity.

The ubiquitous nature of the TPB in both cross-sectional, prospective, and intervention studies makes it an ideal model to compare with the predictive validity of the COM-B. Accordingly, we investigated the following four hypotheses in a sample of healthy adult participants;

(1) The three constructs, Capability, Opportunity, and Motivation of the COM-B can be represented as latent variables each defined by selected measures representing domains from the TDF
(2) Each COM-B construct uniquely accounts for a portion of the variance in moderate-to-vigorous physical activity (MVPA) over a one-week period
(3) Capability and Opportunity will influence MVPA directly as well as indirectly with Motivation as a mediator
(4) The predictive validity of the COM-B model will be stronger than that of the TPB in relation to MVPA over a one-week period.

6.1. Method

6.1.1. Participants.

This study used a prospective survey design using questionnaires relating to the TDF completed at baseline and the assessment of MVPA collected seven days later. Individuals were eligible for participation if they had no conditions preventing them performing regular physical activity, were over 18, and resided in the UK. Data were collected using opportunity sampling between November 2014 and April 2015. In total 214 participants completed an online survey, but 11 were excluded (one was under 18, 10 were not residents of the UK) and 17 did not respond to contact requests for the follow-up phone call. The final sample size was 186 and relevant demographic information is included in Table 6.1.

Table 6.1.

Sample demographics (N = 186).

Characteristics		**Means (SD)[a] and frequencies (percentages)[b]**
Age[a]		38.25 (14.12), range 18-74
BMI[a]		24.58 (4.67), range 14.3-44.1
Female participants[b]		132 (71)
Smoker[b]		10 (5)
Highest education level (or equivalent)[b]:	GSCE	7 (4)
	A Level	35 (19)
	Bachelors degree	60 (32)
	Masters degree	62 (33)
	PhD	22 (12)
Employment[b]:	Full-time work	88 (47)
	Part-time work	30 (16)
	Flexible hours	4 (2)
	Full-time student	37 (20)
	Part-time student	4 (2)

	Retired	5 (3)
	Unemployed	4 (2)
Salary Level[b]:	£0-25000	22 (12)
	£25001-50000	63 (34)
	£50001-75000	34 (18)
	£75001-100000	21 (11)
	Over £100000	11 (6)
Marital Status[b]:	Married	81 (44)
	Living with partner	32 (17)
	Single	53 (29)
	Divorced	6 (3)
	Separated	5 (3)
	Widowed	1 (1)

A post-hoc sensitivity analysis revealed that this sample size was large enough to detect a modest effect size correlation (r = .23) with a power of .90 and an alpha error of 5% (two-tailed).

6.1.2. Measures.

Measures were selected based on published components mapped onto TDF domains listed within Table 2 of Cane et al. (2012). The 14 TDF domains are: Knowledge; Skills; Memory, attention and decision processes; Behavioural regulation; Social influences; Environmental context and resources; Social/Professional role & identity; Beliefs about capabilities; Optimism; Beliefs about consequences; Intentions; Goals; Reinforcement; Emotion. Measures were selected for components relevant for MVPA and where published questionnaires could be identified. There were some TDF components that were deemed unnecessary to measure. For example, under the knowledge domain the following three components are listed: Knowledge (including knowledge of condition/scientific rationale); Procedural knowledge; Knowledge of task environment. Procedural and environment knowledge would only be relevant for a particular form of exercise in a particular place (i.e.

playing tennis in a public park), and not for generic MVPA. Therefore, these components were not measured in this study. In contrast, within the behavioural regulation domain, self-monitoring, breaking habits, and action planning are all relevant for MVPA and therefore measures were identified for all three components within this domain.

Five measures were identified as defining the Capability construct, six for Motivation and four for Opportunity (see Appendix C for full measures). The following measures were used as formative indicators for Capability, Opportunity, and Motivation (Table 6.2), with higher scores representing high levels in each domain (e.g. stronger intentions or a greater level of self-monitoring or knowledge.

Table 6.2.

Mapping of COM-B to the TDF domains, with the appropriate questionnaire measures representing key components for physical activity (based on Cane et al., 2012).

COM-B construct	TDF Domain	Indicator and measure
Capability	Knowledge	Knowledge (Physical activity guideline questions; NHS Choices)
	Memory, attention and decision making	*No appropriate validated measures*
	Behavioural regulation	Self-monitoring (Sniehotta, Scholz et al., 2005) Breaking habit (Self-report habit index; Verplanken & Orbell, 2003) Action planning (Sniehotta, Schwarzer, Scholz, & Schuz, 2005)
	Physical ability (Skills)	Ability (Medical Outcomes Short Form Survey; Ware & Sherbourne, 1992)
Opportunity	Social influences	Social support (family and non-family) (Social Support for Exercise Behaviour Scale; Sallis, Grossman, Pinski, Patterson, & Nader, 1987) Social/group norms (subjective norms; Francis et al., 2004)

	Environmental context and resources	Barriers and facilitators (Neighbourhood Environment Scale; Echeverria, Diez-Roux, & Link, 2004) Resources/material resources (Presence of Recreational Facilities Index; Echeverria et al., 2004)
Motivation	Social/professional role and identity, Optimism	Identity (Exercise Self-Identity Scale; Anderson & Cychosz, 1994)
	Beliefs about capabilities	Self-efficacy (Physical Exercise Self-Efficacy Scale; Schwarzer & Renner, 2009) Perceived behavioural control (Francis et al., 2004)
	Beliefs about consequences	Beliefs (Attitudes; Francis et al., 2004)
	Intentions	Intentions (Francis et al., 2004)
	Goals	Covered by action planning (included in capability)
	Reinforcement	*No appropriate validated measures*
	Emotion	Positive/negative affect (International Positive and Negative Affect Schedule Short Form; Thompson, 2007)

6.1.2.1. Capability construct (5 measures).

Physical ability (skills) was measured with the 10-item physical functioning scale of the Medical Outcomes Short Form Survey (Ware & Sherbourne, 1992). The items were activities one might do during a typical day (e.g. climbing several flights of stairs). Participants were then asked about how much their health limits them in these activities and, if so, how much on a scale from 1 '*Yes, limited a lot*' to 3 '*No, not limited at all*'. This scale showed excellent reliability (a = .87).

Ability to self-monitor was measured by two items, which asked participants to rate how much they agreed with statements such as 'I constantly monitored myself whether I exercise frequently enough' on a scale from 1 '*Completely disagree*' to 4 '*Totally agree*', retrospectively over the past week (Sniehotta, Scholz et al., 2005). This scale showed good reliability (*a* = .82).

Ability to plan for action was measured by four items about when, where, how, and how often participants had made detailed plans regarding physical activity on a scale from 1 '*Completely disagree*' to 4 '*Totally agree*', retrospectively over the past week (Sniehotta, Schwarzer, et al., 2005). This scale showed excellent reliability (*a* = .98).

Ability to control habit was measured with the Self-Report Habit Index (Verplanken & Orbell, 2003), containing 12 items exploring the past history and automaticity of their physical activity. The items were prefaced by 'Regular exercise is something…' Participants were then asked to rate the extent to which they agreed with each statement (e.g. 'I do without thinking') based on a 7 point scale from 1 '*Disagree strongly*' to 7 '*Agree strongly*'. This scale showed excellent reliability (*a* = .96).

As there was no validated measure, knowledge of physical activity was measured by asking participants three multiple choice questions, which map directly onto the three main parts of the national physical activity guidelines (Bull et al., 2011). The questions referred to the recommended amount of moderate, vigorous, and muscle-strengthening activity, adults should perform per week. For example, 'How much time should you spend doing moderate physical activity a week'? The answer options were '*50*', '*100', '150',* or '*200 minutes'*.

6.1.2.2. Opportunity construct (4 measures).

Barriers and facilitators in the local environment (within a 20 minute walk from residence) for physical activity were measured with the Neighbourhood Environment Scale (Echeverria et al., 2004) which consisted of 10 items. An example item was 'My neighbourhood offers many opportunities to be physically active', with responses on a scale from 1 '*Strongly disagree*' to 5 '*Strongly agree*'. This scale showed acceptable reliability (*a* = .72).

The availability and condition of local resources (within a 20 minute walk from residence) was also explored using the Presence of Recreational Facilities Index (Echeverria et al., 2004) consisting of six items. The availability of each type of facility (e.g. public park) was measured based on a yes or no answer. The condition of the facilities was then measured on a scale from 1 '*Poor*' to 4 '*Excellent*' if applicable.

Subjective norms were measured with three items (Francis et al., 2004). Each item referred to the amount of physical activity the individual would do over the next week that was influenced by their social environment, and was rated on a 7-point scale from 1 '*Strongly disagree*' to 7 '*Strongly agree*'. One item was removed ('I feel under social pressure to take part in regular physical activity over the next week'), which improved the reliability (from a =.50 to a = .60). This measure was also used in the TPB analysis.

Social support for physical activity was measured with 10 items from the Social Support for Exercise Behaviour Scale (Sallis et al., 1987). Five items assessed support for physical activity from friends, acquaintances or co-workers, and five items measured support from family (members of household). An example of 'exercised with me' asked participants to rate how often in the last week the people around them had done, or said these things, on a scale from 1 '*None*' to 5 '*Very often*'. Both scales showed excellent reliability (a = .88 and a = .89 respectively).

6.1.2.3. Motivation construct (6 measures).

Self-efficacy was measured with the Physical Exercise Self-Efficacy Scale (Schwarzer & Renner, 2009), which consisted of five items exploring participants' ability to carry out their behavioural intentions in the face of challenges, such as 'even when I feel tense'. The items were measured on a scale from 1 '*Very uncertain*' to 4 '*Very certain*' and showed excellent reliability (a = .88).

Perceived behavioural control was measured with four items (Francis et al., 2004). Each item referred to the amount of physical activity the individual will do over the next week. Three items were rated on a 7-point scale from 1 '*Strongly disagree*' to 7 '*Strongly agree*', and included statements such as 'The decision to take part in regular physical activity over the next week is beyond my control'. One item asked participants to rate how difficult it was going to be to engage in physical activity over the next week on a scale from 1 '*Very difficult*' to 7 '*Very easy*'. This scale showed good reliability (a = .74). This measure was also used in the TPB analysis.

Attitudes were measured with four items (Francis et al., 2004). Each item referred to beliefs in terms of how harmful, healthy, enjoyable, and boring, physical activity was viewed on a set of 7-point scales anchored by negative and positive views (e.g. 1 '*Very unhealthy'* to

7 ‘*Very healthy*’). This scale showed acceptable reliability (a = .69). This measure was also used in the TPB analysis.

Intentions were measured with three items (Francis et al., 2004). Each item referred to the amount of physical activity the individual intended to do over the next week with statements such as ‘I expect to take part in regular physical activity over the next week’. Each item was rated on a 7-point scale from 1 ‘*Strongly disagree*’ to 7 ‘*Strongly agree*’ and showed excellent reliability (a = .91). This measure was also used in the TPB analysis.

Exercise self-identity was assessed by the nine-item Exercise Self-Identity Scale (Anderson & Cychosz, 1994), which measured whether exercise is descriptive of an individual’s self-concept. An example was, ‘I consider myself an exerciser’ measured on a scale ranging from 1 ‘*Strongly disagree*’ to 7 ‘*Strongly agree*’. This scale showed excellent reliability (a = .96).

Positive and negative affect were measured with the International Positive and Negative Affect Schedule Short Form (Thompson, 2007), which consisted of 10 items that cover negative (e.g. afraid) and positive (e.g. inspired) affect. Participants were asked on a scale from 1 ‘*Never*’ to 5 ‘*Always*’ how often they had felt each item over the last week. The scales showed good (positive, a = .83) and acceptable (negative, a = .75) reliability respectively.

6.1.3. Dependent variable.

Physical activity was measured with the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003). Four questions assessed the level of MVPA of each participant by asking the amount of time spent being active and on how many days for both moderate and vigorous intensities. The questionnaire was administered over the phone to reduce the tendency for participants to overestimate their self-reported activity on this measure (Lee et al., 2011). Engaging in more detailed probing through a phone call allowed a more thorough exploration of each instance of activity. This improves the accuracy of reporting, often reducing the over-reporting of both the time spent and intensity of physical activity (Rzewnicki, Auweele, & Bourdeaudhuij, 2003). In order to correct for outliers, reported moderate or vigorous physical activity which exceeded 180 minutes in any day was truncated to be equal to 180 minutes (nine participants). A Metabolic Equivalent of Task (MET) score was then calculated for each activity type by weighting its energy requirements, with 4 METs for moderate-intensity activity and 8 METs for vigorous-intensity activity. A total MVPA MET score was then calculated from the sum of moderate and vigorous-intensity MET-minutes/week score (International Physical Activity Questionnaire, 2005).

6.1.4. Ethics

This research was approved by the University of Hertfordshire Health and Human Science Ethics Committee with Delegated Authority (protocol number: aLMS/SF/UH/00079; Appendix D).

6.1.5. Procedure

A survey link was posted on social media sites (Facebook, Twitter, LinkedIn), relevant online forums (postgraduate, research), and distributed by email and online by colleagues and public health contacts. Participants were shown information (Appendix E) and gave their consent electronically (Appendix F) and were then taken to a page asking for a preferred contact time for the follow-up phone call and health and demographic information (Appendix G). Thereafter they completed all questionnaires online, collecting COM data and the last page provided a short debrief of the nature of the study and reminded participants about the follow-up. Participants were called to complete the IPAQ via phone 1 week after completing the baseline questionnaires. The day before the follow-up phone call was due, a reminder email was sent. Participants who then answered the call were asked the IPAQ questions about their MVPA for the past seven full days. An attempt to call was made on three occasions if the first call was not answered. Participants were then debriefed fully (Appendix H) and thanked over the phone.

6.1.6. Analysis.

Prior to running the analysis, boxplots were used to explore the distributions of the measures for anomalies such as outliers and deviation from normality. Total MVPA MET scores showed a positively skewed distribution (skewness = 1.31) and were, therefore, submitted to a square root transformation (skewness = -.06). For the COM-B analysis, the PLS technique was employed to obtain estimates and fit indices for the proposed measurement and prediction model within the context of SEM using SmartPLS 3 software (Garson, 2016; Hair Jr et al., 2013; Ringle, Wende, & Becker, 2015). The default settings of the PLS algorithm were used to obtain the weights for the outer (i.e. the measurement model) and inner model (i.e. the path model of the constructs) and no convergence problems occurred. Multicollinearity was tested within the inner and outer model, with VIF

< 5 as the suggested cut-off (Garson, 2016). Confidence intervals for the path coefficients were obtained through a bootstrapping method. A final measurement model was established through model trimming by removing statistically non-significant (*p* > .05) indicators step by step. The standardised root mean square residual (SRMR) was used to assess model fit overall with .08 used as cut-off for acceptability (Hu & Bentler, 1998). Cross-loadings of the indicators were examined to explore their unique relationship with the construct they were supposed to define. Finally, estimates for the direct and indirect path coefficients of the inner model were obtained as well as the explained variance R^2 for the two endogenous variables, Motivation and MVPA. All coefficients are reported as standardized.

The TPB path analysis was conducted on IBM SPSS AMOS 22. A final measurement model was established through model trimming by removing statistically non-significant (*p* > .05) paths step by step. The Chi-Square statistic was used to test model fit with greater p-values suggesting better fit. The Tucker Lewis coefficient (TLI, cut-offs: acceptable fit > .90; good fit cut-off > .95), Comparative Fit Index (CFI, cut-offs: acceptable fit > .90; good fit cut-off > .95), and Root Mean Square Error of Approximation (RMSEA, cut-offs: acceptable fit < .08; good fit cut-off < .05, Browne & Cudeck, 1993) were used as additional model fit indices.

6.2. Results

There was no relationship between MVPA and age, and MVPA and BMI. There was however a borderline difference in MVPA between male and female participants, with male participants doing more, $t(184) = -1.85$, $p = .066$, and therefore sex was included in the initial measurement model. Descriptive statistics, ranges for each measure, means, and standard deviations for all formative indicators, and for the dependent variable are presented in Table 6.3. This sample was active overall, with 23.7% achieving the national recommendations of at least 150 minutes of moderate activity and 46.2% achieving at least 75 minutes of vigorous activity. When combining moderate and vigorous activity 53.2% achieved at least 150 minutes.

Table 6.3.

Descriptive statistics for all formative indicators and MVPA (N = 187).

	Measure (possible range from minimum to maximum)	Mean (SD)
Physical Activity Indicators	Knowledge (0-3)	1.10 (.96)
	Physical Health (1-3)	2.87 (.26)
	Self-Efficacy (5-20)	14.28 (3.86)
	Attitudes (1-7)	6.31 (.76)
	Intentions (1-7)	6.10 (1.48)
	Subjective Norms (1-7)	5.03 (1.62)
	Perceived Behavioural Control (1-7)	5.70 (1.27)
	Habits (1-7)	4.42 (1.75)
	Local Environment (10-50)	37.64 (6.51)
	Availability (1-6)	3.45 (1.37)
	Condition (1-4)	3.02 (.66)
	Self-Monitoring (1-4)	2.45 (.97)
	Action Planning (1-4)	2.47 (1.03)
	Social Support (Non-family) (5-25)	9.05 (5.17)
	Social Support (Household) (5-25)	8.42 (4.58)
	Positive Affect (5-25)	17.68 (3.55)
	Negative Affect (5-25)	10.36 (3.40)
	Exercise Self-Identity (1-7)	4.77 (1.88)
Dependent Variable	Vigorous Minutes per week	95.49 (121.12)
	Vigorous METS per week	764.98 (966.48)
	Moderate Minutes per week	109.79 (170.71
	Moderate METS per week	439.15 (682.84)
	Total METS per week	1203.09 (1147.07)

6.2.1. COM-B construct and predictive validity for MVPA.

The results for the first PLS analysis of the initial model showed a good fit overall (SRMR = .06) and the cross loadings confirmed that each formative indicator had its highest loading on the appropriate composite COM-B construct (Figure 6.2). Multicollinearity was not a problem in the inner model (VIF all < 3) and was acceptable in the outer model (both VIF < 4.6).

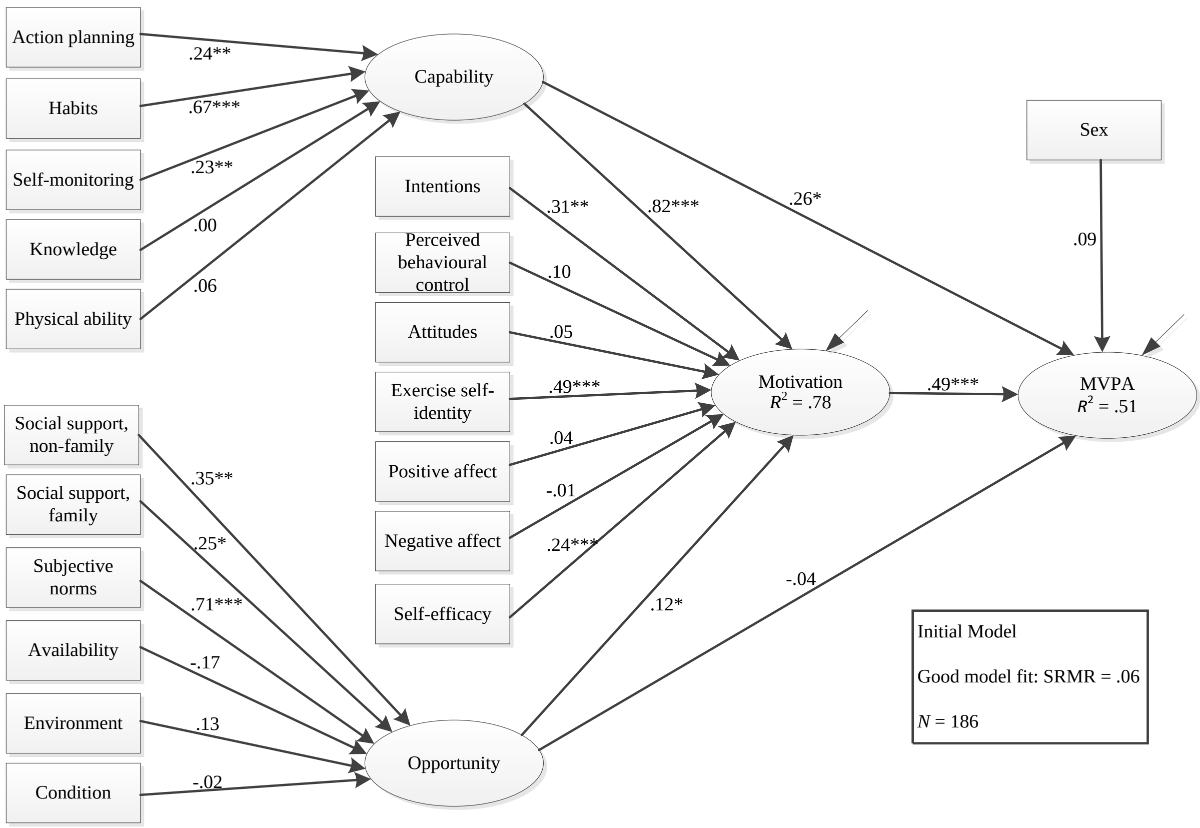

Figure 6.2. Fully specified path model of the COM-B for MVPA, with all coefficients standardised.

Note: **p* < .05, ***p* < .01, ****p* < .001

There were a number of statistically non-significant indicators which were removed one at a time if its weight was small and non-significant (*p* > .10), leaving a fully trimmed outer model with only statistically significant indicators (*p* < .05), aside from social support (family) which was retained at *p* = .077 (see Figure 6.3). Each construct had one salient indicator with a substantial weight (> .50); habits on Capability; subjective norms on Opportunity; exercise self-identity on Motivation. The weights of the other indicators were modest to moderate. Exploration of the inner model revealed that the direct path from Opportunity to MVPA was statistically unreliable (*β* = -.03, *p* = .78) and was, therefore, removed.

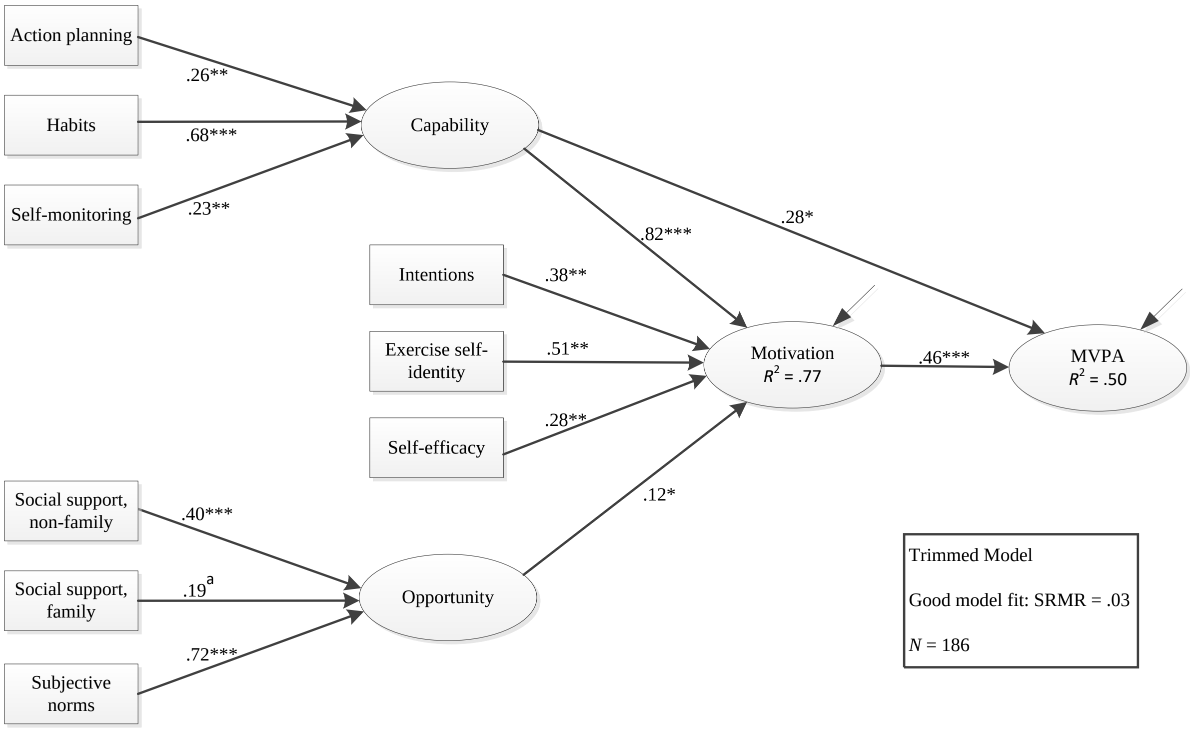

Figure 6.3. Final trimmed path model of the COM-B for MVPA, with all coefficients standardised.

Note: $*p < .05$, $**p < .01$, $***p < .001$

The residuals in the final trimmed model were small (SRMR = .03), and the cross loadings again confirmed that each formative indicator was most strongly associated with its proposed construct suggesting sufficient discriminant validity, although some of the cross-loadings, notably between Capability and Motivation, were substantial (> .50). Multicollinearity was not a problem in the inner model (VIF all < 2.5) and acceptable in the outer model (Capability and Opportunity VIF = 4.17).

There was no indication of a sex effect on MVPA. The model explained 77% of the variance in Motivation and 50% of the variance in MVPA. Capability (β = .81, 95% confidence intervals (CI), .75 to .87, p < .001) and Opportunity (β = .12, 95% CI, .04 to .21, p = .001) were both significant predictors of Motivation, but only Capability (β = .27, 95% CI, .09 to .50, p = .008) and Motivation (β = .46, 95% CI, .23 to .66, p < .001) had a direct effect on MVPA. Consequently, Opportunity only indirectly influenced MVPA via the mediator Motivation and this effect was very small, *IE* = .06, 95% CI, .01 to .11, p = .032. By contrast, the indirect effect of Capability on MVPA through the mediator Motivation was substantial, *IE* = .37, 95%

CI, .18 to .53, $p < .001$, and even larger than its direct effect (*DE* = .27). The total effect of Capability on MVPA was *TE* = .64 making it the most important driver for MVPA, followed by Motivation, *TE* = .46, and finally Opportunity.

6.2.2. Theory of Planned behaviour predictive validity.

The TPB path diagram showed that PBC ($p < .001$), attitudes ($p < .001$), and subjective norms ($p < .001$) were all highly predictive of intentions, and that intentions in turn strongly predicted moderate-intensity MVPA ($p < .001$). Sex ($p = .015$) was an independent predictor of MVPA but PBC ($p = .283$) was not.

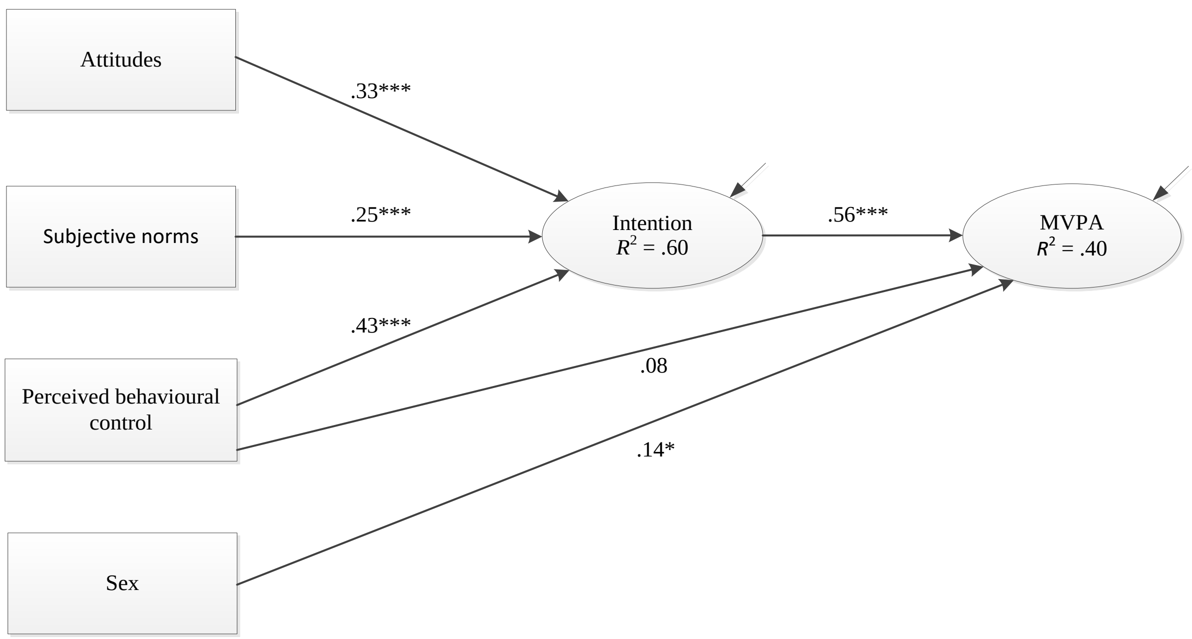

Figure 6.4. Fully specified path model of the TPB for MVPA, with all coefficients standardised.

Note: *$p < .05$, **$p < .01$, ***$p < .001$

The fully specified model explained a large amount of the variance in intentions (60%) and MVPA (40%), but showed poor fit, $\chi^2(3) = 14.02$, $p = .003$ (TLI = .84, CFI = .97, RMSEA = .14). Removing the non-significant path between PBC and MVPA did little to fix this issue (model fit, $\chi^2(4) = 15.17$, $p = .004$, fit indices, TLI = .88, CFI = .97, RMSEA = .12). Further exploration of the model suggested that in this data set, attitudes had an indirect effect on MVPA through intentions and a strong direct effect on MVPA. The amended TPB model showed that PBC ($p < .001$), attitudes ($p < .001$), and subjective norms ($p < .001$) were all highly predictive of intentions, and that intentions in turn strongly predicted moderate-intensity PA ($p < .001$). Sex was still an independent predictor of MVPA ($p = .008$), with attitudes as a strong additional predictor ($p < .001$).

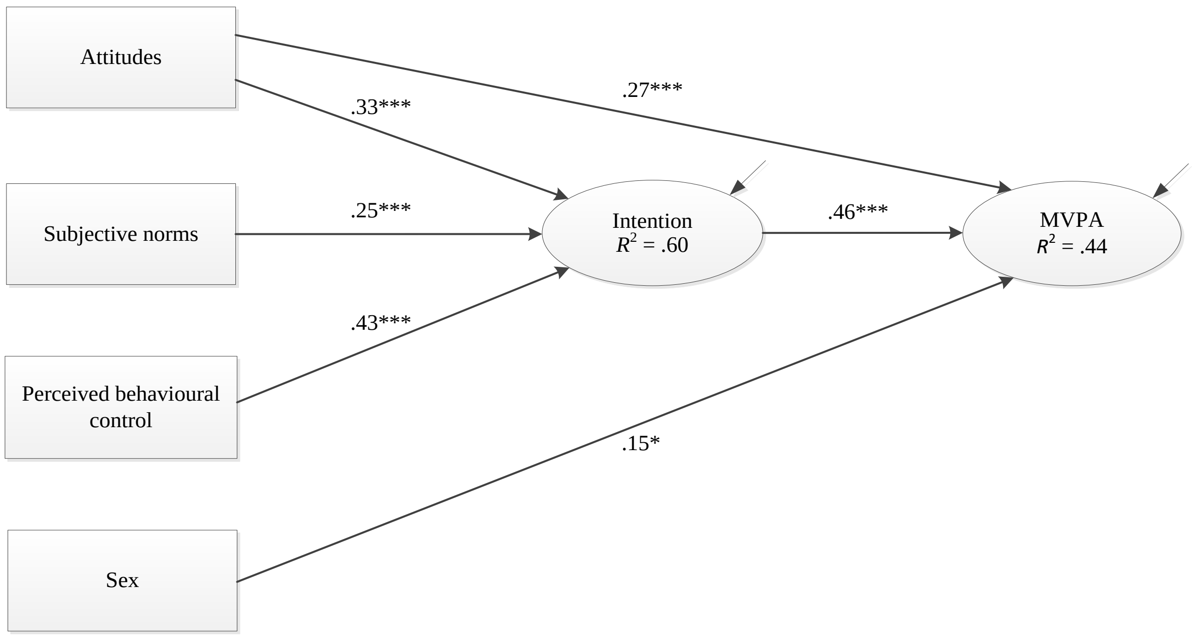

Figure 6.5. Final trimmed path model of the TPB for MVPA, with all coefficients standardised.

Note: *$p < .05$, **$p < .01$, ***$p < .001$

The final trimmed TPB model explained a large amount of the variance in intentions (60%) and MVPA (44%). The model fit statistics also showed both a good fit ($\chi^2(3) = .63$, $p = .889$) and fit indices (TLI = 1.04, CFI = 1.00, RMSEA = .00). Subjective norms (*IE* = .11), attitudes (*IE* = .15), and PBC (*IE* = .20) all had an indirect effect on MVPA through intentions. Intentions (*DE* = .46), attitudes (*DE* = .27, *TE* = 42), and sex (*DE* = .15) had a direct effect on MVPA. Overall intentions had the largest effect on MVPA, followed by attitudes, PBC, sex, and subjective norms.

6.3. Discussion

This study aimed to firstly empirically validate the constructs of the COM-B model in relation to physical activity in a healthy adult sample. Using the TDF as a framework for the selection of suitable measures for each construct, an initial formative measurement model with 18 indicators was specified. The model trimming process lead to a parsimonious model with nine statistically reliable indicators representing the three COM constructs. In this final model, all three constructs were formed of three measures respectively: Capability was defined by self-monitoring, ability to form habits, and action planning (all related to Psychological Capability); Opportunity was defined by social support from family, social support from non-family, and subjective norms (all related to Social Opportunity); Motivation was defined by exercise self-identity, self-efficacy, and intentions (all related to Reflective Motivation). Capability (strongly) and Opportunity (weakly) predicted Motivation, and Motivation was a strong mediator for Capability and a weak mediator for Opportunity on MVPA.

The COM-B predicted a large amount of variance in Motivation and MVPA, with Capability as the most important driver of MVPA, followed by Motivation. A parallel analysis of the TPB showed that this model also predicted a large amount of variance in intentions and MVPA. This study is the first to examine the three constructs of the COM-B in this way, test their predictive validity in relation to MVPA, and then provide a comparison to the TPB. The variance explained for COM-B was marginally better than the TPB (50% vs 44%), and compared favourably to previous reviews of the TPB models of physical activity (e.g. Hagger et al., 2002; McEachan et al., 2011).

For the COM-B, the three indicators for Capability all belong to the behavioural regulation domain of the TDF and so this construct was entirely defined as Psychological Capability. According to Deci and Ryan (1987) people who act in a self-determined manner by autonomously regulating their actions experience better psychological and physical health. Self-monitoring and action planning, both examples of self-determined regulation, are also related to the habit strength of physical activity (Gardner & Lally, 2013). Indeed, habits turned out to be the most important formative indicator for the construct.

Knowledge did not contribute to Capability with only one of three questions answered correctly on average. Previous research shows that despite knowledge often being one of the key targets of behaviour change interventions, it is not always an important influence on behaviour (Cane et al., 2012; Taylor et al., 2013). Study 1 (Chapter 4) did, however, show that information about health consequences may be an effective BCT. The results of this study suggest that physical activity undertaken by healthy adults may not be driven by knowledge about the national guidelines. The TDF domain of skills was not specifically measured for this study as there are no skills specific to performing generic physical activity. If future studies look at a particular activity (e.g. tennis) then specific skills acquired through practice would be of more relevance. Physical Capability, measured through physical ability to perform activity, was not found as important since the physical health of the participants was generally very good. This may be of more importance for other, more sedentary populations.

Opportunity was formed by three measures representing the social influences domain of the TDF. The questionnaires that were used to measure social support as well as subjective norms tapped into the views and actions of important others regarding regular physical activity, and both were relevant for the formation of this construct. However, the influence of subjective norms and parental support on physical activity tends to be small and indirect through its impact on motivations, such as intention formation as a crucial mediator (Hagger et al., 2002; Li, Iannotti, Haynie, Perlus, & Simons-Morton, 2014). This was supported by the indirect effect of Opportunity on MVPA via Motivation in this study. None of the three measures that were selected to represent Physical Opportunity remained in the final model. Previous research has suggested that easy access to sporting facilities can enhance the uptake of physical activity (Halonen et al., 2015). For this sample, the local environment (within a 20 minute walk from their homes) was generally reported to be conducive to walking and physical activity, and where available the condition of sports facilities was generally good. Thus lack of Opportunity was not a barrier of concern. For a different sample (e.g. those living in an area less conducive to physical activity) the importance of the Opportunity construct for Motivation and MVPA might be higher.

The Motivation construct was formed of three measures, all forms of Reflective Motivation. Exercise self-identity was the leading indicator for Motivation, which is consistent with research showing its importance for developing sufficient motivation to exercise (de Bruijn, Verkooijen, & de Vries, & van den Putte, 2012). Exercise self-identity is also related to perceptions of competence (in this case self-efficacy) about performing physical activity (Vlachopoulos, Kaperoni, & Moustaka, 2011), and relevant for forming an intention to be active (Vlachopoulos et al., 2011). Intentions were an important indicator consistent with many psychological theories such as the TPB, placing them as the key determinant and a consistent predictor of physical activity (McEachan et al., 2011). There is, however, often a gap between intentions to be active and fulfilment of those intentions (Rhodes & de Bruijn, 2013), and the inclusion of components such as self-regulation, identity, habits, and self-efficacy have been highlighted as consistent predictors of post-intentional physical activity (Rhodes & Yao, 2015). Self-efficacy was also found to be an important indicator, supporting previous research which has found it to be an independent predictor of physical activity (Hagger et al., 2002). Techniques that are effective in changing self-efficacy also often mirror those that change physical activity (e.g. action planning and providing instruction; Williams & French, 2011).

Michie and colleagues proposed the Behaviour Change Wheel as a new framework for designing interventions with Capability, Opportunity, and Motivation as the key drivers of a specific behaviour (Michie et al., 2011). Their conceptualization of these three constructs was deliberately rather broad, which has the advantage that it can be applied to a range of different types of intervention and corresponding policies for their implementation (Michie et al., 2011). However, because of this breath researchers are required to carefully select the most appropriate indicators for a particular intervention study and justify their selection on theoretical grounds. This study used the most comprehensive published mapping of the TDF onto the COM-B (Cane et al., 2012), which includes ability to control habits as an indicator of Capability (something confirmed by the analysis) and thus separates it from habits as an Automatic Motivation, to which Michie et al. (2014) previously referred. When it comes to developing behaviour change interventions, future research should look at whether habit is better placed within Psychological Capability or Automatic Motivation for different behaviours. A construct validation of the COM-B, therefore, becomes a challenging task as the selection of valid formative indicators for each construct must be based on solid explanations and also borne out by empirical evidence.

This study, therefore, argued in favour of a formative measurement model which defines a construct as an index through a theoretically well-justified selection of indicators (Bollen & Diamantopoulos, 2015). This flexibility in the operationalization of the COM-B constructs is required as their content varies depending on the availability of appropriate validated measures, and the target behaviour and population in question. Our study showed how the TDF can be utilized as a guiding theoretical framework for the selection and justification of measures to define indices representing the COM-B constructs. This makes a contribution to a recent debate regarding the balance between systematisation and variability in theory application (see Ogden, 2016, and associated commentaries). Ogden (2016) cautioned against too much systemisation and asked Health Psychologists to be wary of attempting to control every detail of patient behaviour and interactions. By having such a wide range of theoretical determinants (adapted to populations and behaviours) we can avoid dispensing with the variability and flexibility that marks Health Psychology as such a rich discipline both in research and practice.

With the successful formation of three indices representing Capability, Opportunity, and Motivation, it then became possible to examine their predictive validity and the role of Motivation as a mediator. Michie et al. (2011) did not elaborate on the role of Motivation as a mediator of the influence of Capability and Opportunity on a target behaviour. Rather, the COM-B allows for complex and reciprocal relationships between these drivers and the behaviour. This study specified a unidirectional recursive path model (Kline, 2016). Capability strongly impacted on Motivation and its indirect effect on MVPA via Motivation was even stronger than its direct effect. The very strong direct effect of Capability on Motivation can be understood as reflecting the importance of habits, as well as autonomous actions leading to a strengthening of intrinsic motivation in terms of self-efficacy and intentions, and it shows the importance of physical activity as part of one's self-identity, at least in this sample. This then leads to an initiation and maintenance of physical activity as represented by the substantial link between Motivation and MVPA (Deci & Ryan, 1987; Vlachopoulos et al., 2011).

The comparison analysis of the TPB showed this model to predict a large amount of variance in MVPA. Previous research has suggested that the TPB may be better at predicting activity that is more vigorous in nature (e.g. vigorous, Kimiecik, 1993; moderate and vigorous, Hamilton & White, 2008). The TPB proposes that attitudes only have an effect on physical activity through intentions and not by a direct route. The results of this study suggest that attitudes can have both a direct and indirect effect on MVPA. Contrary to the proposed structure of the TPB, a direct effect of attitudes has also been documented in analyses for other behaviours such as blood donation (Conner, Godin, Sheeran, & Germain, 2012). Despite the strong predictive validity shown in this study, the TPB has also received criticism for excluding important influences on behaviour such as habit, identity, planning, and the physical environment (e.g. Sniehotta et al., 2014). Overall the COM-B offers more potential barriers and facilitators to explore for specific behaviours and populations, and sits within a comprehensive intervention design framework, giving it distinct advantages over the TPB.

A major strength of this study is the novel approach to the statistical modelling of the COM-B constructs which were defined as latent variables within the context of a formative measurement model. The PLS-SEM analysis approach is ideal for complex models with several potential indicators and can achieve high levels of statistical power with relatively small sample sizes (Hair et al., 2013). This study had sufficient statistical power to detect a small effect size correlation. Furthermore, the operationalization of the constructs was based on the TDF and then empirically validated. The time lag between the measurement of the constructs and MVPA is a strength of the study as it limits demand characteristics. Recent work has begun to show how TDF domains can be linked to individual BCTs (Cane et al., 2015), and the systematic review presented in Study 1 (Chapter 4) identified those BCTs that are included in effective interventions for inactive adults.

With respect to limitations, it is important to note that this study used opportunistic sampling to recruit a healthy sample that enjoyed good access to local exercise facilities, and had the physical ability to engage in physical activity. Consequently, relevant components in the TDF reflecting differences in physical capabilities and opportunities did not contribute to the formation of the COM-B constructs in this sample. For populations that are less active, living with chronic health problems, or living in environments offering limited facilities, Physical Capability and Opportunity are likely to be more important. Furthermore, two TDF domains (memory, attention, and decision making; reinforcement) were not included in the initial measurement model because of a lack of validated measures. The strategy utilised for empirically validating the COM-B using a formative measurement model relied on a data-driven approach and so a cross-validation with an independent similar sample would be desirable to strengthen the generalizability of the conclusions. Finally, this study measured behaviour over just one week, and so commentary on the temporal stability of the model cannot be given.

Reflective Motivation was an important mediator of the influence of Psychological Capability, which turned out to be the key driver of MVPA for healthy adults, and so both constructs should be promising targets for an intervention aimed at encouraging or maintaining physical activity. The inclusion of components from a range of TDF domains in a formative measurement model elucidated how the COM-B can be operationalised. This study provided evidence that the COM-B predicts physical activity more strongly than the

TPB. The analysis also identified a number of TDF domains that should represent key targets to address through relevant BCTs, in order to change MVPA in future interventions, many of which were outside the scope of the TPB. The next chapter (Study 3) conducts the same set of analyses with the behavioural focus shifting to sitting as the target behaviour.

Chapter 7

Study 3: Examining the COM-B model for sitting

The previous chapter analysed the key formative indicators of Capability, Opportunity, and Motivation for MVPA, and then compared the predictive validity of the COM-B with that of the TPB. This chapter conducts the same analysis but for sedentary behaviour, which is defined as any activity (during waking hours) that expends less than or equal to 1.5 METS (Tremblay et al., 2017). For the purposes of this chapter, sedentary behaviour will be operationalised as sitting time across work, transport, and leisure. Previous chapters have highlighted the possibility that sedentary behaviour is a separate entity from a lack of physical activity. Individuals can be both active to the recommended amount and highly sedentary, and so each behaviour has potentially different psychological, physical, social, and environmental drivers, and may well need different intervention approaches.

The theoretical underpinnings of sedentary behaviour have been less well studied than physical activity, but there have been some analyses undertaken. The Health Action Process Approach (HAPA) has been found to be able to predict 14% of the variance in objectively-measured sedentary behaviour, but only after the addition of habit which contributed the majority of this variance (Maher & Conroy, 2016). The TPB can provide stronger explanatory power, albeit in predicting self-report sedentary behaviour. The variance explained can range from 25% to 60% for computer use in students and adults (Rhodes & Dean, 2009), whereas another study found that sedentary behaviour at work was more strongly predicted than at leisure time, with the overall figure at 20% (Prapavessis et al., 2015).

Additional behavioural, psychological, and socio-demographic variables have also been investigated in relation to sedentary behaviour. In Canadian older adults sitting for over four hours per day is associated with age, retirement, dwelling type, chronic disease, perceptions of health, body mass index (BMI), mood disorder, and sense of belonging to community (Dogra & Stathokostas, 2014). Van Holle et al. (2015) included an even wider variety of possible determinants and found that only social support from friends and colleagues (and not family), that encouraged breaking long periods of sitting, was related to sedentary behaviour in Australian adults aged 55-65. Further systematic review evidence showed overall sedentary behaviour to be related to positive attitudes towards the behaviour, higher levels of depression, and lower life satisfaction (Rhodes, Mark, & Temmel, 2012). When broken down by type of sedentary behaviour, television watching was associated with lower education levels, higher age and BMI, and unemployment (Rhodes et al., 2012). Higher computer use was related to being younger and having higher levels of education, and sitting was more common in those who did not have children (Rhodes et al., 2012).

Recommendations from a recent systematic review of correlates of sedentary behaviour, concluded that more research was needed on the social, cognitive, and environmental factors that may be important in designing sedentary behaviour interventions (Rhodes et al., 2012). For instance, habits have been shown to be a strong predictor of sedentary behaviour, alongside temporal fluctuations in intentions (Conroy, Maher, Elavsky, Hyde, & Doerksen, 2013). The collective body of research on sedentary behaviour has often not utilised models that sit within a systematic approach to designing behaviour change interventions (Michie et al., 2011). The COM-B model provides this basis from which to explore specific behaviours in particular populations. In line with the previous physical activity chapter, the ubiquitous nature of the TPB in both cross-sectional, prospective, and intervention studies makes it an ideal model to compare with the predictive validity of the COM-B for sitting.

The four main aims of this study were: (1) to explore which of the measures representing TDF domains would be important formative indicators of the three constructs, Capability, Opportunity, and Motivation of the COM-B in a sample of healthy adult participants; (2) to examine the predictive validity of these constructs in relation to levels of sitting over a one week period; (3) to evaluate a key tenet of the COM-B model postulating that Motivation is a mediator for Capability and Opportunity with respect to sitting; (4) to compare the predictive validity of the COM-B model and the TPB in relation to levels of sitting over a one week period.

7.1. Method

7.1.1. Participants.

As with the previous physical activity chapter, a prospective survey design was used with questionnaires relating to the TDF completed at baseline and the assessment of sitting collected seven days later. The same set of individuals (*N* = 186) were used as in Study 2 (Chapter 6), and were eligible for participation if they had no conditions preventing them performing regular physical activity, were over 18, and resided in the UK. A post-hoc sensitivity analysis revealed that this sample size was large enough to detect a modest effect size correlation (*r* = .23) with a power of .90 and an alpha error of 5% (two-tailed).

7.1.2. Measures.

In line with the previous physical activity study, measures were selected based on published components mapped onto TDF domains listed within Table 2 of Cane et al. (2012). Measures (Appendix I) were selected for components relevant for sitting and where published questionnaires could be identified. There were some TDF components that were deemed unnecessary to measure. For example, for the knowledge domain there are no clear government guidelines for sitting time, as there are for physical activity, and therefore this could not be measured (see Chapter 3 greater detail). Four measures were identified as defining the Capability construct, six for Motivation and four for Opportunity (see Table 7.1 for descriptive statistics). The wording of the following measures was adapted from the original physical activity questionnaires for sitting: self-monitoring; breaking habit; action planning; social/group norms; self-efficacy; perceived behavioural control; intentions; beliefs. All other measures remained the same. The following measures were used as formative indicators for Capability, Opportunity, and Motivation (Table 7.1.).

Table 7.1.

Mapping of COM-B to the TDF domains, with the appropriate questionnaire measures representing key components for sitting (based on Cane et al., 2012).

COM-B construct	TDF Domain	Indicator and adapted measure
Capability	Knowledge	*No quantitative guidelines*
	Memory, attention and	*No appropriate validated measures*

	decision making	
	Behavioural regulation	Self-monitoring (Sniehotta, Scholz et al., 2005) - *modified* Breaking habit (Self-report habit index; Verplanken & Orbell, 2003) - *modified* Action planning (Sniehotta, Schwarzer, et al., 2005) - *modified*
	Physical ability (Skills)	Ability (Medical Outcomes Short Form Survey; Ware & Sherbourne, 1992)
Opportunity	Social influences	Social support (family and non-family) (Social Support for Exercise Behaviour Scale; Sallis et al., 1987) Social/group norms (subjective norms; Francis et al., 2004) - *modified*
	Environmental context and resources	Barriers and facilitators (Neighbourhood Environment Scale; Echeverria et al., 2004) Resources/material resources (Presence of Recreational Facilities Index; Echeverria et al., 2004)
Motivation	Social/professional role and identity, Optimism	Identity (Exercise Self-Identity Scale; Anderson & Cychosz, 1994)
	Beliefs about capabilities	Self-efficacy (Physical Exercise Self-Efficacy Scale; Schwarzer & Renner, 2009) - *modified* Perceived behavioural control (Francis et al., 2004) - *modified*
	Beliefs about consequences	Beliefs (Attitudes; Francis et al., 2004) - *modified*
	Intentions	Intentions (Francis et al., 2004) - *modified*
	Goals	Covered by action planning (included in capability)
	Reinforcement	*No appropriate validated measures*

Emotion	Positive/ negative affect (International Positive and Negative Affect Schedule Short Form; Thompson, 2007)

7.1.2.1. Capability construct (4 measures).

The same physical ability (skills) measure was used as in the previous physical activity study. It was assumed that worse physical functioning would indicate more favourable conditions for sitting. Physical ability was measured with the 10-item physical functioning scale of the Medical Outcomes Short Form Survey (Ware & Sherbourne, 1992). The items were activities one might do during a typical day (e.g. climbing several flights of stairs). Participants were then asked about how much their health limits them in these activities and, if so, how much on a scale from 1 '*Yes, limited a lot*' to 3 '*No, not limited at all*'.

Ability to self-monitor was measured by two adapted items which asked participants to rate how much they agreed with statements such as, 'I constantly monitored myself whether I spent long periods sitting (Watching TV, using the computer or at work)' on a scale from 1 '*Completely disagree*' to 4 '*Totally agree*', retrospectively over the past week (Sniehotta, Scholz et al., 2005). This scale showed good internal consistency (*a* = .80).

Ability to plan for action was measured by four adapted items about when, where, how, and how often, participants had made detailed plans to avoid long periods of sitting on a scale from 1 '*Completely disagree*' to 4 '*Totally agree*', retrospectively over the past week (Sniehotta, Schwarzer, et al., 2005). This scale showed excellent internal consistency (*a* = .97).

