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An Intervention to Prompt Changes to Sedentary Behaviour in Office Workers

O'Dolan, Catriona

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An intervention to prompt changes to sedentary behaviour in office workers

Catriona O'Dolan

School of Health & Life Sciences

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Dedication

For my tremendous trio: Orla, Eimear & Finn O’Dolan

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ABSTRACT

Background

Office workers have been identified as being at risk of accumulating high amounts of sedentary time in prolonged events during work hours, which has been associated with increased risk of a number of long-term health conditions. There is some evidence that providing advice to stand at regular intervals during the working day, and using computer-based prompts, can reduce sedentary behaviour in office workers. However, evidence of effectiveness, feasibility, and acceptability for these types of intervention is currently limited. Little is also understood regarding behaviour change theories applicable to occupational sedentary behaviour, and how such theory could inform intervention development and implementation.

The aims of this thesis were to develop and test a low-cost education and prompt intervention to reduce and break up the sedentary behaviour of office workers, and to explore whether existing behaviour change theory can explain sedentary behaviour in the workplace.

Methods

The Medical Research Council's framework for design and evaluation of complex interventions, was used as a basis for developing the intervention which was initially tested in a 2-arm, parallel group, cluster-randomised feasibility trial with office workers in a commercial bank (n=21). Participants were assigned to a control or intervention group. Both groups received education on reducing and breaking up sitting at work, and the intervention group also received hourly prompts, delivered by Microsoft Outlook over a period of 10 weeks, reminding them to stand. Objective measurements of sedentary behaviour were made using activPAL monitors worn at 3 measurement points: baseline; in the last 2 weeks of the intervention period, and 12 weeks after the intervention. Focus groups were conducted to explore the acceptability of the intervention and the motivations and barriers to changing sedentary behaviour.

The education and prompt intervention was subsequently tested in a pilot study of office workers in a large pharmaceutical company (n= 29). In order to address some of the limitations of the feasibility study, the method used in the pilot study was altered slightly to include: minimising information given on study aims prior to baseline; incorporating feedback on baseline activity into the education session; non-clustering of participants; an additional measurement period during the first 2 weeks of the intervention; measures of stage of change and the constructs of social cognitive theory.

Results

The feasibility study demonstrated that randomly generated, customised prompts, delivered by Microsoft Outlook, with messages about breaking up sitting, were a feasible and acceptable way of delivering prompts to office workers. Small, short-term reductions from baseline levels were made to sedentary behaviour outcomes, which were not maintained at follow-up, in participants from both the intervention and control groups. Similar results were obtained in the pilot study, with reductions in sedentary behaviour outcomes in both groups made early in the intervention period not being maintained by late intervention measurement, or at follow up. Analysis of time taken to stand following delivery of a prompt, in both studies, suggested the intervention groups did not react immediately to prompts, and any increase in standing was made at unrelated times.

Five key constructs, in line with Social Cognitive Theory, surrounding motivation for sedentary behaviour at work, were identified: i) situation/environment, ii) outcome expectations, iii) self-efficacy, iv) self-regulation, v) observational learning. The education session seemed to increase outcome expectations of the benefits of changing sedentary behaviour, and promote self-regulation of behaviour in some participants. However, low self-efficacy and a desire to conform to cultural norms were barriers to changing behaviour. Measures of readiness to change sedentary behaviour at work increased in both groups in the pilot study.

Conclusions

Prompts delivered by Microsoft Outlook were a feasible, low cost way of prompting office workers to break up their sedentary behaviour, although further research is needed to determine whether this has an additional impact on sedentary behaviour, to education alone. Social Cognitive Theory provides a useful framework for understanding the barriers and facilitators that influence occupational sedentary behaviour. Future research would benefit from developing this further to include the influence of social and cultural norms, and perceived behavioural control in order to develop a theoretical underpinning for the design and implementation of interventions to improve sedentary behaviour patterns in the workplace.

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Last, but by no means least, I would like to acknowledge the support of my family. Much love to my Mum, Dad, Iain and Fiona, and to my late, but never forgotten, brother Stewart who planted the seed of embarking on a doctorate many years ago. Your self-belief and determination continues to inspire me. The biggest debt of gratitude is owed to my husband Seán, without whom none of this would have been possible. Thank you for the love and support, for the advice and encouragement, and for laughs and adventures during PhD down-time.

Contribution of work declaration

This thesis is composed of original work, and contains no material previously published or written by another person except where appropriate reference has been given. No part of the work included in this thesis has been submitted for any other degree or qualification.

The research studies detailed in this thesis were funded through a PhD studentship awarded by Glasgow Caledonian University.

Catriona O'Dolan was solely responsible for all database searches, screening of abstracts, and write up of the literature reviews conducted as part of this theses (Chapter 2).

Work on developing the feasibility study (Chapter 4 in this thesis) had commenced before the start of this PhD. An Employer consultation exercise had been completed, and, based on that, a decision to use prompts as the basis of the intervention had been taken by the supervisory team (Philippa Dall, Margaret Grant and Maggie Lawrence). Catriona O'Dolan contributed to development of the intervention, including finalising intervention content and evaluation protocols, and liaising with the employer regarding their involvement and pragmatic aspects of the study. Catriona O'Dolan was responsible for all data collection (including its scheduling and organisation), setting the focus group topic guide and conducting the focus groups. This included the decision to align data analysis of the focus groups with Social Cognitive Theory.

All work on designing, developing and carrying out the pilot study (Chapter 5 in this thesis) was carried out by Catriona O'Dolan including liaison with the employer and participants at the study site, quantitative and qualitative data collection, all data processing and analysis, and interpretation of the findings.

Philippa Dall developed the macro for uploading prompts from Microsoft Excel into Microsoft Outlook, and the customised excel sheets used to extract and categorise the activPAL outputs (the original HSC analysis program was co-developed with Malcolm Granat). These were used in both studies described in this thesis.

The education session delivered to participants in both studies was designed and delivered by Margaret Grant with input into the content made by Catriona O'Dolan, Philippa Dall, and Maggie Lawrence. Maggie Lawrence assisted Catriona O'Dolan in facilitating both sets of focus groups.

All chapters in this thesis were written by Catriona O'Dolan with review and guidance from all supervisors: Philippa Dall, Margaret Grant, and Maggie Lawrence.

From this point forward in the thesis, Catriona O'Dolan is referred to as 'The Researcher'. The 'Research Team' refers to the supervisory team: Philippa Dall, Margaret Grant, and Maggie Lawrence.

Presentations and papers during candidacy

Papers

- O'Dolan, C.E., Grant, M., Lawrence, M., Dall, P., 2017. A randomised feasibility study to investigate the impact of education and the addition of prompts on the sedentary behaviour of office workers. *Pilot and Feasibility Studies,* **4**, pp.33- 44

- O'Dolan, C.E., Dall, P.M., 2016. The sedentary office: a modern-day occupational health hazard. *Journal for the Association of Chartered Physiotherapists in Occupational Health and Ergonomics*. **(20.2)**, pp.10-13

- Chastin, S.F.M., De Craemer, M., Lien, N., Bernaards, C., Buck, C., Oppert, J., Nazare, J., Lakerveld, J., O'Donoghue, G., Holdsworth, M., Owen, N., Brug, J., Cardon, G., DEDIPAC Consortium,Expert Working Group And Consensus Panel And On Behalf Of The DEDIPAC Consortium,Expert Working Group and Consensus Panel, 2016. The SOS-framework (Systems of Sedentary behaviours): an international transdisciplinary consensus framework for the study of determinants, research priorities and policy on sedentary behaviour across the life course: a DEDIPAC-study. *The International journal of behavioral nutrition and physical activity,* **13**(1), pp. 83-96
  [Named as a member of the consensus panel]

Posters

- O'Dolan, C.E., Grant, M., Lawrence, M., Dall, P. Can Social Cognitive Theory explain occupational sedentary behaviour? International Society of Behaviour, Nutrition and Physical Activity 16th Annual conference, Vancouver Island, Canada 7-10 June 2017

- O'Dolan, C.E., Grant, M., Lawrence, M., Dall, P. The impact of education and prompts on reducing unhealthy patterns of sedentary behaviour in office workers: a pilot study. International Society of Behaviour, Nutrition and Physical Activity 16th Annual conference, Vancouver Island, Canada 7-10 June 2017

Oral presentations

- O'Dolan, C.E., Grant, M., Lawrence, M., Dall, P. Taking a break from the office chair. Do we all need prompting? Perspectives of Workplace Physical Activity and Sedentary Behaviour seminar. 14th March 2017, Glasgow Caledonian University, Glasgow, UK

- O'Dolan, C. How do you create a dynamic office? Launch of the dynamic office facilities. 11th May 2016, Glasgow Caledonian University, Glasgow, UK.

- O'Dolan, C.E., Grant, M., Lawrence, M., Dall, P. Preliminary results of a pilot study testing prompts to break up sedentary behaviour in the workplace. PhD mini conference 17th December 2015, Glasgow Caledonian University, Glasgow, UK

- O'Dolan, C.E., Grant, M., Lawrence, M., Dall, P. Promotion of healthy patterns of sedentary behaviour in the workplace. RDC2 presentation. 23rd June 2015, Glasgow Caledonian University, Glasgow, UK

- O'Dolan, C.E., Grant, M., Lawrence, M., Dall, P. Promotion of healthy patterns of sedentary behaviour in the workplace. PhD mini conference 27th February 2015, Glasgow Caledonian University, Glasgow, UK

Abbreviations

A	Action (stage of change)
ACAS	Advisory Conciliation and Arbitration Service
ANCOVA	Analysis Of Covariance
ANOVA	Analysis Of Variance
BCT	Behavioural Choice Theory
B-EI	Baseline to Early Intervention
B-FU	Baseline to Follow-Up
BMD	Bone Mineral density
BMI	Body Mass Index
B-pseudo	response to pseudo prompts at baseline
BSE	Barrier Self-Efficacy
B Strategies	Behavioural Strategies
C	Control group
C1-6	Control focus group participants numbered 1-6
CI	Confidence Interval
COM-B	Capability Opportunity Motivation Behaviour model
cpm	counts per minute
CVD	Cardiovascular Disease
DEDIPAC	Determinants of Diet and Physical Activity
Early Int	Early Intervention
EI	Early Intervention
FU-pseudo	response to pseudo prompts delivered at follow-up
HAPA	Health Action Process Approach
I	Intervention group
I1-7	Intervention focus group participants numbered 1-7
ICPHR	Internal Collaboration for Participatory Health Research
IPAQ	International Physical Activity Questionnaire
IPS	International Prevalence Study
I-pseudo	response to pseudo prompts at intervention
IQR	Inter-Quartile Range
I-real	response to actual prompts delivered at intervention
kg	kilograms
Late Int	Late Intervention
LI	Late Intervention

LPL	Lipoprotein Lipase
LTEQ	Leisure Time Exercise Questionnaire
m	metres
METs	Metabolic Equivalents
mins	minutes
MRC	Medical Research Council
MSKD	Musculoskeletal Disorders
MVPA	Moderate-Vigorous Physical Activity
NHANES	National Health And Nutrition Examination Study
n	number
N	No
NICE	National Institute for health and Care Excellence
Obs Learn	Observational Learning
OECD	Organisation for Economic Co-operation and Development
OHP	Occupational Health Practitioners
p	probability
Pa	Pre-action stage of change
PA	Physical Activity
PAWS	Prompting Activity in a Workplace Setting
PBC	Perceived Behavioural Control
PC	Personal Computer
PMT	Protection Motivation Theory
R	correlation coefficient
RCT	Randomised Controlled Trial
SB	Sedentary Behaviour
SBRN	Sedentary Behaviour Research Network
SCHWL	Scottish Centre for Health Working Lives
SCT	Social Cognitive Theory
SCTQ	Social Cognitive Theory Questionnaire
SD	Standard Deviation
SDT	Self Determination Theory
SN	Subjective Norm
SOC	Stage Of Change
SOCQ	Stage Of Change Questionnaire

SOS	Systems of Sedentary behaviours
SPSS	Statistics Package for Social Sciences
TRA	Theory of Reasoned Action
TST	Temporal Self-regulation Theory
TTM	Transtheoretical Model
TV	Television
UK	United Kingdom
US	United States
WH	Work Hours
WHPP	Workplace Health Promotion Programmes
y	linear regression of line of best fit
Y	Yes

1. INTRODUCTION

1.1. Defining sedentary behaviour

The term 'sedentary' derives from the Latin word 'sedere' meaning 'to sit' (Thorp et al. 2011). As interest in sedentary behaviour research has grown over recent years, there have been numerous definitions of 'sedentary behaviour' postulated in the published literature (Owen et al. 2000, Salmon et al. 2003, Jans et al. 2007, Chastin & Granat 2010, Sedentary Behaviour Research Network 2012).

To address inconsistencies, and standardise terminology, a multi-disciplinary steering committee, composed of members of the Sedentary Behaviour Research Network (SBRN), used a methodical consensus process in order to reach an agreed definition for sedentary behaviour and associated terminology (Tremblay et al. 2017). Whilst the results of this consensus project were published towards the end of this PhD, all references made to sedentary behaviour, and associated terminology, within this thesis, correspond to these definitions, which are detailed below.

Sedentary behaviour has been defined as: "*any waking behaviour characterized by an energy expenditure ≤ 1.5 metabolic equivalents (METs), while in a sitting, reclining or lying posture*" (Tremblay et al. 2017, p9). Related definitions include sitting defined as: "*A position in which one's weight is supported by one's buttocks rather than one's feet, and in which one's back is upright*", reclining as a: "*body position between sitting and lying*", and a definition of lying as: "*being in a horizontal position on a supporting surface*" (Tremblay et al. 2017, p10).

Other definitions, important in the context of this thesis, are the terms 'Sedentary time' defined as: "*time spent for any duration (e.g, minutes per day) or in any context (e.g. at school or work) in sedentary behaviors,",* 'Sedentary bout': *"a period of uninterrupted sedentary time and sedentary interruptions/breaks- a non-sedentary bout in between two sedentary bouts*", and physical inactivity: *"an insufficient physical activity level to meet present physical activity recommendation"* (Tremblay et al. 2017, p9).

It should also be noted that the term 'sitting' in this thesis is used interchangeably with sedentary behaviour (unless otherwise stated), as sitting is a term more commonly used by people to describe their own sedentary behaviour.

1.2. Sedentary behaviour as a health risk

High levels of sedentary behaviour have been associated with all-cause mortality (Chau et al. 2013) as well as contributing to the risk of developing a number of long-term health conditions including cancer; cardiovascular disease; diabetes; obesity; musculoskeletal problems; muscle degeneration; osteoporosis; and depression (Chastin et al. 2014a, de Rezende et al. 2014, Zhai et al. 2014, Proper et al. 2011, Thorp et al. 2011). Evidence suggests that prolonged, uninterrupted sedentary events have a greater negative impact on health than sedentary behaviour accumulated in shorter events (Healy et al. 2008a). Whilst some studies have shown that this increased risk may be independent to the amount of physical activity an individual may perform (Thorp et al. 2011, Owen et al. 2010), more recent evidence suggests that relatively high levels of physical activity may attenuate the detrimental health effects of sedentary behaviour (Ekelund et al. 2016). However, reviews of sedentary behaviour interventions suggest that interventions that focus on sedentary behaviour alone, may be more effective at changing sedentary behaviour than those that attempt to both increase physical activity and reduce sedentary behaviour simultaneously (Martin et al. 2015, Prince et al. 2014).

People are living for longer and an increase in the incidence of non-communicable long-term conditions has the potential to cause a steep rise in both economic, societal, and individual costs (World Health Organisation 2011). While causal pathways between sedentary behaviour and such long term conditions are sometimes unclear (Thorp et al. 2011) an increasingly sedentary population will undoubtedly compound the economic, societal, and individual burden of disease and ageing.

1.3. Sedentary behaviour in the workplace

Sedentary behaviour has been a focus of rehabilitation and improving outcomes for a number of clinical groups including stroke survivors (English et al. 2014), people with cardiovascular disease (Dunstan et al. 2011), diabetes (Hu et al. 2001), and obesity (Bond et al. 2014, Thorp et al. 2014, Otten et al. 2009). Children and adolescents (Biddle et al. 2014) and older adults (Rezende et al. 2014) have also been target groups for interventions to improve patterns of sedentary behaviour, although, for both, the distinction between reducing sedentary behaviour and increasing physical activity (PA) is often blurred.

Adults of working age, who are currently free from long-term conditions, are a potential target group for sedentary behaviour interventions, who, have received less attention. The environments and circumstances within which people sit for both work and leisure have changed rapidly since the middle of last century (Owen et al. 2010). These include changes to how people travel between different environments, and the development and widespread uptake of information and communication technology, such as email and skype, that facilitates less movement, as well as a rise in screen-based leisure activities (Saidj et al. 2015). Scottish adults in employment self-reported accumulating almost 50% of their weekday sedentary behaviour during work hours (Strain et al. 2017). Of working adults, office workers have been identified as one of the most sedentary occupational groups (Healy et al. 2012). They have been estimated to spend between 65-75% of their working day sitting (Smith et al. 2015, Clemes et al. 2014a, Ryde et al. 2013, Ryan et al. 2011, Miller & Brown 2004) and make significantly fewer breaks in sedentary time during working hours, than in leisure time (Parry et al. 2013). With an estimated 60% of the world's population forming the global workforce, and these workers spending an estimated 60% of their waking hours at work (Shrestha et al. 2016), for those in sedentary occupations this represents a large amount of sedentary time. It also provides an opportunity to influence the behaviour of a large proportion of adults though workplace interventions (World Health Organisation 2008). In turn, improving the health and productivity of the current workforce, and the next generation of retirees.

1.4. Structure of this thesis

The structure of this thesis follows the methodical approach adopted to the work carried out as part of this PhD, which began with the broad research question of: 'how do you design and implement an intervention aimed at improving sedentary behaviour patterns in the workplace?'. The first step in this process was to conduct a literature review, which is presented in chapter 2. In order to fully understand the topic of sedentary behaviour, its health implications, severity, and context within a workplace environment, sub-sections of the literature review include: health risks associated with sedentary behaviour; the scale of sedentary behaviour in the population and within the workforce; the impact of the physical and cultural work environment; and workplace legislation regarding health. In order to inform the development of an intervention to improve sedentary behaviour, other sub-sections include a review of previously published studies to reduce sedentary behaviour in the workplace and an exploration of behaviour change theories that may be applicable to informing intervention design and implementation. The chapter concludes with highlighting gaps in the literature before outlining the aims and objectives of this thesis.

Chapter 3 follows on from the literature review, outlining the overall methodology used to design the intervention used in both studies reported in this thesis. Chapter 4 describes the first of these studies, a feasibility study used to test the intervention and Chapter 5 describes the second study, a pilot study, in which the intervention is repeated, but the methods refined and expanded as a result of the findings from the feasibility study. Chapter 6 presents the key findings from both the feasibility and pilot studies and discusses implications for the future direction of sedentary behaviour research.

A graphical representation of the thesis structure is presented in Figure 1.1

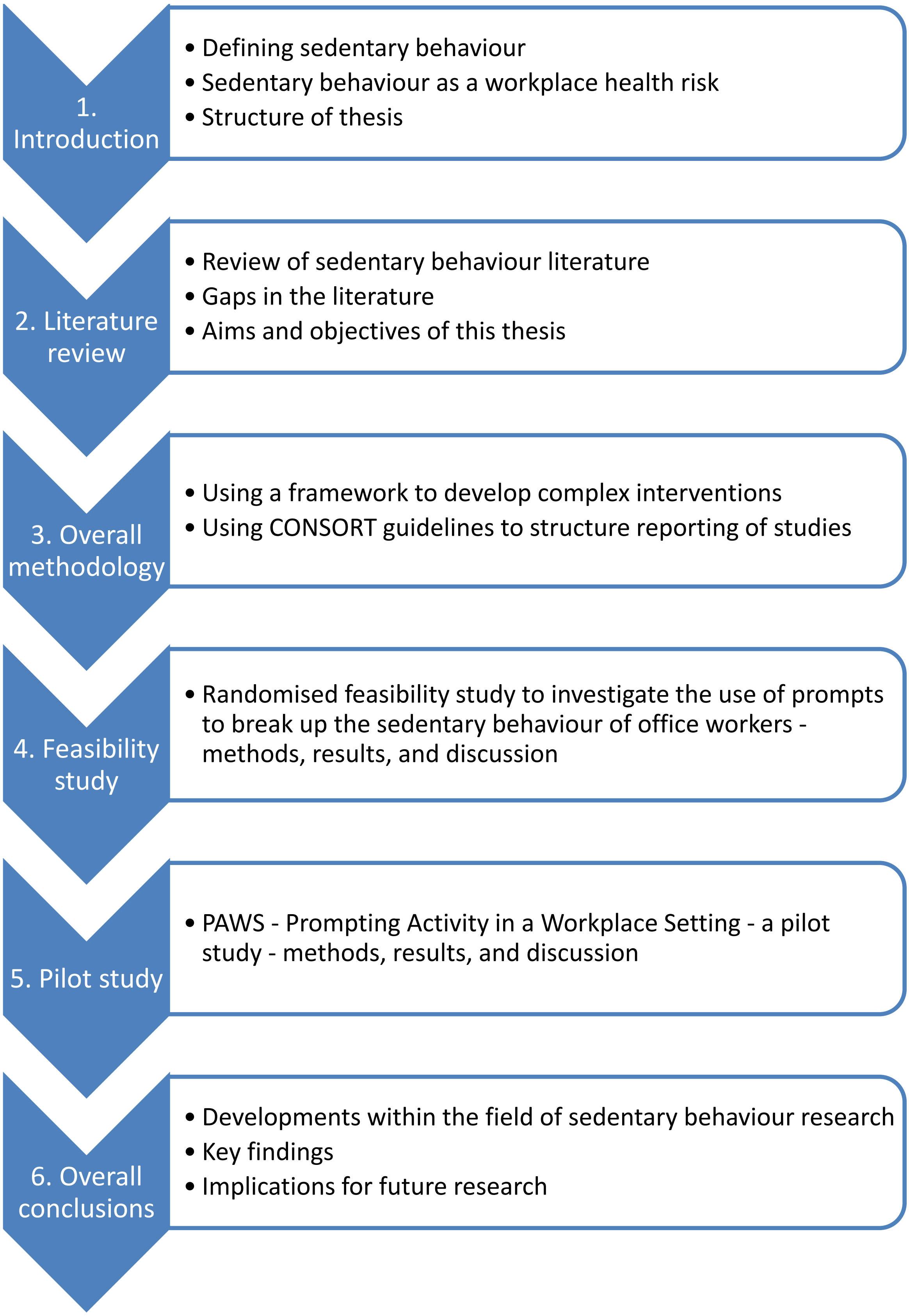


Figure 1.1 Thesis structure

2 LITERATURE REVIEW

2.1 Methodology for literature review

Within the year that this PhD commenced, three systematic reviews on interventions to reduce sedentary behaviour in the workplace were published (Neuhaus et al. 2014a, Prince et al. 2014, Tudor-Locke et al. 2014) and shortly afterwards a registered Cochrane Review on the same topic was published (Shrestha et al. 2015). It was therefore felt that an additional formal systematic review on the topic, at this time, was not required. Instead, a structured approach, outlined below, was adopted with the purpose of reviewing the literature to gain a comprehensive understanding of published research on the topic of sedentary behaviour, and to inform the design of the studies detailed in this thesis. This method allowed articles to be identified and appraised that may have not met the strict inclusion criteria deployed in a formal systematic review.

The main literature review was conducted in December 2014, a summary of which is reported in this chapter, containing relevant literature accessed up to 31/12/2014, including some articles from 2015 that were available pre-publication. Table 2.1 lists the search terms used and Table 2.2 lists databases searched during this review. Abstracts were scanned for relevance and included in the review where appropriate. In general, the review focused on studies that aimed to reduce sedentary behaviour in adults in a workplace setting, though studies in other settings and samples were included where it was felt the results could be applied to further understanding of occupational sedentary behaviour. This search was repeated following completion of the two empirical studies (Chapters 4 and 5), in June 2017, and additional relevant literature published since January 2015, used to inform the discussions of both studies and the overall conclusions of this thesis (Chapter 6). Note that all search terms were searched for in all databases listed. Where search terms included more than one word or phrase, Boolean operators (AND/OR) were used, as appropriate.

In addition to the search conducted for the main review, additional searches were made of the databases listed, to inform the review of behaviour change theory in April 2015 (section 2.6) and the review of relevant guidance and legislation in September 2015 (section 2.4.3), which also involved a search of the grey literature (e.g. using google, google scholar, and through searches of the following online databases: Gov.UK publications, Health & Safety Executive, Office for National Statistics, National Institute for Health Excellence, Cochrane library).

Table 2.1 Search terms used in main literature review conducted Dec 2014.

Search terms (linked by AND/OR as appropriate)
Health risks sedentary behaviour
Health risks sedentary behavior
Reducing sedentary behaviour
Reducing sedentary behavior
Reducing sitting
Sedentary patterns
Prolonged sitting
Sedentary behaviour change
Sedentary behavior change
Sedentary behaviour interventions
Sedentary behavior interventions
Occupational sitting
Workplace sitting

Table 2.2 Databases used for the main literature review conducted Dec 2014

Databases searched
AMED
CINAHL
Cochrane library
Health source
MEDLINE
Ovid
ProQuest family health
ProQuest health & medical
ProQuest health management
ProQuest nursing and allied health source
ProQuest research library
Science direct
TRIP
Web of Science
PsycARTICLES
PyscINFO

2.2 Introduction to literature review

The structured method for reviewing the literature (section 2.1) has resulted in an extensive and comprehensive overview of research into sedentary behaviour in the workplace, the context in which it occurs, and the interventions designed to combat it.

The literature review has been divided into four sections:

1. The consequences and context of sedentary behaviour – an overview of the evidence of how sedentary behaviour patterns may impact on health, the context in which sedentary behaviour occurs and the potential scale of this problem in society.

2. Understanding occupational sedentary behaviour – quantifying how sedentary people are at work, and how the work environment and workplace legislation impacts on behaviour.

3. Interventions to reduce sedentary behaviour in the workplace – a comprehensive overview of interventions conducted in workplaces with the aim of reducing sedentary behaviour.

4. Behaviour change theory and sedentary behaviour – an overview of theories of behaviour change, how they may be applicable to sedentary behaviour, and how their application may inform intervention development.

Each of the four sections is concluded with a brief summary. An overall summary of gaps in the literature is presented at the end of the literature review (section 2.7) which was used to inform the research questions, aims and objectives of this thesis (section 2.8) and, ultimately inform the design of both the feasibility and pilot study detailed in chapters 4 and 5 respectively.

2.3 The consequences and context of sedentary behaviour

Whilst the health benefits of physical activity are well established (Lee et al. 2012), evidence has more recently emerged with regard to the distinct health risks associated with sedentary behaviour. This section will give an overview of the health risks that have been associated with sedentary behaviour, and the scale and implications of this for society. The domains within which people are sedentary will be briefly examined for the purposes of giving context to occupational sitting across the life-course.

2.3.1 What are the health risks of sedentary behaviour?

2.3.1.1 Non-communicable diseases and all-cause mortality

A number of large scale cross-sectional studies have reported positive associations between sedentary behaviour and all-cause mortality in Australian (n=22,497), American (n=240,819), Canadian (n=17,013), and Scottish (n=4,512) adults (van der Ploeg et al. 2012, Matthews et al. 2012, Katzmarzyk et al. 2009, Stamatakis et al. 2011). For all of these studies, this association remained after adjustment for age, sex, education, smoking, diet, existing disease, and levels of moderate-vigorous physical activity (MVPA). All cause-mortality was also positively associated with sedentary behaviour in three meta-analyses (Chau et al. 2013, Wilmot et al. 2012, Grøntved & Hu 2011), the latter two also showing a link between sedentary behaviour and both Type 2 Diabetes, and cardiovascular disease (CVD). Strong evidence of the association between CVD and sedentary behaviour was found in one systematic review of prospective studies (Proper et al. 2011) which also showed a strong association with cancer, a moderate association with Type 2 Diabetes and mixed results regarding the link between sedentary behaviour and obesity. Another systematic review of longitudinal studies found strong links between self-reported sedentary behaviour, mortality, and weight gain from childhood to adulthood (Thorp et al. 2011).

2.3.1.2 Musculoskeletal disorders

The results of some studies support an association between sedentary behaviour and musculoskeletal disorders (MSKD), although evidence is currently limited (de Rezende et al. 2014). Whilst there was no conclusive evidence of a relationship between screen time and MSKD in children (Costigan et al. 2013), there is some evidence to support a link between screen use and low back pain (Chen et al. 2009), and neck, shoulder, and upper limb pain (Waersted et al. 2010) in adults.

Analysis of a National Health And Nutrition Examination Study (NHANES) cohort (n=2117), a cross-sectional representative sample of the U.S. population, found objectively measured sedentary behaviour to be deleteriously associated with bone mineral density (BMD) of the femur and hip sub-regions in women, independent to levels of MVPA (Chastin et al. 2014a). In particular prolonged events, rather than total sedentary time, had a stronger association with reduced BMD. Reduced BMD is associated with the development of osteoporosis and increased risk of bone fractures (Cummings et al. 1993). Osteoporotic fractures have previously been linked to high levels of self-reported sitting in older women (Cummings et al. 1995), but the study by Chastin et al. (2014a) suggested that improving patterns in which sedentary time is accumulated could also improve bone health.

2.3.1.3 Mental well being

Recently, some studies have examined the relationship between sedentary behaviour and mental well-being. A meta-analysis of 24 observational studies found that sedentary behaviour was associated with an increased risk of depression in adults (Zhai et al. 2014). Another study of UK working adults found that computer use, TV viewing and total non-occupational sitting time were adversely associated with mental well-being in women, but only computer use was associated with poorer mental health in men (Atkin et al. 2012a). In both these studies, identifying causal relationships between sedentary behaviour and mental well-being was problematic. For example, was existing depression the cause of increased screen time or the result of it? Further research to provide insight into this bi-directional relationship will benefit understanding of the motivations behind sedentary behaviour in different contexts.

2.3.1.4 Dose-response relationship

For many of the health risks associated with sedentary behaviour, the relationship appears to be exponential rather than linear. In terms of all-cause mortality, one study estimated that those who sat for 8-11 hours a day had a 15% increased risk of death within 3 years compared to those who sat less than four hours, with those sitting more than 11 hours a day increasing this risk a further 40% (van der Ploeg et al. 2012). Similar results were reached in a dose-response meta-analysis by Chau et al. (2013) who found a 5% increased risk of all-cause mortality for each hour of sitting over 7 hours a day, and a 52% greater risk of mortality above 10 hours a day, in comparison to one hour of daily sitting when levels of physical activity were not taken into account. However, this increased risk dropped to 34% when levels of physical activity were taken into account, suggesting that physical activity may in part attenuate the impact of total sitting time and all-cause mortality for those who are sitting the longest (Chau et al. 2013).

2.3.1.5 Mechanism of action

Based on a mixture of self-reported and objectively measured sedentary time, prospective, and longitudinal studies, evidence of the health risks associated with sedentary behaviour is mounting. However, the mechanism by which sedentary behaviour increases disease risk and the direction of causal pathways is unclear (Thorp et al. 2011). For example, does the lack of energy expenditure resulting from high levels of sedentary behaviour lead to obesity, or does existing obesity impede movement and therefore result in sedentary behaviour? The relationship between sedentary behaviour and numerous factors, including the context in which sedentary behaviour is occurring, is likely to play a role in disease risk. For example, Proper et al. (2011) proposed that obesity and physical activity had a mediating effect on the relationship between sedentary behaviour and Type 2 Diabetes. That is, higher obesity and lower activity levels were more likely to result in high levels of sedentary behaviour leading to Type 2 Diabetes. The context in which the sedentary behaviour being measured occurred, may be important in this example. Sedentary behaviour accrued watching television is associated with snacking, and therefore increased risk of obesity (Gore et al. 2003). Such mediation and complex co-existence of factors are likely to explain the relationship between sedentary behaviour and a number of risk factors for disease.

From a physiological perspective, animal studies suggest that loss of contractile stimulation during sedentary behaviour suppresses uptake of glucose, and, due to reduced lipoprotein lipase (LPL) activity, uptake of triglycerides and free fatty acids into muscle (Hamilton et al. 2007). Increased levels of these compounds in the blood can trigger a biochemical cascade which over time can increase the risk of cardiovascular disease (O'Keefe 2007). By replacing sitting with light to moderate physical activity (1.6-5.9METS), such as standing or walking, this process is reversed. The insulin sensitivity of tissues improves, resulting in increased glucose metabolism, whilst muscle contraction serves to increase LPL activity to allow uptake of trigyclerides and fatty acids (Franklin 2011, Healy et al. 2008b). Evidence suggests that these benefits are as likely to result from lower intensity physical activity, including standing, than shorter periods of vigorous exercise (Duvivier et al. 2013, Healy et al. 2008a). Although one study demonstrated that physical activity at all levels of energy expenditure completely attenuated any negative impact of sedentary behaviour on cardio-metabolic markers, (Maher et al. 2014).

2.3.1.6 Prolonged sitting

In addition to the total amount of time spent in sedentary behaviours, Healy et al. (2008a) demonstrated that the pattern in which it is accumulated may be important. An increase in the number of breaks in sedentary time were beneficially associated with waist circumference, BMI, triglycerides and 2-hr plasma glucose, independent of total sitting time (Healy et al. 2008a). These results were independent to the intensity of activity carried out, as measured by an accelerometer. Other laboratory based studies have demonstrated decreasing postprandial blood glucose and insulin in participants who interrupted their sitting every 20 minutes (Dunstan et al. 2012) and 30 minutes (Peddie et al. 2013) with ≤ 2 minute bouts of light intensity exercise. Breaking up sitting has also been shown to reduce resting blood pressure in office workers (Mainsbridge et al. 2014) and in overweight adults (Larsen et al. 2014) who broke their sitting every 45 minutes and every 20 minutes respectively, the former also encouraging participants to engage in a 'short burst of physical activity' of undetermined length or intensity. These studies provide evidence of the potential health benefits of breaking up periods of sedentary time. In situations where sitting is perceived as unavoidable, such as sitting to carry out work tasks, regularly interrupting sedentary time can help mitigate health risks and may provide a more tangible and achievable health message for some. However, further research is required to determine the optimum length of time at which sitting needs to be interrupted, for how long, and with what intensity of activity, in order to achieve any associated health benefits.

2.3.2 What is the scale of sedentary behaviour and how is it measured?

2.3.2.1 Levels of sedentary behaviour in the general population

Estimating levels of sedentary behaviour in the population is problematic. Sedentary behaviour occurs in varying amounts, in different domains, across the life-course (section 2.3.4). Measurements of sedentary behaviour are often made in either specific domains e.g. the workplace (Clemes et al. 2014b), in relation to specific sedentary behaviours e.g. screen time (Stamatakis et al. 2011) or in relation to specific age-ranges e.g. adolescents (Biddle et al. 2009a). Whole population estimates of sedentary behaviour are therefore rare (Hallal et al. 2012), and, in terms of intervention development, arguably not helpful. They may, however, be instrumental in justifying policy changes required to impact sedentary behaviour on a larger scale.

Accelerometer data from large population-based samples of US citizens as part of the National Health and Nutrition Examination Survey (NHANES), found that, overall, participants spent 54.9% of their monitored time, or 7.7 hours/day, in sedentary behaviours (Matthews et al. 2008). Self-reported sitting time measured by the International Prevalence Study (IPS), recorded an average of 5.8 hours sitting a day in adults (n= 49,493) across 20 countries (Bauman et al. 2011). Great variation was noted between countries, suggesting cultural or sampling differences, or perhaps differences using the self-report instrument. Similar variations in sitting were seen across countries in the Eurobarometer data, a standardised long-term pan-European survey investigating a range of economic, social and health issues. In the overall sample of 27,637 adults, average weekday sitting was reported as 5.15 ±3.1 hours a day (Bennie et al. 2013).

2.3.2.2 How is sedentary behaviour measured?

Just as the three studies above differed with regard to how they measured sedentary time, a great deal of variation was seen across the literature in terms of tools used for measuring sedentary behaviour, and how data is analysed and presented, making comparisons, and inferences, across studies difficult. The following sections give an overview of the main methods used to measure sedentary time in free-living adults and the considerations that should be made when analysing and interpreting results.

2.3.2.2.1 Subjective measures of sedentary time

Subjective measures of sedentary time are usually made using questionnaires, behavioural logs or short-term recalls in which participants are asked to either estimate their total sedentary time or to assign an amount of time to specific sedentary behaviours or domains (Atkin et al. 2012b, Healy et al. 2011). In this way subjective measures often provide useful insight into the context of sedentary behaviour: when, where, and why it is happening, allowing interventions to be targeted accordingly. They can also be more economic and pragmatic than asking participants to wear body-worn monitors to obtain objective measurements, especially in large-scale surveillance studies (Bauman et al. 2011).

The limitations of self-report measures are people's ability to accurately recall their sitting behaviour (Healy et al. 2011). The International Physical Activity Questionnaire (IPAQ), a commonly used questionnaire in sedentary behaviour research, asks participants to recall their physical activity and sedentary time over the previous 7 days. Whilst this questionnaire has demonstrated test re-test repeatability (Craig et al. 2003), when compared to concurrently measured objective sitting time from an activPAL accelerometer, the IPAQ underestimated sitting time by an average of 2.2 hours a day (Chastin et al. 2014b). Other studies directly comparing self-reported measures of sedentary time, with objective measurements, have found a range of levels in discrepancy between the two, according to what subjective and objective measurements were used, and in what target group and context (Healy et al. 2011).

One way to potentially improve the correlation between self-reported measures and objective measures is to reduce the time between carrying out the behaviour, and recording it. Short-term recall of active and sedentary behaviours has been shown to correlate with both objective measures (Matthews et al. 2013) and direct observation (Kozey-Keadle et al. 2014). Ecological momentary assessment, in which people are asked to state their current behaviour at random time points (Marszalek et al. 2014), is one way to reduce issues of recall, but whilst its ability to contextualise sedentary behaviour may have uses, it is difficult to accurately upscale events to determine total sedentary time. In addition, it places greater burden on participants than other self-report methods of measuring sedentary behaviour (Biddle et al. 2009b).

A review of self-reported measurements of sedentary behaviour concluded that recalling time spent sitting over a whole day was less accurate than recalling time spent sedentary for specific behaviours or in different domains (Healy et al. 2011). Such a method for collecting subjective measurements of sedentary time may therefore be key to both maximising accuracy of recall and providing useful contextual data for sitting behaviours.