Ability to control habit was measured with an adapted Self-Report Habit Index (Verplanken & Orbell, 2003), containing 12 items exploring the past history and automaticity of their sitting behaviour. The items were prefaced by 'Sitting for long periods of time (e.g. Watching TV, using the computer or at work) is something…' Participants were then asked to rate the extent to which they agreed with each statement (e.g. 'I do without thinking') based on a 7 point scale from 1 (*Disagree strongly*) to 7 (*Agree strongly*). This scale showed excellent internal consistency (*a* = .95).

7.1.2.2. Opportunity construct (4 measures)

The same physical opportunity measures were used as in the previous physical activity study. It was assumed that an unsupportive environment for walking and physical activity would indicate more favourable conditions for sitting. Barriers and facilitators in the local environment (within a 20 minute walk from residence) were measured with the Neighbourhood Environment Scale (Echeverria et al., 2004) which consisted of 10 items, with responses on a scale from 1 (*Strongly agree*) to 5 (*Strongly disagree*).

The availability and condition of local resources (within a 20 minute walk from residence) was also explored using the Presence of Recreational Facilities Index (Echeverria et al., 2004) consisting of six items. The availability of each type of facility (e.g. public park) was measured based on a yes or no answer. The condition of the facilities was then measured on a scale from 1 (*Excellent*) to 4 (*Poor*) if applicable.

Subjective norms were measured with three adapted items (Francis et al., 2004). Each item referred to how important it was to significant others that individuals would attempt to break up long periods of sitting over the next week, and was rated on a 7-point scale from 1 (*Strongly disagree*) to 7 (*Strongly agree*). This scale showed average internal consistency (a = .66). This measure was also used in the TPB analysis.

The same social support for physical activity measures were used as in the previous physical activity study. It was assumed that a lack of social support for physical activity would indicate more favourable conditions for sitting. Social support was measured with 10 items from the Social Support for Exercise Behaviour Scale (Sallis et al., 1987). Five items assessed support for physical activity from friends, acquaintances or co-workers, and five items measured support from family (members of household), on a scale from 1 (*None*) to 5 (*Very often*).

7.1.2.3. Motivation construct (6 measures)

Self-efficacy was measured with an adapted Self-Efficacy Scale for avoiding long periods of sitting (Schwarzer & Renner, 2009), which consisted of five items exploring participants' ability to carry out their behavioural intentions in the face of challenges, such as 'even when I am tired'. The items were measured on a scale from 1 (*Very uncertain*) to 4 (*Very certain*) and showed excellent internal consistency (a = .90).

Perceived behavioural control was measured with four adapted items (Francis et al., 2004). Each item referred to the amount that the individual will avoid long periods of sitting over the next week. Three items were rated on a 7-point scale from 1 (*Strongly disagree*) to 7 (*Strongly agree*), and included statements such as 'The decision to avoid long periods of sitting over the next week is beyond my control'. One item asked participants to rate how difficult it was going to be to avoid long periods of sitting over the next week on a scale from 1 (*Very difficult*) to 7 (*Very easy*). This scale showed very good internal consistency (a = .82). This measure was also used in the TPB analysis.

Attitudes were measured with four adapted items (Francis et al., 2004). Each item referred to the participants' attitudes towards avoiding long periods of sitting in terms of how harmful, healthy, enjoyable, and boring they viewed it on a set of 7-point scales anchored by positive and negative views (e.g. 1 = *Very unhealthy* to 7 = *Very healthy*). One item was removed (Avoiding long periods of sitting (Watching TV, using the computer or at work) is harmful to beneficial), which improved the internal consistency (from a =.61 to a = .70). This measure was also used in the TPB analysis.

Intentions were measured with three adapted items (Francis et al., 2004). Each item referred to how much the individual intended to avoid long periods of sitting over the next week with statements such as 'I expect to avoid long periods of sitting over the next week'. Each item was rated on a 7-point scale from 1 (*strongly disagree*) to 7 (*strongly agree*) and showed good internal consistency (a = .79). This measure was also used in the TPB analysis.

The same identity measure was used as in the previous physical activity study. It was assumed that a weak exercise self-identity would indicate a higher likelihood of sitting for longer periods. Exercise self-identity was assessed by the nine-item Exercise Self-Identity Scale (Anderson & Cychosz, 1994), which measures whether exercise is descriptive of an individual's self-concept, on a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

The same positive and negative affect measure was used as in the previous physical activity study, using the International Positive and Negative Affect Schedule Short Form (Thompson, 2007), which consisted of 10 items that cover negative (e.g. afraid) and positive (e.g. inspired) affect. Participants were asked on a scale from 1 (*Never*) to 5 (*Always*) how often they had felt each item over the last week.

7.1.3. Dependent variable.

Sitting was measured with the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003). One question assessed the amount of minutes over the last week that each individual had spent sitting. The questionnaire was administered over the phone to reduce the tendency for participants to underestimate their time spent sitting (Lee et al., 2011).

7.1.4. Procedure.

The ethical approval (protocol number: aLMS/SF/UH/00079) and procedure was identical to that of the previous physical activity study.

7.1.5. Analysis.

Confounders were explored with sitting as the dependent variable and age, BMI, and sex, as the potential confounders using an independent samples t-test and Pearson's correlations. The rest of the analysis followed the same protocol as the previous physical activity study with PLS-SEM used to analyse the construct and predictive validity of the COM-B and SPSS AMOS 22 used to analyse the predictive validity of the TPB.

7.2. Results

There were no differences in sitting by sex, and no relationship with sitting and age, and sitting and BMI. Descriptive statistics, ranges for each measure, means, and standard deviations for all formative indicators, and for the dependent variable are presented in Table 7.2. Overall this sample sat for an average of seven hours per day at work, home, and during commuting.

Table 7.2.

Descriptive statistics for all formative indicators and sitting time (N = 186).

	Scale name (possible range from minimum to maximum)	Mean (SD)
Sedentary	Physical Health (1-3)	2.87 (.26)
Behaviour	Habits (1-7)	4.53 (1.64)
Indicators	Self-Monitoring (1-4)	2.11 (.80)
	Action Planning (1-4)	1.83 (.81)

	Self-Efficacy (5-20)	13.44 (3.64)
	Attitudes (1-7)	5.45 (.97)
	Intentions (1-7)	4.93 (1.49)
	Perceived Behavioural (1-7) Control	4.31 (1.70)
	Positive Affect (5-25)	17.68 (3.55)
	Negative Affect (5-25)	10.36 (3.40)
	Exercise Self-Identity (1-7)	4.77 (1.88)
	Subjective Norm (1-7)	3.45 (1.36)
	Social Support (Non-family) (5-25)	9.05 (5.17)
	Social Support (Household) (5-25)	8.42 (4.58)
	Local Environment (10-50)	37.64 (6.51)
	Availability (1-6)	3.45 (1.37)
	Condition (1-4)	3.02 (.66)
Dependent Variable	Sitting (Minutes per week)	2946.71 (967.48)

7.2.1. COM-B construct and predictive validity.

The results for the first PLS analysis of the initial model showed a good fit overall (SRMR = .07) and the cross loadings confirmed that each formative indicator had its highest loading on the appropriate composite COM-B construct (Figure 7.1). Multicollinearity was not a problem in the inner model (VIF all < 2) or outer model (both VIF < 2.3).

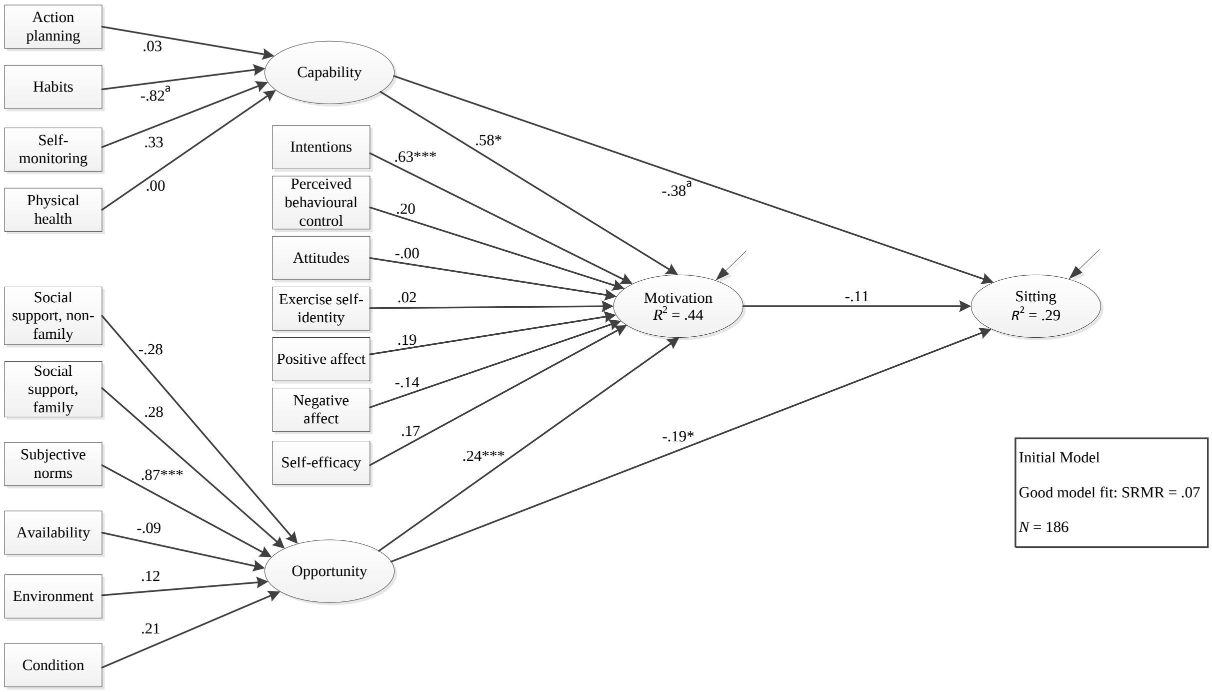

Figure 7.1. Fully specified path model of the COM-B for sitting, with all coefficients standardised.

Note: *$p < .05$, **$p < .01$, ***$p < .001$

However, statistically unreliable indicators were then removed one at a time if its weight was small and non-significant ($p > .10$), leaving a fully trimmed outer model with only statistically significant indicators ($p < .05$, see Figure 7.2). Each construct had one salient indicator with a substantial weight (> .50); habits on Capability; subjective norms on Opportunity; intentions on Motivation. Exploration of the inner model revealed that the direct path from Motivation to sitting was statistically unreliable ($\beta = -.08$, $p = .39$) and was, therefore, removed.

The residuals in the final trimmed model were small (SRMR = .04) and the cross loadings again confirmed that each formative indicator was most strongly associated with its proposed construct suggesting sufficient discriminant validity, although some of the cross-loadings, notably between Capability and Motivation, were substantial (> .50). It is important to note that the standardised betas for self-monitoring on Capability and Opportunity on Sitting are negative because the wording of the items referred to avoiding long periods of sitting (non-performance of the behaviour). Capability has a negative beta on Motivation because this construct is mostly driven by habitual levels of sitting and therefore, would produce lower Motivation to interrupt sitting. Multicollinearity was not a problem in the inner model (VIF all < 1.1) or outer model VIF < 1.9).

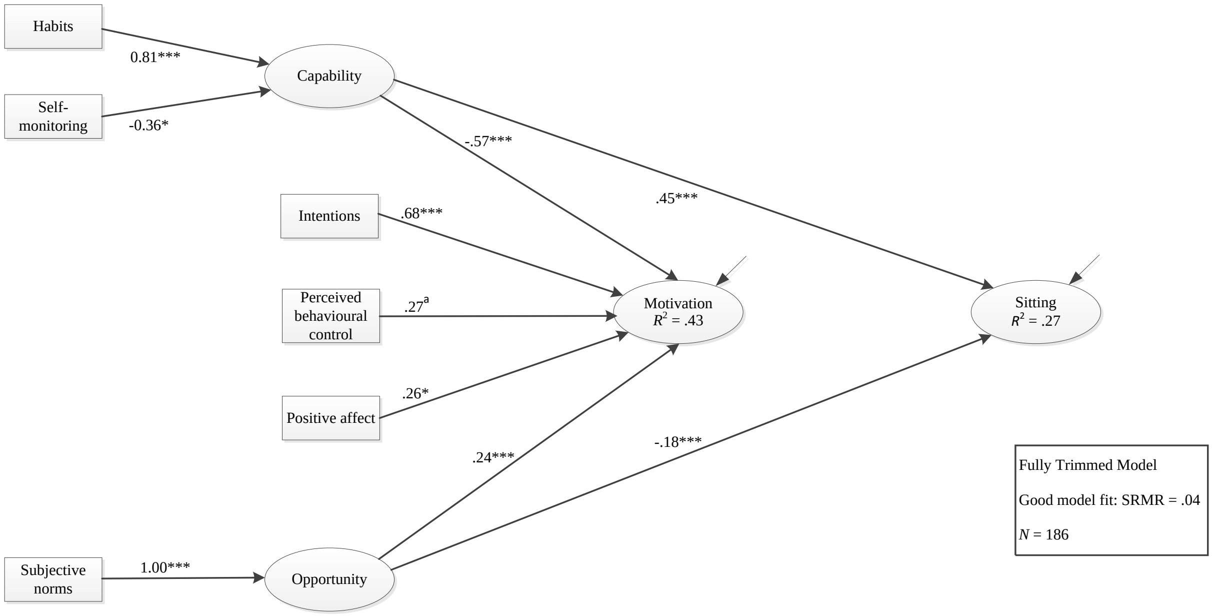

Figure 7.2. Final trimmed path model of the COM-B for Sitting, with all coefficients standardised.

Note: *$p < .05$, **$p < .01$, ***$p < .001$

The fully trimmed model explained 43% of the variance in motivation and 27% of the variance in Sitting. Capability (β = -.57, 95% confidence intervals (CI), -.67 to -.46, $p < .001$) and Opportunity (β = .24, 95% CI, .13 to .36, $p < .001$) were both significant predictors of Motivation, but only Capability (β = .45, 95% CI, .32 to .56, $p < .001$) and Opportunity (β = -.18, 95% CI, -.06 to -.31, $p = .004$) had a direct effect on Sitting, leaving Capability as the strongest predictor of sitting time. The removal of a direct path from Motivation to Sitting precluded the exploration of indirect effects of Capability and Opportunity on Sitting through Motivation.

7.2.2. Theory of Planned behaviour predictive validity.

The fully specified TPB path diagram (see Figure 7.3) showed that PBC, attitudes, and subjective norms were all highly predictive ($p < .001$) of intentions, and that intentions in turn strongly predicted Sitting ($p < .001$). PBC, however, did not independently predict Sitting – this path was therefore removed from the final trimmed model. It is important to note that the standardised direct effect of intentions on Sitting, and the indirect effects of attitudes, subjective norms, and PBC on Sitting are negative because the wording of the items referred to avoiding long periods of sitting (non-performance of the behaviour). The full specified model explained a large amount of the variance in intentions (56%) and a medium amount in Sitting (14%). The full model showed good fit, $\chi^2(2) = 3.94$, $p = .139$ and good fit indices (TLI = .95, CFI = .99, RMSEA = .07).

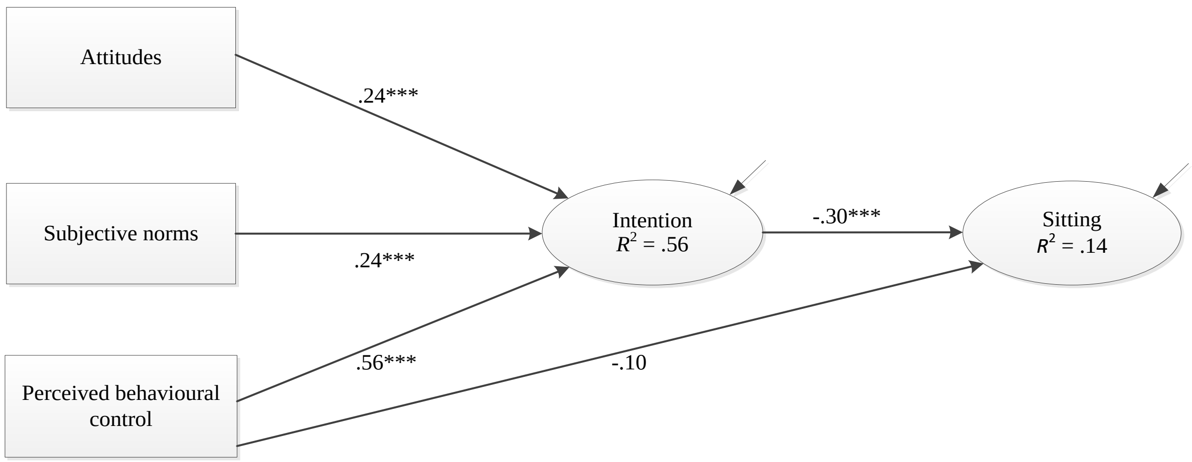

Figure 7.3. Fully specified path model of TPB for Sitting, with all coefficients standardised.
Note: $^*p < .05$, $^{**}p < .01$, $^{***}p < .001$

The final trimmed TPB path diagram (see Figure 7.4) showed that PBC, attitudes, and subjective norms were all highly predictive ($p < .001$) of intentions, and that intentions in turn strongly predicted Sitting ($p < .001$). The final trimmed model explained a large amount of the variance in intentions (56%) and Sitting (13%), and showed good fit, $\chi^2(3) = 5.10$, p = .165 and good fit indices (TLI = .96, CFI = .99, RMSEA = .06). Subjective norms (*IE* = -.09), attitudes (*IE* = -.09), and PBC (*IE* = -.21) all had an indirect effect on Sitting through intentions, and intentions, had a direct effect on Sitting (*DE* = -.37). Overall, intentions had the largest effect on Sitting, followed by PBC, attitudes and subjective norms.

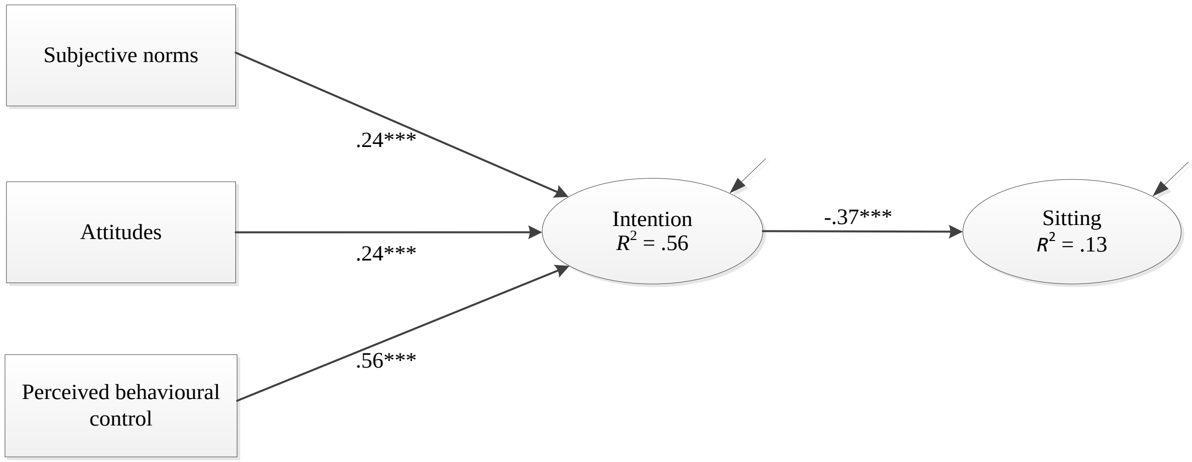

Figure 7.4. Final trimmed path model of TPB for Sitting, with all coefficients standardised.

Note: **p* < .05, ***p* < .01, ****p* < .001

7.3. Discussion

This study aimed to firstly empirically validate the constructs of the COM-B model in relation to sitting. Using the TDF as a framework for the selection of suitable measures for each construct, an initial formative measurement model with 17 indicators was specified. The model trimming process led to a heavily refined model with six statistically reliable indicators representing the three COM constructs. In the final trimmed model Capability was defined by self-monitoring and habits (both related to Psychological Capability), Opportunity was defined solely by subjective norms (Social Opportunity), and Motivation was defined by intentions and PBC (both related to Reflective Motivation), and positive affect (Automatic Motivation). Capability and Opportunity strongly predicted Motivation and sitting, but Motivation did not predict sitting; nor was it a mediator for Capability or Opportunity on sitting.

The COM-B predicted a large amount of variance in Motivation and sitting, with Capability as the most important driver of sitting, followed by Opportunity. A parallel analysis of the TPB showed that this model predicted a large amount of variance in intentions to avoid sitting for large periods, but a lower amount of variance in sitting than the COM-B. This study is the first to examine the three constructs of the COM-B in this way, test their predictive validity in relation to sitting, and then provide a comparison to the TPB. The variance explained for COM-B in this study was clearly greater than for the TPB (27% vs 13%), but was quite consistent with other TPB analyses for sedentary behaviour in general (e.g. Prapavessis et al., 2015; Rhodes & Dean, 2009). There was also inconsistency between the models with Reflective Motivation (which includes intentions) not impacting sitting for the COM-B, but intentions being a significant predictor of sitting for the TPB.

In line with Study 2 (Chapter 6), Capability was the most important construct with habits were the most important predictor. This is supported by previous research that has found that employee's habitual ability to break prolonged sitting (e.g. walking to the printer/coffee machine) predicted objectively measured episodes of breaking sitting with standing (Smith et al., 2018). Self-monitoring was also important but action planning did not contribute to Capability. This may reflect the fact that psychological variables may be better at predicting non-volitional sitting (Prapavessis et al., 2015). In this sample those that self-monitored how often they broke up periods of sitting were more likely to sit less, but they may have been unable to make detailed plans about how and when they were going to do this, because of the constraints of their job role. Consistent with the physical activity analysis, this sample was overall very healthy and therefore physical health was not an important contributor to Capability. Knowledge was also not measured for sitting as guidelines on sitting were not introduced until after data collection had finished (Buckley et al., 2015). However, the guidelines are still quite vague (break up working hours with 2 hours of standing/light activity progressing to 4 hours), only specify advice for people with desk-based jobs, and only focus on working hours so have limited applicability to sitting that includes transport and leisure time. The guidelines also only specify the amount that an individual should stand, and not how often sitting should be broken up by standing. A recent review suggests that the evidence base may not be strong enough currently to recommend credible quantitative guidelines for sitting (Stamakis et al., 2018).

For the Opportunity construct subjective norms was the only formative indicator (this indicator was also the most important for Opportunity in the physical activity analysis). The extent to which others viewed it as important to break up large periods of sitting contributed to sitting behaviour. These types of norms are injunctive rather than descriptive (what others actually do), with previous research suggesting this may be the most important type of norms for some forms of sedentary behaviour (Prapavessis et al., 2015). Social support for physical activity, the surrounding neighbourhood environment, and presence of recreational facilities were not important sources of Opportunity to reduce sitting time. This may be simply due to the fact all of these measures were focused on physical activity and not sitting.

For the Motivation construct the most important indicator was intention, consistent with many other theories of behaviour such as the TPB, SCT, and HAPA. The two other indicators of Motivation were perceived behavioural control and positive affect, suggesting that perceptions about how much control (or not) the participants had over sitting and how often they felt positively (unrelated to sitting) helped form Motivation. The biggest diversion, however, from the physical activity analysis and from the theorised relationships in the COM-B was that Motivation did not impact on sitting behaviour in this sample. This was in direct contrast to the later findings from the TPB analysis which revealed intentions to be the most important influence on sitting. This finding is not without precedent though as habit has been found to contribute more significantly to objectively-measured sedentary behaviour than planning and intentions in other samples (Maher & Conroy, 2016), and including past behaviour can reduce intention-behaviour relationships (Hagger et al., 2002).

The TPB analysis confirmed that the structural pathways proposed by the model were largely true, apart from the direct route from PBC to sitting. This may be due to workplace sitting being perceived to be out of individual control. The variance explained was, however, lower than in previous tests of the model in overall sedentary behaviour (Prapavessis et al., 2015; Rhodes & Dean, 2009), so perhaps breaking sitting into different domains (e.g. leisure, computer use, transport) can provide greater predictive validity. The final COM-B measurement model included all of the TPB constructs, apart from attitudes, with only the addition of habits and positive affect increasing the predictive validity for sitting considerably.

The strengths of this approach were highlighted in detail in the previous study, including the statistical modelling, operationalization of the constructs, and the time lag between formative indicators and sitting. The limitations included opportunity sampling, TDF domains not measured (memory, attention, and decision making; reinforcement; knowledge), and the data-driven validation of the model. An additional limitation to the sitting analysis was that the measures for social support, neighbourhood environment, presence of recreational facilities, and identity were physical activity related. This may have limited their applicability for sitting specifically, and future attempts at testing the COM-B for sitting should utilise (or develop) measures that are potentially more suitable for sitting.

7.3.1. Implications and future considerations.

Research shows that an absence of physical activity may not be the same as sedentary behaviour (van der Ploeg & Hillsdon, 2017), that the two behaviours could have health-related risk factors independent of each other (e.g. Chau et al., 2013; Katzmarzyk et al., 2009), and that replacing prolonged sitting with light activity could be highly beneficial (Bailey, 2017). There is, however, some debate regarding the quality of the evidence base for separating sedentary behaviour completely from inactivity (Stamakis et al., 2018). If sedentary behaviour is going to become a consistent target for intervention designers, then there is a need to develop questionnaires measuring key psychological drivers/antecedents of this behaviour. This study adapted measures designed for physical activity which may have not been ideal for probing the intricacies of sedentary behaviour. More so than physical activity, there also needs to be a distinction between volitional and non-volitional behaviour. Many modern jobs necessitate large periods of sitting at a desk (and during commuting) and the lack of control (and subsequent planning) may mean that non-volitional sedentary behaviour has a different set of drivers, that are more externalised, than the volitional equivalent.

This distinction is also important for the design of interventions to change workplace sitting, which may need to be targeted at the multiple levels with buy in from organisations and individuals. There is evidence to suggest that breaking up large amounts of sitting with treadmill desks may have important health benefits (Champion et al., 2018) and that the use of active workstations do not deplete cognitive performance or productivity (Ojo, Bailey, Chater, & Hewson, 2018). The fact that the final COM-B model contained predominantly TPB-related constructs could be interpreted in two different ways. It may mean that a modified TPB, with habits and positive affect included, is a suitable theoretical basis for interventions. Alternatively, it may reflect the inherent issues with how other COM-B indicators were measured, and therefore were not appropriate conceptualisations of potentially important constructs. Subjective norms were the one consistent predictor of sitting from both models and therefore, may be an important consideration to target in future interventions. Recent research has highlighted some of the problems that employees perceive when trying to break up long periods of sitting in meetings (Mansfield et al., 2018). Employees reported feeling uncomfortable at breaking accepted norms by standing and were wary of the power dynamics in standing, either as the group leader (too controlling), or a group member (challenging authority; Mansfield et al., 2018).

7.3.2. Conclusion.

This study provided less clarity on the main constructs and some of the proposed structure of the COM-B than the study on physical activity, but the COM-B model still explained sitting much more strongly than the TPB. Subjective norms were a consistent predictor of sitting and needs to be addressed in future interventions, particularly in workplaces where sitting norms in meetings and at the desk are influential. For future sedentary behaviour interventions there is a need for greater clarity in quantitative guidelines, both for goal development and for well-specified outcomes (akin to 150 per week of physical activity). Furthermore, the development of validated measures representing the psychological drivers underpinning this behaviour would be beneficial.

Chapter 8

Study 4: The ‘Active Herts’ physical activity programme

The introduction and methods from this chapter have been published as: Howlett, N., Jones, A., Bain, L., & Chater, A. (2017). How effective is community physical activity promotion in areas of deprivation for inactive adults with cardiovascular disease risk and/or mental health concerns? Study protocol for a pragmatic observational evaluation of the ‘Active Herts’ physical activity programme. *BMJ Open, 7*(11), e017783.

8.1. Prelude

My involvement in the Active Herts programme was serendipitous. My supervisor Angel Chater was doing some training on behaviour change theory and intervention design for public health consultants in Hertfordshire. After the training Angel was approached by a public health consultant who had secured funding for a physical activity programme, and really wanted some of these principles applied to their project. We had recently completed our systematic review and completed most of the data analysis from the TDF/COM-B/TPB studies. After meeting the Active Herts programme leads and discussions with the lead evaluator at the University of East Anglia (Andy Jones), we agreed to help design the Active Herts booklet (with BCTs identified from our systematic review), train and supervise the Get Active Specialists (GAS), based on Angel’s training experience, add some measures of Capability and Motivation (from the prospective studies) into the evaluation and monitor fidelity through training, supervision, and feedback to the GAS. In exchange, we gained access to the data and involvement in the project management, refinement, and evaluation; something I am very grateful for to this day. For the purposes of this PhD, two-year interim data were analysed to fit the timeline with the full three-year evaluation to follow.

At the point we got involved, the grant had already been awarded and the design was set. There was no scope to do the following steps identified in Chapter 2: a behavioural analysis was not possible as physical activity was already the primary outcome; the target population had been agreed; limitations in time and resources also precluded feasibility testing prior to the start. There were also some concerns from the programme manager at the outset (and subsequently the GAS in the initial months) about the need for the additional measures of Capability and Motivation. For this reason the shortest measures of Capability (action planning, 4 items; self-monitoring, 2 items) and Motivation (intentions, 3 items; self-efficacy, 5 items) were included from Study 2 (Chapter 6). This omitted the strongest predictor of Capability (habits, 12 items) and Motivation (self-identity, 9 items) because the measures were too long. Measures of Opportunity were omitted partly because of this need to keep the questionnaire to a manageable length and for two additional reasons: Opportunity did not directly influence MVPA in Study 2; Active Herts provided additional social and physical opportunities, in terms of 12 weeks of physical activity sessions that were relatively equal between groups. Therefore, it may be that only pre-existing differences in Opportunity due to location, work, or family responsibilities, were not accounted for. That said, we closely followed recommendations for intervention design, delivery and evaluation.

8.2. Introduction

Chapter 3 highlighted that overall physical activity and sporting participation needs to be improved in the UK. Inactivity is even more prevalent in low-socioeconomic status (SES) adults and those living with major disease. Lower SES adults are less likely to participate in vigorous and moderate-intensity physical activity, and walking (Giles-Corti & Donovan, 2002). They are also more likely to perceive the opportunities to be active in their local environment more negatively shown through physical activity related factors such as attractiveness, safety, and access to pavements for walking (Giles-Corti & Donovan, 2002). Furthermore, lower SES adults are less likely to perceive themselves as overweight or try to lose weight, which in turn lessens the chances of them participating in physical activity as a weight control strategy (Wardle & Griffith, 2001). Additionally, those living with CVD and a combination of CVD and type 2 diabetes report lower levels of physical activity and greater sedentary behaviour in terms of television watching (Cassidy, Chau, Catt, Bauman, & Trenell, 2016). Overall, those living in low SES areas and/or with ongoing diseases are an important target to increase physical activity through intervention.

The Active Herts programme attempted to address adult inactivity by drawing on the latest evidence, analysing how to support inactive adults to be more physically active. The systematic review in Study 1 (Chapter 4) has shown that interventions in inactive adults show statistically significant small to moderate effect sizes post-intervention, and small but still statistically significant effect sizes for at least 6 months after intervention contact has finished (follow-up) (Howlett et al., 2018). The review also analysed the BCTs that were associated with effective interventions and highlighted several approaches that can heighten the likelihood of physical activity programmes, producing meaningful changes in physical activity (e.g. action planning, self-reward, information about health consequences). Whilst it is important to understand which techniques are effective when attempting to intervene with an inactive population to increase physical activity, so too is the communication style in which the techniques are delivered (Chater, 2014, 2018). Motivational interviewing has been shown to be an effective communication method with which to change several health behaviours including physical activity (e.g. Rubak et al., 2005).

Used in combination, BCTs, motivational interviewing, and health coaching can target key determinants of behaviour, which can be understood in terms of the individual's Capability (physical and psychological), Opportunity (social and physical), and Motivation (reflective and automatic) (COM-B; Michie et al., 2011) to be more active. The selected BCTs in the Active Herts programme have been mapped onto and, therefore, target all 6 aspects of the COM-B (for method, see Cane et al., 2015). Study 2 (Chapter 6) showed that the COM-B model can explain a large amount of variance in physical activity participation, highlighting psychological capability (such as action planning and self-monitoring) and reflective motivation (such as intentions and self-efficacy) as key drivers (Howlett, Schulz, et al., 2017).

The purpose of the Active Herts programme was to support engagement in physical activity and promote wellbeing in inactive adults with elevated risk of CVD and/or mental health concerns, living in four areas of the English county of Hertfordshire where need is the highest (e.g. high CVD risk, diabetes, and obesity). The wider economic value for health from sport participation in Hertfordshire in 2015 was £461.6 million. Inactivity (excluding costs related to obesity and mental health) was also costing the health economy between £1.1 and £1.4 million per year in the four focus districts of Active Herts (Sport England Bid, ref: 2015000295). The districts contained the highest number of deprived Lower Super Output Areas (LSOA) in Hertfordshire and were in the five highest under 75 mortality rates from CVD (2-3%), adult obesity (8-10%), and diabetes (4-6%). A life expectancy gap of 6-9.6 years existed between the most and least deprived areas across these districts (Public health profiles, 2014). Less than 50% of this population participated in 30 minutes of physical activity once per week.

Pragmatic delivery considerations mean the programme used two different approaches. In the first programme users had an initial consultation, were signposted to 12 weeks of exercise sessions, and provided further support in person or by phone throughout a 12-month period ('standard delivery'). The second approach included additional support in the form of optional exercise buddies and free tailored exercise sessions organised by the programme staff themselves ('enhanced delivery'). The aim of this study was to report the Active Herts programme (content, delivery mode and staff, staff training, setting, and analysis) and evaluation. The objectives of the evaluation were:

Primary objective:

- To observe whether programme users on the Active Herts programme increased reported physical activity, sporting participation, and sitting with (enhanced delivery) and without (standard delivery) additional support from exercise buddies and free access to tailored exercise classes.

Secondary objectives:

- To observe whether programme users on the Active Herts programme increased perceived health, mental wellbeing, life satisfaction, Capability (self-monitoring and action planning), Motivation (intention and self-efficacy), and attitudes with (enhanced delivery) and without (standard delivery) additional support from exercise buddies and tailored exercise classes.
- To explore whether Capability (self-monitoring and action planning) and Motivation (intention and self-efficacy) components were drivers of reported MVPA performance at baseline, 3 and 6 months.
- To explore whether changes in Capability (self-monitoring and action planning) and Motivation (intention and self-efficacy) components were drivers of changes in reported MVPA between baseline and 3 months, and baseline and 6 months.

8.3. Method

8.3.1. Design

This evaluation was a longitudinal (baseline, 3, 6 and 12 months) observational design, with comparison of the two different delivery methods employed in different localities, between November 2015 and November 2018. The design of the evaluation is illustrated in Figure 8.1. This evaluation is reported according to the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND; Des Jarlais et al., 2004) guidelines, and with reference to the Template for Intervention Description and Replication (TIDieR; Hoffmann et al., 2014) checklist. The present analysis only includes analysis of 3 and 6-month outcomes.

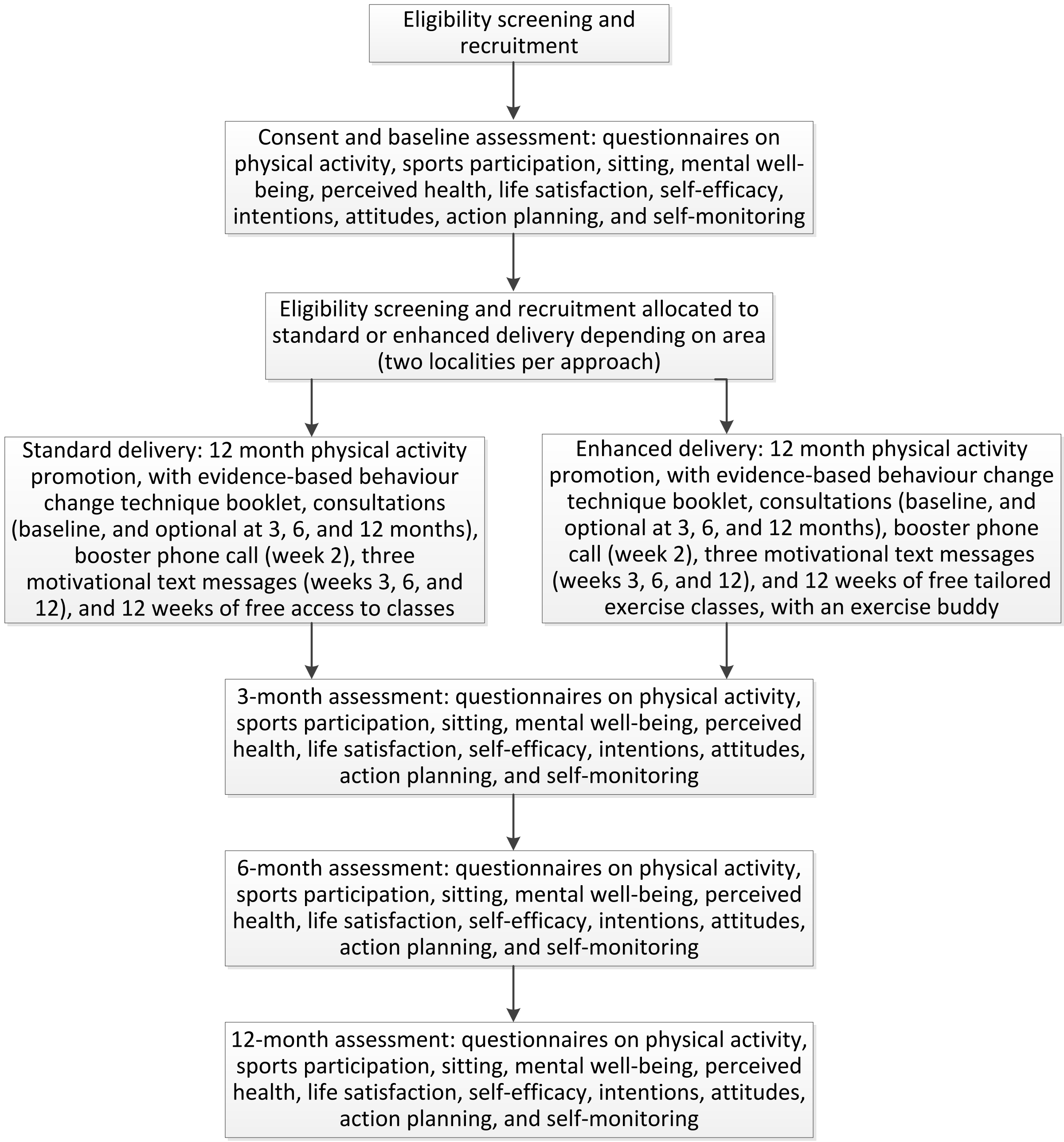

Figure 8.1. Active Herts programme design

8.3.2. Programme users

The inclusion criteria for participation in the Active Herts programme was inactive adults aged 16 and over who had one or more risk factors for CVD and/or a mild to moderate mental health concern. Inactivity was classed as participating in less than one reported episode of 30 minutes of physical activity per week on a regular basis. Additional risk factors for CVD included: diabetes, hypertension, high cholesterol, obesity (BMI > 30 or

BMI > 28 if one or more co-morbidities), and/or smoking. Those with a severe mental health condition could also participate if their general practitioner (GP), Mind (a mental health charity), or Improving Access to Psychological Therapies (IAPT) consultant, deemed them suitable for the programme. An additional criterion for inclusion in the evaluation was the ability to give informed consent for their data to be used.

Programme users were primarily recruited into the programme through 23 GP services throughout the four localities: five in Broxbourne; five in Hertsmere; six in Stevenage; four in Watford. A Mind wellbeing centre in each location also referred into the programme. Hertfordshire residents who met the inclusion criteria could also access the programme through self-referral. As this programme was funded by Sport England, Hertfordshire County Council, and local CCGs, with a focus on delivery, pre-specified power calculations were not deemed necessary and all eligible programme users were invited to engage in the evaluation. The objective was to provide as many eligible residents as possible with access to this programme over the 3-year life of the project, with a minimum expectation of engagement from 1500 programme users. .

8.3.3. Programme Materials and Procedure

Programme users in both delivery groups received the same content in terms of an initial 45-60 minute consultation with a Get Active Specialist (with additional consultations at 3, 6, and 12 months), an Active Herts booklet (Appendix J), a two week booster call, and access to activities in their local area. Programme contacts in person and by phone on a one-to-one basis were managed using ReferAll (http://www.refer-all.net/), which is software regularly used for lifestyle services throughout the UK. Aside from access to a range of free or discounted group activity sessions (e.g. swimming, pilates, walking football, low-intensity circuit training) over the first 12 weeks, there were no additional incentives for programme users to attend consultations. Programme users in the enhanced delivery group were provided 12 weeks of free sessions organised for the Active Herts programme and often run by the Get Active Specialist (GAS), whereas programme users in the standard delivery group were signposted to pre-existing physical activity sessions in the local area suitable for each individual, which were often discounted but not subsidised from Active Herts. As the majority of the contact was provided in the first 3 months this was viewed as the intensive phase of the programme with the remaining 9 months a tapering off phase of lower intensity.

The content of the Active Herts programme was based in part on the review (Howlett et al., 2018) in Study 2 (Chapter 4) by including BCTs found to be present in effective physical activity interventions. The exception was 'Biofeedback' as giving each participant heart rate monitors in a programme of this size was unfeasible. BCTs were either included in the booklet (Appendix M) given to programme users, used by Get Active Specialists during their consultations with programme users, or delivered in exercise classes, and targeted all 6 facets of the COM-B model of behaviour change (Cane et al., 2015). Table 8.1 provides a detailed breakdown on the BCT type and content for each phase of the programme.

Table 8.1.

Programme content specified by behaviour change techniques and linked to constructs of the COM-B model

Programme component	**Behaviour change technique**	**COM-B construct targeted**	**Content**
Booklet (both groups)	Pros and Cons	Reflective motivation	A page asked whether exercise is good for you and programme users were given two blank columns to fill out possible advantages and disadvantages of becoming more active. They were then asked how confident they felt about becoming active on a scale of 1-10.
	Problem Solving	*Psychological capability; Reflective motivation	Programme users were asked to think about their current situation and to list the things that might be currently stopping them from being active and how they might overcome them.
	Goal setting	Reflective motivation	Programme users were given the opportunity to set short (2 weeks), medium (3 months), or long-term (12 months) goals, and then rate how confident they were of achieving each one from 1-10.
	Action planning	Psychological capability and Reflective motivation	This page allowed programme users to complete sections referring to their plans of becoming more active in terms of what they were going to do, where they were going to do it, when they were going to do it,

		and who they were going to do it with. A second page allowed them to explore their time management by mapping out the week in terms of morning, afternoons, and evenings.
Relapse prevention	*Psychological capability; Reflective motivation	In contrast to the problem-solving page which focused on current problems, this page explained how even the most habitual exercisers can struggle at times. Programme users were asked to think about situations in the future that may affect their progress and then about options to avoid or cope with these situations.
Self-monitoring of behaviour	Psychological capability	Programme users were given an exercise and activity diary to track their progress and highlight their engagement. A table contained columns for the date, activities completed, time in minutes, enjoyment level (from 1, low to 10, high), and how they felt after completing the activity. The table contained several rows so programme users could track this over time.
Information about health consequences: Information on	Psychological capability; Reflective motivation	A page summarised the health and emotional benefits of being active in a positively framed manner. For example, did you know that being active can 'help you manage high blood pressure' and 'make you feel

	emotional consequences		good and improve your mental health'.
	Instruction on how to perform the behaviour	*Psychological capability	Programme users were given the national exercise guidelines for moderate and vigorous activity. Additionally information was given for examples of moderate and vigorous activity, how to break up long periods of sitting, how to improve balance to reduce the chance of falls, and an example of how these activities can fit into everyday life.
	Self-reward	Automatic motivation	Programme users were told the importance of rewarding themselves for the effort they made towards their activity goals. Examples were then given of how to reward themselves in ways that were healthy and free. For example, 'listen to music' or 'have a nice relaxing bath'. Self-reward was also discussed briefly during the goal setting page when thinking about what success looks like.
Consultation (both groups)	Social support unspecified; Social support emotional	Social opportunity; Automatic motivation	Programme users were given an initial 45-60 minute consultation in person one-to-one where motivational interviewing and health coaching were used to structure the session to fit participant needs, move them towards becoming more active, signposting activities and

			discussing goals and plans, while providing emotional support. This was then repeated in subsequent consultation meetings at 3, 6, and 12 months. The additional consultations varied between 15-30 minutes and were optional based on participant needs.
	Credible source	*Social opportunity; Automatic motivation	Expert Get Active Specialists who were trained in motivational interviewing and behaviour change, with specialist knowledge of obesity, diabetes, exercise referral, and mental health discussed becoming more active in a favourable light with programme users.
	Verbal persuasion about capability	Reflective motivation	Programme users set goals and the Get Active Specialists encouraged their belief in their ability to fulfil those goals and make long-term change.
	Focus of past success	Reflective motivation	During the consultation programme users set physical activity goals and the Get Active Specialists discussed previous success or progress.
Exercise sessions (both groups)	Instruction on how to perform the behaviour;	Social opportunity; Psychological capability	Programme users chose to attend 12 weeks of exercise classes either referred to them (standard delivery) or organised as bespoke sessions (enhanced delivery) by the Get Active Specialists. These involved

	Demonstration of the behaviour; Behavioural practice/rehearsal		detailed instruction on how to perform a range of exercises (e.g. yoga, pilates, light to moderate-intensity circuit training). During these classes programme users were given demonstrations of the correct way to perform the activities and provided with ample opportunity to practice and gain confidence in performing the exercises.
	Graded tasks	Physical capability	During the exercise classes, exercise specialists encouraged programme users to start slowly and build up intensity throughout the 12 weeks.
Booster call (both groups)	Social support unspecified; Verbal persuasion about capability; Prompts and cues	Social opportunity; Reflective motivation; Physical opportunity	Programme users received a phone call at 2 weeks, which was approximately 5 minutes in duration prompting them to keep working towards their physical activity goals and stating that they were capable of achieving them.
Text messages (both groups)	Social support unspecified; Verbal persuasion about capability; Prompts and cues	Social opportunity; Reflective motivation; Physical opportunity	A text message was sent to programme users at 2, 6, and 12 weeks prompting them to keep working towards their physical activity goals and stating that they were capable of achieving them.

Exercise buddies and tailored exercise classes (enhanced delivery only)	Social support practical and emotional	Social opportunity; Automatic motivation	For programme users in the enhanced delivery areas, Get Active Specialists ran and/or organised a range of exercise classes based on the preferences of programme users, where they could also be paired with an exercise buddy to help them attend the exercise classes and provide emotional support if needed.

Note: *denotes that a BCT was not explicitly linked to a COM-B construct in the consensus study from Cane et al. (2015), but the authors believed that this BCT would impact this area.

8.3.4. Get Active Specialists

One GAS was employed by local organisations (e.g. borough councils or leisure providers) in each of the four localities, for the 3-year duration of the programme. The GASs worked predominantly with local GPs and occasionally with Mind centres to recruit eligible programme users. The GASs all had a minimum of level 3 Register of Exercise Professionals (REPs) and GP Exercise Referral qualifications. The GASs were further trained so that conversations with programme users were user-led, involving open-ended questions, reflections, and summaries, which allowed programme users to take ownership of setting their own goals, plans, and rewards for progress. The specialists received the following training specific to this programme:

- The two-day 'British Heart Foundation: Promoting health behaviour change – A solution focused approach' course (http://www.bhfactive.org.uk/training-and-events-item/506/index.html)
- The three-day 'The Wright Foundation: Obesity and Diabetes' course (http://www.wrightfoundation.com/spec_ob_di.php)
- The one-day 'The Wright Foundation: Level 4 mental health' course (http://www.wrightfoundation.com/spec_men.php)
- The two GASs working in the localities designated to provide exercise buddies also attended a one day Recruiting and Retaining Volunteer course organised by Volunteer Centres, Hertfordshire (http://www.volunteeringherts.org.uk/index.php/events/details/12-recruiting-and-retaining-volunteers).

An additional two-day workshop and quarterly boosters were developed and led by AC and supported by NH. This covered how to create a behavioural diagnosis from COM-B using a motivational interviewing (Rollnick, Miller, & Butler, 2008) congruent approach, and how to deliver the BCTs with an emphasis on expressing empathy and being client-focused (Jubraj et al., 2016). This training highlighted the need to Engage the patient in the consultation process, Resist telling them what to do, allowing Focus on what is desired and achievable, to Understand the patient's perspective, Evoke a sense of empowerment, ensure that the client feels Supported and has a Plan going forward (Chater, 2018). Core communication skills to support an effective consultation (Chater, 2015, 2016) such as RULE

(Resist the righting reflex; Understand your client's motivation; Listen to your client; Empower your client) and OARS (Open-ended questions, Affirmations, Reflective listening, Summaries) were covered, and linked to the delivery of the BCTs.

Furthermore, the training covered the GROW model from Health Coaching (Goal, Reality, Options, Will/Way forward; Whitmore, 1995), to help guide the GAS through the consultation and use of BCTs effectively, acknowledging that clients may be in differing 'stages of change'. Finally, the British Psychological Society's Code of Ethics and Conduct (British Psychological Society, 2018) and the Health and Care Professions Council's Standards of Conduct, Performance and Ethics were highlighted throughout (e.g. working within professional boundaries; Health and Care Professions Council). This training enabled conversations with programme users that were user-led, and allowed programme users to take ownership of developing their own goals, overcoming barriers, specifying plans, and rewards for progress.

8.3.5. Assessment of Fidelity

To ensure fidelity of programme delivery, a number of measures were put in place. GASs were video-recorded at the onset of training to identify their baseline skills in a consultation scenario. They were then asked to audio-record (with permission from programme users) a random sample of consultations and reviewed the audios amongst themselves, the project lead and at quarterly booster sessions with the trainers (NH; AC, second supervisor). The GASs scored each consultation with the Motivational Interviewing Treatment Integrity coding scheme (MITI; Moyers, Martin, Manuel, Miller, & Ernst, 2010) and a checklist of BCTs included in the programme. The MITI was used to score the specialists on five domains core to motivational interviewing: Evocation – the GASs worked proactively to evoke participant's own reasons for change; Collaboration – the GASs actively fostered and encouraged power sharing in the interaction; Autonomy/Support – the GASs added significantly to the feeling and meaning of participant's expression of autonomy; Direction – the GASs resisted the righting reflex, yet generally did not miss opportunities to direct participants towards the target behaviour; Empathy – the GASs showed evidence of deep understanding of participant's point of view.

Every 3 months throughout the duration of the evaluation, the GASs and project lead met for booster sessions with a Chartered Sport and Exercise and Health Psychologist (AC, second supervisor) and NH to review recorded consultations, recap training, discuss any barriers to successful delivery, and highlight what was working well. Motivational Interviewing was also used to deliver the training and in these booster sessions with the GASs, whereby open-ended questions, reflections and summaries were used to facilitate the learning process. In addition, both trainers (AC, second supervisor; NH) attended quarterly stakeholder meetings and were in regular contact with the delivery team, with booster sessions developed around feedback from the previous quarter by the programme team. NH also attended monthly team meetings to provide input and to catch up on the project progress. Finally, the GASs were interviewed (as presented in Study 5) in the first year of the programme life-cycle to gauge how the training went and any additional support needed. This was then embedded into future booster sessions.

8.3.6. Outcomes

8.3.6.1. Primary outcomes:

Physical activity and sitting were measured with the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003), previously used in Study 2 (Chapter 6). An additional two questions asked about the amount of time spent doing sports and on how many days, with the minimum being 10 minutes at a time.

Secondary outcomes:

Mental wellbeing was measured using the Warwick Edinburgh Mental Wellbeing Scale (WEMWBS; Tennant et al., 2007), a 14-item scale exploring thoughts and feelings over the last two weeks. Programme users were presented with items such as 'I've been feeling useful' or 'I've been thinking clearly' and rated themselves on a scale from 1 '*None of the time*' to 5 '*All of the time*'. This scale showed excellent reliability (a = .93).

Perceptions of health were measured using the Euroqual EQ-5D-5L (Rabin & Charro, 2001), which has five domains focusing on mobility, self-care, usual activities, pain/discomfort, and anxiety/depression, with one question per domain. Each question had five options to choose from ranging from no problems to inability to function. An additional question asked how good or bad programme users perceived their health to be on a scale ranging from 0 (*the worst health you can imagine*) to 100 (*the best health you can imagine*).

Life satisfaction was measures with a single item taken from the Office of National Statistics annual population survey (ONS, 2016). The item asked programme users how satisfied they were with their life on a scale from 1 '*Not at all satisfied*' to 10 '*Completely satisfied*'.

8.3.6.2. COM-B measures

The following COM-B related scales were used from Study 2 (Chapter 6) and produced a mean score apart from self-efficacy which produced a total score: Self-monitoring, a = .81; Action Planning, a = .96; Self-efficacy; a = .90; Intentions, a = .87; Attitudes*,* a = .68. During the referral process potential programme users were asked about existing medical conditions to pass onto the GAS. These were recorded at baseline but not utilised as an outcome. A full list of the measures can be found in Appendix K.

8.3.7. Analysis

The primary evaluation was based on a comparison between recorded values at baseline for the primary and secondary outcomes and those captured at 3 and 6 months. As this data set comprised the two-year interim data (November 2015 to December 2017) the sample size at 12 months was too small to analyse, particularly in the standard delivery group (enhanced delivery, n = 50, standard delivery, n = 9). Therefore, only those data up to 6 months were included in the analysis. Prior to running the analysis, boxplots were used to explore the distributions of the outcomes measures for anomalies such as outliers and deviation from normality. Physical activity MET scores, sporting participation, sitting time, and self-care across all time points showed positively skewed distributions and were, therefore, submitted to a square root transformation. Differences in baseline characteristics of programme users between the 'standard' and 'enhanced' delivery areas were tested using either an Independent Samples t-test or a Mann-Whitney U test depending on whether the variable being tested followed a normal distribution. Potential confounding factors were explored with correlations between Index of Multiple Deprivation (IMD) scores (based on postcode), age and changes in physical activity levels and Independent Samples T-tests grouped by sex.

Two sets of analysis were completed at 3 and 6 months. The first set of analyses were performed on only those that completed the measures at each time point. The second set of analyses utilised an intention-to-treat approach; whereby, baseline scores were carried forward for all programme users missing 3 and 6 months data. This approach was conservative in assuming no change in outcomes for programme users who dropped out at

3 months and a return to baseline levels for those that had completed 3 but not 6 months. A summary of this second approach is included in the results and full details can be found in Appendix N. Changes in physical activity, sporting participation, sitting, mental wellbeing, perceived health, life satisfaction, self-monitoring, action planning, intentions, self-efficacy, and attitudes were analysed using mixed ANOVAs, with group ('standard' and 'enhanced' delivery) as the between subjects variable and time as the within subjects variable. Bonferroni follow-up tests were utilised to explore differences between the three time points at 6 months. The percentage of programme users achieving the recommended amount of moderate-intensity (150 minutes) and vigorous-intensity (75 minutes) of physical activity were analysed at baseline, 3, and 6 months using 2x2 chi-squares with group (standard, enhanced) and yes/no as the nominal variables.

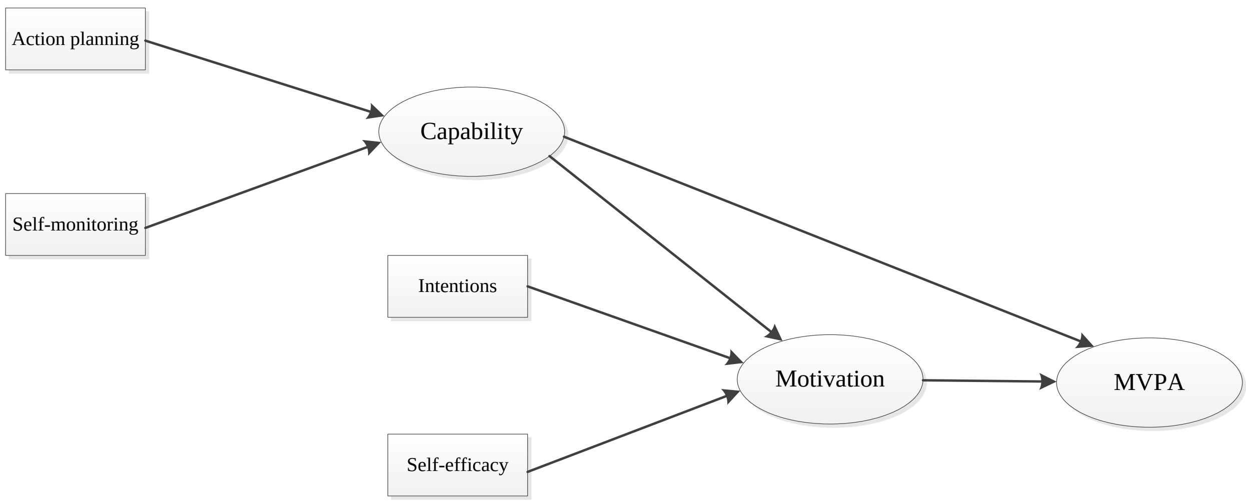

Figure 8.2. COM-B theory explored in secondary analyses with action planning and self-monitoring as Capability indicators and intentions and self-efficacy as Motivation indicators.

In line with Study 2 (Chapter 6), the outcome of interest for analysis of Capability (action planning and self-monitoring) and Motivation (intentions and self-efficacy) was reported MVPA METs. Firstly, analysis explored how well Capability (action planning and self-monitoring) and Motivation (intentions and self-efficacy) predicted reported MVPA performance at baseline, 3 and 6 months and then whether changes in these constructs predicted changes in reported MVPA at 3 and 6 months (compared to baseline). The theoretical model being tested for both performance and change measurement models is depicted in Figure 8.2. The purpose of this analysis was to explore whether the COM-B measures could predict performance (in line with Study 2) or changes in performance following the programme. Correlations were first explored between reported MVPA, self-monitoring, action planning, self-efficacy, and intentions scores at baseline, 3 month, and 6 month time points. Further correlations were then explored between changes from baseline in reported MVPA, self-monitoring, action planning, self-efficacy, and intentions at 3 and 6 months.

Partial mediation path analysis models using AMOS 22 were then explored to analyse whether Capability (action planning and self-monitoring) and Motivation (intentions and self-efficacy) constructs predicted reported MVPA, and whether Capability constructs had any indirect effect on reported MVPA through Motivation constructs at baseline, 3 months and 6 months (Figure 8.2). Two further partial mediation path analysis models then analysed whether changes in Capability (action planning and self-monitoring) and Motivation (intentions and self-efficacy) constructs predicted changes in reported MVPA, and whether changes in Capability constructs had any indirect effect on reported MVPA changes through changes in Motivation constructs at 3 months and 6 months (from baseline). The chi-square statistic was used to test model fit with greater p-values suggesting better fit. The Tucker Lewis coefficient (TLI, cutoffs: acceptable fit > .90; good fit cutoff > .95), Comparative Fit Index (CFI, cutoffs: acceptable fit > .90; good fit cutoff > .95), and Root Mean Square Error of Approximation (RMSEA, cutoffs: acceptable fit < .08; good fit cutoff < .05, Browne & Cudeck, 1993) were used as additional model fit indices.

8.3.8. Ethics

This study (and recording/analysis of consultations) was approved by the Health and Human Science Ethics Committee at the University of Hertfordshire (Protocol number: LMS/PGR/UH/02427; Appendix P). Original ethics approval was given by the Faulty of Medicine and Health Sciences Research Ethics Committee at the University of East Anglia (Lead evaluators). Written informed consent (Appendix L) was obtained from all programme users. For the purposes of this thesis the two-year interim data were analysed. In a clinical trial the data would be sealed until the planned end of the project and then would be analysed by a statistician blinded to treatment allocation. This was a service evaluation funded by Sport England, who required a yearly evaluation report, and therefore annual analyses were pre-planned. The programme continued to recruit as planned the following year and this analysis caused no deviations from the original protocol.

8.4. Results

8.4.1. Participant flowchart

Data on eligibility screening was not available and programme users were allocated to group based on the regional area in which they lived: Hertsmere and Stevenage (standard group); Broxbourne and Watford (enhanced group).

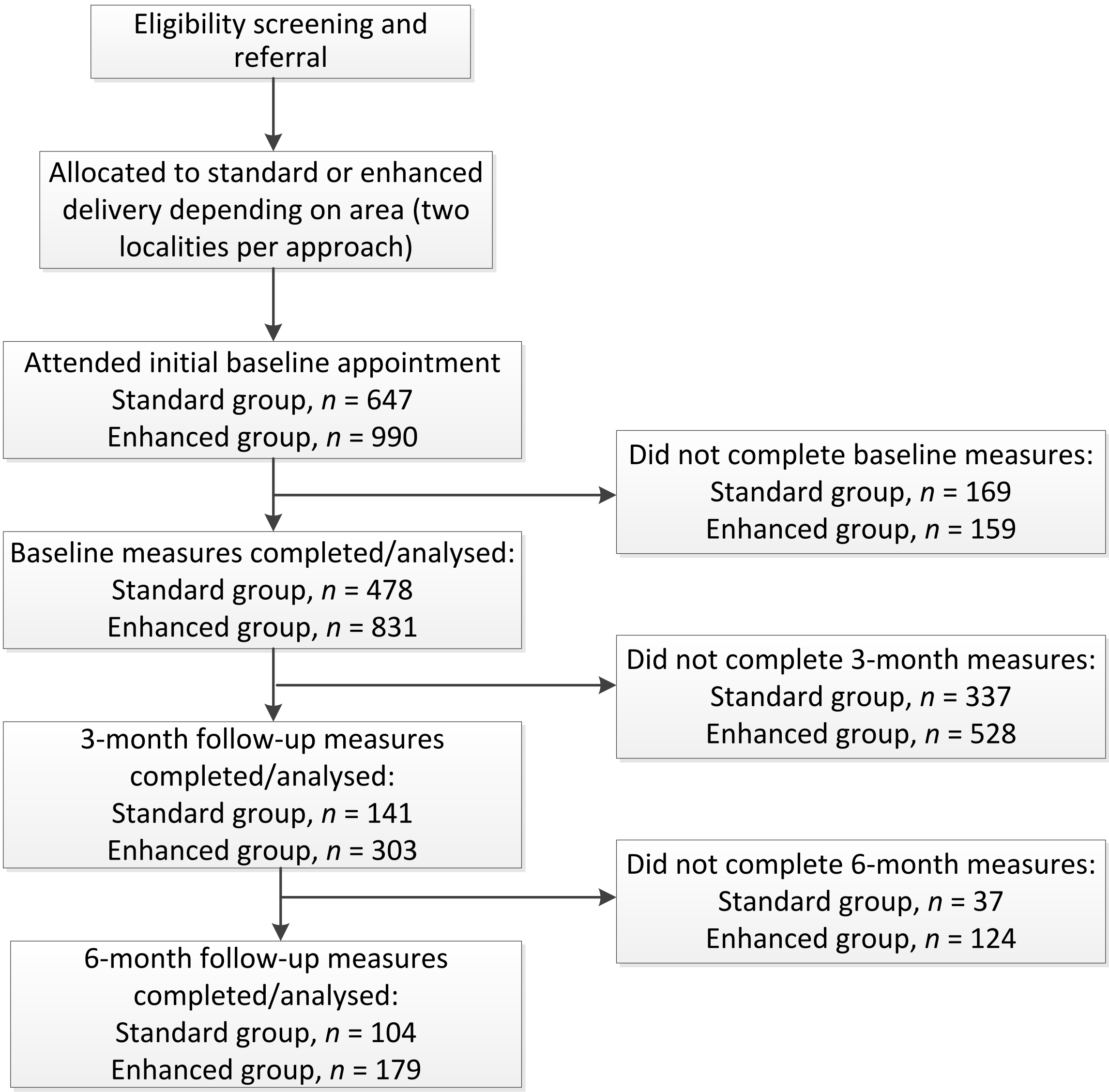

Figure 8.3. Active Herts programme design

8.4.2. Protocol deviations

The only planned differences between groups was that the enhanced delivery group would have access to optional exercise buddies, and that the physical activity sessions were free and organised (and often facilitated) by the GAS themselves. Exercise buddies were not recruited at the rate originally planned, and therefore, were generally not an option available to programme users in the enhanced group. Also, in the two standard delivery areas, by the middle of the 3-year programme, the GAS had begun to put on additional exercise sessions specifically for the programme, often run by the GAS themselves. These changes from the original protocol diminished the difference in planned delivery between the two groups.

Based on the interviews reported in Study 5 (Chapter 9) and ongoing dialogue with the GASs there were also a number of improvements to the formatting of questionnaires, materials, and running of the programme. Based on GAS and client feedback, the questionnaire order and presentation were changed so that the measures fit on fewer pages and the order was more coherent. Although the questionnaires and scale wording were not changed, so as not to invalidate standardised measures, words were used instead of numbers for scale points and these were repeated for every measure item in boxes instead of just at the top of tables. Programme users were also given the option of completing questionnaires online using Qualtrics.

The booklet size was also reduced from A4 to A5 so that it could be more easily fit in a variety of bags. The BCTs remained the same but the order and presentation of pages was changed based on GAS and client feedback. The following changes were made: removal of a contents page; photos of the GASs were added to the contact details; the page outlining the structure of the programme was moved to page 15 (from page 4) and a 12-month box was added; a page with empty speech bubbles to complete regarding thoughts about being active was added; an 'about this booklet page' was removed; the appointments page was moved to page 16 (from page 7); some of the wording was changed alongside images (e.g. 'I'm doing it to improve my wellbeing' instead of 'I'm doing it for my kids'). In an attempt to engage more clients with the programme after the initial 12 weeks of activity sessions, 'conversation cafes' were hosted. This presented an opportunity for programme users to socialise with each other at a local venue and discuss their experiences of the programme. It also enabled the GASs to reconnect with clients and encourage completion of follow-up questionnaires in person.

8.4.3. Did the Active Herts programme improve outcomes at 3 months and did this differ by group?

8.4.3.1. Completer analysis

Due to large attrition rates from baseline to 3 months the baseline characteristics of those that completed the 3-month questionnaires were compared with those of the original baseline sample. The 3-month completers had a similar IMD score. Completers were significantly older (dropouts, M = 50.83, SD = 14.58; completers, M = 56.22, SD = 14.30, $t(1307) = -6.36$, $p < .001$) and had a greater percentage of male participants (dropouts, 71% female participants; completers, 65% female participants, $X^2(1) = 4.71$, $p = .030$). All primary outcomes were similar apart from 3-month completers reported more sitting minutes per week at baseline (dropouts, M = 416.57, SD = 238.94; completers, M = 444.66, SD = 248.19, $t(1282) = 1.97$, $p = .049$). A number of differences in secondary outcomes were also found all indicating higher baseline scores for 3-month completers: perceived health (dropouts, M = 53.31, SD = 22.55; completers, M = 58.02, SD = 20.13, $t(827.44) = 3.49$, $p = .001$), action planning (dropouts, M = 1.61, SD = 0.86; completers, M = 1.79, SD = 0.93, $t(689.85) = 3.05$, $p = .002$), self-monitoring (dropouts, M = 1.52, SD = 0.76; completers, M = 1.64, SD = 0.84, $t(681.53) = 2.28$, $p = .023$), self-efficacy (dropouts, M = 11.99, SD = 4.13; completers, M = 13.06, SD = 4.00, $t(1044) = 4.04$, $p < .001$), intentions (dropouts, M = 5.70, SD = 1.39; completers, M = 6.05, SD = 1.21, $t(834.96) = 4.18$, $p < .001$), attitudes (dropouts, M = 5.81, SD = 0.94; completers, M = 5.95, SD = 0.86, $t(1043) = -2.36$, $p = .018$), and life satisfaction (dropouts, M = 6.13, SD = 2.52; completers, M = 6.51, SD = 2.29, $t(800.49) = 2.42$, $p = .016$).

Table 8.2.

Demographics for baseline sample and 3 month completers

Demographic/measure	**Level**	**Baseline sample**		**3 month sample**	
		Standard (*n* = 478)	**Enhanced (*n* = 831)**	**Standard (*n* = 141)**	**Enhanced (*n* = 303)**
Age		52.76 (*SD* = 13.88)	52.58 (*SD* = 15.17)	55.74 (*SD* = 14.00)	56.66 (*SD* = 14.34)
Sex	Male participants	166 (35%)	243 (29%)	57 (40%)	98 (32%)
	Female participants	312 (65%)	588 (71%)	84 (60%)	205 (68%)
IMD		17.24 (7.43)	18.28 (9.44)	15.96 (11.45)	18.51 (9.77)
Ethnicity	White British	137 (29%)	569 (69%)	31 (22%)	211 (70%)
	African	10 (2%)	43 (5%)	2 (1%)	15 (5%)
	Other white	5 (1%)	49 (6%)	2 (1%)	18 (6%)
	Indian	6 (1%)	16 (2%)	2 (1%)	5 (2%)
	Pakistani	1 (0%)	46 (6%)	0 (0%)	10 (3%)
	Remaining others	13 (3%)	93 (11%)	2 (1%)	34 (11%)
	Missing	303 (63%)	15 (2%)	102 (74%)	10 (3%)

Health condition	Arthritis	36 (8%)	76 (9%)	11 (8%)	30 (10%)
	Asthma	44 (9%)	50 (6%)	10 (7%)	20 (7%)
	Cancer	12 (3%)	14 (2%)	5 (4%)	9 (3%)
	COPD	13 (3%)	19 (2%)	5 (4%)	8 (3%)
	Depression	66 (14%)	63 (8%)	12 (8%)	29 (10%)
	Diabetes (T2)	90 (19%)	97 (12%)	27 (19%)	31 (10%)
	Hypertension	92 (19%)	164 (20%)	33 (23%)	68 (23%)
	Muscoskeletal	36 (8%)	104 (13%)	7 (5%)	47 (16%)
	Overweight	58 (12%)	80 (10%)	20 (14%)	35 (12%)
	Obese	90 (19%)	112 (14%)	19 (13%)	45 (15%)
	Severely Obese	25 (5%)	36 (4%)	7 (5%)	17 (6%)
	Stress/Anxiety	17 (4%)	53 (6%)	5 (4%)	21 (7%)

The baseline sample had a higher percentage of female participants in the standard than the enhanced group (65%, standard; 71%, enhanced, $X^2(1) = 4.25$, $p = .039$), with an average age of 53 years old across both groups. Programme users in the enhanced group had significantly higher IMD scores than the standard group, $t(1183.18) = -2.19$, $p = .029$). Although the majority of the data on ethnicity were missing (63%) in the standard delivery group the majority (69%) of enhanced group programme users were White British. Analysis of the health conditions by programme users in each group revealed that the standard group had a higher percentage of Asthma, $X^2(1) = 4.63$, $p = .031$, depression, $X^2(1) = 13.42$, $p < .001$, type 2 diabetes, $X^2(1) = 12.69$, $p < .001$, musculoskeletal problems, $X^2(1) = 7.89$, $p = .005$, and obesity levels, $X^2(1) =6.66$, $p = .010$ (see Table 8.2). Dropout rates were also compared between groups, showing that the dropout rate in the standard group was greater from baseline to 3 months than in the enhanced delivery group (70.5%, standard; 63.9%, enhanced), $X^2(1) = 5.92$, $p = .015$.

Examination of baseline outcomes between standard and enhanced delivery groups revealed that only sitting time, $t(1282) = 3.63$, $p = .001$, and intention scores, $t(1042) = -4.26$, $p < .001$, differed between groups (see Table 8.3). The standard delivery group reported sitting for longer and the enhanced delivery group had higher intentions at baseline. Data at 3 months were then analysed for completers only ($N = 434$). At baseline programme users reported on average completing 36.86 ($SD = 152.26$, standard group) and 37.59 ($SD = 112.01$, enhanced group) minutes of vigorous physical activity and 74.43 ($SD = 201.67$, standard group) and 86.43 ($SD = 159.90$, enhanced group) of moderate physical activity, representing a relatively active group, based on mean scores. These scores were heavily positively skewed, however, and median values provided a more realistic impression of the reported physical activity participation. At baseline programme users reported median minutes of 0 (standard group) and 0 (enhanced group) for vigorous physical activity and 0 (standard group) and 10 (enhanced group) of moderate physical activity, representing an inactive sample, which was the original target population of the programme.

Table 8.3.

Baseline and 3 month outcomes for 3 month completers (standard, n = 141, enhanced, n = 303). MET values were square-rooted for analysis.

Outcome measure (range from minimum to maximum)	**Baseline**		**3 months**	
	Standard	**Enhanced**	**Standard**	**Enhanced**
Primary outcomes				
Vigorous METs	290.70 (1209.94)	303.27 (898.95)	716.62 (1548.98)	897.67 (1400.44)
Vigorous mins	36.34 (151.23)	37.91 (112.37)	89.58 (193.62)	112.21 (175.06)
Moderate METs	295.63 (804.18)	338.31 (633.07)	424.11 (826.41)	587.31 (836.02)
Moderate mins	73.91 (201.05)	84.58 (158.27)	106.03 (206.60)	146.83 (209.01)
Walking METs	556.50 (957.77)	667.65 (851.08)	685.15 (916.01)	978.46 (1075.86)
Walking mins	168.64 (290.32)	202.32 (257.90)	207.62 (277.58)	296.50 (326.02)
MVPA METs	590.50 (1842.77)	635.91 (1285.83)	1138.61 (2129.46)	1491.82 (1858.19)
Total METs	1156.78 (2480.17)	1326.54 (1657.27)	1837.39 (2735.50)	2496.76 (2486.49)
Sport minutes	3.25 (16.68)	17.81 (61.96)	48.10 (93.81)	72.73 (123.28)
Sitting minutes	500.98 (206.96)	422.66 (264.71)	436.14 (213.83)	344.52 (194.54)
Secondary outcomes				
Mobility (1-5)	1.91 (0.99)	1.94 (1.04)	1.70 (0.97)	1.87 (1.04)
Self-care (1-5)	1.23 (0.61)	1.23 (0.61)	1.16 (0.52)	1.22 (0.57)
Usual activities(1-5)	1.71 (0.93)	1.56 (0.86)	1.58 (0.97)	1.56 (0.89)
Pain (1-5)	2.35 (1.01)	2.27 (1.02)	2.26 (0.97)	2.26 (0.99)

Anxiety/depression (1-5)	1.73 (0.88)	1.78 (1.02)	1.68 (0.91)	1.71 (0.97)
Perceived health (1-100)	58.01 (21.35)	57.92 (19.75)	62.97 (19.35)	65.43 (20.38)
Mental wellbeing (14-70)	48.90 (9.90)	48.11 (10.74)	50.66 (9.52)	50.57 (10.74)
Life satisfaction (1-10)	6.25 (2.24)	6.59 (2.29)	6.75 (2.11)	6.97 (2.22)
Action planning (1-4)	1.66 (0.95)	1.81 (0.91)	2.65 (1.02)	2.59 (1.00)
Self-monitoring (1-4)	1.61 (0.81)	1.64 (0.84)	2.41 (1.00)	2.36 (0.93)
Self-efficacy (5-20)	12.34 (3.78)	13.26 (4.02)	14.16 (4.20)	14.07 (3.87)
Intentions (1-7)	5.52 (1.23)	6.21 (1.12)	5.87 (1.51)	6.17 (1.24)
Attitudes (1-7)	5.67 (0.83)	6.03 (0.84)	6.04 (0.91)	6.23 (0.73)

To analyse changes in primary and secondary outcomes between baseline and 3 months in the standard and enhanced delivery groups, a set of mixed ANOVAs were utilised with time (baseline, 3 months) as the within subjects variable and group (standard, enhanced) as the between subjects variable.

Table 8.4.

Mixed ANOVA results for 3 month primary outcomes

Primary Outcomes	**Effect**	**Result**	**Effect size**
Vigorous METs	Time	$F(1, 399) = 89.45$***	$\eta^2 = .18$
	Group	$F(1, 399) = 6.08$*	$\eta^2 = .02$
	Time*Group	$F(1, 399) = 3.63$	$\eta^2 = .01$
Moderate METs	Time	$F(1, 400) = 38.42$***	$\eta^2 = .09$
	Group	$F(1, 400) = 8.92$**	$\eta^2 = .02$
	Time*Group	$F(1, 400) = 3.08$	$\eta^2 = .01$
Walking METs	Time	$F(1, 397) = 28.27$***	$\eta^2 = .07$
	Group	$F(1, 397) = 7.90$**	$\eta^2 = .02$
	Time*Group	$F(1, 397) = .63$	$\eta^2 = .00$
Total METs	Time	$F(1, 433) = 93.42$***	$\eta^2 = .17$
	Group	$F(1, 433) = 14.31$***	$\eta^2 = .03$
	Time*Group	$F(1, 433) = 2.19$	$\eta^2 = .01$
MVPA METs	Time	$F(1, 442) = 95.46$***	$\eta^2 = .18$
	Group	$F(1, 442) = 9.86$**	$\eta^2 = .02$
	Time*Group	$F(1, 442) = 2.96$	$\eta^2 = .01$
Sport	Time	$F(1, 379) = 123.02$***	$\eta^2 = .22$
	Group	$F(1, 379) = 8.41$**	$\eta^2 = .02$
	Time*Group	$F(1, 379) = 1.14$	$\eta^2 = .00$
Sitting	Time	$F(1, 395) = 37.88$***	$\eta^2 = .08$
	Group	$F(1, 395) = 26.62$***	$\eta^2 = .06$
	Time*Group	$F(1, 379) = .27$	$\eta^2 = .00$

There were highly statistically significant main effects of time for all primary outcomes, showing that regardless of group, reported physical activity and sporting participation increased and sitting time decreased. The effect sizes ranged from moderate to relatively large (e.g. $\eta^2 \geq .13$, moderate; $\eta^2 \geq .26$, large). All primary outcomes also showed statistically significant main effects of group, showing that regardless of time point, reported physical activity and sporting participation was larger and sitting time was lower in the enhanced group. Effect sizes were, however, much smaller than the time effects. There were no statistically significant interaction effects showing that the enhanced delivery did not have additional benefits over and above the standard delivery at three months.

Table 8.5.

Percentage of programme users who reported being active to the recommended amount at baseline and at 3 months for reported moderate and vigorous intensity activity

Outcome	**Yes/No**	**Baseline**		**3 months**	
		Standard	**Enhanced**	**Standard**	**Enhanced**
Moderate 150 minutes	Yes	14 (10%)	54 (18%)	29 (20%)	99 (33%)
	No	127 (90%)	246 (82%)	115 (80%)	203 (67%)
Vigorous 75 minutes	Yes	11 (8%)	36 (12%)	39 (27%)	125 (41%)
	No	129 (92%)	263 (88%)	105 (73%)	177 (59%)

The percentage of programme users that reported completing at least 150 minutes of moderate activity and 75 minutes of vigorous activity, in line with national physical activity recommendations, were then analysed at baseline and 3 months. At baseline, the association between whether programme users reported completing 150 minutes of moderate physical activity and group was statistically significant (10%, standard vs 18%, enhanced), $X^2(1) = 4.79$, $p = .029$. At 3 months, both groups reported a higher percentage of programme users completing 150 minutes of moderate physical activity. The association between whether programme users reported completing 150 minutes of moderate physical activity and group was stronger than at baseline (20%, standard vs 33%, enhanced), $X^2(1) = 7.62$, $p = .006$, suggesting that the enhanced group may have improved more than the standard group. There was no association between the number of programme users reporting 75 minutes of vigorous physical activity and group at baseline (8%, standard vs 12%, enhanced), $X^2(1) = 1.75$, $p = .186$. At 3 months, programme users in both groups reported a higher percentage completing 75 minutes of vigorous physical activity. There was, however, a statistically significant association between the number of programme users reporting 75 minutes of vigorous physical activity and group at 3 months (27%, standard vs 41%, enhanced), $X^2(1) = 8.59$, $p = .003$, suggesting that the enhanced group improved more than the standard group.

Table 8.6.

Mixed ANOVA results for 3 month secondary outcomes

Secondary Outcomes	**Effect**	**Result**	**Effect size**
Mobility	Time	$F(1, 376) = 6.62$**	$\eta^2 = .02$
	Group	$F(1, 376) = .65$	$\eta^2 = .00$
	Time*Group	$F(1, 376) = 1.64$	$\eta^2 = .00$
Self-Care	Time	$F(1, 376) = 1.84$	$\eta^2 = .01$
	Group	$F(1, 376) = .28$	$\eta^2 = .00$
	Time*Group	$F(1, 376) = 1.34$	$\eta^2 = .00$
Usual activities	Time	$F(1, 376) = 1.30$	$\eta^2 = .00$
	Group	$F(1, 376) = .76$	$\eta^2 = .00$
	Time*Group	$F(1, 376) = 1.44$	$\eta^2 = .00$
Pain	Time	$F(1, 376) = .91$	$\eta^2 = .00$
	Group	$F(1, 376) = .14$	$\eta^2 = .00$
	Time*Group	$F(1, 376) = .50$	$\eta^2 = .00$
Anx/dep	Time	$F(1, 376) = 1.11$	$\eta^2 = .00$
	Group	$F(1, 376) = .19$	$\eta^2 = .00$
	Time*Group	$F(1, 376) = .02$	$\eta^2 = .00$
Health	Time	$F(1, 376) = 25.15$**	$\eta^2 = .06$
	Group	$F(1, 376) = .28$	$\eta^2 = .00$

	Time*Group	*F*(1, 376) = 1.05	η^2 = .00
Wellbeing	Time	*F*(1, 376) = 18.53***	η^2 = .05
	Group	*F*(1, 376) = .12	η^2 = .00
	Time*Group	*F*(1, 376) = .49	η^2 = .00
Life Satisfaction	Time	*F*(1, 364) = 15.25***	η^2 = .04
	Group	*F*(1, 364) = 1.10	η^2 = .00
	Time*Group	*F*(1, 364) = .33	η^2 = .00
Action planning	Time	*F*(1, 370) = 127.77***	η^2 = .26
	Group	*F*(1, 370) = .21	η^2 = .00
	Time*Group	*F*(1, 370) = 1.84	η^2 = .01
Self-monitoring	Time	*F*(1, 370) = 112.28***	η^2 = .23
	Group	*F*(1, 370) = .01	η^2 = .00
	Time*Group	*F*(1, 370) = .31	η^2 = .00
Self-efficacy	Time	*F*(1, 371) = 24.61***	η^2 = .06
	Group	*F*(1, 371) = .92	η^2 = .00
	Time*Group	*F*(1, 371) = 3.56	η^2 = .01
Intentions	Time	*F*(1, 367) = 2.32	η^2 = .01
	Group	*F*(1, 367) = 16.31***	η^2 = .04
	Time*Group	*F*(1, 367) = 3.56	η^2 = .01
Attitudes	Time	*F*(1, 367) = 24.74***	η^2 = .06
	Group	*F*(1, 367) = 9.61**	η^2 = .03
	Time*Group	*F*(1, 367) = 2.17	η^2 = .01

Note: * = p < .05; ** = p < .01; *** = p < .001

The analysis of secondary outcome measures showed statistically significant main effects of time for mobility, perceptions of health, mental wellbeing, life satisfaction, action planning, self-monitoring, self-efficacy, and intentions. Aside from mobility which decreased, all of the outcomes listed improved over the intensive 3 month stage of the programme. All effect sizes were relatively small apart from large effect sizes for action planning and self-monitoring. There was also a main effect of group for intentions and attitudes with the enhanced group having higher scores regardless of time point.

8.4.3.2. Intention-to-treat analysis

This second set of analyses used an intention-to-treat approach; whereby, baseline scores were carried forward for all programme users missing 3-month data. This approach was conservative in assuming no change in outcomes for programme users who dropped out at 3 months. The full breakdown of the intention-to-treat analyses can be found in Appendix N. There were highly statistically significant main effects of time for all primary outcomes, showing that regardless of group reported physical activity and sporting participation increased and sitting time decreased. The effect sizes were, however, all small. Vigorous METs, sporting participation, and sitting also showed statistically significant main effects of group, showing that regardless of time point vigorous physical activity and sporting participation was higher in the enhanced group and sitting time was lower in the enhanced group. Effect sizes were however very small. There were also statistically significant interaction effects for vigorous, moderate, total, and MVPA METs. The enhanced delivery showed additional benefits over and above the standard delivery. The interaction effect sizes were also very small.

At baseline, there was no association between whether programme users reported completing 150 minutes of moderate physical activity. At 3 months, programme users in both groups reported a lower percentage (than baseline) completing 150 minutes of moderate physical activity. The association between whether programme users reported completing 150 minutes of moderate physical activity and group was significant at 3 months, with the enhanced group reporting higher levels. There was no association between the amount of programme users reporting 75 minutes of vigorous physical activity and group at baseline. There was, however, a statistically significant association between the number of programme users reporting 75 minutes of vigorous physical activity and group at 3 months, with the enhanced group reporting higher levels.

The analysis of secondary outcome measures showed statistically significant main effects of time for mobility, perceptions of health, mental wellbeing, life satisfaction, action planning, self-monitoring, self-efficacy, and attitudes. Aside from mobility which decreased, all of the outcomes listed improved over the intensive 3 month stage of the programme. All effect sizes were small. There was also a main effect of group for intentions with the enhanced group having higher scores regardless of time point.

8.4.4. Did Capability (self-monitoring and action planning) and Motivation (intention and self-efficacy) predict reported MVPA at baseline and 3 months?

8.4.4.1. Baseline prediction of reported MVPA performance

In line with the results of Study 2 (Chapter 6), further analyses were conducted to see whether the COM-B measures could predict reported MVPA levels at baseline. Initially scores were analysed to see whether there was a relationship at baseline between Capability (action planning, self-monitoring), Motivation (self-efficacy, and intentions), and reported MVPA.

Table 8.7.

Matrix of correlations at baseline between reported MVPA, Capability (self-monitoring and action planning), and Motivation (intention and self-efficacy).

Measures	MVPA	AP	SM	SE
Action planning (AP)	.24**	-	-	-
Self-monitoring (SM)	.27**	.71***	-	-
Self-efficacy (SE)	.13**	.26**	.27**	-
Intentions	.11**	.30**	.24**	.32**

Note: * = p < .05; ** = p < .01; *** = p < .001

The correlation matrix showed small but statistically significant correlations between reported MVPA and self-efficacy, MVPA and intentions, MVPA and action planning, and self-monitoring and intentions at baseline. There were also moderate statistically significant correlations between MVPA and self-monitoring, action planning and intentions, action planning and self-efficacy, self-monitoring and self-efficacy, and self-efficacy and intentions, and a large correlation between action planning and self-monitoring.

Using AMOS the impact of baseline Capability (action planning and self-monitoring) and Motivation (self-efficacy and intentions) variables on reported MVPA was analysed using a partial mediation path analysis model. The effect of group was accounted for and the model also allowed analysis of the direct effect of all variables on reported MVPA and the indirect effect of Capability variables through Motivation variables on reported MVPA.

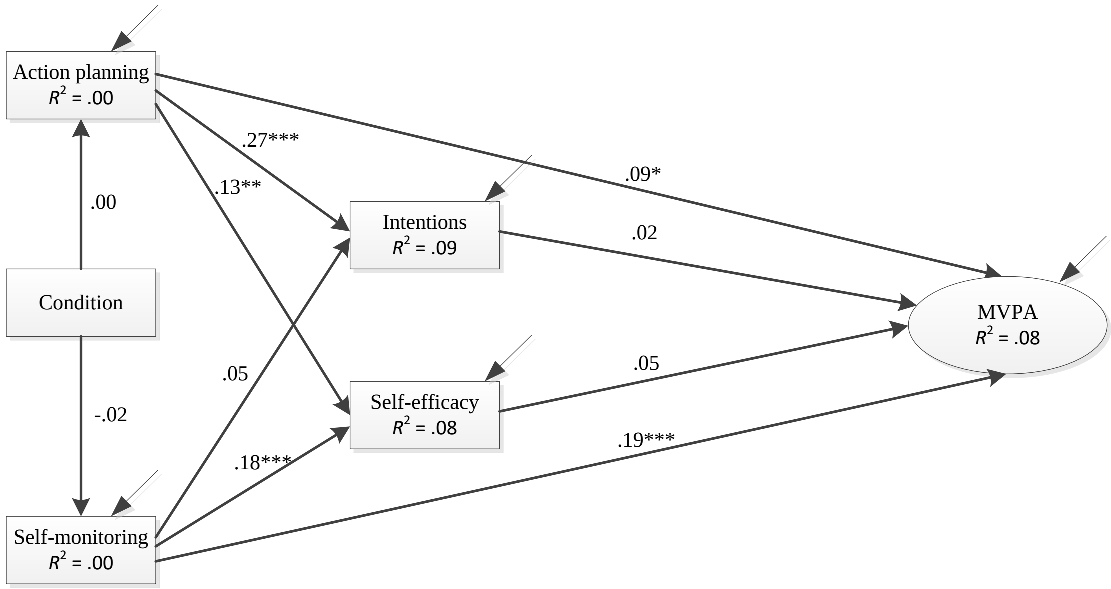

Figure 8.4. Partial mediation path analysis of how well the COM-B measures predicted reported MVPA performance at baseline, with all coefficients standardised.

Note: **p* < .05, ***p* < .01, ****p* < .001

The fully specified model explained a moderate amount of the variance in intentions (9%), self-efficacy (8%), and MVPA (8%), but showed poor fit, $\chi^2(3) = 23.94$, $p < .001$, and inconsistent fit indices (TLI = .90, CFI = .98, RMSEA = .08). Exploration of the model suggested that action planning ($p = .003$) and self-monitoring ($p < .001$) had an effect on self-efficacy. Action planning also had an effect on intention ($p < .001$). Action planning ($p = .033$) and self-monitoring ($p < .001$) had a direct effect on reported MVPA but no indirect effect through self-efficacy or intentions (both *IE* = .01). Intentions and self-efficacy did not have a direct impact on MVPA.

8.4.4.2. Three-month prediction of reported MVPA performance

Three-month outcomes were analysed to see whether there was a relationship between Capability (action planning, self-monitoring), Motivation (self-efficacy and intentions), and reported MVPA.

Table 8.8.

Matrix of correlations at 3 months between reported MVPA, Capability (self-monitoring and action planning), and Motivation (intention and self-efficacy).

Measures	MVPA	AP	SM	SE
Action planning (AP)	.27**	-	-	-
Self-monitoring (SM)	.35**	.70**	-	-
Self-efficacy (SE)	.25**	.50**	.44**	-
Intentions	.19**	.50**	.39**	.43**

Note: * = p < .05; ** = p < .01; *** = p < .001

The correlation matrix showed moderate statistically significant correlations between reported MVPA and all COM-B measures, apart from a small correlation between MVPA and intentions. There were also strong statistically significant correlations between action planning and intentions, action planning and self-efficacy, self-monitoring and self-efficacy, self-monitoring and intentions, self-efficacy and intentions, and action planning and self-monitoring. Using AMOS the impact of Capability (action planning and self-monitoring) and Motivation (self-efficacy and intentions) variables on reported MVPA was analysed using a partial mediation path analysis model. The effect of group was accounted for and the model also allowed analysis of the direct effect of all variables on reported MVPA, and the indirect effect of Capability (action planning and self-monitoring) through Motivation (intentions and self-efficacy) variables on reported MVPA.

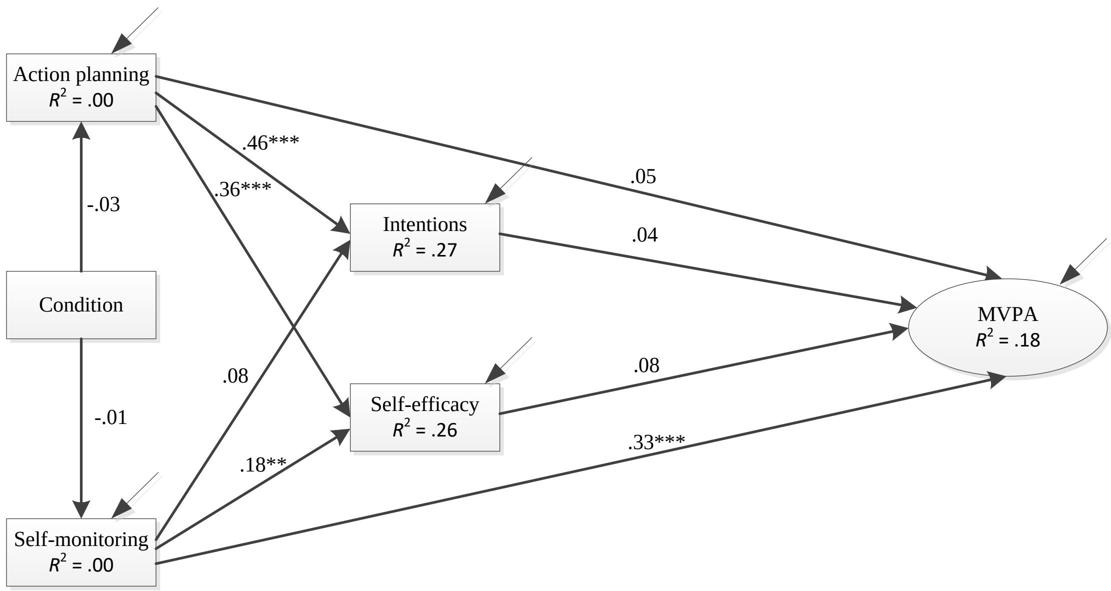

Figure 8.5. Partial mediation path analysis of how well Capability (action planning and self-monitoring) and Motivation (self-efficacy and intentions) predicted reported MVPA performance at 3 months, with all coefficients standardised.

Note: *$p < .05$, **$p < .01$, ***$p < .001$

The fully specified model explained a large amount of the variance in intentions (27%) and self-efficacy (26%) and a moderate amount of the variance in reported MVPA (18%). All of these figures were much larger than at baseline. The model showed good fit, $\chi^2(3) = 5.08$, $p = .166$, and fit indices (TLI = .98, CFI = 1.00, RMSEA = .04). Exploration of the model suggested that action planning ($p < .001$) and self-monitoring ($p = .004$) had an effect on self-efficacy. Action planning also had an effect on intention ($p < .001$). Self-monitoring ($p < .001$) but not action planning ($p = .529$) had a direct effect on reported MVPA but neither had an indirect effect on MVPA (action planning, *IE* = .05; self-monitoring, *IE* = .02). Intentions and self-efficacy did not have a direct impact on MVPA.

8.4.5. Did changes in Capability (self-monitoring and action planning) and Motivation (intention and self-efficacy) predict changes in reported MVPA at 3 months?

The primary analysis showed clear improvements in physical activity and many secondary outcomes regardless of the group for programme users that completed 3-month measures. Secondary analysis then showed that the COM-B measures predicted reported MVPA performance better at 3 months (after the intensive stage of the programme) than at baseline. Further analysis was then conducted to see whether changes in the underlying COM-B measures could predict changes in reported MVPA. Initially, change scores were computed and analysed to see whether there was a relationship between the changes in the COM-B measures (action planning, self-monitoring, self-efficacy, and intentions), and changes in reported MVPA.

Table 8.9.

Matrix of correlations of mean changes between baseline and 3 months on reported MVPA, Capability (self-monitoring and action planning), and Motivation (intention and self-efficacy).

Measures	ΔMVPA	ΔAP	ΔSM	ΔSE
ΔAction planning (AP)	.00	-	-	-
ΔSelf-monitoring (SM)	.14*	.68**	-	-
ΔSelf-efficacy (SE)	.12*	.33**	.35**	-
ΔIntentions	.04	.35**	.26**	.29**

Note: * = p < .05; ** = p < .01; *** = p < .001; Δ = change score

The correlation matrix showed small, but statistically significant correlations between changes in reported MVPA and change scores in self-monitoring and self-efficacy. There were also moderate statistically significant correlations between changes in action planning and intentions, action planning and self-efficacy, self-monitoring and self-efficacy, self-monitoring and intentions, and self-efficacy and intentions, and a large correlation between changes in action planning and self-monitoring. Using AMOS, the impact of changes in Capability (action planning and self-monitoring) and Motivation (self-efficacy and intentions) variables on changes in reported MVPA, was analysed using a partial mediation path analysis model. The effect of group was accounted for and the model also allowed analysis of the direct effect of all variables on changes in reported MVPA, and the indirect effect of Capability variables through Motivation variables on changes in reported MVPA.

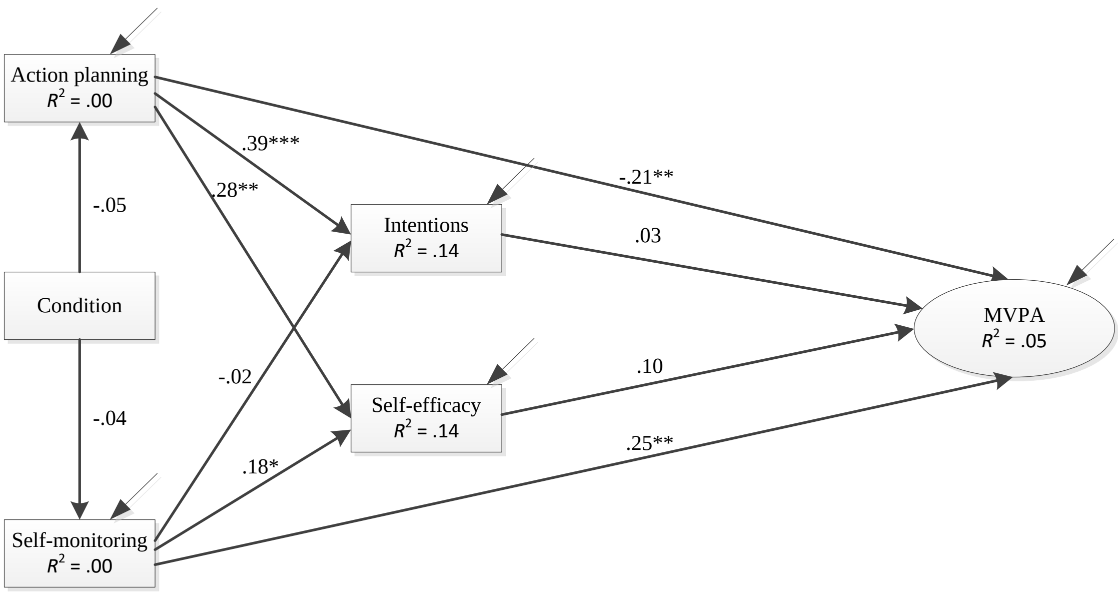

Figure 8.6. Partial mediation path analysis of how well changes in Capability (action planning and self-monitoring) and Motivation (intentions and self-efficacy) predicted changes in reported MVPA at 3 months, with all coefficients standardised.

Note: **p* < .05, ***p* < .01, ****p* < .001

The fully specified model explained a moderate amount of the variance in the changes in intentions (14%) and self-efficacy (14%) and a small amount of the variance in reported MVPA (5%), and showed good fit, $\chi^2(3) = 4.91$, $p = .178$ and fit indices (TLI = .97, CFI

= .99, RMSEA = .05). Exploration of the model suggested that changes in action planning (p = .002) and self-monitoring (p = .017) had an effect on changes in self-efficacy. Changes in action planning also had an effect on changes in intention (p < .001). Changes in action planning (p = .010) and self-monitoring (p = .002) had a direct effect on changes in reported MVPA, but no indirect effect. Changes in intentions and self-efficacy did not have a direct impact on changes in reported MVPA.

8.4.6. Did the Active Herts programme improve outcomes at 6 months and did this differ by group?

8.4.6.1. Completer analysis

Due to large attrition rates (76% enhanced; 75% standard) from baseline to 6 months, the baseline characteristics of those that completed the 6 month questionnaires were compared with those of the original baseline sample. The completers had similar IMD scores, but were on average older (dropouts, M = 50.42, SD = 14.78; completers, M = 57.62, SD = 13.53, $t(1121) = -7.16$, p < .001) and more likely to be female participants (dropouts, 70% female participants, completers, 62%, $X^2(1) = 6.15$, p = .013). Baseline scores on outcome measures were also compared between those that completed the 6 month questionnaires and the original baseline sample. All primary outcomes were similar at baseline (i.e. not significantly different).

However, a number of significant differences in secondary outcomes were found all indicating higher baseline scores (aside from anxiety/depression) for 6-month completers: anxiety/depression (dropouts, M = 1.92, SD = 1.07; completers, M = 1.74, SD = 0.92, $t(433.40) = 2.40$, p = .017), perceived health (dropouts, M = 53.04, SD = 22.00; completers, M = 59.91, SD = 19.84, $t(893) = -4.12$, p < .001), mental wellbeing (dropouts, M = 47.08, SD = 10.82; completers, M = 49.37, SD = 10.65, $t(888) = -2.74$, p = .006), action planning (dropouts, M = 1.64, SD = 0.86; completers, M = 1.81, SD = 0.89, $t(876) = -2.46$, p = .014), self-efficacy (dropouts, M = 11.89, SD = 4.04; completers, M = 13.42, SD = 3.92, $t(878) = -4.88$, p < .001), intentions (dropouts, M = 5.64, SD = 1.42; completers, M = 6.10, SD = 1.16, $t(446.34) = -4.82$, p < .001), attitudes (dropouts, M = 5.77, SD = 0.95; completers, M = 5.94, SD = 0.85, $t(877) = -2.39$, p = .017), and life satisfaction (dropouts, M = 6.06, SD = 2.50; completers, M = 6.75, SD = 2.28, $t(867) = -3.56$, p < .001).

Table 8.10.