2.3.2.2.2 Objective measurement of sedentary time

Direct observation of posture and activity provides an accurate objective measurement of sedentary time, but is not feasible for measuring behaviour over long periods of time or for numerous participants concurrently (Grant et al. 2006). This is more feasibly achieved through use of body-worn monitors to objectively record sedentary behaviour (Kozey-Keadle et al. 2011) and has the advantage of reducing error associated with self-recall (section 2.3.2.2.1). However, without accompanying logs recording the environment or timing of tasks, such objective measures of sedentary behaviour have the disadvantage of not being able to provide researchers with information regarding the context in which sedentary behaviour is occurring.

Whilst use of body-worn monitors is generally considered the most accurate way of measuring sedentary time in free-living adults (Kozey-Keadle et al. 2011), there are a number of considerations regarding their use for this purpose. Firstly, and arguably most importantly, it should be ensured that monitors are able to accurately distinguish and measure sedentary behaviour. To recap, the definition of sedentary behaviour is "any waking behaviour characterised by an energy expenditure ≤1.5 metabolic equivalents (METs), while in a sitting, reclining or lying posture" (Tremblay et al. 2017). Objective measurement, without subjective input to identify behaviour, therefore needs to capture three things:

1) low energy expenditure, equal to or below 1.5 METS;
2) a sitting, reclining or lying posture; and
3) wakefulness.

The most commonly used body-worn monitors in sedentary behaviour research are tri-axial accelerometers which measure body movements in terms of acceleration over three planes: anteroposterior; mediolateral; and vertical (Chen & Bassett 2005). Low, or zero, acceleration indicates low movement and thus low energy expenditure and in this way body-worn accelerometers can categorise behaviours that are likely to result in expenditure of less than 1.5 METs. Measurement of acceleration across multiple directions also allows accelerometers to measure posture in relation to the position of the monitor (Chen & Bassett 2005).

Depending on where on the body a monitor is placed, it can therefore distinguish between time spent in sitting, standing and ambulatory postures, although some (commonly used) monitor locations are not able to make this distinction. Where accelerometers currently fall short is on the third requirement, being able to distinguish wakefulness from sleeping. In order to accurately interpret data from body-worn accelerometers, researchers need to exclude sleep time by asking participants to log sleep and nap times, or wear time if the monitor is removed at night. Again this has the disadvantage of introducing elements of self-reporting error.

The comparative validity of a number of body-worn accelerometers has been studied in terms of their ability to measure different types of physical activity (Trost et al. 2005). However, evidence regarding their comparative validity in terms of measuring sedentary behaviour is lacking. Whilst it is beyond the scope of this review to address this, two of the most commonly used accelerometers used in sedentary behaviour research, the Actigraph and activPAL, will be considered in terms of understanding their ability to accurately measure sedentary time, and other considerations to be made when analysing and interpreting the data they produce.

The Actigraph accelerometer (ActiGraph LLC, Pensacola, FL) has been used in a number of studies to measure sedentary behaviour (Clemes et al. 2014b, Henson et al. 2013, Healy et al. 2008b). It is usually a hip worn device and is most commonly programmed to classify behaviour as sedentary when acceleration is measured at less than 100 or 150 counts per minute (cpm) (Matthews et al. 2008). This low level of acceleration is assumed to be indicative of energy expenditure equal to or less than 1.5 METS, although this cut point was not empirically derived which has lead to the monitor's ability to distinguish between sedentary behaviour and light activity being questioned (Kozey-Keadle et al. 2011). In addition, the positioning of the Actigraph on the hip is likely to prohibit the monitor from measuring changes in posture, as gravity, measured as acceleration, will always be in the same plane. Low-energy expenditure activities resulting in monitor outputs <100cpm performed whilst standing, such as washing dishes, may therefore be incorrectly categorised as sedentary by an Actigraph monitor, when they are not (Kozey-Keadle et al. 2011). Indeed, a study in which the accuracy of output from the Actigraph GT3X+ accelerometer was tested for a variety of postures and activities under controlled conditions, found that the accelerometer only correctly identified sedentary postures for 61-67% of the time (Carr & Mahar 2012). This figure was even lower in a smaller scale study in which the Actigraph only correctly classified 40% of postures in both controlled and free-living conditions (Berendsen et al. 2014). The Actigraph has been shown to be sensitive at distinguishing different speeds of free-living upright walking motions (Steeves et al. 2015). However, its ability to distinguish changes in posture, and therefore sedentary behaviour, is questionable (Steeves et al. 2015, Berendsen et al. 2014, Lyden et al. 2012).

In contrast, the activPAL monitor (PAL technologies, Glasgow) is a thigh-worn accelerometer which produces a signal related to acceleration from limb movement and thigh position from which proprietary software classifies posture into either: sitting/lying, standing or walking (Grant et al. 2008). In this way 'quiet standing' of low energy expenditure can be distinguished from sedentary behaviour of equally low METs but occurring in a sitting or reclining posture (Ainsworth et al. 2000). In comparison to the Actigraph, the activPAL demonstrated 99% agreement with direct observation of sitting postures in controlled conditions and 94% agreement in a simulation of activities of daily living (Grant et al. 2006). In addition, the activPAL has been shown to be more accurate at distinguishing sit-stand transitions than the Actigraph (Lyden et al. 2012, Kozey-Keadle et al. 2011), although its ability to distinguish slow walking speeds (i.e.<0.5m/s) from standing has been criticised (Stansfield et al. 2015). Whilst this may be an issue in studies concerned with measuring activity, especially in populations where movement may be slow e.g. older adults, the activPALs ability to differentiate between standing and sitting/reclining means that as a tool for objectively measuring sedentary behaviour it can currently be considered the 'gold standard' (Kozey-Keadle et al. 2011). As such, the ActivPAL has been used to objectively measure sedentary behaviour in a variety of studies including those in a workplace setting (Neuhaus et al. 2014b, Healy et al. 2013, Evans et al. 2012).

The ability of body-worn accelerometers to accurately measure sedentary behaviour is also dependent on how they are used and how their data is analysed. For example, how and whom attaches an accelerometer can potentially impact the quality of outcome measures. Large population-based studies require participants to follow instructions for attaching monitors (Matthews et al. 2008), whilst those in clinical settings or for less-able participants, the monitors may be attached by a researcher (Kunkel et al. 2015). Whilst there have been no studies directly comparing compliance between self-administered versus researcher-administered attachment of monitors, issues of compliance with wearing monitors for the duration of a given data collection period have been reported in school children (Mattocks et al. 2008) and older adults (Murphy 2009). To date, compliance with wearing monitors has not been examined in workplace studies. Waterproofing monitors and asking participants to continue to wear monitors 24 hours a day, including during bathing or swimming, has been suggested as a way to increase compliance and maximise wear time (Tudor-Locke et al. 2015). However, continuous wear also requires participants to accurately log wake and sleep time and work hours in order to meaningfully interpret data.

The length of monitoring period and minimum wear time are also important considerations and vary between studies. A review of accelerometer based activity assessments suggested 3-5 days of monitoring can provide a reliable estimate of outcome measures (Trost et al. 2005) but this will undoubtedly depend on what outcomes are being measured. There are currently no recommendations for length of monitoring time for measuring sedentary behaviour, although 5-7 days seems to be a time adopted by most (Clemes et al. 2014b, Healy et al. 2013, Evans et al. 2012). Length of monitoring period is also dependent on compliance with minimum levels of wear-time. Minimum daily wear-time for inclusion in analysis should be established and adhered to, with 10 hours a day of wake time deemed an acceptable level in many studies (Dunstan et al. 2013, Yates et al. 2012, Wilmot et al. 2011).

Once data is collected there are several other analytical decisions to be made which can impact on how data on sedentary time is presented and interpreted. Rules need to be established regarding how data is validated and cleaned and how missing data and outliers are dealt with. Outcome measures for sedentary behaviour derived from accelerometer outputs are numerous and vary from study to study (Healy et al. 2011). Consideration should therefore be given to the outcome measures used in order to be able to meaningfully compare results to other studies.

2.3.3 What are the implications regarding the health risks of sedentary behaviour?

As indicated in the large cross-sectional studies mentioned previously, high levels of sedentary behaviour are widespread throughout populations across the world. Regardless of the mechanisms of action, there is strong evidence that excessive and prolonged sedentary behaviour is detrimental to health, and contributes in causality to the incidence of, and mortality from, non-communicable chronic diseases. People are living for longer and an increase in the incidence of non-communicable chronic diseases such as cancer, cardiovascular disease and diabetes has the potential to cause a steep rise in both economic and societal costs (World Health Organisation 2011). Physical inactivity is estimated to cost the UK National Health Service (NHS) £1,6 billion a year in direct costs (NICE 2012). Whilst no such estimates are available for sedentary behaviour specifically, given the evidence presented in section

2.3.1, it is likely that sedentary time not only contributes to this cost, but, as an independent health risk, adds to it.

In addition to the burden on the health service, high levels of sedentary behaviour at work (section 2.4.1) are likely to contribute to the 1.2 million workers in the UK estimated to be suffering from an illness believed to be caused or exacerbated by work (Health & Safety Executive 2014b). This represents approximately 4% of the entire UK workforce (Office for National Statistics 2014). Based on a 3-year average estimate of work-related illness and injury cases in the UK, the total cost to society of ill health related to work, was estimated at £14.2 billion in 2012/13 (Health & Safety Executive 2014a). In addition to these costs, is the potential impact of presenteeism, the total cost of which is unknown. Presenteeism refers to lost productivity resulting from employees coming to work ill and performing below standard due to their illness (Cooper & Dewe 2008) and therefore could result from any number of the conditions to which sedentary behaviour has been linked (section 2.3.1).

2.3.4 Who should be targeted?

With problematic levels of sedentary behaviour recognised as being a health risk across a range of age and cultural groups (Brodersen et al. 2007), to whom should initiatives to reduce sedentary behaviour be targeted?

Understanding the determinants of sedentary behaviour is an essential starting point in defining how and who to target. These are likely to vary between individuals and also throughout an individual's lifetime, often with sitting behaviour in one stage of life influencing behaviour in a later stage. For example, sedentary children tend to become sedentary adults (Biddle et al. 2010), and those in sedentary occupations have been shown to demonstrate high levels of screen time in retirement (Van Dyck et al. 2015).

Owen et al. (2011) proposed an ecological model of sedentary behaviour in which sedentary behaviour can be classed into four domains: household, leisure time, transport and occupation (Figure 2.1). Ecological models of health assume there are multiple levels for influencing health behaviours (Sallis et al. 2008). For sedentary behaviour, the model proposes that each domain can be influenced on a policy, environmental and intrapersonal level.

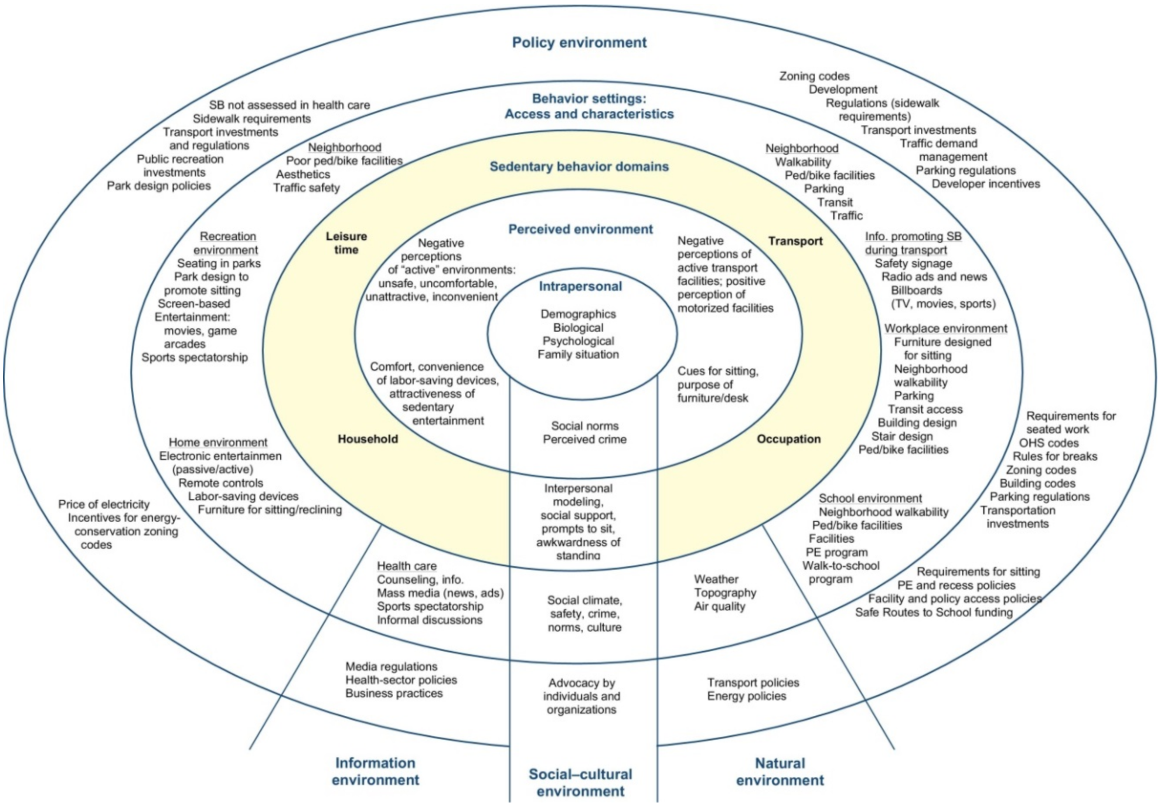


Figure 2.1 Ecological model of the four domains of sedentary behaviour (Owen et al. 2011)

The influence of these domains on sedentary behaviour has changed greatly since the middle of last century (Owen et al. 2010). For example, the increased use of cars has reduced distances walked and increased sitting time (Fox & Hillsdon 2007), whilst developments in technology have facilitated less movement as well as providing sedentary-based entertainment as a stalwart of leisure time for many (Saidj et al. 2015). Workforces are also increasingly employed in low activity occupations in the post- industrial era (Parry et al. 2013, Parry & Straker 2013).

Understanding the specific attributes and social framing that occurs in these changing domains is essential in designing effective interventions to reduce and improve patterns of sedentary behaviour (Owen et al. 2011). A great deal of research on the correlates of sedentary behaviour has focused on children, but less so on adults (Rhodes et al. 2012). Adults are likely to be exposed to different determinants of sedentary time in each of the four domains of the ecological model in their daily lives, which represent numerous opportunities in which sedentary behaviour could be targeted. For working aged adults, a substantial proportion of waking hours are spent at work (Goetzel & Ozmlnkowski 2008) and this domain is receiving increasing attention in the development of interventions to reduce sedentary behaviour.

2.3.5 Summary of the consequences and context of sedentary behaviour

Evidence is building regarding the health risks associated with both excessive and prolonged, uninterrupted events of sedentary time, and importantly this increased risk may be independent to levels of MVPA (Thorp et al. 2011). Those that are meeting guidelines for physical activity are therefore still at risk of ill health, if the majority of their time not exercising is spent sedentary. Sedentary behaviour has been linked to all-cause mortality (van der Ploeg et al. 2012), cancer (Proper et al. 2011), cardiovascular disease, and type 2 diabetes (Chau et al. 2013). As well as links to muscular pain (Chen et al. 2009), osteoporosis (Chastin et al. 2014a), and depression (Teychenne et al. 2010).

Problematic levels of sedentary behaviour are common place across a range of age and cultural groups (Brodersen et al. 2007) and countries (Bauman et al. 2011), at a substantial cost to society. Quantifying sedentary behaviour on a population scale is problematic, and there are various methodological issues in both subjective and objective measures of sedentary time even in small-scale studies.

Time spent in different domains of sedentary behaviour, and the influence of different determinants, changes across the life course and potentially represent different ways and levels in which to influence behaviour (Owen et al. 2011). Working-age adults represent an important target group for reducing high levels of sedentary behaviour accrued (Smith et al. 2015). Improving the health of this cohort will not only have a positive impact on and absenteeism and presenteeism (Marshall & Gyi 2010), but has the potential to improve the health of future older adults, as well as influencing the health behaviours and sedentary behaviour of their offspring.

The remainder of this literature review focuses on understanding the workplace as a target environment for sedentary behaviour change, interventions trialled in workplaces to date, and the potential for establishing a behaviour change model to underpin such interventions.

2.4 Understanding occupational sedentary behaviour

Advances in technology have reduced the physical strain of work in many sectors (Craig et al. 2002) and consequently people are increasingly employed in low activity occupations (Parry et al. 2013, Parry & Straker 2013). High levels of sedentary behaviour are commonplace in a number of occupational groups, in particular those in the transportation industry (e.g. taxi drivers, truck drivers, bus drivers, and aeroplane pilots), those who operate machinery whilst seated (e.g. crane operators, road workers), and those who work in offices (Healy et al. 2012). The potential for intervening in the sedentary behaviour of the latter of these three groups is greater than the former, due to the nature of the work tasks being performed, and therefore targeting office workers represents a good foundation from which to address the broader problems of workplace sitting (Healy et al. 2012). This section explores how much office workers sit, and attempts to understand the impact of the physical environment, work tasks, and working policies on this behaviour. The workplace as an environment for health promotion is also examined in order to understand how it may facilitate or inhibit interventions to reduce sedentary behaviour.

2.4.1 How much do people sit at work?

A number of studies have attempted to measure sedentary time in office workers using a variety of both subjective and objective measurement tools. Subjective measurements of sedentary time including recording periods of sitting in a diary, and retrospective estimates of sedentary time, recorded office workers sitting, on average, for 65% (Clemes et al. 2014a), and 75% (Miller & Brown 2004) of working hours respectively. Similar results were obtained using objective measurements including accelerometers, such as a waist worn Actigraph measuring 71% of working hours spent sedentary (Clemes et al. 2014b) and the thigh-worn ActivPAL measuring 66% of work time in sedentary postures (Ryan et al. 2011) in two different samples of UK office workers. A novel objective measurement tool, a cushion with a pressure sensor to detect transitions to and from sitting, also produced consistent results, measuring proportion of work time seated as 66% (Ryde et al. 2012) and 67% (Ryde et al. 2013) in two different studies. Although it should be noted that this only included time spent sitting at a person's desk, not work time spent sitting in other locations e.g. meeting rooms.

Fewer studies have measured length of sitting events, but those that did demonstrated that office workers engaged in prolonged sitting events during work hours. Ryan et al. (2011) calculated the group mean of the longest sitting event in a sample of office-based university employees to be 98±34 minutes, whilst measurements made by a pressure-sensor cushion demonstrated a mean longest sitting event at a desk of 60±24 minutes in a cross-sectional study (Ryde et al. 2012). Other studies showed that 27% (Healy et al. 2013) and 55% (Evans et al. 2012) of working time was spent in sedentary events greater than 30 minutes.

Studies comparing work time and leisure time have demonstrated that employees tend to spend more time in sedentary postures on work days compared to non-work days, in the region of an additional 100-120 minutes a day (Thorp et al. 2012, McCrady & Levine 2009). Office workers have also been shown to make significantly fewer breaks in their sedentary time during working hours, than in leisure time (Parry et al. 2013).

A study utilising a web-based survey to examine moderating effects on self-reported occupational sitting, found greater levels of sitting were associated with being male, younger, and obtaining higher education and income (De Cocker et al. 2014). However, individuals with those demographic characteristics were also more likely to be employed in sedentary jobs which therefore explained the greatest variance in work time sitting (De Cocker et al. 2014).

Whilst there is great heterogeneity in methods of measurement, and calculation of sedentary time in office workers, there is strong evidence to suggest that high amounts of sedentary time are accumulated during work hours in this population. A direct causative relationship between occupational sitting and health risks is yet to be proven (van Uffelen et al. 2010) but with evidence regarding sedentary behaviour as an independent health risk mounting (section 2.3.1), it follows that reducing and breaking up sitting at work should improve health (Rutten et al. 2013, Gilson et al. 2011, Hamilton et al. 2008).

2.4.2 How do workplaces impact on sedentary behaviour?

2.4.2.1 Physical environment

The environment in which people live and move has been shown to impact on activity patterns due to a number of factors including infrastructure, accessibility, and perceptions of comfort and safety (Koohsari et al. 2015, Handy et al. 2002, Frank & Engelke 2001). The focus of examining the physical environment of the workplace has been to ensure compliance with health and safety regulations and/or facilitate improvements to work productivity. Increasing connectivity, or the number of alternative routes for movement within in an office space has been shown to increase walking for any purpose within a building (Rashid et al. 2006), but the relationship between the office environment and sitting behaviour is seldom explored (Duncan et al. 2013). Cues in the environment influence behavioural choices and this includes the presence of, or arrangements of, furniture (Levine 2014). If an office is full of chairs, placed at desks, is it any wonder office workers feel expected to sit on these chairs to work, and remain there? Providing desk-based office workers with sit-stand desks that allow them to carry out their usual work-tasks whilst standing, is one way to change the environment to facilitate less sitting, and this is discussed further in section 2.5.4 (Changing the office environment).

Re-arranging office furniture and equipment in order to increase incidental movement within routine tasks e.g. increasing the distance from desks to printers, was a strategy devised by office workers in one study adopting a participatory approach (Parry et al. 2013). However, not all workplaces in the study supported such changes. If the physical workplace environment is something beyond the control of the workers, it might well be that the behaviours performed within that environment are also perceived as being out-with individual control.

2.4.2.2 Office culture

Currently, there is no commonly accepted definition for the term 'office culture'. It is likely to differ from an organisation's working culture which refers to the expectations placed on employees with regard to working practices that reflect the ethos of the organisation and are often ultimately aimed at maximising productivity (Green 2005). Office culture, more specifically, refers to prevailing behaviour norms within an office setting and is more likely to be dictated by un-written rules of practice that are influenced by the behaviour of the majority e.g. workers remaining at their desk to eat lunch. It is conceivable that both working and office culture influence sitting patterns at work, but this is yet to be explored directly within the literature.

Working culture is dynamic and ever changing (Green 2005) and it follows that office culture is likely to be too, which suggests that, if culture does influence sedentary behaviour, there is scope to influence it so that less sitting becomes the behavioural norm. The behaviour of others in the immediate environment is thought to influence behaviour by reinforcing social norms (Bandura 1997) and reinforcing perceptions of what other people believe to be accepted behaviour (Ajzen & Fishbein 1980). Owen et al. (2011) believed that such social norms were important in influencing sitting behaviour at work. This concept is explored further in section 2.6 (A behaviour change model for sedentary behaviour).

2.4.2.3 Work tasks and pressures

As well as the physical work environment and office culture, the task of work itself can influence sitting patterns. Sedentary time in office workers is thought to have increased over recent years due to increased computer use, and tasks that previously involved breaking sitting, such as filing, printing and visiting colleagues in person, being less frequently required (Healy et al. 2012). However, there is lack of empirical data to confirm this, or the impact of other workplace factors on sitting. Qualitative studies tend to have focused on participants' experiences of workplace sedentary behaviour interventions (Bort-Roig et al. 2014b, Chau et al. 2014b, Cooley et al. 2014, Grunseit et al. 2013, Bennie et al. 2011) although the influence of work tasks and pressures is often a theme that emerges in such qualitative evaluations. Lack of time was cited as a reason for not participating in physical activity breaks (Bennie et al. 2011), and some components of the ‘sit less, move more’ study of Spanish office workers (Bort-Roig et al. 2014b). Participants in a study utilising computer based prompts to interrupt sitting, identified the disruption to work-flow as a negative consequence of receiving prompts (Cooley et al. 2014). Whilst recipients of a sit-stand desk were mixed in whether they felt standing whilst working increased or decreased their productivity and used their desk more or less, accordingly (Grunseit et al. 2013).

Such insights into the effectiveness of interventions to reduce and break up sitting, are invaluable in understanding their impact, and also for fine-tuning them and planning future interventions. However, few studies have attempted to understand the potential influence of work tasks and pressures on sitting, prior to design and implementation of interventions. One study which aimed to further such understanding, conducted focus groups with both employees and occupational health practitioners (OHPs) to explore perceptions of health risks and sitting reduction strategies in office workers (Gilson et al. 2012, Gilson et al. 2011). Participants in this study felt that different office-based roles and tasks enabled and restricted movement from desks in different ways. Some felt that those who had more ‘client-contact time’ were more able to incorporate incidental movement into their roles. Others described their role as requiring a high level of concentration which would be interrupted by breaking up their sitting. Employees raised concerns that breaking sitting would reduce productivity (Gilson et al. 2011), although interestingly this was not cited as a concern by the OHPs or management interviewed (Gilson et al. 2012). It was also felt that management could perceive people taking breaks as not working hard enough, or avoiding assigned work tasks, raising the question of how much control workers perceive they have over their sedentary behaviour whilst at work. Such autonomy over behaviour is important as an individuals’ intention to carry out a behaviour is believed to be stronger if they perceive they have control over the behaviour and the environment in which it is to be carried out (Ajzen 1985). This is explored further in section 2.6 (A behaviour change model for sedentary behaviour).

Levels of working autonomy, and perceptions of management regarding the importance of reducing occupational sedentary behaviour, and acceptable strategies to reduce it, are likely to vary between workplaces. This was the case in a randomised controlled trial in which a participatory approach was used to design interventions to reduce sedentary time and increase physical activity (Parry et al. 2013). In two of the three participating organisations, it was found that workplace practices were too regimented to allow variation in office tasks in order to incorporate incidental activity. Therefore, as a result of not being fully supported by management, the interventions were difficult to implement (Parry et al. 2013). Engaging with, and understanding the motivations of management, as well as workers, is therefore essential to ensuring interventions to tackle occupational sedentary behaviour have a chance of success. This includes understanding relevant policy, laws and regulations that govern work practices and how these may compliment or impede efforts to reduce sitting within a workforce.

2.4.3 Policy, law and regulations

In the UK, the Health & Safety Executive is the government body that is responsible for providing guidance on health and safety in the workplace. Depending on the type of business involved, they also share responsibility for enforcing legislation with local authorities/councils.

There are 3 levels of Health & Safety regulation in the UK:

1. Regulations/legislation, that are compulsory under law
2. Approved codes of practice, which employers can be held accountable to; and
3. Guidance, which is non-compulsory.

2.4.3.1 Regulations and codes of practice

The key piece of health and safety legislation in the UK is the *Health and Safety at Work Act (1974)* which places a duty on all employers to ensure, as far as possible, the health, safety, and welfare of their employees at work. In organisations with more than 5 employees, this must be documented in a written policy and, under RIDDOR (*The reporting of injuries, diseases and dangerous occurences regulations.* 2013), employers are required to report work-related deaths, major injuries, work-related diseases, and dangerous occurrences. *The Management of Health and Safety at Work Regulations (1999) (U*K) places a duty on employers to assess and manage risks to their employees whilst the *Workplace (Health, Safety and Welfare) Regulations (1992) (UK*) and the associated Approved Code of Practice outlines more specific requirements (Health & Safety Executive 2013). These include standards for working environments, welfare facilities, and workplace safety.

A number of UK health and safety laws originate from Directives of the European Commission. Of particular importance to occupational health and well-being is the *Working Time Directive (2003)*, which led to the working time regulations being introduced in the UK (*Terms and Conditions of Employment. Working time regulations.* 1998, *Working time (amendment) regulations.* 2003). These regulations set limits on working time, and outline entitlement to periods of rest between work shifts, and during work-time. Most notably they state that employees should not work, on average, more than 48 hours a week, have 11 hours rest a day, and be entitled to one day off a week. However, employees are able to opt out of the 48 hour limit if they want to and there are a number of professions to which the rules do not apply, for example, where 24 hour staffing is required, for the armed forces and emergency services, security and surveillance work and domestic servants (*Working time (amendment) regulations.* 2003). In terms of breaks during work time, the regulations state that employees over the age of 18 are entitled to at least 20 minutes break from work when working for 6 hours or more. In a sedentary occupation where breaking sitting requires a break from work, this would mean an employee working an 8 hour shift would have to split their break into a series of breaks of less than 1.5 minutes in order to avoid sitting for continuous periods of more than 30 minutes. More importantly, an employee working 5 hours and 59 minutes is not legally entitled to any break. The working time regulations do, however, also state that "*where the pattern according to which an employer organizes work is such as to put the health and safety of a worker employed by him at risk, in particular because the work is monotonous or the work-rate is predetermined, the employer shall ensure that the worker is given adequate rest breaks*" (*Working time regulations 1998, Part II, Regulation 8*). Such a vague condition is open to interpretation, but with the growing body of evidence demonstrating the health risks of sedentary behaviour in the workplace (Chau et al. 2013, Healy et al. 2012), the regulation could and should be interpreted to ensure that those in sedentary occupations take adequate breaks from sitting.

For sedentary occupations that are also primarily computer–based, regulations exist under the *Health and Safety (Display Screen Equipment) Regulations (1992) (UK)*. Guidance states that employers should plan activities so that use of display screen equipment is periodically interrupted with non-screen based tasks in order to prevent eye-strain and repetitive strain through keyboard use. It also states that breaks should ideally be short and frequent and must allow users to vary their posture, although it does not stipulate that this should involve standing (*The Health and Safety (Display Screen Equipment) Regulations.* 1992).

Regulations to safeguard employees' health do exist, but tend to be generic in order to be applicable to a huge variety of occupations and working environments. In terms of non-compliance, it is the responsibility of employees to report their employers for not meeting requirements of health and safety legislation. The latest advice from the UK government (UK government 2015) recommends that this is initially done informally with management before advice is sought from ACAS (Advisory Conciliation & Arbitration Service) and potentially dealt with through an employment tribunal. Given the increasing issue of job security (Cooper & Dewe 2008) this may be a course of action employees are reluctant to take.

2.4.3.2 Guidance and policy

In addition to regulations and codes of practice produced by the Health & Safety Executive, policies and guidance relevant to addressing healthy working environments have been produced by a number of governmental organisations, institutions and public bodies. NICE guidelines exist for developing working practices to promote well-being and reduce stress 'Workplace policy and management practices to improve the health and wellbeing of employees' (NICE 2015). In England, employers are supported in developing their own strategies and plans for improving occupational health by signing up to the Workplace Wellbeing Charter (Wellbeing charter 2015). Employers can gain accreditation through achieving standards in leadership, absence management, health & safety, mental health of employees, smoking cessation, physical activity (which includes taking regular breaks), healthy eating and providing support to employees with alcohol and substance misuse (Health@work 2008). Employers in Scotland can obtain similar accreditation by signing up to the Healthy Working Lives Award Programme which offers bronze, silver and gold awards to organisations demonstrating commitment to the health and well-being of their staff by meeting set criteria (Healthy Working Lives 2015). Healthy Working Lives also provides free advice and resources to organisations, employees and those wishing to return to work, on aspects of workplace well-being.

In terms of addressing inactivity in the workplace, the focus of strategy and guidance documents has centred around increasing physical activity amongst the working population, recognising that the workplace represents a productive setting for physical activity interventions (Fletcher et al. 2008). Current recommendations state that adults should aim to be active daily, accumulating at least 150 minutes of moderate intensity activity in bouts of 10 minutes or more and that the amount of time sedentary for extended periods should be kept to a minimum (Department of Health 2011). In 2003 the Scottish Government published 'Let's Make Scotland More Active' – a broad framework of objectives and priorities for developing physical activity across the lifespan in Scotland (Scottish Government 2003). Within this, workplaces are recognised as an important environment in which to promote physical activity. It recommends that employers should be given incentives to promote physical activity and employees should be supported in becoming more active at work. However, reducing sedentary behaviour is not included in the strategy. Similarly, 'A games legacy for Scotland 2009' (Scottish Government 2009a) and the outcome indicators that are being measured following the 2014 Commonwealth Games, focus on achieving recommended levels of physical activity, including active travel to work, but neglect targeting sedentary behaviour as a separate issue. This is also the case in UK-wide strategies such as the legacy from the London Olympics (UK Government 2014) and the NICE guidelines on promoting physical activity in the workplace (NICE 2008).

Recently, a consensus statement was published in the British Journal of Sports Medicine with a number of recommendations to guide employers on reducing prolonged sedentary behaviour in the workplace (Buckley et al. 2015). The statement recommends that workers in predominantly sedentary occupations should progress towards accumulating four hours a day of standing and light activity during working hours through standing-based work, use of sit-stand desks, or taking short active breaks. It also recommends that staff should be educated on the health risks of prolonged sitting during work and leisure time. Whilst these represent the first set of detailed guidance for UK employers and employees regarding what constitutes too much sitting, it is worth noting that these recommendations are not compatible with current legislation that only requires a 20 minute break for working periods of 6 hours or more (*Working time (amendment) regulations.* 2003), unless provision is made to enable employees to work standing up.

Currently, workplace regulations and guidance fail to tackle the issue of sedentary behaviour. In the UK there is currently no regulations that safeguard those employed in sedentary occupations in terms of limiting time spent sitting. Any guidance and regulations on sedentary behaviour in the workplace will need to be consistent with the latest research, made explicitly clear and achievable, widely disseminated, and enforceable, in order to achieve the associated health benefits for a significant proportion of the workforce.

2.4.4 Health promotion in the workplace

The workplace has the potential to be a good environment for interventions to improve health (Rongen et al. 2013, Plotnikoff & Karunamuni 2012), benefitting both individuals and the productivity of an organisation (Conn et al. 2009, Cancelliere et al. 2011). Systematic reviews of workplace health promotion programmes (WHPPs) conclude that they can be effective at: improving overall health (Hutchinson & Wilson 2012); reducing weight (Anderson et al. 2009); improving diet (Ni Mhurchu et al. 2010); increasing physical activity (Conn et al. 2009); reducing depression (Tan et al. 2014); and reducing sitting through use of sit-stand workstations (Neuhaus et al. 2014a). A recent meta-analysis of WHPPs highlighted that effectiveness is dependent on the study population, the content of the intervention, and the quality of the methodology used (Rongen et al. 2013). The results of the meta-analysis showed that effectiveness of WHPPs on all work-related outcome measures was small, but the studies that were most effective were those in which contact was made with participants on a weekly basis, and where the target group were young, white-collared workers (Rongen et al. 2013). However, the disparity between the types of interventions included in the meta-analysis, coupled with noted poor quality of the studies, does not allow definitive conclusions to be drawn.

The cost-benefit to organisations of conducting WHPPs is difficult to quantify due to intervention differences and interpretation of what constitutes productivity (Cherniack 2015). However, there is evidence that such programmes have the potential to reduce sickness absence (Conn et al. 2009, Kuoppala 2008) and improve work productivity (Cancelliere et al. 2011). Other benefits to organisations include the improved corporate image associated with being seen to care for employees, also known as 'corporate social responsibility' (Carroll 1999). However, Holmqvist (2009) warns that WHPPs may be used by organisations as a way of intentionally controlling the behaviour of their employees to meet corporate needs, namely productivity. Whilst it is hard to dismiss or substantiate such claims, if employees believe that the health messages or interventions they are being offered have an ulterior motive, this could have a negative impact on health behaviours.

Organisational management style has been shown to be related to the prevalence of health promotion in the workplace (Witte 1993). In a study of 500 organisations, those with democratic management styles were more likely to plan and implement health promotion programs than those with authoritarian management styles (Witte 1993). Those working under such authoritarian styles are also more likely to lack autonomy in their behaviour and feel less likely to be able to sit less at their desk. With a lack of enforceable regulations surrounding sitting time at work, this means that those more at risk of high levels of sedentary time at work are also less likely to be given the opportunity to participate in initiatives to reduce occupational sedentary behaviour.

2.4.5 Summary of understanding occupational sedentary behaviour

The impact that work has on the lives of those in employment is far reaching with the physical, emotional, mental, and social experiences encountered at work extending beyond working hours into people's personal lives (Danna & Griffin 1999). Office workers represent one of the most sedentary occupational groups (Healy et al. 2012) sitting for, on average, between 65-75% of working hours (Clemes et al. 2014a, Clemes et al. 2014b, Ryde et al. 2013, Ryde et al.

2012, Ryan et al. 2011, Miller & Brown 2004). In order to design effective interventions to address this, firstly the impact of the workplace, and work practices, on the behaviour of employees, needs to be understood.

The physical work environment, in terms of presence and arrangement of furniture provide cues for behaviour (Levine 2014). Management need to be convinced of the benefits of reducing sitting in their workforce to facilitate necessary organisational changes and changes to work practices (Gilson et al. 2011). In addition, employees need to feel able to change their behaviour whilst remaining within the social norm of the office culture (Owen et al. 2011).

Regulations and guidelines are in place to safeguard employees' health at work but these often fall short of being effective, in terms of being un-enforceable and open to interpretation. This serves to reinforce the balance of control in favour of the employers, who are currently faced with the difficulty of safeguarding jobs in a time of world recession and fragile economies (Cooper & Faragher 2013). The result is increased job insecurity and the impact this has not only on health (Virtanen et al. 2013, Faragher et al. 2005), but on the willingness of individuals to speak up against a workplace and practices that are causing them harm (Cooper & Faragher 2013).

2.5 Interventions to reduce sedentary behaviour in the workplace

Reducing sedentary behaviour has been a focus of rehabilitation and improving outcomes for a number of clinical groups including stroke survivors (English et al. 2014), those suffering from cardiovascular disease (Dunstan et al. 2011), diabetes (Hu et al. 2001), and obesity (Bond et al. 2014, Otten et al. 2009). In terms of those free from long-term conditions, children and adolescents (Biddle et al. 2014), and older adults (Rezende et al. 2014) have also been target groups for interventions to improve patterns of sedentary behaviour. Healthy, working-age adults, until recently, have not been the target of interventions to specifically reduce sedentary behaviour, despite studies demonstrating high levels of sedentary time, especially at work (Smith et al. 2015, Clemes et al. 2014a, Ryde et al. 2013, Ryan et al. 2011, Miller & Brown 2004). This section of the literature review aims to give an overview of workplace interventions to reduce or break up sedentary behaviour, in accordance with literature published at the time of this review (December 2014). Workplace refers to studies conducted in an office or call centre, unless otherwise stated.

2.5.1 The relationship between physical activity & sedentary behaviour interventions

Until recently, the majority of workplace interventions that have had the potential to impact on sedentary behaviour, have had increasing physical activity as their primary focus, or outcome (Chau et al. 2010). However, increasing physical activity levels does not necessarily lead to a reduction in total sedentary time, as evidence suggests that sedentary behaviour is most likely to displace light intensity activity and vice versa (Mansoubi et al. 2014). This was illustrated by two workplace interventions to increase step counts which resulted in no significant decrease in self-reported sitting time at work (Roig et al. 2012, Gilson et al. 2009). Interestingly, though, the study by Roig and colleagues did result in a reduction in self-reported leisure time sitting (27 minutes, $p<0.05$).