Demographics for baseline sample and 6-month completers

Demographic/measure	**Level**	**Baseline sample**		**6-month sample**	
		Standard (*n* = 400)	**Enhanced (*n* = 723)**	**Standard (*n* = 104)**	**Enhanced (*n* = 179)**
Age		52.53 (*SD* = 14.06)	51.24 (*SD* = 15.67)	56.73 (*SD* = 13.71)	58.37 (*SD* = 13.40)
Sex	Male participants	148 (37%)	214 (30%)	39 (38%)	70 (39%)
	Female participants	252 (63%)	509 (70%)	65 (62%)	109 (61%)
IMD		17.33 (7.69)	18.25 (9.66)	16.38 (7.58)	18.67 (10.50)
Ethnicity	White British	106 (27%)	488 (67%)	24 (23%)	211 (70%)
	African	9 (2%)	38 (5%)	1 (1%)	15 (5%)
	Other white	5 (1%)	44 (6%)	0 (0%)	18 (6%)
	Indian	6 (1%)	14 (2%)	1 (1%)	5 (2%)
	Remaining others	15 (4%)	126 (16%)	0 (0%)	34 (11%)
	Missing	259 (65%)	13 (2%)	78 (75%)	10 (3%)
Health condition	Arthritis	26 (7%)	65 (9%)	5 (5%)	16 (9%)

Asthma	34 (9%)	43 (6%)	11 (11%)	17 (10%)
Cancer	12 (3%)	3 (0%)	4 (4%)	7 (4%)
COPD	11 (3%)	18 (3%)	5 (5%)	6 (3%)
Depression	55 (14%)	58 (8%)	9 (9%)	16 (9%)
Diabetes (T2)	79 (20%)	84 (11%)	28 (27%)	29 (16%)
Hypertension	77 (19%)	137 (19%)	24 (23%)	45 (25%)
Muscoskeletal	27 (7%)	74 (10%)	9 (9%)	34 (19%)
Obese	77 (19%)	96 (13%)	15 (14%)	27 (15%)
Severely Obese	21 (5%)	29 (4%)	3 (3%)	5 (3%)
Overweight	41 (10%)	73 (10%)	12 (12%)	26 (15%)
Stress/Anxiety	15 (4%)	47 (6%)	4 (4%)	9 (5%)

The significant association observed between sex and group from the 3 month analysis remained for 6-month completers (63%, standard; 70%, enhanced, $X^2(1) = 6.46$, p = .011). Although the majority of data on ethnicity was missing (65%) in the standard delivery group, the majority (67%) of enhanced group programme users were still White British. Analysis of the 6-month completers living with health conditions in each group revealed that the standard group had a higher percentage of depression ($X^2(1) = 9.34$, $p = .002$), type 2 diabetes ($X^2(1) = 13.72$, $p < .001$), and obesity ($X^2(1) = 7.05$, $p = .008$) (see Table 8.10). Further examination of baseline scores of 6-month completers between standard and enhanced delivery groups revealed that only sitting time ($t(1098) = 3.45$, $p = .001$) and intentions scores ($t(876) = -3.51$, $p < .001$) differed between groups. The standard delivery group sat for longer and the enhanced delivery group had higher intentions at baseline (see Table 8.11).

At baseline, 6-month completers reported on average completing 37.00 (*SD* = 120.81, standard group) and 31.92 (*SD* = 117.92, enhanced group) minutes of vigorous physical activity and 68.49 (*SD* = 155.07, standard group) and 84.79 (*SD* = 214.01, enhanced group) of moderate physical activity, representing a relatively active group, based on mean scores. These scores were heavily skewed however, and using medians provided a more realistic impression of the reported physical activity participation of the sample. At baseline, 6-month completers reported median scores of 0 (standard group) and 0 (enhanced group) minutes for vigorous physical activity and 0 (standard group) and 0 (enhanced group) of moderate physical activity, representing an inactive sample, which was the original target population of the programme.

Table 8.11.

Baseline, 3, and 6-month outcomes for 6-month completers (Standard, n = 104, Enhanced, n = 179). MET values were square-rooted for analysis.

Outcome measure (range from minimum to maximum)	**Baseline**		**3 months**		**6 months**	
	Standard	**Enhanced**	**Standard**	**Enhanced**	**Standard**	**Enhanced**
Primary outcomes						
Vigorous METs	49.55 (159.86)	280.59 (812.06)	716.42 (1669.63)	984.41 (1340.06)	492.54 (1225.41)	1025.00 (1468.34)
Vigorous mins	6.19 (19.98)	35.07 (101.51)	89.55 (208.70)	123.05 (167.51)	61.57 (153.77)	128.13 (183.54)
Moderate METs	247.94 (598.55)	360.43 (592.98)	336.12 (619.42)	671.65 (971.32)	470.41 (720.56)	715.97 (888.03)
Moderate mins	61.99 (149.64)	90.11 (148.24)	84.03 (154.86)	167.91 (242.83)	117.60 (180.41)	178.99 (222.01)
Walking METs	401.17 (700.96)	693.00 (829.06)	632.17 (921.08)	1039.97 (1071.45)	754.57 (1052.49)	754.57 (1052.49)
Walking mins	121.57 (212.41)	210.00 (251.23)	191.57 (279.12)	315.14 (324.68)	228.66 (318.94)	253.16 (282.59)
MVPA METs	301.19 (637.06)	647.01 (1192.06)	1057.55 (24.25)	1628.66 (1791.66)	969.07 (1730.74)	1707.76 (2022.68)
Total METs	710.27 (1134.57)	1359.59 (1452.54)	1723.44 (2643.40)	2682.72 (20.21)	1773.63 (2353.02)	2562.34 (2502.11)
Sport minutes	2.24 (13.12)	20.31 (76.55)	41.42 (89.30)	91.38 (147.02)	38.76 (78.06)	68.86 (126.23)
Sitting minutes	486.46 (209.97)	423.75 (249.24)	415.62 (204.91)	349.21 (191.89)	417.38 (212.15)	344.28 (223.96)
Secondary outcomes						
Mobility (1-5)	2.06 (1.00)	1.94 (1.01)	1.81 (0.95)	1.87 (0.98)	2.00 (0.97)	1.90 (1.01)
Self-care (1-5)	1.29 (0.64)	1.24 (0.63)	1.16 (0.45)	1.18 (0.49)	1.32 (0.60)	1.22 (0.53)
Usual activities(1-5)	1.71 (0.97)	1.60 (0.85)	1.68 (1.17)	1.46 (0.78)	1.68 (0.98)	1.69 (0.92)

Pain (1-5)	2.52 (1.06)	2.33 (0.95)	2.45 (1.03)	2.30 (0.89)	2.26 (1.09)	2.23 (0.92)
Anxiety/depression (1-5)	1.61 (0.72)	1.75 (0.95)	1.48 (0.81)	1.57 (0.89)	1.55 (0.96)	1.54 (0.81)
Perceived health (1-100)	60.48 (20.63)	60.83 (19.59)	60.39 (18.88)	68.98 (18.61)	67.90 (18.79)	68.65 (18.98)
Mental wellbeing (14-70)	49.10 (9.63)	49.62 (10.90)	50.87 (9.64)	52.77 (9.66)	49.77 (8.11)	51.68 (10.11)
Life satisfaction (1-10)	6.16 (2.08)	6.97 (2.29)	6.68 (1.92)	7.43 (1.99)	6.77 (2.03)	7.50 (1.84)
Action planning (1-4)	1.81 (1.01)	1.90 (0.92)	2.78 (0.89)	2.74 (0.96)	2.70 (0.85)	2.54 (1.03)
Self-monitoring (1-4)	1.68 (0.87)	1.71 (0.86)	2.45 (0.98)	2.49 (0.92)	2.34 (0.83)	2.39 (0.93)
Self-efficacy (5-20)	13.00 (3.74)	13.81 (4.00)	14.97 (3.82)	15.12 (3.43)	13.32 (3.94)	14.96 (3.86)
Intentions (1-7)	5.52 (0.85)	6.08 (0.78)	5.90 (0.91)	6.33 (0.63)	5.95 (0.82)	6.30 (0.79)
Attitudes (1-7)	5.52 (0.85)	6.08 (0.78)	5.90 (0.91)	6.33 (0.63)	5.95 (0.82)	6.30 (0.79)

To analyse changes in primary and secondary outcomes between baseline, 3, and 6 months in the standard and enhanced delivery groups, a set of mixed ANOVAs were utilised with time (baseline, 3, and 6 months) as the within subjects variable and group (standard, enhanced) as the between subjects variable.

Table 8.12.

Mixed ANOVA results for changes in primary outcomes between baseline, 3, and 6 months, by group (standard and enhanced groups)

Primary Outcomes	**Effect**	**Result**	**Effect size**
Vigorous METs	Time	$F(2, 402) = 38.62$***	$\eta^2 = .16$
	Group	$F(1, 201) = 14.82$***	$\eta^2 = .07$
	Time*Group	$F(2, 402) = 1.83$	$\eta^2 = .01$
Moderate METs	Time	$F(2, 410) = 19.89$***	$\eta^2 = .09$
	Group	$F(1, 205) = 13.90$***	$\eta^2 = .06$
	Time*Group	$F(2, 410) = 1.45$	$\eta^2 = .01$
Walking METs	Time	$F(2, 412) = 15.52$***	$\eta^2 = .07$
	Group	$F(1, 397) = 11.14$**	$\eta^2 = .05$
	Time*Group	$F(2, 412) = 2.14$	$\eta^2 = .01$
Total METs	Time	$F(2, 390) = 43.66$***	$\eta^2 = .18$
	Group	$F(1, 433) = 18.10$***	$\eta^2 = .09$
	Time*Group	$F(2, 390) = .42$	$\eta^2 = .00$
MVPA METs	Time	$F(2, 398) = 46.26$***	$\eta^2 = .19$
	Group	$F(1, 442) = 17.18$***	$\eta^2 = .08$
	Time*Group	$F(2, 398) = 1.13$	$\eta^2 = .01$
Sport	Time	$F(1.94, 383.91) = 41.03$***	$\eta^2 = .17$
	Group	$F(1, 199) = 14.22$***	$\eta^2 = .07$
	Time*Group	$F(1.94, 383.91) = 2.87$	$\eta^2 = .01$
Sitting	Time	$F(1.94, 393.41) = 11.95$***	$\eta^2 = .06$
	Group	$F(1, 203) = 8.48$**	$\eta^2 = .04$
	Time*Group	$F(1.94, 393.41) = .10$	$\eta^2 = .00$

There were highly statistically significant main effects of time for all primary outcomes, showing that regardless of group, reported physical activity and sporting participation increased and sitting time decreased. The effect sizes ranged from small to moderate. For all primary outcomes post-hoc, Bonferroni tests showed highly statistically significant differences between baseline and 3 months, and baseline and 6 months, but not between 3 and 6 months. This pattern shows that improvements made during the first 3 months of the programme were maintained at 6 months. All primary outcomes also showed statistically significant main effects of group, showing that regardless of time point, reported physical activity and sporting participation was larger and sitting time was lower in the enhanced group. Effect sizes were all in the small to moderate range. There were no interaction effects, showing that the enhanced delivery did not have additional benefits over and above the standard delivery.

Table 8.13.

Percentage of programme users who reported being active to the recommended amount at baseline and at 6 months for moderate and vigorous intensity activity

Outcome	**Yes/No**	**Baseline**		**6 months**	
		Standard	**Enhanced**	**Standard**	**Enhanced**
Moderate 150 minutes	Yes	14 (14%)	32 (19%)	26 (25%)	68 (38%)
	No	86 (86%)	141 (82%)	78 (75%)	111 (62%)
Vigorous 75 minutes	Yes	2 (3%)	25 (15%)	28 (27%)	68 (38%)
	No	96 (97%)	147 (85%)	76 (73%)	111 (62%)

The percentage of programme users that reported completing at least 150 minutes of moderate activity and 75 minutes of vigorous activity, in line with national physical activity recommendations, were then analysed at baseline and 6 months. At baseline, there was no association between whether programme users reported completing 150 minutes of moderate physical activity and group (14%, standard vs 19%, enhanced), $X^2(1) = .92$, $p = .339$. At 6 months, programme users in both groups reported a higher percentage completing 150 minutes of moderate physical activity. The association between whether programme users reported 150 minutes of moderate physical activity and group was statistically significant (25%, standard vs 38%, enhanced), $X^2(1) = 5.00$, $p = .025$, suggesting that the enhanced group improved more than the standard group. There was a statistically significant association between the amount of programme users reporting 75 minutes of vigorous physical activity and group at baseline (3%, standard vs 15%, enhanced), $X^2(1) = 8.98$, $p = .003$. At 6 months, programme users in both groups reported a higher percentage completing 75 minutes of vigorous physical activity. However, the association between the amount of programme users reporting 75 minutes of vigorous physical activity and group at 6 months was not maintained (27%, standard vs 38%, enhanced), $X^2(1) = 3.59$, $p = .058$.

Table 8.14.

Mixed ANOVA results for change in secondary outcomes between baseline, 3, and 6 months

Secondary Outcomes	**Effect**	**Result**	**Effect size**
Mobility	Time	$F(2, 342) = 1.55$	$\eta^2 = .01$
	Group	$F(1, 171) = .10$	$\eta^2 = .00$
	Time*Group	$F(2, 342) = .58$	$\eta^2 = .00$
Self-Care	Time	$F(1.75, 299.54) = 2.21$	$\eta^2 = .01$
	Group	$F(1, 171) = .23$	$\eta^2 = .00$
	Time*Group	$F(1.75, 299.54) = .73$	$\eta^2 = .00$
Usual activities	Time	$F(2, 342) = .78$	$\eta^2 = .01$
	Group	$F(1, 171) = .55$	$\eta^2 = .00$
	Time*Group	$F(2, 342) = .72$	$\eta^2 = .00$
Pain	Time	$F(2, 342) = 2.31$	$\eta^2 = .01$
	Group	$F(1, 171) = .60$	$\eta^2 = .00$
	Time*Group	$F(2, 342) = .41$	$\eta^2 = .00$
Anx/dep	Time	$F(1.93, 329.15) = 2.53$	$\eta^2 = .02$
	Group	$F(1, 171) = .21$	$\eta^2 = .00$
	Time*Group	$F(1.93, 329.15) = .50$	$\eta^2 = .00$
Health	Time	$F(2, 342) = 7.79^{***}$	$\eta^2 = .04$
	Group	$F(1, 171) = 1.11$	$\eta^2 = .01$

	Time*Group	$F(2, 342) = 2.89$	$\eta^2 = .02$
Wellbeing	Time	$F(2, 340) = 5.93^{**}$	$\eta^2 = .03$
	Group	$F(1, 170) = .63$	$\eta^2 = .00$
	Time*Group	$F(2, 340) = .62$	$\eta^2 = .00$
Life Satisfaction	Time	$F(2, 332) = 6.30^{**}$	$\eta^2 = .04$
	Group	$F(1, 166) = 4.65^{*}$	$\eta^2 = .03$
	Time*Group	$F(2, 332) = .03$	$\eta^2 = .00$
Action planning	Time	$F(2, 338) = 35.60^{***}$	$\eta^2 = .17$
	Group	$F(1, 169) = .08$	$\eta^2 = .00$
	Time*Group	$F(2, 338) = .57$	$\eta^2 = .00$
Self-monitoring	Time	$F(2, 338) = 31.80^{***}$	$\eta^2 = .16$
	Group	$F(1, 169) = .09$	$\eta^2 = .00$
	Time*Group	$F(2, 338) = .00$	$\eta^2 = .00$
Self-efficacy	Time	$F(1.89, 319.80) = 8.74^{***}$	$\eta^2 = .05$
	Group	$F(1, 169) = 2.10$	$\eta^2 = .01$
	Time*Group	$F(1.89, 319.80) = 1.79$	$\eta^2 = .01$
Intentions	Time	$F(1.87, 316.07) = 1.30$	$\eta^2 = .01$
	Group	$F(1, 169) = 10.53^{**}$	$\eta^2 = .06$
	Time*Group	$F(1.87, 316.07) = .97$	$\eta^2 = .01$
Attitudes	Time	$F(1.88, 316.96) = 10.16^{***}$	$\eta^2 = .06$
	Group	$F(1, 169) = 14.90^{***}$	$\eta^2 = .08$
	Time*Group	$F(1.88, 316.96) = .84$	$\eta^2 = .01$

Note: * = $p < .05$; ** = $p < .01$; *** = $p < .001$

The analysis of secondary outcome measures showed statistically significant main effects of time for perceptions of health, mental wellbeing, life satisfaction, action planning, self-monitoring, self-efficacy, and attitudes. For action planning, self-monitoring, life satisfaction, and attitudes, post-hoc bonferoni tests showed highly statistically significant differences between baseline and 3 months, and baseline and 6 months, but not between 3 and 6 months. This pattern shows that improvements made in these areas during the first 3 months of the programme were maintained at 6 months. For health, only the increase from baseline to 6 months was statistically significant and for mental wellbeing, only the change from baseline to 3 months was statistically significant. For self-efficacy, the differences from baseline to 3 months and 3 months to 6 months were statistically significant, but not from baseline to 6 months. All effect sizes were relatively small apart from moderate to large effect sizes for action planning and self-monitoring. There was also a main effect of group for intentions with the enhanced group having higher intentions regardless of time point.

8.4.6.2. Intention-to-treat analysis summary

This second set of analyses used an intention-to-treat approach; whereby, baseline scores were carried forward for all programme users missing 6-month data. This approach was conservative in assuming no change in outcomes for programme users who dropped out at 6 months. The full breakdown of the intention-to-treat analyses can be found in Appendix N. There were highly statistically significant main effects of time for all primary outcomes, showing that regardless of group, reported physical activity and sporting participation increased and sitting time decreased. The effect sizes were all small. For all primary outcomes post-hoc bonferoni tests showed highly statistically significant differences from baseline to 3 months, and from baseline and 6 months, but not from 3 to 6 months, with the exception of vigorous METs (all differences were significant). There were statistically significant interaction effects for vigorous, MVPA and total METS, showing that the enhanced delivery group improved more at 3 months and then returned back to similar levels to the standard group at 6 months.

At baseline, there was no association between whether programme users reported completing 150 minutes of moderate physical activity and group. At 6 months, programme users in both groups reported a lower percentage completing 150 minutes of moderate physical activity than at baseline, but there was no association between whether programme users reported 150 minutes of moderate physical activity and group. There was no association between the number of programme users reporting 75 minutes of vigorous physical activity and group at baseline. At 6 months, programme users in both groups reported a lower percentage completing 75 minutes of vigorous physical activity than at baseline. There was also no association between the number of programme uses reporting 75 minutes of vigorous physical activity and group at 6 months.

The analysis of secondary outcome measures showed statistically significant main effects of time for perceptions of health, mental wellbeing, life satisfaction, action planning, self-monitoring, self-efficacy, and attitudes. The effect sizes were, however, very small. For perceived health, mental wellbeing, life satisfaction, self-efficacy, and attitudes, post-hoc bonferoni tests showed statistically significant differences between baseline and 3 months, and baseline and 6 months, but not between 3 and 6 months. For perceived health and action planning, post-hoc bonferoni tests showed statistically significant differences between all time points, with significant improvements at 3 months but significant decreases from 3 to 6 months. There was a main effect of group for intentions with the enhanced group having higher intentions regardless of time point. There were also statistically significant interaction effects for perceived health and self-efficacy, showing that the enhanced delivery group improved more at 3 months and then returned back to similar levels to the standard group at 6 months.

8.4.7. Did Capability (self-monitoring and action planning) and Motivation (intention and self-efficacy) predict reported MVPA at 6 months?

Six-month outcomes were analysed to see whether there was a relationship between Capability (action planning and self-monitoring), Motivation (self-efficacy and intentions), and reported MVPA.

Table 8.15.

Matrix of correlations at 6 months between reported MVPA, Capability (self-monitoring and action planning), and Motivation (intention and self-efficacy).

Measures	MVPA	AP	SM	SE
Action planning (AP)	.30***	-	-	-
Self-monitoring (SM)	.33***	.74***	-	-
Self-efficacy (SE)	.14*	.31***	.35***	-
Intentions	.30***	.43***	.38***	.32***

Note: * = p < .05; ** = p < .01; *** = p < .001

The correlation matrix showed moderate statistically significant correlations between reported MVPA and all COM-B measures, aside from a small correlation between reported MVPA and self-efficacy. There were also a strong statistically significant correlations between action planning and intentions, and action planning and self-monitoring, and moderate strength correlations between action planning and self-efficacy, self-monitoring and self-efficacy, self-monitoring and intentions, self-efficacy and intentions. Using AMOS, the impact of Capability (action planning and self-monitoring) and Motivation (self-efficacy and intentions) variables on reported MVPA, was analysed using a partial mediation path analysis model. The effect of group was accounted for and the model also allowed analysis of the direct effect of all variables on reported MVPA and the indirect effect of Capability variables through Motivation variables on reported MVPA.

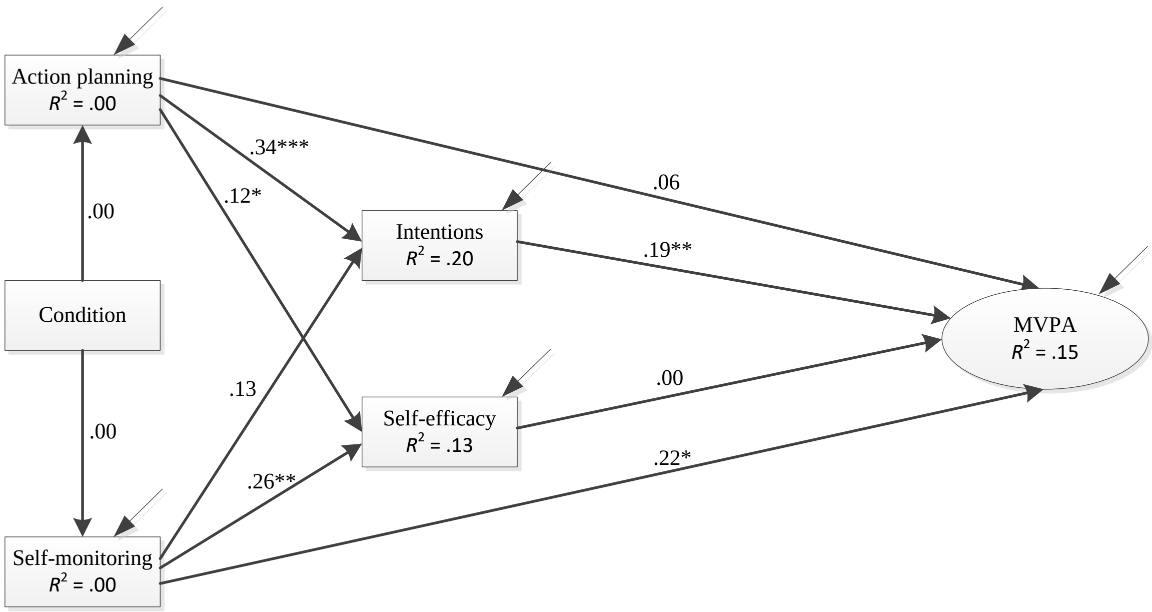

Figure 8.7. Partial mediation path analysis of how well (action planning and self-monitoring) and Motivation (self-efficacy and intentions) predicted reported MVPA performance at 6 months, with all coefficients standardised.

Note: **p* < .05, ***p* < .01, ****p* < .001

The fully specified model explained a moderate to large amount of the variance in intentions (20%) and a moderate amount of variance in self-efficacy (13%) and reported MVPA (15%). The model showed reasonable fit, $\chi^2(3) = 8.05$, $p = .045$, and fit indices (TLI = .92, CFI = .98, RMSEA = .09). The model fit was improved by setting meaningless path coefficients to zero. This was completed for the paths from condition to action planning and self-monitoring, and from self-efficacy to reported MVPA. The updated model showed better fit, $\chi^2(6) = 10.17$, $p = .118$, and fit indices (TLI = .97, CFI = .99, RMSEA = .06).

Exploration of the model suggested that self-monitoring (p = .005) had an effect on self-efficacy. Action planning also had an effect on intention (p < .001). Self-monitoring (p = .020) but not action planning (p = .531) had a direct effect on reported MVPA, but neither had a substantial indirect effect of reported MVPA (action planning, *IE* = .06; self-monitoring, *IE* = .03). Intentions (p = .005) also had a direct impact on reported MVPA.

8.4.8. Did changes in Capability (self-monitoring and action planning) and Motivation (intention and self-efficacy) predict changes in reported MVPA at 6 months?

Further analysis was then conducted to see whether changes in Capability (self-monitoring and action planning) and Motivation (intention and self-efficacy) predicted changes in reported MVPA from baseline to 6 months. Initially, change scores were computed and analysed to see whether there was a relationship between the changes in Capability (self-monitoring and action planning), Motivation (intention and self-efficacy), and changes in reported MVPA.

Table 8.16.

Matrix of correlations of mean changes between baseline and 6 months on reported MVPA, Capability (self-monitoring and action planning), and Motivation (intention and self-efficacy).

Measures	ΔMVPA	ΔAP	ΔSM	ΔSE
ΔAction planning (AP)	.24***	-	-	-
ΔSelf-monitoring (SM)	.22**	.67***	-	-
ΔSelf-efficacy (SE)	.01	.26***	.24***	-
ΔIntentions	.19**	.37***	.28***	.25***

Note: * = p < .05; ** = p < .01; *** = p < .001; Δ = change score

The correlation matrix showed small, but statistically significant correlations, between changes in reported MVPA and changes in action planning, self-monitoring, and intentions, and self-monitoring and self-efficacy. There were also moderate statistically significant correlations between changes in action planning and intentions, action planning and self-efficacy, self-monitoring and intentions, and self-efficacy and intentions, and a large correlation between changes in action planning and self-monitoring. Using AMOS, the impact of changes in Capability (action planning and self-monitoring) and Motivation (self-efficacy and intentions) variables on changes in reported MVPA, was analysed using a partial mediation path analysis model. The effect of group was accounted for and the model also allowed analysis of the direct effect of all variables on changes in reported MVPA and the indirect effect of Capability variables through Motivation variables on changes in reported MVPA.

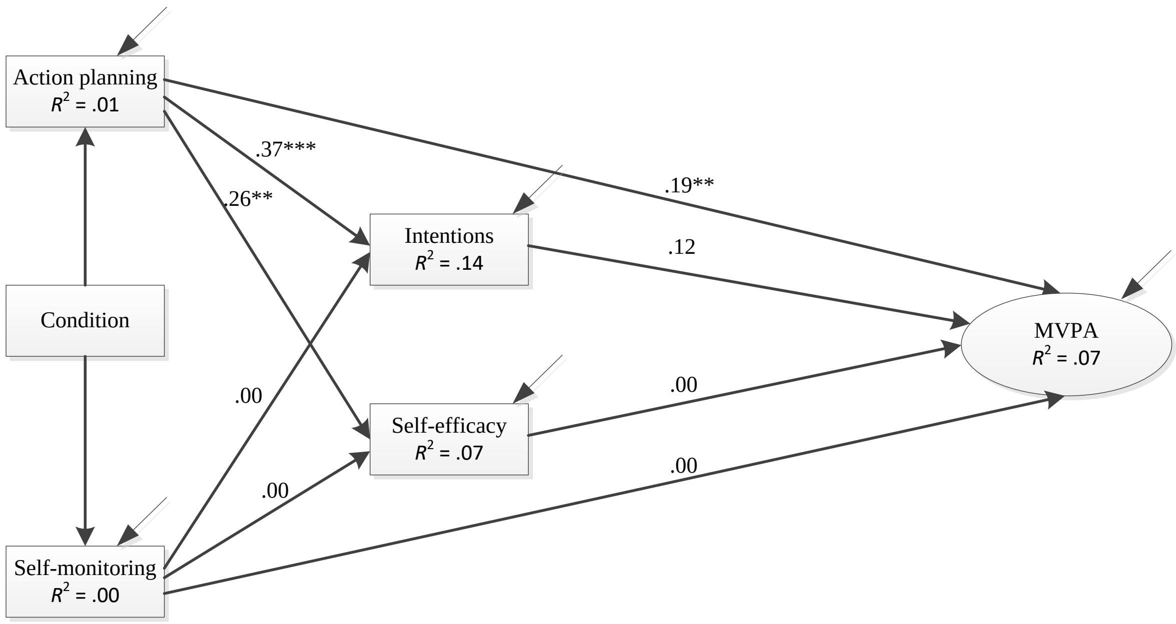

Figure 8.8. Partial mediation path analysis of how well changes in Capability (action planning and self-monitoring) and Motivation (intentions and self-efficacy) predicted changes in reported MVPA at 6 months from baseline, with all coefficients standardised.

Note: $^*p < .05$, $^{**}p < .01$, $^{***}p < .001$

The fully specified model explained a moderate amount of the variance in changes in intentions (14%) and a small amount of variance in self-efficacy (8%) and reported MVPA (8%), and showed reasonable fit, $\chi^2(3) = 7.82$, $p = .050$ and fit indices (TLI = .88, CFI = .98, RMSEA = .09). The model fit was improved by setting meaningless path coefficients to zero. This was completed for the paths from condition to action planning and self-monitoring, from self-monitoring to intentions, self-efficacy, and MVPA, and from self-efficacy to reported MVPA. The updated model showed better fit, $\chi^2(6) = 12.61$, $p = .126$, and fit indices (TLI = .96, CFI = .98, RMSEA = .05). Exploration of the model suggested that changes in action planning had an effect on changes in intentions ($p = .002$) and self-efficacy ($p = .001$) over six months. Changes in action planning ($p = .007$) also had a direct effect on changes in reported MVPA, but no indirect effect. Changes in intentions and self-efficacy did not have a direct impact on changes in reported MVPA.

8.5. Discussion

The Active Herts programme recruited users that were mostly not performing the recommended amount of physical activity at baseline, with a wide range of health conditions. The programme was therefore successful at reaching its target population. There was, however, substantial dropout at 3 and 6 months, with the sample size too low to analyse 12-month data at this two-year interim stage. The first 3 months of participation in Active Herts was the intensive stage of the programme, and analysis of completers at the end of this period showed moderate-to-large improvements in reported physical activity, sporting participation, and sitting time, regardless of group. Those in the enhanced group did, however, show greater increases in the proportion achieving 150 minutes of moderate or 75 minutes of vigorous intensity activity per week, in line with national guidelines. Improvements in secondary measures displayed a similar pattern to primary outcomes, with programme users showing improvement in both groups on a range of measures (perceived health, mental wellbeing, life satisfaction, action planning, self-monitoring, self-efficacy, and attitudes), albeit with smaller effects than the primary outcomes. The intention-to-treat analysis largely mirrored these results, but with much more modest effects, and a pattern of improvement in the enhanced group that was better than the standard group.

At 6 months there were still consistent small-to-moderate improvements in all primary outcomes regardless of group. Programme users improved considerably from baseline to 3 months and then maintained this improvement at 6 months. In terms of the percentage of programme users achieving 150 minutes of moderate of 75 minutes of vigorous intensity activity, the enhanced group improved to a greater extent than the standard group for reported moderate activity, but not vigorous. Improvements in secondary outcomes were largely in line with primary outcomes on a range of measures (the same as 3 months), regardless of group, between baseline and 3 months, which were then maintained at 6 months. Again, the intention-to-treat analysis largely mirrored these results, but with much more modest effects, and a pattern of improvement in the enhanced group that was better than the standard group at 3 months, but similar again at 6 months.

The lack of large differences between groups on key outcomes over time was not surprising for a number of reasons. The original protocol specified that programme users in both delivery groups receive the same content in terms of an initial 45-60 minute consultation with a GAS, with additional consultations at 3, 6, and 12 months, an Active Herts booklet, a two week booster call, and access to activities in their local area. The only two planned differences between groups (optional exercise buddies and physical activity sessions organised and facilitated by the GAS) were changed markedly during the programme. Exercise buddies proved very difficult to recruit and in the two standard delivery areas the GASs had begun to put on additional exercise sessions specifically for the programme, often run by the GASs themselves. These changes from the original protocol may well have been responsible for the lack of difference in outcomes between the two delivery approaches. In addition, the standard delivery often involved signposting programme users onto other physical activity sessions and programmes. Therefore, the programme users may have been exposed to additional BCTs above and beyond those proposed in the protocol.

The secondary analysis contained two novel complementary approaches. The first was to explore whether Capability (action planning and self-monitoring) and Motivation (intentions and self-efficacy) predicted MVPA performance at baseline, 3 and 6 months. The second part of the approach explored whether changes in Capability (action planning and self-monitoring) and Motivation (intentions and self-efficacy) predicted changes in MVPA at 3 and 6 months (from baseline). Although Capability (action planning and self-monitoring) and Motivation (intentions and self-efficacy) showed potential in predicting MVPA performance at one time point (see analysis in Study 2), whether changes in these measures, as a function of the programme, changed levels of MVPA was yet to be determined.

Prior to any intervention, at baseline, Capability (action planning and self-monitoring) predicted a relatively small amount of Motivation (intentions and self-efficacy) and MVPA performance, with poor model fit. Following the intensive 3-month phase of the programme, the extent to which Capability (action planning and self-monitoring) predicted Motivation (intentions and self-efficacy) and MVPA improved considerably (for MVPA performance the variance explained went from 8% to 18%). This improvement was largely maintained at 6 months with good model fit and relatively strong prediction of intentions, self-efficacy, and MVPA, albeit less than at 3 months. The Active Herts programme targeted Capability (action planning and self-monitoring) and Motivation (self-efficacy and intentions), and these factors were more closely linked to MVPA performance following the 3 and 6-month stages of the programme. Across the three time points self-monitoring was the most important driver of MVPA. The nature of the Motivation construct in the COM-B model precluded the examination of the path from self-efficacy to intentions, but correlations suggested this relationship was of moderate strength for MVPA performance and change.

In contrast to the path models predicting performance of MVPA, the models attempting to predict changes in MVPA over time were not as successful. Changes in Capability (action planning and self-monitoring) between baseline and 3 months predicted a medium amount of variance in intentions and self-efficacy (Motivation) and a small amount of change in MVPA. Changes in Capability (action planning and self-monitoring) between baseline and 6 months predicted a medium amount of variance in changes in intentions and a small amount of variance in changes in self-efficacy (Motivation) and MVPA. Similar to the models predicting performance, changes in self-monitoring were the key driver of changes in MVPA across time points. Action planning and self-monitoring were BCTs included in the intervention (alongside being Capability measures). It may be that self-monitoring was one of the more utilised (and effective) BCTs and so this drove MVPA performance and change.

The COM-B measures struggled to predict more than small amounts of change in MVPA, which could have occurred for a number of reasons. Due to pragmatic considerations only four measures from the COM-B analysis were including in the questionnaires. All of these measures contained between 2 and 5 items, with the burden on programme users the most important consideration in choosing to administer brief measures. The biggest drivers of MVPA from the study in Study 2 (Chapter 6) were habits and exercise self-identity. In hindsight, modified brief measures such as the Self-report Behavioural Automaticity Index, may have been a useful addition to the set of measures (Gardner, Abraham, Lally, & de Bruijn, 2012). It may be that changes in these indicators would have been key drivers of change in MVPA. The other large omission was any measure of Opportunity. In Study 2 (Chapter 6) the sample was healthy and had adequate access to physical opportunities to exercise that were in a good condition. The programme users in this study may have lived in areas where existing provision of physical activity opportunities was limited. This sample was often unhealthy and this may have further limited their ability to access opportunities to exercise even when they did exist.

One of the key ingredients of the Active Herts programme was to provide either additional opportunities that did not exist previously (enhanced group) or to facilitate the signposting of local opportunities that may not have been known already at a discounted rate (standard delivery). Therefore changes in MVPA may have been driven most strongly by large changes in the perceived opportunities available as a result of enrolling on the programme. These extra classes and support represent both an increase in physical and social opportunities. Subjective norms and social support for physical activity comprised the Opportunity construct in Study 2 (Chapter 6), so these may well have contributed to MVPA in this study. Future studies would ideally include a more comprehensive range of COM-B measures, while balancing the burden on programme users of overly lengthy questionnaires. Earlier involvement in the planning of this programme would have allowed a more thorough theoretical evaluation.

Overall the Active Herts programme has shown potential for sustained behaviour change by providing programme users with the potential to develop better self-regulation (particularly self-monitoring), better physical resources through free or discounted activity sessions, a more supportive environment for physical activity, and greater social support, all of which are proposed theoretical drivers of behaviour change maintenance (Kwasnicka et al., 2016). Despite the COM-B indicators improving at both time points, only self-monitoring was a consistent driver of physical activity performance and change. These findings mirror previous theoretical examinations of interventions, which found that although TPB constructs can be improved through intervention, they often do not predict physical activity performance and change (e.g. Hardeman et al., 2011).

The COM-B (and TDF, Cane et al., 2012) have been primarily used qualitatively to draw out barriers and facilitators of target behaviours in both patients (Mulligan et al., 2017) and healthcare professionals (McBain et al., 2016), with a view to designing interventions. The two previous COM-B-related questionnaires developed for physical activity both had serious limitations, with the adult questionnaire based on a previous version of the TDF (and sometimes unable to distinguish between high and low exercisers; Taylor et al., 2013) and the child one being brief and only tested in how well it related to BMI (Taylor et al., 2016). Future studies should try to build on the current study by using quantitative COM-B related measures to evaluate intervention effectiveness and the processes by which behaviour is performed or changed during the intervention.

This study had a number of strengths which included having the methods pre-registered in a detailed published protocol (Howlett, Jones, et al., 2017) and the content heavily guided by evidence-based BCTs from the systematic review (Study 1, Howlett et al., 2018). A related strength was the wide range of outcome measures which captured multiple levels of physical activity and potential psychological drivers of MVPA. An additional positive of this study was that it evaluated a real-world programme and not a controlled research project that would bear little resemblance to a service that could be realistically delivered in routine practice. The ongoing training and supervision of the GAS throughout the programme also ensured a greater likelihood of fidelity. The COM-B analysis was, as far as the author knows, the first attempt at including measures capturing key constructs of the COM-B and exploring them as drivers of physical activity performance and change in adults. Although the sample size was more modest than was hoped from such a large baseline sample, it was still adequately powered to detect modest effects.

. The issue of attrition rates was a considerable limitation with 67% (3 months) and 75% (6 months) dropout. Therefore, the analysis was in danger of capturing a select sample of programme users that were different than those who dropped out. However, a number of tests between completers and those that dropped out revealed only minimal differences at baseline. The intention-to-treat analysis also provided a conservative comparison analysis, with a much larger sample size, which largely matched the completer analysis. A related problem was that the poor levels of questionnaire completion precluded an analysis of effectiveness and COM-B drivers at 12 months, which was the official duration of the programme. Questionnaire completion was particularly problematic at the beginning of the programme when the GASs were not convinced of the importance of the measures, so buy-in took some time. Future research should consider ways to incentivise better completion rates, although financial incentives do not always impact response rates to surveys (Robb, Gatting, & Wardle, 2017). Also, the fact that Active Herts offered the potential for 12 months of contact, and only measured outcomes up to this point, did not allow the measurement of any true follow-up after contact ended. In Study 1 (Chapter 4), follow-up was defined as at least 6 months of no contact after the end of intervention and this would have been ideal for this programme, although poor completion rates may have made this sort of long-term data capture unfeasible. Active Herts was also a programme and not a controlled trial, and therefore there was no randomisation or control group.

Overall, the findings from the 2-year interim data of the Active Herts programme showed consistent improvements in physical activity, sporting participation, sitting, and a number of secondary outcomes at 3 and 6 months after baseline. COM-B related indicators predicted physical activity performance better after 3 and 6 months of the programme than at baseline, but changes in MVPA were only predicted to a small degree using the same analysis. A consistent finding was that self-monitoring was key in driving MVPA performance and change. This study provided an example of how to quantitatively analyse how the COM-B can have both an impact on the design, delivery, and evaluation of a physical activity programme and this method should be expanded going forward. The Active Herts programme showed preliminary evidence that it could be an effective service, delivered in real world settings, to change behaviour and improve the health of residents living in areas of deprivation who need it most. Future research should test this approach in a randomised controlled trial to provide a more robust test of effectiveness and assess the effect of training on delivery quality and programme fidelity more systematically.

8.5.1. Addendum

Additional analysis that was beyond the scope of this PhD is also ongoing. The process evaluation of Active Herts has taken place over three phases with each phase exploring a different theme. Data was collected in the form of one-to-one interviews with stakeholders, group interviews with the Get Active Specialists, and focus groups with programme users. The initial phase focused on areas related to the set-up of Active Herts, including developments in the method of recruitment or delivery of the programme, barriers and facilitators to reaching the target audience, partnership working, and engagement with primary and secondary care. The second phase explored deviations in programme delivery from those planned, potential mechanisms by which the programme works, and external factors which may have influenced the programme. A final phase has adopted a reflective focus looking back over the programme and considering what worked well and what did not, and identifying examples of best practice. This phase also considered the future sustainability of Active Herts including exit routes for programme users and continuation of the programme where appropriate.

The cost-effectiveness evaluation is using Version 2 (November 2016) of the Sport England MOVES model, a tool for conducting economic analysis of physical activity programmes developed by the Health Economics Group at the University of East Anglia. The MOVES tool is being used to monetarise the reduced disease burden associated with participation in Active Herts, by comparing predicted disease risk against that of a similar cohort not participating in any programme. The MOVES model links changes in physical activity with changes in disease prevalence over time for depression, diabetes, stroke, coronary heart disease, dementia, colorectal cancer, breast cancer, and hip fracture. The ratio of costs to effects – i.e. "the incremental cost-effectiveness ratio" (ICER) is being assessed against a "cost-effectiveness threshold", representing the opportunity cost of spending the money. In the UK, the National Institute for Health and Care Excellence (NICE) uses a threshold range of £20,000–30,000; if interventions are within this area of cost-effectiveness or below, then they are considered "cost-effective" or good "value for money". The model is being used to assess the financial return to the NHS (treatment costs saved), ICER, and the health impacts (Quality Adjusted Life Years (QALYs) gained) in the enhanced delivery compared with the standard delivery groups.

During the programme the Get Active Specialists (GAS) also received quarterly booster sessions, during which they provided random consultation audios. This is in line with recommendation 14 of the latest National Institute for Health and Clinical Excellence (NICE, 2014) guidance on individual approaches to behaviour change. The guidance suggests that behaviour change practitioners should be regularly assessed, including on their ability to deliver BCTs and to tailor interventions for individuals. These audios are currently being analysed with the Motivational Interviewing Treatment Integrity coding scheme (MITI; Moyers et al., 2010) and a checklist of BCTs included in the programme. This analysis will track the development of GAS skills over the duration of the programme and be published in the future for others to learn from.

Chapter 9

Study 5: A qualitative exploration of the experiences of the Get Active Specialists

9.1. Introduction

Public health departments, research funding bodies, and other government agencies spend large amounts of money trying to intervene in people's lives at the individual and population level, with varying degrees of success. Public Health England has recently tried to provide training for 'physical activity champions' across the country. This scheme trains healthcare professionals (HCPs) in primary and secondary care to provide brief behaviour change interventions for physical activity (Vishnubala, 2016). Making every contact count (MECC; NHS Future, 2012) has also been emphasised for frontline HCPs. Public health professionals, whose remit it is to design and deliver MECC, consider it a useful approach but believe implementation, standardisation of training, and the evidence base could all be improved (Chisholm, Ang-Chen, Peters, Hart, & Beenstock, 2018). Recommendations have also been made for primary care and sport and exercise physicians to prescribe physical activity for the management and/or prevention of a plethora of non-communicable diseases (e.g. Thornton et al., 2016). These schemes have built on earlier initiatives such as the NHS Health Trainer booklet that provided a range of theoretically-based practical techniques to change behaviour (Michie et al., 2008), and the Scottish government's Behaviour Change Competency Framework for deliverers of behaviour change interventions (Dixon & Johnston, 2010). There is, however, very little robust evaluation of any of these schemes.

Despite many physical activity interventions being well designed they do not always have the desired effect in terms of behaviour change (e.g. Biddle et al., 2017), and even when positive effects are found they are often not maintained (Hobbs et al., 2013). There are many reasons why interventions are not effective. For instance, people sometimes view public health efforts as an attempt to control their lives and often do not trust the evidence-based guidance provided (Gardner, Smith, & Mansfield. 2017). If intervention evaluations only measure quantitative outcome data, the potential reasons for effectiveness (or lack of) can remain hidden. For this reason, the Medical Research Council guidance (Craig et al., 2008) on process evaluations recommends capturing quantitative process evaluation measures (alongside outcomes) and using qualitative methods to explore factors such as implementation and experiences of the intervention (e.g. from staff and participants; Moore et al., 2015).

The way in which an intervention is delivered can vary considerably from the way it was intended to be delivered when designed. Research from a range of international studies has highlighted some of the barriers for the HCPs often tasked with delivering the interventions. Whitaker, Wilcox, Liu, Blair, and Pate (2016) explored the perceptions of American HCPs (e.g. physicians and nurses) delivering lifestyle advice to prenatal patients and the patients themselves about receiving the advice. The vast majority of HCPs delivered advice on weight management, physical activity, and nutrition that was positively perceived by patients, but the advice was not always in line with evidence-based guidelines (Whitaker et al., 2016). HCPs reported barriers to the effective delivery of health advice including time constraints, lack of training, the sensitive nature of the topic, cultural differences, and issues with patient income, education and interest in their own health (Whitaker et al., 2016).

When HCPs are tasked with specifically targeting physical activity there have been mixed views on how well placed they are to deliver such advice. Persson, Brorsson, Hansson, Troein, and Strandberg (2013) explored the views of 15 Swedish GPs about delivering physical activity on prescription. The GPs viewed talking about physical activity with patients as an important and acceptable part of their role, but this comfort level did not extend to writing a prescription for physical activity. A lack of training, guidelines, a clear protocol, and a view that other HCPs such as nurses may be better placed to prescribe physical activity, all contributed to what the authors noted as ‘ambivalence’ towards to the task (Persson et al., 2013). GPs tended to be more comfortable with pharmacological treatments (e.g. using a biomedical rather than biopsychosocial approach), which have been the emphasis of their extensive training. They also often considered the responsibility to maintain an active lifestyle a problem for society and the patients themselves, and not necessarily the GPs (Persson et al., 2013). A recurring theme from these studies is that often HCPs perceived themselves to lack the necessary training and support to promote physical activity in their normal roles.

There are factors which facilitate the ease with which HCPs can incorporate physical activity promotion within their roles, which make it more likely that they will be willing and effective in providing this service. Huijg et al. (2015) conducted a systematic review of the factors which influence the physical activity promotion of HCPs. Important facilitating factors were the provision of appropriate materials that focused on the physical activity of patients, a comprehensive summary of local opportunities for physical activity, the promotion approach being clearly evidence-based, support from the organisation where they work, and a good relationship with local physical activity facilities and programmes (Huijg et al. 2015). HCPs also commented on the need for the physical activity promotion approach to have clear guidelines, but with enough flexibility that it could be tailored somewhat to the abilities and interests of each individual. Potential barriers included time constraints, other priorities within the consultation, lack of resources, inadequate training, and patient apathy (Huijg et al. 2015). Overall, an evidence-based approach, linked to local providers and supported by training, resources, and the organisation, seems to be the ideal combination for physical activity promotion.

The overall conditions within which physical activity promotion occurs are important, but so is the specific content of the intervention and the mechanism by which it is delivered. For example, a systematic review of older adult's perception of physical activity interventions, showed that graded tasks (the process by which physical activity is gradually increased in terms of duration and/or intensity) was viewed positively, as was keeping costs low and opportunities being as local as possible (Devereux-Fitzgerald, Powell, Dewhurst, & French, 2016). Self-monitoring (in this instance completing regular physical activity logs) was viewed negatively because of the effort it entailed. This backs up previous evidence that suggests that although self-monitoring can be effective for adults in general (Michie et al., 2009), self-regulatory approaches do not appear to be a favourable strategy to increase physical activity in older adults (French, Olander, Chisholm, & McSharry, 2014). Older adults also preferred face-to-face approaches to more remote contacts due to it being more personal (Devereux-Fitzgerald et al., 2016). This research shows that identifying the most acceptable and effective behaviour change techniques (BCTs) from the perspective of both the delivery staff and the patient/participant receiving the intervention is crucial.

Interventions should look to evaluate the acceptability of BCTs as part of their process evaluation because these are the key ingredients designed to change the target behaviour/s. The Walk to Work intervention trained volunteers to encourage employees to choose more active ways of commuting to work and provides a good example of BCT evaluation (Procter, Mutrie, Davis, & Audrey, 2014). Procter et al. (2014) found that the extent to which participants responded to certain BCTs was dependent on a range of factors including employee perceptions of the intervention booklet, variations in the attitudes and methods of the volunteer promoters, perceptions of the promoter and participant booklets, workload challenges for volunteer promoters, and different approaches to encouragement by the promoters. The promoters found self-monitoring in diaries useful to monitor the activity of employees, although there were some concerns about asking participants to wear pedometers for the duration of the ten-week intervention (Proctor et al., 2014). Employee participants also gave mixed reviews about pedometer use.

Further suggestions from this intervention were that a wider range of delivery modes and additional training would allow the promoters to better react to the needs of participants (Proctor et al., 2014). One suggestion that was put forward by both promoters and participants was that providing financial incentives (e.g. cash or vouchers) and practical support (e.g. trainers) would be beneficial for future interventions – something echoed by HCPs in a previous review (Huijg et al. 2015). An important point was also raised about not just the content of the BCTs themselves but about the language used to describe them. One promoter in particular had some concern about the wording of the BCT 'relapse prevention' (from the 26-item older BCT taxonomy; Abraham & Michie, 2008), with this term being viewed as inappropriate for re-engaging in an active lifestyle and more suitable for a behaviour such as smoking (Proctor et al., 2014). This BCT involves problem solving which may be a more acceptable term to use. Overall, the way in which BCTs are promoted, described, and delivered, has a large impact on how they are received by participants.

This study aimed to evaluate the acceptability of the Active Herts programme from the perspective of the Get Active Specialists (GAS) delivering it on the ground. Previous research has found that training and support have been a big issue for HCPs promoting physical activity to patients and service users. The content of interventions in terms of BCTs and the delivery mode in terms of face-to-face consultations versus more remote approaches has also been raised as an important factor. These issues were explored in depth in this study, in addition to the key area of outcome measures. Achieving an appropriate balance between capturing important data and the burden on participants is always a challenge in the evaluation of 'real-world' programmes. The purpose of the interview study described in this chapter was to explore the GAS's views on the training they received, the consultations they have delivered (both in terms of content and perceptions of client experience), and the evaluation measures being utilised (also in terms of content and client perceptions). This information can then be fed into the development of future interventions and adds important context to the outcome evaluation presented in Study 4 (Chapter 8) and the process evaluation being led by UEA.

Therefore, the aim of this study was to explore the GAS's perceptions of the Active Herts programme in terms of training, delivery, outcome measures, and client receptiveness.

9.2. Method

9.2.1. Design

This study used a qualitative approach, with semi-structured interviews utilised to ask questions on the following topics: the initial two-day training received during the end of November and beginning of December 2015; the delivery of the programme in terms of the one-to-one initial consultation, booster call(s) and follow-up consultations; the questionnaire from both GAS and client perspectives; the overall Active Herts programme.

9.2.2. Participants

One GAS was employed in each of the four Hertfordshire localities (Broxbourne, Stevenage, Hertsmere, and Watford) for the three-year duration of the programme. All four GASs agreed to participate in giving feedback about their experiences of the Active Herts programme. There were two male and two female participants, all white British, with ages ranging between 29 and 39. As there were only four participants, random labels of 'GAS 1-4' were assigned to maintain anonymity as much as possible. The GASs were trained in a number of key areas which are covered in more detail in Study 4 (Chapter 8; e.g. behaviour change including the COM-B model, motivational interviewing, health coaching, obesity, diabetes, mental health, research methods). At the time of the interview, the four participants had delivered on average over 100 new consultations each.

9.2.3. Materials

Throughout the questions and interviews, programme users were referred to as clients in line with the language used by the GAS and programme-co-ordinator. The interview schedule (Appendix O) was designed to explore the thoughts and feelings of the GASs on four key areas of the Active Herts programme. In the first topic area they were asked nine key questions, with additional prompts, on the two-day training involving motivational interviewing, health coaching, and behaviour change. The questions focused on the training experience, memorable features/techniques, the most useful and most challenging aspects, what skills or techniques they were employing in practice (including what was working well or not), their confidence in using the techniques, other areas that could be covered in future, overall satisfaction, and how they found listening to recordings of their role plays. Examples questions were '*What aspects of the training did you find most useful*?' and '*Which specific techniques and/or skills have you used in your practice since you attended the training*?'