A systematic review and meta-analysis of physical activity and sedentary behaviour interventions by Prince et al. (2014) concluded that interventions with a focus on physical activity, or that had both a physical activity and a sedentary behaviour component, produced inconsistent findings and generally resulted in modest reductions in sedentary time. More meaningful reductions in sedentary time were seen in the studies in which the intervention focused on reducing sedentary behaviours. In a workplace trial in which office workers (n=60) were randomised to either a stand group that received hourly prompts to stand or a walk group that received the same prompt but were additionally told to take 100 steps, both groups significantly reduced the duration of average sitting events and the number of events of 60 minutes or more (Swartz et al. 2014). However, only the group prompted to stand significantly reduced total sitting time (by 6.6%), duration of the longest event (by 29%) and number of events of 30 minutes or more (by 13%) leading the authors to conclude that when interventions to break to sitting are paired with a physical activity prompt, the effect on sitting time may be attenuated.

Encouraging employees to take active breaks is one way to interrupt sedentary patterns. Taylor, et al. (2013) introduced 15 minute physical activity ‘booster breaks’ across 5 worksites over periods ranging from 3 months to 1 year. During these breaks, employees were encouraged to participate in facilitator lead exercise sessions which involved warm up, movements and stretches. Monthly attendance at the breaks ranged from 76% to 86% and they were evaluated favourably by participants in terms of perceived health benefits and reducing stress. However, no data was collected to ascertain the impact on sitting, and it can be argued that one 15 minute break a day does little to reduce prolonged sitting or increase physical activity towards recommended levels. Active breaks were also a component of the

‘W@W scheme’ in Spanish workplaces which introduced activity to the working day in 4 phases (Bort-Roig et al. 2014b):

> 1) Incidental movement – employees were encouraged to get up and speak to colleagues, walk to printers, stand up when on the phone, have walking meetings, take short walks during active morning and afternoon breaks;
> 2) Active travel to work and increased walking was encouraged;
> 3) Employees were asked to regularly achieve 10,000 steps a day and increase the frequency of incidental movement;
> 4) Employees were encouraged to use the stairs not lifts, walk on inclines and take longer walks with increased cadence or number of steps per minute.

Participation in activities was measured by a post-intervention questionnaire, with the most popular activities reported to be increased incidental movement and vigorous walking. Longer walks and walking meetings were the least popular. Unfortunately the scheme was not evaluated in terms of sitting time or any quantifiable health markers. Enablers of increased movement were identified as the educational material, fortnightly emails, goal setting and feedback and perceived health improvements. Whilst barriers included: strategies not suiting the workplace (e.g. walking meetings); walking during lunch impacting on social time with colleagues; it being hard to estimate time sitting and therefore set goals; excessive workloads; and absenteeism from desks being frowned upon by managers (Bort-Roig et al. 2014b). Interestingly, the latter was only an issue for those in administrative positions, not for those in academic roles which suggests interventions to reduce sitting at work need to be tailored to suit different occupational roles. It also highlights the need to target the organisation in order to ensure managers are on-board with the behaviour changes their employees are being asked to make.

There is some evidence that increased physical activity prompted by a training program is compensated for by a decline in spontaneous activity in older adults (Westerterp & Meijer 2001). However, it is not clear whether such compensation applies to sedentary behaviour or to other age groups. Further investigation into how people process and respond to messages about increasing physical activity and reducing sedentary behaviour is important in order for both health messages to be understood and acted upon.

2.5.2 Developing tailored interventions using a participatory approach

One way to potentially empower those in sedentary occupations into feeling that behaviour change is both attainable and acceptable is to involve them in designing measures to facilitate less sitting. Such participatory approaches have proved effective in other areas of health research and practice (Jagosh et al. 2012), including increasing physical activity (Farag et al. 2010, Goh et al. 2009). Following feedback quantifying their sedentary behaviour at work, office workers in Australia suggested a number of measures, including reconfiguring the workplace and restructuring progress meetings to be more activity permissive, which were adopted by the organisation (Phillips et al. 2010). However, there was no follow-up to determine if these actions actually resulted in reduced sedentary behaviour. Parry et al. (2013) also used a participatory approach to designing a variety of workplace interventions to reduce sedentary time across 3 large organisations including promotion of incidental activity, physical activity and changes to office ergonomics. All participants showed a slight decrease in sedentary time and an increase in breaks in sitting, as measured by an accelerometer, but with no significant differences between the 3 types of intervention. Participants also reported organisational barriers to implementing some of the ideas, but the participatory approach in designing the interventions was very much valued by employees. One way to prevent or minimise interventions being blocked by management or organisational processes is to include higher management in the participatory process. However, care needs to be taken to ensure that ownership of the intervention stays with those whose sedentary behaviour is being targeted, and that the intervention does not appear to be a top-down dictation from management (ICPHR 2013).

2.5.3 Multi-level interventions

Given that real or perceived organisational barriers are likely to exist in most workplaces, it is important that an ecological approach (Figure 2.1), consistent with best practice health promotion frameworks, is adopted in promoting healthier sedentary patterns. That is, interventions should target the organisation and work environment, as well as the individual (Plotnikoff & Karunamuni 2012). Healy, et al. (2013) took such an approach to reduce occupational sitting using a multi - component intervention in a single workplace with control and intervention groups occupying different floors of the building. The organisation was targeted through research-led consultation with representatives from the intervention group, and their management. This informed a workshop for all intervention group participants and their management during which strategies and reasons for reducing sitting were identified based on 3 central messages 'stand up, sit less, move more'. The environment was targeted through the provision of sit-stand workstations and individuals were provided with tailored support through goal setting, motivational interviewing, feedback on activity and follow up telephone consultations. Objectively measured sedentary behaviour (activPAL) showed people in the intervention group stood more frequently and for longer periods, and, although length of standing events were not specified, the authors note that such increases in standing have the potential to be detrimental to health (Stephens et al. 2014, Healy et al. 2013). Regular, high levels, of standing (>8 hours a day) have been associated with chronic venous insufficiency, musculoskeletal pain of the lower back and feet, and premature births (Mcculloch 2002). It is therefore important that a balance is achieved between reducing sitting, and the consequent increased levels of standing.

A similar multi-component study was conducted by Neuhaus, et al. (2014a) in which the organisation, environment, and individuals were targeted in the same way as Healy's study, but with the addition of a work-station only group (n=14). This allowed analysis of the impact of the organisational and individual components, and demonstrated that greater reductions in sitting were achieved in the multi-component group (-89minutes, $p<0.001$) than in the group that only received sit-stand workstations (-33 minutes, $p=0.285$) relative to the control group. Both studies had limitations in terms of small sample size and non-randomised allocation to groups, but the results are encouraging for future interventions based on an ecological model. Long term follow up is required to ascertain whether such an approach demonstrates greater sustainability as a result of targeting change at all levels.

2.5.4 Changing the office environment

In terms of reducing sedentary behaviour in an office setting, it is rarely possible to make changes to the physical environment without also involving policy/practice changes and targeting change at the individual level, in tandem. Changes at an environmental level will most likely require input at the organisational level in order for them to be authorised. At a minimum, management will need to be convinced of the benefits of reducing sitting for their employees and business, especially if such changes require financial outlay. Targeting change at an environmental level will also require efforts to be made at an individual level so that employees understand how and why to use new furniture or changes to the office layout. Environmental measures not only facilitate changes in behaviour, but can act as both a visual cue to remind employees to reduce their sitting and show that such behaviour is supported by the organisation. Introducing physical stimuli to provoke desired behaviour responses has long been recognised as an effective managerial tool (Davis 1984).

A number of workplace interventions have been piloted that focus on reducing workplace sitting at organisational and system levels. Healy (2012) conducted a review of such studies and found that they could be grouped into one of five strategies to reduce sitting:

(1) increasing the number of breaks from sitting time (i.e. outcome measures of sitting time resulting from prompts to take micro-breaks involving standing, short walks or stretches);

(2) implementing strategies around postural change (i.e. outcome measures of musculoskeletal discomfort resulting from use of sit-stand desks or walking or standing breaks) ;

(3) focusing on ergonomic changes to the individual workspace (i.e outcome measures of sitting time resulting from individuals' use of height adjustable desks or stools);

(4) altering the built design of the broader workplace (i.e outcome measures of sitting time resulting from re-design of the workplace as a whole to facilitate less sitting, through re-arrangement of furniture and facilities, including office-wide installation of sit-stand desks);

(5) using multiple strategies (i.e.combinations of the strategies outlined above).

All studies approached the issue from an occupational health and safety and ergonomics perspective and as such the main outcome measured was the impact on musculoskeletal problems, the incidence of which was reduced upon implementation of the reduced sitting strategies. However, the review notes that the quality of studies was mixed, that reliable and valid measures of sedentary time were not used and therefore conclusions about the impact on sitting could not be corroborated (Healy et al. 2012). It should also be noted that the review did not use a systematic methodology and as such cannot be relied on to have identified all relevant literature.

Re-arranging the design of an office to encourage workers to stand and move further in order to carry out everyday tasks such as collecting work from a printer or accessing the water cooler, could be a cheap way to encourage less sitting. Increasing connectivity, or the number of alternative routes for movement within an office space has been shown to increase walking for any purpose within a building (Rashid et al. 2006), but the relationship between the office environment and sitting behaviour is seldom explored (Duncan et al. 2013). An 'active office' group and 'office ergonomic' group were both effective at significantly reducing sedentary time (-1.7%, $p = 0.014$) and increasing breaks from sitting (0.72, $p = 0.015$) during work hours (Parry et al. 2013). In both these groups participants were instrumental in designing strategies for introducing breaks from sitting within their normal work tasks, such as walking further to the printer, but the effect of individual measures was not recorded.

An alternative to encouraging regular breaks away from the desk is the installation of activity-permissive workstations. These include: height-adjustable desks to allow employees to alternate between sitting and standing; treadmill desks in which a desk surface is attached to the front of a treadmill to allow workers to walk and work; substituting office chairs for a stability ball requiring the user to engage leg and core muscles to remain seated; and stepping or pedal devices fitted underneath desks to facilitate walking and pedalling whilst carrying out desk-based tasks (Neuhaus et al. 2014a). In 2014, two literature reviews on activity-permissive workstations were published: one focusing on their impact on energy expenditure (Tudor-Locke et al. 2014); and the other examining outcomes of sedentary time, health-risk biomarkers, work performance and feasibility (Neuhaus et al. 2014a). Both standing and use of a stability ball whilst performing clerical work lead to increased energy expenditure compared to normal sitting (Beers et al. 2008). Whilst there was little difference between standing and use of the stability ball in terms of measured energy expenditure, office workers preferred using the ball over standing. Treadmill and pedal desks were both effective at increasing energy expenditure compared to a traditional office environment (Tudor-Locke et al. 2014). The pooled effect from a meta-analysis of 38 studies showed that activity-permissive workstations resulted in a 77 minute reduction in sedentary time in an 8 hour workday, though non-significant changes were reported for most health and work related outcomes (Neuhaus et al. 2014a). The majority of studies in both reviews stated that use of alternative workstations had little impact on work output and were agreeable to both employers and employees. Both reviews noted great heterogeneity in study design and recommended that larger scale randomised controlled trials (RCT) are needed with long-term follow up in order to fully understand the pros and cons of long-term use of activity-permissive workstations.

The majority of studies on activity-permissive workstations published since Neuhaus' systematic review are similarly limited by small sample sizes and heterogeneity of study design. Objectively measured sitting time was reduced in two randomised controlled trials (Chau et al. 2014a, Dutta et al. 2014) of sit-stand workstations. A qualitative arm of the Chau study revealed that common barriers to sit-stand workstation use were working in an open plan office, and issues with the desk design, whilst facilitators included a supportive work environment and perceived health and work benefits. Similar results were found by Thorp, et al. (2014) who tested sit-stand workstations on obese and overweight participants in a laboratory setting. The participants reported a reduction in musculoskeletal complaints and reduced fatigue when using the sit-stand desks. Atkinson, et al. (2014) surveyed employees of an organisation who furnished 3 of their meeting rooms with height adjustable meeting desks and provided information to staff on how and why to use them. Forty-two percent of those who responded said everyone had stood at their last meeting, 45% said everyone had sat, and 13% said there had been a mixture of both. Most respondents were in favour of standing meetings especially for brief internal meetings where extensive note taking was not required. Whilst the results are promising, the response rate to the survey was low, suggesting a possible bias with only those interested in the initiative responding. It is therefore hard to get a true picture of how the meeting rooms were being used.

The results of a 12 month trial of treadmill desks by sedentary office workers showed an average reduction in sitting of 77 minutes per working day and, after an initial decline, improved quality and quantity of self-assessed work performance (Ben-Ner et al. 2014). Similar results were obtained in a 3 month RCT of shared treadmill desks in obese office workers, but in addition it was noted that treadmill users showed no significant reduction in number and length of sedentary bouts and no reduction in weight or waist circumference (Schuna et al. 2014). Participants used the treadmills less than the prescribed amount, reporting that work often superseded using the treadmill in their pre-booked time slot, in terms of priority.

Only 7% of staff and students used one of the 13 portable pedal machines installed in a university library over an 11 week period, despite extensive promotion and respondents rating the scheme as feasible (Maeda et al. 2014). The feasibility of cycling whilst carrying out work tasks was further corroborated by a study which asked participants to type a passage whilst sitting at a cycling workstation and whilst sitting and pedalling at the same workstation (Elmer & Martin 2014). It found that whilst pedalling increased metabolic cost, it had no impact on typing time or errors. However, no comparison was made to typing at a standard sitting desk or over a longer period of time, closer to normal working conditions.

Investing in activity-permissive workstations requires a financial outlay and can require re-arrangement of office space and working practises, especially if workstations are shared. This, in part, explains why all studies of such workstations to date are limited to a few activity-permissive desks and in turn, a small number of study participants. With only small numbers of office workers using such desks, it does not embed standing at work as part of the office culture. The behaviour of others in our immediate environment is thought to influence behaviour and reinforce social norms (Bandura 1997). This could be important in terms of influencing the sitting patterns of workplaces on a large scale, yet is rarely a consideration of intervention design.

As evidence regarding the health benefits and positive impact on productivity for activity-permissive workstations strengthens, workplaces are more likely to invest in them on a larger scale. This will not only create a culture of acceptability, but allow larger-scale studies on their effectiveness, over longer periods of time and in a greater cross-section of the office-workers population (i.e. not bias to the type of people most likely to volunteer to be a study participant). As well as being larger scale, future studies should look to objectively measured patterns of sedentary time, not just total sitting time, and other health outcomes such as well-being. The relationship between alternative workstation use and sedentary behaviour and physical activity levels outside of work are also worthy of exploration, as is a comparison of their effectiveness with other non-environmental interventions. This is the aim of an RCT currently being run where the objective is to determine whether providing office workers with an adjustable sit-stand desk and individually targeted education, or education alone, is more effective at decreasing sitting than no intervention (Radas et al. 2013).

2.5.5 Targeting the individual.

Whilst changing individual's sitting behaviour is obviously an essential component of interventions made at an organisational and environmental level, a number of studies have been conducted which focus solely on individual behaviour change within an organisational and environmental setting which remains the same.

2.5.5.1 Education and information provision

As sedentary behaviour, as a distinct and independent health risk, is an emerging area of research, it cannot be assumed that all members of the general public are aware that sitting could be detrimental to their health. Providing such information usually forms part of interventions to reduce sitting, if not to intentionally form part of the behaviour change process, then to fulfil the ethical requirements of the research. However, this element is rarely described within sedentary behaviour interventions, let alone evaluated in terms of its impact. Where educational components are recorded they are often too vague to draw comparisons or to elicit best practice.

A study investigating the use of sit-stand desks previously installed in four companies found that employees that used the desks most frequently were working for the company that had delivered an information campaign about the benefits of their use (Wilks et al. 2006). Again, whilst the exact content of the information campaign is not given, it is stated that it involved a series of lectures by health professionals, followed up with 'motivational work' by an occupational health nurse. In the other three companies, whose use of desks was less frequent, one had provided a short film (content unknown) at the time the desks were installed, and the other two had not given any information or education.

The content and focus of such information is undoubtedly important. In a randomised controlled trial a non-significant decrease in sitting (95% CI -70 to 59 per working day) was seen in employees who had received a weekly newsletter on the dangers of sitting compared to those that had received a weekly newsletter focusing on health in general (Gordon 2013).

Whilst it is intuitive that specifically telling people about the risks of sitting, is more likely to prompt a change in sitting behaviour than not, what the content and mode of delivery for health promotion messages about sedentary behaviour should be, is yet to be determined. Evidence from health communication studies for other health behaviours suggest that message framing (Rothman & Salovey 1997), tailoring (Keller & Lehmann 2008), and credibility of the message giver (Rogers, Shoemaker 1971) are important in determining whether health messages are received, understood and acted upon. These elements are worthy of further investigation in terms of communicating messages about sedentary behaviour.

2.5.5.2 Personal consultations, interviewing and mindfulness

A number of studies have used individual or group consultations in which tools such as mindfulness, motivational interviewing and behaviour change techniques have been used to encourage employees to make changes to their sedentary behaviour.

Motivational interviewing is a style of counselling that seeks to promote behaviour change by focusing on exploring and resolving ambivalence towards a particular behaviour (Miller 2002). This was used alongside a package of measures, including organised lunch time walks, and provision of sit-stand desks, to significantly reduce self-reported sedentary time in office workers (Ellegast et al. 2012). Similarly, group motivational interviewing was used alongside measures such as promoting stair use and active commuting, to achieve reductions in self-reported sedentary time and increased breaks from work in a study of 412 office workers (Coffeng et al. 2014). However, due to the multiple components of the interventions in both of these studies, it is not possible to distinguish the specific impact of motivational interviewing on sedentary behaviour.

Mindfulness is a meditation technique that involves focusing on present feelings, thoughts and body sensations, and has been used successfully in a workplace obesity prevention programme (Barrington et al. 2012). Objective measurements of sedentary behaviour were made before and after a workplace mindfulness programme that aimed to encourage workers to make general lifestyle improvements, but no significant changes to sedentary behaviour were observed. However, this may be due to the mindfulness sessions not solely focusing on sedentary behaviour.

Behaviour change counselling, in which behavioural strategies such as decisional balance (shifting the balance of pros and cons in favour of changing behaviour) and goal setting (establishing measurable goals and timeframes for changing behaviour) were used, has been used to target reducing sedentary behaviour in office workers. One study, which also aimed to increase fruit intake as well as reduce sedentary behaviour achieved a significant reduction in self-reported sitting during working hours (Verweij et al. 2012). Whilst a study focused solely on reducing the sedentary behaviour of Scottish office workers, found that participants undertook four additional daily sit-to-stand transitions post-intervention, but showed no significant reduction in total sitting as measured objectively by an activPAL (Kirk et al. 2012). Of note is the fact that subjective reductions in sitting (measured by IPAQ questionnaire) were almost twice (-70 minutes) the length objectively measured sedentary time (-38 minutes), further demonstrating the inaccuracy of relying on self-reported measurements of sitting (Kirk, et al. 2012).

2.5.5.3 Prompts to break sedentary time

Cooley & Pedersen (2013) argue that sitting for desk-based work is a habit, based on the fact that "*it is a learned act automatically performed in the presence of cues*" (Cooley & Pedersen 2013, p2). One way in which to alter an existing habit is the use of prompts at the point of decision in order to get an individual to re-evaluate their behaviour (Aarts & Dijksterhuis 2000). There is also evidence to suggest that multiple repetition of a message or messages may be more effective than single exposure (Dijkstra et al. 1999). There have been a number of studies that have successfully used prompts to break periods of sitting with standing or physically active breaks. Evans, et al. (2012) conducted a randomised controlled trial in a convenience sample of office workers (n=28) in which both the control and intervention group received education on the importance of reducing prolonged sitting. Subsequently, the intervention group received prompts on their PC to stand for one minute, every 30 minutes, for a period of 5 days. It was found that whilst there was no significant differences in total sitting time, the number (ANCOVA; −6.8%, p=0.014) and length (−15.5%, p=0.007) of prolonged sitting events (>30 minutes) was significantly reduced in the intervention group. Pedersen, et al. (2014) used a similar study design, but participants in the intervention group were asked to engage in short-bursts of physical activity during their standing breaks which were instructed by a message on their computers every 45 minutes. A reduction in self-reported sitting in both the control and intervention groups was noted, but only the intervention group reported that they stood more and exhibited increased energy expenditure. It is worth noting that participants of this study were screened for inclusion on the basis that they were ready to engage in changing their sedentary behaviour as measured by the transtheoretical model of behaviour change (DiClemente 2007). Whilst it could be argued that participants volunteering for any research study are biased in terms of their willingness to engage in new behaviours, it does highlight the question of how appropriate an intervention would be if rolled out to all employees within an organisation, including those in pre-contemplative stages of change.

A potentially important difference between the studies conducted by Evans and Pedersen is the use of active and passive prompts. In the former study the prompts could be considered 'active' as although the message displayed could not be minimised or moved, participants were able to ignore it and continue working in any open windows around it. Therefore, engaging in a break from sitting in this scenario could be considered as a voluntary, active action in which only those who choose to engage in the behaviour will benefit from the health benefits. Conversely, the prompts used in the study by Pedersen could not be removed from the screen and no other work could be carried out on the computer whilst it was displayed. Following the break, participants were required to log their activity in order to de-activate the prompt. The prompts were therefore deemed to be 'passive' in that an individual's freedom of choice to engage was removed. This passive approach has been used in addressing other unhealthy behaviours, in order to make continuing an existing bad habit more difficult. For example, removing high calorie foods from workplace vending machines (French 2005). It has been argued that such passive approaches to protecting health are the only way to prevent unhealthy behaviours in the majority of the population (Williams 1982). However, it could also be argued that in the case of irremovable full-screen computer prompts, the behaviour being prevented is not continued sitting, but continued working. The individual still has to make an active choice to stand up during their enforced break from work.

Cooley and Pedersen (2013) investigated the use of both active and passive prompts in reducing sedentary behaviour in the workplace. They exposed participants (n=46) to passive prompts, which deactivated their computer screens every 45 minutes and asked them to partake in a range of physical activities, for a period of 13 weeks. After this period participants could voluntarily engage the software for a further 13 weeks by clicking on the prompt icon every 45 minutes (i.e. active prompts). Participants were five times more likely to log taking part in a physical activity break when exposed to a passive prompt than when exposed to an active one. Whilst this suggests that passive prompts may be more effective, the methodological limitations of both style of prompts not being run concurrently in two experimental groups, cannot be ignored. Running both prompt groups at the same time would have eliminated the possibility that the decreased impact was a result of a natural drop-off in compliance.

Hourly active prompts made via a computer and wrist band were used in a study by Swartz, et al. (2014) who demonstrated that only significant reductions (-6.6%) in objectively measured sitting time were seen in the group prompted to stand, not the group prompted to stand and walk. The stand group was also the only group that displayed a significant reduction in prolonged sitting periods and a significant increase in sit-stand transitions and standing time. These results suggest that when breaks in sitting are instigated with a physical activity prompt, people may be more likely to increase their workday physical activity, but the effect on sitting time may be attenuated.

A study into the most effective frequency of prompts to reduce excessive sedentary behaviour in overweight and obese individuals, showed greater compliance in taking breaks from sitting when prompts were more frequent (Bond et al. 2014). The study used a smartphone to both prompt and monitor breaks of varying length and frequency and showed that prompts recommending shorter breaks at more frequent intervals were most effective (Bond et al. 2014). Three minute breaks every 30 minutes were shown to be most effective at reducing sedentary time, although participants favoured a prompt every hour to be active for 6 minutes. Prompts could be dismissed and can therefore be described as active, but compliance with an activity break resulted in a message praising their accomplishment and a 'go' light appearing permanently on their phone dashboard. Persistent displays have been shown to motivate health behaviour in other studies using similar technology (Consolvo et al. 2009). Whilst this study was not limited to the workplace, the majority of participants were employed (occupations not given) and with 7 in 10 people in the UK now owning a smartphone (Styles 2013) use of this technology could help support large scale behaviour changes in sedentary patterns. Use of mobile phone applications is discussed further in section 2.6.1.1

The use of prompts to encourage breaks in sitting has produced promising results (Bond et al. 2014, Cooley et al. 2014, Pedersen et al. 2014, Swartz et al. 2014, Evans et al. 2012). However, further research is required to determine whether prompts should be active or passive, what their optimum frequency should be, what messages they should contain, and what their impact is at long-term follow-up.

2.5.6 Summary of interventions to reduce sedentary behaviour in the workplace

Workplace interventions to reduce sitting, provide numerous challenges. Management buy-in (Healy et al. 2013) and competing pressures of work (Bennie et al. 2011, Gilson et al. 2011) can impact on whether a workforce motivated to change their sitting behaviour, feel able to take action. Ideally organisations should be convinced to make changes at a policy level, but with no standard agreement on what constitutes 'too much sitting' this currently represents a challenge.

Changing the physical environment of offices to facilitate less sitting not only makes behaviour change easier, but provides a visual cue that new behaviour is both expected and accepted. There is growing evidence that activity-permissive workstations, especially sit-stand desks are effective at reducing total occupational sitting time without effecting work performance (Neuhaus et al. 2014a). However, more research is required to determine their impact on prolonged sitting events, leisure time sitting, physical activity and long-term use. A cheaper alternative to changing the work environment, is to re-arrange offices so that standing and moving to carry out everyday tasks, such as collecting work from the printer, is required. However, there is currently little data available to support or dismiss this approach and its applicability will also be determined by the confines of existing office space.

Tackling behaviour change at an individual level represents challenges in the diverse population that represents the national workforce. Little has been done to distinguish between different groups of office workers in terms of occupational role, socioeconomic status, age group or stage of behavioural change in terms of tailoring sedentary behaviour interventions. Evidence suggests that such characteristics are important in designing health promotion initiatives (Goetzel & Ozmlnkowski 2008) and that employees perception of the acceptability of taking breaks from their desk is linked to the role they perform within an organisation (Bort-Roig et al. 2014b). There are mixed results in studies that have offered one-to-one counselling sessions with employees to address their sedentary behaviour and such an approach is not feasible on a large-scale in terms of cost and time. Active breaks have been effective at increasing physical activity, but there is no evidence to suggest that they impact on sitting time (Bort-Roig et al. 2014b, Taylor et al. 2013). Providing education on the risks associated with excessive sitting has proved successful, but only significantly when coupled with changes to workstations (Neuhaus et al. 2014b) or prompting software (Evans et al. 2012). The use of prompts to encourage frequent breaks in sitting has produced promising results (Bond et al. 2014, Cooley et al. 2014, Pedersen et al. 2014, Evans et al. 2012) but further research is required to determine whether prompts should be active or passive, what their optimum frequency should be and what messages they should contain. Evidence suggests that messages encouraging physical activity during breaks from sitting reduces the impact on sitting (Swartz et al. 2014) and therefore future studies should look at ways of encouraging non-purposeful movement or standing during these breaks.

As noted by those performing reviews of the literature, there is great heterogeneity in the methodologies used to evaluate interventions to reduce sedentary time, with many displaying limitations such as small sample size, use of convenience samples, lack of control or comparison groups and non-random allocation to groups (Shrestha et al. 2015, Neuhaus et al. 2014a, Prince et al. 2014, Tudor-Locke et al. 2014, Chau et al. 2010). In terms of measuring sedentary behaviour, studies to date have used a variety of self-reporting methods such as real-time recording, diaries, the IPAQ physical activity questionnaire and objective measurements made by a variety of devices such as tri-axial accelerometers, armbands, pedometers and smartphones. There is evidence to question the validity of relying on self-reported measures of sitting time (Clark et al. 2011, Marshall et al. 2010) and this is further complicated by inconsistent use of the term 'sedentary'; being used to describe both sitting time and periods of inactivity which may not necessarily involve sitting.

2.6 A behaviour change model for sedentary behaviour

2.6.1 Introduction

Changing both the physical work environment, and policies governing workplaces, to facilitate reductions in sedentary behaviour may have an impact, but, in addition, understanding what initiates, motivates and sustains behaviour change in individuals is likely to be the key to long-term success of sedentary behaviour interventions. The MRC Framework for developing and evaluating complex interventions to improve health (Craig et al. 2008) highlights identifying or developing explanatory theories for the behaviour in the early stages of intervention development, in order to understand how and what factors could be changed. Reviews of theory-based interventions have been shown to be effective at promoting physical activity in work places (Taylor et al. 2012), however similar theory-based research is lacking within the field of sedentary behaviour (Biddle 2011).

The focus of this section of the literature review is to critically examine selected theories of behaviour change, in order to identify how they might be applicable to sedentary behaviour in a workplace setting. Behaviour change theories are numerous and overlapping. Those chosen for examination here have been applied widely in the field of health promotion and/or the researcher considered could add value to understanding sedentary behaviour.

2.6.2 The Health Belief Model & Subjective Expected Utility Theory

The Health Belief Model (HBM) was developed by a group of investigators in the Public Health Service in the 1950s, as a result of a set of independent, applied research problems (Rosenstock 1974). The model explains people's health related behaviour by understanding individuals' beliefs about health. It proposes that the likelihood of an individual taking action related to a given health problem is based on their perception that they are susceptible to the problem, that it has serious consequences, that a course of action will minimise these consequences, and the benefits of taking action outweigh the costs or barriers (Becker 1974). The balance of these pros and cons feeds into self-efficacy which describes an individuals' perceived ability to carry out the recommendation (Figure 2.2). Self-efficacy refers to "the belief in one's capabilities to organize and execute the courses of action required to manage prospective situations." (Bandura 1995). High self-efficacy has been identified as an important determinant of health behaviour, future health behaviour and health behaviour change (Holloway & Watson 2002) and is a component of many behaviour change theories. There is consistent evidence to suggest that self-efficacy is strongly correlated to physical activity (Bauman et al. 2012), but its specific relationship to sedentary behaviour is yet to be explored.

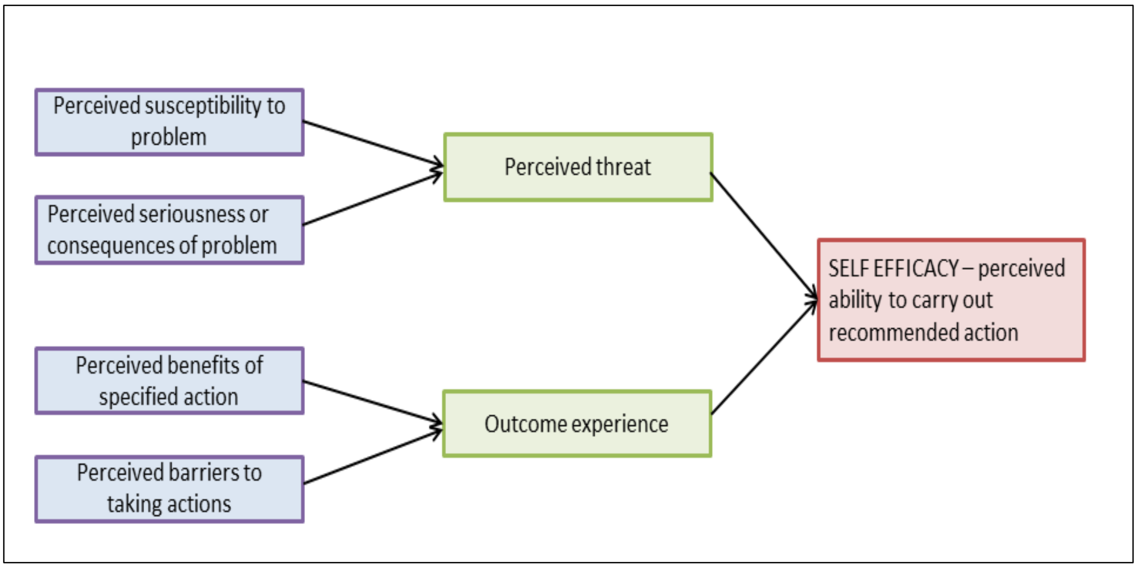


Figure 2.2 Health Belief Model (Nutbeam et al. 2010)

Subjective expected utility theory takes this pros and cons decisional balance a step further by proposing that individuals put a subjective value on the likelihood that a course of action will result in a particular outcome (Edwards 1954). This value is then used to assess which course of action or behaviour will result in the most benefit with the least cost.

These two models are therefore useful in identifying the costs and benefits that people perceive when considering or dismissing behaviour change. By failing to understand individuals' beliefs about health behaviour, in a given target group, there is a risk of developing ineffective health promotion campaigns (Tinker 1996). As a recently emerging health concern, little, if not nothing, is known about the public's perceptions or knowledge of the health risks associated with sedentary behaviour. A number of interventions have contained an educational component in which this information is relayed to participants (Neuhaus et al. 2014b, Healy et al. 2013, Evans et al. 2012) but these components have not been evaluated in terms of how participants perceive, process, and act upon the health warnings about sedentary behaviour.

The health belief model and subjective expected utility theory have been demonstrated to be most useful when applied to preventative behaviours such as screening and immunisation, but less useful in guiding interventions that address more long-term, complex and socially determined behaviours e.g. substance addiction (Nutbeam et al. 2010). Their limitations lie in the fact that little account is taken of social, economic and environmental influences and inequalities in health. Consideration of such factors are important for any health communication to be effective (Sallis et al. 1997), and especially so for targeting occupational sedentary behaviour in which environmental, social and economic factors are likely to greatly influence whether behaviour is changed or not (Rhodes et al. 2012).

2.6.3 Temporal self-regulation theory

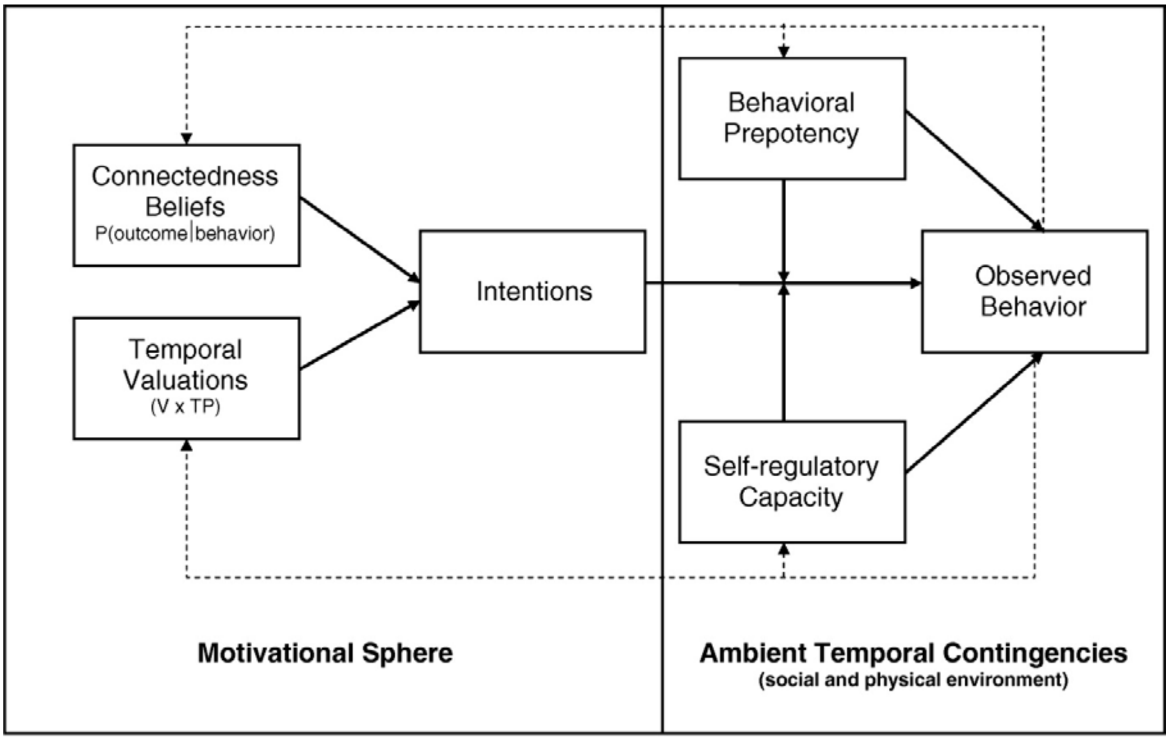
Where the health belief model and subjective expected utility theory fall short, is that they do not take into consideration the factor of time. A cost and benefit analysis of a particular behaviour is likely to factor in whether the resulting effects are immediate or long-term (Hall & Fong 2007). This, also referred to as time perspective, may be of importance in the case of occupational sedentary behaviour where the immediate inconvenience of breaking sitting does not outweigh the less tangible long term health benefits.

According to Temporal Self-regulation Theory (TST), the capacity to engage in a behaviour with long-term benefits arises from a complex combination of biological, cognitive, and social factors (Hall & Fong 2007) (Figure 2.3). There is also some evidence that time perspective may be linked to personality type (Adams & Nettle 2009). Consistent with other theories of behaviour, including the health belief model, TST proposes that motivation is linked to belief that the behaviour will lead to expected outcomes and the value an individual puts on these outcomes. In TST, two factors can moderate this intention-behaviour link:

1) Behavioural prepotency – a value reflecting the frequency of past performance and/or the presence of cues in the environment;

2) Self-regulatory capacity – any trait that impacts on an individual's capacity to effortfully regulate their own behaviour.

The influence of these two moderating factors strengthens as the time between immediate and non-immediate outcomes increases. In addition, other crucial factors for future-orientated behaviour include: Connectedness beliefs – that present behaviour will lead to later outcomes; and temporal valuations – values attached to future outcomes (Hall & Fong 2007).



Note: Arrows between Behavioral Prepotency and Self-regulatory Capacity to the Intentions-Behavior arrow implies moderation; V = value; TP = perceived temporal proximity. Broken arrows denote weaker (i.e., secondary) hypothesized effects.

Figure 2.3 Temporal Self-Regulation Theory (Hall & Fong 2007)

As well as moderating the intention-behaviour link, behavioural pre-potency and self-regulatory capacity can directly affect behaviour. For example, the frequency of past sedentary behaviour and the presence of cues in the environment, such as office furniture, would make sitting behaviour more likely to occur even in the absence of intention. These moderating factors are also more likely to be influential when the gap between perceived costs and benefits is more pronounced (Hall & Fong 2007).