In the second topic area the GASs were asked 12 key questions, with additional prompts, on their experiences of delivering the programme to clients. The questions focused on how many clients they had seen, the aspects of the session that went well or were challenging, the additional funding (for Broxbourne and Watford for buddies and free sessions), how they used the booklet and the most useful or challenging parts, how the clients reacted to the booklet, how the two week booster call, and three and six month consultations had gone, and whether the booklet was used in these sessions. Examples questions were '*How has the additional funded support for activities and buddies helped?*' and '*What aspects of the sessions did you find most challenging?*'

In the third topic area the GASs were asked three key questions on their experiences of administering the questionnaire (IPAQ, 7 questions; WEMWBS, 14 questions; EuroQol EQ-5D-5L, 6 questions; COM-B measures, 18 questions; the ONS single life satisfaction single item; two additional questions about sporting participation). The questions focused on participant and client impressions of the questionnaire, how long it took to complete and whether there were any difficulties with any sections, and things that they would change if they could. Example questions were '*How long did it take clients to complete the questionnaires and were there any difficulties for clients?*' and '*What would you change about the questionnaires if you could design/pick them again?*'

In the final topic area, the GASs were asked three key questions about the overall Active Herts programme. The questions focused on the GAS's impressions of Active Herts as a whole, client likes and dislikes about the programme, and how the GASs felt the Active Herts programme had impacted client lifestyles. Example questions were '*What are your impressions of the Active Herts programme?*' and '*What do you think the clients like or dislike about the Active Herts programme?*' The interview ended by asking participants for recommendations for the future and if there was anything that they would like to add.

Interviews were recorded with an Olympus audio recording device. Transcription was performed using Express Scribe Transcription software and an Olympus foot pedal.

9.2.4. Ethics

This study (and recording/analysis of consultations) was approved by the Health and Human Science Ethics Committee at the University of Hertfordshire (Protocol number: LMS/PGR/UH/02427; Appendix P). Written informed consent was obtained from all four participants.

9.2.4. Procedure

Participants were briefly introduced to the study and informally invited to take part by email. A formal invitation was then extended by email and all four GASs agreed to participate. Interviews were conducted in private rooms in August 2016 (8-9 months after the beginning of the programme), where participants were given an information sheet (Appendix Q) and consent form (Appendix R). After signing the consent form the researcher introduced themselves and the structure of the interview schedule. Interviews lasted between 48 and 60 minutes each. Participants were then thanked for their time and debriefed fully (Appendix S).

9.2.4. Data analysis

The audio recordings of the four interviews were transcribed verbatim and thematic analysis followed the six stage process of Thematic Analysis recommended by Braun and Clarke (2006) involving: familiarising yourself with the data; generating initial codes;

searching for themes; reviewing themes; defining and naming themes; producing the report. This analysis adopted an inductive approach whereby themes and sub-themes were generated from the data and were not composed through a particular theoretical lens (see Appendix T for coding audit trail).

The interviews were transcribed meticulously, with the foot pedal allowing easy multiple listening opportunities for every interaction. The transcripts were read and re-read for both accuracy and further familiarisation with the content. The next stage was to use an inductive approach to generate initial codes that were based on the semantic content. This was initially done manually on the entire data set. This process was repeated to ensure any relevant content or codes were not missed. The transcripts and initial codes were then uploaded and coded in Nvivo 11 software to aid the process of organising and subsequently drawing out potential themes. Before any themes were generated, the codes were checked for duplication and clarity of labels. The next stage was to explore the codes for overlapping themes that shared key features within and across interviews. Themes that appeared to strongly represent a significant amount of data were counted as full themes, and ones that appeared to be facets of these themes were organised as sub-themes. Once an initial collection of themes was generated, a thematic coding table was produced with themes containing sub-themes and codes in lower hierarchies.

Reviewing and naming of themes proceeded in three stages. Firstly, each coded piece of data was checked to judge whether the semantic content fit well within the chosen theme, or, whether it was better placed in another theme or needed to be removed as unrepresentative. This process involved removing some codes, re-arranging sub themes, and addressing some duplication. Secondly, the themes and sub-themes were analysed to explore how well they fit the overall data set. For example, strong themes should sample data from the majority of interviews otherwise they would not be representative of the views of the sample overall. The thematic coding table was then refined and a thematic map was produced to visually plot how each theme and sub-theme sat in the analysis.

At this stage AC (second supervisor) double-coded two (50%) of the transcripts. The second coder was given two transcripts with codes highlighted, but not labelled. They were then given the thematic coding table (containing central themes and sub-themes, but not codes) and coded the highlighted portions of the transcript to see how well the themes and sub-themes could be used to reliably code the transcripts. During this process any points that were not coded by the original researcher were also highlighted for later discussion. Following second coding, the second researcher also corroborated or helped to further refine the labels for themes and sub-themes, so that they more accurately captured the key features of the data. The two researchers then met to discuss these further refinements and changes in the naming of themes and sub-themes. Example changes that happened at this stage included improving the labelling of some sub-themes to improve clarity, such as changing 'Applying skills for training' to 'Practice makes perfect' and 'Watching or listening to recordings' to 'Reflecting on practice to build skill'.

The last stage involved the primary researcher finalising the themes and sub-themes in terms of structure and naming. The other two transcripts were then printed and colour coded for themes and sub-themes. This transcript was then checked by the second coder to agree the final coding.

9.2.3. Results

Three minor tweaks were made to the naming of three sub-themes before being agreed fully. Sub-theme 2.2 was changed from 'Feedback enhances GP engagement' to 'Positive feedback enhances stakeholder engagement' to incorporate the fact that the feedback covered other health professionals other than GPs (e.g. diabetes nurse). Additionally, two sub-themes under theme 5 ('Balancing data collection with service delivery' and 'Make data collection easier') were combined to form the sub-theme 'Need more user-friendly measures'. This decision was made due to the high overlap between codes in each sub-theme. The last refinement was to combine the two sub themes 'practice makes perfect' (1.1) and 'reflecting on practice to build skill' (1.4) under the second heading.

The final coding produced five main themes. The first theme, 'Strengthening capabilities by practicing skills', contains three sub-themes and 41 codes covering 125 comments across the four interviews. The second theme, 'Maximising opportunities', contains two sub-themes and 16 codes covering 46 comments across the four interviews. The third theme, 'Enabling behaviour change', contains two sub-themes and 18 codes covering 35 comments across the four interviews. The fourth theme, 'Understanding the client journey', contains five sub-themes and 33 codes, covering 68 comments across the four interviews. The fifth theme, 'Future considerations', contained three sub-themes and

55 codes covering 128 comments across the four interviews (see Appendix U for the fill list of codes). What follows is a detailed breakdown of the themes and sub-themes with descriptions and exemplar quotes.

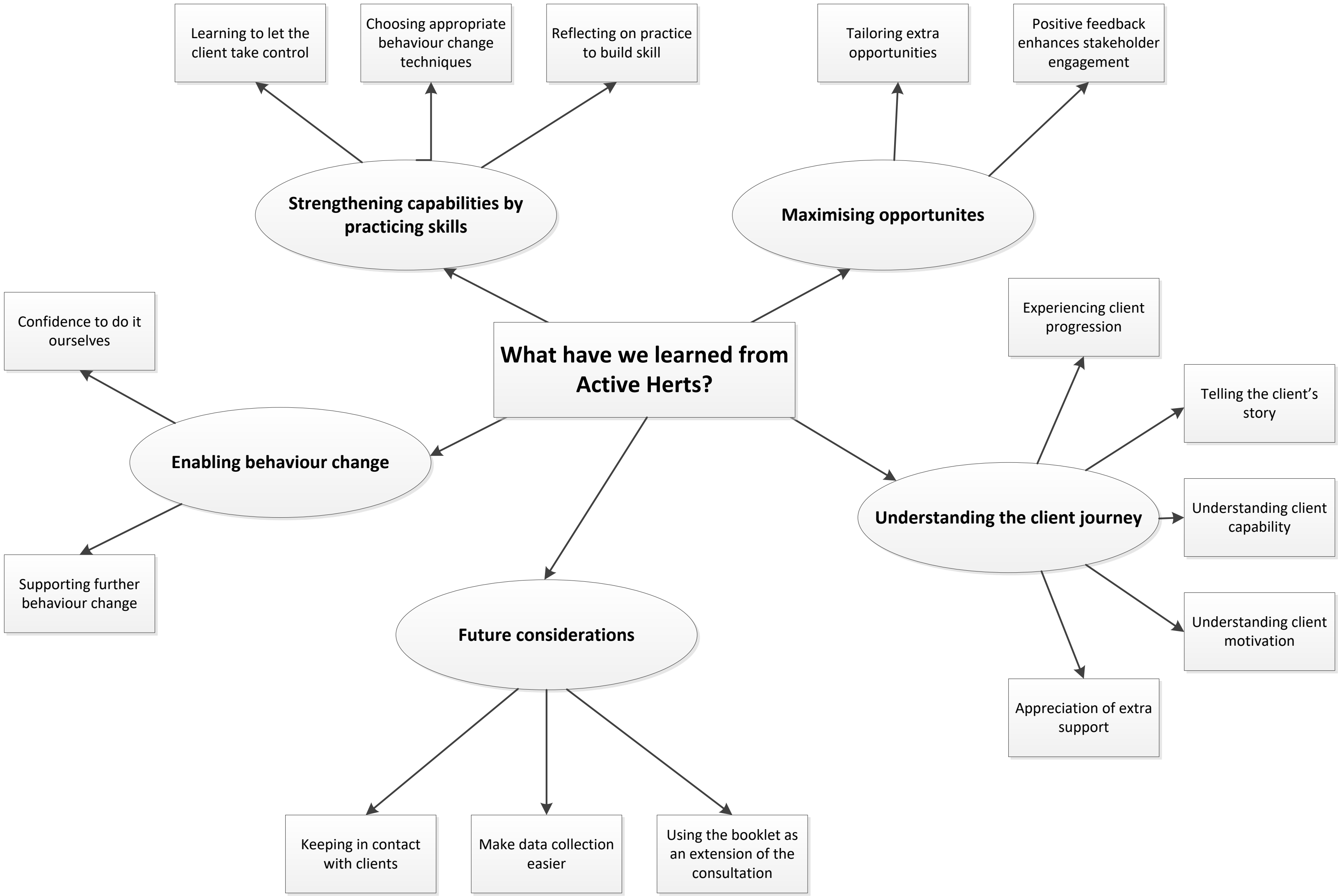

Figure 9.1. Final thematic map displaying main themes and related sub-themes.

9.2.1. Theme one: Strengthening capabilities by practicing skills

This theme centred round the GAS building their confidence in leading consultations without being too directive to the client. There was a feeling across all of the GASs that their ability to feel comfortable and competent in the consultations was helped by the initial training, but then further solidified through live consultations. Particular challenges that were highlighted included getting the right structure for the consultations, letting the client lead at the most suitable times, and utilising BCTs in the most suitable way. One of the key parts of the training was the role-play exercises, which gave the GASs the ability to analyse their own consultation style and make positive changes. The final sub-themes under this theme were: '*reflecting on practice to build skills'; 'learning to let the client take control'; 'choosing appropriate Behaviour Change Techniques'*.

9.2.1.1. Reflecting on practice to build skills

The experience of training was heavily featured in this theme, with the GASs commenting on both the quality and depth of the training, with a key highlight being the chance to practice consultations in role plays with each other. This element was appreciated for allowing the GASs to see how well their knowledge was being accumulated. The sessions were recorded and then played back to the group to analyse what went well and points that were more challenging.

> '*Erm, because you can read as much as you like but you can't, you don't how you are going to deliver it; so it was really useful for that, practically, to sort of have a have a practice at it*' (GAS-1)

The GASs found the role play really useful in highlighting gaps in their skillset and identifying areas to improve their consultations. This included both verbal motivational interviewing skills but also non-verbal communication through posture and facial expressions.

> '*We done the video of the consultations which was useful to look back on yourself. I found that really interesting because you always you know think you sound different and you do in the way you are delivering it, your body language and it was good for all that sort of stuff, to see how you really do, you know the way you are coming across and things that you can maybe tweak'* (GAS-1)

There was sometimes a disparity between how the GASs perceived themselves and how the practice consultations actually unfolded. This allowed an honest appraisal of their strengths and weaknesses at that point. It was observed that not just the content of their speech, but the amount was an important consideration.

> '*So actually when you listen to the training you've either picked up new ideas or you've realised like how much you speak and how much the other person speaks so you can actually sort of listen and think actually they spoke 30% of the time, but maybe I, you know, I thought I was doing MI and where they should be speaking like 70% of the time so actually it makes you think about your timings and what you're doing.*' (GAS-3)

Viewing the role plays allowed reflections on the fact that despite their best intentions they had been doing the majority of the talking and this ran counter to the motivational interviewing training. Overall, the ability to practice consultation skills both in the controlled role-play environment and in live consultations, was seen as challenging but highly beneficial and has led the GASs to feel confident and competent in their roles.

After the training the GASs discussed the importance of getting to deliver consultations straight away and test how well they could stick to the principles of motivational interviewing, particularly the challenge of stifling the need to tell people what they should do.

> *'So, I think the challenge is not necessarily the training, but having you take that training and go away and develop it and make sure and staying on an MI rather that sort of a righting reflex.'* (GAS-3)

There was a consistent sense that the skills could be solidified through doing regular consultations and further developed through experiencing different individuals with a range of challenging circumstances.

9.2.1.2. Learning to let the client take control

Even though the GASs became more comfortable with practice and were getting more adept at structuring the consultations, the need to be aware of maintaining the correct framing of language was consistently mentioned. In particular, the tendency to fall back into asking closed questions was highlighted as a challenge (e.g. questions whereby the GAS defines the answer in the question, which can be answered usually by a yes or no answer, and therefore can prematurely shut down a promising discussion about change).

> *'If you're dealing with an individual that fires out a lot of sort of closed answers or you try and avoid obviously using closed questions, trying to be more open to find the solution from the individual'* (GAS-2)

Another related challenge that the GASs faced, even when they had developed a strong skill base, was to avoid interrupting clients if they were going off track or becoming too negative. They had to fine tune the balance between guiding the clients to be an effective conversation about physical activity without controlling the content of the conversation too strongly.

> *'I think just ensuring erm that I'm not jumping in and becoming prescriptive. Erm because I think that is just so easy to do.'* (GAS-1)

Overall, allowing the client to take the lead in the consultation and develop their own plans and goals was a key skill that the GASs valued and had to continue to work on. They ultimately saw positive outcomes from their clients when the conversations were conducted in this way and there was a sense of fulfilment when this was achieved, particularly with a challenging client.

9.2.1.3. Choosing appropriate Behaviour Change Techniques

The Active Herts booklet was introduced in the first consultation so that clients could take something away with them. Many of the comments in this sub-theme centred round their comfort level with and use of different BCTs, both in the flow of the consultation or directly from the booklet. There was a sense that some BCTs were better to do in the consultations and that others were more suitable for clients to do in their own time when they had a bit more of a chance to think about their goals. Action planning for instance was something that was used less in the consultation.

> '*Sometimes you'd like to write like a personal plan for someone but there isn't really the time within the consultation to do that once you've found all that out, so I think that is one of the tricky bits around the action planning part erm because you've only*

just found out you know all the details about what they wanna achieve, how they're gonna do it, what sport they might be involved in, once you've found something that they might enjoy erm and then trying to write a detailed action plan of what they might do, you haven't got that chance' (GAS-1)

Lack of time in the consultation and the fact that the client may have only just formulated their goal and targets often precluded the completion of action plans. There was a feeling that clients could do this later by themselves or with the person running an exercise class. Other BCTs were seen as more useful in the consultation because they were more accessible for both the GAS and the client, providing good conversation starters.

'It was interesting going through sort of the MI techniques and looking at the goal setting approaches but then also trying to break it down into I guess numbers which was a bit easier for me to understand as well and I found that a lot of people that have been coming into the project I use that one quite a lot, looking at scales, looking at numbers to see you know where they are at in terms of their readiness to change so that's been erm pretty interesting.' (GAS-2)

The numbered scales, in terms of how confident the client was in achieving a goal, were easier to understand. This was also related to the client's readiness to change in terms of the TTM, which provided the GASs with a clear conceptualisation of where the client was on their journey to becoming more active. Other comments suggested that the numbered scales gave the GASs a good tool to use even if a client was being especially negative. If the client picked anything other than a 1 out of 10 on the scale then this used for reflection about why their confidence was not even lower (i.e. 1). If the client picked 1 then the training encouraged the GAS to reflect on what brought them to the consultation. Setting short and medium-term goals was seen as a useful task that engaged the client and provided a target for the GASs to use for the rest of the consultation.

'Erm, and then start trying to elicit out of them what's your target, what do you want to achieve. Erm, pretty much everyone came up with like a short-term goal, erm, a medium-term goal. Not everybody has a long-term goal, but most people know where they want to be in a couple of weeks.' (GAS-3)

The GASs felt that everyone can come up with a short-term goal. Having a BCT that was this easy to use gave the GAS a way of engaging the client no matter how challenging they were.

9.2.2. Theme two: Maximising opportunities

This theme focused partly on the funding and external structural support of Active Herts over and above the standard delivery. Two of the regional areas received additional funding from Sport England to provide free tailored exercise sessions for 12 weeks and the option of an exercise buddy. The use and limitations of this additional funding and how much autonomy the GASs were given featured prominently in the interviews. Another key learning was how important it was to engage with local stakeholders and community partners from the very beginning. A particular focus was on the challenges the GASs had in engaging GPs and communicating positive stories of client progression in terms of physical and mental health, to encourage them to be more prolific referrers. The final sub-themes under this theme were: '*Tailoring extra opportunities'; 'Positive feedback enhances stakeholder engagement'.*

9.2.2.1. Tailoring extra opportunities

In the two areas that received additional funding to run tailored sessions, this was seen as very beneficial for a number of reasons. GAS-2 reported that the variety of classes afforded by this extra funding was really appreciated by clients. Many people assume that they are going to be asked to go to the gym and so having a range of activities, particularly low-impact options that may appeal to older adults and/or people with injuries, was seen as a strength of the programme.

> *'I think the clients like the erm. I guess the variety of exercise that they can choose. So from the actual project we've got swimming, pilates, walking football, low-impact exercises, erm, like exercise sessions, like circuit classes and also like health walks as well so we've got a lot to offer which has been a blessing that we've got the funding through you know Sport England for you know as part of the project.'* (GAS-2)

Alongside the client appreciation of the activity sessions, having these sessions increased engagement with the programme and may have prevented a larger proportion of clients from dropping out completely. Importance was also placed on the GASs themselves delivering some or all of the sessions so that clients maintained regular contact with them between the initial consultation at baseline and the consultation at three months.

> *'Yes definitely, if I probably wasn't teaching these exercise sessions or didn't have the budget in place, I do have a feeling that the dropout rate might be a bit higher and the ratio could become 50:50 possibly. Erm, but I do think that by having a budget in place and by actually physically teaching some of the sessions it really has helped encourage more people to take part in the sessions.'* (GAS-2)

Despite issues in one participating area related to partial control of the extra activity session budget and locations changing for some of the sessions, the extra classes that the funding allowed was seen as a strong positive for both client enjoyment and engagement.

9.2.2.2. Positive feedback enhances stakeholder engagement

Across the GASs there was a consistent feeling that initially engaging with local referrers such as GPs was a real challenge. They cited reasons such as a lack of prior dialogue with local healthcare professionals before funding was granted, and a lack of visibility of the Active Herts programme to make it distinct from a regular exercise-referral scheme.

> *'A lot of the GPs were sceptical at the beginning as well so maybe engaging them a little bit more from initially and writing to them saying what's in it for you, why would you want to refer, this is why because, erm. That's taken a while to get through that this is beneficial to them, erm, in terms of reducing their consultations and all that sort of stuff. None of that information was there, it was just us sort of turning up on the door one day and going we want you to refer in to us.'* (GAS-1)

After the initial challenges of introducing the programme to local referrers, there was not enough clear communication about how the programme could benefit the GPs. For instance, by saving them time and improving the health of some of their most disadvantaged residents. This may have led to an easier relationship with local stakeholders so that they could become partners in the programme. One thing that was seen as beneficial as the programme progressed was individual clients going back to their GP and explaining the health benefits they had achieved from engaging.

'And that's made it come about from them actually seeing results, I know that there's patients that have gone back and said you know thanks for referring me, I've lost this weight and thanks for referring me, this has really made a difference and that's really helped but it's taken time for them to sort of get those results and go back and give that feedback to their GPs, which has prompted them to start talking about it in the meetings that they're having and getting other GPs to refer in and all that sort of stuff and the snowball effect.' (GAS-1)

Seeing the positive results for their patients has the potential to be a catalyst to get more GP buy-in in terms of referring clients and spreading the word to other GPs and wider healthcare professionals. One of the main learnings from this programme is the need to engage with GP surgeries before the funding is received and then intensively during the set up and initial delivery of this type of programme. This could help drive referrals and local partnership building.

9.2.3. Theme three: Enabling behaviour change

This theme focused on the current support and resources and ongoing needs that the GASs saw as integral to the effective running of the programme. There was a consistent sense that the training had been more in-depth than in previous roles, but there was still a need for ongoing feedback and guidance. The GAS also highlighted that greater guidance and feedback would have been ideal when they first started doing consultations, until they were fully confident in motivational interviewing in combination with using the booklet. Ongoing requirements were also focused around additional resources, guidance to give to clients, and gaps in exercise provision in their respective local communities. The final sub-themes under this theme were: *'confidence to do it ourselves'; 'supporting further behaviour change'*.

9.2.3.1. Confidence to do it ourselves

Overall the training was seen as more in-depth and useful than many previous training/courses the GASs had attended. Having experts in the field who added evidence and theory to the content they were delivering was seen as a strength that underpinned the Active Herts approach.

'And I think it just added credibility to what we was doing to have you know someone as experienced as you guys delivering that training for us then to be able to deliver it out to the clients.' (GAS-1)

Having a range of tools in terms of motivational interviewing, the consultation booklet with several BCTs, using health coaching for consultation structure (GROW), and physical activity sessions to refer to, was viewed as a positive in dealing with challenging clients who may at first appear like they do not want to change. The ability to practice at the initial training sessions, in live consultations, and reflecting on audio-recorded client consultations, was again seen as really helpful in developing the confidence in guiding clients through the Active Herts programme.

'Erm, yeah I think my confidence er has improved definitely. Erm, I think it just it allows you to approach certain circumstances obviously at different times as well you might have an individual that has really got a lot on their chest. Erm, you know they might not be looking for physical activity, they know it's good for them but they don't know how to start or where to go about starting er and maybe their motivation is at an all-time low, so by going through a lot of MI and sort of behaviour change training with yourselves in the past and running it through the programme, I found that erm I can tackle a lot of difficult situations a lot easier than what I could when I first started the programme.' (GAS-2)

Although the initial training was seen as intensive and a steep learning curve at times, it was seen to provide a solid foundation with which to develop consultation skills over the course of the Active Herts programme. This combined with the range of tools at their disposal made the GASs confident in helping to enable clients to change their behaviour to become more active.

9.2.3.2. Supporting further behaviour change

One thing learned from the GASs was that more consistent oversight from the trainers and potentially a trained line manager would be beneficial. This was viewed as particularly important in the early stages of the project when the GASs were still building their confidence and sharpening their consultation skills. One GAS mentioned how useful this would have been in person because they were worried that they might be making errors and no one would have known.

> *'I say just a little bit more maybe sort of like erm in the initial stages as I said previously, it's sort of peer support so sort of like you know buddying up, coming out seeing consultations, feeding back because I think that's sort of, it's almost like, you almost like wonder now because like for me I've been doing consultations till August erm. M's been out to see me twice and I've had two consultations, two recorded. Yet I could be doing absolutely anything in that period.* (GAS-3)

Alongside more regular observations the GASs also mentioned additional opportunities that might be useful to support client behaviour change. The lack of a structured walking programme was mentioned as a potential issue in one of the areas, as this sort of activity is ideal for obese clients looking to gradually get back into exercise. Another tool that was seen as potentially useful was to be able to recommend health apps that have a reliable evidence base.

> *'Maybe even like some apps to recommend because there's such a minefield, you can't recommend an app. Cause it could be John Smith has put this app together so it would be good to have sort of apps that are accredited apps if you like, for us to be able to sort of say here's one about diet to help with that and here's one you know erm, around exercise, so that would have been quite useful.'* (GAS-1)

One GAS was sceptical of the credibility of many available apps and was keen on getting some guidance. This was seen as particularly important for diet/healthy eating as this is frequently a topic of conversation in consultations, but not something the GAS were focused on (or qualified for) in the Active Herts programme. Additionally, further mental health training was viewed as desirable. The original remit of the programme focused mainly on clients with mild to moderate mental health issues. The GASs were, however, often faced with clients with serious mental health challenges that they often felt were beyond the scope of their training. Despite the fact that the Active Herts programme was primarily designed to encourage physical activity the GASs often found themselves playing the role of counsellor, particularly at the start of consultations when clients would often be the most upset.

'I think we've just done a level 4 mental health course which is obviously interesting erm but I would, I don't know about the others, but I would certainly would like more training in mental health. Erm, like I said I don't know whether that's more for when I finish this project but because of the kind of clients that I have come across I'm not going to be a counsellor to them, not on this project but by all means, but to be able to kind of just have a bit more of an understanding, a bit more of a technical understanding if you like.' (GAS-4)

One of the GAS saw more comprehensive mental health training as beneficial both for the current role and for any future related jobs. Part of the Active Herts training was to ensure that the GASs they were working within their professional boundaries and knew when to refer on to appropriate services or a crisis team should the need arise. Peer support and supervision for their own mental health was also included into the training.

9.2.4. Theme four: Understanding the client journey

Throughout the interviews from all four GASs there was a strong sense of being on the journey with the client and taking pride and satisfaction from transformations in physical and mental health that clients were experiencing. There were many examples of clients improving long-term conditions, experiencing more family cohesion, and elevating their mobility. There was a sense from some of the GASs that these stories were not being shared enough and that the Active Herts team could do a better job of promoting these inspiring case studies. Across the GASs there was also a focus on really understanding the client's capability levels to try to provide them with the best opportunities to become more active in a way that was suitable and sustainable for each individual. The final sub-themes under this theme were: *'experiencing client progression'; 'telling the client's story; understanding client capability'; 'understanding client motivation'; 'appreciation of extra support'*.

9.2.4.1. Experiencing client progression

A consistent message from the four interviews was that the GASs got to watch people progress in the programme and felt proud of being a part of this process. There were comments related to immediate changes even within the first consultation. Many clients arrived for the first meeting with barriers such as poor health and lack of time, but were often coming up with solutions themselves to these issues by the end of the session.

> *'Just watching how people can change within that hour that you've got them how they can come in from being so different and then leaving and actually feeling that, that motivation there. So you can just watch people on a journey and I know it's not you're not going to change their life there and then, it is an ongoing process but to be able to put those wheels in motion and just to plant those little seeds of thought there of someone going okay maybe I do need to start doing this erm letting them like I say come up with their own ideas and how they're going to do it.'* (GAS-4)

There was a sense that although they could not provide a solution to every client problem, particularly in under an hour, they could play a small part in influencing the client behaviour in a positive manner and letting them take ownership of this change. A common theme was also that clients improved a range of short and long-term health problems over the three months of exercise that followed the initial consultation.

> *'There's been people coming in who you know as I said there's one lady in particular who has had a lot of operations in the past on her back and she never thought that she could jog or even use a skipping rope again in her life due to what's happened to her in the past and after doing you know fifteen weeks of low-impact exercise and swimming she's managed to actually pick up that skipping rope and do a couple of skips which she is over the moon about.'* (GAS-2)

Clients often thought initially that they would never be able to do certain activities again but by the end of the activity sessions, they had experienced a real breakthrough in health and confidence. Having a range of appropriate low-intensity activity sessions was seen as a real catalyst for this kind of change. Alongside physical-health problems the GASs stated that the majority of the clients they see had some form of mental health challenge, often of a serious nature.

> *'I've had someone with anxiety and agoraphobia, where they're going out and erm now they are going to exercise classes.'* (GAS-1)

There were examples of dramatic improvements, with someone who had initially been living with agoraphobia and would not leave the house, now attending activity sessions.

9.2.4.2. Telling the client's story

There was a feeling among the GASs that some of the best stories of client improvement were not getting captured or shared well enough. Although the questionnaires capture overall group changes the GASs felt these case studies should be featured more prominently.

> *'That's it's, it's one of the problems with the project at the moment I would say almost is that we don't really, the information is not sort of recorded as such, erm apart from within the system that no one's really going to get to see about some of the good results we're getting.'* (GAS-1)

There was recognition of the importance of the main outcome of the programme, which was to move people from an inactive lifestyle to active. However, they felt that this focus, although necessary, sometimes meant that the client story from a 'human' perspective was getting lost. This was both in terms of communicating to the steering group and feeding back to wider stakeholders.

> *'That stuff doesn't get sort of filtered out because what we're looking for is someone that's going from not active to erm doing sport one times per week. That's how the programme's sort of done so the sort of human sort of story behind it all gets a little bit lost in all the numbers.'* (GAS-1)

9.2.4.3. Understanding client capability

The GASs commented on the wide range of health issues that the clients experience. Understanding the physical and psychological capability of the client was seen as one of the keys to help provide them with appropriate advice and signposting to suitable activity sessions. The prevalence of mental health issues in particular was very high, with the majority of clients that GAS-4 had for consultations living with problems.

> *'I erm probably would say nine out of ten people that come to see me regardless of if they've been actually referred to me for mental health have some sort of underlying*

mental health condition. Erm it comes out you know someone will come in and sit down, I'm, you know they'll fill in the questionnaire and they'll be I'm absolutely fine you know and actually as you get talking and people obviously warm to you and realise that actually they can potentially trust you, they'll tell me oh no I've had I'm actually really depressed or this that and it's difficult' (GAS-4)

Some of these mental health issues were deemed very serious by the specialists, which may have also impacted on their psychological capability to engage in physical activity. These types of clients also should not have been referred to Active Herts in the first place and this put a strain on the GASs. The training highlighted the importance of working within professional boundaries, and working with such extreme clients was not covered in their initial training, but added in future boosters.

Clients were also often unaware of the provision of exercise classes in their local community. This lack of knowledge would often impede them from becoming active.

'I know that a lot of them were not aware of a lot of the stuff that was going on in the local area.' (GAS-1)

Simply providing information about local opportunities and signposting clients onto appropriate activity sessions was seen as a beneficial part of the programme.

9.2.4.4. Understanding client motivation

This sub-theme covers how the GAS understood the nuances of what drove the client to either be more active or withdraw from the process. Across the interviews the GASs referred to the stages of change from the TTM model, to conceptualise how ready clients were to engage with the process. This proved a useful way of them communicating what they were observing in the consultations.

'*A lot of people who are coming through are already in that er readiness to change, they want to just see what the projects about, they're raring to go, they've done exercise in the past and they know the benefits of it. Yeah, they don't have any erm sort of mild to moderate mental health issues that are stopping them becoming fitter.*' (GAS-2)

Some clients already have positive outcome expectations, past experiences of success in being active, and the requisite motivation to engage again. In these instances, the role of the GAS was to inform them about the project and get them going to the most appropriate sessions. Other clients presented stronger barriers to their participation. One GAS commented on how their own body shape may impact on a client. They saw the fact that they were fit and healthy as a potential problem in engaging the client, as clients may see them as judgemental because of being overweight or feel that they represent an unrealistic goal for them personally.

> '*I do think sometimes they think we do judge them because being individuals that are obviously you know we're not overweight ourselves we are, we do sport they think oh well I'm never going to be like you.*' (GAS-4)

The GAS also discussed ways in which these barriers could be alleviated somewhat through the relationship and regular contact provided by the programme, particularly in the two areas with the additional Sport England funding. Motivational barriers included the worry that activity sessions would be too demanding and facilitators too harsh. In combination with the consultation, running some of the sessions themselves was seen to really encourage engagement and to lessen these types of fears.

> '*Signposting suitable exercise for that individual which is actually sort of tailored for their own ability and also letting them know that quite a few of the sessions that I personally teach myself because it's helped that individual to reduce barriers because they've met me already in the consultation, and I guess for them, for them seeing me and knowing that I'm no sergeant major in these sessions, I'm not pointing fingers, I'm not blowing whistles. It is really more creating that relaxed environment for them to attend and I think that's been quite beneficial and it's going to be a strong factor that's encouraged more people to take part in some of the sessions*' (GAS-2)

9.2.4.5. Appreciation of extra support

A number of different ways in which the programme was supportive of clients emerged from the interviews. For instance, older adults were glad that there were activity sessions appropriate for them. Their expectations were too often that exercise was for young people who are fit.

'*So they're sort of pleasantly surprised that there's stuff for them. I mean there's women in their 70s think, who come in and say I don't know whether you can do anything for me but, and when you know I bring out things like the healthy walks and fifty plus programme and that sort of stuff, erm, they seem shocked that there is something for them. They were almost expecting that erm it would have to be for someone young and fit.*' (GAS-1)

Clients also seem to appreciate the fact that support is available for the duration of the programme. They may be used to seeing a GP for five minutes and the consistent availability and flexibility in communication channels afforded by this programme was a refreshing change.

'*It kind of shows them as well that the project isn't going to be a quick flash in the pan, there is a lot of you know longevity to it and, and myself is going to be there supporting them for twelve months continuously if it is going to be a phone call, a text message or an email or booking them back in again for their next review.*' (GAS-2)

Additionally, clients appreciated their non-judgemental approach, which was often in contrast to the advice and information that was pushed on them by loved ones. Speaking to someone who did not have a personal connection to them and who let them guide their own decision making seemed to be real positive for clients.

'*Because that's what happens isn't it, in a family environment you tell the people that you love what you think is best for them so the righting reflex is there in a family environment. Having someone that isn't telling them what to do but is offering them that kind of unconditional support if you like because we're never asking for anything back really, we're just saying you know, keep in contact with us and erm let us know how you're doing, and them just knowing that we're on the end of the phone for them to come help keep them going through it is really important for them.*' (GAS-4)

9.2.5. Theme five: Future recommendations

One of the most consistent themes across the interviews was issues with the questionnaire from both the GAS's experience and their perceptions of how clients engaged with it. There was a general consensus that having to introduce the questionnaire at the beginning of the consultation (their first face-to face meeting with the client) could place a barrier in the way of a productive consultation. Due to some clients struggling to understand the questionnaire and because some were emotional, completion often took a long time and caused upset at times. The GASs struggled to balance the importance of collecting the data for evaluation purposes with delivering the best service they could to clients, many of whom were living with mental health issues. This was especially an issue at the start where data collection was given lower priority or sometimes not collected at all due to the barriers they felt it created. Other topics that were highlighted were considerations about how best to use the booklet in the consultation and the challenges in keeping clients engaged in the programme throughout the 12 months. The final sub-themes under this theme were: *'keeping in contact with clients'; 'need more user-friendly measures'; 'using the booklet as an extension of the consultation'*.

9.2.5.1. Keeping in contact with clients

All of the GASs mentioned difficulties in getting clients to stay engaged for the whole programme, particularly after the 12 weeks of activity sessions. This was either due to illness/injury or holidays, which had interrupted their progress or from clients doing well and not feeling like they need to come back in for the 3, 6, and 12 month consultations. GAS-2 tried to make the case that it was important for them to still report their progress in the questionnaires, but this was often not enough of an incentive.

> '*The three-month review that's when it does get tricky, er so the individuals that I contact or I haven't seen attend sessions for maybe a number of weeks where they might have dropped out or gone into a relapse, I try contacting them. Erm, the majority of them are some have said they've had an operation or they're going on holiday or some unfortunately have actually moved away. Erm, but there are, there have been a number of people that feel that erm, they don't need the project anymore, they feel that they're okay without it, and they've sort of joined their local gym, even though I've said to them it's still great to, to capture all this information for part of the project, but they wouldn't want anything to do with it anymore.*' (GAS-2)

One of the perceived reasons that clients dropped out between the baseline and 3-month consultations, particularly in the two areas with only the standard funding, was the lack of consistent contact in this time. Despite the option of a two-week phone call, specialists saw this as too minimal to maintain engagement with some clients.

> '*I do find that as I said earlier might need something between that initial consultation. I know there's a two-week telephone call and then there's a three month consultation so something in there, er I think is needed to.*' (GAS-1)

9.2.5.2. Need more user-friendly measures

The biggest complaint that the GASs consistently voiced was with the length, format, and wording of the questionnaire. Many comments were made about the literacy levels of the clients and how long it was taking them. The questionnaire would take clients 15 minutes on average, but this could be much longer on occasion. This took away time from the consultation and could ruin rapport with the client before the consultation had properly begun. The specialists felt that a questionnaire that was a few pages and that took five minutes would be much better (the questionnaire was eight pages long).

> '*Erm, if we had something where it was you know condensed into erm a couple of pages to, sort of five minutes rather than erm I've timed it at over fifteen for some people.*' (GAS-1)

Aside from the length of the questionnaire the GASs also highlighted potential formatting issues which led to confusion with the client. For example, having numbers and not words on the likert scale points and scales changing the wording of endpoints between measures (e.g. from completely disagree/completely agree to very uncertain/very certain). On occasion some rows were also missed by clients and the GASs had to go back and get them to complete the missing answers.

> '*Erm, and also sometimes erm so the way it's set out, people can miss parts of the question and it's something like that I mean I did sort of bring up very back at the beginning but I thought the formatting was poor so as I said people aren't really sure erm what to do.*' (GAS-3)

The other consistent worry was with the wording of some of the questions. Some felt self-conscious that the clients would think that they had come up with the wording, particularly when reading the question aloud to some clients.

'*Yeah so I don't think that has been worded the best way, but when I'm trying to explain to some of the participants who are coming into the project, erm they look at me as though I'm stupid, but just because the questions are so general, and I think they think that is was myself that created these questions.*' (GAS-2)

Other comments mentioned that clients may have struggled to comprehend the meaning of some questions, or the subtle difference between words such as intend, want, or expect (these were the three items measuring intentions).

9.2.5.3. Using the booklet as an extension of the consultation

There was a consistent sense from the GASs that the booklet was used in different ways depending on the client. Language was used in relation to the stages of change to describe where clients were on their journey and what parts of the booklet were needed. The booklet was seen as a good support for the GASs with some pages seen as good cues to stimulate more MI-congruent talk.

'*So with the booklet as I said kind of at the beginning I won't use it all the time. It will always be there on standby and if I feel that an individual needs the booklet just by doing the questions etc using the MI then I'll bring the booklet out because it is a useful tool, with a lot of motivational interviewing cues in there, which I can then you know bring out and er try and help the individual with them also to get into that readiness to change.*' (GAS-2)

The GAS also mentioned that some pages were more often used in the consultations and for others they were more likely to direct clients to complete in their own time. This provided a way of giving clients some pointers in the session, but also allowed them to take ownership of using the booklet away from the programme structure.

'*Yeah so it's a bit of a funny one that one….yeah I think the booklet has been very useful er like I say the only ones I haven't really used is that time is precious and sort of the diary er so I can try and let them have a bit of responsibility to fill that in for themselves.*' (GAS-2)

Overall the booklet was viewed as a positive addition to the range of tools at the GAS's disposal. It helped with guiding the consultations but also in describing the format and length of the programme, including when the meetings were. It was seen as a good way of getting the client to do things such as homework in addition to the normal sessions, as it was more interactive than just the normal information provision about health benefits that other approaches adopt.

> '*I think they enjoy being talked through it because quite often they have questions so they will ask you well it, how many times will I see you, what will I do that, so I think it sort of in that sort of sense it sort of gives them something to do. I've not had any negative reactions to it at all.*' (GAS-3)

9.3. Discussion

The five overall themes that emerged were *strengthening capabilities by practising skills, maximising opportunities, enabling behaviour change, understanding the client journey, and future considerations*. The GASs enjoyed the training and the chance to practice and refine skills, found the consultations challenging and rewarding, particularly as they became more comfortable in their ability to be MI-congruent, they had serious reservations about the questionnaire, and were grateful and appreciative of being involved in a project which helps the most vulnerable members of their communities.

9.3.1. Learning for future programmes

There were a number of key considerations to take forward for future programmes of this kind. One recommendation was to ensure an in-depth level of training, both in the initial stages of the programme development and during the early period of the consultations. In the Active Herts programme the initial training was well received and appreciated because of the expertise of the trainers. Previous research has shown that if HCPs view the programme or approach to be evidence-based then this can be a facilitator for physical activity promotion efforts (Huij et al., 2015). However, there was a feeling that after the initial training there needed to be more consistent supervision and support at the beginning of programme delivery until the GAS's comfort level with MI and use of BCTs was high during consultations. The initial training and quarterly boosters were not written into the grant and, therefore, did not have funding. Future programmes should make provision for specialist training and supervision throughout and to ensure that this is more intense in the beginning before tapering off when the delivery staff are more confident.

During the delivery itself the differential use of BCTs in the consultation is also an important point. Previous research has found that how participants react to BCTs can depend on the deliverer's perception of intervention materials such as booklets, and variations in deliverer attitudes towards BCTs and methods of delivery (Proctor et al., 2014). This study highlighted that the four GASs were more comfortable with some BCTs than others. Techniques such as action planning were viewed as too simple, patronising, or more suitable for clients to complete on their own once they had thought about their goals. At other times the GASs reported inconsistently using the booklet and therefore it is hard to tell how frequently some of the key BCTs were being used. This is consistent with previous research suggesting that often BCTs specified in protocols are not delivered in practice (Michie, West, Sheals, & Godinho, 2018). Evaluation of the recorded consultations is ongoing, analysing adherence to BCTs and motivational interviewing integrity. Future programmes could look at more active involvement of deliverers and clients in the design and formatting of intervention materials, so that they have the greatest chance of being utilised as intended.

Alongside the perceptions of different BCTs, it was interesting to note how the GASs mentioned the theory included in the training. In the interviews the GAS referred to 'readiness to change' but not explicitly to the COM-B. In this way the TTM still provides a useful way of conceptualising where an individual is on their journey towards changing their physical activity. Although the COM-B was not explicitly mentioned, the programme user's barriers and facilitators were frequently discussed and GASs were behaviourally diagnosing programme users before picking appropriate BCTs to help facilitate change. Having a method of training that allows deliverers to use complementary theories to ascertain the readiness and needs of programme users is crucial for intervention/programme effectiveness.

A further consideration regarding programme delivery and the GASs approach was body shape and/or BMI. One of the specialists mentioned that their healthy body shape and regular exercise habits might be a potential barrier for the clients who often struggled in both of these areas. Previous research shows that physicians with a healthy BMI were more likely to discuss weight loss with obese patients, feel more confident in providing weight loss or physical activity advice, and felt that the advice would be trusted more than overweight or obese physicians (Bleich, Bennett, Gudzune, & Cooper, 2012). A related study showed that health professionals (other than physicians) with healthy BMIs reported more success in helping patients lose weight but not in their confidence in delivering the advice or how much it was trusted by patients (Bleich, Bandara, Bennett, Cooper, & Gudzune, 2014). Further research could look at the role that body shape plays in how confident deliverers are in giving physical activity advice and how the advice is received by patients.

Another key consideration is to engage with local referrers and stakeholders, particularly GPs, before the programme starts. GPs in each locality were the main source of referrals into the programme. Research has shown that GPs often face real barriers which make them uncomfortable providing 'physical activity prescriptions', including lack of training, clear guidelines, and a protocol to follow (Persson et al., 2013), alongside the time constraints faced by HCPs in general (Whitaker et al., 2016). Future physical activity programmes should engage with GPs early by communicating how their service can be beneficial for both alleviating their workload and the short and long-term health outcomes of their most prolific patients. Programme staff such as the GASs are ideally placed because of their training, knowledge of local opportunities, and good relationship with similar programmes to deliver this advice and support for physical activity (Huij et al., 2015). A related point is that future programmes could do a better job of communicating back to GPs and other referrers how well clients are doing. Powerful case studies (Appendix V) should be used which capture the personal stories that a change in overall activity numbers cannot possibly capture.

The most challenging consideration from the interviews was the range of issues the GASs experienced with the questionnaire. The Active Herts questionnaire included the IPAQ (7 questions), WEMWBS (14 questions), EuroQol EQ-5D-5L (6 questions), COM-B measures (18 questions), the ONS single life satisfaction item, and two additional questions about sporting participation, giving a total of 48 items. This allowed the evaluation to answer not only whether the programme worked on a range of outcomes, but potentially what drove this change. Nevertheless, the length, format, and wording of the questionnaire caused significant problems for the GASs. This included their own comfort level in asking clients to complete it (particularly the 'I've been feeling loved' item from the WEMWBS), client comprehension, time taken out of the consultation, and the barrier to rapport that the questionnaire often represented. The programme was a service that had elements of research added to it but was by no means a planned research project. Therefore, the balance between the depth of data collected and effective delivery has to be considered very seriously in future programmes. In an ideal world, researchers would complete the questionnaires in a separate time and place before the consultations commenced. In a programme of this kind where this is not possible, a less onerous questionnaire that can be completed quickly may be more desirable.

The last consideration is the support that is needed for the deliverers of physical activity programmes such as these. The GASs in this programme dealt with clients who had schizophrenia, were suicidal, homeless, depressed, and anxious. There was also more than one instance of an unexpected death of a client while actively registered on the programme. However well trained these advisors are, they are not equipped to deal with these types of issues and the focus of the programme is physical activity. There was a protocol in place to deal with clients who were in need of specialist mental health support, whereby they would be referred to the Hertfordshire Partnership Foundation Trust single point of access. Although the supervision from trainers and the project manager allowed some level of debriefing from these events and experiences, a more formal arrangement with weekly support would be ideal in future to support the wellbeing of the deliverers as well as the clients they serve.

9.3.2. Changes implemented to Active Herts during the three years

As reported in the Study 4 (Chapter 8), based on these interviews there have been a number of improvements to the recruiting, advertising, and running of the programme, alongside changes to the questionnaire layout and data collection processes. The questionnaire order and presentation was changed, words were used instead of numbers for scale points, the booklet size was reduced from A4 to A5, the order of pages was changed, and programme users were also given the option of completing questionnaires online using Qualtrics. Conversation cafes were also hosted to reconnect with clients, socialise, and to complete follow-up questionnaires in person. This led to some family members signing up to the programme. Case studies and lay summaries of changes in behaviour were also printed and/or circulated to the steering group and wider stakeholders so that they could see the impact Active Herts was having both on a community level and individual level. This feedback has helped further engage local GPs and other referrers as they can clearly see the positive impact of the programme on the clients.

9.3.3. Strengths and limitations

The strengths of this study were the depth of questioning and analysis. The extensive coding and theme generation that was double-coded blind on two occasions, provided a robust basis from which the learnings from this study were generated. All of the GASs who delivered the programme were interviewed so although this was only four participants, this represented 100% of the possible population. One limitation, however, was that the interviewer was involved in the design and training of the programme and therefore, on paper, was not an objective observer in both the interviews and analysis. Based on the content of the interviews and themes, however, this does not seem to have prevented a realistic appraisal of the problems with the programme. The most important points centred on things that could have been improved and that were not in place at the start of the delivery stage, and did not gloss over the limitations in the Active Herts approach.

9.3.4. Conclusions

The GASs who delivered the Active Herts programme appreciated the training and the opportunity to make a real impact in client's lives. However, despite acknowledging the importance of evaluating the programme, there were strong reservations about the length and complexity of the measures. Closer supervision at the beginning of the delivery stage and greater engagement with local partners and referrers at the very beginning of the programme design stage would have benefitted the programme. Despite these challenges the GASs enjoyed working for Active Herts and reported many positive stories.

Chapter 10

Overall Discussion

This thesis began with a review of behaviour change intervention (BCI) frameworks and guidelines, and concluded that there may be an optimal way forward which combines several of the strongest approaches. The Medical Research Council guidance (Craig et al., 2013) provides a useful overview of designing complex interventions. The suggested combination of methods included the following stages: an initial needs analysis (e.g. knowledge gathering on population, setting, health problems); a systematic review (and meta-analysis if possible) of previous interventions and/or programmes; a behavioural analysis of the target behaviour/s using the COM-B (Michie et al., 2011) and Theoretical Domains Framework (TDF; Cane et al., 2012); selecting appropriate intervention functions, policy categories (if appropriate) and BCTs using the Behaviour Change Wheel (BCW; Michie et al., 2014) and BCT Taxonomy (Michie et al., 2013); choosing an appropriate delivery method or style and upskilling the deliverers accordingly (i.e. MI; Rollnick & Miller, 1995); feasibility testing to assess factors such as acceptability and recruitment; an appropriately designed trial of the intervention (e.g. randomised controlled trial (RCT), non-randomised trial); robust evaluation of a range of markers using RE-AIM (Glasgow et al., 1999); dissemination and replication (i.e. using TIDieR; Hoffman et al., 2014) utilising a range of academic and lay-person channels.

Several theories of behaviour and frameworks for BCI design and evaluation reviewed do not see changes in behaviour as the endpoint. The Social Ecological Model (Panter-Brick et al., 2006) theorises that the wider health impact of behaviour change is the end goal of health promotion efforts. The PRECEDE-PROCEED model (Porter, 2015) proposes two important outcomes after changes in behaviour, which are health and quality of life. The six stage model for evaluating health promotion (Nutbeam, 1998) specifies a range of health and social outcomes at the top of the hierarchy above changes in behaviour. These include quality of life and functional independence. In an ideal world, future programmes such as Active Herts would have some mechanism in place to capture outcomes related to health and quality of life over a longer period of time to truly analyse the benefits of changes in behaviour. Changes in behaviour are a proxy for improvements in, or maintenance of, wider health outcomes. It may be that measuring wider health impacts is more suitable for community and population-level interventions, but better mechanisms need to be in place to routinely measure these factors.

To help guide intervention designers through a plethora of frameworks, there is also the need for both qualitative and quantitative research examining the usability and effectiveness of different behaviour change frameworks for designing interventions. Currently, there is a dearth of evidence about whether, for example, Intervention Mapping is more usable and produces more effective interventions than the Behaviour Change Wheel. This would help guide researchers through the range of different approaches. A similar question is also relevant for evaluation frameworks, to attempt to answer which approaches produce more robust evaluations accessible to widest range of people. The Human Behaviour Change Project (Michie et al., 2017) is a big step forward in evidence synthesis and will help us answer *'What works, compared with what, how well, with what exposure, with what behaviours (for how long), for whom, in what settings and why?'* Ambitious projects such as these will hopefully move the field of behavioural science forward into a new era of efficiency and accessibility.

Many adults in the UK are not performing the recommended amount of physical activity on a regular basis, with objective measures showing that the rate may be dramatically less than subjective measures suggest (Health and Social Care Information Centre, 2014). Levels of sedentary behaviour are also high, often linked to commuting and workplace practices that involve sitting for long periods, yet there are no formal guidelines. The highly impactful nature of regular physical activity on a range of physical and mental health issues, and the national and international guidance that reflect this strong evidence base, are clear. Although there is a growing body of research exploring the dangers of excessive sedentary behaviour, this field of research is underdeveloped compared to physical activity. This is reflected in the advice of a recent review stating that quantitative guidelines on sedentary behaviour would be 'premature' (Stamatakis et al., 2018).

Adults who are inactive that may be in danger of developing long-term health problems were identified as an important target population. Systematically reviewing RCTs of interventions targeting physical activity and/or sedentary behaviour in Study 1 (Chapter

4) revealed common components in effective interventions for healthy inactive adults. The meta-analysis showed that physical activity change and maintenance of change could be achieved, and highlighted the BCTs that were associated with effectiveness, pointing towards potentially effective ingredients in future programmes. Intervention descriptions need to be much more detailed and well structured (i.e. using TIDieR; Hoffman et al., 2014), fidelity assessment needs to play a more prominent role in evaluations, and more interventions are needed to change sedentary behaviour in inactive adults.

Taking theory into consideration, Chapter 5 reviewed key theories of behaviour (and change) which have been most commonly applied in physical activity research. The Transtheoretical model (TTM; Prochaska & DiClemente, 1982, 1983) lacks validity and has been inconsistently used in interventions, which show limited evidence of effectiveness, yet can be helpful in gauging readiness to change. The Theory of Planned Behaviour (TPB; Ajzen, 1985, 1991) shows good predictive validity at times but changes in intentions have too often not led to changes in behaviour through intervention, highlighting the intention-behaviour gap. This is echoed through the Social Cognitive Theory (SCT; Bandura 1989, 2004) that shows better predictive validity and intervention effectiveness, but does not account for the gap between plans and behaviour. The Health Action Process Approach (HAPA; Schwarzer, 1992, 2008) provides additional variables between intention and behaviour, but physical activity-related evidence on effectiveness and proposed mechanisms is lacking. The Motivation-Opportunities-Ability model (Ölander & Thøgersen, 1995) and Social Ecology Model (Panter-Brick et al., 2006) both show promise as theories but lack evidence and testing in the area of physical activity.

The case was made that the COM-B (Michie et al., 2011) is the most comprehensive model with the inherent advantage of occupying the centre of the Behaviour Change Wheel (BCW) to design interventions. To test the COM-B model in this context, Study 2 and 3 (Chapters 6-7) focused on physical activity and sitting, and compared the COM-B to the TPB. The COM-B and TPB predicted a large amount of variance in MVPA in healthy adults, and Psychological Capability (self-monitoring, action planning, and ability to create habits) and Reflective Motivation (intentions, self-efficacy, and exercise self-identity) were keys to driving behaviour. This pointed towards potential drivers of physical activity that could be harnessed and evaluated in physical activity programmes. The analysis of sedentary behaviour showed the COM-B predicted more variance in sitting than the TPB. Psychological Capability (self-monitoring and ability to create habits) and Social Opportunity (subjective norms) were significant influences on sitting, and could be targeted in future programmes to reduce sitting.

Measuring the constructs of the COM-B is another rich avenue for future research. Studies 2 and 3 were the first attempts to test the predictive and construct validity of the COM-B. The greatest strength of the COM-B is how broad it is in scope, but this can also be a problem in conceptualising and measuring the constructs. Motivation in particular contains a very wide array of potential indicators. Other theories posit that self-efficacy (e.g. SCT, Bandura, 1989, 2004; Social Ecological Model, Panter-Brick et al., 2006), outcome expectancies (e.g. SCT, Bandura, 1989, 2004; HAPA, Schwarzer, 1992, 2008; Motivation-Opportunities-Ability model, Ölander & Thøgersen, 1995), and attitudes (e.g. TPB; Ajzen, 1985, 1991; Social Ecological Model, Panter-Brick et al., 2006) are pre-cursors to intention or goal formation. HAPA (Schwarzer, 1992, 2008) also places planning and self-efficacy variables in the post-intention stage.

The reflective portion of the Motivation construct from the COM-B places all of these variables in the same construct and therefore does not allow for these nuanced relationships to be clearly conceptualised and tested. For instance, the path analysis in Study 4 (Chapter 8) showed consistent correlations of moderate strength between self-efficacy and intentions, but as the COM-B specifies these two variables concurrently, this path was not tested. Future research should explore whether this is the best way to conceptualise Motivation when building interventions to target the COM-B constructs. Some of the indicators representing TDF domains also doubled as BCTs (e.g. self-monitoring), which may also make exploration of mechanisms of actions trickier. Further research could also test the validity of the feedback loops hypothesised by the COM-B with behaviour potentially affecting Capability, Opportunity, and Motivation. These points cover a wider issue with the COM-B in that it is not falsifiable because of how broad the constructs and relationships between them are. The breadth of potential behavioural influences covered in the three constructs is therefore its greatest strength and an inherent weakness. A recent survey of implementation scientists showed that theories are selected for reasons such as ‘logical consistency/plausibility’ and ‘description of the change process’ (Birken et al., 2017). Falsifiability was near the bottom of the list, which shows that implementations scientists may not value this as much as they should.

A thorough programme evaluation should evaluate pre-specified primary and secondary outcomes and perform intention-to-treat analysis to provide a realistic view of effectiveness. The measurement of underlying theoretical constructs can also highlight the most influential drivers of behaviour. In Study 4, Active Herts was shown to be effective in changing physical activity (walking, moderate, and vigorous) at 3 and 6 months, and a range of secondary measures (including COM-B elements, mental wellbeing, perceived health, and life satisfaction). The completer analysis (moderate-to-relatively large effects) and more conservative intention-to-treat analysis (small effects) both showed significant improvements. Measures capturing Capability (self-monitoring and action planning) and Motivation (self-efficacy and intentions) were better at predicting MVPA performance at the three time points (baseline, 3, and 6 months) than changes in MVPA between time points (baseline to 3 months, baseline to 6 months). Self-monitoring was consistently a significant predictor of both performance and changes in MVPA, showing that the ability to monitor one's physical activity may be key in encouraging behaviour change.

When developing interventions, it is not enough to simply write the content and hope it is delivered as planned, the perceptions of deliverers should be explored to optimise programme delivery and support fidelity. Study 5 (Chapter 9) described a thematic analysis of interviews with the four Get Active Specialists (GAS). The central themes were strengthening capabilities by practicing skills (e.g. learning to let the client take control), maximising opportunities (e.g. providing positive feedback to stakeholders to enhance engagement), enabling behaviour change (e.g. confidence in their ability to do it themselves), understanding the client journey (e.g. understanding client motivation and capability), and future considerations (e.g. making data collection easier). The GASs highlighted that they enjoyed the job, felt valued by the programme users (clients), and thought they were making a real difference with the programme. Future programme designers should limit the length and complexity of the questionnaire, focus intensive training/mentoring at the beginning, and build relationships with GPs before the programme begins.

In relation to programme training, delivery, and content, there is a need to further elaborate on the 93-item BCT taxonomy to incorporate techniques, such as signposting opportunities. Currently, multi-layered behavioural approaches such as motivational interviewing and Cognitive Behavioural Therapy are included under the generic 'social support unspecified' technique. Examination of the BCTs that make up motivational interviewing suggested up to 22 new BCTs that are not reflected in the current taxonomy (Hardcastle et al., 2017). Hardcastle et al. (2017) drew a distinction between content-based (e.g. consider change options) and relational BCTs (e.g. open-ended questions). The relational techniques are delivery tools rather than BCTs and many were used in Active Herts. A taxonomy representing shared language for modes and tools of delivery would be beneficial going forward. This is a problem with other techniques such as problem solving, which also contains relapse prevention. The Active Herts booklet contains separate pages on problem solving (focus on current barriers) and relapse prevention (prospective barriers), but were only captured by one BCT. Goal setting BCTs should also be further separated into self and other-generated (e.g. programme or deliverer) goals, with self-generated goals likely to encourage more autonomous thinking (Chater, 2014). The BCTs which are used to train HCPs are also important to specify and a recent tool will help with clearly outlining training methods, and provides ways to incorporate behaviour change into a range of continued professional development (Pearson, Byrne-Davis, Bull, & Hart, 2018).

When designing behaviour change interventions and training deliverers there also needs to be a realistic appraisal of the balance between standardisation and the needs of the deliverer to be comfortable and tailor the approach to each individual. Although programme designers can specify a detailed protocol and train HCPs to use it, there will be BCTs that some deliverers prefer over others, and this will not always be consistent with the evidence on effectiveness. Some programme users will also need different approaches than others and so overly-standardised approaches may always lack strong fidelity. This consideration is even more important for approaches such as exercise referral schemes, where an individual may be signposted to a wide array of choices which contain a multitude of different BCTs packaged together. In this instance, only the initial meeting can be standardised in any meaningful way. This makes it harder to gauge which parts of the programme were the most useful, although a strong pre-planned process evaluation will help illuminate this.

The final consideration is to include a transdisciplinary approach from the very beginning in designing behaviour change programmes. Although Active Herts ended up as a collaboration between many different disciplines, it was not always from the outset. The programme design and subsequent grant application lacked behavioural science experts to help refine the design and training for the programme. This meant that the content, training, and secondary analysis was only finalised just before the launch of the programme. Funding bodies could also play their part in this process by demanding that teams have certain expertise on the bid and that certain steps must be incorporated into the programme. For example, feasibility testing before the full rollout was not possible in this case but, had it done so, may have improved the efficiency with which the programme ran in the first 6-12 months.

10.1. Future considerations

The findings and learning from the five studies in this thesis have produced the following key considerations for future behaviour change intervention research and development:

- Measuring outcomes of behaviour change as the end goal of interventions/programmes (e.g. health, quality of life)
- More sedentary behaviour interventions are needed for inactive adults, which measure maintenance of changes in this behaviour
- The planning and evaluation of fidelity monitoring needs to become an integral part of any intervention/programme going forward
- Research is needed on the effectiveness and usability of different BCI frameworks (e.g. the BCW vs IM)
- The feedback loops hypothesised by the COM-B need to be formally tested i.e. does behaviour impact Capability, Opportunity, and Motivation?
- Intervention planners should focus resources at the beginning to ensure adequate training and mentoring for deliverers and to ensure health professional buy-in
- Further separation of some BCTs (e.g. social support, goal setting) is needed alongside the addition of omitted techniques (e.g. signposting)

- Standardisation of programme/intervention content delivery needs to be balanced against the need to tailor to individuals
- Programmes should adopt a transdisciplinary approach from the grant writing stage all the way to dissemination

10.2. Further Active Herts Analysis and Impact Case

The Active Herts programme will be used either on its own or as part of wider behaviour change impact case for REF2021. The background research was conducted and published as part of this PhD in the form of the systematic review (protocol and full paper; Howlett et al., 2015a, 2018) and COM-B analysis of physical activity (Howlett, Schulz, et al., 2017). The Active Herts approach has also been detailed in a published protocol (Howlett, Jones, et al., 2017). The analysis presented in Study 4 (Chapter 8) was on the two-year interim data and the full data was only available to analyse at the end of 2018. In addition to the published papers, the following are being written or are planned: COM-B/TPB analysis of sitting; fidelity assessment of the GAS skill development; a paper analysing effectiveness and cost-effectiveness; a process evaluation paper; a paper analysing how the COM-B drivers influenced performance and changes in MVPA. The process and cost-effectiveness evaluations are being led by Professor Andy Jones at the University of East Anglia (see end of Chapter 8 for details). It is not within the scope of this PhD to cover all of this analysis.

There have also been a number of further impacts from Active Herts. The Active Living programme from Epping Forest District Council has utilised the Active Herts approach in their materials and delivery. Early evaluation is already highlighting successful results in changing the physical activity of programme users. A spin-off programme 'Active Watford and Three Rivers' has also been funded by the premier league to run for the next three years (Appendix X). Sport England have featured Active Herts in their document on design principles for tackling inactivity (Sport England, 2016; Appendix Y).

The research and training approach informing Active Herts has been presented at the British Psychological Society's Division of Health Psychology annual conference (Howlett, Trivedi, Troop, & Chater 2015b), to the European Health Psychology Society in September 2016 (Chater, Howlett, Trivedi, & Troop, 2016) and at an invited symposium at the British Psychological Society's annual conference in Brighton (Chater, 2017). The Active Herts approach, and research behind it have also been provided to the Moldovian government (Chater, Howlett, Trivedi, Troop, & Jones, 2018) to support the development of health promotion and behaviour change programmes for non-communicable diseases wider afield. The UCL Centre for Behaviour Change Summer School programme also featured Active Herts as an example of translational behavioural science into public health practice (July/August 2017 & 2018).

The method and results from Active Herts have also been presented in a Sport England symposium at the International Society for Physical Activity and Health (ISPAH; Deans & Freeman, 2018) conference in October 2018, and have further been included in a number of keynotes (by AC, second supervisor) across the country highlighting the benefit of integrating health psychology and behavioural science with public health to partners, stakeholders, and the wider academic and public health communities. The evidence-based approach to intervention content development and specialist training has been presented as an example of good practice to tackle weight management, using physical activity in an invited All Party Parliamentary Group meeting on Understanding Obesity (November 2018). Finally, two-year interim results were presented at the annual UK Society for Behavioural Medicine conference in December 2018 (Howlett, Trivedi, Troop, Jones, & Chater, 2018). The Active Herts website also details the approach and encourages those wishing to draw from this programme of work to register their interest and download the relevant materials (http://www.activeherts.org.uk/healthcare-professionals/our-approach/).

10.3. Reflections on future directions

In my future work I intend to build on existing behaviour change research, to co-produce research knowledge with local and national partners in public health. Through membership of the Executive Committee of the Behavioural Science and Public Health Network (BSPHN, www.bsphn.org.uk), I intend to help lead on trans-disciplinary research that embeds behavioural science into public health efforts so as to reduce the burden of unhealthy behaviours in the most disadvantaged communities. The BSPHN is a collaboration of academics and those working across public health, NHS, and charities. The network hosts the Behavioural and Social Sciences Strategy, co-created and led by Public Health England, which aims to embed the best research insights into the training and practices of the public health workforce. Working with partners from Hertfordshire County Council and local Higher Education Institutions (HEIs) in this network has already helped produce the Active

Herts programme. My plans are to continue building evidence-based approaches to health promotion by using the latest innovations to synthesise evidence and examine the processes by which unhealthy behaviours can be changed. My ambition is to help shape local (East of England), national and international health strategy with the very latest innovations in behavioural science.

I am well situated within a supportive infrastructure, with health and wellbeing one of the six key research themes of the University of Hertfordshire and excellent collaborations with the local HEIs at the University of Bedfordshire (Angel Chater) and University of East Anglia (Andy Jones). I also have two existing grants with the charity HENRY and am looking to expand on this portfolio of evaluation projects to work with a wider range of partners to provide behavioural science expertise. In addition, the Department of Psychology and Sport Sciences at Hertfordshire will be expanding its behaviour change capacity to develop a centre for research excellence in this area. This will enable us to continue to pursue large grants from organisations such as the NIHR to test large-scale interventions in the most rigorous way possible.

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Appendices

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Appendix A: Systematic review search terms

Search terms were combined with 'OR' and concepts were combined with 'AND' (Pubmed example).

Concept	Search terms
Population	MeSH terms: adult (exp), body weight, body mass index, sedentary lifestyle, overweight (exp) Free text terms: BMI, inactive, sedentary
Intervention	MeSH terms: behaviour, behavior therapy, exercise, exercise therapy (exp), health behaviour, health education, health promotion (exp), intervention studies, lifestyle (exp), physical education and training, primary health care, social environment (exp) Free text terms: BCT*, behaviour*, behaviour* change*, behaviour change strateg*, behaviour change technique*, behaviour* intervention*, behaviour* modification*, behaviour* therapy, behavior* change*, behavior change strateg*, behavior change technique*, behavior* intervention*, behavior* modification*, exercise activit*, exercise fitness, exercise intervention*, exercise prescribe*, exercise program*, exercise promot*, exercise referral*, exercise supervis*, exercise train*, health* behaviour*, lifestyle change*, lifestyle intervention*, lifestyle modification*, lifestyle train*, MVPA, MVPA intervention*, Peer support*, physical activit*, physical activity intervention*
Comparator	MeSH terms: clinical trials Free text terms: Clinical trial [pt], placebo [ab], randomly [ab], randomized [ab], trial [ti]
Outcomes	MeSH terms: exercise, physical fitness, resistance training, sports, walking Free text terms: MVPA, physical activit*, physical inactivit*, sedentary behaviour*, sedentary behavior*, fitness

Notes: Filters were included to refine the date (1990 onwards), participants (human, over 18), and language (English only). These terms were adapted to the syntax and subject headings of the remaining databases.

Appendix B: Characteristics of final review studies

Study ID, Country, Funding source	Participant characteristics	Intervention condition/s	Control condition	Inactive criterion/ baseline activity	Duration	FU duration	Attrition rates at follow-up	Primary outcome/s	Intervention effect – post and FU
Aittasalo (2012) Finnish Work Environment Fund and Juho Vainio Foundation Finland	Baseline sample size: Int – 123; con - 118 Mean age: Int – 44.1; con – 45.3 BMI: int – 51% over 25; con – 64% over 25 Gender (% female participants): int – 71; con - 66	One hour meeting with researcher emphasising health benefits of exercise. Provided with walking leaflets, pedometers, and logbooks. Followed by six monthly emails focusing on techniques such as action and coping planning.	Passive: Data collection only	Were insufficiently physically active health (less than 150 mins of MPA or less than 75 mins of VPA per week from fewer than 3 days a week)	6 months	6 months	Int – 28%; con – 26%	PA: Minutes per week of walking (at work, for transportation, for leisure and stairs). SB: minutes per day of sitting	Post: Change in stair walking in favour of the intervention. FU: Change in stair and leisure walking in favour of the intervention.
Annesi (2016) Funded in part by a grant from Thrivent Foundation America	Baseline sample size: Int – 55; con – 55 Mean age: 48.2 overall BMI: 35.3 overall Gender (% female): 100	A mixture of 32 individual and group sessions between 30-60 minutes focusing on empowering participants with self-regulatory skills and abilities to deal with barriers to managing their weight effectively, while increasing their feelings of mastery and competence (ie, self-	Active: 12 phone sessions over six months covering the LEARN (lifestyle, exercise, attitudes, relationships, nutrition) Program for Weight Management	Less than 20 minutes physical activity/exercise per week during the past year	14 months	10 months	13% overall	PA: Number of weekly sessions of strenuous, moderate, and light physical exertion for more than 15 minutes	Post: n/a FU: No difference between groups.

		efficacy).							
Belanger-Gravel (2013) Doctoral award from the Canadian Institutes of Health Research Canada	Baseline sample size: Int –51; con - 50 Mean age: 59.4 overall BMI: 33.5 overall Gender (% female participants): int – 65; con – 54	Three sessions with a PA counsellor over two months. Content same as controls with the addition of implementation intentions.	Active: Three sessions with a PA counsellor over two months. Content included goal setting, self-monitoring, feedback, encouragement, and information about health consequences.	Not achieving 24 units on Godin leisure-time physical activity questionnaire	2 months	6 months	Int – 22.8%; con – 21.6%	Daily pedometer steps	Post: No difference between groups. FU: Increased steps in favour of the intervention.
Bickmore (2013) National Institutes of Health National Institute (NIA) on Aging Grant America	Baseline sample size: Int – 132; con - 131 Mean age: Int – 71.7; con – 70.8 BMI: int – 29.6; con – 29.4 Gender (% female participants): int – 67; con - 55	Embodied Conversation Agent (ECA) on tablet computer was taken home for two months, pedometers were given, and participants were instructed to log on daily and review goals and overcome barriers	Active: Given pedometers to wear every day and monthly logs to record steps.	Not engaged in regular MVPA ≥3 d/wk for at least 20 min/d over the previous 6 months	2 months	10 months	Int – 58.4%; con – 44.3%	Daily pedometer steps	Post: Increased steps in favour of the intervention. FU: Marginally increased steps in favour of the intervention (*p* = .09).
Bock (2001) Rhode Island Affiliate of the American Heart Association	Baseline sample size: 194 overall Mean age: 44.3 overall BMI: 28.4 overall	Individually-tailored feedback reports matched to participant's stage of motivation readiness. Content included using rewards, increasing self-efficacy, and	Active: Four self-help booklets from the American Heart Association addressing participation in different types of	Less than 30 mins per day for 5 days of MPA or less than 3 days of 20 mins of	6 months	6 months	39% overall	Minutes of PA per week	Post: Increased PA in favour of the intervention. FU: No difference

Grant/ National Cancer Institute Grants America	Gender (% female participants): 76.3 overall	benefits/barriers. Participants also received the control self-help manuals.	PA.	VPA					between groups.
Buman (2011) Several funding sources America	Baseline sample size: Int – 41; con - 40 Mean age: Int – 63.5; con – 63.4 BMI: int – 28.4; con – 26.7 Gender (% female participants): int – 85.4; con - 80	Weekly sessions with peer mentor-led advice including topics such as engaging social support, goal setting, feedback, and encouragement. Access to community exercise facility	Active: Two educational sessions including benefits of exercise and feedback. Participants were also given pedometers for self-monitoring and access to exercise facility	Not meeting national PA recommendations during the past 6 months	16 weeks	14 months	Int – 52.5%; con – 51.3%	Minutes of MVPA per week	Post: No difference between groups. FU: Increased PA in favour of the intervention.
Carels (2004) Funding source not given America	Baseline sample size: Int – 21; con - 23 Mean age: Int – 55.1; con – 54.3 BMI: int – 37.8; con – 35.1 Gender (% female participants): 100	24 weekly group sessions of 90-120 mins including the same content as the controls with an additional self-control element. This included topics such as increasing self-control and concentration using relaxation and coping skills.	24 weekly group sessions of 60-75 mins including topics such as self-monitoring, goal setting, and relapse prevention.	Not participating in a program of physical conditioning two or more times per week for at least 20 minutes per session	24 weeks	6 months	25% overall	Weight loss, body composition, self-reported physical activity, and psychosocial functioning	Post: No difference between groups. FU: No difference between groups.
Chen (1998)	Baseline sample size: Int – 62; con	In addition to the two control booklets,	Active: Two booklets about	Not exercising	8 weeks	28 months	Int – 61.3%; con	Minutes of walking per	Post: No difference

Funding source not given America	- 63 Mean age: Int – 36.3; con – 36.7 BMI: 28.3 overall Gender (% female participants): 100	participants received Stanford six-page walking kit and 6 x 20-30min counselling calls over 8 weeks. Call topics including social support, instruction, and relapse prevention.	exercise from the American Heart Association. One five minute phone call covering the benefits of PA and PA goals.	more than once a week or walking more than 90 mins per week			– 58.7%	week	between groups. FU: No difference between groups.
Dallow (2003) Funding source not given America	Baseline sample size: Int – 29; con - 29 Mean age: 46.7 overall BMI: 36.1 overall Gender (% female participants): 100	16 weekly sessions and 4 fortnightly sessions, all 90 minutes. Topics included benefits of PA, activity planning, identifying barriers, and relapse prevention.	Active: Four educational classes, individualised exercise prescription, and 6 months free access to local health centre.	Less than 3 x 20 mins PA per week	24 weeks	24 weeks	Int – 52%; con – 41%	Daily energy expenditure /fitness	Post: Energy expenditure increased in favour of the intervention. FU: Energy expenditure increased in favour the intervention
Dzator (2004) West Australian Health Promotion Foundation (Healthway) Australia	Baseline sample size: Int – 86; con - 94 Mean age: Int – 30.4; con – 28.8 BMI: int – 25.1; con – 25.5 Gender (% female participants): int	High: Alternate 3 modules by post and three interactive group sessions every 2-3 weeks. Topics included goal setting and benefits. Low: One introductory group workshop plus 6 mailouts every 2-3 weeks. Same content	Passive: Data collection only	76% not sufficiently active (4 x 30 mins per week) at baseline.	4 months	8 months	41% overall	Energy, dietary consumptio n, BMI, exercise days, fitness, cholesterol, blood pressure	Post: Increased exercise days in favour of the intervention. FU: No difference between groups.

	– 50; con - 50								
Halbert (2000) Public Health Research & Development Project grant from the National Health & Medical Research Council & Dep of Health, Housing, Local Government & Community Services Australia	Baseline sample size: Int – 149; con - 150 Mean age: Int – 67.3; con – 67.8 BMI: int – 27.2; con – 26.9 Gender (% female participants): int – 52; con - 56	Initial 20 minute session (individualised advice and pamphlet) – including benefits and planning. Then 3 and 6 month meetings involving self-monitoring the week before.	Active: Nutrition pamphlet and 20 minute discussion.	Participants were required to be inactive.	6 months	6 months	Int – 17%; con – 6%	Physical activity (walking/vigorous), BP, weight, serum levels, and QOL	Post: Increased VPA (but not walking) in favour of the intervention. FU: Increased VPA (but not walking) in favour of the intervention.
Harland (1999) NHS National R&D Programme on Cardiovascular Disease and Stroke England	Baseline sample size: Int – 102; con - 103 Mean age: not given BMI: not given Gender (% female participants): 59	In addition to controls: Group 1: one motivational interview (40 minutes) Group 2: one motivational interview plus 30 leisure vouchers Group 3: six motivational interviews (40 minutes each)	Active: Feedback on baseline results, information pack, and 19 leaflets on local facilities and activities.	Not engaged in habitual vigorous activity at least three times a week over the previous 6 months	12 weeks	9 months	15% overall	Physical activity score, and sessions of moderate and vigorous activity per week	Post: Increased PA score in favour of the intervention. FU: No difference between groups.

	overall	Group 4: six motivational interviews (40 minutes each) plus 30 leisure vouchers							
Hertogh (2010) Dutch Cancer Society Netherlands	Baseline sample size: Int – 96; con - 93 Mean age: Int – 58.9; con – 58.4 BMI: int – 26.6; con – 27.3 Gender (% female participants): 100	Bi-weekly group exercise sessions (60 mins), with instructions for a third weekly session at home individually.	Active: Instructed to behave normally but did receive newsletters.	Participating less than 2 h/wk of moderate-intensity sports and recreational activities	12 months	12 months	Int – 20.8%; con – 29%	MET-hours per week (of at least moderate intensity) and Modified Baecke Questionnaire score	Post: Increased MET-hours per week in favour of the intervention. FU: Increased MET-hours per week in favour of the intervention.
Jimmy (2005) Health insurance Helsana AG Switzerland	Baseline sample size: Int – 69; con - 92 Mean age: Int – 47.3; con – 50.3 BMI: int – 25.5; con – 24.9 Gender (% female participants): int – 57; con - 58	GPs gave questionnaire feedback (stage of change) face-to-face; stage specific leaflet to take home; discounted counselling session offered; three follow-up telephone calls to review goals (3, 6, & 12 weeks).	Active: GPs gave questionnaire feedback (stage of change) face-to-face related to the international recommendations of health enhancing physical activity.	In stages of pre-contemplation, contemplation, or preparation, and engaged in VPA less than three times per week	12 weeks	12 months	Int – 20%; con – 16%	Percentage classified as active (engaged in at least half an hour of moderate activity daily or at least 20 min of vigorous activity three times per week)	Post: n/a FU: No difference between groups.
Kolt (2007) National Heart	Baseline sample size: Int – 93; con - 93	8 telephone counselling sessions over a 12-week period: weekly for the first 4	Passive: Data collection only	Participated in less than 30 minutes of	12 weeks	9 months	Int – 11%; con – 10%	Physical activity (MVPA and walking),	Post: Increased total PA in favour of the

Foundation of New Zealand New Zealand	Mean age: Int – 74.1; con – 74.3 BMI: not given Gender (% female participants): int – 69.9; con - 62.4	weeks and then every 2 weeks for the remaining 8 weeks of the intervention. In addition, a walking log and pamphlets were mailed to support the counselling approach.		activity on 5 or more days per week for 6 months				QOL	intervention. FU: Increased MPA only in favour of the intervention.
Lawton (2008) Several funding sources New Zealand	Baseline sample size: Int – 544; con - 545 Mean age: Int – 59.1; con – 58.7 BMI: int – 29.2; con – 29.2 Gender (% female participants): 100	Initial meeting (7-13 mins) including goal setting and barriers; average of five calls for 15 mins; one 30min visit to primary care nurse (6 months) including reviewing goals.	Passive: Usual care	Not achieving the recommended 150 minutes of moderate level physical activity a week	9 months	15 months	Int – 10.5%; con – 10.7%	Minutes per week of PA and percentage completing 150 minutes of at least moderate PA per week	Post: Increased PA in favour of the intervention. FU: Increased PA in favour of the intervention.
Lewis (2013) National Heart, Lung, and Blood Institute America	Baseline sample size: Int – 224; con - 224 Mean age: Int – 43.1; con – 42.2 BMI: not given Gender (% female participants): int – 87.1; con – 87.1	11 feedback reports (weekly during the first month, biweekly during months two and three, and monthly during months four through six); stage of change manuals at the start and throughout the study when participants endorsed a different stage of change; 14 tip sheets (bi-weekly during the	Active: Health and wellness education materials at the same frequency as intervention participants.	Low-active was defined as self-reporting 90 minutes per week or less of moderate or vigorous intensity physical activity for the last 6	6 months	6 months	Int – 22%; con – 18%	Minutes of PA per week	Post: Increased PA in favour of the intervention. FU: Increased PA in favour of the intervention.

		first two months and monthly during months three through six)		months.					
Marshall (2004) National Heart Foundation of Australia Australia	Baseline sample size: Int – 361; con - 358 Mean age: 43 overall BMI: 25 overall Gender (% female participants): 64 overall	One mailing of stage of change booklets one week after randomisation	Passive: Data collection only	Only those that were inactive and/or not in maintenance stage of change. 73% not sufficiently active (150 mins of PA per week over occasions per week) at baseline.	1 week	34 weeks	Int – 15%; con – 12%	Physical activity (minutes per week and percentage active); stages of change	Post: n/a FU: No difference between groups.
Mutrie (2002) Scottish Executive, Chief Scientists Office; Health Education Board for Scotland & Greater	Baseline sample size: Int – 145; con - 150 Mean age: 38 overall BMI: not given Gender (% female participants): 64 overall	One information pack containing materials based on the TTM, educational, and practical information on: choosing routes; maintaining personal safety; safe cycle storage information. The pack also included an activity diary, a workplace map, distances from local	Passive: Data collection only	Participants identified as contemplating or preparing to actively commute	Just initial contact	6 months	Int – 30%; con – 39%	Stage of change for active commuting, seven day recall of physical activity, and perceived physical and mental functioning	Post: n/a FU: Increased walking to work in favour of the intervention.

Glasgow Health Board Scotland		stations, local cycle retailers, relevant contacts, local maps, and reflective safety accessories.							
Napolitano (2006) Robert Wood Johnson Foundation America	Baseline sample size: Int – 95; con - 92 Mean age: Int – 47.6; con – 47.2 BMI: int – 29; con – 28.3 Gender (% female participants): 100	Jumpstart intervention: Four sets of tailored feedback reports addressing self-efficacy, barriers, benefits, social support, and goal setting, a stage of change booklet, and letter. Choose to move intervention: One letter and booklet designed by the American Heart Association with a 12-week programme included.	Active: Participants received one mailing of women's health information, including topics such as sleep, cancer prevention, and nutrition	Not participating in more than 90 min of MPA per week or more than 60 min of VPA	6 months	6 months	7.1% overall	Minutes of at least moderate PA per week	Post: n/a FU: No difference between groups.
Nies (2006) National Institutes of Health NINR grant America	Baseline sample size: Int – 90; con - 83 Mean age: 45 overall BMI: not given Gender (% female participants): 100	Telephone counselling group: 16 x 15 minute calls over 24 weeks (8 weekly followed by 8 fortnightly). Brief telephone group: Received calls at same frequency but for 2-5 minutes for monitoring purposes.	Active: Shown one 20 minute video on the importance of walking.	Engaged in PA very infrequently or not at all, and walked less than 90 minutes per week	6 months	6 months	19% overall	Minutes of walking per week, energy expenditure, 1 mile walk test, BMI, blood pressure, body fat percentage	Post: No difference between groups. FU: No difference between groups.

Norton (2011) Australian Research Council and the South Australian Department of Health Australia	Baseline sample size: Int – 148; con - 251 Mean age: Int – 36.6; con – 40.1 BMI: not given Gender (% female participants): int – 71.6; con – 77.3	Three weekly supervised training sessions of 60mins (four in the last week). In addition participants were asked to complete 30 minutes of activity on all other days.	Active: Given pedometer and sent weekly emails with graded step goals and tips to increase walking.	Less than 150 min of weighted PA per week	40 days	10.5 months	Int – 32%; con – 35%	Minutes per week of PA; Percentage reaching 150 mins of PA per week; adherence	Post: Increased PA in favour of the intervention. FU: No difference between groups.
Opdenacker (2008) Flemish Government Belgium	Baseline sample size: Int – 60; con - 60 Mean age: Int – 67; con – 66.3 BMI: int – 26.8; con – 27.3 Gender (% female participants): int – 50; con - 50	Lifestyle condition: An individual session with instructor, 16 phone calls, and five monthly exercise sessions. Behavioural strategies included goal setting, discussing barriers, and self-monitoring.	Structured condition: Three weekly supervised training sessions of 60-90mins in groups of 10.	Not active at moderate intensity for more than 2 hours per week	11 months	12 months	Int – 18.3%; con – 23.3%	PA kcal per week for leisure, transport, household/garden and in total; steps; accelerometer data	Post: Increased PA in favour of the intervention. FU: Increased active transport and steps in favour of the intervention.
Rovniak (2005) California Tobacco-Related Disease Research Program of	Baseline sample size: Int – 30; con - 31 Mean age: 40.2 overall BMI: int – 27.5; con – 27.1	Same as controls with the addition of brief modelling demonstration, more specific goals, more precise, immediate self-monitoring, and more specific	Active: One face-to-face meeting with project coordinator (30 mins) including benefits and action planning; received program manual and	Less than 90 minutes of physical activity per week	12 weeks	9 months	21.3% overall	Minutes of walking per week	Post: No difference between groups. FU: Marginally increased walking in favour of the

the University of California America	Gender (% female participants): 100	feedback about performance relative to past accomplishments and normative standards.	feedback about walk speed relative to program goals.						intervention (*p* = .08).
Steptoe (1999) NHS research and developmen t programme in cardiovascul ar disease and stroke England	Baseline sample size: Int – 316; con - 567 Mean age: 46.7 overall BMI: int – 28.6; con – 28.2 Gender (% female participants): 54 overall	Two or three counselling sessions of up to 20 minutes and 1-2 phone calls to consolidate the counselling and encourage behaviour change.	Active: Information provision and exhortation.	Fewer than 12 episodes of vigorous or moderate exercise for at least 20 minutes in the past 4 weeks	4 months	8 months	Int – 46%; con – 38%	The number of episodes of vigorous or moderate activity completed in the past 4 weeks (alongside smoking, cholesterol and diet).	Post: Increased PA in favour of the intervention. FU: Increased PA in favour of the intervention
Van Hoecke (2014) Flemish Government Belgium	Baseline sample size: Int – 150; con - 146 Mean age: 69.5 overall BMI: 27.1 overall Gender (% female participants): 66.7 overall	WALK: in addition to controls participants were prescribed an individualised walking program. COACH: In addition to previous two groups, participants also received individualised tailored PA coaching, a 60 minute session, and a choice of face-to-face or phone calls every 10 days for 30 mins.	Active: 15 minute face-to-face with coach and self-help booklet.	Less than 150 minutes of moderate to strenuous PA during a typical week	10 weeks	12 months	21.3% overall	Frequency of mild, moderate and strenuous PA bouts of at least 20 minutes in a usual seven-day period during the past month; Pedometer steps	Post: Increased PA in favour of the intervention. FU: Increased PA in favour of the intervention.

Appendix C: COM-B study physical activity measures

The Theory of Planned Behaviour Physical Activity Questionnaire (Francis et al., 2004)

Each question in this section refers to the amount of physical activity you will engage in over the next week (circle one number for each question). As a guide regular physical activity is defined as either 2 ½ hours (150 minutes) of moderate intensity activity every week or 75 minutes of vigorous intensity activity every week. Regular exercising can also be a mixture of both.

Moderate-intensity physical activity leads to faster breathing, increased heart rate and feeling warmer. Examples of activities that are moderate intensity for most people include:

- walking fast
- riding a bike on level ground or with few hills
- doubles tennis
- pushing a lawn mower
- hiking

Vigorous-intensity physical activity leads to very hard breathing, shortness of breath, rapid heartbeat and should leave a person unable to maintain a conversation comfortably. Examples of activities that are moderate intensity for most people include:

- jogging or running
- cycling
- swimming
- singles tennis
- martial arts

1.	Regular physical activity is	Harmful	1 – 2 – 3 – 4 – 5 – 6 – 7	Beneficial
2.		Boring	1 – 2 – 3 – 4 – 5 – 6 – 7	Interesting
3.		Unenjoyable	1 – 2 – 3 – 4 – 5 – 6 – 7	Enjoyable
4.		Unhealthy	1 – 2 – 3 – 4 – 5 – 6 – 7	Healthy
5.	Most people who are important to me think that I should take part in regular physical activity over the next week	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree
6.	For me to take part in regular physical activity over the next week will be	Difficult	1 – 2 – 3 – 4 – 5 – 6 – 7	Easy
7.	I expect to take part in regular physical activity over the next week	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree
8.	I am confident that I could take part in regular physical activity over the next week	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree

9.	I want to take part in regular physical activity over the next week	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree
10.	It is expected of me that I take part in regular physical activity over the next week	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree
11.	I intend to take part in regular physical activity over the next week	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree
12.	The decision to take part in regular physical activity over the next week is beyond my control	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree
13.	I feel under social pressure to take part in regular physical activity over the next week	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree
14.	Whether I take part in regular physical activity over the next week is entirely up to me	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree

The Self-Report Habit Index for physical activity and sedentary behaviour (Verplanken & Orbell, 2003)

Here are a number of statements that may or may not apply to you. Please circle a number next to each of the 12 statements to indicate the extent to which you agree or disagree with that statement. Below is the seven point rating scale.

Disagree strongly	Disagree moderately	Disagree a little	Neither agree nor disagree	Agree a little	Agree moderately	Agree strongly
1	2	3	4	5	6	7

Regular physical activity is something:

I do frequently.	1 – 2 – 3 – 4 – 5 – 6 – 7
I do automatically.	1 – 2 – 3 – 4 – 5 – 6 – 7
I do without having to consciously remember.	1 – 2 – 3 – 4 – 5 – 6 – 7
That makes me feel weird if I do not do it.	1 – 2 – 3 – 4 – 5 – 6 – 7
I do without thinking.	1 – 2 – 3 – 4 – 5 – 6 – 7
That would require effort not to do it.	1 – 2 – 3 – 4 – 5 – 6 – 7

That belongs to my (daily, weekly, monthly) routine.	1 – 2 – 3 – 4 – 5 – 6 – 7
I start doing before I realize I'm doing it.	1 – 2 – 3 – 4 – 5 – 6 – 7
I would find hard not to do.	1 – 2 – 3 – 4 – 5 – 6 – 7
I have no need to think about doing.	1 – 2 – 3 – 4 – 5 – 6 – 7
That's typically "me."	1 – 2 – 3 – 4 – 5 – 6 – 7
I have been doing for a long time.	1 – 2 – 3 – 4 – 5 – 6 – 7

Self-Efficacy Scale (Schwarzer & Renner, 2006)

Below is a list of things people might do while trying to improve their physical activity habits. Whether or not you exercise please rate how certain you are that you could really motivate yourself to do things like these consistently, for at least one week. Please circle *one* number for each item.

How certain are you that you could overcome the following barriers?

I can manage to carry out my exercise intentions		Very Uncertain	Rather Uncertain	Rather Certain	Very Certain
1.	… even when I have worries or problems	1	2	3	4
2.	… even if I feel depressed	1	2	3	4
3.	… even when I feel tense	1	2	3	4
4.	… even when I am tired	1	2	3	4
5.	… even when I am busy	1	2	3	4

Neighbourhood Environment Scale (Echeverria et al, 2004)

We would like to find out what you think about the neighbourhood that you live in. For each of the statements below please tell us whether you agree or disagree on a scale of 1 (strongly agree) to 5 (strongly disagree) by choosing the best option. In answering the questions, please think of your neighbourhood as the area within a 20-minute walk from your home.

Exercise/Walking Environment	Strongly Disagree	Disagree	Neither Agree or	Agree	Strongly Agree

1.	My neighbourhood offers many opportunities to be physically active	1	2	3	4	5
2.	It is pleasant to walk in my neighbourhood	1	2	3	4	5
3.	There are enough trees in my neighbourhood to provide shade	1	2	3	4	5
4.	My neighbourhood has heavy traffic	1	2	3	4	5
5.	There are busy roads to cross when out for walks in my neighbourhood	1	2	3	4	5
6.	In my neighbourhood it is easy to walk to places	1	2	3	4	5
7.	There are stores within walking distance of my home	1	2	3	4	5
8.	In my neighbourhood, the streets and sidewalks are in good condition	1	2	3	4	5
9.	I often see other people walking in my neighbourhood	1	2	3	4	5
10.	I often see other people exercise (for examples, jog, bicycle, play sports) in my neighbourhood	1	2	3	4	5

Presence of Recreational Facilities Index (Echeverria et al, 2004)

Now I would like you think about the things available in your neighbourhood. Please tell us if there are any of the following within a 20-minute walk from your home, and if so the condition in which they are in.

			Poor	Fair	Good	Excellent
1.	Public Park	☐ Yes ☐ No ☐ Don’t know	1	2	3	4
2.	Public sports field, basketball court or tennis court	☐ Yes ☐ No ☐ Don’t know	1	2	3	4
3.	Public pool or beach	☐ Yes	1	2	3	4

	☐ No ☐ Don’t know				
4. Schools, colleges, or community centres with recreational facilities that are free and open to the public	☐ Yes ☐ No ☐ Don’t know	1	2	3	4
5. Gyms, health/fitness clubs or pools that you have to join and pay for	☐ Yes ☐ No ☐ Don’t know	1	2	3	4
7. YMCAs or YWCAs	☐ Yes ☐ No ☐ Don’t know	1	2	3	4

International Physical Activity Questionnaire (IPAQ) - Short Last 7 Days Telephone

READ: I am going to ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

READ: Now, think about all the *vigorous* activities which take *hard physical effort* that you did in the last 7 days. Vigorous activities make you breathe much harder than normal and may include heavy lifting, digging, aerobics, or fast bicycling. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities?

   _____ Days per week [VDAY; Range 0-7, 8,9]

   8. Don't Know/Not Sure
   9. Refused

   [**Interviewer clarification**: Think only about those physical activities that you do for at least 10 minutes at a time.]

   [**Interviewer note**: If respondent answers zero, refuses or does not know, skip to Question 3]

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

__ __ Hours per day [VDHRS; Range: 0-16]

__ __ __ Minutes per day [VDMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[**Interviewer clarification**: Think only about those physical activities you do for at least 10 minutes at a time.]

[**Interviewer probe**: An average time for one of the days on which you do vigorous activity is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "How much time in total would you spend **over the last 7 days** doing vigorous physical activities?"

__ __ Hours per week [VWHRS; Range: 0-112]

__ __ __ __Minutes per week [VWMIN; Range: 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

READ: Now think about activities which take *moderate physical effort* that you did in the last 7 days. Moderate physical activities make you breathe somewhat harder than normal and may include carrying light loads, bicycling at a regular pace, or doubles tennis. Do not include walking. Again, think about only those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities?

____ Days per week [MDAY; Range: 0-7, 8, 9]

8. Don't Know/Not Sure

9. Refused

[**Interviewer clarification**: Think only about those physical activities that you do for at least 10 minutes at a time]

[**Interviewer Note**: *If respondent answers zero*, refuses or does not know, skip to Question 5]

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

__ __ Hours per day [MDHRS; Range: 0-16]

__ __ __ Minutes per day [MDMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[**Interviewer clarification**: Think only about those physical activities that you do for at least 10 minutes at a time.]

[**Interviewer probe**: An average time for one of the days on which you do moderate activity is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, or includes time spent in multiple jobs, ask: "What is the total amount of time you spent over the **last 7 days** doing moderate physical activities?"

__ __ __ Hours per week [MWHRS; Range: 0-112]

__ __ __ __Minutes per week [MWMIN; Range: 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

READ: Now think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

____ Days per week [WDAY; Range: 0-7, 8, 9]

8. Don't Know/Not Sure

9. Refused

[**<u>Interviewer clarification</u>**: Think only about the walking that you do for at least 10 minutes at a time.]

[**<u>Interviewer Note</u>**: *<u>If respondent answers zero</u>*, refuses or does not know, skip to Question 7]

6. How much time did you usually spend **walking** on one of those days?

__ __ Hours per day [WDHRS; Range: 0-16]

__ __ __ Minutes per day [WDMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[**Interviewer probe**: An average time for one of the days on which you walk is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: “What is the total amount of time you spent walking over **the last 7 days**?”

__ __ __ Hours per week [WWHRS; Range: 0-112]

__ __ __ __Minutes per week [WWMIN; Range: 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

Self-Monitoring Scale (Sniehotta, Scholz, Schwarzer, Fuhrmann, Kiwus, & Voller, 2005)

Here are a number of statements that may or may not apply to you. Please circle a number next to each of the 4 statements to indicate the extent to which you agree or disagree with that statement. Below is the five point rating scale.

Completely Disagree	Disagree	Agree	Totally Agree
1	2	3	4

During the last week, I have

constantly monitored myself whether I exercise frequently enough	1 – 2 – 3 – 4
watched carefully that I trained with moderate intensity or vigorous intensity for the recommended amount	1 – 2 – 3 – 4

Action planning (Sniehotta, Schwarzer, Scholz , & Schuz, 2005)

Here are a number of statements that may or may not apply to you. Please circle a number next to each of the 8 statements to indicate the extent to which you agree or disagree with that statement. Below is the four point rating scale.

Completely Disagree	Disagree	Agree	Totally Agree
1	2	3	4

During the last week, I have made a detailed plan regarding…

when to exercise	1 – 2 – 3 – 4
where to exercise	1 – 2 – 3 – 4
how to exercise	1 – 2 – 3 – 4
how often to exercise	1 – 2 – 3 – 4

Medical Outcomes Study short form (SF-36; Ware & Sherbourne, 1992)

The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

Yes, Limited a lot	Yes, Limited a little	No, Not limited at all
1	2	3

Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports	1 – 2 – 3
Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	1 – 2 – 3
Lifting or carrying groceries	1 – 2 – 3
Climbing several flights of stairs	1 – 2 – 3
Climbing one flight of stairs	1 – 2 – 3
Bending, kneeling, or stooping	1 – 2 – 3
Walking more than a mile	1 – 2 – 3
Walking several blocks	1 – 2 – 3
Walking one block	1 – 2 – 3
Bathing or dressing yourself	1 – 2 – 3

Social Support for Exercise Behaviours (Sallis et al., 1987)

Here are a number of statements that may or may not apply to you. Please circle a number next to each of the 10 statements rating the extent to which your friends of family have done or said what is described in the last three months. Below is the five point rating scale.

None	A little	Sometimes	Often	Very Often
1	2	3	4	5

My friends, acquaintances or co-workers have done or said the following things in the last week…

exercised with me	1 – 2 – 3 – 4 - 5
offered to exercise with me	1 – 2 – 3 – 4 - 5
gave me helpful reminders to exercise	1 – 2 – 3 – 4 - 5
gave me encouragement to stick with my exercise program	1 – 2 – 3 – 4 - 5
changed their schedule so we could exercise together	1 – 2 – 3 – 4 - 5

My family (members of my household) have done or said the following things in the last week…

exercised with me	1 – 2 – 3 – 4 - 5
gave me encouragement to stick with my exercise program	1 – 2 – 3 – 4 - 5
changed their schedule so we could exercise together	1 – 2 – 3 – 4 - 5
offered to exercise with me	1 – 2 – 3 – 4 - 5
gave me helpful reminders to exercise	1 – 2 – 3 – 4 - 5

The International Positive and Negative Affect Schedule Short Form (I-PANAS-SF; Thompson, 2007)

Here are a number of statements that may or may not apply to you. Please circle a number next to each of the 10 statements. Below is the five point rating scale.

Never	Rarely	Sometimes	Often	Always
1	2	3	4	5

Thinking about yourself and how you have felt in the last week, to what extent have you felt:

Upset	1 – 2 – 3 – 4 - 5

Hostile	1 – 2 – 3 – 4 - 5
Alert	1 – 2 – 3 – 4 - 5
Ashamed	1 – 2 – 3 – 4 - 5
Inspired	1 – 2 – 3 – 4 - 5
Nervous	1 – 2 – 3 – 4 - 5
Determined	1 – 2 – 3 – 4 - 5
Attentive	1 – 2 – 3 – 4 - 5
Afraid	1 – 2 – 3 – 4 - 5
Active	1 – 2 – 3 – 4 - 5

The Exercise Self-Identity Scale (Anderson & Cychosz, 1994)

The following statements relate to the way in which you view yourself. Please rate on the 1-7 scale whether you strongly agree or strongly disagree with each statement.

		Strongly Disagree						Strongly Agree
1.	I consider myself an exerciser	1	2	3	4	5	6	7
2.	When I describe myself to others, I usually include my involvement in exercise	1	2	3	4	5	6	7
3.	I have numerous goals related to exercising	1	2	3	4	5	6	7
4.	Physical exercise is a central factor to my self-concept	1	2	3	4	5	6	7
5.	I need to exercise to feel good about myself	1	2	3	4	5	6	7
6.	Others see me as someone who exercises regularly	1	2	3	4	5	6	7
7.	For me, being an exerciser means more than just exercising	1	2	3	4	5	6	7
8.	I would feel a real loss if I was forced to give up exercising	1	2	3	4	5	6	7
9.	Exercising is something I think about often	1	2	3	4	5	6	7

Appendix D: COM-B study original ethics approval and updated protocol

UNIVERSITY OF HERTFORDSHIRE
HEALTH & HUMAN SCIENCES

ETHICS APPROVAL NOTIFICATION

TO	Neil Howlett
CC	Nick Troop
FROM	Dr R Southern, Health and Human Sciences ECDA Chairman
DATE	17 September 2014

Protocol number: **LMS/SF/UH/00079**

Title of study: Exploring the predictors of physical activity behaviour using the COM-B model of behaviour

Your application for ethical approval has been accepted and approved by the ECDA for your school.

This approval is valid:

From: 17 September 2014

To: 30 June 2015

Please note:

Approval applies specifically to the research study/methodology and timings as detailed in your Form EC1. Should you amend any aspect of your research, or wish to apply for an extension to your study, you will need your supervisor's approval and must complete and submit form EC2. In cases where the amendments to the original study are deemed to be substantial, a new Form EC1 may need to be completed prior to the study being undertaken.

Should adverse circumstances arise during this study such as physical reaction/harm, mental/emotional harm, intrusion of privacy or breach of confidentiality this must be reported to the approving Committee immediately. Failure to report adverse circumstance/s would be considered misconduct.

Ensure you quote the UH protocol number and the name of the approving Committee on all paperwork, including recruitment advertisements/online requests, for this study.

Students must include this Approval Notification with their submission.

UNIVERSITY OF HERTFORDSHIRE
HEALTH & HUMAN SCIENCES

ETHICS APPROVAL NOTIFICATION

TO Neil Howlett

CC Nick Troop

FROM Dr Richard Southern, Health and Human Sciences ECDA Chairman

DATE 20/10/14

Protocol number: **aLMS/SF/UH/00079**

Title of study: Exploring the predictors of physical activity behaviour using the COM-B model of behaviour

Your application to modify the existing protocol **LMS/SF/UH/00079** as detailed below has been accepted and approved by the ECDA for your school.

Modifications:

- Time point 3 (one month post predictors) removed (reflected in Q5).
- Changed all measure wording in line with time point 2 (one week) – see measure section.
- Added duplicate measures of sedentary behaviour alongside physical activity so that predictors of both behaviours are measured. This includes the following scales:
    - Theory of planned behaviour questionnaire related to sedentary behaviour (page 31).
    - Self-report habit index related to sedentary behaviour (page 32).
    - Self-efficacy scale related to sedentary behaviour (page 33).
    - Two self-monitoring items for sedentary behaviour (page 40).
    - Four action planning items for sedentary behaviour (page 41).
- Added an Exercise Self-Identity Scale (page 44).
- Added the short form of the Positive and Negative Affect Scale (page 43).
- Added five questions to measure participant knowledge about physical activity and sedentary behaviour guidelines (page 46).
- Added questions on height and weight to capture BMI (page 27) and questions about the amount of TV screens (page 27) and computer screens (page 28) in the house.
- Alcohol consumption question removed at the end of the physical health questionnaire (pages 27-28).
- Removed 4 self-regulation items and 5 coping planning items (pages 40

This approval is valid:

From: 20/10/14

To: 30/06/15

Please note:

Any conditions relating to the original protocol approval remain and must be complied with.