The TST has been demonstrated as particularly relevant to health-protective behaviours such as exercise and healthy eating (Booker & Mullan 2013). These behaviours often have immediate negative consequences, such as effort or discomfort, but, if performed consistently, result in long term health benefits. Whilst no studies could be found that applied TST to sedentary behaviour, a study focusing on six common health behaviours supported its use in predicting healthy lifestyle behaviours, including physical activity (Booker & Mullan 2013). Of particular relevance is that the study supported the contention that TST-related factors varied in accordance to how supportive the environment was perceived to be in relation to the behaviour in question. In terms of occupational sedentary behaviour this suggests that changes to the office layout or installation of standing desks, may not only facilitate less sitting but also act as cue to stand more, and convey that standing is supported and acceptable in the office environment. In terms of addressing the issue of time perspectives, educational components of occupational sedentary behaviour interventions should also emphasise the immediate short-term benefits experienced from breaking sitting (e.g. release of muscle tension, boost of energy) in order to shift the cost-benefit analysis in favour of acting immediately to reduce sedentary behaviour.

The TST therefore goes someway to explain the gap between intention and behaviour and how this might be mediated and potentially intervened with, in terms of developing and implementing an intervention. However, one aspect that is lacking within the model, is the impact of the behaviour of others, which has been shown to effect behaviour by influencing subjective norms (Ajzen & Fishbein 1980). Subjective norms refer to a person's perception of other people's opinions about their behaviour and their motivation to fall in line with these opinions. It forms an important component of some of the theories addressed below.

2.6.4 Theories of reasoned action and planned behaviour

The Theory of Reasoned Action (TRA) is based on the premise that intention to act is the most immediate determinant of behaviour and that all other influences will be mediated through this intention (Ajzen & Fishbein 1980). Similar to the health belief model an individual's attitude towards carrying out or changing a behaviour, is the belief that the desired outcome will result if a particular behaviour is followed. Another key influence within this model is the influence of subjective norms (SN) on an individual's intention to carry out the behaviour in question. Ajzen and Fishbein (1980) propose that SN are most powerful when affected by significant others such as valued family members or peers, celebrity role models or favoured media.

The TRA therefore proposes that an individual is most likely to adopt, maintain or change a behaviour if they believe it will benefit their health, it is socially acceptable, and they feel social pressure to do so (Ajzen & Fishbein 1980). This model has been successful in predicting behaviour and intentions for actions that are primarily controllable by the individual (Smith & Biddle 1999), but for some health related behaviours, such as smoking and weight control (and arguably occupational sitting) volitional control may not be complete (Ajzen 1988). The TRA was therefore expanded to include an additional element of perceived behavioural control (PBC) (Figure 2.4). This element, alongside the original TRA, became known as the 'Theory of Planned Behaviour' (TPB) (Ajzen 1985). The addition of PBC proposes that intention to carry out a behaviour will be stronger if an individual believes they have control over carrying out that behaviour and the environment or context in which it is to be carried out (Trafimow et al. 2002). In terms of sedentary behaviour, the TPB therefore proposes that an individuals' intention to be sedentary is the main determinant of sedentary time, whilst proximal determinants are an individual's: evaluation of the costs and benefits of sitting (attitude); perceived expectations of significant others with regard to sitting (subjective norm, SN); and perception of the control they have over their time spent being sedentary (PBC) (Prapavessis et al. 2015). What may be particularly important in predicting sedentary behaviour in the workplace, is that PBC can contribute to the targeted behaviour (sedentary time) when it is not under volitional control. Figure 2.4 illustrates that PBC is linked to intentions and to behaviour and, therefore, can predict behaviour regardless of an individual's attitude or any social factors in operation (Smith & Biddle 1999). This could be important in terms of sedentary behaviour, because in a qualitative study examining factors that influence breaks from sitting at work, it was the focus group with employees (Gilson et al. 2011) and not with employers (Gilson et al. 2012) in which reduced productivity was cited as a reason for not breaking sitting. Therefore, if employees are empowered to feel that they are able and allowed to regularly break their sitting, then this could impact on their sedentary behaviour.

Smith and Biddle (1999) explored the relationship between TPB and intentions to be physically active and sedentary in office based employees (n=155). Questionnaires to measure each of the four constructs of TPB were completed with two distinct sections: one relating to physical activity; and the other to sedentary behaviour. Self-reported activity was measured using a modified version of the Leisure-Time Exercise Questionnaire (LTEQ) (Godin & Shephard 1985). The results showed that the TPB was useful in predicting intention to exercise and reported physical activity, from attitudes and PBC, but that SN did not predict exercise behaviour. However, predicting sedentary behaviour using the TPB was less clear and the authors concluded that future research would benefit from defining the specific target sedentary behaviour and context (watching TV, driving a short journey) in order to measure intention (Smith & Biddle 1999). Also, use of the LTEQ to estimate actual sedentary time has questionable accuracy. The LTEQ is a simple questionnaire that asks subjects to estimate time spent on strenuous, moderate and mild activities in a typical week. Using this questionnaire to calculate sedentary behaviour infers that any time not spent engaging in activity could be considered sedentary, which is a questionable assumption.

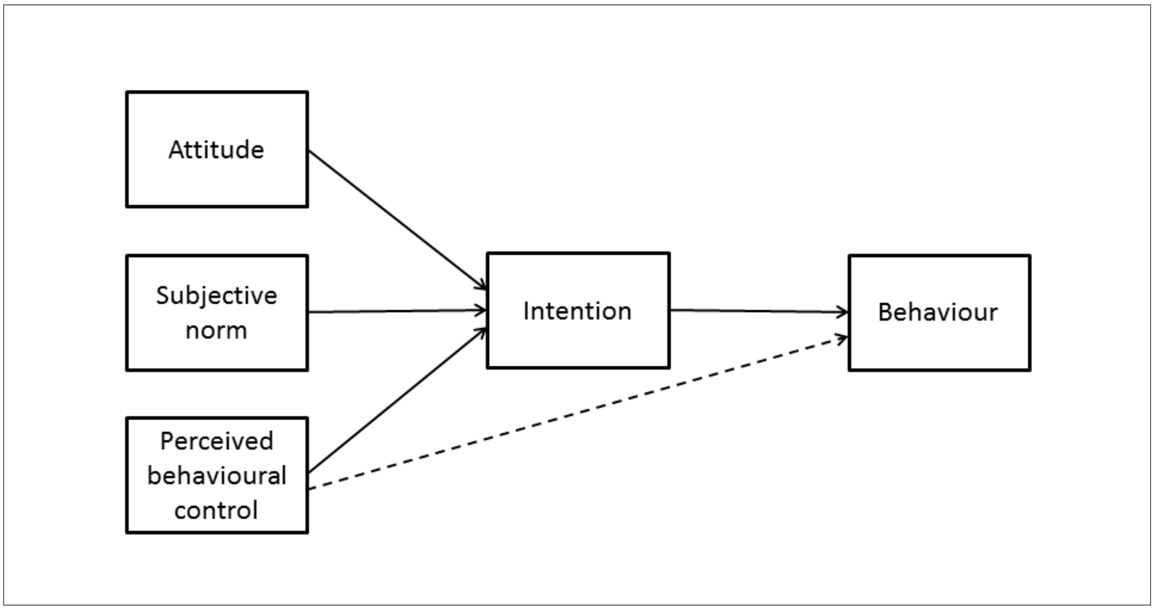


Figure 2.4 The Theories of Reasoned Action & Planned Behaviour. The Theory of Planned Behaviour includes the element of Perceived Behavioural Control (Smith & Biddle 1999)

Rhodes & Dean (2009) applied the TPB to understand the motives underlying four specific sedentary leisure activities: television viewing, computer use, reading/music, and socialising. Their results showed a significant correlation between intention and attitude, and the four sedentary behaviours investigated, but small or inconsistent relationships with SN or PBC. However, there were a number of limitations. In particular, the four activities investigated were limited to leisure activities and can therefore be deemed to be under volitional control, which may not be the case with all sedentary behaviours, especially occupational sitting. The study also relied on self-reported sedentary behaviour which has been shown to be inaccurate (Clark et al. 2011, Marshall et al. 2010) using un-validated scales that defined sedentary behaviour as accumulating at least 30+ minutes of inactivity in the previous week and weekend (Prapavessis et al. 2015).

Self-reported sedentary time was also used in a pilot study which examined the value of TPB with the addition of habit strength to predict both occupational and leisure time sedentary behaviour (Warner & Biddle 2011). Habit strength refers to repeated behaviours carried out without conscious decision, and has been shown to be a stronger predictor of behaviour than intention, in a study of active travel choices (Bruijn et al. 2009). This pilot study showed that variance in occupational, but not leisure-time sedentary behaviour, was explained by attitude, SN and PBC. Habit strength explained an additional 34% of this variance. This led the authors to conclude that interventions to break occupational sedentary behaviour need to be looked at from the perspective of habit breaking, with greater emphasis on environmental manipulation, alongside behavioural prompts (Warner & Biddle 2011).

A more recent study tested five separate TPB models for different contexts of sedentary behaviour on weekends and weekdays (Prapavessis et al. 2015). The aim was to assess cognitions towards non-volitional (work/school) and volitional (leisure/recreation) sedentary time on both weekends and weekdays, with a fifth model looking at general sedentary behaviour. Sedentary behaviour was measured using a modified Sedentary Behaviour Questionnaire (Rosenberg et al. 2010) administered online. Items grouped into factors consistent with the TPB in all 5 models explained 9% to 58% and 8% to 43% of the variance in intention and behaviour, respectively. Unlike in the studies by Smith & Biddle (1999) and Rhodes & Dean (2011), SN proved to be a strong predictor of sedentary intentions, which in turn predicted sedentary time (Prapavessis et al. 2015). However, SN did not relate directly to sedentary behaviour in 4 of the 5 models. This may be due to the fact that sedentary behaviour is often socially acceptable, which diminishes the impact that cues from significant others may have on behaviour. Evidence suggests that subjective norms are more likely to impact directly on behaviour, if the behaviour in question is not socially approved (Manning 2009). In terms of intention to carry out sedentary behaviour, there was wide discrepancy across the five models tested. The two models examining sedentary behaviour in a workplace/school context showed the greatest variance in intention (58% at weekends and 33% on weekdays) compared to those investigating leisure time sedentary behaviour (9% weekday and 17% weekend). Surprisingly, though, PBC was found to be a poor predictor of both sedentary intentions and actual sedentary time, suggesting that such differences may not be dependent on whether the sedentary behaviour was under volitional control or not. However, the way in which PBC was measured in this study could be questioned as it was the only TPB construct that did not qualify a period of sedentary time e.g. whether a person felt they had control over sitting for 30 minutes or 5 hours. Such qualification is important, especially in understanding sedentary behaviour in a workplace setting.

Whilst no theoretical basis was stated, a workplace study that aimed to understand the correlates of occupational sitting, examined a number of 'psychosocial' factors in line with TPB (De Cocker et al. 2014). It found that whilst such factors did not explain variance in self-reported sedentary time, those perceiving lower social norms and having less control to reduce sitting reported more occupational sitting than those who had identified more benefits of sitting less and had expressed greater intention to sit less (De Cocker et al. 2014). The authors concluded that occupational role was a stronger determinant of sitting time than any of the psychosocial factors measured, although it is worth noting that each of these factors was measured by a single question using an un-validated questionnaire.

The TPB is, to date, the behavioural model most frequently applied to sedentary behaviour. The small amount of evidence available suggests that it may prove relevant to understanding sedentary behaviour in some contexts, though exactly which contexts and which constructs are most applicable is currently unclear. Use of objective measurements of sedentary behaviour in future TPB studies would strengthen the case for TPB predicting sedentary behaviour, but the environment in which sedentary behaviour is occurring will need to be taken into account.

2.6.5 Health Action Process Approach

The Health Action Process Approach (HAPA) (Schwarzer 1992) attempts to explain why intentions are not always acted upon. Just as a number of factors predict intention, a number of factors may also compromise or facilitate the translation of intentions into behaviour. HAPA therefore proposes two distinct phases: a) pre-intentional motivation processes leading to behavioural intention and b) post-intentional volition processes that lead to health behaviour (Schwarzer 2008) (Figure 2.5).

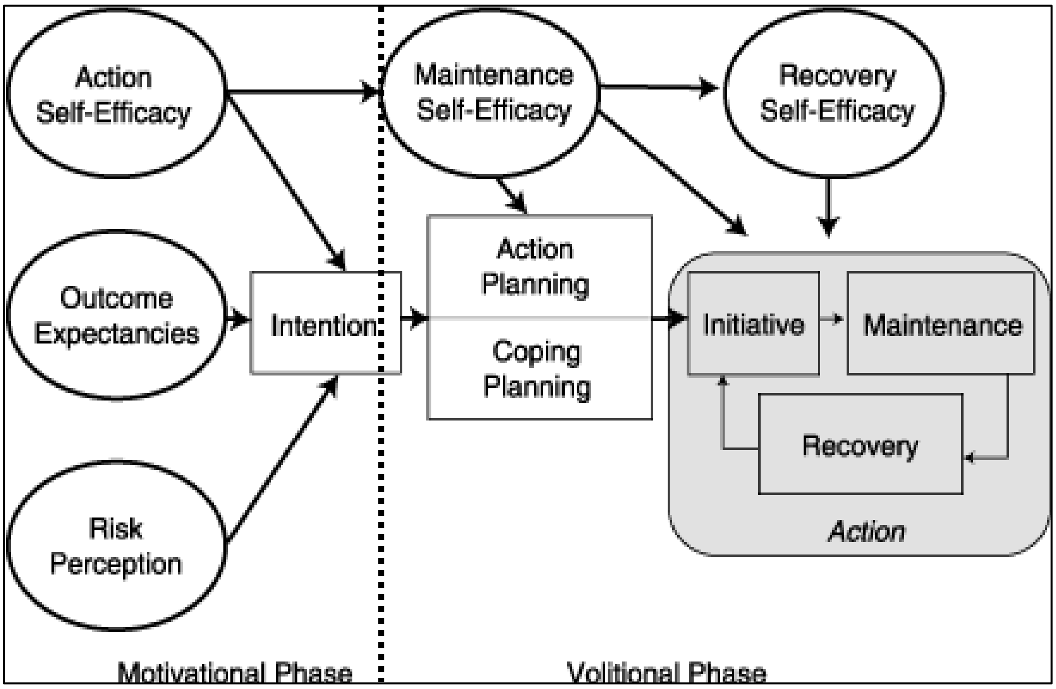


Figure 2.5 Health Action Process Approach (Schwarzer 2008)

In the initial motivational phase, risk is seen as a distant antecedent and therefore not sufficient to, alone, form intention. Instead it forms the basis for a contemplation process and elaboration of thoughts about consequences and competencies (Schwarzer 2008). Outcome expectancies (the balance of pros and cons of a behaviour) and action self-efficacy (belief in one's ability to begin a new behaviour) also help form intentions. In HAPA, different types of self-efficacy are distinguished in relation to the different tasks that have to be mastered in order to achieve behaviour change. Action self-efficacy describes the beliefs a person may have before action is taken. Someone with high action self-efficacy will anticipate success, potential outcomes and be more likely to initiate new behaviour compared to those with low action self-efficacy who anticipate failure, have self-doubt and may procrastinate. Maintenance self-efficacy refers to a person's belief about their capacity to deal with barriers that may arise. Those with high maintenance self-efficacy are more likely to invest more effort in overcoming such barriers. Recovery self-efficacy describes how a person actually reacts to failure. Those with high recovery self-efficacy will more likely attribute failure to an external source, trust their own competence to recover from failure and try again. Those with low recovery self-efficacy are more likely to interpret failure as a full-blown relapse from which they are unlikely to recover (Schwarzer 2008).

The HAPA has demonstrated predictive validity across a range of health behaviours including physical activity (Schwarzer 2008, Scholz et al. 2009), nutrition (Schwarzer & Renner 2000), and dental hygiene (Schuz et al. 2007). Scholz, et al. (2009) also demonstrated that HAPA could be used to describe within- person differences as well differences between people in terms of intentions to carry out exercise. This therefore goes some way to understanding intrapersonal processes in terms of adherence to recommended healthy behaviours, which can help inform the development of health interventions.

Whilst HAPA has not yet been applied to sedentary behaviour, if it proves to be a reliable predictor of sedentary behaviour, it could prove to be a useful framework in terms of intervention design. Equipping individuals with planning strategies to increase all phases of self-efficacy could be crucial to closing the intention-behaviour gap. Where HAPA falls short, in terms of sedentary behaviour in the workplace, is that it does not take into account the potential environmental cues for behaviour in this context, nor the behaviour of others.

2.6.6 Behavioural choice theory

One theory that incorporates both individual-level and environmental influences is Behavioural Choice Theory (BCT) (Epstein 1998). BCT states that behavioural choices are made according to the cost and reinforcing value of alternative options. Alternatives to the usually preferred behaviour will therefore be made if the value of the alternative is deemed higher (Epstein 1998). Having the choice of such 'reinforcer' alternatives is important in explaining behaviour and the value people place on them may change over time or be influenced or modified by other behaviours. Individuals may also choose less valued reinforcers if there is a delay in the ability to carry out the preferred alternative (Epstein 1998). Environmental constraints, such as access or cost, are also associated with participation in alternative behaviours (Lappalainen & Epstein 1990). In laboratory studies a greater preference for sedentary behaviour has been found to be negatively associated with time spent in physical activity in a free-choice situation (Epstein et al. 1997). Changing the consequences of sedentary behaviour led to increased activity levels, which led to the proposition that population-wide physical activity promotion should also focus on time spent in sedentary behaviours (Epstein 1998). However, whilst this may be effective at increasing physical activity levels, more recent research suggests that the impact on reducing sedentary behaviour is attenuated in interventions that contain both messages to increase activity and decrease sedentary behaviour (Prince et al. 2014, Swartz et al. 2014).

Salmon, Owen et al. (2003) used the constructs of BCT to examine environmental and individual-level factors associated with participation in both physical activity and sedentary behaviour, in a population-based study of adults. They found that barriers, enjoyment, and preferences all predicted self-reported leisure-time physical activity and sedentary behaviour. Personal barriers such as lack of time, other priorities, work, and family commitments were inversely associated with physical activity and sedentary behaviour. Most environmental barriers were not strongly related to participation in physical activity, but weather was highly related to participation in sedentary behaviours (Salmon et al. 2003).

BCT has the potential to explain sedentary behaviours, due to the fact that they are often easy to form and ubiquitous in nature (Biddle 2011). However, further research is required in terms of applying BCT to sedentary behaviour in real-world settings. Providing reinforcement (rewards for goal attainment) and identifying enjoyable non-sedentary activities are potentially useful constructs from BCT that could be utilised in strategies to reduce sedentary behaviour (Owen et al. 2011).

2.6.7 Social Cognitive Theory

Social Cognitive Theory (SCT) is also based on the interaction between individuals and their environment, but recognises that this relationship is more complex than simply an environment facilitating or prohibiting specific behaviours. An important writer on the use of SCT in health promotion is Albert Bandura who coined the phrase 'reciprocal determinism' to describe the way in which individuals, their environment (including other individuals) and their behaviour continuously interact (Bandura 1997). He argued that the behaviour and opinions of those in the immediate environment are more likely to influence behaviour than regulations alone. For example, if work colleagues are pro standing, are moving around more and are assertive in this behaviour and belief, this is more likely to influence others to stand more than a directive from management telling them they must take a standing break every 30 minutes. Owen et al. (2011) argued that social norms, what is deemed by the majority to be acceptable and normal, in the context of sitting at work are implemented socially, by questioning why someone may be standing in a meeting instead of sitting, and by environmental cues such as providing chairs in all meeting rooms. Modifying social norms may therefore be fundamental to impacting on sedentary behaviour in workplace environments.

To help understand the relationship between individuals and their environment, Bandura identified a number of cognitive factors that help explain behaviour:

- **Situation/environment** – the situation and/or the environment an individual is in will influence their ability to successfully complete a behaviour. Environmental factors have the ability to influence an individual's self efficacy with regard to changing their behaviour.
- **Outcome expectations** – anticipating and placing value on the outcomes of a behaviour e.g. if standing more is believed to aid weight loss, and weight loss is deemed important, an individual is more likely to increase time spent standing.
- **Self-efficacy** – an individual's belief that they can successfully carry out the behaviour. Bandura believed this to be the most important pre-requisite for behaviour change.
- **Self-regulation** – the ability to get past short-term negative outcomes in pursuit of a long-term goal which can be achieved through goal setting and feedback.
- **Observational learning** – individuals will learn behaviour from observing others and the rewards they associate with it e.g. if a role model they admire and regard attractive is seen smoking, they will associate attractiveness with smoking and therefore are more likely to continue to smoke themselves.

With SCT it is important to recognise the interactions between people, environments and behaviour are dynamic and can be continually changing for an individual (Nutbeam et al. 2010). This could be within the same environment at different times of the day, or as a person changes environment and therefore alters their behaviour. For example, a person may recognise the importance of standing more at work, have high self-efficacy for carrying out the behaviour and be motivated by reciprocal determinism of colleagues at work, but when the individual is at home may sit for hours at a time in front of the TV with their family.

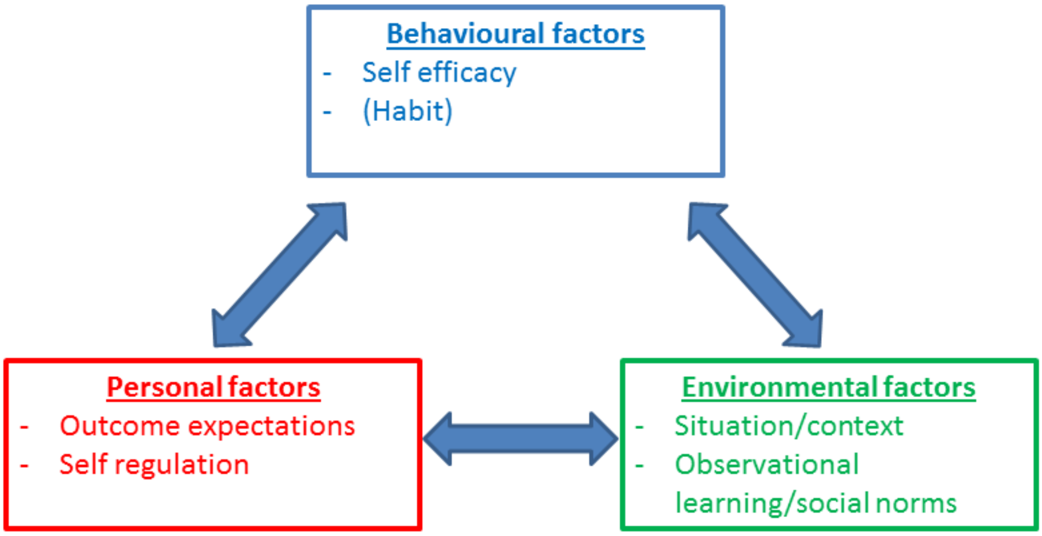


Figure 2.6 Representation of Social Cognitive Theory

By using techniques to influence the constructs of SCT, behaviour change can be influenced. Skills, techniques and strategies based on SCT were used to target sedentary behaviour in people with multiple sclerosis (Klaren et al. 2014). Behavioural coaching via Skype, and goal setting strategies via a website, significantly reduced self-reported sedentary behaviour in the intervention group. SCT was also used as the theoretical basis for increasing self-efficacy for physical activity in sedentary workers in a manufacturing plant, via use of a web-based intervention tool (Irvine et al. 2011). The more frequently participants accessed the web-tool, the greater their self-efficacy for participating in physical activity, although it is questionable whether high levels of self-efficacy in such individuals was a result of the intervention, or previously present, resulting in them being more likely to engage more frequently. A program of measures to improve physical activity and nutrition and reduce sedentary behaviour in adolescent girls also centred on increasing self-efficacy, as well as increasing social support, behavioural strategies, and changing the perceived environment (Dewar et al. 2014). Such techniques proved successful at reducing objective and subjective measurements of sedentary behaviour. However, in all three studies, the basis for using SCT to inform the intervention design was not clear, as the theory has not yet been proven to predict sedentary behaviour. Without studies measuring the validity of each of the constructs of SCT to sedentary behaviour, researchers are relying on the inference of a 'good fit' from its applicability to other behaviours, such as physical activity.

The applicability of SCT to developing workplace interventions to reduce sedentary behaviour is worthy of exploration as it takes into account the impact of both the environment and social interactions with others on behaviour. However, SCT relies, to a certain extent, on conscious and effortful motivation. Evidence suggests that cognitive control systems, such as self-efficacy, are important in the acquisition of behavioural proficiencies, but when a behaviour is less demanding and more easily engaged in, (e.g. sitting at a desk) then such cognitive control systems give way to regulation by lower control systems in which behaviour is automatic and less consciously thought about (Stevens et al. 2003, Bandura 1997). Although sitting behaviour as a potentially unconscious 'habit' is not addressed directly in Bandura's Social Cognitive Theory, Figure 2.6 illustrates that habits could be classed under behaviour factors as they are formed by the repetition of a behaviour (Lally et al. 2010). In the context of workplace sitting, it may therefore also be important to recognise the role of how office environmental factors influence sitting habits. The concept of habit is explored further in the dual process theory of motivation.

2.6.8 Self Determination Theory

Motivation refers to the processes that initiate, orient, and regulate behaviour over time (Conroy et al. 2013). One theoretical approach to motivation is Self Determination Theory (SDT) (Deci & Ryan 2008) (Figure 2.6). SDT proposes that the 'quality' rather than the quantity of motivation will predict positive behavioural outcomes, through developing a sense of autonomous motivation and competence enabling individuals to self-regulate and maintain behaviour change (Ryan et al. 2008). In addition to autonomy and competence, the SDT recognises the importance 'relatedness' which refers to the belief that people are more likely to adopt behaviours favoured by others they trust and feel connected to. Figure 2.6 depicts how supportive environments, personality differences and internally and externally driven life priorities all impact on whether an individual feels levels of autonomy, competence and relatedness that facilitate improved mental and physical health outcomes (Ryan et al. 2008).

Autonomous motivation comprises of both intrinsic motivation, when an activity is carried out because of its inherent satisfactions, and some types of extrinsic motivation (motivated by an outcome separate to the behaviour itself) in which people have identified with the value of an activity (Teixeira et al. 2012). SDT argues that autonomous motivation is more likely to result in maintained change towards healthier behaviours in comparison to controlled motivation which is based on external regulation (external rewards or punishment) and introjected regulations (driven by self-approval, esteem and avoidance of shame) (Deci & Ryan 2008). Fostering autonomy is also central to the NHS' manifesto to empower citizens with greater control over their health and care (Muir & Quilter-Pinner 2015)

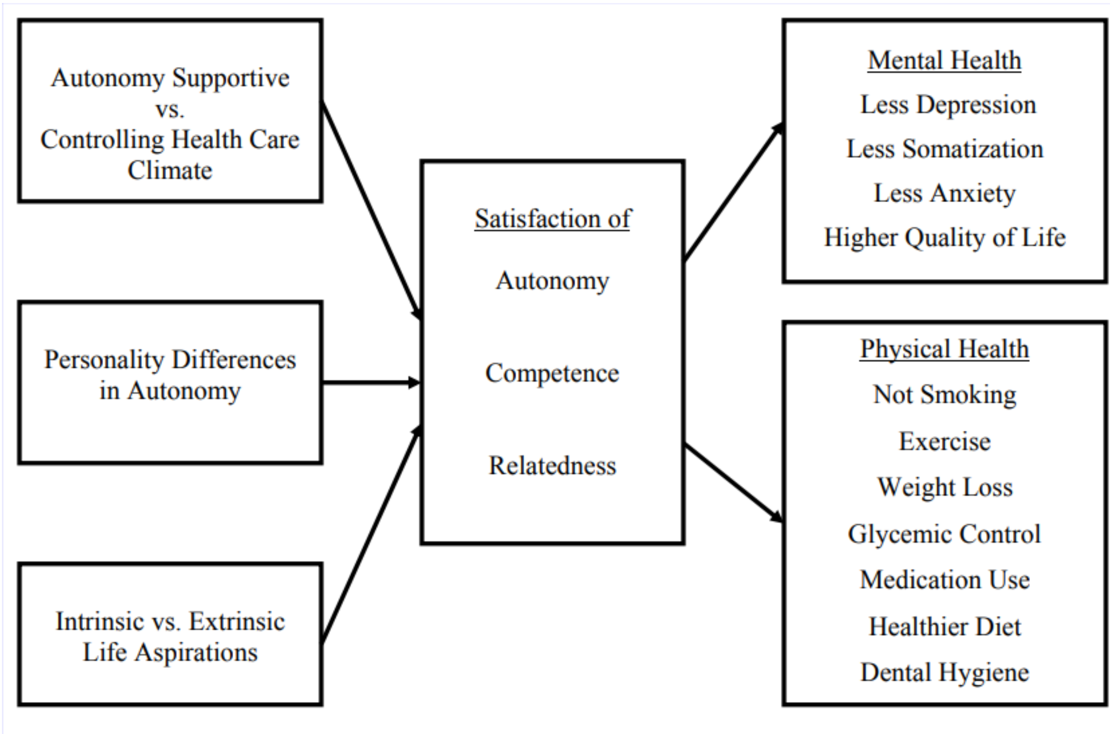


Figure 2.7 Self Determination Theory (Ryan et al. 2008)

A meta-analysis of the application of studies utilising SDT, concluded that it is viable as a conceptual framework to understanding motivation for changing health-related behaviours (Ng et al. 2012). However, its application specifically to sedentary behaviour is not known. A systematic review of the relationship between SDT constructs and physical activity outcomes, found that intrinsic motivation was predictive of long-term exercise adherence (Teixeira et al. 2012). Given that intrinsic motivation is based on self-satisfaction, it is less likely to be a predictor of sitting behaviour in a work environment. However, the notion that extrinsic motivation may result in behaviour change being less likely to be sustained, is an important consideration with regard to interventions addressing occupational sedentary behaviour. It implies that interventions should focus on aiming to increase autonomous motivation, by selling the short and long-term benefits of less sitting, and avoid any intervention appearing like a prescribed instruction from management.

2.6.9 Dual process theory of motivation

The dual-process theory of motivation distinguishes between controlled, reflective, motivational processes and automatic, compulsive processes. (Strack & Deutsch 2004, Smith & DeCoster 2000). Controlled processes tend to be conscious, slow, effortful and volitional, whilst automatic processes are non-conscious, fast, effortless and unintended (Bargh & Chartrand 1999).

Conroy, Maher et al. (2013) conducted a study on motivational processes for sedentary behaviour in undergraduate students (n=130). They found that both intentions to be less sedentary (controlled processes) and measures of habit strength (automatic processes) predicted both subjective and objective measures of sedentary behaviour over a 14 day period. Participants with stronger sedentary habits, on average, reported more sedentary behaviour, and those with stronger intentions to limit sedentary behaviour were less sedentary. These results suggest that there is value in targeting both types of processes in order to reduce sedentary behaviour. Intentions to be less sedentary are the focus of many interventions aimed at tackling sedentary behaviour in the workplace through techniques such as education to alter health beliefs, goal setting, feedback or motivational interviewing to increase self-efficacy (Neuhaus et al. 2014a, Healy et al. 2013). Whereas addressing a habit, such as sitting, requires breaking the association of the behaviour with contexts or environmental cues (Wood & Neal 2007). In an office context this could involve removing chairs in a meeting room, installing sit-stand desks, moving furniture and equipment within the office space, or giving point of choice prompts to break sitting via a PC or personal worn device.

Another result of Conroy's study was that intention to be sedentary tended to fluctuate within individuals on a daily basis, whereas habit was more predictive of behavioural differences between individuals (Conroy et al. 2013). However, a more recent study concluded that habit strength was the strongest predictor of daily changes in sedentary behaviour but, unlike for physical activity, did not have any impact on the effectiveness of action planning for sedentary behaviour (Maher & Conroy 2015). The implications of these results are that breaking sitting habits could be important for reducing sedentary behaviour, and the daily fluctuations that individuals intentionally or non-intentionally display.

Whilst both the studies examining the dual process theory of motivation for sedentary behaviour have limitations in terms of self-reported measures and the potential behavioural impact of self-monitoring, the results provide useful insight into the processes behind sedentary behaviour. Further research is needed into the motivational processes of different age-groups, genders, occupational roles and status in different contexts, and into determining which processes are most effective at initiating and maintaining long term sedentary behaviour change.

2.6.10 Protection motivation theory

Protection motivation theory (PMT) attempts to gain insight into the conscious processes related to motivation (Rogers 1975). It proposes that a balance between threat appraisal constructs and coping appraisal constructs leads to goal intention and, in turn, behaviour. Threat appraisal constructs include perceived severity, an assessment of danger to life, and perceived vulnerability, how susceptible an individual feels to the threat. Coping appraisals include response efficacy - how effective an individual believes a response will be to averting the threat, and self-efficacy - how confident an individual feels they are at performing the coping response (Milne et al. 2000).

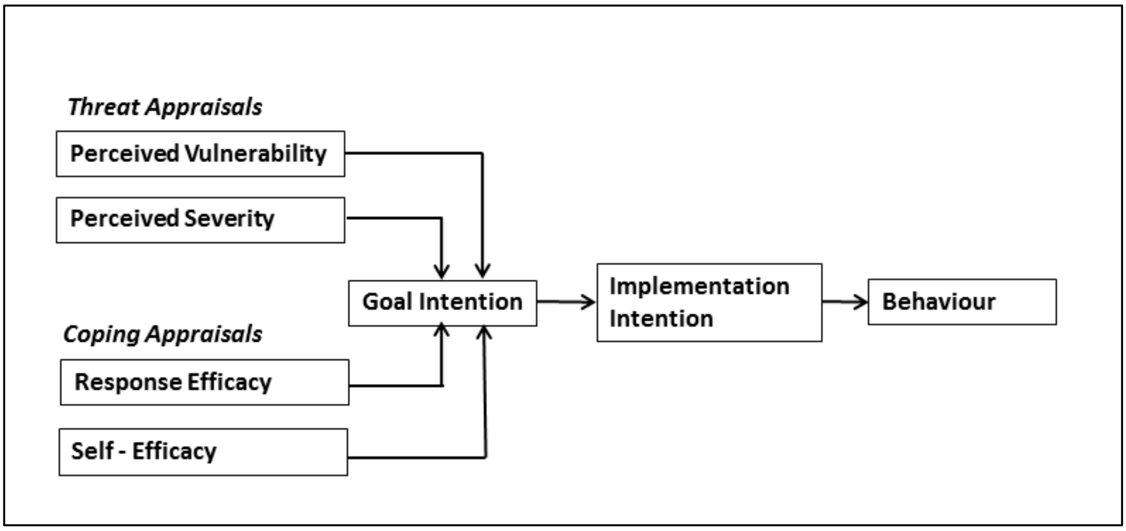


Figure 2.8 Conceptual model of the modified protection motivation theory (Wong et al. 2016)

Some researchers have modified the PMT framework to include a post-intentional process that they named 'implementation intention' (Gaston & Prapavessis 2009). Implementation intention describes un-conscious processing that is controlled by a selected situational cue (Gollwitzer 1999). This could be important in understanding people's unconscious response to sitting when entering a room with chairs. It differs from goal intention which describes an individual's intention to perform a behaviour in the future. Distinguishing between, and understanding the processes of these two types of intention may be key to bridging the intention-behaviour gap

The addition of implementation intention has proved to be beneficial by improving the initiation and performance of health behaviours including physical activity (Milne et al. 2002). However, to date, PMT is yet to be applied directly to sedentary behaviours. Using 'nudges' in the form of environmental cues, such as leaving standing desks in an upright position, to influence implementation intention may be important in helping those whose goal is to reduce their sitting, but there is currently no evidence to support this.

2.6.11 Control theory

Control theory proposes that effective self-management and behavioural control is best achieved through setting goals, monitoring behaviour and receiving feedback (Carver & Scheier 1982). These components act within a negative feedback loop with people's perception of their behavioural achievements (input function), and planning and intention (output function) acting as determinants of future behaviour when compared to a central reference point (comparator) (Figure 2.8). If a discrepancy is detected between the present state and the reference point, the behaviour is performed. The model also allows for the fact that external influences may interrupt and disturb internal feedback loops (Carver & Scheier 2002).

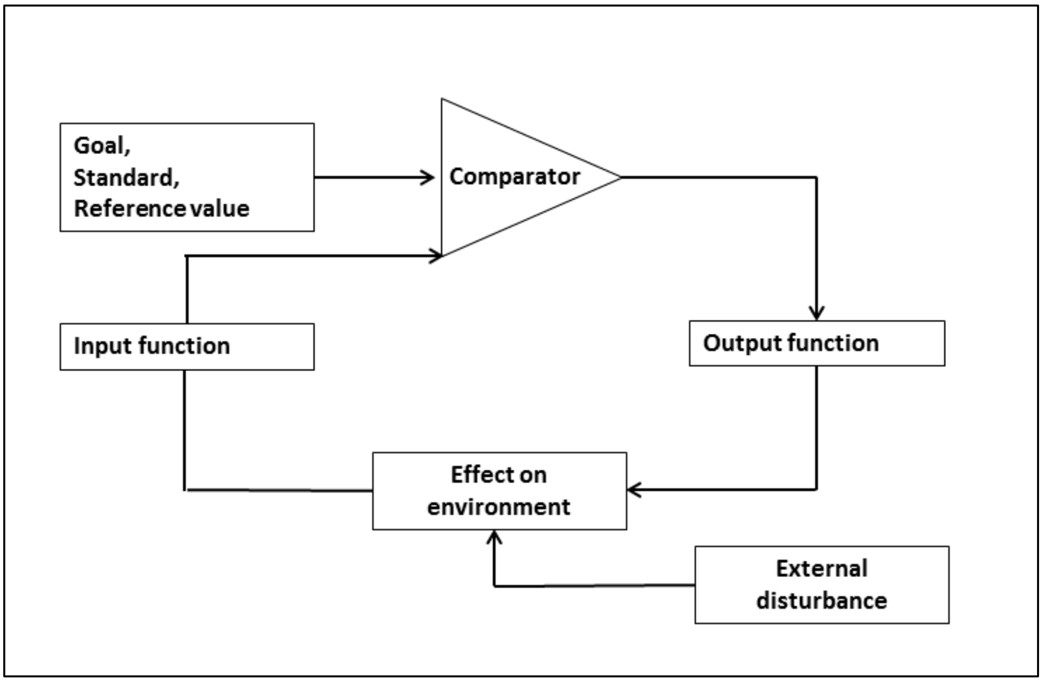


Figure 2.9 Schematic diagram of a feedback loop (Carver & Scheier 2002)

Whilst there are no studies applying control theory directly to sedentary behaviour, a number of self-regulation techniques derived from control theory have been used in interventions to reduce sedentary behaviour, with some success. These include goal setting (Bort-Roig et al. 2014b, Neuhaus et al. 2014a, Healy et al. 2013, Kirk et al. 2012), feedback on performance (Bort-Roig et al. 2014b, Neuhaus et al. 2014a, Fitzsimons et al. 2013, Healy et al. 2013, Parry et al. 2013), self-monitoring of behaviour (Neuhaus et al. 2014a, Healy et al. 2013) and reviewing behavioural goals (Kirk et al. 2012).