Approval applies specifically to the research study/methodology and timings as detailed in your Form EC1 or as detailed in the EC2 request. Should you amend any further aspect of your research, or wish to apply for an extension to your study, you will need your supervisor's approval and must complete and submit a further EC2 request. In cases where the amendments to the original study are deemed to be substantial, a new Form EC1 may need to be completed prior to the study being undertaken.

Should adverse circumstances arise during this study such as physical reaction/harm, mental/emotional harm, intrusion of privacy or breach of confidentiality this must be reported to the approving Committee immediately. Failure to report adverse circumstance/s would be considered misconduct.

Ensure you quote the UH protocol number and the name of the approving Committee on all paperwork, including recruitment advertisements/online requests, for this study.

Students must include this Approval Notification with their submission.

Appendix E: COM-B study information sheet

Participant Information Sheet

Title of research: Exploring the ways we can adopt a more active lifestyle

Introduction:

You are being invited to take part in a research study. Before you decide whether to do so, it is important that you understand the research that is being done and what your involvement will include. Please take the time to read the following information carefully. Do not hesitate to ask me anything that is not clear. Thank you for reading this.

Purpose:

I am interested in exploring the factors which may motivate people to have an active and healthy lifestyle. The purpose of this survey is to gather information not only about your physical health but also about your physical and social environment. The latest research suggests that your behaviour is determined by a mixture of motivation, capability and opportunity. This study explores the extent to which these three factors are related to maintaining an active and healthy lifestyle.

Do I have to take part?

It is completely up to you whether or not you decide to take part in this study. If you do decide to take part please print this information sheet to keep. You will also be asked to indicate your consent. Agreeing to join the study does not mean that you have to complete it. You are free to withdraw at any stage without giving a reason.

How long will my part in the study take?

If you decide to take part in this study, you will be involved at two time points over one week. The main commitment will be now where you will fill in this online survey, which will take approximately 30 minutes. A week later you will then be called and asked 7 questions related to your behaviour, which will take approximately 10 minutes.

What are the possible benefits of taking part?

The insights provided by your answers will inform a lifestyle intervention which will be piloted after this study and can help create a better understanding of the best possible approaches to promote healthier and more active lifestyles.

How will my taking part in this study be kept confidential?

Any information you provide today will only be used for this study. All your responses and the information you provide will be kept confidential, and all the information collected will be anonymised so that you cannot be identified from any reports that result from the study.

What will happen to the results of the research study?

A research report will be written up as part of a PhD thesis. There is also a possibility that the results will be published in a peer-reviewed journal at a later stage. If you wish to be contacted about the results after the analyses has taken place then please contact me.

Who has reviewed this study?

This research has been reviewed by the Health and Human Science Ethics Committee at the University of Hertfordshire (protocol number: aLMS/SF/UH/0079).

If you would like further information or would like to discuss any details personally, please get in touch with me by phone or by email: Neil Howlett, n.howlett@herts.ac.uk, 01707 285971.

Appendix F: COM-B study consent form

Participant Consent Form

Title: Exploring the ways we can adopt a more active lifestyle

1 I confirm that I have been shown a Participant Information Sheet giving particulars of the study, including its aims, methods and design, the names and contact details of key people and, as appropriate, the risks and potential benefits, and any plans for follow-up studies that might involve further approaches to participants. I have been given details of my involvement in the study. I have been told that in the event of any significant change to the aim(s) or design of the study I will be informed, and asked to renew my consent to participate in it.

2 I have been assured that I may withdraw from the study at any time without disadvantage or having to give a reason.

4 I have been told how information relating to me (data obtained in the course of the study, and data provided by me about myself) will be handled: how it will be kept secure, who will have access to it, and how it will or may be used.

6 I have been told that I may at some time in the future be contacted again in connection with this or another study.

I hereby understand the above statements and agree to take part in this study by clicking the continue button.

Appendix G: COM-B study demographic and health questionnaire

Demographic Questionnaire

Please provide a participant anonymity code. Your code should consist of your initials, your birth month and your birth year. For example, if your name is Johnny Smith and you were born in June 1981, your code would be JS0681.

Participant Code:
As previously mentioned, you will be required to complete a follow up questionnaire via the telephone or Skype. Please provide a telephone number or Skype username/email address by which we can contact you and a preferred time of contact 7 days from now. Please note that this may appear as a withheld/unidentified number.

Contact Details:
Phone number –
Email -

Preferred time of contact:
☐ Morning (9am – 12pm)
☐ Afternoon (12pm – 3pm)
☐ Early Evening (3pm – 6pm)
☐ Late Evening (6pm – 9pm)
☐ Other (Please specify)

Age:

Sex
☐ Male
☐ Female

Country of residence
Please specify

County of residence
Please specify

Marital Status
☐ Divorced
☐ Living with partner (not married)
☐ Married
☐ Separated
☐ Single (never married)
☐ Widowed
☐ Would rather not say
☐ Other (Please Specify)

Employment Status:
☐ Employed full-time
☐ Employed part-time
☐ Employed with varying hours
☐ Full-time student
☐ Part-time student
☐ Retired
☐ Unemployed
☐ Other (Please specify)

Job Title:
____

Highest Level of Education:
☐ Secondary School or equivalent
☐ Sixth Form, College or equivalent
☐ Bachelor's Degree
☐ Master's Degree
☐ Doctoral Degree
☐ Other (Please Specify)

Household Salary:
☐ £0-25000
☐ £25001-50000
☐ £50001-75000
☐ £75001-100000
☐ Over £100000
☐ Would rather not say

Physical Health Questionnaire

Height (Please specify whether you have used feet/inches or metres/centimetres):
____

Weight (Please specify whether you have used kilograms/kg or stone and pounds):
____

Are you pregnant?
☐ Yes
☐ No
☐ N/a

Are you currently trying to lose weight?
☐ Yes, I am trying to lose weight
☐ Yes, I want to maintain my weight

☐ No, I am trying to gain weight
☐ No, nothing
☐ Other (Please specify)

Are you currently attending a “Diet Club” (E.g. Weight Watchers, Slimming World, etc)?
☐ Yes
☐ No

Are you currently attending a gym, exercise classes, sports club or any other organised regular physical activity?
☐ Yes
☐ No
gym? ____

How many TVs do you have in the house?
____
How many PCs, Macs or tablet computers do you have in the house?
____

Do you smoke?
☐ Yes
☐ No
☐ No, but I used to
If yes, how many cigarettes do you smoke on average per day? ____

Appendix H: COM-B study debrief sheet

Debrief Sheet

Title: Exploring the ways we can adopt a more active lifestyle

The aim of this study was to explore the factors which motivate and facilitate people to have a more active and healthy lifestyle, by gathering information not only about your physical health but also about your physical and social environment. The latest research suggests that your behaviour is determined by a mixture of motivation, capability and opportunity. This study explores the extent to which a number of factors associated with these three constructs are related to maintaining an active and healthy lifestyle. Consequently, you filled in questionnaires addressing habit strength, intentions, control, social influences, confidence, social support, your neighbourhood, the recreational facilities available to you, your ability to plan your physical activity and about your physical heath. A week later you answered questions on the phone about your actual physical activity.

This study will help with our understanding of the strongest predictors of physical activity and sedentary behaviour (sitting, TV watching). The results of this study will be combined with evidence from a systematic review of the research literature to determine the most effective techniques used in physical activity interventions. The aim is then to use this combined knowledge to design and pilot a community-based physical activity intervention.

Your input into this study is extremely valuable, however if you do not want your answers to be included in the study, please inform the investigator and they will be removed.

If you are concerned about anything related to physical activity, speak with your GP. If you would like to find out more about NHS physical activity recommendations follow the link below:

http://www.nhs.uk/Livewell/fitness/Pages/physical-activity-guidelines-for-adults.aspx

As a participant you will be asked not to discuss the study with others until it is completed in June 2015.

If you have any further questions or you wish to be informed of the outcome of the study please contact the principal researcher - Neil Howlett, n.howlett@herts.ac.uk, 01707 285971

Thank you for participating in this study.

Appendix I: COM-B study sitting measures

The Theory of Planned Behaviour Sedentary Behaviour Questionnaire (Francis et al., 2004)

Each question in this section refers to the amount of sitting (Watching TV, using the computer or at work) you will engage in over the next week (circle one number for each question).

1.	Avoiding long periods of sitting (Watching TV, using the computer or at work) is	Harmful	1 – 2 – 3 – 4 – 5 – 6 – 7	Beneficial
2.		Boring	1 – 2 – 3 – 4 – 5 – 6 – 7	Interesting
3.		Unenjoyable	1 – 2 – 3 – 4 – 5 – 6 – 7	Enjoyable
4.		Unhealthy	1 – 2 – 3 – 4 – 5 – 6 – 7	Healthy
5.	Most people who are important to me think that I should avoid long periods of sitting over the next week	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree
6.	For me to avoid long periods of sitting over the next week will be	Difficult	1 – 2 – 3 – 4 – 5 – 6 – 7	Easy
7.	I expect to avoid long periods of sitting over the next week	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree
8.	I am confident that I could avoid long periods of sitting over the next week	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree
9.	I want to avoid long periods of sitting over the next week	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree
10.	It is expected of me that I avoid long periods of sitting over the next week	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree
11.	I intend to avoid long periods of sitting over the next week	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree
12.	The decision to avoid long periods of sitting over the next week is beyond my control	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree
13.	I feel under social pressure to avoid long periods of sitting over the next week	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree
14.	Whether I avoid long periods of sitting over the next week is entirely up to me	Strongly Disagree	1 – 2 – 3 – 4 – 5 – 6 – 7	Strongly Agree

The Self-Report Habit Index for sedentary behaviour (Verplanken & Orbell, 2003)

Here are a number of statements that may or may not apply to you. Please circle a number next to each of the 12 statements to indicate the extent to which you agree or disagree with that statement. Below is the seven point rating scale.

Disagree strongly	Disagree moderately	Disagree a little	Neither agree nor disagree	Agree a little	Agree moderately	Agree strongly
1	2	3	4	5	6	7

Sitting for long periods of time (e.g. Watching TV, using the computer or at work) is something:

I do frequently.	1 – 2 – 3 – 4 – 5 – 6 – 7
I do automatically.	1 – 2 – 3 – 4 – 5 – 6 – 7
I do without having to consciously remember.	1 – 2 – 3 – 4 – 5 – 6 – 7
That makes me feel weird if I do not do it.	1 – 2 – 3 – 4 – 5 – 6 – 7
I do without thinking.	1 – 2 – 3 – 4 – 5 – 6 – 7
That would require effort not to do it.	1 – 2 – 3 – 4 – 5 – 6 – 7
That belongs to my (daily, weekly, monthly) routine.	1 – 2 – 3 – 4 – 5 – 6 – 7
I start doing before I realize I'm doing it.	1 – 2 – 3 – 4 – 5 – 6 – 7
I would find hard not to do.	1 – 2 – 3 – 4 – 5 – 6 – 7
I have no need to think about doing.	1 – 2 – 3 – 4 – 5 – 6 – 7
That's typically "me."	1 – 2 – 3 – 4 – 5 – 6 – 7
I have been doing for a long time.	1 – 2 – 3 – 4 – 5 – 6 – 7

Self-Efficacy Scale (Schwarzer & Renner, 2006)

Below is a list of things people might do while trying to improve their physical activity habits. Whether or not you exercise please rate how certain you are that you could really motivate yourself to do things like these consistently, for at least one week. Please circle *one* number for each item.

How certain are you that you could overcome the following barriers?

	Very Uncertain	Rather Uncertain	Rather Certain	Very Certain
I can manage to avoid long periods of sitting (watching TV, using the computer or at work)				

1.	… even if I need a long time to develop the necessary routines	1	2	3	4
2.	… even if I have to try several times until it works	1	2	3	4
3.	… even when I am tired	1	2	3	4
4.	… even if I have to make a detailed plan	1	2	3	4
5.	… even when I am busy on the computer at work or home	1	2	3	4

Neighbourhood Environment Scale (Echeverria et al, 2004)

We would like to find out what you think about the neighbourhood that you live in. For each of the statements below please tell us whether you agree or disagree on a scale of 1 (strongly agree) to 5 (strongly disagree) by choosing the best option. In answering the questions, please think of your neighbourhood as the area within a 20-minute walk from your home.

Exercise/Walking Environment		Strongly Disagree	Disagree	Neither Agree or Agree	Agree	Strongly Agree
1.	My neighbourhood offers many opportunities to be physically active	1	2	3	4	5
2.	It is pleasant to walk in my neighbourhood	1	2	3	4	5
3.	There are enough trees in my neighbourhood to provide shade	1	2	3	4	5
4.	My neighbourhood has heavy traffic	1	2	3	4	5
5.	There are busy roads to cross when out for walks in my neighbourhood	1	2	3	4	5
6.	In my neighbourhood it is easy to walk to places	1	2	3	4	5
7.	There are stores within walking distance of my home	1	2	3	4	5
8.	In my neighbourhood, the streets and sidewalks are in good condition	1	2	3	4	5
9.	I often see other people walking in my	1	2	3	4	5

	neighbourhood					
10.	I often see other people exercise (for examples, jog, bicycle, play sports) in my neighbourhood	1	2	3	4	5

Presence of Recreational Facilities Index (Echeverria et al, 2004)

Now I would like you think about the things available in your neighbourhood. Please tell us if there are any of the following within a 20-minute walk from your home, and if so the condition in which they are in.

			Poor	Fair	Good	Excellent
1.	Public Park	☐ Yes ☐ No ☐ Don't know	1	2	3	4
2.	Public sports field, basketball court or tennis court	☐ Yes ☐ No ☐ Don't know	1	2	3	4
3.	Public pool or beach	☐ Yes ☐ No ☐ Don't know	1	2	3	4
4.	Schools, colleges, or community centres with recreational facilities that are free and open to the public	☐ Yes ☐ No ☐ Don't know	1	2	3	4
5.	Gyms, health/fitness clubs or pools that you have to join and pay for	☐ Yes ☐ No ☐ Don't know	1	2	3	4
7.	YMCAs or YWCAs	☐ Yes ☐ No ☐ Don't know	1	2	3	4

International Physical Activity Questionnaire (IPAQ) - Short Last 7 Days Telephone

READ: Now think about the time you spent sitting on week days during the last 7 days. Include time spent 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.

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

__ __ Hours per weekday [SDHRS; 0-16]

__ __ __ Minutes per weekday [SDMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[**Interviewer clarification**: Include time spent lying down (awake) as well as sitting]

[**Interviewer probe**: An average time per day spent sitting is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "What is the total amount of time you spent *sitting* last **Wednesday**?"

__ __ Hours on Wednesday [SWHRS; Range 0-16]

__ __ __ Minutes on Wednesday [SWMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

Self-Monitoring Scale (Sniehotta, Scholz, Schwarzer, Fuhrmann, Kiwus, & Voller, 2005)

Here are a number of statements that may or may not apply to you. Please circle a number next to each of the two statements to indicate the extent to which you agree or disagree with that statement. Below is the five point rating scale.

Completely Disagree	Disagree	Agree	Totally Agree
1	2	3	4

During the last week, I have

constantly monitored myself whether I spent long periods sitting (Watching TV, using the computer or at work)	1 – 2 – 3 – 4
watched carefully that I disrupt long periods of sitting with standing and walking	1 – 2 – 3 – 4

Action planning (Sniehotta, Schwarzer, Scholz , & Schuz, 2005)

Here are a number of statements that may or may not apply to you. Please circle a number next to each of the 8 statements to indicate the extent to which you agree or disagree with that statement. Below is the four point rating scale.

Completely Disagree	Disagree	Agree	Totally Agree
1	2	3	4

During the last week, I have made a detailed plan regarding…

when to avoid long periods of sitting (Watching TV, using the computer or at work)	1 – 2 – 3 – 4
where to avoid long periods of sitting	1 – 2 – 3 – 4
how to avoid long periods of sitting	1 – 2 – 3 – 4
how often to avoid long periods of sitting	1 – 2 – 3 – 4

Medical Outcomes Study short form (SF-36; Ware & Sherbourne, 1992)

The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

Yes, Limited a lot	Yes, Limited a little	No, Not limited at all
1	2	3

Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports	1 – 2 – 3
Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	1 – 2 – 3
Lifting or carrying groceries	1 – 2 – 3
Climbing several flights of stairs	1 – 2 – 3
Climbing one flight of stairs	1 – 2 – 3
Bending, kneeling, or stooping	1 – 2 – 3

Walking more than a mile	1 – 2 – 3
Walking several blocks	1 – 2 – 3
Walking one block	1 – 2 – 3
Bathing or dressing yourself	1 – 2 – 3

Social Support for Exercise Behaviours (Sallis et al., 1987)

Here are a number of statements that may or may not apply to you. Please circle a number next to each of the 10 statements rating the extent to which your friends of family have done or said what is described in the last three months. Below is the five point rating scale.

None	A little	Sometimes	Often	Very Often
1	2	3	4	5

My friends, acquaintances or co-workers have done or said the following things in the last week…

exercised with me	1 – 2 – 3 – 4 - 5
offered to exercise with me	1 – 2 – 3 – 4 - 5
gave me helpful reminders to exercise	1 – 2 – 3 – 4 - 5
gave me encouragement to stick with my exercise program	1 – 2 – 3 – 4 - 5
changed their schedule so we could exercise together	1 – 2 – 3 – 4 - 5

My family (members of my household) have done or said the following things in the last week…

exercised with me	1 – 2 – 3 – 4 - 5
gave me encouragement to stick with my exercise program	1 – 2 – 3 – 4 - 5
changed their schedule so we could exercise together	1 – 2 – 3 – 4 - 5
offered to exercise with me	1 – 2 – 3 – 4 - 5
gave me helpful reminders to exercise	1 – 2 – 3 – 4 - 5

The International Positive and Negative Affect Schedule Short Form (I-PANAS-SF; Thompson, 2007)

Here are a number of statements that may or may not apply to you. Please circle a number next to each of the 10 statements. Below is the five point rating scale.

Never	Rarely	Sometimes	Often	Always
1	2	3	4	5

Thinking about yourself and how you have felt in the last week, to what extent have you felt:

Upset	1 – 2 – 3 – 4 - 5
Hostile	1 – 2 – 3 – 4 - 5
Alert	1 – 2 – 3 – 4 - 5
Ashamed	1 – 2 – 3 – 4 - 5
Inspired	1 – 2 – 3 – 4 - 5
Nervous	1 – 2 – 3 – 4 - 5
Determined	1 – 2 – 3 – 4 - 5
Attentive	1 – 2 – 3 – 4 - 5
Afraid	1 – 2 – 3 – 4 - 5
Active	1 – 2 – 3 – 4 - 5

The Exercise Self-Identity Scale (Anderson & Cychosz, 1994)

The following statements relate to the way in which you view yourself. Please rate on the 1-7 scale whether you strongly agree or strongly disagree with each statement.

		Strongly Disagree						Strongly Agree
1.	I consider myself an exerciser	1	2	3	4	5	6	7
2.	When I describe myself to others, I usually include my involvement in exercise	1	2	3	4	5	6	7
3.	I have numerous goals related to exercising	1	2	3	4	5	6	7
4.	Physical exercise is a central factor to my self-concept	1	2	3	4	5	6	7

5.	I need to exercise to feel good about myself	1	2	3	4	5	6	7
6.	Others see me as someone who exercises regularly	1	2	3	4	5	6	7
7.	For me, being an exerciser means more than just exercising	1	2	3	4	5	6	7
8.	I would feel a real loss if I was forced to give up exercising	1	2	3	4	5	6	7
9.	Exercising is something I think about often	1	2	3	4	5	6	7

Knowledge Questions

1. How much time should you spend doing moderate physical activity a week (50, 100, 150 or 200mins)?
2. How much time should you spend doing vigorous activity a week (65, 75, 85, 95 mins)?
3. How many days a week should you spend doing muscle-strengthening activity a week (1, 2, 3 or 4 days)?
4. How important is it to avoid long periods of sitting (watching TV, using the computer or at work)?

   Not important at all 1 – 2 – 3 – 4 – 5 – 6 – 7 Very important

5. How long is too long to be sitting (watching TV, using the computer or at work) without standing or walking around on a single occasion? Please give your answer in minutes and/or hours.

   ____

Appendix J: Active Herts Booklet

ABOUT ACTIVE HERTS

We know that getting active can be difficult so our local, friendly and professional Get Active Specialists can help you get started.

Our team of highly qualified and experienced health and fitness professionals will work with you to set your own personal plan of action that will help you to find ways to fit physical activity into your daily life.

Our Get Active Specialists will help you find fun and friendly activities suited to you, based on your fitness level and interest. From free walks to badminton, from dance to swimming, you will find the right thing for you.

www.activeherts.org.uk

KEEP IN TOUCH

Your local Get Active Specialist is:

Broxbourne
Andrew Rix
Mob: 07506 503 316
Email:
Andrew.Rix@broxbourne.gov.uk

Hertsmere
Lee Bruce
Mob: 07741 248 852
Email:
Lee.Bruce@hertsmereleisure.co.uk

Stevenage
Hannah Marsh
Mob: 07766 160 149
Email:
Hannah.Marsh@stevenage.gov.uk

Watford
Alison Goodchild
Mob: 07710 096 398
Email:
Alison.Goodchild@watfordfc.com

YOUR THOUGHTS ABOUT BECOMING ACTIVE...

HURDLES TO JUMP OVER

Overcoming your barriers

Think about your current situation. What things in your life might be hurdles that stop you from being active.

What's currently stopping you being active?	How can you overcome this?


6
I'm doing it
TO IMPROVE MY
WELLBEING
www.activeherts.org.uk

TIME IS PRECIOUS

Plan exercise into your routine

This timetable will help identify gaps in your week that you could use to be active. The key is to start small and slowly build up the number of minutes of activity you fit in your week. Think about when you might have some free time to do something different.

Remember just 10 minutes a day will start to make a big difference!

	Morning	Afternoon	Evening
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			
Sunday			

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GET FOCUSED

Set your goals and work towards them

Becoming active can seem like a really tough challenge. The key is to think about what you want to achieve and how you are going to do it. This task will help you to set your goals over the short, medium and long term.

	What do you want to achieve?	How will you achieve it?
Short term (2 weeks)		
On a scale of 1 to 10 how confident are you in achieving this goal	(please circle)	Not confident 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 Very confident
Medium term (3 months)		
On a scale of 1 to 10 how confident are you in achieving this goal	(please circle)	Not confident 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 Very confident
Long term (12 months)		
On a scale of 1 to 10 how confident are you in achieving this goal	(please circle)	Not confident 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 Very confident

HOW TO CHANGE

Your next steps for success

This action plan is your quick guide to success. Make a note of the things you are going to do to get active.

What am I going to do?	Where am I going to do it?	When am I going to do it?	Who am I going to do it with?

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10
I'm doing it
TO MEET NEW
PEOPLE
www.activeherts.org.uk

BUMPS IN THE ROAD

It won't always be a smooth ride but planning is the key

Getting active is not a smooth ride for anyone. This task will help you plan how to avoid or cope with your bumps in the road and increase your chance of success.

Remember, your Get Active Specialist is contactable if you feel you need a little extra support.

Difficult situations If ….	How I will avoid or cope with them Then I will...

EXERCISE AND ACTIVITY DIARY

Keep track of your progress

A great way to track your progress is to keep an exercise diary. Think about how you felt afterwards and more importantly, whether you enjoyed it?

Use this diary to track your progress over time.

Date	Activities I did	Time	Enjoyment Level 1 - Low 10 - High	How did you feel after? Happy, sad, tired, relaxed, energized etc...

BENEFITS OF EXERCISE | 13

BENEFITS OF EXERCISE

Did you know that being active can...

- Improve the health of your heart and lower your risk of a heart attack or stroke
- Help you manage high blood pressure
- Make you feel good and improve your mental health
- Give you more energy
- Prevent diabetes and help you manage it better
- Lower your cholesterol levels
- Help you to manage your weight
- Help you meet new people

These are just a few of the benefits and it is important to remember that most of all, exercise can be fun! It is about finding the activity that is right for you.

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EXERCISE GUIDELINES

WHAT YOU SHOULD BE AIMING FOR

For a healthy heart and mind

Be Active

Vigorous exercise	Moderate exercise
Run	Brisk Walking
Sport	Cycle
Heavy Gardening	Swim

Minutes per week

75	150
Vigorous Intensity (Breathing fast, difficulty talking)	Moderate Intensity (Increased Breathing, able to talk)

OR a combination of both

To keep your muscles, bones and joints strong

Sit Less	Build Strength
Tv	Gym
Sofa	Yoga
Computer	Carry Bags

Break up sitting time

To reduce your chance of falls

Improve Balance

- Dance
- Tai Chi
- Bowls

2 Days per week

For more ideas about how to get active and what's going on in your area, visit **www.activeherts.org.uk** and select "Getting Active"

YOUR REWARDS

It's not all hard work! Remember it is important to reward yourself for the effort you put in, so here are a few ideas to try.

Rewards that are free

- Have a nice relaxing bath
- Read a book or magazine
- Invite friends round
- Listen to music
- Watch a film
- Spend time in the garden
- Go on a family day out
- Ask friends to look after the children and enjoy some down time

How are you going to reward yourself?

www.activeherts.org.uk

THIS IS WHERE YOUR PATH BEGINS...

1. Your first appointment

At this appointment you and your Get Active Specialist will talk about the steps you can take to start getting active.

Together you will look at what you want to achieve, how to get there and how we can support you.

This will include agreeing your personal Get Active plan to guide you. They will also help to find a local activity or sport session to suit your needs.

2. Two week catch up

After two weeks your Get Active Specialist will give you a call to see how you are getting on with your plan. You will discuss progress so far and how you are feeling about being more active.

If you feel you would like some motivation or extra guidance at this stage, you will be able to book another free appointment to talk about any concerns you may have.

3. Three month

After three months, your Specialist will contact you to book in a review. This will be a chance to look at your progress so far and see how you're getting on.

At this appointment, you can discuss how you are feeling, identify any health improvements and develop your plan for the coming months.

4. Six month appointment

Hopefully you are sticking to your plan and are feeling the benefits of being more active.

Your Get Active Specialist will contact you to arrange a telephone or one-to one review to see how you are getting on.

Further support may be offered to help motivate you to keep active.

5. Twelve month appointment

Congratulations on reaching twelve months! You have done fantastically well.

At this appointment, you can work with your Get Active Specialist to explore some tips to maintain your healthy behaviours.

Why not ask your Get Active Specialist how you can support others to become more active?

Supporting you every step of the way

If you have any questions or need additional help, feel free to call or email your Get Active Specialist at any point.

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YOUR APPOINTMENTS

Appointment	Date	Time	Venue
First			
2 weeks			
3 months			
6 months			
12 months			

Notes:

EAT WELL
BASIC NUTRITION ADVICE

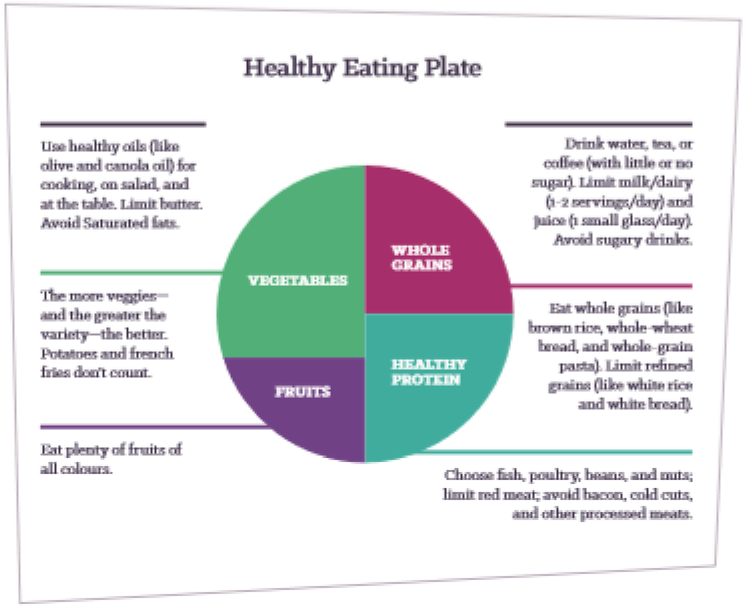
Eating a healthy, balanced diet is an important part of maintaining good health. It can help you feel your best and doesn't have to be too difficult either. Here are some tips to get you started.

The key to a healthy diet is to do the following:

Eat the right amount of calories for how active you are, so that you balance the energy you consume with the energy you use. If you eat or drink too much, you'll put on weight. If you eat and drink too little, you'll lose weight. It is recommended that men have around 2,500 calories a day (10,500 kilojoules). Women should have around 2,000 calories a day (8,400 kilojoules). Most adults are eating more calories than they need, and should eat fewer calories.

Eat a wide range of foods to ensure that you're getting a balanced diet and that your body is receiving all the nutrients it needs.

- **Base your meals on starchy foods like** – Potatoes, rice or pasta. They fill you up for longer and release energy slower. They are cheap too.
- **Eat lots of fruit and veg** – 5 a day is recommended and you will get essential vitamins and minerals to keep your body working well.
- **Eat more fish** – It has essential oils and is lower in calories than red meat or chicken.
- **Cut down on saturated fat and sugar** –Sugars mess with your energy levels and can make you feel tired and lazy or even change your mood. Fatty foods will make you gain weight rapidly and can clog up your arteries.
- **Eat less salt** – Even if you don't add salt to your food, you may still be eating too much. Eating too much salt can raise your blood pressure. People with high blood pressure are more likely to develop heart disease or have a stroke.
- **Don't get thirsty** - You need to drink about 1.6 to 2 litres of fluid every day to stop you getting dehydrated. All non-alcoholic drinks count, but water and lower-fat milk are healthier choices. Try to avoid sugary soft and fizzy drinks that are high in added sugars and calories, and are also bad for teeth.
- **Don't skip breakfast** - Some people skip breakfast because they think it will help them lose weight. A healthy breakfast is an important part of a balanced diet, and provides some of the vitamins and minerals we need for good health. A wholegrain, lower-sugar cereal with fruit sliced over the top is a good option.

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I'm doing it
TO HELP OTHERS
GET ACTIVE
COULD YOU BE AN EXERCISE BUDDY
IN YOUR LOCAL COMMUNITY?
Adan Freeman
Phone: 01707 285880
Email: a.freeman2@herts.ac.uk
Website: activeherts.org.uk
www.activeherts.org.uk

Active Herts

Your first step to a more active lifestyle

@activeherts1 /activeherts1 activeherts.org.uk

Working in partnership

University of Bedfordshire

University of Hertfordshire UH

herts sports partnership

LOTTERY FUNDED | SPORT ENGLAND

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COMMUNITY SPORTS & EDUCATION TRUST

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Appendix K – Active Herts measures

SECTION 1 - Your physical activity levels

The following questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, around the house or garden, to get from place to place, and in your spare time for recreation, exercise or sport.

Questions 1 and 2 - Vigorous physical activity

Think about all the **vigorous** activities that you did in the **last 7 days.**

Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1.) During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling**?**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6
☐ 7

2.) How much time did you usually spend doing **vigorous** physical activities on **one** of those days? *Please answer in hours/minutes e.g. Hours: 0 Minutes: 15*

_____ hours per day _____ minutes per day

Questions 3 and 4 – Moderate physical activity

Think about all the **moderate** activities that you did in the **last 7 days.**

Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3.) During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6
☐ 7

4.) How much time did you usually spend doing **moderate** physical activities on **one** of those days? *Please answer in hours/minutes e.g. Hours: 0 Minutes: 15*

_____ hours per day _____ minutes per day

Questions 5 and 6 – Walking

Think about the time you spent **walking** in the **last 7 days.**

This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5.) During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6

☐ 7
6.) How much time did you usually spend doing **walking** on **one** of those days? _____ hours per day _____ minutes per day

Question 7 – Sitting

This is about the time you spent **sitting** on weekdays during the **last 7 days**
Include time spent 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.

7.) During the **last 7 days** how much time did you spend **sitting** on a weekday? _____ hours per day _____ minutes per day

Questions 8 and 9 – Sport

Think about the time you spent doing **sport** in the **last 7 days.**
By sport, we mean any competitive or non-competitive sporting activity, including sessions of deliberate exercise such as running or jogging. Think only about those sports or exercises that you did for at least 10 minutes at a time.

8.) During the **last 7 days,** on how many days did you take part in any **sport**? ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7
9.) How much time did you usually spend doing **sport** on **one** of those days? _____ hours per day _____ minutes per day

SECTION 2 - Your physical activity habits

Question 10 – Physical activity habits

Q10.) Here are a number of statements. Please put a cross in one box for each of the six statements to indicate the extent to which you agree or disagree with that statement.

No.	Your physical activity habits	Completely disagree	Somewhat disagree	Somewhat agree	Completely agree
		Please cross			
Q10.1	During the **last week**, I have made a detailed plan regarding **when to exercise**				
Q10.2	During the **last week**, I have made a				

	detailed plan regarding **where to exercise**				
Q10.3	During the **last week,** I have made a detailed plan regarding **how to exercise**				
Q10.4	During the **last week** I have made a detailed plan regarding **how often to exercise**				
Q10.5	During the **last week,** I have constantly monitored myself **whether I exercise frequently enough**				
Q10.6	During the **last week,** I have watched carefully that I exercised with **moderate intensity or vigorous intensity for the recommended amount**				

Questions 11- Barriers to exercise

Q11.) Below is a list of things people might do while trying to improve their physical activity habits. Whether or not you exercise, please rate how certain you are that you could really motivate yourself to do things like these consistently, for at least once a week. Please put a cross in one box for each item.

	How certain are you that you could overcome the following barriers?	Very uncertain	Rather uncertain	Rather certain	Very certain
Q11.1	I can manage to carry out my exercise intentions even when I have **worries or problems**				
Q11.2	I can manage to carry out my exercise intentions even if **I feel depressed**				
Q11.3	I can manage to carry out my exercise intentions even when I **feel tense**				
Q11.4	I can manage to carry out my exercise intentions even when **I am tired**				
Q11.5	I can manage to carry out my exercise intentions even if **I am busy**				

Question 12 – Your feelings and intentions about physical activity

Q12.) For each statement below please put a cross in the box that most corresponds with your view

Q12.1) Regular physical activity is:-

Very harmful	Moderately harmful	A little harmful	Neither harmful nor beneficial	A little beneficial	Moderately beneficial	Very beneficial
☐	☐	☐	☐	☐	☐	☐

Q12.2) Regular physical activity is:-

Very boring	Moderately boring	A little boring	Neither interesting nor boring	A little interesting	Moderately interesting	Very interesting
☐	☐	☐	☐	☐	☐	☐

Q12.3) Regular physical activity is:-

Very unenjoyable	Moderately unenjoyable	A Little unenjoyable	Neither unenjoyable nor enjoyable	A little Enjoyable	Moderately Enjoyable	Very Enjoyable
☐	☐	☐	☐	☐	☐	☐

Q12.4) Regular physical activity is:-

Very Unhealthy	Moderately Unhealthy	A Little Unhealthy	Neither Unhealthy or Healthy	A little Healthy	Moderately Healthy	Very Healthy
☐	☐	☐	☐	☐	☐	☐

Q12.5) I expect to take part in regular physical activity over the **next week**

Strongly disagree	Disagree moderately	Disagree a little	Neither agree nor disagree	Agree a little	Agree moderately	Strongly agree
☐	☐	☐	☐	☐	☐	☐

Q12.6) I want to take part in regular physical activity over the **next week**

Strongly disagree	Disagree moderately	Disagree a little	Neither agree nor disagree	Agree a little	Agree moderately	Strongly agree
☐	☐	☐	☐	☐	☐	☐

Q12.7) I intend to take part in regular physical activity over the **next week**

Strongly disagree	Disagree moderately	Disagree a little	Neither agree nor disagree	Agree a little	Agree moderately	Strongly agree
☐	☐	☐	☐	☐	☐	☐

SECTION 3: Your current health today

We are interested in what you think about your current health. In the following section under each heading please cross **one** box which best describes how you feel **today.**

Questions 13 - Your health today

No.	MOBILITY	Please cross <u>one box</u> per section which is most relevant to you
Q13.1	I have no problems in walking about	☐
	I have slight problems in walking about	☐
	I have moderate problems in walking about	☐
	I have severe problems in walking about	☐
	I am unable to walk about	☐
	SELF-CARE	
Q13.2	I have no problems washing or dressing myself	☐
	I have slight problems washing or dressing myself	☐
	I have moderate problems washing or dressing myself	☐
	I have severe problems washing or dressing myself	☐
	I am unable to wash or dress myself	☐
	USUAL ACTIVITIES	
Q13.3	I have no problems doing my usual activities	☐
	I have slight problems doing my usual activities	☐
	I have moderate problems doing my usual activities	☐
	I have severe problems performing my usual activities	☐
	I am unable to do my usual activities	☐
	PAIN/DISCOMFORT	
Q13.4	I have no pain or discomfort	☐
	I have slight pain or discomfort	☐
	I have moderate pain or discomfort	☐
	I have severe pain or discomfort	☐
	I have extreme pain or discomfort	☐
	ANXIETY/DEPRESSION	
Q13.5	I am not anxious or depressed	☐
	I am slightly anxious or depressed	☐
	I am moderately anxious or depressed	☐
	I am severely anxious or depressed	☐
	I am extremely anxious or depressed	☐

Question 14 – Your health today

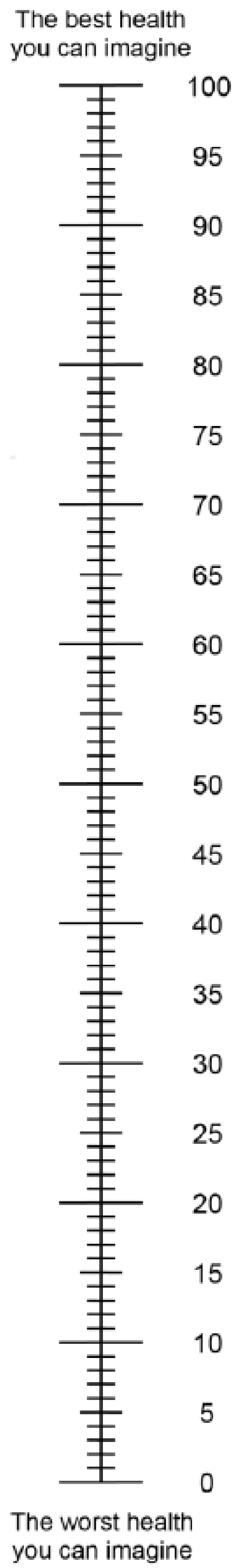
We would like to know how good or bad your **health** is **today.**

The scale on the right is numbered from 0 to 100.

- 100 means the BEST health you can imagine
- 0 means the WORST health you can imagine

Q14.) Mark an X on the scale to indicate how your **health** is **today**.

Please write the number you marked in the box.



SECTION 4: Life Satisfaction

We would like to ask about your overall life satisfaction and your thoughts and feelings.

Question 15 – Life satisfaction

Q15.) On a scale of 0 to 10, where 0 is 'not at all satisfied' and 10 is 'completely satisfied', how satisfied are you with your life?

Not at all satisfied										**Completely satisfied**
0	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Question 16 - Your thoughts and feeling

Q16.) Below are some statements about thoughts and feelings. Please mark a cross in the box that best describes your experience of each over the last **two weeks**.

	Your thoughts and feelings	**None of the time**	**Rarely**	**Some of the time**	**Often**	**All of the time**
No.		**Please mark your answers with a cross**				
Q16.1	I've been feeling optimistic about the future					
Q16.2	I've been feeling useful					
Q16.3	I've been feeling relaxed					
Q16.4	I've been feeling interested in other people					
Q16.5	I've had energy to spare					
Q16.6	I've been dealing with problems well					
Q16.7	I've been thinking clearly					
Q16.8	I've been feeling good about myself					
Q16.9	I've been feeling close to other people					
Q16.10	I've been feeling confident					
Q16.11	I've been able to make up my own mind about things					
Q16.12	I've been feeling loved					
Q16.13	I've been interested in new things					

Q16.14	I've been feeling cheerful					

Thank you

Your responses to the questions in this survey will be used to help us understand people's experiences of the 'Active Herts' programme and to improve future programmes.

Appendix L: Active Herts ethics approval (UEA)

Faculty of Medicine and Health Sciences Research Ethics Committee

University of East Anglia

Research & Enterprise Services
West Office (Science Building)
University of East Anglia
Norwich Research Park
Norwich, NR4 7TJ

Telephone: +44 (0) 1603 591720
Email: fmh.ethics@uea.ac.uk

Web: www.uea.ac.uk/researchandenterprise

Lucy Bain
MED

13.9.16

Dear Lucy,

Title: An Evaluation of Active Herts
Ref: 20152016 - 28

The amendments to your above proposal have been considered by the Chair of the Faculty Research Ethics Committee and we can confirm that your proposal has been approved.

Please could you ensure that any further amendments to either the protocol or documents submitted are notified to us in advance and also that any adverse events which occur during your project are reported to the Committee. Please could you also arrange to send us a report once your project is completed.

Yours sincerely,

Mark Wilkinson
Chair FMH Research Ethics Committee

Appendix M: Active Herts information sheet and consent form

Active Herts Evaluation
Information sheet

About the study

You have been referred or have referred yourself into the Active Herts project, which is why you are being asked to take part in this evaluation study. This programme aims to help people who are inactive to make lifestyle changes to be more physically active. The University of East Anglia, are working with Hertfordshire Sports Partnership to look at how well this programme works through an evaluation. The information you provide will only be used to assess the programme overall and we are not collecting it to assess individual participants.

What is involved?

If you agree to take part in the evaluation study, you will be asked to complete a questionnaire at four different time points across the year (when you join Active Herts and then at 3, 6, and 12 months follow up appointments). The questionnaire covers topics such as your physical activity levels, mental wellbeing and general health. There are no physical risks to taking part, as we will only be asking you to fill out a questionnaire. However, if there are any questions you do not feel comfortable completing please leave them out.

In addition, we may contact you in the future to invite you to talk to us in more depth about your experience of the Active Herts project.

What will you do with my information?

The information collected by Herts Sports Partnership (c/o University of Hertfordshire) will be stored on a secure computer server. The information will not be accessible to any third parties other than The University of East Anglia and University of Hertfordshire who will only access relevant information needed for the evaluation study. The findings from this study will be used to plan future programmes to help more people become more physically active, by providing us with information about what works and what does not in practice.

Opting out

You are free to stop participating in the study at any time, without giving reason. If you do so, this will not stop you participating within the Active Herts project and accessing the support on offer. Please contact Lucy Bain (contact details are provided below) if you would like to withdraw.

Questions and further information

If you have any further questions about the evaluation study, please contact the Study Coordinator, Lucy Bain, at Norwich Medical School, University of East Anglia, Norwich, NR4 7TJ, or email: l.bain@uea.ac.uk or phone 01603 591361. If this has not answered your concerns please contact the head of Norwich Medical school, Professor Michael Frenneaux, on 01603 593971 or m.frenneaux@uea.ac.uk

Thank you for taking the time to read this information sheet.

Fiona Deans

Dr. Lucy Bain

Study Coordinator
University of East Anglia
Anglia
l.bain@uea.ac.uk
01603 591 361

Fiona Deans

Strategic Lead for Health
Herts Sport Partnership

Prof. Andy Jones

Study Leader
University of East

Evaluation of Active Herts

Introduction

This survey is to help us evaluate the ‘Active Herts’ programme that you have been referred to, run by Herts Sports Partnership. It asks you questions about your levels of physical activity, wellbeing and quality of life. We ask that you complete the survey as honestly as possible.

Your consent

Please read each of the statements below and mark each box with a **cross** to confirm your understanding and agreement.

Please mark each box with a cross if you agree: -

1. I confirm that I have read and understand the information sheet for the evaluation of the Active Herts programme. ☐

2. I understand that taking part is voluntary, and that I am free to leave the study at any time without giving a reason. ☐

3. I understand that the University of East Anglia may look at information collected during the evaluation of Active Herts, and other organisations involved in the programme including University of Hertfordshire, University of Bedfordshire, Hertfordshire Sports Partnership and the NHS Trust. ☐

4. I consent to take part in the study. ☐

Client name : **Client signature:** **Date:**

Staff name: **Staff signature:** **Date:**

Appendix N: Active Herts intention-to-treat analysis

Table N1

Baseline and 3 month outcomes for 3 month for all programme users providing baseline data (N = 1282). MET values were square-rooted for analysis.

Outcome measure	**Baseline**		**3 months**	
	Standard	**Enhanced**	**Standard**	**Enhanced**
Primary outcomes				
Vigorous METs	269.31 (940.72)	303.20 (971.24)	397.99 (1100.22)	526.93 (1208.10)
Vigorous mins	33.66 (117.62)	37.90 (121.41)	49.75 (137.53)	65.87 (151.01)
Moderate METs	352.47 (857.46)	300.05 (695.29)	391.29 (863.25)	393.01 (784.96)
Moderate mins	88.12 (214.37)	75.01 (173.82)	97.82 (215.81)	98.25 (196.24)
Walking METs	646.38 (935.14)	701.57 (955.25)	685.61 (920.43)	817.41 (1043.24)
Walking mins	195.87 (283.38)	212.60 (289.47)	207.76 (278.92)	247.70 (316.13)
MVPA METs	616.74 (1531.36)	596.59 (1401.10)	781.88 (1655.64)	917.16 (1683.07)
Total METs	1252.35 (2080.24)	1302.31 (1869.75)	1458.59 (2188.06)	1737.63 (2261.18)
Sport minutes p/week	3.25 (16.68)	17.81 (61.96)	48.10 (93.81)	72.73 (123.28)
Sitting minutes p/week	500.98 (206.96)	422.66 (264.71)	436.14 (213.83)	344.52 (194.54)
Secondary outcomes				
Mobility (1-5)	1.87 (0.97)	1.88 (1.04)	1.82 (0.97)	1.85 (1.03)

Self-care (1-5)	1.08 (0.21)	1.08 (0.21)	1.07 (0.20)	1.08 (0.21)
Usual activities(1-5)	1.67 (0.89)	1.58 (0.89)	1.63 (0.90)	1.58 (0.90)
Pain (1-5)	2.25 (0.99)	2.22 (1.06)	2.22 (0.97)	2.22 (1.05)
Anxiety/depression (1-5)	1.85 (0.97)	1.86 (1.05)	1.83 (0.98)	1.83 (1.04)
Perceived health (1-100)	53.87 (22.92)	55.29 (21.42)	55.18 (22.79)	58.25 (22.31)
Mental wellbeing (14-70)	48.23 (10.42)	47.62 (10.87)	48.71 (10.39)	48.58 (10.98)
Life satisfaction (1-10)	6.19 (2.45)	6.29 (2.46)	6.33 (2.43)	6.43 (2.45)
Action planning (1-4)	1.68 (0.92)	1.67 (0.87)	1.94 (1.03)	1.97 (1.03)
Self-monitoring (1-4)	1.58 (0.81)	1.55 (0.78)	1.79 (0.94)	1.84 (0.92)
Self-efficacy (5-20)	12.16 (4.02)	12.43 (4.15)	12.64 (4.23)	12.75 (4.17)
Intentions (1-7)	5.54 (1.35)	5.93 (1.32)	5.62 (1.43)	5.92 (1.35)
Attitudes (1-7)	5.80 (0.89)	5.88 (0.93)	5.90 (0.91)	5.96 (0.91)

To analyse changes in primary and secondary outcomes between baseline and 3 months in the standard and enhanced delivery groups a set of mixed ANOVAs were utilised with time (baseline, 3 months) as the within subjects variable and group (standard, enhanced) as the between subjects variable. This analysis utilised intention-to-treat analysis with missing values replaced by baseline values indicating no change for programme users that dropped out.

Table N2

Mixed ANOVA results for 3 month primary outcomes by group (standard and enhanced groups)

Primary Outcomes	**Effect**	**Result**	**Effect size**
Vigorous METs	Time	$F(1, 1281) = 80.65$***	$\eta^2 = .06$
	Group	$F(1, 1281) = 4.61$*	$\eta^2 = .00$
	Time*Group	$F(1, 1281) = 7.04$**	$\eta^2 = .01$
Moderate METs	Time	$F(1, 1293) = 40.11$***	$\eta^2 = .03$
	Group	$F(1, 1293) = .19$	$\eta^2 = .00$
	Time*Group	$F(1, 1293) = 4.49$*	$\eta^2 = .00$
Walking METs	Time	$F(1, 1280) = 35.21$***	$\eta^2 = .03$
	Group	$F(1, 1280) = 2.45$	$\eta^2 = .00$
	Time*Group	$F(1, 1280) = 2.46$	$\eta^2 = .00$
Total METs	Time	$F(1, 1253) = 82.79$***	$\eta^2 = .06$
	Group	$F(1, 1253) = 3.06$	$\eta^2 = .00$
	Time*Group	$F(1, 1253) = 5.23$*	$\eta^2 = .00$
MVPA METs	Time	$F(1, 1275) = 84.92$***	$\eta^2 = .06$
	Group	$F(1, 1275) = 1.89$	$\eta^2 = .00$
	Time*Group	$F(1, 1275) = 6.62$**	$\eta^2 = .01$
Sport	Time	$F(1, 1254) = 103.30$***	$\eta^2 = .08$

	Group	$F(1, 1254) = 6.11*$	$\eta^2 = .01$
	Time*Group	$F(1, 1254) = 3.69$	$\eta^2 = .00$
Sitting	Time	$F(1, 1275) = 36.85***$	$\eta^2 = .03$
	Group	$F(1, 1275) = 14.55***$	$\eta^2 = .01$
	Time*Group	$F(1, 1275) = 1.41$	$\eta^2 = .00$

There were highly statistically significant main effects of time for all primary outcomes, showing that regardless of group reported physical activity and sporting participation increased and sitting time decreased. The effect sizes were however all small. Vigorous METs, sporting participation, and sitting also showed statistically significant main effects of group, showing that regardless of time point vigorous physical activity and sporting participation was higher in the enhanced group and sitting time was lower in the enhanced group. Effect sizes were however very small. There were also statistically significant interaction effects for vigorous, moderate, total, and MVPA METs. The enhanced delivery showed additional benefits over and above the standard delivery.

Table N3

Percentage of programme users who reported being active to the recommended amount at baseline and at 3 months for reported moderate and vigorous intensity activity

Outcome	**Yes/No**	**Baseline**		**3 months**	
		Standard	**Enhanced**	**Standard**	**Enhanced**
Moderate	Yes	71 (15%)	116 (14%)	29 (6%)	101 (12%)
150 minutes	No	404 (85%)	713 (86%)	444 (94%)	727 (88%)
Vigorous 75	Yes	49 (10%)	99 (12%)	41 (9%)	128 (16%)
minutes	No	425 (90%)	719 (88%)	434 (91%)	689 (84%)

The percentage of programme users that reported completing at least 150 minutes of moderate activity and 75 minutes of vigorous activity, in line with national physical activity recommendations, were then analysed at baseline and 3 months. At baseline, there was no association between whether programme users reported completing 150 minutes of moderate physical activity (15%, standard vs 14%, enhanced), $X^2(1) = .22$, $p = .636$. At 3 months, programme users in both groups reported a lower percentage completing 150 minutes of moderate physical activity. The association between whether programme users reported completing 150 minutes of moderate physical activity and group was significant (6%, standard vs 12%, enhanced), $X^2(1) = 12.32$, $p < .001$. There was no association between the amount of programme user reporting 75 minutes of vigorous physical activity and group at baseline (10%, standard vs 12%, enhanced), $X^2(1) = .92$, $p = .337$. At 3 months, programme users in both groups reported a higher percentage completing 75 minutes of vigorous physical activity. There was however a statistically significant association between the amount of programme user reporting 75 minutes of vigorous physical activity and group at 3 months (6%, standard vs 16%, enhanced), $X^2(1) = 13.08$, $p < .001$.