Goal-setting and providing feedback were two of the most common behaviour change techniques used in a review of 167 top-ranked mobile applications (apps) for physical activity (Conroy et al. 2014). Goal-setting was also quoted as one of the most desired features of such apps by potential users (Munson & Consolvo 2012, Rabin & Bock 2011). However, the authors of the review note that the most common techniques used were educational, which although valuable for potentially increasing self-efficacy and therefore intentions, may not, alone, be adequate enough to sustain behaviour change (Conroy et al. 2014). A smartphone app to reduce excessive sedentary behaviour in overweight and obese individuals provided self-monitoring and feedback in the form of a text message praising compliance following a prompt to break sitting, and a green light appearing on the phone dashboard (Bond et al. 2014). Use of the app resulted in a 5.9% (47 mins/day) decrease ($p<0.005$) in sedentary time during a 7 day trial. Similar results were found in an acceptability trial of the NEAT! app designed for people with Type 2 diabetes (Pellegrini et al. 2015). The smartphone software prompted people to stand based on information from a body-worn accelerometer and asked individuals to log a response if they felt unable to comply with the prompt. In this way users could be considered as monitoring their behaviour. Use of the app during the one month trial resulted in an average 8.1% reduction in sedentary time.

2.6.12 The Transtheoretical Model

The Transtheoretical Model (TTM) describes behaviour change as a dynamic process, as opposed to a single event, or a series of multiple, events (Prochaska & DiClemente 1983). It identifies the different stages that people go through on the path towards changing behaviour, based on the premise that people have varying levels of motivation or readiness to change. The model identifies five stages of change:

1. Precontemplation – individuals who are not considering changing their behaviour or who have consciously decided not to change.
2. Contemplation – individuals considering making a change to a specific behaviour

3. Preparation (determination) – an individual makes a serious commitment to change and takes preparatory steps to do so
4. Action – behaviour change has been initiated
5. Maintenance – sustaining the behaviour change

Individuals vary in terms of the stage of change they start at, how quickly they move through the stages, and how many times they may repeat different stages (Nutbeam et al. 2010). The model is often depicted as cyclical to convey how individuals may 'relapse' behaviour and return to earlier stages in the cycle before reaching long term behaviour change. A sixth stage, 'termination', is sometimes added in which maintenance is so secure that efficacy is so high in relation to the changed behaviour it's as if the original behaviour had never been performed in the first place. This is especially applicable when applied to addictive behaviours (Prochaska et al. 1992).

Knowing an individual's stage of change helps determine when particular shifts in intention, attitudes and behaviour occur, but a second dimension of the TTM – processes of change – enables understanding about how these shifts occur (Prochaska et al. 1992). Ten processes have been identified across diverse behaviours which have been mapped against the different stages so that interventions can be tailored according to an individual's current stage of change in order to facilitate movement from that stage to the next (Table 2.3).

DiClemente more recently suggested the model should contain a third dimension; context of change (DiClemente 2005). This attempts to recognises the impact that both an internal and external environment can have on behaviour change and moving through the various stages e.g. an environment in which it is difficult to stand more, but easy to continue sitting, will facilitate sitting and prohibit standing. However, there is little evidence of this element being used alongside the TTM in behavioural change studies to date.

The TTM has been widely applied to a variety of behaviours including addiction, physical activity, weight control and preventative screening (Nutbeam et al. 2010), but, to date, has not been used to specifically examine how individuals may work towards reducing their sedentary behaviour. There are critics of the model who claim that it does not account for the complexity of behaviour change processes (Bridle et al. 2005) although this may be due to some aspects of the model e.g. processes of change, being ignored in its application in some studies (Hutchison et al. 2009). Other critics argue that the TTM focuses on personal motivation for change and does not take into account external and social factors such as age, gender, and socioeconomic position (Adams & White 2005). However, the strengths of the TTM lie in identifying the needs and motivations of individuals at different stages in a process of change and therefore opens the possibility of tailoring interventions accordingly, instead of relying on a one-size fits all approach. This may be useful in designing a workplace intervention to reduce sedentary behaviour, in order to ensure that the behaviour change technique is suitable to all employees, not just those who are initially open to changing their behaviour.

Table 2.3 Movement between stages of change and the associated processes of changes and their interventions. Adapted from Prochaska, DiClemente & Norcross 1992

Movement between stages of change	Processes emphasised in facilitating movement	Definitions of processes: Interventions
Precontemplation to contemplation	Consciousness raising	Increasing information about self and problem: observations, confrontations, interpretations, bibliotherapy
	Dramatic relief	Experiencing and expressing feelings about one's problems and solutions psychodrama, grieving losses, role playing
	Environmental re-evaluation	Assessing how one's problem affects the physical environment: empathy training, documentaries
Contemplation to preparation	Self-reevaluation	Assessing how one feels and thinks about oneself with respect to a problem: value clarification, imagery, corrective emotional experience
Preparation to action	Self-liberation	Choosing and commitment to act or belief in ability to change: decision-making therapy, New Year's resolutions, logotherapy techniques, commitment enhancing techniques
Action to maintenance	Reinforcement management	Rewarding one's self or being rewarded by others for making changes: contingency contracts, overt and covert reinforcement, self-reward
	Helping relationships	Being open and trusting about problems with someone who cares: therapeutic alliance, social support, self-help groups
	Counterconditioning	Substituting alternatives for problem behaviours: relaxation, desensitisation, assertion, positive self-statements
	Stimulus control	Avoiding or countering stimuli that elicit problem behaviours: restructuring one's environment (e.g. removing alcohol or fattening foods), avoiding high risk cues, fading techniques
	Social liberation	Increasing alternatives for non-problem behaviours available in society: advocating for rights of repressed, empowering, policy interventions

2.6.13 COM-B Model

Whilst the application of behaviour change models to sedentary behaviour is scarce, one or more behaviour change techniques are often at the core of sedentary behaviour interventions. For example, goal setting, which links into SCT and the dual process theory of motivation, has been a successful component of interventions to reduce sedentary behaviour (Neuhaus et al. 2014a, Healy et al. 2013). Determining which behaviour change techniques are successful at bringing about change is important in identifying the 'active ingredients' of interventions, allowing them to be refined and replicated (Gardner et al. 2010). However, behaviour change techniques cited in studies often have no standard definition and are not linked to models of behaviour change (Michie et al. 2011).

To address this, a framework has been developed to categorise behaviour change components of interventions into nine functions: education; persuasion; incentivisation; coercion; training; enablement; modelling; environmental restructuring; and restrictions, depicted within a 'behaviour change wheel' (Michie et al. 2011) (Figure 2.9).

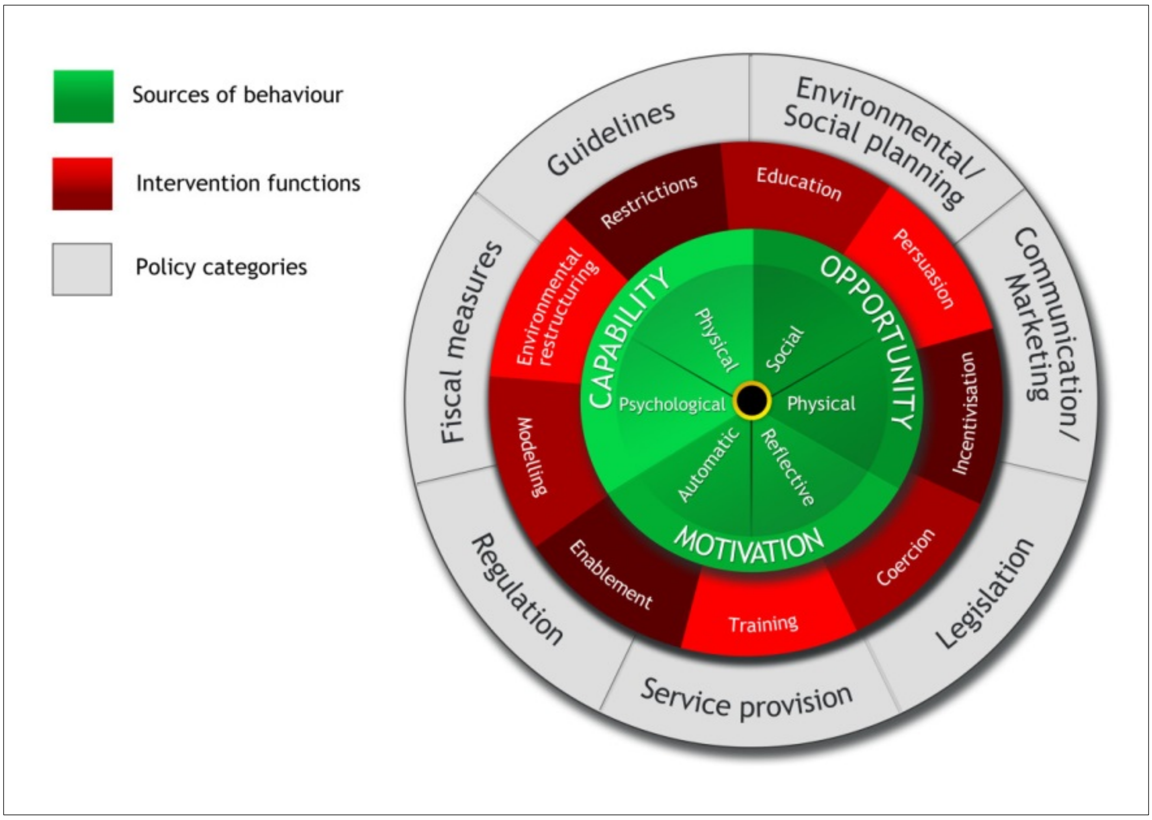


Figure 2.10 Behaviour change wheel (Michie et al. 2011)

Central to the framework is the COM-B model which recognises that capability, opportunity, and motivation all interact in order to determine behaviour. These need to be modified accordingly to facilitate behaviour change, using one of the nine intervention functions. In turn, these intervention functions can be supported by one of the seven policy categories depicted on the outer rim of the behaviour change wheel (Michie et al. 2011). Once appropriate intervention functions have been determined, behaviour change techniques can be chosen that will facilitate bringing about the desired change. A comprehensive taxonomy of behaviour change techniques (Michie et al. 2013) can be used to identify a range of strategies that can be used in an intervention, based on the intervention function(s) selected from the Behaviour Change Wheel (Michie et al. 2011) .

Whilst there are no published studies utilising the COM-B model to design interventions to reduce sedentary behaviour, at the time of writing, a systematic review of behaviour change techniques used in sedentary behaviour interventions was being conducted. Categorising and determining which techniques were used in successful sedentary behaviour interventions, is an important step in identifying appropriate behaviour change theories on which to base future interventions.

2.6.14 Summary of a behaviour change model for sedentary behaviour

Behaviour change theories provide us with various constructs with which to build up a picture of human behaviour and what influences it. Explaining health behaviours, including sedentary behaviour, is complex. It is likely to involve the balance between numerous factors such as: health beliefs (Bandura 1997, Schwarzer 1992, Edwards 1954); risk perception (Schwarzer 1992); self-efficacy (Bandura 1997, Schwarzer 1992, Edwards 1954); behavioural pre-potency (Hall & Fong 2007); self-regulation (Bandura 1997, Carver & Scheier 1982); reinforcing alternatives (Epstein 1998); observational learning (Bandura 1997); autonomous and controlled motivation (Conroy et al. 2013, Deci & Ryan 2008); attitude, subjective norms and perceived behavioural control (Ajzen 1985, Ajzen & Fishbein 1980). Factors that influence behaviour can vary between individuals and also within individuals, with motivation to reduce sedentary behaviour fluctuating on a daily basis (Conroy et al. 2013). Whilst the majority of the theories presented within this literature review have been applied to physical activity, only the theory of planned behaviour (Prapavessis et al. 2015, Rhodes & Dean 2009, Smith & Biddle 1999) and dual process theory of motivation (Maher & Conroy 2015, Conroy et al. 2013) have been applied directly to sedentary behaviour. Whilst these studies supported the applicability of both these theories to sedentary behaviour, further research is needed to confirm whether they are useful in predicting sedentary behaviour across populations and in different environments.

A number of studies trialling interventions to reduce sedentary behaviour have used behaviour change techniques without pinning sedentary behaviour to a particular theoretical background. More needs to be understood about which behaviour change techniques are effective in interventions which often involve many interactive components. It is likely that techniques that link to a combination of constructs from a number of existing theories will be effective at altering sedentary behaviour in different environments and groups of people. For example, Owen, et. al (2011) proposed that self-efficacy from SCT suggests the use of self-monitoring techniques, and setting realistic, and measurable goals alongside highlighting the benefits of reduced sitting to improve outcome expectancies. Also, providing reinforcement or rewards for goal attainment as well as identifying enjoyable non-sedentary activities could be utilised from Behavioural Choice Theory (Owen et al. 2011). This review also highlights the importance of targeting attitudes to sedentary behaviour, environmental cues, and habit/non-volitional behaviour which may be particularly relevant to sedentary behaviour in the workplace. Research is needed to ascertain the most effective behaviour change techniques to influence these components and care should be taken to identify and document such techniques in line with the behaviour change technique taxonomy (Michie et al. 2011) in order for effective studies to be replicated. However, tying these techniques into an existing behaviour change theory or developing a theory specifically for sedentary behaviour, is an important first step.

Tackling sedentary behaviour in the workplace presents a number of unique challenges in terms of the influence of policy, time pressures, and productivity. A behaviour change theory for sedentary behaviour would therefore have to pay attention to such external environmental factors in order to be relevant in this context. Rather than group all sedentary behaviours together, it might be that a theory that fits well with occupational sedentary behaviour is not relevant to sedentary behaviour in other contexts e.g. television watching, just as interventions developed to address them would also differ.

2.7 Gaps in the literature

Evidence regarding the detrimental effects of excessive and prolonged periods of sedentary behaviour on health is growing (Chau et al. 2013, van der Ploeg et al. 2012, Thorp et al. 2011). Whilst more research is needed regarding mechanisms of action (Thorp et al. 2011) and the potential of physical activity to mitigate these health risks (Chau et al. 2013), it is imperative that action is taken to tackle high levels of sedentary behaviour in those most at risk. With office workers spending on average between 65-75% of working hours sitting (Clemes et al. 2014a, Clemes et al. 2014b, Ryde et al. 2013, Ryde et al. 2012, Ryan et al. 2011, Miller & Brown 2004) and making few breaks in their sitting (Parry et al. 2013), the office environment represents an important setting in which to tackle sedentary behaviour.

Research into interventions to reduce sedentary behaviour in a workplace environment is in its infancy (Shrestha et al. 2015, Chau et al. 2010), and as such there are numerous gaps in the literature. In broad terms, these research gaps include issues with both the methodology and methods used:

- Failure of studies to identify an existing or new theory to explain occupational sedentary behaviour.
- Lack of studies using existing behaviour change theories as the basis for developing sedentary behaviour interventions.
- No studies using qualitative techniques to understand personal motivations and the impact of office culture on sedentary behaviour in the workplace.
- Lack of studies using 24 hour objective measurements of sedentary time.
- Lack of studies using non-convenience samples.
- Lack of control or comparison groups and use of randomisation to allocate participants to groups.

To date, the focus of interventions to tackle occupational sedentary behaviour have tended to focus on high–cost solutions, both in terms of financial outlay, e.g. sit-stand desks, and time, e.g. one-to-one employee consultations. Due to cost, such interventions could be considered less inclusive, less likely to appeal to management, and less feasible in terms of rolling out to larger numbers of employees. Fewer studies have investigated the use of low-cost solutions, but promising results have been demonstrated by a small number of studies using computer-based prompts and education to help office workers break the ‘habit’ of sitting (Bond et al. 2014, Cooley et al. 2014, Pedersen et al. 2014, Evans et al. 2012). A number of gaps exist in the literature, however, regarding how, and to what degree, such interventions impact on sedentary behaviour. In particular:

- No studies have investigated the acceptability and favourability of using education as an intervention to change sedentary behaviour patterns in a workplace setting.

- There is a lack of knowledge regarding the acceptability of prompt messages and mode of delivery to the recipients of the prompts.
- There is a lack of studies investigating the impact of education alone, compared to education and prompts on the sedentary behaviour of office workers.
- No studies have investigated the impact of prompts with messages to stand, customised to individual workplaces, on sedentary behaviour.
- No studies have investigated if the impact of prompts on sedentary behaviour changes over both short-term and long-term.
- No studies have analysed how people respond, in terms of changing or not changing posture, directly after receiving a prompt.

2.8 Aims and objectives of this thesis

The aim of this thesis was to develop and explore the impact of a low-cost education and prompt intervention on the sedentary behaviour of office workers, and to explore whether existing behaviour change theory can explain sedentary behaviour in the workplace. Whilst addressing the gaps identified in the literature, the following research questions were answered:

- **Primary research question:** is education, and education coupled with computer based prompts, a feasible and acceptable intervention to reduce and break up sitting in office workers?
- **Secondary research questions:**
  - can an existing theory of behaviour change be applied to occupational sedentary behaviour and the development of interventions to tackle it?
  - is education coupled with computer based prompts, more effective at reducing or breaking up sedentary time, than education alone, in a sample of office workers?

The objectives of this thesis were:

- To qualitatively assess the feasibility and acceptability of education and prompts, with customised messages to stand on a non-convenience sample of office workers.
- To qualitatively examine the personal motivations, barriers and facilitators behind sedentary behaviour in an office environment.

- To investigate the applicability of an existing behaviour change theory to occupational sedentary behaviour and how it might be used in intervention development.
- To determine whether education coupled with computer based prompts, is more effective at reducing or breaking up sedentary time, than education alone by examining objective measurements of sedentary time in office workers randomly assigned to control or intervention groups.
- To analyse whether prompts evoke an immediate response in sitting/standing behaviour and whether changes to sedentary behaviour are sustained both in the short-term and longer-term.

The gaps highlighted regarding the methods used in previous studies (section 2.7) were addressed by use of: 24 hour objective measurements of sedentary time; non-convenience samples, control/comparison groups; randomisation of participants.

The aims and objectives of this thesis were achieved through the following process:

1. Development and testing of a feasibility study to assess the use of Microsoft Outlook as a mode of delivering hourly prompts to stand, coupled with education, as an intervention to reduce sedentary behaviour in a non-convenience sample of office workers.

2. Qualitative and quantitative analysis of the results of the feasibility study to:

   a) Estimate feasible eligibility, recruitment and follow up rates.
   b) Determine feasibility and limitations of the study design.
   c) Determine feasibility and acceptability of the intervention.
   d) Explore personal motivations, facilitators and barriers behind sedentary behaviour, with a view to identifying appropriate theory/ies of behaviour change.
   e) Gain insight into the impact of the intervention on sedentary behaviour.
   f) Collect data to inform the sample size of a definitive trial.
   g) Examine how participants responded to prompts in the short and long-term.

3. Addressing the limitations identified in the feasibility study, development and testing of a pilot study to further investigate the use of prompts as an intervention to reduce sedentary behaviour in office workers, and gain additional insight into the motivations and processes behind such behaviour change.

4. Qualitative and quantitative analysis of the results of the pilot study to:

a) Confirm feasibility and acceptability of the intervention.
b) Further explore barriers and facilitators behind sedentary behaviour and investigate how motivation to change behaviour varied during the study and its relationship to sedentary behaviour.
c) Explore the applicability of behaviour change theory (identified during the feasibility study) to sedentary behaviour outcomes and the implications for the design of future interventions.
d) Investigate the impact of education, compared to education and prompts on sedentary behaviour of office workers and if this changes over time.
e) Examine how participants responded to prompts in the short and long-term, including changes within the intervention period.
f) Give recommendations for the direction of future research.

3. OVERALL METHODOLOGY

In order to fulfil the objectives of this thesis (section 2.8), a low-cost intervention to reduce and break up sedentary behaviour in office workers was developed and tested. This chapter describes the overall methodology behind the development of the intervention that was first tested in a feasibility study (Chapter 4) and subsequently in a pilot study (Chapter 5).

3.1 Utilising a framework for developing complex interventions

Using evidence-based frameworks to develop and evaluate interventions to improve health provides a structural approach that is more likely to lead to successful adoption and evaluation of the intervention in question (Speller et al. 1997). Complex frameworks such as Intervention Mapping (Bartholomew et al. 1998) and the PRECEDE-PROCEED model (Green &Kreuter 2005) are highly prescriptive and, in terms of time and cost, can be restrictive. Whilst the focus of other models such as the RE-AIM framework (Glasgow et al. 1999) is heavily weighted towards the evaluation of interventions rather than their development.

In 2000 the Medical Research Council (MRC) published a framework for the development and evaluation of complex interventions to improve health (Campbell et al. 2000). These were more recently updated (Craig et al. 2008) to provide a flexible, less linear, framework to assist researchers recognise and adopt appropriate methods in the development of complex health interventions.

Whilst broad and wide-ranging in its approach, the MRC Framework has been widely influential in its field (De Silva et al. 2014). Due to its flexibility and iterative approach, it was deemed suitable as a structure to follow in the development of an intervention to address the research questions of this thesis (section 2.8). The structure and components of the MRC Framework are outlined below, followed by a summary of how it was applied to developing a workplace intervention to reduce and break up sitting.

3.1.1 The MRC Framework for the development and evaluation of complex interventions

The MRC framework outlines four key elements in the development and evaluation process of complex interventions which do not necessarily follow a set sequence (Figure 3.1):

1. Development
2. Feasibility/Piloting
3. Evaluation
4. Implementation

The process from development through to implementation can take a number of routes and is often determined by a number of factors including the nature of the intervention, ethical considerations, and political priorities (Craig et al. 2008).

3.1.1.1 Development

The MRC recommends identifying relevant, existing evidence as an ideal starting point for intervention development. The framework states that conducting a systematic review is an ideal approach to fulfil this, in the absence of a recently published review in the field (Craig et al. 2008). This allows both best practice and limitations of previous studies to be identified and addressed in the intervention being developed. Ideally interventions should also have a theoretical basis (Craig et al. 2008) as interventions based on evaluated theories and models are more likely to result in successful health outcomes or improvements, than those that are not (Glanz & Bishop 2010).

The Framework recognises that the development phase is an iterative process that may be repeated, building on knowledge gained after other stages have been completed (Craig et al. 2008).

3.1.1.2 Feasibility and piloting

The MRC Framework emphasises the importance of feasibility and piloting studies for testing procedures, understanding their acceptability, and estimating recruitment and retention of participants, and sample size calculations (Craig et al. 2008). The framework does not attempt to define or distinguish between feasibility and pilot studies, unlike other sources which have conflicting definitions. Guidance from the National Institute for Health Research (NIHR) define feasibility studies as a pre-cursor to pilot studies which are used to test whether something works, whereas pilot studies are a smaller scale version of the intended full trial, to test whether components of the study can work together (National Institute for Health Research 2015). This contradicts the MRC framework that stipulates pilot studies need not be a 'scale model' of the main evaluation (Craig et al. 2008). Eldridge et al. (2016b) conducted a Delphi study with experts in the research community regarding the definition of feasibility and pilot studies which concluded that pilot studies were a subset of feasibility studies, but the two were not necessarily exclusive. However, in the subsequent expansion of the CONSORT guidelines to include writing up feasibility and pilot studies, the term 'pilot trials' was used to include all feasibility and pilot studies used to inform all or part of a future definitive RCT (Eldridge et al. 2016a).

The MRC framework recommends that both qualitative and quantitative approaches are used in order to fulfil the objectives of feasibility and pilot studies, and that it may be necessary for several of such studies to take place in order to refine the study design, before a full scale evaluation takes place (Craig et al. 2008).

3.1.1.3 Evaluation

The MRC Framework states that evaluation design depends on the research question and context of the research, and that choice of outcome measures is crucial in order to evaluate effectiveness (Craig et al. 2008). Beyond this vague guidance, the framework is not more prescriptive regarding how evaluations should be conducted, despite this stage being a vital part of the process of consolidating knowledge and refining intervention design. The framework does recommend that, where possible, studies should randomly assign participants to groups in order to prevent selection bias and increase the robustness of the evaluation.

The value of process evaluation within a trial is also recognised. Process evaluation can be used to assess the fidelity and quality of implementation, as well as identify contextual factors and potential causal mechanisms for the outcome measures being assessed (Oakley et al. 2006).

3.1.1.4 Implementation

The MRC Framework recommends wide-scale publication of results in order for findings to be translated into routine policy and practice (Craig et al. 2008). Long-term follow up is recognised as being important in order to determine whether short-term changes are maintained, as is an understanding with regard to the barriers and facilitators to such change. Again, information on how best to identify such facilitators for long-term take up of behaviour change is not detailed, but is likely to have important implications for study design. It also assumes that effectiveness of an intervention has been proven and is feasible for wide-scale implementation, and this is more likely to result after an intervention has been tested and revised through several cycles of the framework.

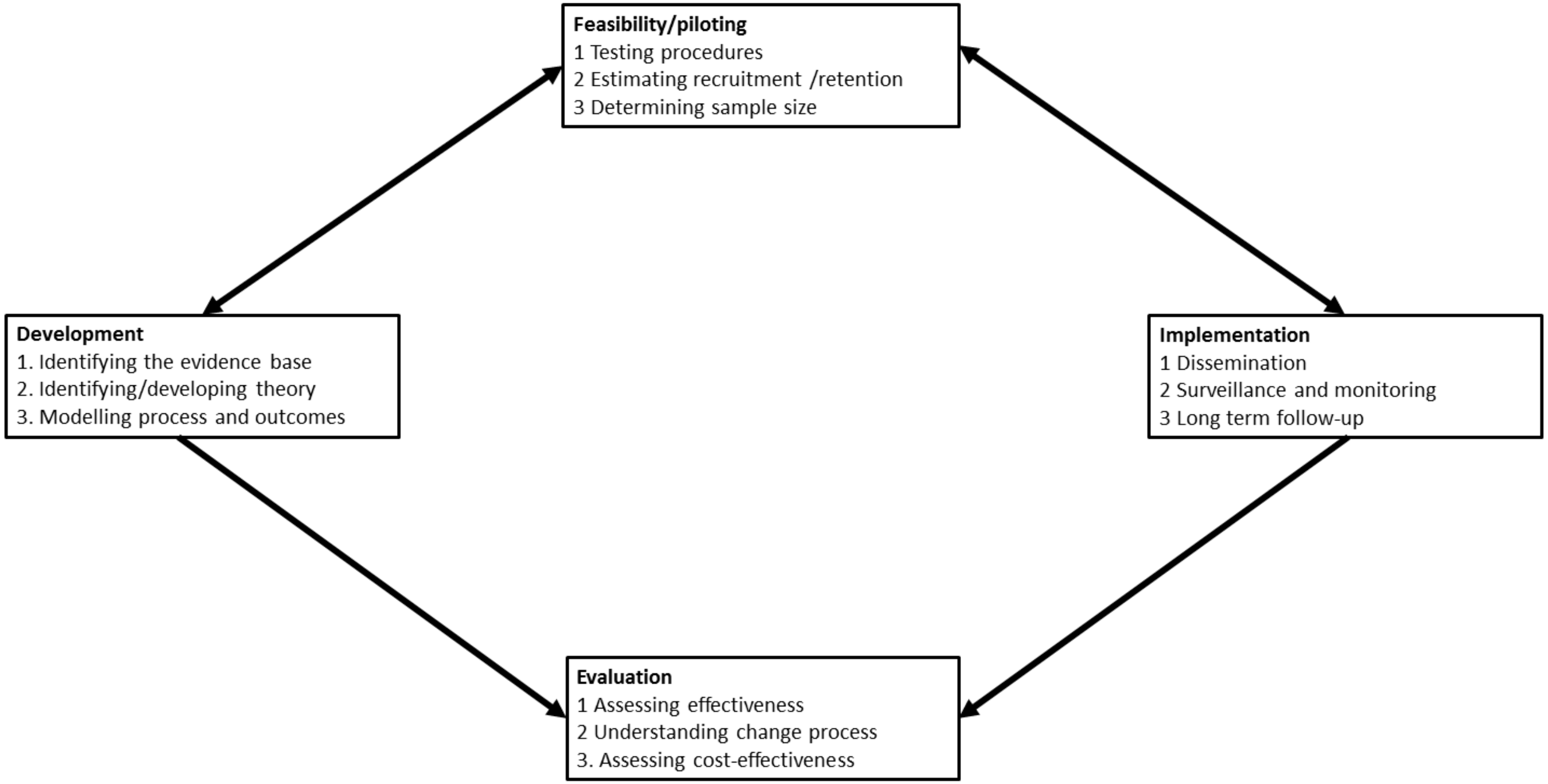


Figure 3.1 MRC Framework for developing and evaluating complex interventions (Craig et al. 2008)

3.1.2 Applying the MRC Framework to developing an intervention to prompt changes to sedentary behaviour in office workers

The MRC Framework for developing and evaluating complex interventions was used as guidance for developing an intervention to prompt changes to sedentary behaviour in office workers. The process began with the primary step in the development phase, a methodical review of the literature to identify important research gaps (Chapter 2) and refine the research question (section 2.8). A systematic review was not conducted as at the time three systematic reviews on workplace interventions to reduce sedentary behaviour had recently published and a soon to be published Cochrane review was registered on the same topic. This literature review informed the development of an education and prompt intervention designed to answer the primary research question (section 2.8).

Whilst the MRC Framework advocates drawing on theory during the process of intervention design, it does not specify how such theories should be selected or applied (Michie et al. 2011). The National Institute for Health and Clinical Excellence guidelines on the development and evaluation of behaviour change interventions are equally vague in this respect (NICE 2007). More detailed guidance is given in the Theoretical Domains Framework (French et al. 2012) but this is specific to behaviour change interventions initiated by clinical practitioners in a clinical setting and therefore not directly relevant to worksite health promotion. The literature review conducted as part of this PhD, identified that little had been done to identify a theory applicable to occupational sedentary behaviour. It was therefore decided, as a first step in this process, that a qualitative arm of the feasibility study could be used to not only evaluate the intervention, but to further understanding of the behaviour itself, with the aim of ultimately identifying such a theory.

In line with the subsequent stage of the MRC Framework, it was decided that the education and prompt intervention should initially be tested as a feasibility study in order to identify any problems regarding delivery of the intervention and refine the process before proceeding to a pilot study. Utilising the bi-directional arrow between development and feasibility/piloting (Figure 3.1) also allowed components of behaviour change theory identified in the feasibility study to be further examined in the pilot study, as well as appraisal and refinement of the content of the prompt messages. In such a way, theory could be used to explain accounts of behaviour and also generate recommendations for future practice (Michie & Abraham 2004).

With conflicting definitions and lack of uniformity regarding definitions for feasibility and pilot studies, the term feasibility study is used in this thesis to describe the first study conducted within this PhD as its primary objective was to ascertain the feasibility and acceptability of the education and prompt components of the intervention. The second study, whose methods were adopted in light of the evaluation of the feasibility study, is termed a 'pilot study' in order to distinguish it from the former, but also to indicate changes in study design that are more likely to be taken forward to inform a definitive RCT.

The evaluation stage of the framework notes that choice of outcome measures is key to evaluating effectiveness. The outcome measures chosen for the feasibility and pilot studies reported in this thesis were chosen based on those deemed best to answer both the primary and secondary research questions. It is recognised that these are not the only outcome measures that could answer them, but that is was important to select a range of measures that could be measured accurately and consistently across the two studies. Participants were randomised to groups in order to minimise selection bias and address the absence of such robust study design noted in previous workplace sedentary behaviour studies (Shrestha et al. 2015). In addition, the qualitative component of the studies was adopted in both the feasibility and pilot studies, to both draw out explanatory theories and to allow a more thorough in-depth evaluation of the intervention itself.

The MRC Framework recommends wide-scale publication of results in order for findings to be translated into routine policy and practice, which is beyond the scope and aim of the feasibility and pilot studies conducted as part of this thesis. That is not to say that the results do not provide an important contribution to existing knowledge regarding effective interventions to reduce and break up sitting in office workers. As such, it is intended that the results of both the feasibility and pilot studies will be written up as journal articles. The feasibility study has already been submitted to the peer reviewed journal 'Pilot and Feasibility Studies'. What is not recognised in the MRC framework is the impact that small scale studies, such as those reported in this thesis, may have on not only the participants, but also their peers and networks. Knowledge gained by participants regarding the health risks associated with sitting at work, may well have been disseminated further by participants in terms of work and social networks, and, in turn, this may impact both on the uptake and success of future interventions designed to mitigate these risks.

3.2 Reporting

Following extensive consultation, existing CONSORT guidelines for reporting RCTs were extended to include reporting randomised feasibility and pilot studies (Eldridge et al. 2016a). The need for such guidelines was prompted by the growing number of feasibility or pilot studies being published with weaknesses identified in both their reporting and conduct

(Eldridge et al. 2016b). In order to maximise quality and transparency, the updated CONSORT guidelines (Eldridge et al. 2016a) were used to structure the reporting of the feasibility and pilot studies in chapter 4 and 5 respectively. A copy of the CONSORT checklist can be found in annex 9.18.

4 RANDOMISED FEASIBILITY STUDY TO INVESTIGATE THE USE OF PROMPTS TO BREAK UP THE SEDENTARY BEHAVIOUR OF OFFICE WORKERS

4.1 Rationale for feasibility study

Since 2012, Glasgow Caledonian University has been working in collaboration with the Scottish Centre for Healthy Working Lives to investigate the extent of sedentary behaviour in the workplace, the issues surrounding it, and potential ways to reduce its impact. The Scottish Centre for Healthy Working Lives (SCHWL) is part of NHS Health Scotland and offers a variety of customer-focused solutions and services to improve the health of workers in a range of occupational settings (Healthy Working Lives 2015). These services include free advice, training and resources, as well as a structured award scheme in which organisations are supported to develop appropriate health promotion and safety initiatives. The work of SCHWL directly contributes to the Scottish Government's national aims for improving occupational health as documented in Health Works (Scottish Government 2009b).

As part of this collaboration, and prior to the commencement of this PhD, objective measures of sedentary behaviour were taken from 67 employees across 6 organisations associated with SCHWL in the Glasgow and Greater Clyde area. The results demonstrated high levels of sedentary behaviour during working hours across all organisations, in line with those reported in other studies (Smith et al. 2015, Clemes et al. 2014a). Following these measurements representatives from organisations, including those that participated in the feasibility study, took part in a consultation regarding the acceptability of an intervention to reduce sedentary behaviour in the workplace. During the consultation different strategies to reduce and break-up sitting during working hours were discussed. Considerable interest was voiced regarding the use of prompts to remind employees to break up their sitting, and the use of Microsoft Office as a mode for delivery of these prompts was deemed acceptable by many. Hourly prompts were agreed as being a suitable and feasible frequency of delivery. As this consultation did not form part of this PhD, further details of this process are not given within this thesis, but a summary is attached as an annex (annex 9.1).

On the basis of the consultation with local employers, and previous evidence on the potential benefits of using prompts to break up sedentary behaviour (section 2.5.5.3), a randomised feasibility study was designed to investigate the feasibility and acceptability of using Microsoft Office as a mode for delivering prompts to desk-based office workers. Current Medical

Research Council (MRC) guidance advocates the use of feasibility studies as a first step in the development of complex interventions (Craig et al. 2008). In addition, an indication of efficacy of the prompts on breaking up sedentary behaviour was sought through the collection of both quantitative outcome measures and qualitative data. Updated guidelines on reporting feasibility trials (Eldridge et al. 2016a) recognise that whilst sample sizes in such studies may preclude definitive conclusions regarding efficacy, such conclusions may have important implications for future trial design. The study was also designed to address gaps in the literature identified during the literature review (section 2.7) as outlined in section 4.1.1.

Although the researcher was not involved in the aforementioned consultation process, she contributed to the design of the study protocol, liaison with the volunteer workplace, collection of data, and data analysis, as detailed in section 4.2.

4.1.1 Aims and objectives

The aim of this feasibility study was to assess the use of Microsoft Outlook as a mode of delivering hourly prompts to stand, coupled with education, as an intervention to reduce sedentary behaviour in a cohort of office workers. The primary objectives were:

- To estimate feasible eligibility, recruitment, and follow-up rates.
- To ascertain whether adequate activity data could be collected over a 7 day period on 3 separate occasions for each participant.
- To determine whether it was feasible for customised prompts to be successfully uploaded to Microsoft Outlook by participants.
- To investigate ease of use of prompts and their acceptability to participants.
- To determine feasibility and acceptability of an education session and perceived impact on sitting behaviour.
- To explore personal motivations, barriers and facilitators behind sedentary behaviour in the workplace with a view to identifying appropriate theory/ies of behaviour change.

The study also aimed to investigate key outcome measures of sitting in order to give a quantitative indication of efficacy of the intervention and inform collection of such data in a future definitive trial. The secondary objectives were therefore:

- To determine whether individuals who received prompts to stand, as well as education on the health risks of sedentary behaviour, reduced their objectively measured total sitting and/or prolonged sitting, in comparison to those who only received education.

- To collect data to inform the sample size of a definitive trial.
- To determine whether any changes to sedentary behaviour were sustained over time, following removal of the prompts.
- To investigate whether individuals were more likely to stand directly after a prompt, or if any changes to standing were independent of prompt timings.

4.2 Methods

4.2.1 Feasibility study design

This feasibility study was a 2-arm, parallel group, randomised controlled trial (RCT) in which participants were randomly divided into a control and intervention group (section 4.2.7). At the start of the intervention, both groups received education on why and how to reduce prolonged sitting, but the intervention group also received hourly prompts reminding them to stand, for a period of 10 weeks. Objective measurements of sedentary behaviour were made at 3 measurement points: baseline; in the last 2 weeks of the 10 week prompt intervention period, and 12 weeks after the end of the intervention to determine whether any changes in sedentary behaviour had been made, and sustained.

Two focus groups were run at the end of the study to further explore the experiences of participants and their motivations and barriers to changing sedentary behaviour.

Both the education session and focus groups were held onsite, at the participants' place of work.

This study was registered as a clinical trial on clincaltrials.gov (ID: NCT02609282).

4.2.2 Ethical approval

Management at SCHWL were consulted regarding the design of the study prior to approaching organisations regarding participation. Ethical approval was granted by Glasgow Caledonian University School of Health & Life Sciences Ethics Committee (reference: HLS/Psy/A14/083) on 29/01/2015.

4.2.3 Recruitment

Organisations involved in the aforementioned consultation process (section 4.1) were approached to take part in the project. A commercial bank in Glasgow expressed an interest, and a number of meetings took part with management to finalise the study design, timings, and clarify issues surrounding implementation. Employees were recruited via email and posters displayed in communal areas within the building. The recruitment e-mail was written by the researcher and sent to all employees (~150) by a member of staff at the commercial bank, who acted as a champion and contact point for the project throughout. Information on the study was also disseminated by the champion at team meetings. Those that wished to take part in the study, were asked to contact the researcher who screened volunteers according to the following criteria.

Inclusion criteria, participants:

- Were aged 18 or over;
- Were primarily engaged in sedentary, computer-based activities during working hours (self-report);
- Had access to Microsoft Outlook calendar.

Exclusion criteria, participants:

- Had a workstation comprising of a standing or height adjustable desk;
- Had a pre-existing health condition that prohibited standing on a regular basis.

All volunteers fulfilling the inclusion/exclusion criteria were given a participant information sheet outlining the aims of the project and their role within it, (annex 9.2) and were then asked to sign a consent form (annex 9.3).

4.2.4 Sample size

Since this was a feasibility study, a sample size calculation was not performed prior to recruitment. The study aimed to recruit 30 employees from a single workplace as it was felt this would be a large enough sample to gather data on the feasibility of implementation and the experiences of participants. Data from key outcome measures were then used to determine the sample size of a definitive trial.

4.2.5 Baseline measurement

Following consent, participants met with the researcher in small groups and were asked to complete a questionnaire to ascertain basic demographic data, knowledge of and attitudes towards sedentary behaviour, and previous engagement with health promotion initiatives (see annex 9.5). This information was collected to informally assess how representative of the general population, the sample was. They were then asked to collect activity data for 7 consecutive days using an activPAL3^{TM} monitor (PAL technologies, UK). Participants were asked to not remove the monitor during the measurement period. The activPAL is a tri-axial accelerometer worn on the midline of the anterior aspect of the thigh, and from the time-stamped acceleration signal, processes data into categories of sitting/lying, standing and walking (Evans et al. 2012). It has been validated as an accurate tool for capturing changes in posture and motion in adults during daily activities (Godfrey et al. 2007, Grant et al. 2006). In addition, the activPAL has been demonstrated to be more sensitive at measuring changes in sedentary behaviour than other similar monitors (Kozey-Keadle et al. 2011).

The activPALs were programmed using the manufacturer's software, (activPAL™ Professional v7.2.32) to run for a period of 14 days. In order to waterproof the activPAL monitors, they were placed inside transparent plastic tubing and heat-sealed along the two longest edges. An adhesive pad (PAL stickie) was used to attach the waterproofed activPAL to the midline of either one of a participant's thighs and a waterproof dressing (Opsite Flexifix) placed over the monitor to provide added security and protection. This method of waterproofing has been used in previous studies adopting a continuous wear protocol (Edwardson et al. 2016). Participants were provided with spare waterproof dressing should the dressing come loose. The correct way of attaching and positioning the monitor was demonstrated by the researcher to all participants in person, and participants were asked to begin wearing the monitor before going to bed on the evening before day 1 of monitoring. Once attached, participants were asked to avoid removing the monitor for the entire 7 day monitoring period, including when bathing or swimming, in order to maximise wear time, capture all activity and increase compliance (i.e. to minimise the possibility of forgetting to re-attach the monitor) (Tudor-Locke et al. 2015). A 7 day monitoring period was chosen in order to attempt to incorporate a full working week and non-working days for comparison, not be too onerous for participants, and meet the threshold of 3-5 days of monitoring deemed to be a reliable estimate of the outcome variables being measured (Trost et al. 2005). To accompany this measurement, participants were also asked to keep a diary recording waking and working hours, and any periods of non-wear, for the same 7 day period (annex 9.6).

Collection of baseline activity data was staggered in order to maximise the amount of data collected (i.e. to accommodate absences from the office). All baseline data was collected within a time period spanning 11 days between 06/03/2015 and 16/03/2015.

4.2.6 Education session

Following baseline measurement, all participants attended one of two education sessions held on 17/03/2015 and 19/03/2015. The evidence-based education session covered the health risks associated with sedentary behaviour, the potential benefits of breaking up prolonged sitting, and tips on how to reduce sedentary behaviour at work. The information provided was based on recently published research in the field of occupational sedentary behaviour (annex 9.4).

The education session was delivered to groups onsite at the participant's place of work and was led by a chartered physiotherapist, an expert on sedentary behaviour, who was also a member of the research team. Participants were encouraged to interact and ask questions to ensure the health messages being delivered regarding sedentary behaviour, had been understood. Each education session lasted approximately 45-60 minutes.

4.2.7 Group assignment

During onsite meetings prior to the commencement of the study, it was noted that due to the open-plan nature of the office, participants' physical location in the office could potentially result in cross-contamination between the control and intervention groups. For example, a control participant seated in a section with intervention participants may inadvertently be influenced by the prompts through the standing behaviour of their neighbouring colleagues. Therefore, once a list of volunteers had been compiled, the location of their desk within the office was noted and two 'clusters' of desks were determined which were in separate areas of the open plan office (although potentially within sight of each other). Participants were assigned equally to one or other cluster based upon their physical location in the office and then the clusters were randomly assigned to being either the control or intervention group. It should be noted that two of the participants worked in smaller multi-occupancy offices off the main open-plan office. Randomisation of groups was achieved using sealed envelopes prepared by a member of the research team not involved in recruitment or intervention implementation.

4.2.8 Blinding

The researcher, was blinded to the cluster allocation, and assignment of clusters to groups during collection of all activity data, until facilitating focus groups no longer made this possible. As with many non-pharmacological trials it was not possible to blind participants to their group allocation (Boutron et al. 2005).

4.2.9 Prompt intervention

The intervention group received a prompt to stand, delivered via Microsoft Outlook on their work PC, once every hour during work hours for a period of 10 weeks beginning on the 30/03/2015. A period of 10 weeks was chosen on the basis of a study which showed that, on average, new behaviours needed to be performed for 66 days before becoming a habit that was performed without conscious decision (Lally et al. 2010). In addition, the qualitative arm of a study investigating the impact of prompts to increase energy expenditure at work found that participants found the prompts to be irritating and a source of annoyance for the first few weeks, but less so in subsequent weeks (Cooley et al. 2014). It was therefore important that the length of the intervention exceeded both the potential timeframe for prompts to be annoying and for changes in behaviour to become a habit, in order to potentially result in long-term behaviour change.

Microsoft Outlook was used as a mode for delivering prompts as it is commonly available on PCs, had familiarity of use for many, posed no additional cost, and did not involve the security issues of downloading commercially available prompt software. In addition, the prompts appeared as meeting reminders which could be dismissed or snoozed with one click, and therefore work could remain relatively uninterrupted if necessary. Although evidence suggests that such active prompts, where there is a choice in whether to dismiss the prompt, may not be as effective as passive prompts, which prevent the recipient from working (Cooley & Pedersen 2013), the consultation with employers indicated that such active prompts were more acceptable to management.

A list of 70 prompt messages, to be delivered by Microsoft Outlook, was compiled by members of the research team at GCU. From this list, a custom Excel macro-program was used to assign one prompt message to a randomly generated time point every hour. The random times were restricted to a half hour period in the middle of each hour, in order to prevent the generation of prompts a few minutes apart e.g. a prompt at 09.58 and then again at 10.02. Participants were asked to provide dates of annual leave, absences from the office and their usual working hours, and times absent from the office were excluded from the Excel prompt file. Prompt messages centred around reminding people to stand and break up their sitting (appendix 8.1). They were designed to be easily and quickly read in order to get the message across, but also varied in order to capture interest and maintain attention. Positively framed messages emphasising what is to be gained from carrying out a behaviour, as opposed to what is to be lost by failing to comply, have been shown to result in more compliance of the desired behaviour for encouraging disease prevention behaviours (O'Keefe & Jensen 2006). Some messages were also customised to include the organisation's name and location, as tailored health messages have been shown to have more impact (Keller & Lehmann 2008). Participants in the intervention group were instructed to set up a new Microsoft Outlook calendar and to upload their personal prompt Excel file into this calendar ahead of the 10 week intervention period. Setting up a parallel calendar for the prompts allowed participants to continue to use their main work calendar unaffected by the uploaded prompts. A member of the research team was on hand to help with any issues uploading prompts.

During the 10 week intervention period, Microsoft Outlook delivered the prompts five minutes prior to each random time point as a meeting reminder that flashed up on the screen. Participants then had the option to dismiss or snooze the prompt, the former ending the prompt, or the latter making Outlook repeat the prompt again at the random time point itself. If participants were away from their desk for a period of time, they were also able to dismiss groups of prompts using the 'dismiss all' function. At the end of intervention period the prompts ceased to be delivered by Microsoft Outlook, and participants were advised to delete the calendar.

4.2.10 Intervention measurement

A second 7 day activity monitoring period with accompanying diary completion was repeated by all participants (as described in section 4.2.5) between weeks 8-10 of the intervention period. Data collection was staggered in order maximise data collected. All data was collected was within a 17 day period between 19/05/2015 and 04/06/2015.

4.2.11 Follow up measurement

Follow up measurement, to ascertain longer-term changes, was made 12 weeks after the intervention had finished. Activity monitoring and diary completion over 7 consecutive days were repeated as previously detailed (section 4.2.5). Staggered data collection resulted in all data being collected over a 13 day period from 19/08/2015 to 31/08/2015.

4.2.12 Focus groups

After follow-up measurement was complete, all participants were invited to one of two focus groups, both run on 01/09/2015, to discuss their experiences of taking part in the study and their thoughts about sedentary behaviour in a workplace environment. Separate focus groups were run for the control and intervention groups so that the prompt intervention could be discussed in detail with those that received it, without excluding those in the control group. Groups contained a mixture of staff of different levels of seniority within the organisation. Focus group rules were outlined at the beginning of each session in which participants were asked to speak in turn, and were assured that the transcript would only be used for the purposes of the research, with any publicised quotes made anonymous. This was explicitly stated in order to encourage participants to speak freely. A semi-structured focus group schedule (appendix 9.8) was used to structure the focus groups, but digression was allowed, and encouraged, on related topics/areas as led by participants. Focus groups were moderated by the researcher and co-moderated by a member of the research team. The control focus group lasted 29 minutes and the intervention focus group lasted 37 minutes.

4.2.13 Outcome measures

The primary objectives regarding the feasibility, acceptability and ease of use of prompts, were assessed from analysis of the focus group transcripts, as was the acceptability of the education session, and insight into experiences, motivations, and barriers of participants. Technical issues regarding uploading or using the prompts were logged. The flow of participants through the study was recorded in order to collect data on eligibility, recruitment and follow-up rates. The number of days of valid activPAL data collected by participants was logged and a list of validation rules against which to assess data quality, was established (Appendix 8.2).

The secondary objectives with respect to changes in objectively measured sedentary behaviour were measured using the following outcome measures:

- Total sitting time as a proportion of time activPAL was worn during waking hours
- Total sitting time as a proportion of time activPAL was worn during work hours
- Number of sitting events per hour of time activPAL was worn during work hours
- Mean event duration of sitting events occurring during work hours
- Proportion of wear time during work hours spent in sitting events >20 minutes
- Proportion of wear time during work hours spent in sitting events >30 minutes

These outcome measures were extracted from activPAL outputs from each of the three measurement periods as described in sections 4.2.5, 4.2.10, and 4.2.11. Wear time was calculated using information provided by participants in their diaries about times the monitor was not worn, which was cross-checked during the validation process (section 4.2.14). See section 4.3.2.1 for details of non-wear time.

Response to prompts was also analysed by comparing the times that prompts were scheduled, to the time of the next standing event.

4.2.14 Data validation & processing

Activity data for the 3 data periods were classified into sitting, standing, and walking by proprietary software (version 7.2.32, PAL technologies, UK). This was cross-validated with the information provided in the diaries, and inconsistencies flagged. A set of validation rules was applied to the data prior to processing (appendix 8.2) to remove or, where appropriate, amend inconsistencies between diary entries and activity data. Events-based outputs of sedentary behaviour were extracted from the ActivPAL files and entered into customised Excel spreadsheets, into which the diary information was also entered. Events were classed as a continuous period of sitting with a start and end time. In combination with wake and work times, different outcomes of sedentary time could therefore be extracted. The minimum data required for inclusion was 3 days of data, including at least one working day, for at least two of the three time periods.

Member checking was made at intervals during the focus groups as a way of concluding particular discussions, and verifying understanding. Notes were taken during both focus groups which were also audio-recorded and transcribed verbatim. Both the moderators reviewed the transcripts for validation.

4.2.15 Data analysis

For the primary outcomes the feasibility criteria reported were the operational issues encountered uploading and using the prompts, the recruitment, and the retention rates, and the compliance with collecting minimum requirements of activity data. Acceptability of the prompt and education interventions were reported descriptively and narratively.

A thematic analysis framework was used to analyse the focus group data allowing the experiences of participants to be explored without being grounded in a particular theory (Braun & Clarke 2006). This inductive approach identified several broad themes in line with the key constructs of Social Cognitive Theory (SCT) (Bandura 1997). Further analysis then used a more deductive approach to review focus group discussions within the precepts of this theoretical framework.

The researcher was responsible for facilitating the focus groups and also transcribing them. She then reviewed the transcripts whilst listening to the audio-recordings in order to immerse herself in the data. Key words and phrases were identified as 'meaning units', and subsequently grouped together with other units that shared the same meaning or inference to form themes. These were reviewed alongside the five key constructs of SCT and further defined, resulting in the following five themes: situation/environment, outcome expectations, self-efficacy, self-regulation and behavioural strategies, and observational learning. Data was once again reviewed in terms of these refined themes and SCT was used to aid interpretation and elicit meaning from the focus group discussions.

For the secondary objectives examining the six key outcomes detailed in section 4.2.13, an exploratory approach to data analysis was adopted due to the sample size and novel intervention. This facilitated investigation of a number of aspects of the data set to inform a future definitive trial, without restricting its scope. SPSS (Statistics Package for Social Sciences IBM version 22) was used to perform descriptive statistics and tests appropriate to the nature and distribution of the data were performed to examine statistical significance.

Response to prompts was analysed by comparing timings of standing events against time that the prompt was delivered. Pseudo-prompts were also created to provide comparison of normal standing patterns. This is described further in section 4.3.5.

4.2.16 Feedback to participants.

Following both focus groups, all participants in the study were presented with a personal activity report illustrating their activity patterns on the least and most sedentary days of each data collection period (annex 9.7). Participants could request a more detailed breakdown of their activity data if they desired.

4.3 Results

4.3.1 Sample

4.3.1.1 Participant retention

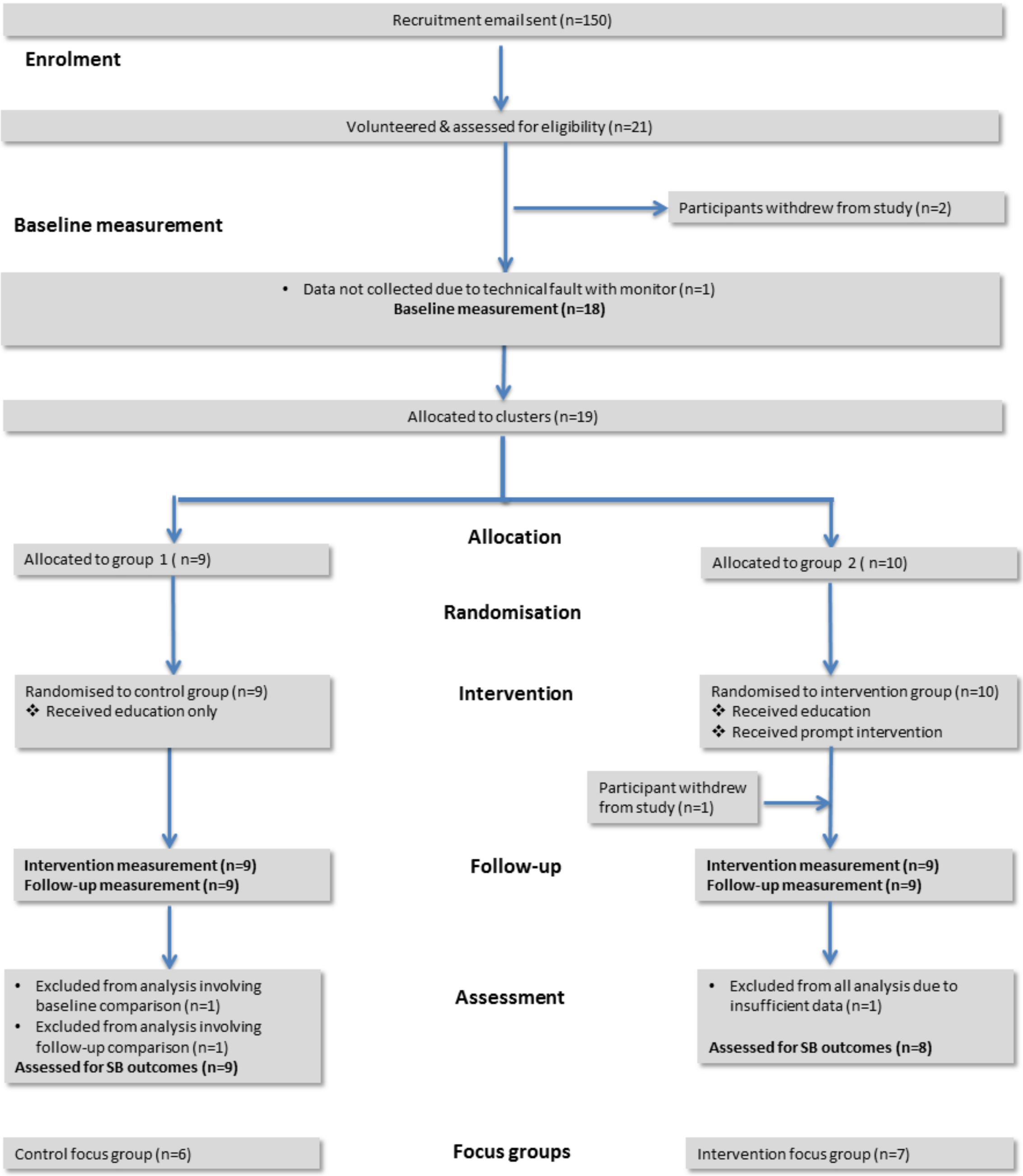


Figure 4.1 CONSORT Flow diagram illustrating participant retention, adapted from Eldridge et al. (2016)

Twenty-one participants were recruited, 14% of those approached, over a period of three weeks in February and March 2015. All met the eligibility criteria and signed a consent form indicating their willingness to participate in the project. Two participants withdrew prior to collection of baseline data, and one withdrew following allocation to the intervention group (Figure 4.1). These participants did not give a reason for withdrawing from the study.

Six participants from the control group and seven participants from the intervention group volunteered to take part in focus groups specific to their group allocation.

With regards to the quantitative analysis of the secondary outcomes: one participant in the intervention group was excluded from analysis due to failure to meet minimum data collection requirements of 3 days of data, including at least one working day, for at least two of the three time periods. Of the remaining 17 participants, 15 met the minimum data requirement for all three time periods (baseline, intervention, and follow up). One participant met the requirements for the intervention and follow up measurement periods only, and one participant met the requirement for baseline and intervention measurement only. Both these participants were in the control group. Due to the small sample size, these two participants were included in analysis where appropriate. Where the missing data period prevented inclusion of an individual's data, this has been detailed in subsequent sections.

4.3.1.2 Participant Demographics

The majority of the 17 participants included in the quantitative analysis were female (76%), aged between 22-56 years and all self-reported their health to be good, very good, or excellent. The group mean Body Mass Index (BMI) was 25.1kg/m^2 which is categorised as 'over-weight' (World Health Organisation 2000), but individuals ranged from 'healthy' to 'obese' (BMI range 20.1-31.6kg/m^2). (Table 4.1).

The majority of participants were employed full time (71%) and all participants met the criteria of being employed in a role that required them to spend the majority of their working hours at their desk. The main difference between the control and intervention group in terms of demographics were that there were no men in the intervention group, whilst the control group was composed of 44% males (n= 4). The intervention group also tended to be younger and more likely to rate their health as 'excellent' in comparison to the control group.

Table 4.1 Participant demographics at baseline

	Control group	Intervention group	Whole sample
Number of participants	9	8	17
Mean age [years]	42	36	39
Age range [years]	22-56	29-42	22-56
Male/ Female	44%/56%	0/ 100%	24%/76%
Self-reported general health:			
Excellent	33%	62.5%	47%
Very good	33%	12.5%	24%
Good	33%	25%	29%
Mean BMI kg/m^2 (SD)	25.6 (±3.2)	24.5 (±1.9)	25.1 (±2.7)
Number of smokers	1	1	2
Employed full time/part time	67%/33%	75%/25%	71%/29%

As part of the questionnaire completed at baseline (Annex 9.5), participants answered three multiple choice questions to ascertain their understanding of the potential impact of sedentary behaviour on health. The results showed that whilst all participants (n=17) recognised there were benefits to breaking up long periods of sitting, over half (n=10, 59%) were not aware that the health risks associated with sedentary behaviour were independent to the amount of physical activity an individual undertook. All participants correctly identified a link between prolonged sitting and back pain, but fewer were aware of links with depression (n=7), cancer (n= 1), or heart disease (n= 7).

4.3.2 Feasibility of intervention

4.3.2.1 Compliance with minimum activity data requirements.

As previously stipulated in section 4.2.14, the minimum data set for inclusion was 3 days of data, including at least one working day, for at least two of the three time periods. Whilst this was at the lower end of the 3-5 days of monitoring deemed to be a reliable estimate of the outcome variables being measured (Trost et al. 2005), it was set at this level in order to maximise use of the data collected from a small sample. Only one participant (from the intervention group) failed to meet this requirement.

The majority of participants collected five or more days of validated data for each measurement period (Table 4.2). One participant failed to collect any validated days of data at baseline, despite wearing the activPAL for 7 days, due to a technical fault with the monitor. Another participant failed to collect any days of validated data at follow-up due to being absent from the office for a prolonged period of time.

Table 4.2 Percentage of sample collecting total number of days of validated activPAL data for each measurement period

Measurement period	Total number of days of validated data collected								% ≥ 3 days
	7	6	5	4	3	2	1	0	
Baseline	58.8%	0.0%	29.4%	0.0%	5.9%	0.0%	0.0%	5.9%	94.1%
Intervention	47.1%	23.5%	5.9%	11.8%	0.0%	11.8%	0.0%	0.0%	88.2%
Follow-up	58.8%	11.8%	5.9%	0.0%	11.8%	0.0%	5.9%	5.9%	88.2%

Data displayed in cells are percentage of whole sample (n=17) who collected validated data for total number of days indicated, for each measurement period

When activPAL monitors had been removed for some, or all of a day, a validation rule was imposed which excluded days during which the activPAL monitor had been worn for less than 10 hours or for less than 70% of waking hours. The threshold of 10 hours wear time has been adopted by similar studies using continuous measurement by activPAL (Edwardson et al. 2016), but by also adding the 70% threshold, this allowed days in which waking hours were less than 10, to be included. In total 41 days of data, across the three measurement periods, were excluded from analysis due to failing to meet the minimum daily wear-time. This equates to 14% of the total number of days processed. Table 4.3 breaks down the different reasons for this, giving insight into how compliance might be increased in future studies.

Table 4.3 Reasons for data not meeting minimum wear time criteria

Reason for minimum wear-time not met	Number of days excluded during study
Monitor removed before end of monitoring period	19 (46.3%)
Monitor stopped working before end of monitoring period	14 (34.1%)
Put on late on day 1 of monitoring	3 (7.3%)
Skin irritation caused by monitor	2 (4.8%)
Removed to go on a night out	1 (2.4%)
Illness	1 (2.4%)
Removed before end of the day (replaced subsequent day)	1 (2.4%)
Total	**41 (100%)**

Figures given are for number of days excluded from study for each reason and in brackets proportion of total exclusions for each reason.

Where monitors had been temporarily removed, put on late, or removed early and wear-time exceeded 10 hours in a day or 70% of wake time, data was included but non-wear time was logged, subtracted from wake time and used in the calculation of the six key outcome measures of sedentary behaviour. On average, across the three measurement periods, non-wear time accounted for 10.2 ± 28.2 minutes (mean ± SD) for each participant for each measurement period, and an average of 6.0 ± 19.2 minutes (mean ± SD) during work hours for each measurement period.

Key C1-C6 = focus group participants from the control group. I1 –I7 = focus group participants from the intervention group.

During the measurement periods some participants expressed discomfort at wearing the monitors and this was raised in both focus groups.

> I1: *" They make a proper mess of your legs though, eh?"*
>
> C3*:"You end up with a rash."*

One participant in the intervention group logged removing the monitor for two days as a result of a skin irritation during baseline measurement, but subsequently replaced the monitor and was also able to complete data collection at intervention and follow-up measurement periods.

4.3.2.2 Feasibility and acceptability of prompts delivered by Microsoft Outlook

The onsite IT team at the commercial bank were informed about the plan to upload Excel files to Microsoft Outlook, in order to pre-empt any security issues, and none of the participants reported any problems uploading their files. The research team contacted all members of the intervention group by email in order to check that their prompt files were uploaded and operational. No issues regarding delivery of prompts were reported during the 10 week intervention period.

During the focus group run with intervention group participants, participants spoke favourably about the content and variety of the messages delivered in the prompts.

> I5: *" I thought they were all good. Bit of information."*
>
> I3: *" Bit better than just 'stand up'"*

However, focus group participants agreed that as time went on, prompts were less likely to be read or acted upon.

> I2: *"Eventually I think I switched off to them. I just saw the prompt coming up. Because I don't have any other prompts so I knew what it was, and I didn't even read it, I just…just missed it."*
> I5: *"The thing is, the prompts were good at first – you were getting up, and doing it. And then as the weeks went on you're getting caught up in work. You're doing things and then you're forgetting about it and you're not getting up as much. I just felt as the weeks went on, the prompts were getting forgotten about."*

Work pressures were the main reason for ignoring a prompt, and when participants did break their sitting, they felt frustration at not being able to continue to work whilst standing

> I2: *"It's frustrating because you can't do stuff. So that whole minute you're raging, dying to get back into it."*

One participant, claimed that the prompt screen became lost behind other work on their screen

> I1: *"well I missed it flashing up on my computer a few times and then it goes behind your emails and then that's you. So you kind of forget about that"*

However, when prompts that froze the computer and prevented further working were suggested to participants in both groups, they were horrified at the prospect, dismissing it as not feasible.

> C2: "*No, couldn't have that, I wouldn't like that"*
> C6: *"That's too extreme"*

4.3.2.3 Feasibility and acceptability of education intervention

The education session was easy to organise and deliver in two separate sessions to participants. Only one participant was unable to attend the group sessions and a face-to-face delivery of the education material was made to this participant at a later date.

In terms of the acceptability of the education component of the intervention, participants in both groups agreed that the session had made them more conscious about their sitting behaviour and were shocked about the potential health consequences of too much sedentary behaviour. In particular they were surprised that the risks were independent to the amount of physical activity undertaken.

I2: *"The fact that I can sit all day and then go the gym at night, it still isn't helping me."*

Participants were aware of the recent coverage regarding sedentary behaviour in the media and felt that the education session complimented and reinforced some of the messages they had already heard

I2: *"There's been quite a bit in the news recently, hasn't there? The BBC website has always got stuff on about it. It seems to be, kind of, the hot topic just now."*

4.3.3 Focus group analysis of motivations, barriers and facilitators behind sedentary behaviour

Six participants from the control group took part in one focus group, and seven participants from the intervention group took part in a second focus group. Half the participants in the control focus group were male and all of the participants in the intervention focus group were female, as all participants randomly assigned to this group were female. Other key demographics of focus group participants are given in Table 4.4, and demonstrate that the sample used in the focus groups were representative of the overall sample (Table 4.1).

Table 4.4 Key demographics of participants attending two focus groups

	Control focus group	Intervention focus group
Number of participants	6	7
Mean age [years]	43	35
Age range [years]	22-56	27-42
Male/ Female	50%/50%	0/ 100%
Employed full time/part time	67%/33%	61%/29%

The results of the focus group discussions are presented below and are considered further in relation to the theoretical framework of social cognitive theory in the discussion (section 4.4.2). Thematic analysis identified five key themes in line with the main constructs of SCT: i) situation/environment, ii) outcome expectations, iii) self-efficacy, iv) self-regulation, v) observational learning.

In addition, participants in the intervention group were asked to share their thoughts and experiences about receiving prompts, and their mode of delivery, in terms of assessing the feasibility of delivering prompts in this manner, as previously reported in sections 4.3.2.2 and 4.3.2.3.

4.3.3.1 Situation/environment

This theme refers to the influence of the physical environment and the context in which sedentary behaviour is occurring.

All participants felt that their sitting behaviour was linked to their environment and that they were far more sedentary in the office than at home in the evenings, or on non-work days.

> I5: *"I don't think I sit down a lot outside of work. If I sit down, it's mostly in work. I don't sit down at night and stuff."*

The reason for more sedentary behaviour occurring in the office was attributed to the fact that the office environment was not conducive to standing, that the tasks required by work roles took priority, and there was a perception that these could only be performed comfortably whilst sitting.

> C5: *"Our work is our work and we need to sit when we need to sit. It's very difficult not to."*

The nature of the work being carried out did not lend itself to natural breaks in sitting and it was noted by some that this had changed over the years.

> I2: *"Offices are trying to go paperless, it's not like you're getting up and going to the printer all of the time. You don't really need to do that."*

Participants disagreed over whether changes to the physical office environment allowing workers to continue to work whilst in a standing posture e.g. standing desks, would be agreeable. Some welcomed the opportunity to try such solutions, whilst others had tried a standing desk and didn't like it.

> I2: "*I thought; 'I can't do this'* [and] *sat back down again*."
>
> I4: "*I think maybe if we had more standing desks for people that were comfortable, like you were saying you couldn't do it, but if there were other people that were comfortable to do that, then if they had more of those available you probably would give it a good bash anyway."*

4.3.3.2 Outcome Expectations

Outcome expectations is the anticipation and value placed on the outcomes of reducing sedentary behaviour.

Many participants were surprised by the health arguments for breaking up sitting presented to them during the education session.

> C5: *"It was quite surprising –what it [sedentary behaviour] actually does. Cos you generally think that sitting down couldn't cause that much harm."*

Participants agreed that they were convinced by the health messages, yet were reticent at sharing the health warnings with friends and family. Those that had relayed the message to others had been dismissed as it not being relevant.

> I1: *"I got the whole 'well I'm up all day, everyday anyway'. One's an electrician so he's running all the time and ***'s a teacher, so 'I don't get to sit down. Shut up'"*

Those in the control group thought that prompts reminding them of the health risks would be valuable at reinforcing the health messages. Both groups felt that posters in the office about reducing sedentary behaviour would help remind them to break up their sitting.

Participants in both groups spoke about experiencing some immediate benefits from taking breaks from their desks, although this was generally linked to being more mobile, rather than just standing.

> I7: *"Actually getting up and walking away. Coming back you feel more refreshed than just standing up."*

> I1: *"I found it helpful because I had back and neck problems years ago and it's become a bad habit, sitting back down at your desk for long periods of time rather than getting back up. So it prompted me to get back up again. So it has been helpful from that point."*

4.3.3.3 Self-efficacy

Self-efficacy refers to an individual's belief that they can successfully reduce their sedentary behaviour.

Many participants believed they did not have the ability to reduce the amount of time that they spent sitting at work. Sitting at work was reported as being 'easy' and taking breaks from sitting as 'hard'.

> I3: *"It's so hard in work. There's so much to do"*

As well as the physical environment not facilitating standing, work was cited as the main barrier to breaking sitting. More than just the practical aspects of needing to be seated at a desk, work posed as a distraction leading to prolonged periods of sedentary behaviour occurring unconsciously.

> *C4: "Cos I do think I just don't think about it, I just start and it doesn't even occur to me, I just get on with what's in front of me, what I need to do."*
>
> C2: *"Yeah, you lose track of how long you have been sitting"*

Whilst some spoke of a perceived lack of control over their sedentary behaviour, others admitted to purposefully waiting until lunch time to take a comfort break.

> I3:*"You don't even go to the toilet cos you're hanging on"*
>
> I7:*"You're like, 'I might just wait* [to go to the toilet] *for lunchtime'. You do, you just sit there don't you?"*

Others felt that changing their sedentary behaviour at work was someone else's responsibility.

> C6: *"We are the control [group] so we thought we wouldn't do anything"*
>
> I3: *"The organisation should be more aware of it"*

A few individual's felt that they did have the ability to break up their sedentary behaviour, and had taken steps to do so. Their strategies are discussed in the section 4.3.3.4 below.

4.3.3.4 Self-regulation

Self-regulation refers to the behavioural strategies adopted by individuals in order to achieve the goal of reducing sedentary behaviour at work.

A few participants from both groups spoke about strategies that they had previously used, or adopted since the start of the study, with the aim of reducing their sedentary behaviour. Many of these strategies were related to work tasks –designating specific tasks to be performed in non-sedentary postures.

C1: "*I have changed. If I have got a lot of stuff to check, I'll now go and stand by one of the high cabinets. I'll stand instead of actually sitting at my desk."*

C2: "*I'm consciously making an effort if we have short team meetings or conference calls, quite often there are not enough seats anyway. I make a conscious effort to stand during those, rather than grab one of those seats."*

I1: *"I think more people were going and doing the water run, just to get up."*

Breaking up sedentary behaviour was also health- or emotionally- led, with some participants reporting improved musculoskeletal problems, feeling more energised, and happier from breaking up their sitting.

C2: "*If I get 2 or 3 days where I've been in the office in a row I actually feel quite down. I deliberately organise my diary so that doesn't happen. Just sitting at a desk all day, I've found I really struggle with that*."

Participants were keen to have feedback on how much they actually sat at work, as they felt that learning this information would be useful to prompt them to regulate their sedentary behaviour.

C4: "*When the results come in, we might end up actually standing more at work*."

4.3.3.5 Observational learning

Observational learning refers to how individuals learn behaviour from observing others and how they believe their own behaviour is perceived.

Participants in the control group said they had not noticed members of the intervention group standing, whilst those in the intervention group were very self-conscious about their changed behaviour.

I2: *"It did look kind of strange. I did do it at a couple of meetings when we first started, fair enough the people knew about it, but I did feel awkward."*

I3: *"People do look at you. Unless you're going for…if you're just standing at your desk you look like an idiot. Most of the time I get up and try to get up and go somewhere, if you're just standing there if you're on the phone or something, people are just like [pulls a funny face] 'what's she doing?'"*

Participants were therefore concerned about how their behaviour was perceived by others including, but not exclusively, management.

I4: *"I think people would probably do it more if there was management buy-in because people are maybe not wanting to do it in case they're not for it"*

A culture of conformity was described with the tendency for workers to eat lunch at their desks being learned by the behaviour of the majority.

C5: *"You know if someone new moves in and sees everybody doing that* [eating lunch at their desk] *then they tend to drift towards that as well"*

The few participants that reported leaving the office at lunch time and taking an hour for lunch were employed in positions of higher authority than the majority of other participants in the study.

Derogatory terms were used to describe people acting out of the norm and standing or walking around the office.

C2: *"You wouldn't make it that obvious* [standing]. *You would try and click or do something. Or people would think you're a weirdo."*
C5:*"I would fear for your mental state* [in reference to people walking around the office to break their sitting]

Participants therefore suggested that an intervention that everyone was participating in would be more favourable. They felt that peer pressure and support would be an effective tool at encouraging breaks in sedentary behaviour within the office, as well as normalising the behaviour.

I7: *"I think doing it as a group, doing it together. Rather than just doing it individual."*

A role model or office champion to encourage and remind people to break their sitting was also suggested for future interventions.

This suggests that observational learning of SB is important, that workers learn and conform to the behaviour of the majority, and are concerned about how behaviour outwith this norm is perceived by others.

4.3.4 Sedentary behaviour outcomes

Whilst the primary objectives of this study were to assess the feasibility of conducting the different elements of this study, the secondary objectives were to explore the outcome measures of sedentary behaviour derived from the activPAL outputs.

Shapiro-Wilk tests identified that all outcome measures of sedentary behaviour were normally distributed at all three measurement points. Parametric tests were therefore used to examine differences between groups and measurement points.

4.3.4.1 Baseline sedentary behaviour

At baseline, participants (n=16) spent on average 60.9% ± 5.9% (mean ± SD) of their waking hours (daily average 15.29hrs ± 1.08), in sedentary postures, which equated to a daily average of 9.4 ±1.3 hours spent sitting. During working hours (daily average 8.25 ± 0.99 hrs) this rose to 75.2% ± 17.4% of the time the monitor was worn at work, which equated to an average of 6.1 ±1.5 hours spent sitting at work a day. The mean duration of sitting events during work hours for the whole sample at baseline was 14.5 ± 5.7 minutes, with a mean of 3.5 ±1.2 events per hour. Prolonged sitting in events of 20 minutes or more accounted for 49.4% ± 19.3% of time at work, and events of 30 minutes or more 36.0% ± 17.9% of time at work (Table 4.7).

4.3.4.2 Changes to sedentary behaviour - between group differences

Independent t-tests, to examine the statistical significance of the differences between group means for each outcome measure, revealed no statistical differences [p>0.05] between groups for key outcome measures at baseline. However there was a tendency for the intervention group to sit slightly less during work hours, in shorter and more frequent events (Table 4.5).

Comparison between the control and intervention groups for all key outcome measures showed a tendency (though non-significant) for the intervention group to perform better in terms of a lower proportion of time spent sitting during work hours, less time spent sitting in prolonged (>20 minute and >30 minute) events, and more frequent events of shorter duration during working hours across all 3 time periods. Independent t-tests found these differences between groups to be not significant [p>0.05] at any measurement point (Table 4.5), however this could be due to the small number of participants in each group. A sample size calculation was performed based on an average standard deviation in total sitting on work days at follow-up of 1.27 hours, and an effect size of 1.0 hours at 80% confidence interval (alpha = 0.05). Using a standardised calculator (sample-size.net 2015) it was estimated that a sample size of 27 participants per group would have been needed to show statistical differences between groups for the level observed.