Table N4

Mixed ANOVA results for 3 month secondary outcomes by group (standard and enhanced groups)

Primary Outcomes	**Effect**	**Result**	**Effect size**
Mobility	Time	$F(1, 1056) = 5.55$*	$\eta^2 = .01$
	Group	$F(1, 1056) = .10$	$\eta^2 = .00$
	Time*Group	$F(1, 1056) = .61$	$\eta^2 = .00$
Self-Care	Time	$F(1, 1056) = 1.50$	$\eta^2 = .00$

	Group	$F(1, 1056) = .10$	$\eta^2 = .00$
	Time*Group	$F(1, 1056) = .81$	$\eta^2 = .00$
Usual activities	Time	$F(1, 1056) = .85$	$\eta^2 = .00$
	Group	$F(1, 1056) = 1.36$	$\eta^2 = .00$
	Time*Group	$F(1, 1056) = .99$	$\eta^2 = .00$
Pain	Time	$F(1, 1056) = .69$	$\eta^2 = .00$
	Group	$F(1, 1056) = .05$	$\eta^2 = .00$
	Time*Group	$F(1, 1056) = .28$	$\eta^2 = .00$
Anx/dep	Time	$F(1, 1056) = 1.23$	$\eta^2 = .00$
	Group	$F(1, 1056) = .01$	$\eta^2 = .00$
	Time*Group	$F(1, 1056) = .14$	$\eta^2 = .00$
Health	Time	$F(1, 1056) = 26.30^{***}$	$\eta^2 = .02$
	Group	$F(1, 1056) = 2.35$	$\eta^2 = .00$
	Time*Group	$F(1, 1056) = 3.96^{*}$	$\eta^2 = .00$
Wellbeing	Time	$F(1, 1047) = 19.33^{***}$	$\eta^2 = .02$
	Group	$F(1, 1047) = .26$	$\eta^2 = .00$
	Time*Group	$F(1, 1047) = 2.21$	$\eta^2 = .00$
Life Satisfaction	Time	$F(1, 1024) = 14.49^{***}$	$\eta^2 = .01$
	Group	$F(1, 1024) = .37$	$\eta^2 = .00$
	Time*Group	$F(1, 1024) = .02$	$\eta^2 = .00$
Action planning	Time	$F(1, 1039) = 97.94^{***}$	$\eta^2 = .09$
	Group	$F(1, 1039) = .02$	$\eta^2 = .00$
	Time*Group	$F(1, 1039) = .64$	$\eta^2 = .00$
Self-monitoring	Time	$F(1, 1039) = 89.75^{***}$	$\eta^2 = .08$
	Group	$F(1, 1039) = .01$	$\eta^2 = .00$
	Time*Group	$F(1, 1039) = 1.97$	$\eta^2 = .00$
Self-efficacy	Time	$F(1, 1041) = 20.96^{***}$	$\eta^2 = .02$
	Group	$F(1, 1041) = .50$	$\eta^2 = .00$
	Time*Group	$F(1, 1041) = .81$	$\eta^2 = .00$
Intentions	Time	$F(1, 1036) = 1.34$	$\eta^2 = .00$
	Group	$F(1, 1036) = 15.66^{***}$	$\eta^2 = .02$

	Time*Group	*F*(1, 1036) = 2.56	$\eta^2 = .00$
Attitudes	Time	*F*(1, 1037) = 21.75***	$\eta^2 = .02$
	Group	*F*(1, 1037) = 1.23	$\eta^2 = .00$
	Time*Group	*F*(1, 1037) = .21	$\eta^2 = .00$

Note: * = p < .05; ** = p < .01; *** = p < .001

The analysis of secondary outcome measures showed statistically significant main effects of time for mobility, perceptions of health, mental wellbeing, life satisfaction, action planning, self-monitoring, self-efficacy, and attitudes. Aside from mobility which decreased, all of the outcomes listed improved over the intensive 3 month stage of the intervention. All effect sizes were small. There was also a main effect of group for intentions with the enhanced group having higher scores regardless of time point.

Table N5

Baseline, 3, and 6 month outcomes for 6-month completers (N = 1111). MET values were square-rooted for analysis.

Outcome measure	**Baseline**		**3 months**		**6 months**	
	Standard	**Enhanced**	**Standard**	**Enhanced**	**Standard**	**Enhanced**
Primary outcomes						
Vigorous METs	256.00 (944.42)	299.07 (971.55)	404.69 (1135.40)	549.60 (1249.43)	413.88 (1272.79)	450.86 (1157.97)
Vigorous mins	32.00 (118.05)	37.38 (121.44)	50.59 (141.93)	68.70 (156.18)	51.73 (159.10)	56.36 (144.75)
Moderate METs	340.86 (857.86)	272.95 (621.61)	375.01 (845.16)	377.00 (744.90)	396.23 (880.72)	362.97 (733.96)
Moderate mins	85.21 (214.46)	68.24 (155.40)	93.75 (211.29)	94.25 (186.23)	99.06 (220.18)	90.74 (183.49)
Walking METs	639.67 (923.07)	715.12 (963.02)	680.50 (906.30)	826.22 (1040.32)	704.15 (968.21)	756.38 (990.12)
Walking mins	193.84 (279.72)	216.70 (291.82)	206.21 (274.64)	250.37 (315.25)	213.38 (293.40)	229.20 (300.04)
MVPA METs	590.75 (1562.38)	564.68 (1364.89)	770.86 (1694.87)	916.86 (1713.71)	804.93 (1909.38)	796.48 (1648.69)
Total METs	1219.68 (2132.33)	1288.94 (1863.87)	1443.96 (2245.52)	1748.23 (2296.58)	1500.61 (2446.79)	1561.35 (2172.99)
Sport minutes	13.77 (78.47)	14.23 (52.25)	28.11 (94.89)	34.91 (88.64)	21.20 (85.33)	25.52 (74.58)
Sitting minutes	459.08 (228.66)	416.41 (255.78)	438.74 (228.88)	385.47 (232.05)	442.82 (232.36)	399.93 (252.45)
Secondary outcomes						
Mobility (1-5)	1.85 (0.96)	1.89 (1.05)	1.80 (0.97)	1.86 (1.05)	1.83 (0.96)	1.88 (1.06)
Self-care (1-5)	1.24 (0.62)	1.22 (0.57)	1.21 (0.60)	1.21 (0.54)	1.22 (0.60)	1.21 (0.59)
Usual activities(1-5)	1.64 (0.87)	1.58 (0.88)	1.61 (0.90)	1.58 (0.89)	1.62 (0.88)	1.60 (0.91)
Pain (1-5)	2.24 (0.99)	2.24 (1.07)	2.21 (0.97)	2.23 (1.06)	2.19 (0.99)	2.21 (1.06)

Anxiety/depression (1-5)	1.82 (0.98)	1.89 (1.06)	1.82 (0.99)	1.85 (1.04)	1.81 (0.99)	1.84 (1.05)
Perceived health (1-100)	54.26 (22.71)	54.82 (21.31)	55.41 (22.63)	58.00 (22.33)	56.50 (23.39)	56.77 (22.14)
Mental wellbeing (14-70)	47.97 (10.35)	47.53 (10.98)	48.44 (10.50)	48.52 (11.06)	48.39 (10.32)	48.09 (11.15)
Life satisfaction (1-10)	6.20 (2.41)	6.25 (2.49)	6.35 (2.43)	6.40 (2.49)	6.36 (2.40)	6.37 (2.47)
Action planning (1-4)	1.64 (0.90)	1.69 (0.86)	1.90 (1.02)	1.99 (1.01)	1.85 (1.01)	1.87 (0.98)
Self-monitoring (1-4)	1.58 (0.82)	1.57 (0.77)	1.81 (0.96)	1.84 (0.90)	1.74 (0.88)	1.75 (0.89)
Self-efficacy (5-20)	12.03 (3.89)	12.35 (4.13)	12.59 (4.23)	12.65 (4.14)	12.13 (3.98)	12.69 (4.22)
Intentions (1-7)	5.48 (1.35)	5.85 (1.36)	5.57 (1.45)	5.84 (1.40)	5.54 (1.38)	5.79 (1.42)
Attitudes (1-7)	5.75 (0.91)	5.83 (0.94)	5.85 (0.94)	5.91 (0.92)	5.83 (0.91)	5.89 (0.95)

To analyse changes in primary and secondary outcomes between baseline and 6 months in the standard and enhanced delivery groups a set of mixed ANOVAs were utilised with time (baseline, 3, and 6 months) as the within subjects variable and group (standard, enhanced) as the between subjects variable. This analysis utilised intention-to-treat analysis with missing values at 6 months replaced by baseline values.

Table N6

Mixed ANOVA results for 6 month primary outcomes by group (standard and enhanced groups)

Primary Outcomes	**Effect**	**Result**	**Effect size**
Vigorous METs	Time	$F(1.81, 1988.10) = 44.69$***	$\eta^2 = .04$
	Group	$F(1, 1096) = 3.98$*	$\eta^2 = .00$
	Time*Group	$F(1.81, 1988.10) = 4.15$*	$\eta^2 = .00$
Moderate METs	Time	$F(1.88, 2087.70) = 24.42$***	$\eta^2 = .02$
	Group	$F(1, 1109) = .13$	$\eta^2 = .00$
	Time*Group	$F(1.88, 2087.70) = 2.70$	$\eta^2 = .00$
Walking METs	Time	$F(1.84, 2007.59) = 15.70$***	$\eta^2 = .01$
	Group	$F(1, 1093) = 2.46$	$\eta^2 = .00$
	Time*Group	$F(1.84, 2007.59) = 1.76$	$\eta^2 = .00$
Total METs	Time	$F(1.85, 1963.82) = 43.73$***	$\eta^2 = .04$
	Group	$F(1, 1063) = 2.48$	$\eta^2 = .00$
	Time*Group	$F(1.85, 1963.82) = 4.10$*	$\eta^2 = .00$
MVPA METs	Time	$F(1.84, 1998.53) = 48.87$***	$\eta^2 = .04$
	Group	$F(1, 1089) = 1.49$	$\eta^2 = .00$
	Time*Group	$F(1.84, 1998.53) = 4.17$*	$\eta^2 = .00$
Sport	Time	$F(1.79, 1913.96) = 39.47$***	$\eta^2 = .04$
	Group	$F(1, 1069) = 0.76$	$\eta^2 = .00$

	Time*Group	$F(1.79, 1913.96) = 1.31$	$\eta^2 = .00$
Sitting	Time	$F(1.93, 2095.65) = 15.75$***	$\eta^2 = .01$
	Group	$F(1, 1088) = 10.56$**	$\eta^2 = .01$
	Time*Group	$F(1.93, 2095.65) = .86$	$\eta^2 = .00$

There were highly statistically significant main effects of time for all primary outcomes, showing that regardless of group, reported physical activity and sporting participation increased and sitting time decreased. The effect sizes were all small. For all primary outcomes post-hoc bonferoni tests showed highly statistically significant differences between baseline and 3 months, and baseline and 6 months, but not between 3 and 6 months, with the exception of vigorous METs (all differences were significant). This pattern shows that improvements made in these areas during the first 3 months of the programme were maintained at 6 months. Vigorous METs improved significantly at 3 months but decreased significantly from 3 to six months. Vigorous METs and sitting showed statistically significant main effects of group, showing that regardless of time point reported vigorous physical activity was larger in the enhanced group and sitting time was lower in the enhanced group. Effect sizes were very small. There were statistically significant interaction effects for vigorous, MVPA and total METS, showing that the enhanced delivery group improved more at 3 months and then returned back to similar levels to the standard group at 6 months.

Table N7

Percentage of programme users who reported being active to the recommended amount at baseline and at 6 months for moderate and vigorous intensity activity

Outcome	Yes/No	Baseline		6 months	
		Standard	**Enhanced**	**Standard**	**Enhanced**
Moderate	Yes	55 (14%)	97 (13%)	27 (7%)	70 (10%)
150 minutes	No	343 (86%)	624 (87%)	375 (93%)	654 (90%)
Vigorous 75	Yes	37 (9%)	84 (12%)	29 (7%)	70 (10%)
minutes	No	360 (93%)	626 (88%)	373 (93%)	642 (90%)

The percentage of programme users that reported completing at least 150 minutes of moderate activity and 75 minutes of vigorous activity, in line with national physical activity recommendations, were then analysed at baseline and 6 months. At baseline, there was no association between whether programme reported completed 150 minutes of moderate physical activity and group (14%, standard vs 13%, enhanced), $X^2(1) = .03$, $p = .864$. At 6 months, programme users in both groups reported a lower percentage completing 150 minutes of moderate physical activity, but there was no association between whether programme users reported 150 minutes of moderate physical activity and group (7%, standard vs 10%, enhanced), $X^2(1) = 2.86$, $p = .091$, There was no association between the amount of programme users reporting 75 minutes of vigorous physical activity and group at baseline (9%, standard vs 12%, enhanced), $X^2(1) = 1.65$, $p = .199$. At 6 months, programme users in both groups reported a lower percentage completing 75 minutes of vigorous physical activity. However, there was no association between the amount of programme uses reporting 75 minutes of vigorous physical activity and group at 6 months (7%, standard vs 10%, enhanced), $X^2(1) = 2.17$, $p = .140$.

Table N8

Mixed ANOVA results for 3 month secondary outcomes by group (standard and enhanced groups)

Secondary Outcomes	**Effect**	**Result**	**Effect size**
Mobility	Time	$F(1.94, 1726.60) = 1.88$	$\eta^2 = .00$
	Group	$F(1, 890) = .45$	$\eta^2 = .00$
	Time*Group	$F(1.94, 1726.60) = .21$	$\eta^2 = .00$
Self-Care	Time	$F(1.95, 1733.09) = 0.98$	$\eta^2 = .00$
	Group	$F(1, 890) = .09$	$\eta^2 = .00$
	Time*Group	$F(1.95, 1733.09) = .30$	$\eta^2 = .00$
Usual activities	Time	$F(1.87, 1666.92) = .24$	$\eta^2 = .00$
	Group	$F(1, 890) = .26$	$\eta^2 = .00$
	Time*Group	$F(1.87, 1666.92) = .59$	$\eta^2 = .00$
Pain	Time	$F(1.91, 1699.28) = 2.11$	$\eta^2 = .00$
	Group	$F(1, 890) = .03$	$\eta^2 = .00$
	Time*Group	$F(1.91, 1699.28) = .13$	$\eta^2 = .00$
Anx/dep	Time	$F(1.79, 1592.90) = 1.32$	$\eta^2 = .00$
	Group	$F(1, 890) = .36$	$\eta^2 = .00$
	Time*Group	$F(1.79, 1592.90) = .48$	$\eta^2 = .00$
Health	Time	$F(1.93, 1718.78) = 13.51$***	$\eta^2 = .02$
	Group	$F(1, 890) = .51$	$\eta^2 = .00$
	Time*Group	$F(1.93, 1718.78) = 3.58$*	$\eta^2 = .00$
Wellbeing	Time	$F(1.80, 1589.68) = 8.56$***	$\eta^2 = .01$
	Group	$F(1, 884) = .07$	$\eta^2 = .00$
	Time*Group	$F(1.80, 1589.68) = 1.10$	$\eta^2 = .00$
Life Satisfaction	Time	$F(1.88, 1618.04) = 7.81$**	$\eta^2 = .01$
	Group	$F(1, 859) = .04$	$\eta^2 = .00$
	Time*Group	$F(1.88, 1618.04) = .12$	$\eta^2 = .00$
Action planning	Time	$F(1.93, 1690.08) = 44.36$***	$\eta^2 = .05$
	Group	$F(1, 874) = .69$	$\eta^2 = .00$

	Time*Group	$F(1.93, 1690.08) = .54$	$\eta^2 = .00$
Self-monitoring	Time	$F(1.91, 1664.81) = 40.60^{***}$	$\eta^2 = .04$
	Group	$F(1, 874) = .03$	$\eta^2 = .00$
	Time*Group	$F(1.91, 1664.81) = .38$	$\eta^2 = .00$
Self-efficacy	Time	$F(1.89, 1658.86) = 10.45^{***}$	$\eta^2 = .01$
	Group	$F(1, 876) = 1.09$	$\eta^2 = .00$
	Time*Group	$F(1.89, 1658.86) = 3.70^{*}$	$\eta^2 = .00$
Intentions	Time	$F(1.83, 1590.39) = .73$	$\eta^2 = .00$
	Group	$F(1, 871) = 8.83^{**}$	$\eta^2 = .01$
	Time*Group	$F(1.83, 1590.39) = 1.58$	$\eta^2 = .00$
Attitudes	Time	$F(1.90, 1655.73) = 10.29^{***}$	$\eta^2 = .01$
	Group	$F(1, 872) = .92$	$\eta^2 = .00$
	Time*Group	$F(1.90, 1655.73) = .21$	$\eta^2 = .00$

Note: * = $p < .05$; ** = $p < .01$; *** = $p < .001$

The analysis of secondary outcome measures showed statistically significant main effects of time for perceptions of health, mental wellbeing, life satisfaction, action planning, self-monitoring, self-efficacy, and attitudes. The effect sizes were however very small. For perceived health, mental wellbeing, life satisfaction, self-efficacy, and attitudes, post-hoc bonferoni tests showed statistically significant differences between baseline and 3 months, and baseline and 6 months, but not between 3 and 6 months. This pattern shows that improvements made in these areas during the first 3 months of the programme were maintained at 6 months. For perceived health and action planning, post-hoc bonferoni tests showed statistically significant differences between all timepoints, with significant improvements at 3 months but significant decreases from 3 to 6 months. There was a main effect of group for intentions with the enhanced group having higher intentions regardless of time point. There were also statistically significant interaction effects for perceived health and self-efficacy, showing that the enhanced delivery group improved more at 3 months and then returned back to similar levels to the standard group at 6 months.

Appendix O: Active Herts Get Active Specialists interview schedule

Activity adviser Interview Schedule

Introduction

I will begin by explaining my background and role.

This interview is about your ideas about being part of the Active Herts programme. We are hoping to talk to all four activity advisers as we are very interested in hearing about their own experiences and views.

Would it be OK if I record the conversations, this will just mean that I won't have to write everything down and can listen to you with my full attention. The recording will only be listened to by myself and my second supervisor, and will be transcribed and anonymised to ensure that you cannot be identified. Also you can leave the interview at any time. Thank you.

The aim is to provide themes around issues of interest (eg quality of the training) and also allows for novel subjects to arise (eg any unintended consequences of materials used). Additionally other issues of importance to the advisors may emerge during the course of the focus groups.

The Guide:

Opening questions

How many clients have you had sessions with in the Active Herts programme?

The Get Active Programme

- What are your impressions of the Active Herts programme?
- What do you think the clients like or dislike about the Active Herts programme?
- Were you aware of clients making changes on the Active Herts programme?
- How do you feel the Active Herts programme changed their lifestyles?

Delivery

- What aspects of the sessions did you find most easy?
- What aspects of the sessions did you find most challenging?
- Describe to me how you used the booklet during the sessions?
- What were the most useful/challenging parts of the booklet?
- How did the clients react to the booklet in the sessions?

Training

- Overall, what was your training experience like?
- What things can you remember from the training session?
    - Prompt: Which techniques do you remember?
- What aspects of the training did you find most useful?
- What aspects of the training did you find most challenging?
- Which specific techniques have you used in your practice since you attended the training?
    - Prompt: What examples can you give me where this worked well?
    - Prompt: What didn't work so well?
- How would you judge your confidence with using Motivational Interviewing skills after attending the training session?
- What else would you like to learn around this topic area?
- How would you rate your overall satisfaction with the training session that you attended?

- How did you find listening the recordings of your sessions?

Questionnaire measures

- What were your impressions of the client questionnaires?
- How long did it take clients to complete the questionnaires and were there any difficulties for clients?
- Would you change anything about the questionnaires? If so, what?

Ending Questions

- Is there anything that you would like to add?

Appendix P: Active Herts Get Active Specialists interview study ethics approval

UNIVERSITY OF HERTFORDSHIRE

HEALTH AND HUMAN SCIENCES

ETHICS APPROVAL NOTIFICATION

TO	Neil Howlett
CC	Nick Troop
FROM	Dr Richard Southern, Health and Human Sciences ECDA Chairman
DATE	22/06/2016

Protocol number: **LMS/PGR/UH/02427**

Title of study: How does motivational interviewing training affect interactions between physical activity advisers and clients, and the delivery of behaviour change techniques?

Your application for ethics approval has been accepted and approved by the ECDA for your School.

This approval is valid:

From: 22/06/2016

To: 30/06/2019

Please note:

If your research involves invasive procedures you are required to complete and submit an EC7 Protocol Monitoring Form, and your completed consent paperwork to this ECDA once your study is complete.

Approval applies specifically to the research study/methodology and timings as detailed in your Form EC1. Should you amend any aspect of your research, or wish to apply for an extension to your study, you will need your supervisor's approval and must complete and submit form EC2. In cases where the amendments to the original study are deemed to be substantial, a new Form EC1 may need to be completed prior to the study being undertaken.

Should adverse circumstances arise during this study such as physical reaction/harm, mental/emotional harm, intrusion of privacy or breach of confidentiality this must be reported to the approving Committee immediately. Failure to report adverse circumstance/s would be considered misconduct.

Ensure you quote the UH protocol number and the name of the approving Committee on all paperwork, including recruitment advertisements/online requests, for this study.

Appendix Q: Active Herts Get Active Specialists interview information sheet

Active Herts Your first step to a more active lifestyle

herts sports partnership

University of Hertfordshire UH

Activity adviser INFORMATION SHEET

Title of study

Using Motivational Interviewing during interactions with clients

Introduction

You are being invited to take part in a study. Before you decide whether to do so, it is important that you understand the research that is being done and what your involvement will include. Please take the time to read the following information carefully and discuss it with others if you wish. Do not hesitate to ask us anything that is not clear or for any further information you would like to help you make your decision. Please do take your time to decide whether or not you wish to take part. Thank you for reading this.

What is the purpose of this study?

The purpose of this study is to ask you about your experiences during interactions with clients in terms of how useful the motivational interviewing training was, how helpful the materials were, what you found challenging about the sessions and how many behaviour change techniques you incorporated into the sessions.

Do I have to take part?

It is completely up to you whether or not you decide to take part in this study. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. Agreeing to join the study does not mean that you have to complete it. You are free to withdraw at any stage without giving a reason.

Are there any age or other restrictions that may prevent me from participating?

There are no relevant restrictions.

How long will my part in the study take?

If you decide to take part in this study, you will be involved in it for between 60-90 minutes depending on how long the interview lasts.

What will happen to me if I take part?

You will be interviewed by the researcher about your experiences of the motivational interview training, delivering the activity sessions to clients and any challenges you have faced throughout the process.

We would also like to record some of your sessions with clients in order to listen to the actual interaction. However, if you prefer, you may still participate in the interview even if you do not wish to have a session with a client recorded.

What are the possible disadvantages, risks or side effects of taking part?

There are no disadvantages of taking part in this research.

What are the possible benefits of taking part?

The interviews may help you think about the benefits you've experienced from the motivational interview training. People often appreciate the opportunity to share their views in an interview. The feedback you provide will also help us improve the training and design of implementations of interventions in the future.

How will my taking part in this study be kept confidential?

All the information that you provide will be kept strictly confidential. You will not be able to be identified in any reports or publications that are produced. All information that you provide is voluntary. The interviews will be recorded (audio, not video). The purpose of this is to make sure that all information is collected correctly and can be analysed. No one outside the research team (Neil Howlett, Dr Nick Troop, and Dr Angel Chater) will hear the recording and it will be stored securely on the researcher's password protected hard-drive. Once the recording has been typed up, it will be erased and any identifying information (names etc.) will be removed from the document. This is true also for the recording of the session with a client (if you and the client consent to that).

What will happen to the data collected within this study?

Please note that any information you provide today will only be used for this study. All your responses and the information you provide will be kept confidential, and all the information collected will be anonymised so that you cannot be identified in any reports that result from the study. The data from the interviews will be securely stored for at least three years. As soon as the recordings of focus groups have been typed up, they will be erased.

Who has reviewed this study?

This study has been reviewed by: The University of Hertfordshire Health and Human Sciences Ethics Committee with Delegated Authority

The UH protocol number is: LMS/PGR/UH/02427

Who can I contact if I have any questions?

If you would like further information or would like to discuss any details personally, please get in touch with me, in writing, by phone or by email: Neil Howlett, n.howlett@herts.ac.uk, 01707 285971 or the Lead Supervisor Nick Troop, n.a.troop@herts.ac.uk

Although we hope it is not the case, if you have any complaints or concerns about any aspect of the way you have been approached or treated during the course of this study, please write to the University's Secretary and Registrar.

Thank you very much for reading this information and giving consideration to taking part in this study.

Appendix R: Active Herts Get Active Specialists interview consent form

Activity Adviser Consent Form

I, the undersigned *[please give your name here*, *in BLOCK CAPITALS]*

…….…

hereby freely agree to take part in the study entitled *[insert name of study here]*

……..

1 I confirm that I have been given a Participant Information Sheet giving particulars of the study, including its aim(s), methods and design, the names and contact details of key people and, as appropriate, the risks and potential benefits. I have been given details of my involvement in the study. I have been told that in the event of any significant change to the aim(s) or design of the study I will be informed, and asked to renew my consent to participate in it.

2 I have been assured that I may withdraw from the study at any time without disadvantage or having to give a reason.

3 In giving my consent to participate in this study, I understand that a voice recording will take place.

4 I have been told how information relating to me (data obtained in the course of the study, and data provided by me about myself) will be handled: how it will be kept secure, who will have access to it, and how it will or may be used.

I consent to being interviewed about my experience of delivering the intervention YES / NO

I consent to having one of my sessions with clients being recorded YES / NO

Signature of participant……………………………………..…Date………………………….

Signature of (principal)
investigator………………………………………………………Date…………………………

Name of (principal) investigator

…… NICK TROOP pp. NEIL HOWLETT …………………………

Appendix S: Active Herts Get Active Specialists interview debrief sheet

Activity Adviser Debrief Sheet

Title: How does motivational interviewing training affect interactions between physical activity advisers and clients, and the delivery of behaviour change techniques?

The main aim of this study was to explore the impact the motivational interviewing training had on the sessions with clients and your experiences of the programme and delivery in general. An additional aim was to determine how well this training helped you as advisers to adhere to principles of motivational interviewing in your interactions with clients. This was rated on the following five elements:

- Working proactively to evoke client's own reasons for change and ideas about how change should happen.
- Actively encouraging power sharing in the interaction in such a way that client's ideas influence the session.
- Adding to the feeling and meaning of client's expression of autonomy.
- Exerting influence on the session and not missing opportunities to direct client toward the target behaviour.
- Showing understanding of client's point of view, not just for what has been explicitly stated.

Your input into this study is extremely valuable, however if you do not want your answers to be included in the study, please inform the investigator and they will be removed.

If you have any further questions or you wish to be informed of the outcome of the study please contact the principal researcher - Neil Howlett, n.howlett@herts.ac.uk, 01707 285971 or the Lead Supervisor Nick Troop, n.a.troop@herts.ac.uk

Thank you for participating in this study.

Appendix T: Coding audit trail

Initial manual coding

solution for themselves. Erm, I felt the training was very beneficial, it was needed, erm, before I went and stepped out there in the wide world and did the Active Herts so without the MI training I think you know I might have had a lot more people who, you know, might not actually wanted to attend these sessions just by not having been there and had that training, prior to the actual erm I guess consultations I'd say. Erm, yeah.

Delivery

NH Great, that's good. So we are going to sort of the delivery now, after the training. Erm how many clients have you had sessions with in the Active Herts programme so far?

Is it sessions as in erm the activity sessions?

NH The consultations

The consultations right. So at the moment I've been through about 140 consultations, erm and I'd probably say a hundred of those I've definitely used MI, motivational interviewing, as I said, it's not for everyone. A lot of people who are coming through are already in that er readiness to change, they want to just see what the projects about, they're are raring to go, they've done exercises in the past and they know the benefits of it. Yeah, they don't have any erm sort of mild to moderate mental health issues that are stopping them becoming fitter. So that's been pretty good, but for the other I'd say like the hundred and yes I have been using a lot of motivational interviewing, looking at er the the booklet if it was goal setting approaches which I use quite a lot. Erm, signposting suitable exercise for that individual which is actually sort of tailored for their own ability and also letting them know that quite a few of the sessions that I personally teach myself because it's helped that individual to reduce barriers because ~~they've met me already in the~~ consultation and I guess for them, for them seeing me and knowing that I'm no sergeant major in these sessions, I'm not pointing fingers, I'm not blowing whistles, erm, it is really more creating that relaxed environment for them to attend and I think that's been quite beneficial and it's going to be a strong factor that's encouraged more people to take part in some of the sessions that have been created through the project. By having me actually you know teach some of the activities as well.

→ MI is not for everyone

Some client are already raring to go

→ Goal setting approaches which I use a lot.

→ teaching classes helps break down barriers

NH Yeah, that's a really good thing. So we've, we've come on to this anyway, so er, aspects of the sessions, so what do, anything else that went well and then things that might have been a bit more challenging.

Erm, I think, the things that have went, that have gone well is obviously I'm the get active specialist in Broxbourne and Borxbourne is like phase A of the project where we've got erm a budget in place, which has allowed us to create exercise sessions so I've found that by having that budget in place and creating a number of exercise session across the

→ extra funding for exercise sessions has been beneficial borough. . that has been paramount in getting more people in to the sessions and actually active again. Erm, it's been quite rare me signposting external activities if it was like er a football club or a boxing club or a Zumba class, I still give that option but because erm the participants coming into the project receive 12 weeks free of activity which they can do through the exercise on, on, on the project I think it's er more of an incentive for them to actually try that as it is to sort of erm termed low impact exercise and I'm there personally to kind of reduce the barriers and er water it down a little bit, kind of hold their hand through the process to get them in the door in the first place. I'd say some of the, the hard things that I've faced erm. . .I'm, it's, it's been some of the questionnaires in, in, in the actual question, I think the, the last page they're very general questionnaires, erm

more reducing barriers (linked to last point).

NH We will get on to that bit as well, yeah.

Yeah so I don't think that has been worded the best way, but when I'm trying to explain to some of the participants who are coming into the project, erm they look at me as though I'm stupid, but just because the questions are so general, and I think they think that is was myself that created these questions, but erm I think that could just, yeah that is maybe just one thing but any other difficulties. . erm. . I think it's the initial consultation has been, has been wonderful, it's been, you know, I'd say. . . 80% has been really productive and, and helping me to signpost erm exercises mostly through the project for those individuals erm of course on the, the three month review that's when it does get tricky, er so the individuals that I, that I contact or I haven't seen attend sessions for maybe a number of weeks where they might have dropped out or gone into a relapse, I try contacting them. Erm, the majority of them are some have said they've had an operation or they're going on holiday or some unfortunately have actually moved away. Erm, but there are, there have been a number of people that feel that erm they don't need them, they don't need the project anymore, they feel that they're okay without it, and they've sort of joined their local gym, even though I've said to them it's still great to, to capture all this information for part of the project, but they, they wouldn't want anything to do with it anymore so erm it's about trying to sort of erm I guess. . . keep them encouraged through that, through that time, because we do give them the two week telephone call to see, you know, if everything is okay and you know nine times out of ten it is okay, they are doing it and they've, they've, they've started the exercise. But I think possibly having that three month catch up, it, it might be a little bit too long so some people fall off the bandwagon erm before you get to that three month so maybe having a brand new or changing it intervention in between that to try and catch those individuals before they go into that relapse or that pre-contemplation back into the er trans, transtheoretical model (laughs).

Concerns about client perceptions of questions + him

The three month review has been tricky to organise.

Clients ~~other~~ don't need the project anymore

Too long between 2 week + 3 month meetings

NH Yeah that's a bit of a mouthful. Okay, erm, just to follow on from the things you've said briefly. The, so you've got extra funding for putting on the sessions, is that a, for two of the areas and not the other two or is it just you need to. .

Refined coding highlighting themes

feel now that I'm a lot more capable and confident or competent of actually erm going through an MI interview to you know really see or make a change and get that individual to find a solution for themselves. Erm, I felt the training was very beneficial, it was needed, erm, before I went and stepped out there in the wide world and did the Active Herts so without the MI training I think you know I might have had a lot more people who, you know, might not actually wanted to attend these sessions just by not having been there and had that training, prior to the actual erm I guess consultations I'd say. Erm, yeah.

Delivery

NH Great, that's good. So we are going to sort of the delivery now, after the training. Erm how many clients have you had sessions with in the Active Herts programme so far?

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1 + 4

NH Yeah, that's a really good thing. So we've, we've come on to this anyway, so er, aspects of the sessions, so what do, anything else that went well and then things that might have been a bit more challenging.

2

Erm, I think, the things that have went, that have gone well is obviously I'm the get active specialist in Broxbourne and Broxbourne is like phase A of the project where we've got erm a budget in place, which has allowed us to create exercise sessions so I've found that by having that budget in place and creating a number of exercise session across the borough. . that has been paramount in getting more people in to the sessions and actually active again. Erm, it's been quite rare me signposting external activities if it was like er a football club or a boxing club or a Zumba class, I still give that option but because erm the participants coming into the project receive 12 weeks free of activity which they can do through the exercise on, on, on the project I think it's er more of an incentive for them to actually try that as it is to sort of erm termed low impact exercise and I'm there personally to kind of reduce the barriers and er water it down a little bit, kind of hold their hand through the process to get them in the door in the first place, I'd say some of the, the hard things that I've faced erm. . .I'm, it's, it's been some of the questionnaires in, in, in the actual question, I think the, the last page they're very general questionnaires, erm

1 + 4

5

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Yeah so I don't think that has been worded the best way, but when I'm trying to explain to some of the participants who are coming into the project, erm they look at me as though I'm stupid, but just because the questions are so general, and I think they think that is was myself that created these questions, but erm I think that could just, yeah that is maybe just one thing but any other difficulties. . erm. . I think it's the initial consultation has been, has been wonderful, it's been, you know, I'd say. . . 80% has been really productive and, and helping me to signpost erm exercises mostly through the project for those individuals erm of course on the, the three month review that's when it does get tricky, er so the individuals that I, that I contact or I haven't seen attend sessions for maybe a number of weeks where they might have dropped out or gone into a relapse, I try contacting them. Erm, the majority of them are some have said they've had an operation or they're going on holiday or some unfortunately have actually moved away. Erm, but there are, there have been a number of people that feel that erm they don't need them, they don't need the project anymore, they feel that they're okay without it, and they've sort of joined their local gym, even though I've said to them it's still great to, to capture all this information for part of the project, but they, they wouldn't want anything to do with it anymore so erm it's about trying to sort of erm I guess. . . keep them encouraged through that, through that time, because we do give them the two week telephone call to see, you know, if everything is okay and you know nine times out of ten it is okay, they are doing it and they've, they've, they've started the exercise. But I think possibly having that three month catch up, it, it might be a little bit too long so some people fall off the bandwagon erm before you get to that three month so maybe having a brand new or changing it intervention in between that to try and catch those individuals before they go into that relapse or that pre-contemplation back into the er trans, transtheoretical model (laughs).

5

1

5

5

5

Initial coding in Nvivo

Nodes

Name	Sources	References	Created By	Created On	Modified By	Modified On
Applying skills from training	4	17	NH	29/11/2016 15:21	NH	29/11/2016 15:21
BCTs	4	70	NH	25/11/2016 17:14	NH	25/11/2016 17:14
Booster call	3	6	NH	03/01/2017 13:56	NH	03/01/2017 13:56
Capturing stories	2	3	NH	08/12/2016 15:18	NH	08/12/2016 15:18
Changes made_procedure	3	6	NH	29/11/2016 16:13	NH	08/12/2016 11:24
Client barriers	4	14	NH	08/12/2016 11:20	NH	08/12/2016 11:20
Client changes	4	14	NH	29/11/2016 16:04	NH	29/11/2016 16:04
Client perspectives	4	18	NH	08/12/2016 14:34	NH	08/12/2016 14:34
Comparison with other training	4	15	NH	29/11/2016 15:02	NH	29/11/2016 15:02
Concerns or points about follow-up consutlations	4	12	NH	08/12/2016 11:39	NH	04/01/2017 14:34
Consultation challenges	2	5	NH	29/11/2016 16:08	NH	29/11/2016 16:08
Distinguishing between other programmes	1	1	NH	03/01/2017 13:34	NH	03/01/2017 13:34
Enjoyment of role	4	10	NH	04/01/2017 09:58	NH	06/01/2017 11:20
Expertise of trainers	1	2	NH	29/11/2016 15:05	NH	29/11/2016 15:05
Extra funding	2	23	NH	03/01/2017 12:42	NH	03/01/2017 13:02
Further needs	3	10	NH	08/12/2016 15:28	NH	08/12/2016 15:28
Gaining experience	2	3	NH	29/11/2016 15:20	NH	29/11/2016 15:20
GAS development	1	1	NH	03/01/2017 11:37	NH	03/01/2017 11:37
GP engagement and role	3	17	NH	08/12/2016 14:27	NH	04/01/2017 11:16
Initial challenges	3	12	NH	08/12/2016 14:24	NH	08/12/2016 14:24
Mental health of clients	4	18	NH	29/11/2016 16:02	NH	29/11/2016 16:12
Motivation for role	2	2	NH	08/12/2016 15:22	NH	08/12/2016 15:22
Motivational interviewing	1	1	NH	03/01/2017 12:34	NH	03/01/2017 12:34
Ongoing challenges	2	10	NH	04/01/2017 10:02	NH	04/01/2017 10:02
Open-ended questions	4	6	NH	29/11/2016 15:11	NH	29/11/2016 15:11
Opportunity to practice skills	2	6	NH	29/11/2016 15:09	NH	29/11/2016 15:09
Questionnaire acceptance	4	8	NH	08/12/2016 14:04	NH	08/12/2016 14:04
Questionnaire challenges	4	78	NH	29/11/2016 16:09	NH	29/11/2016 16:09
Questionnaire use	2	5	NH	08/12/2016 14:07	NH	08/12/2016 14:07
Role plays	1	3	NH	03/01/2017 11:13	NH	03/01/2017 11:21
Signposting activities	3	6	NH	08/12/2016 11:02	NH	04/01/2017 11:58
Stages of change	3	9	NH	25/11/2016 14:33	NH	06/01/2017 10:03
Support from line manager	2	3	NH	04/01/2017 10:00	NH	04/01/2017 16:00
Time constraints	1	1	NH	08/12/2016 11:12	NH	08/12/2016 11:12

Final coding scheme in Nvivo

Nodes

Name	Sources	References	Created By	Created On	Modified By	Modified On
Enabling behaviour change	4	35	NH	15/01/2018 16:24	NH	15/01/2018 16:24
Confidence to do it ourselves	3	16	NH	15/01/2018 16:24	NH	15/01/2018 16:25
Adding credibility	1	1	NH	25/11/2016 17:39	NH	29/11/2016 15:07
Confidence from training	1	2	NH	03/01/2017 11:46	NH	09/02/2017 09:47
Having someone oversee useful	1	1	NH	29/11/2016 15:06	NH	29/11/2016 15:06
More in-depth	2	2	NH	29/11/2016 15:16	NH	06/01/2017 08:31
Not much previous training	2	2	NH	29/11/2016 15:04	NH	03/01/2017 11:11
Previous experience	1	2	NH	06/01/2017 08:28	NH	06/01/2017 08:30
Range of tools	1	2	NH	03/01/2017 11:18	NH	03/01/2017 11:40
Too much information	1	3	NH	06/01/2017 08:31	NH	06/01/2017 08:50
Using training in a practical sense	1	1	NH	29/11/2016 15:17	NH	29/11/2016 15:17
Supporting further behaviour change	4	19	NH	15/01/2018 16:25	NH	15/01/2018 16:25
Future considerations	4	128	NH	15/01/2018 16:40	NH	15/01/2018 16:40
Keeping in contact with clients	3	15	NH	15/01/2018 16:40	NH	15/01/2018 16:40
Need more user-friendly measures	4	77	NH	15/01/2018 16:41	NH	15/01/2018 16:41
Using the booklet as an extension of the consultation	4	36	NH	15/01/2018 16:41	NH	15/01/2018 16:41
Maximising opportunities	3	20	NH	15/01/2018 16:15	NH	15/01/2018 16:15
Positive feedback enhance stakeholder engagement	3	20	NH	15/01/2018 16:16	NH	15/01/2018 16:16
Tailoring extra opportunities	0	0	NH	15/01/2018 16:15	NH	15/01/2018 16:15
Strengthening capbability by practicing skills	4	125	NH	15/01/2018 15:47	NH	15/01/2018 15:47
Choosing appropriate BCTs	4	75	NH	15/01/2018 15:49	NH	15/01/2018 15:49
Learning to let client take control	4	13	NH	15/01/2018 15:49	NH	15/01/2018 15:49
Reflecting on practice to build skill	4	37	NH	15/01/2018 15:58	NH	15/01/2018 15:58
Understanding the client journey	4	68	NH	15/01/2018 16:17	NH	15/01/2018 16:23
Appreciation of extra support	4	17	NH	15/01/2018 16:19	NH	15/01/2018 16:19
Experiencing client progression	4	14	NH	15/01/2018 16:18	NH	15/01/2018 16:18
Telling the client's story	2	3	NH	15/01/2018 16:18	NH	15/01/2018 16:18
Understanding client capability	4	23	NH	15/01/2018 16:18	NH	15/01/2018 16:18
Understanding client motivation	4	11	NH	15/01/2018 16:19	NH	15/01/2018 16:19

Appendix U: Final thematic coding by theme, sub-theme, and codes.

Theme	Sub-theme	Codes
1. Strengthening capability by practicing skills	**1.1 Reflecting on practice to build skill**	Amount of talking Applying training correctly Asking permission Audio better than video Bad habits Body language Consultation structure Different perspectives Difficulty asking client Disappointment Disparity Feeling weak How client was going to change Huge learning curve Putting it into practice Righting reflex Role plays Takes time to fine tune The way you come across Things you can tweak Thinking too much
	1.2. Learning to let the client take control	Allowing the client to speak Making it more client-centred Not becoming prescriptive Not jumping in Open questions Trying to steer them Holding myself back
	1.3. Choosing appropriate Behaviour Change Techniques	Action planning Advantages vs disadvantages Barriers Benefits Bumps in the road Confidence scales Eatwell Goal setting Guidelines Self-monitoring Self-reward Signposting activities Time is precious

2. Maximising opportunities	**2.1. Tailoring extra opportunities**	Buddies Council-run extra sessions External instructors GAS-run extra sessions Moving location of sessions Partial control Using own equipment Workload
	2.2. Positive feedback enhances stakeholder engagement	Buy in Diabetes nurse Engaging stakeholders Feedback to GPs from clients Lack of information Save them time Selling it right Slow burner
3. Enabling behaviour change	**3.1. Confidence to do it ourselves**	Adding credibility Having someone oversee useful More in-depth Not much previous training Previous experience Range of tools Too much information Using training in a practical sense Confidence from training
	3.2. Supporting further behaviour change	Apps to recommend Continued feedback Facilities Money More techniques Ongoing CPD Structured walking programme Writing to all patients Need for guidance
4. Understanding the client journey	**4.1. Experiencing client progression**	Activity to go to Client changes – consultation Family improvement Mental health Physical health Time management
	4.2. Telling the client's story	Human story getting lost

		Not seeing good results Steering group members
	4.3. Understanding client capability	Agoraphobia Anxiety and depression Counselling services Ethnicity Re-focus on physical activity Relapsers Schizophrenia Suicidal Physical health Nothing for me
	4.4. Understanding client motivation	Being judged Body concerns Cold weather Don't want to be seen GAS-led sessions MI not for everyone Motivational messages Not enough time
	4.5. Appreciation of extra support	Booklet Gas-led sessions Given time Something for them Support Variety of classes
5. Future considerations	**5.1. Keeping in contact with clients**	Attendance at extra sessions Engagement Letter is better No pressure Text message Additional consultations Difficulty with relapsers Don't need project anymore Emphasising support Mostly for relapsers Too much of a gap
	5.2. Need more user-friendly measures	Clients feel pressured Client embarrassment Client expectation Client honesty GAS discomfort

		Introducing barriers It’s a pain Learning difficulties Length or time to complete Literacy Negative environment Not always appropriate Not influencing Providing explanations Reading questions to clients Refuse to complete Second language Trigger words You can sense annoyance You want to get to know them Better definitions Formatting Generic questions Questions are upsetting Wording GAS understanding Length or time to complete
	5.3. Using the booklet as an extension of the consultation	Arranging appointments Better use of booklet Booklet as reinforcement Booklet as reminder Booklet at end Client responsibility Complete with client Extra support It depends on consultation or clients Just another bit of paper Not necessarily completing pages Number of BCTs Patronising, basic Printed advice pages Suitability of BCTs Time constraints Timeline

Appendix V: Case study example

Since joining Active Herts in May 2016, Hannah Marsh and the programme has helped me immensely in my weight loss journey. I had not long moved to the area from London; away from friends and feeling down as well as being out of shape, weighing close to 17st. While sat in the doctors I saw a poster of an overweight man playing football and looking worn out; two situations I knew well - it was like looking in a mirror! It was promoting a healthy way to live, as well as a chance to meet local people. So I arranged to meet with no expectations, and thinking if I get to play football it's a bonus.

After our first meeting the Get Active Specialist made me feel relaxed to talk about myself and be honest. I was 16st 10 and I remember her first bit of advice regarding my eating habits made me change the way I see snack food.

If I was bored at work I would pop to the canteen for a sugar fix which consisted of sweets, chocolates and crisps. Hannah suggested having clementine's on my desk was the first step. She then got me membership at my local gym, which I have never been a fan of as I always felt out of place and wandering around not really working out. My brother in law invited me to play in his 5-a-side team on a Wednesday night, but a few weeks later I hurt my knee.

At my next catch up with Hannah, and sensing I was using this as an excuse to not do as much, which I was most probably doing, she informed me of a local "Fella's Fitness" men's exercise session starting up on a Wednesday. This was where other men she was helping go to get fit, and suggested that I go while not playing football. Here I came out of my shell more and could then take what I was doing there back to the gym which made me more confident – so much so that I quit the football to attend this instead. While it was tough at the start I found myself getting more and more into it and looked forward to going to a gym. I then found a local group of lads that play football at a school 2mins from my house and was playing there on a Friday. I was starting to get a routine of fitness I've not had since PE lessons at school!

In January 2017 I was a little down with the post-Christmas blues, missing my friends and again while at the doctors I saw Hannah and popped in to say hello. 10mins later I was sobbing while confessing how down I was and again it came back to my weight. While I was feeling better, I wasn't looking it. I mentioned how my wife had started Slimming World and was wondering whether to also try it. Hannah urged me to go. So I started eating what my wife ate, cutting out more of the wrong snacks and eating better, and within 6wks I had lost a stone and I was on a roll!

The Wednesday night class was good but I then found myself wanting to push myself more, and then in June 2017 I found a local boot camp group that workout outdoors. I was now eating better, losing weight and working out 3 times a week. Again at another chance meeting with Hannah she informed me of an afternoon circuit group she was running that was starting that day! The old me would have made up an excuse, but here I was more than happy to join in if not to support Hannah - but it was also another chance to work out! I have been going virtually every Friday since and love the different mix of work outs she comes up with, including Pilates!

Now in September 2018 I weigh 13st 10, I completed a 5km 'Muddy Mayhem' mud run in February, and I'm wearing 34inch waist skinny jeans! I go to circuit classes up to 5-6 times a week, still play football and I'm feeling better than ever - all from Active Herts. But none of this could have been possible without the efforts, support and friendship of Hannah. Now whenever I go shopping and see a bag of clementine’s I always think back to that first meeting and that first bit of advice and a little smile creeps.

Appendix W: Website screenshot

Active Herts
Your first step to a more active lifestyle

Sign Up   Contact Us

Getting Active   Get Started   Real Stories   Volunteer   Healthcare Professionals   About Us

ABOUT ACTIVE HERTS

Active Herts is a research led and independently evaluated project which uses proven behaviour change techniques to support inactive adults to increase their physical activity levels. The project follows a protocol developed by Howlett et al. (2017) which identifies and applies the latest behaviour change theory and techniques to support the target audience. These behaviour change techniques are embedded throughout the programme, both through the consultations with the Get Active Specialists (highly trained delivery staff) and through the consultation booklet.

The independent evaluation of this project is showing fantastic outcomes, with physical activity increasing, sitting time reducing and mental health improving. These outcomes are evident at 3 months, and are sustained at 6 and 12 months, highlighting the long-term benefits experienced by participants

KEEN TO USE THE SAME MODEL IN YOUR AREA?

The Active Herts team are keen for this innovative and exciting approach to be shared and applied in other locations, and would like to see the benefits replicated across the country and beyond. We would like to be able to track the usage of the Active Herts model, and would therefore ask that you complete the details below so we can track where the Active Herts approach is being used. We also ask that where the Active Herts approach is being followed or adapted, the project is credited, as outlined below:

* We would like to credit the Active Herts team for the research and design supporting this booklet. For more details please see www.activeherts.org.uk

We would also encourage prospective users to contact our team so that we can support you, and explore potential training and evaluation.

Please complete the form below and we will send you the required programme materials.

Appendix X: Watford Booklet

Appendix Y: Sport England screenshot

14 Sport England – Design Principles

Principle 8: PROVIDE SUPPORT FOR BEHAVIOUR CHANGE

People make or break the experience. Make sure your participants are appropriately supported along the way.

Train and support coaches/volunteers to provide a quality experience – they'll need to adapt sessions, pitch them at the right level, and use behaviour change principles.

Provide a buddy system for new participants – using people who are confident in an activity can make it easier and more enjoyable for new participants.

Be adaptable in your delivery – coaches/ exercise professionals will need to arrange sessions to meet a range of fitness levels.

Incorporate social elements – like post-session tea or coffee. Encourage people to talk to each other and make commitments to be active together.

Minimise the risk of people relapsing – get people to publicly commit to their activity goals and help them plan for potential lapses, so that missing a few sessions doesn't become a full relapse into inactivity.

Contact people who have missed a couple of sessions – Understand what the reason is and help them to understand that missing a few sessions or a few weeks of activity is really common. Reassure them that they will welcomed back again when they are ready.

Activity levels can be seasonal – good project planning and delivery can minimise the effects of people relapsing to inactive behaviour in winter.

Celebrate people's achievements – promote and celebrate what they have done. The 'I did it' factor is incredibly important in improving confidence in their ability to be active. Coaches should help people see what they have achieved, how much more they could achieve, and what they would lose by stopping.

"They use WhatsApp all the time – if one of the women in the group sends a WhatsApp then they all get it, so we ask them to say: 'Where were you this week?'"

GLL's For the Girls, by the Girls, Sporta MYM project

The Active Herts project supports people to change in a number of ways

"The Active Herts project provides dedicated behaviour change support. We developed a personal action plan guide as part of our tools to support people who have been referred to our Active Herts project. The guide helps people to set goals, plan to get active and plan for times when it gets difficult to build their activity habit. It can also help people track their progress. People can fill it in by themselves or it can be used as part of the consultation with the Get Active Specialists".

Joe Capon, Senior Health Project Officer, Herts Sports Partnership