Table 4.5: Sedentary behaviour key outcomes for control and intervention group at 3 measurement points

Time point	Baseline		Intervention		Follow-up	
Group	**C (n=8)**	**I (n=8)**	**C (n=9)**	**I (n=8)**	**C (n=8)**	**I (n=8)**
Total sitting all days [a] [%]	62.7 ±8.9	60.9 ±3.7	60.4 ±9.0	62.3 ±12.0	62.9 ±12.3	60.1 ±8.2
Between group differences	*p= 0.61*		*p = 0.72*		*p = 0.60*	
Total sitting work hours [b] [%]	78.7 ±11.8	71.8 ±22.0	72.2 ±15.0	69.4 ±17.2	77.1 ±11.7	70.0 ±17.8
Between group differences	*p= 0.45*		*p = 0.73*		*p = 0.36*	
Sitting events per hour at work [b] [number]	3.2 ±1.1	3.8 ±1.3	3.9 ±1.5	4.2 ±1.9	3.6 ±1.5	4.0 ±1.5
Between group differences	*p = 0.30*		*p = 0.74*		*p = 0.64*	
Mean sitting event duration work hours [b] [mins]	16.4 ±5.2	12.5 ±5.7	12.4 ±4.9	11.6 ±5.5	15.3 ±7.9	12.6 ±6.6
Between group differences	*p = 0.17*		*p = 0.73*		*p = 0.47*	
Time in event >20 minutes work hours [b] [%]	53.2 ±15.0	45.6 ±23.2	40.4 ±21.0	39.6 ±23.0	47.6 ±23.0	43.0 ±26.5
Between group differences	*p = 0.45*		*p = 0.94*		*p = 0.72*	
Time in event >30 minutes work hours [b] [%]	39.8 ±13.4	32.2 ±21.8	27.8 ±20.0	28.0 ±21.5	33.1 ±23.6	33.6 ±24.7
Between group differences	*p= 0.42*		*p = 0.99*		*p = 0.97*	

Data displayed in each cell are Mean ±standard deviation were calculated using data on amount of time the activPAL was worn during waking hours [a] and working hours [b]. C = control group, I = Intervention group. P values are the result of independent t-tests measuring differences between control & intervention groups.

A non-significant reduction in mean from baseline to intervention measurement was seen in total sitting (Figure 4.2), sitting event duration (Figure 4.3), and both measures of prolonged sitting (Figure 4.4 and Figure 4.5) during work hours in both the control and intervention groups. However, these reductions were not maintained at follow-up, with the mean of each group returning towards baseline levels (Table 4.5). A two-way ANOVA was conducted to examine the effect of measurement point and group on each of the key outcomes. No statistically significant interaction between the effect of time and group was found for any outcome.

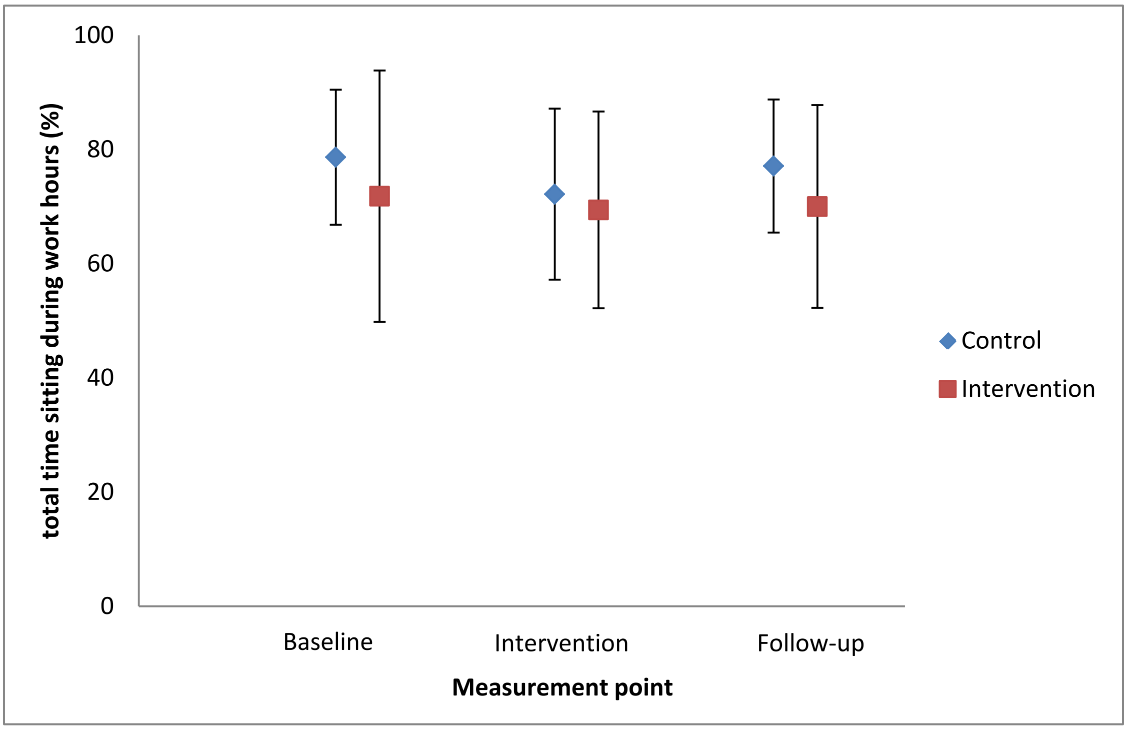


Figure 4.2: Mean & confidence intervals for percentage of sitting during work hours for control and intervention groups across 3 measurement points

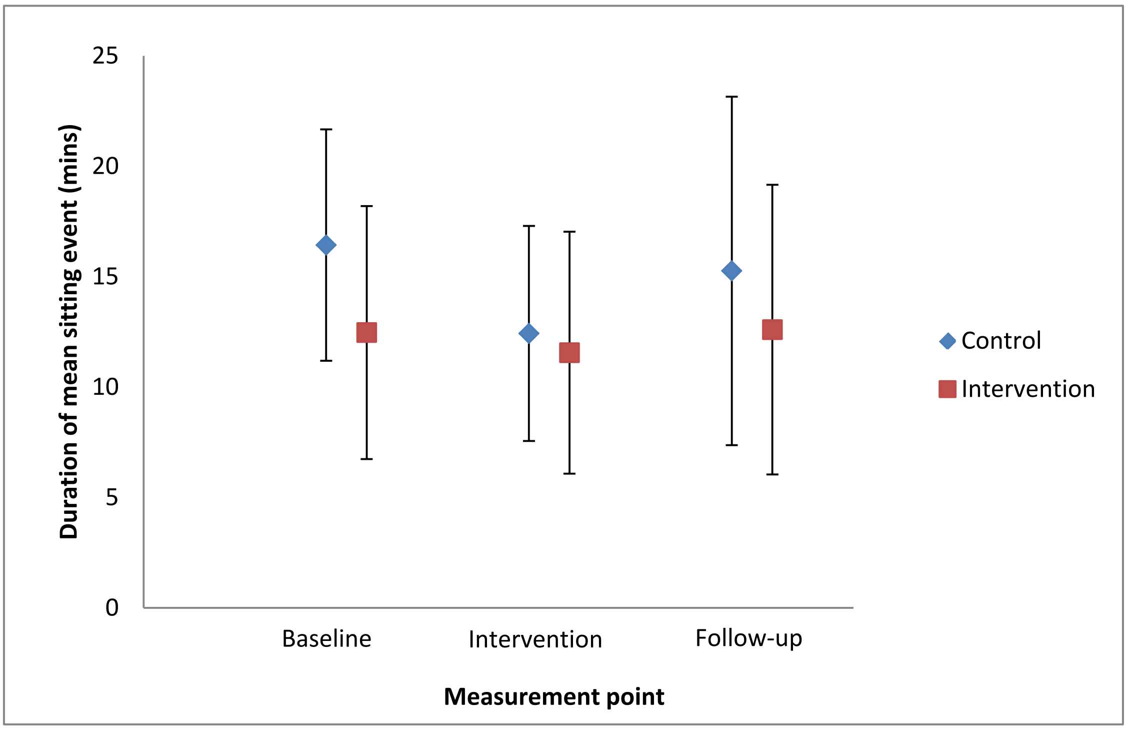


Figure 4.3: Mean & confidence intervals for mean duration of sitting event for control and intervention groups across 3 measurement points

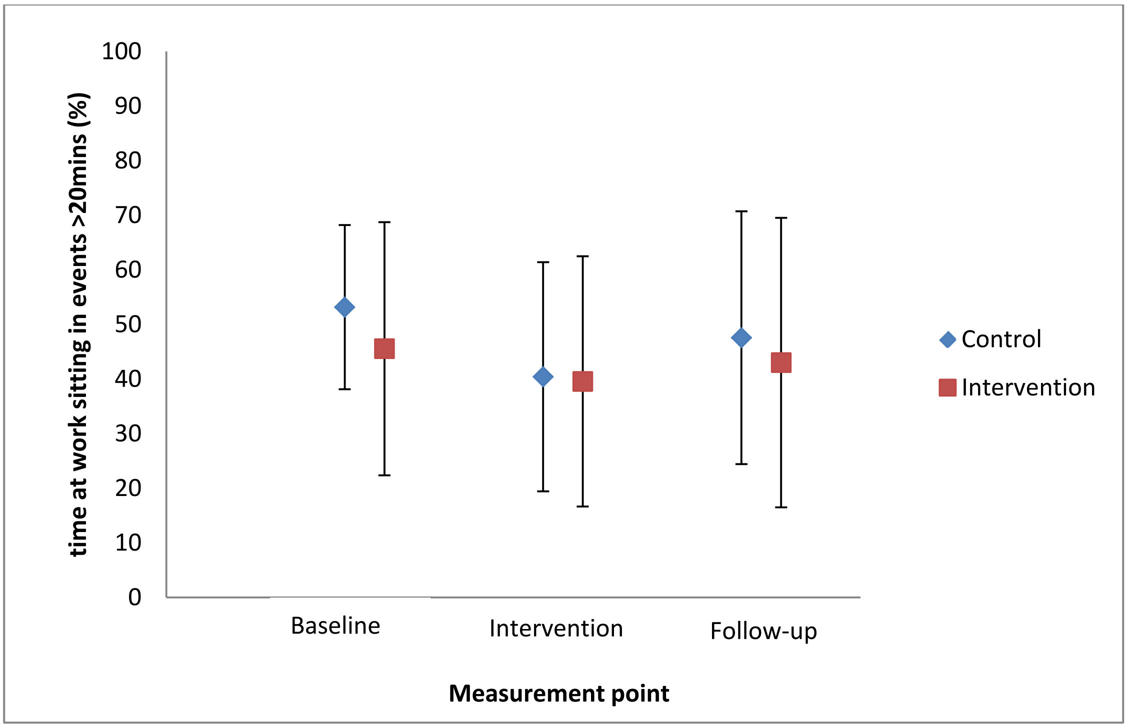


Figure 4.4: Mean & confidence intervals for proportion of time sitting in events >20 minutes for control and intervention groups across 3 measurement points

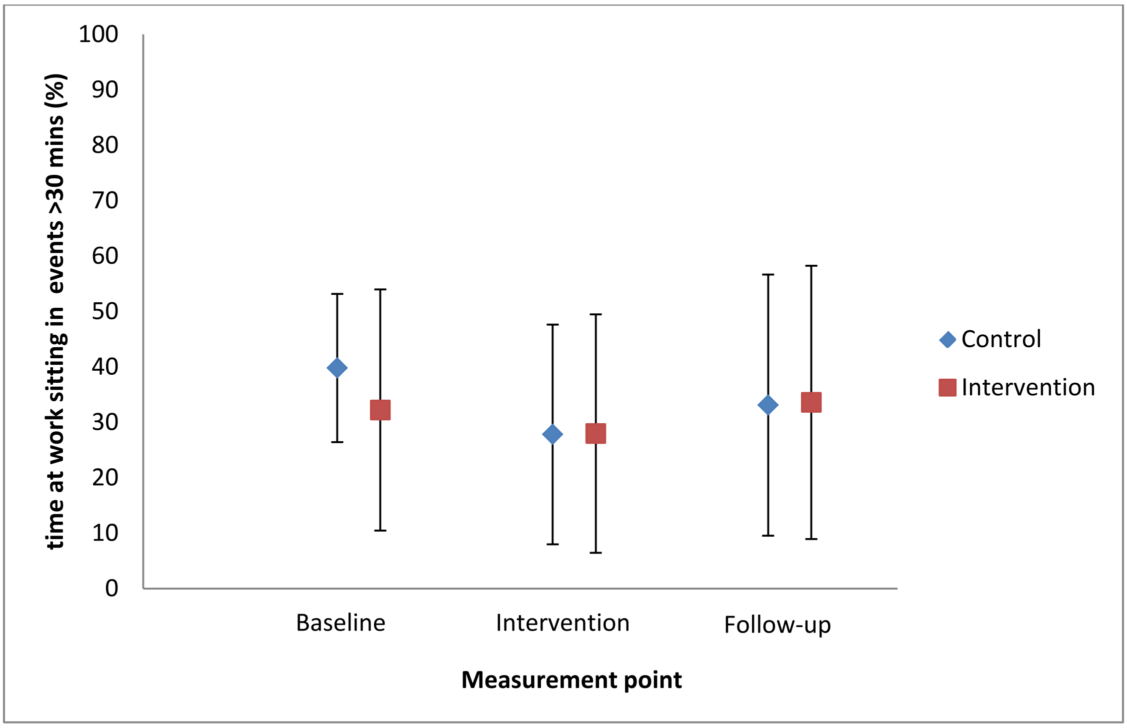


Figure 4.5: Mean & confidence intervals for proportion of time sitting in events >30 minutes for control and intervention groups across 3 measurement points

4.3.4.3 Changes to sedentary behaviour – individual behaviour change

Whilst the small sample size may explain the absence of significant differences between the groups over time, it is interesting to note that reductions in sitting were seen in both groups between baseline and intervention. Looking at the data for changes in individuals' sitting behaviour allowed the sample to be split into 'improvers' - those that reduced their sitting at intervention or follow-up from their sitting measured at baseline, and 'non-improvers' who showed no reduction or an increase in sitting during working hours (Table 4.6). It is worth noting that improvers included both those that improved at intervention and maintained their reduction in sitting at follow-up, those that improved at intervention and did not maintain the improvement, and those that did not show improvements until follow-up.

Table 4.6: Number of participants that improved and did not improve sitting outcomes by group

Outcome	Improvers			Non-improvers		
Group	**C**	**I**	**All**	**C**	**I**	**All**
Total sitting all days [a] [%]	5	3	**8**	3	5	**8**
Total sitting work hours [b] [%]	6	4	**10**	2	4	**6**
Mean sitting event duration work hours [b] [minutes]	7	5	**12**	1	3	**4**
Time in event >20 minutes work hours [b] [%]	7	5	**12**	1	3	**4**
Time in event >30 minutes work hours [b] [%]	6	5	**11**	2	3	**5**

Data displayed in cells are for number of individuals (n=16). Outcomes are calculated using data on amount of time the activPAL was worn during waking hours [a]. and working hours [b].Improvers are those that have reduced % sitting time from baseline. Non-improvers have shown no reduction, or an increase in sitting %. C = control group, I = Intervention group

Overall, more participants were improvers in terms of reducing their sitting for all outcomes during work hours, than were non-improvers. However, participants were as likely to be improvers as non-improvers in terms of sitting time on all days (including non-work days).

It should be noted that the number of sitting events was not examined for this purpose as this outcome in isolation does not provide an insight into sitting improvement e.g. an increase in the number of sitting events might indicate more sitting, or might be indicative of more frequent events of shorter duration.

The number of improvers in the control group exceeded the number of improvers in the intervention group for all sitting outcomes. This could be due to the intervention group showing less sitting at baseline compared to the control group (Table 4.5) with regression to the mean resulting in the intervention group being less likely to improve on their baseline sitting.

4.3.4.4 Changes in sedentary behaviour across the whole sample

Whilst only the intervention group received prompts to stand, both groups received the same education session following baseline measurement. During this session information was provided about the health risks of prolonged sedentary behaviour and tips on how to break up sitting during the working day. Given there were no significant differences between groups at the 3 measurement points and that individuals in the control group also showed improvement in sitting outcomes (Table 4.5), examining changes in the sample as a whole may give an insight into the impact that the education session had on sitting behaviour.

Paired t-tests showed that there was a significant decrease between baseline and intervention in the mean length of sitting events during working hours (-2.1 ± 3.3 minutes, *p=0.02*) and the proportion of work hours spent in sitting events longer than 20 minutes (- 7.7 ± 12.8%, *p=0.03*) for the sample as a whole (Table 4.7). There was also a reduction in proportion of time spent in events longer than 30 minutes (-6.8% ± 13.3%) between baseline and intervention, which tended towards significance (*p=0.059*). Correspondingly, there was a significant increase in the number of sitting events during work hours between the same time periods (+0.5 ± 0.9, *p=0.04*). For all of these four outcomes, changes seen at intervention were not maintained, with increases in mean event duration, sitting in events of 20 and 30 minutes or more increasing at follow-up, and number of sitting events decreasing, back to baseline levels. For mean sitting event duration, the increase between intervention and follow-up was significant (*p=0.02*).

Table 4.7: Difference in means between measurement points for whole sample

Outcome	Baseline (n=16)	Intervention (n= 17)	Follow-up (n=15)	Difference baseline – intervention (n=16)	Difference baseline – follow-up (n=15)	Difference intervention – follow-up (n=16)
Total sitting all days [a] [%]	60.9 ± 5.87	61.3 ± 10.2	61.4 ± 10.2	+0.5 ± 9.3 *p = 0.82*	+0.7 ± 7.1 *p = 0.72*	+0.0 ± 6.4 *p = 0.99*
Total sitting work hours [b] [%]	75.2 ± 17.4	71.1 ± 16.1	73.6 ± 15.0	-4.2 ± 9.4 *p = 0.1*	-2.7 ± 11.2 *p = 0.37*	+0.7 ±8.4 *p = 0.73*
Sitting events per hour at work [b] [number]	3.5 ± 1.2	4.08 ± 1.66	3.79 ± 1.42	+0.5 ± 0.9 ***p = 0.04***	+0.2 ± 0.7 *p = 0.34*	- 0.4 ± 0.9 *p = 0.08*
Mean sitting event duration work hours [b] [mins]	14.5 ± 5.7	12.0 ± 5.0	13.9 ± 7.1	- 2.1 ± 3.3 ***p = 0.02***	+ 0.1 ± 3.2 *p=0.94*	+ 1.9 ± 3.0 ***P=0.02***
Time in event >20 minutes work hours [b] [%]	49.4 ± 19.3	40.0 ± 21.2	45.3 ± 24.1	- 7.7 ± 12.8 ***p = 0.03***	- 2.9 ± 12.9 *p = 0.39*	+ 4.6 ± 11.3 *p = 0.13*
Time in event >30 minutes work hours [b] [%]	36.0 ± 17.9	27.9 ± 20.0	33.3 ± 23.3	- 6.8 ± 13.3 ***p = 0.059***	-0.8 ± 14.9 *p = 0.85*	+5.1 ± 11.8 *p = 0.10*

Data displayed in cells are for means and standard deviations or difference between means and standard deviations at 2 measurement points for the whole sample. P values are the result of paired t-tests at 95% confidence interval, those in red represent significant differences p≤0.05, those in bold are approaching significance. Outcomes are calculated using data on amount of time the activPAL was worn during waking hours [a] . and working hours [b]. C = control group, I = Intervention group.

4.3.5 Response to prompts

As each participant in the intervention group received a unique set of randomly generated prompts, this allowed comparison between the time at which the prompt was delivered, and the time at which the next standing episode occurred. Consequently, individuals' response to prompts were examined, in order to provide insight into how, if at all, prompts impacted on sitting/standing behaviour i.e. did participants respond to them immediately by standing, or did they act as a general reminder which was acted upon at other times during the day. A standing event shortly after the delivery time of a prompt, however, did not necessarily indicate that standing occurred as a direct response to the prompt. It may have been an unrelated act that would have occurred anyway. As there were no data available to compare standing events after prompts to random, unrelated standing events, a set of 'pseudo-prompts' were created for all participants for each measurement period. These pseudo-prompts were created in the same way as the actual prompts that were delivered to the intervention group, but were not actually given to participants. Instead, they provided a random set of times against which actual standing events were mapped, to allow comparison of standing following delivery of real prompts. This allowed conclusions to be drawn as to whether participants in the intervention group were standing as a direct response to the prompts they received.

The standing time after prompts was not normally distributed, and therefore the median time to stand (and inter-quartile range) following pseudo (non-existent) and actual prompts was examined (Table 4.8).

Time to respond to pseudo-prompts was lower in the intervention group than the control group at all 3 measurement periods, though reductions in median time to stand were seen in both groups from baseline to intervention (Figure 4.6). A reduction in the longest time to stand following a pseudo-prompt was also seen in both groups from baseline to follow-up (Figure 4.8). There was little change to the shortest response time in both groups (Figure 4.7).

For the intervention group response times to real prompts were slightly quicker (-0.8 minutes/ 48 seconds) than a 'response' to the pseudo-prompts, although this difference was not significant (Table 4.8). This suggests that the standing events occurring in the intervention group during the intervention period were not necessarily as a direct response to the prompts they were receiving.

Table 4.8: Time taken to stand following random and real prompts by group

Time point: Pseudo/real prompts	Baseline pseudo-prompts		Intervention pseudo-prompts		Intervention real prompts	Follow-up pseudo prompts	
Group	**C (n=8)**	**I (n=8)**	**C (n=9)**	**I (n=8)**	**I (n=8)**	**C (n=8)**	**I (n=8)**
Median time to stand following prompt (mins)	13.0 (7.1-29.6)	17.3 (6.0-10.3)	9.7 (6.7 – 17.4)	8.6 (4.5 – 18.7)	7.8 (5.1 – 13.1)	10.7 (2.6 – 20.2)	10.5 (4.5 – 19.8)
Shortest time to stand following prompt (mins)	0.14 (0.03-0.21)	0.1 (0.05-0.4)	0.07 (0.03 – 0.2)	0.13 (0.04–0.43)	0.17 (0.12–0.20)	0.18 (0.02–0.55)	0.13 (0.05–0.34)
Longest time to stand following prompt (mins)	119 (70 –274)	169 (52–217)	105 (43–171)	121 (37–219)	117 (39–215)	37 (27–108)	53 (31–93)

Data in each cell is for median time in minutes (inter-quartile range). Random refers to non-existent prompts created after data collection for the purposes of comparison. Real refers to the actual prompts received by the intervention group. C = control group, I = Intervention group

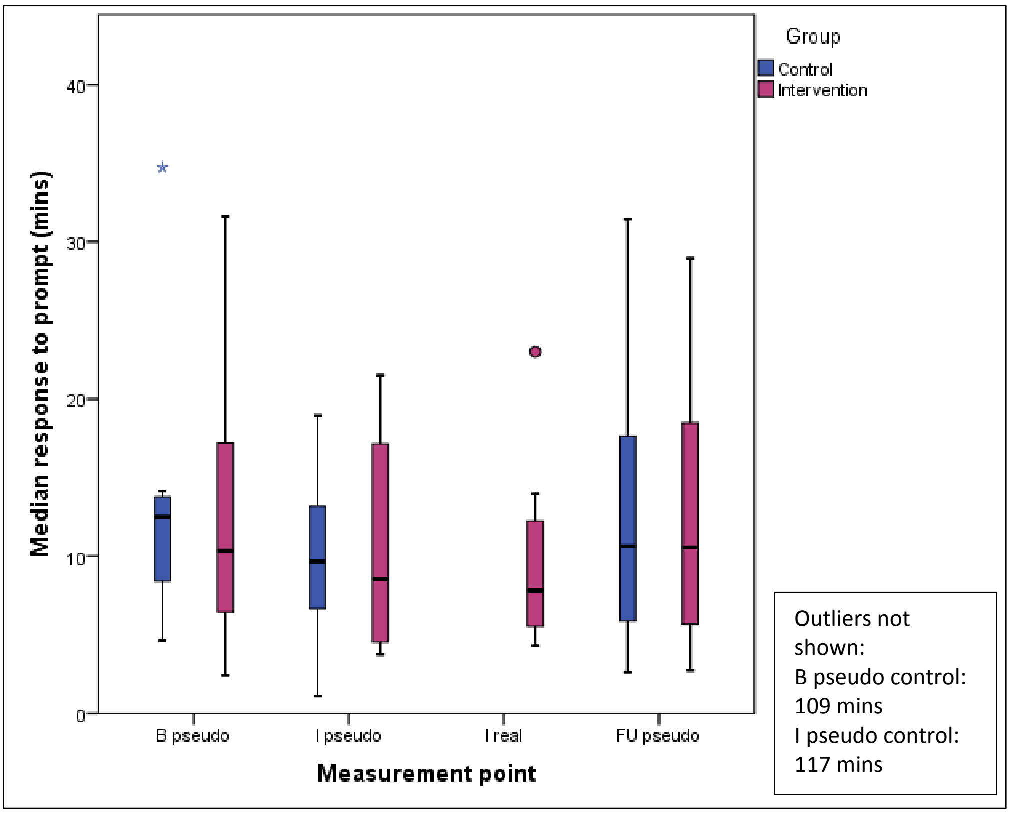


Figure4.6: Median and range of time taken to stand following pseudo and real prompts

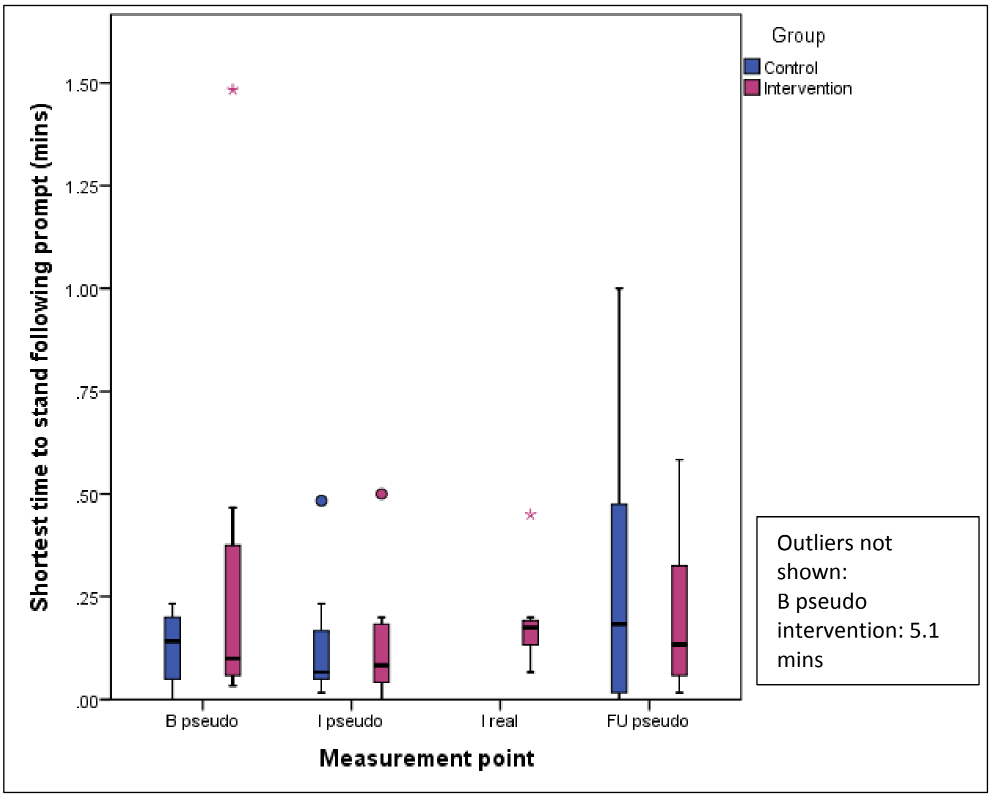


Figure4.7: Median and range of shortest time to stand following pseudo and real prompts

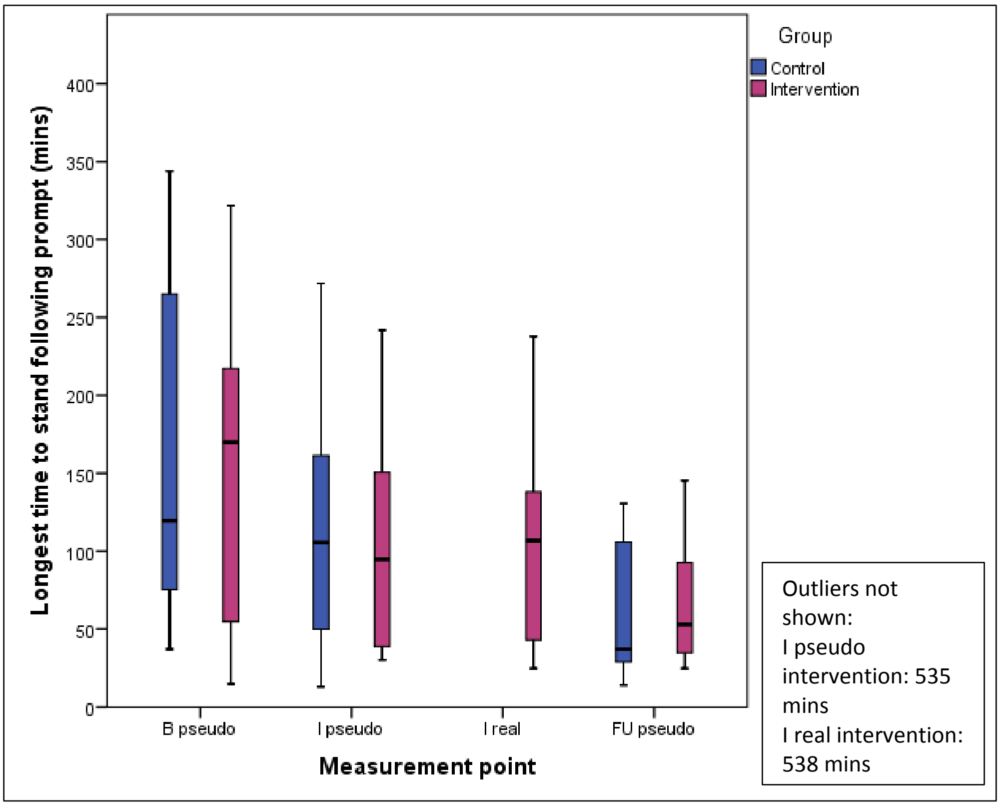


Figure 4.8: Median and range of longest time to stand following pseudo and real prompts

<u>**Key for graphs 4.6-4.8**</u>:
B pseudo = response to pseudo prompts at baseline; **I pseudo** = response to pseudo prompts at intervention;
I real = response to actual prompts delivered at intervention; **FU pseudo** = response to pseudo prompts at follow-up

4.4 Discussion

4.4.1 Feasibility of intervention

4.4.1.1 Recruitment and retention

The recruitment target of 30 participants was not met despite an on-site study contact engaging with potential participants in person and by email. It is not known how many participants were recruited as a result of this personal contact or via the posters displayed in common areas. Recruitment is therefore an issue to be considered for future larger scale studies, which may need to consider recruitment across multiple work sites in order to attract larger numbers of participants. However, variations in worksite practices and occupational roles will need to be taken into account, in terms of how these may influence results.

All office workers that volunteered met the eligibility criteria and, once recruited to the study, retention was good with 86% of participants remaining in the study until the follow-up measurement. This is perhaps a reflection of effective communication with participants maintained by the researcher throughout the project, and also the promise of feedback on activity patterns at the end of the project. A future study should therefore attempt to replicate this to maintain similar levels of retention.

4.4.1.2 Collecting activity data

Participants were, on the whole, compliant with collecting data that met or exceeded the minimum requirement for inclusion, with only one participant excluded from analysis for this reason. Ninety-four percent of participants collected 3 or more days of baseline data, and 88% achieved this level at intervention and at follow-up measurement. This level of compliance is similar to that achieved in other studies using continuous activPAL monitoring (Edwardson et al. 2016) and demonstrates that future studies should expect to achieve high levels of compliance for the duration of the study.

Despite being asked to wear the activPAL monitors continuously for a period of 7 days, including securing the monitor the night prior to day 1, participants frequently removed monitors, attached them after waking or removed them prematurely. Failing to meet minimum wear time accounted for 41 days of data being excluded over the 3 measurement periods. This amounted to 14% of the total number of days processed and analysed (section 4.3.2.1). The main reason for not meeting the minimum wear-time was removing the monitor before the end of the monitoring period (46% of days excluded). For the majority of the cases, no specific reason was given for this and the researcher was not aware that the monitor had been removed prematurely until the validation process. However, on some occasions participants informed the researcher they were ending the measurement period due to travel. Where possible, this should be addressed in future studies by encouraging participants to anticipate travel arrangements during monitoring periods so monitoring can be bought forward. Also, contact should be maintained with participants during the measurement period, specifically reminding them to keep the monitor on for the full 7 day period. The other main issue for days being excluded was due to monitors, that had been programmed for 14 days, stopping working prematurely (34% of days excluded). In future studies monitors should be tested prior to distribution and steps taken to ensure a minimum amount of time between distribution and the monitor being worn. Participants in both focus groups complained of discomfort and irritation wearing the monitors, however skin irritation was only cited as the reason for removal of the monitor that resulted in 2 days being excluded (5% of excluded days).

4.4.1.3 Prompts delivered by Microsoft Outlook

Creating sets of randomly generated and timed prompts in Excel, and uploading them to Microsoft Outlook, proved to be an easy process. Little time commitment was required by either the researcher or participants. No issues were experienced by any of the intervention group participants regarding the upload of prompts or during their delivery. In this regard using Excel and Microsoft Outlook, proved to be a feasible, low cost method of providing office workers with randomly timed reminders to break-up their sitting. The short, positively framed messages, delivered at a random time point once within each hour, were evaluated favourably by participants in the intervention focus group, in terms of length, content and frequency. With Microsoft Outlook being widely used across organisations, this method for delivering prompts could be replicated on a much larger scale.

However, participants in the intervention focus group felt that whilst the prompts were initially effective at changing their behaviour, this diminished over time, with prompts being ignored by the end of the 10 week intervention period. See section 4.4.5.5 for further discussion.

4.4.1.4 Education session

The education sessions were evaluated favourably by participants in both focus groups. The brief questionnaire assessing prior knowledge of the health implications of sedentary behaviour, administered before the session, highlighted the need for clarification regarding key risks and links to physical activity. It was, in particular, the health risks being independent to the amount of physical activity undertaken, that had surprised participants and had not been understood from information gleaned from media reports. Participants in both groups said that the education session had made them more conscious about their sitting behaviour. If effective at changing behaviour, such education sessions therefore represent a low-cost solution to reaching large groups of people in a short amount of time. A standard presentation could easily replicate sessions across worksites, with a video presentation potentially eliminating the need for a presenter to visit in person. The impact of education on sedentary behaviour is discussed further in section 4.4.4.

4.4.2 Applying Social Cognitive Theory to understand occupational sedentary behaviour

As previously discussed, analysis of focus group discussions resulted in the emergence of five themes surrounding the experiences and motivations of participants with regard to their occupational sedentary behaviour, in line with the key constructs of Social Cognitive Theory (SCT) (Bandura 1997). To date, no study has attempted to determine the applicability of SCT to occupational sedentary behaviour.

The five themes were as follows: i) situation/environment, ii) outcome expectations, iii) self-efficacy, iv) self-regulation, v) observational learning. Two themes in particular dominated discussions in terms of the proportion of time spent of these issues, amount of times discussion on the topic was initiated by participants, and the intensity of the language used to describe these aspects, suggesting that they evoked strong feelings. These themes were self-efficacy and observational learning, and are discussed first, in further depth below.

4.4.2.1 Self-efficacy

Self-efficacy refers to an individual's belief that they can successfully carry out a behaviour. Bandura (1997) believed this to be the most important pre-requisite for behaviour change. The majority of discussions around self-efficacy in the focus groups centred around a lack of belief that participants could reduce or break up their sedentary behaviour during working hours. The only exceptions were two individuals in the control group who were positive that they could, and had, improved their sedentary behaviour by adopting their own behavioural strategies. It was notable that these individuals were also in roles which had more autonomy over how, and when, they conducted their work tasks throughout the day. As previously mentioned, this echoes the findings of a previous study by Bort-Roig et al. (2014b). The implications of this are that the majority of workers in lower positions of authority do not feel empowered to change their sedentary behaviour and are therefore more susceptible to any resulting health problems. Other factors may also compound the issue such as lower paid workers working in larger peer groups and being less likely to have their own office. As lower grade positions are associated with lower wages, and lower socioeconomic status with poorer health (Adler et al. 1994), a perceived inability to reduce sedentary behaviour at work, could be further exacerbating existing health inequalities.

Those that believed they did not have the ability to change their sedentary behaviour, blamed work pressures for either making them feel unable to interrupt their work outside of official breaks, or for causing them to lose track of time and to forget to break their sitting. This endorses the findings of other studies in which participants cited perceived time pressures (Bennie et al. 2011) and interruptions to productivity (Gilson et al. 2011) as barriers to taking breaks from sitting. In this way employees felt they are not to blame for their sitting behaviour, almost absolving themselves from responsibility. An attitude at odds with the NHS' manifesto to empower citizens with greater control over their health and care (Muir & Quilter-Pinner 2015). However, the question remains of how to overcome such perceived barriers, the exact nature of which will vary from organisation to organisation and from role to role.

The answer, perhaps, lies within the culture and ethos of an organisation, and, in particular, how it is perceived by its employees. Focus group discussions centred around the desire to carry out a behaviour that was seen as normal (section 4.4.2.2 Observational Learning), but also the desire to carry out behaviour that was approved of by management. Organisations should ideally be engaged by winning the support of management and instigating change at a policy level. Improving productivity and reducing absenteeism of employees are likely to be key arguments in achieving this. There is some evidence to show that regular, short breaks can benefit productivity and well-being (Henning et al. 1997) and that taking mental breaks from tasks can increase concentration (Ariga & Lleras 2011). However, such studies do not necessarily equate breaks from work with breaks from sitting. Evidence demonstrating a positive correlation between breaks from sitting and productivity would be of benefit in engaging organisations, alongside providing clear guidelines regarding what constitutes 'too much sitting', and advice on how changes to working practices can help their employees achieve necessary changes. Care needs to be taken to achieve the correct balance between management approving changes in work to facilitate less sitting, and employees feeling less empowered, and that their sitting behaviour is being dictated.

4.4.2.2 Observational learning

Observational learning is the understanding that individuals will learn behaviour from observing others and the rewards they associate with it (Bandura 1986). A great deal of discussion in both focus groups was devoted to how people perceived other people's behaviour and, in particular, how they felt their behaviour was observed by others. Participants thought they would be perceived as 'weird' and 'strange' if they stood at their desks, and expressed a desire not to be carrying out a behaviour that was not the office norm. Changing what constitutes normal behaviour within an office is likely to be key to facilitating large-scale behavioural change to reduce sitting at work. It will involve changing the culture not only in terms of behaviour, but in terms of the environment, policies, leadership, and individual beliefs. There have been a few studies examining how making changes to the physical office environment can help facilitate greater movement by employees (Rashid et al. 2006), but there are no studies examining how to facilitate such change through modifying culture and managerial practices. Instead, the focus of such studies is to improve employee performance and productivity (Chandrasekar 2011, Haynes 2007), rather than health. If breaking sedentary behaviour at work is seen to negatively correlate with the global objective of improved productivity, then this will pose a serious barrier to encouraging changes in work practice. Employers, perhaps, need to be sold the health benefits of reducing sedentary behaviour in their employees in terms of gains in productivity and reduced losses due to sickness absence.

4.4.2.3 Environment/situation

Participants believed that they sat more during working hours than not, and that this was in order to carry out their work tasks comfortably and in response to the physical environment of the office. There were mixed views about the acceptability of introducing sit-stand desks. Trials of sit-stand desks that include a qualitative component, evaluated their use favourably (Dutta et al. 2015, Chau et al. 2014b), however none have sought to gauge opinion on their favourability before installation. This could be important in terms of how people react having a ready-made solution or intervention forced upon them, with studies suggesting the value of using a participatory approach to intervention design (Parry et al. 2013, Farag et al. 2010, Goh et al. 2009). The use of self-regulation by the control group in this feasibility study also lends support to such an approach.

4.4.2.4 Outcome expectations

Outcome expectations refers to the anticipated outcomes of changing sedentary behaviour and the value participants place on these outcomes. The likelihood of an individual taking action related to a given health problem is based on their perception that they are susceptible to the problem, that it has serious consequences, that a course of action will minimise these consequences, and the benefits of taking action outweigh the costs or barriers (Nutbeam et al. 2010).

Focus group participants reported being surprised by the health consequences of excessive and prolonged events of sitting, presented to them during the education session. They agreed that they were convinced by the health messages received, which it appears were initially acted upon by both groups, resulting in a decrease in the length of sitting events and prolonged sitting events from baseline to intervention. Participants reported short-term benefits of changing their behaviour in terms of feeling refreshed, which may have fed back to encourage this behaviour in the short-term. The decision process of whether to conduct a behaviour believed to improve health are thought to be linked to whether the resulting outcomes are immediate or longer-term (Hall & Fong 2007). Immediate outcomes and feedback can help to reinforce behaviour, but longer term benefits of altering sedentary behaviour in the future may not necessarily be tangible to participants (e.g. reducing risk of diabetes or cancer). There may, therefore, be value to reinforcing the short-term benefits of breaking up sitting, in order to encourage longer-term maintenance of behaviour change.

4.4.2.5 Self-regulation

Self-regulation describes the ability to get past short-term negative outcomes in pursuit of a long-term goal through the use of behavioural strategies. Goal setting and feedback are common behavioural strategies associated with self-regulation (Bandura 1986). A recent review of techniques used in sedentary behaviour interventions found that setting behavioural goals was the most frequently discussed behavioural change technique (Gardner et al. 2016). In order to set goals regarding behaviour, it is essential to have a true understanding of current behaviour, which was not necessarily a pre-requisite of studies that utilised this technique as part of an intervention. Participants in this feasibility study were not given feedback on their objectively measured sedentary behaviour until the end of the study, but focus group participants expressed a desire for such feedback and felt it may have helped motivate them to change. Therefore, there could be benefit in future studies of providing participants with feedback on their baseline sedentary behaviour as a tool for motivating change and facilitating goal setting.

Focus group participants that had developed their own behavioural strategies to break up their sitting had assigned specific work tasks to be done whilst standing. This method not only provided an existing cue (the task) for changing posture, but fulfilled the desire to be carrying out a work task whilst standing, that was expressed by participants in both groups. In addition, by associating particular tasks with standing, some of the conscious decision to stand is removed. Evidence suggests that cognitive control systems, such as self-efficacy, are important in the acquisition of behavioural proficiencies. When a behaviour is less demanding and more easily engaged in, (e.g. sitting at a desk) then such cognitive control systems give way to regulation by lower control systems in which behaviour is automatic and less consciously thought about (Stevens et al. 2003, Bandura 1997). Assigning tasks to standing could therefore be an effective strategy that has the potential to result in long-term behaviour change, however it is recognised that this may not be an option for all occupational roles (section 4.4.4.2).

4.4.3 Effect of prompts on sedentary behaviour

Whilst the primary focus of this study was to determine the feasibility of the intervention, analysis of changes to key outcomes of sedentary behaviour has given valuable feedback on how such analysis might be conducted in future studies, and also where such studies may benefit from changes to the study design. Based on the outcome measures in this study, a sample size calculation estimated future studies should aim to achieve a sample size of at least 27 participants per group in order to show statistical differences between groups.

Despite favourable evaluation from intervention group participants, objective measurements of sedentary behaviour showed no significant differences between the control and intervention groups at baseline, intervention or follow-up. This suggests that the prompts provided no additional effect on sedentary behaviour than the impact of education alone, which was received by all participants, although the small sample size prevents drawing definitive conclusions regarding this.

Previous small-scale studies (n=14 to n=25 per group) have shown prompts to be effective at making small reductions in both objectively measured and self-reported sedentary behaviour (Donath et al. 2015, Bond et al. 2014, Pedersen et al. 2014, Swartz et al. 2014, Evans et al. 2012). Most notable is the study by Evans, et al. (2012) which also compared the impact of education only to education and prompts on objectively measured sedentary behaviour. They found that whilst there was no significant differences in total sitting time, the number (ANCOVA; −6.8%, p=0.014) and length (−15.5%, p=0.007) of prolonged sitting events (>30 minutes) was significantly reduced in the intervention group who had received computer-based prompts for a period of 5 days. Reductions in these outcomes were not seen in the control (education only group). The reasons why such reductions were not seen in the intervention group in this study, could be due a number of factors, addressed below.

4.4.3.1 Timing of measurement periods

Firstly, the study by Evans et al (2012) measured follow-up over the 5 days during which the prompt intervention was being delivered, whilst this study measured sedentary behaviour 8 weeks after the prompts began and again 12 weeks after they had ceased. Participants in the intervention focus group felt that they initially responded well to prompts, but that the impact of the prompts reduced over time. Whilst no time-frame for this loss of impact was suggested by participants, it is possible that the prompts were at their most effective during the first two weeks of the intervention period and, had sedentary behaviour been measured at the roll out of the intervention, as in the Evans study, a reduction in sedentary outcomes would have been observed. The analysis of time taken to stand following a prompt demonstrated that at 8 weeks into the intervention, there was little difference between standing events following real prompts and pseudo-prompts created for comparison. This suggests that at this measurement point, participants were not responding immediately to prompts by standing, and whilst the prompts may have acted as a reminder to break sitting at a different point, this was not sufficient to significantly reduce measures of sedentary behaviour.

4.4.3.2 Ability to work through prompts

The analysis of the response to prompts gives an interesting insight into how participants reacted to prompts which they had the option to snooze and/or ignore. Prompts delivered by Microsoft Outlook appeared on the screen as meeting reminders which could be snoozed to re-appear five minutes later, or immediately dismissed with one click of a mouse. Participants in the intervention group spoke of them being lost behind other open work on the computer, and that even prompts that were noticed were ignored due to the immediate pressures of work. Analysis of the time taken to stand following delivery of a prompt, confirms that prompts tended not be responded to immediately. In the Evans study, whilst it was possible to continue working in open windows around the prompts, it may have been harder, and less convenient to do so, and in such a way a break from work was encouraged. Although there still remained a choice over whether to stand during a break, perhaps restricting the ability to work was enough to draw attention to the purpose of the prompt and act on its message.

Another study using computer-based prompts warned recipients of an impending break and then completely froze the computer from further use during the duration of the prompt (Pedersen et al. 2014). Unlike, the feasibility study in which participants were given no specific instructions what to following a prompt other than break their sitting, workers in the study by Pedersen et al. were encouraged to engage in short bursts of physical activity during their breaks. Sedentary behaviour was significantly reduced in the intervention group receiving the prompts at the end of the 13 week intervention, although this was based on self-reported behaviour. When the concept of such passive prompts that prevented computer use were put to both focus groups in this study, participants were horrified and dismissed them as not feasible in terms of interrupting workflow. Interestingly, interviews with study participants in the study by Pedersen, et al. (2014) revealed that whilst initially enforced breaks caused frustration, many participants learnt to adapt their way of working and welcomed the breaks (Cooley et al. 2014).

4.4.3.3 Population sample

Another important difference between this study and the one conducted by Evans et al. (2012), is the sample used. The Evans study used a convenience sample of 30 adults employed within offices at a University. Although occupational roles are unspecified, it is likely that participants had been formally educated to a high level, and may well have had an interest in the subject, or the research process, which may have increased their compliance to prompts. Participants in this feasibility study worked in the office of a commercial bank, which is likely to be a different work environment to a University in terms of types of work pressure, deadlines, and autonomy over working practices. The influence of specific occupational roles on the ability to break up sedentary behaviour cannot be ignored. For example, roles that require people to be at a desk to make or receive phone-calls do not prevent standing, but do not offer the opportunities for movement that other roles might. This was one of the results of a multi-centred study that asked office workers to design strategies to break up their sitting. They found that in two of the centres: a call-centre and data-processing office; workplace practices were regimented, so that varying office tasks to incorporate incidental activity were difficult to implement and not fully supported by the management (Parry et al. 2013). It was notable in this feasibility study, that those in positions of higher authority in the study sample, had the autonomy to arrange their tasks and working day and were more likely to take longer lunches away from their desks. This finding echoes that of a qualitative study into factors that influenced the uptake of an intervention to increase movement in Spanish office employees, which concluded that employees' perception of the acceptability of taking breaks from their desk was linked to the role they performed within an organisation (Bort-Roig et al. 2014b).

4.4.3.4 Office environment

Another potential difference in study samples is the office environment, and physical location of participants within it. It is not clear if participants in the Evans study were working in the same office in close physical proximity to each other or not. In this feasibility study, most participants were in a large open-plan office with low height partition screens. Cluster randomisation to groups was used with the aim of minimising any influence that observing the intervention group standing, may have had on the behaviour of the control group. Observing the behaviour of others, and placing value on that behaviour, is believed to influence behavioural choices (Bandura 1986). It is therefore possible that observing the sitting and standing behaviour of colleagues in an office environment could influence choices regarding sedentary behaviour. In this way cluster randomisation may have influenced baseline sedentary behaviour, and be the reason why the intervention group sat less and in shorter sitting events, than the control group (Table 4.5). These differences at baseline, although not statistically significant, may have contributed to only small improvements in sitting outcomes seen in the intervention group in comparison to the lower levels of sitting seen at baseline.

The use of cluster randomisation may also explain improvements in sedentary behaviour patterns seen in the control group from baseline to intervention measurement. With neighbouring colleagues having a positive influence on each other's behaviour. However, if this was the case, it is likely that such observations and mimicking of behaviour was not done consciously, with members of the control group reporting in the focus group not to have observed changes in the behaviour of their co-workers.

Although cluster randomisation may have influenced sedentary behaviour in a positive way, it is possible that being within a larger open-plan office had a negative impact on sedentary behaviour. Participants in the intervention focus group felt very self-conscious about their standing behaviour, and carrying out a behaviour that was not the norm within the office. It was important for them to conform to the office culture and participants felt that they would be more likely to comply with a prompt that asked all people to stand at the same time.

4.4.4 Effect of education on sedentary behaviour

4.4.4.1 Changes to sedentary behaviour outcomes for whole sample

Whilst there were no significant differences in outcomes between the control and intervention group, statistically significant reductions in some sedentary behaviour outcomes were seen in the sample as a whole. Examining changes in outcome measures for all participants between baseline and intervention using individual paired data showed a significant reduction in mean length of sitting events (-2.1 ± 3.3 minutes, *p=0.02*) and time spent in sitting events longer than 20 minutes (-7.7 ± 12.8%, *p=0.03*) during work hours. As all participants received education between these two measurement points, it is possible that this was responsible for the reduction in sedentary behaviour, with no additional effect gained by receiving the prompts. Reductions in sedentary behaviour outcomes were not maintained for the sample as a whole at follow up, with both event length and prolonged events (>20 minutes) returning to baseline levels. Possible explanations for these changes in all participants, are explored further below.

4.4.4.2 Self-regulation and behavioural strategies

Evidence from the focus groups also suggests that education may be the cause of the reductions seen in the sample as a whole. Participants agreed that they were very much convinced by the health messages given in the education session. Participants also spoke of strategies they had designed and adopted to break up their sitting, in addition to/instead of the prompts. The majority of these behavioural strategies were task-based and were mostly, but not exclusively, discussed by members of the control group. Studies have demonstrated the value of using a participatory approach, in which participants are involved in the design of the intervention, in both reducing sedentary behaviour, and increasing physical activity (Parry et al. 2013, Farag et al. 2010, Goh et al. 2009). Whilst the strategies deployed by control group participants to reduce their sedentary behaviour were not developed in collaboration with the researcher team, it is likely that they resulted from the tips and information given from the education session since they had mostly not been used previous to that session. Such self-regulatory strategies may also have been behind reductions in sedentary behaviour in the intervention group. However, it is notable that such behavioural strategies were not maintained at follow-up to a level that resulted in reductions in sedentary behaviour outcomes being maintained. It would therefore be interesting to examine further what prompted the adoption of behavioural strategies, by whom, and if they were not maintained over time, why not.

4.4.4.3 Literature supporting the impact of education on sedentary behaviour

Studies investigating the impact of education on reducing sedentary behaviour, are limited. Most commonly, studies aimed at reducing sedentary behaviour that include an educational component, are measuring the effect of the education in combination with another component to form an intervention. For example, education on reducing sedentary behaviour to accompany the installation of sit-stand desks (Donath et al. 2015) or a prompt intervention (Evans et al. 2012). However, in the absence of an education only group, and a control group who receive no intervention at all, it is not possible to distinguish the impact of these educational components alone. There have also been a few studies investigating the effect of personalised one-to-one interventions which involve educating participants alongside techniques such as mindfulness (van Berkel et al. 2014), behaviour change counselling (Verweij et al. 2012), and person-centred consultation (Kirk et al. 2012) to facilitate lifestyle changes, including improving sedentary behaviour. Only the study utilising behaviour change counselling resulted in reductions to sedentary behaviour, which were not statistically significant at six month follow-up. Even with long-term significant improvements to sedentary behaviour, the feasibility of such one-to-one interventions would need to be questioned in terms of the time and cost of delivering them to large numbers of office workers. If education alone proved to be effective at reducing sedentary time, this could provide a cost-effective and time-efficient solution to employees wishing to target large numbers of sedentary employees.

Future research investigating the impact of education on sedentary behaviour would also benefit from unpicking which elements of an education session were effective, in order to optimise its delivery in terms of content and length. In order to be feasible, an education session would need to result in reduced sedentary behaviour being sustained at follow-up, and show added value to simple information provision e.g. providing information leaflets or posters around the office. Currently, details in the literature regarding the nature, and content of the education or information component of sedentary behaviour interventions, is too vague to draw comparisons or to elicit best practice.

4.4.5 Limitations

The limitations of this feasibility study are worthy of note in evaluating the results and in order to attempt to eliminate them from future studies.

4.4.5.1 Sample

This study proved valuable in terms of assessing the feasibility and usability of prompts delivered via Microsoft Outlook to office workers to encourage breaks in work-time sitting. However, although not its primary aim, the small sample size did not allow inferences to be drawn regarding the statistical significance of the differences in sedentary behaviour outcomes observed.

It could be argued that the study sample is not likely to be representative of the spectrum of office-based working adults. More females than males volunteered, and the oldest volunteer was aged 56. Males were therefore likely to be under-represented as were older working adults. Self-reported health from volunteers was high, and the mean BMI was below the national average for the general population. Although, not definitive evidence of good health, these indices suggest that the sample consisted of health-conscious individuals who would be more likely to respond to an intervention whose purpose was to improve health outcomes. There is little that could have been done to eliminate such recruitment bias, as participants were recruited on a voluntary basis, but it is worth considering when judging the applicability of an intervention to the wider population.

4.4.5.2 Randomisation

A process of cluster randomisation was used to assign participants to either the control or intervention group (section 4.2.7). Whilst this may have helped minimise each group being influenced by the other's behaviour, it may have led to within-group influences, perhaps resulting in differences in sedentary behaviour at baseline, and how participants did, or did not respond to prompts. Non-clustered randomisation to groups might have prevented such influences, but at the same time it is important to consider that behaviour may be influenced by the behaviour of those in close proximity within an office environment and cannot always be eliminated.

4.4.5.3 Compliance with collection of activity data

Overall, compliance with data collection was good and the feasibility of collecting three rounds of activity data from participants proved feasible in terms of future study design. However, all activPAL monitors should be checked prior to distribution, to prevent monitors from ceasing to record data before the end of their programmed date, in order to minimise the number of days of data lost due to technical problems. Also, contact should be maintained with participants during measurement periods, to encourage participants to continue collecting data for the full 7 day period.

4.4.5.4 Contaminated baseline measurement

Ideally, baseline measurement should be a true reflection of participants' normal sedentary behaviour levels and patterns, but the very act of being part of a study, and wearing an activity monitor, is likely to have had some influence on behaviour. Although participants were not given any education regarding the health risks of sedentary behaviour until after the baseline measurement was completed, some information of this nature was given in the participant information sheet in order to explain the background to, and purpose of the study. Participants received this information sheet prior to the collection of baseline activity data. In addition, the influence of information provided in the media about sedentary behaviour cannot be eliminated. At the time the study was conducted there were a number of news items about the health risks of sedentary behaviour, and it cannot be assumed that participants were or were not exposed to these and what influence on their baseline activity this would have had. Whilst it is not possible to eliminate exposure of individuals to any information on the health risks of sedentary behaviour prior to baseline measurement, steps could be taken to minimise how much information was given in the study materials e.g. participant information sheet, at this stage. Blinding participants to the study hypothesis has been suggested as a method of reducing bias in trials on non-pharmacological interventions (Boutron et al. 2007).

4.4.5.5 Timing of measurements

Feedback from the intervention focus group suggested that participants felt that prompts were initially effective, but became less effective over the course of the 10 week intervention period. As the second measurement period occurred towards the end of the intervention period it is not possible to corroborate this with objective measurements. It is therefore possible that any short-term impact of the prompts was not being measured.

4.4.5.6 Application of Social Cognitive Theory themes following focus groups

The potential for Social Cognitive Theory to explain occupational sedentary behaviour was only identified after the focus groups had been conducted. Thematic analysis was therefore used to apply SCT themes to transcripts of discussions that had not specifically been led to answer these themes. However, the fact that all five key constructs of SCT were covered in the course of focus group discussions, lends weight to applicability of this theory to occupational sedentary behaviour. Future focus groups would perhaps benefit from more in-depth exploration of specific aspects of the SCT themes, in particular focusing on self-efficacy and observational learning which seemed to have strong links to explaining sedentary behaviour in an office environment.

4.4.6 Future study design

Future studies would benefit from addressing the above limitations which include making improvements to both the intervention, and its evaluation.

Based on discussions in the feasibility study focus groups, the intervention could be improved by providing participants with feedback on their baseline activity levels in order to facilitate goal setting and self-regulation. This should therefore form part of the education received by all participants.

In terms of evaluation, in order to further explore the impact of prompts on sedentary behaviours outcomes, future studies should ideally aim to recruit a larger sample of participants. Where possible studies should aim to recruit participants of a variety of staff grades and, if necessary, conduct separate focus groups with different grades, in order to help ensure that the views of all participants are captured. The issue of recruitment bias could be examined further by ascertaining participant's motivation to change at the start, during, and at the end of the study. For example, by using Prochaska & DiClemente's (1982) stage of change model. This could determine whether those who volunteer for such studies are, indeed, motivated to change behaviour and how this changes over the course of the study, and its relationship to group allocation.

Steps should be taken to minimise the information given to participants about the focus of the study, by reducing references to sitting and breaking up prolonged sitting, in study materials given prior to the education session. In this way, a more representative baseline measurement might be achieved.

Participants should be assigned randomly to groups, without clustering participants based on their physical location. Whilst this may lead to participants from different groups observing each other's behaviour, it will mimic more closely a normal working environment and help distinguish between intervention effects, and clustered behaviour of groups working in close proximity.

Conducting an additional measurement period soon after the start of the prompts would ascertain whether the prompts had any short-term effect on sedentary behaviour and whether this diminished over the course of the intervention. It would also provide an insight into the impact of the education session and how this changed over time. The acceptability, feasibility, and impact of prompts that prevent computer use may be worthy of further investigation.

The applicability of Social Cognitive Theory to explaining occupational sedentary behaviour should be explored further. A focus groups schedule could be developed that is informed by the key constructs of this theory, in order to explore various elements in more depth. In addition it may be of benefit to develop a questionnaire to measure these constructs and ask participants to complete it at different measurement points throughout the study. Given the importance of self-regulation highlighted in the qualitative analysis of this study (section 4.4.2.5), behaviour change may be facilitated in future studies by providing participants with feedback on their baseline sedentary behaviour. This will allow them to understand their sedentary behaviour patterns and use this as a reference to set goals for future behaviour.

4.5 Conclusions

This feasibility study provides a valuable contribution to research into the use of prompts and education on changing the sedentary behaviour of office workers. The use of prompts delivered by Microsoft Outlook proved to be agreeable to recipients, of low-cost, and easy to use, although potentially not effective at changing sedentary behaviour on a long-term basis. Similarly, the education component was evaluated favourably, and, potentially, also impacted on sedentary behaviour in the short-term. Future research would benefit from further investigation into use of both these components of the intervention and in particular, how any short-term behaviour change can be translated into long-term changes that are sustainable over time. In doing so the role of office culture in terms of what is seen as normal behaviour, as well as increasing self-efficacy and promoting self-regulation should be taken into consideration. Greater theoretical understanding regarding the components and mechanisms that underpin occupational sedentary behaviour, therefore, would allow the most effective behaviour change techniques to be identified and utilised in future intervention design.

5 PAWS – PROMPTING ACTIVITY IN A WORKPLACE SETTING. A PILOT STUDY

5.1 Rationale and background of study

The results of the feasibility study investigating the use of prompts to break up sedentary behaviour in office workers (chapter 4) demonstrated that it was feasible to deliver hourly, customised prompts via Microsoft Outlook, reminding office workers to break their sitting. Focus group discussions suggested that although evaluated favourably, in terms of frequency and content, over time participants became less likely to stand as a result of a prompt. Due to the timings of the activPAL measurement periods, it was not possible to corroborate this with objective measurements of standing and sedentary behaviour. However, measurements made over one week towards the end of the intervention period suggested that if the prompts were the cause of breaking up sitting, participants were, on the whole, not standing immediately after a prompt had been received. Analysis of the activity data also suggested that improvements in sedentary behaviour made by intervention group participants, was not significantly better than those made by the control group, who did not receive the prompts, and that improvements were not maintained at 12-week follow-up. This suggested that the education session, also favourably evaluated, may be responsible for some short-term improvements in sedentary behaviour.

A number of limitations with regard to the design of the feasibility study, were also identified (section 4.4.5) and ways in which to address these in the design of future studies proposed (section 4.4.6). The design of the original feasibility study was therefore adapted to incorporate these changes. Namely:

- Attempted recruitment of a larger sample of office workers.
- Introduction of a novel measurement of the components of Social Cognitive Theory in relation to sedentary behaviour and examination of how this changed from baseline, and related to sedentary behaviour outcomes.
- Introduction of a novel measurement of motivation to change sedentary behaviour and examination of how this changed from baseline, and related to sedentary behaviour outcomes.
- Minimising the information given regarding the aims of the study before baseline measurement, in order to obtain a more representative measure of baseline sedentary behaviour.

- Providing feedback on baseline sedentary behaviour as part of the education session to facilitate self-regulation and goal setting.
- Introduction of an additional measurement to determine any changes to sedentary behaviour outcomes at the beginning of the 10 week intervention period.

This pilot study was named ‘PAWS – Prompting Activity in a Workplace Setting’. Due to the similarity in methodology with the feasibility study, and to avoid repetition, appropriate sections of the methodology of the PAWS study have been referenced back to the relevant section in the previous chapter.

5.1.1. Aims and objectives

The aim of this study was to further investigate the use of prompts, alongside education, as an intervention to reduce sedentary behaviour in office workers and gain additional insight into the motivations and processes behind such behaviour change. Similar to the feasibility study the objectives were:

- To estimate feasible eligibility, recruitment, and follow up rates.
- To determine compliance with collecting activity data and reasons for collected data not passing the validation process.
- To further explore the feasibility of using Microsoft Outlook as a mode of delivering prompts to office workers, to remind them to break their sedentary behaviour.
- To investigate the ease of use of prompts and their acceptability to participants.
- To determine feasibility and acceptability of an education session and perceived impact on sitting behaviour.
- To explore personal motivations, barriers, and facilitators behind sedentary behaviour in the workplace.
- To understand whether individuals who received prompts to stand, as well as an education session on the health risks of sedentary behaviour, were more likely to reduce their objectively measured total sitting and/or prolonged sitting in comparison to those who only received the education session.
- To determine whether any changes to sedentary behaviour were sustained over time, following removal of the prompts.
- To investigate whether individuals were more likely to stand directly after a prompt, or if any changes to standing were not related to prompt timings.

In addition, the PAWS pilot study aimed to:

- To investigate whether the different constructs of Social Cognitive Theory could explain people's patterns of sedentary behaviour and whether this changed over the course of the study and could be related to any changes in behaviour.
- To demonstrate if and how participant's self-reported stage of change, changed throughout the study and how this related to changes in patterns of sedentary behaviour.
- To determine whether any changes to sedentary behaviour were greater at the start of the prompt intervention or towards the end of the prompt intervention.

5.2 Methods

5.2.1 Pilot study design

This study was a 2-arm, parallel group, randomised controlled trial (RCT) in which participants were randomly divided into a control and intervention group (section 5.2.7). Both groups received education on why and how to reduce prolonged sitting, but the intervention group also received hourly prompts reminding them to stand, for a period of 10 weeks. Objective measurements of sedentary behaviour were made at 4 measurement points: baseline; within the first 2 weeks of the 10 week prompt intervention period (early intervention), within the last 2 weeks of the intervention period (late intervention), and 12 weeks after the end of the intervention (follow-up) to determine whether any changes in sedentary behaviour had been made, and sustained. Measures of Social Cognitive Theory and Stage of Change were made using questionnaires administered at baseline, early intervention and at follow up.

Two focus groups were run after the follow-up measurement, to further explore the experiences of participants and their motivations and barriers to changing sedentary behaviour.

Both the education session and focus groups were held onsite at the participants' place of work.

This study was registered as a clinical trial on clincaltrials.gov (ID: NCT02785640).

5.2.2 Ethical approval

Ethical approval was granted by Glasgow Caledonian University School of Health & Life Sciences Ethics Committee (reference: HLS/PSWAHS/A15/167) on 02/03/2016.

5.2.3 Recruitment

Dr Philippa Dall from Glasgow Caledonian University was approached by the Principal Ergonomist of a multi-national medical devices and pharmaceutical company after hearing her present her work on sedentary behaviour at a seminar in London. He expressed an interest in participating in research investigating interventions to reduce sedentary behaviour in office workers, at his company based in Livingston, Scotland.

A number of meetings took place between Dr Dall, the Principal Ergonomist, and the researcher, to ascertain suitability and feasibility of conducting a pilot study to investigate the use of education and prompts to reduce sedentary behaviour in a cohort of office workers based onsite in Livingston, Scotland.

Following ethical approval of the study design, employees were invited to volunteer for the study via email, sent to 110 office workers, and posters displayed in communal areas onsite at the volunteer organisation. The recruitment email was written by the researcher, but sent by a member of staff who acted as a champion and contact point for the project throughout. Volunteers were screened according to the same criteria used in the feasibility study:

Inclusion criteria, participants:

- Were aged 18 or over;
- Were primarily engaged in sedentary, computer-based activities during working hours (self-report);
- Had access to Microsoft Outlook calendar.

Exclusion criteria, participants:

- Had a workstation comprising of a standing or height adjustable desk;
- Had a pre-existing health condition that prohibited standing on a regular basis.

All volunteers meeting the inclusion/exclusion criteria were given a participant information sheet informing them about what participation in the project entailed. This information sheet (annex 9.12) was slightly different from the one that was issued to participants in the feasibility study (annex 9.2). It was felt that whilst the information sheet should not be misleading, there may be benefit to de-emphasising the focus on measuring sitting, in order to minimise any influence on baseline measurement. This was achieved through use of phrases such as ‘improving people’s activity patterns whilst at work’ to describe the aim of the project, as opposed to ‘reducing people’s sedentary behaviour whilst at work’. The study title was also given the acronym PAWS: Prompting Activity in a Workplace Setting and this was used on all material given to participants. The exact focus of the study was revealed to all participants during the education session which followed baseline measurement (section 5.2.6). All eligible participants were asked to sign a consent form before baseline measurements were made (annex 9.13).

5.2.4 Sample size

Discussions with the onsite contact indicated that it may have been possible to recruit enough participants to achieve the 27 per group required to sufficiently power the study to detect significant differences (section 4.3.4.2). Therefore, whilst this study was primarily a pilot study to inform a larger, definitive trial, it initially aimed to recruit 60 participants, allowing for 10% attrition.

5.2.5 Baseline measurement

Following consent, participants were asked to complete a questionnaire to ascertain basic demographic data, knowledge of and attitudes towards sedentary behaviour, and previous engagement with health promotion initiatives. The baseline demographic questionnaire used in the feasibility study (annex 9.5) was expanded to include to include ethnic categories (brief version) used by the Office for National Statistics (Office for National Statistics 2015) and a question regarding level of educational achievement taken from the 2011 Scotland Census (National Records of Scotland 2017) (annex 9.14). These questions were added to give a fuller picture of the demographics of participants. In addition, participants were asked to complete a questionnaire which asked questions about their perceptions of their current sitting behaviour based on the different constructs of Social Cognitive Theory (annex 9.10) and a questionnaire to determine their current Stage of Change (annex 9.11).

The potential for Social Cognitive Theory (SCT) to explain sedentary behaviour in the workplace was identified during analysis of the feasibility study focus groups (section 4.3.3). In order to explore this further, a Social Cognitive Theory questionnaire (SCTQ) was developed. As there was no existing questionnaire to measure the constructs of SCT in the context of sedentary behaviour, a questionnaire used to determine the role of SCT in adolescent dietary behaviours (Dewar et al. 2012) was adapted. This questionnaire had demonstrated reliability and factorial validity for each of the five SCT constructs (Dewar et al. 2012). It was adapted by changing the context of each of the questions to workplace sedentary behaviour, where an equivalent context could not be found questions were omitted; this resulted in one less question being asked in the self-efficacy, behavioural strategies and social support scales. For example, in the behavioural strategies scale, one question was asked about choosing reduced fat over full fat foods and one about choosing reduced sugar drinks, and these were amalgamated to one question about choosing standing over sitting. Whilst there was not time to validate this questionnaire prior to commencement of the study, it was felt that its use would further understanding the potential link between key constructs of SCT and sedentary patterns.

The stage of change questionnaire (SOCQ) is a tool used to assign people to one of five stages of behavioural change as postulated in the transtheoretical model (TTM) (Prochaska & DiClemente 1983). The TTM describes behaviour change as a dynamic process which begins with precontemplation about changing a given behaviour, moving to contemplation about change, preparation for change, action – actually making the change, and then to the final stage of change – maintenance, when the behaviour change is sustained (see section 2.6.12 for more detail). It was felt that it would be useful to understand how individual's perceive their own journey of behaviour change with regard to occupational sedentary behaviour, and how this relates to actual changes in patterns of sedentary behaviour as measured objectively by the activPAL monitors. The SOCQ used in this study was an adaptation of the readiness for physical activity stages of change scale (Haakstad et al. 2013), with the wording changed to reflect changes to breaking up sedentary behaviour during working hours (appendix 9.11). This version did not contain a 6th stage of change, termination (Prochaska et al. 1992), as it was felt that the 12 week follow-up did not give participants enough time to reach this stage within the time-frame of the project. Again whilst this version of SOCQ had not been validated for sedentary behaviour, it was felt that its applicability to changing a wide range of behaviours (Nutbeam et al. 2010) was worth exploring in this context.

Participants were then asked to collect activity data for a 7-day period using an activPAL3 ™ monitor (PAL technologies, UK) as described in section 4.2.5. A diary detailing waking and working hours was also completed for the same day monitoring period (annex 9.6).

Collection of baseline activity data was staggered in order to maximise the amount of data collected (i.e. to accommodate absences from the office), but all baseline data was collected within a time period spanning 16 days between 21/04/16 and 06/05/2016.

5.2.6 Education session

All participants were invited to attend an education session on the health risks associated with sedentary behaviour, the potential benefits of breaking up prolonged sitting, and tips on how to reduce sedentary behaviour. This was delivered onsite in Livingstone on 17/05/2016. The same presentation was delivered by the same presenter as in the feasibility study (annex 9.4). For participants who could not attend the education session (n=10), a narrated PowerPoint of the same presentation was sent to them and they were asked to confirm by email once they had watched it. These participants watched the presentation between 23/05/2016 - 27/05/2016.

Subsequent to receiving education, participants were provided with a summary of their baseline activity data. The report detailed the proportion of each day spent sedentary, standing and walking, including a daily step count. In addition, an hourly breakdown of sitting, walking and standing was provided for the most sedentary work day recorded (annex 9.9). This feedback on personal sedentary behaviour was provided, as in the feasibility study focus groups participants had expressed a desire to know whether their perceptions of their own sitting behaviour were accurate. Goal setting and feedback are also common behavioural strategies associated with self-regulation (Bandura 1986) which was one of the themes of SCT on which participants put great emphasis during focus group discussions. It was therefore felt that feedback on their baseline sedentary behaviour would provide participants with an additional tool to assist them with making changes to their sedentary behaviour.

5.2.7 Group assignment

As discussed in section 4.4.5.2, there was a possibility that the cluster randomisation used to allocate participants to groups in the feasibility study, may have had an impact on group behaviour. Therefore, participants in the PAWS study were randomly assigned to groups independent to their physical location in the office, in order to attempt to minimise such 'contamination'. Although it should be noted that it was still possible for participants in the same group to be located close to each other.

Once all participants had collected baseline data and received the education presentation, they were randomly assigned, in equal numbers, to one of two groups. Random assignment was completed on 23/05/2016 by the researcher. All volunteers were assigned consecutive integers in the order in which they were listed in the study log and www.randomization.org was used to randomly generate a sequence of 1's and 2's to the total number of participants, in equal proportions. This random sequence was then listed against the study log. Participants matched to number 1 were assigned to the control group and those matched to number 2 were assigned to the intervention group.

5.2.8 Blinding

In this study the researcher was required to create and distribute all prompt files and it was therefore not feasible for them to be blinded to the group allocation. As with many non-pharmacological trials it was not possible to blind participants to their group allocation (Boutron et al. 2005).

5.2.9 Prompt intervention

The intervention group received a prompt to stand, delivered via Microsoft Outlook on their work PC, once every hour during work hours for a period of 10 weeks, beginning on 30/05/2016. The prompts were created, uploaded and run as described in section 4.2.9. The messages contained in the study were the same as those used in the feasibility study, but any customised prompts were changed accordingly. For example, those that contained the name of the organisation or the location.

5.2.10 Early intervention measurement

A 7 day activity monitoring period with accompanying diary completion was repeated by all participants (as described in section 5.2.5) between weeks 2-4 of the prompt intervention period. Data collection was once again staggered in order maximise data collected. All data was collected within a 17 day period between 04/06/2016 and 20/06/2016. Whilst it had been the intention to collect a repetition of the SCTQ and SOCQ after the education session and before the second activity measurement, this was delayed until participants were collecting their early intervention activity data. The reason for this was that, for some, the questionnaires would have been completed very shortly after the baseline measurement (as little as 11 days). Consequently, it was decided participants should complete the questionnaires at the time of their second activity measurement period in order for timings to be more consistent, reduce burden on participants, and increase the likelihood of compliance of completion.

5.2.11 Late intervention measurement

A 7 day activity monitoring period with accompanying diary completion was repeated by all participants (as previously described) between weeks 8-10 of the prompt intervention period. Data collection was once again staggered in order maximise data collected. All data was collected was within a 19 day period between 20/07/2016 and 07/08/2016.

5.2.12 Follow up measurement

Follow up measurement, to ascertain longer-term changes, was made 12 weeks after the intervention had finished. Activity monitoring and diary completion, over 7 consecutive days, were repeated as previously detailed. Staggered data collection resulted in all data being collected over an 11 day period between 26/10/2016-05/11/2016. All participants were asked to once again complete the SOCQ and SCTQ.

5.2.13 Focus groups

After follow-up measurement was complete, all participants were invited to one of two focus groups, both run on 12/12/2016, to discuss their experiences of taking part in the study and their thoughts about sedentary behaviour in a workplace environment. Separate focus groups were run for the control and intervention groups so that the prompt intervention could be discussed in detail with those that received it, without excluding those in the control group. A semi-structured focus group schedule (annex 9.16) was used to guide discussion. This was based on the schedule used in the feasibility study focus groups, with additional elements of interest added as a result of the analysis of these focus groups. Whilst guided by this structure, discussion and digression were encouraged around the topic of sedentary behaviour as led by participants. Focus groups were audio-taped and transcribed, moderated by the researcher, and co-moderated by a member of the research team. The control focus group lasted 52 minutes and the intervention focus group lasted for 45 minutes.

5.2.14 Outcome measures

The objectives regarding the feasibility, acceptability and ease of use of prompts, were assessed from analysis of the focus group transcripts, as was the acceptability of the education session, and insight into experiences, motivations, and barriers experienced by participants. Participants were asked to report any technical issues regarding uploading or using the prompts, and these were logged. The flow of participants through the study was recorded in order to collect data on eligibility, recruitment and follow-up rates. The number of days of valid activPAL data collected by participants was logged and compliance against established validation rules (Appendix 8.2) was recorded.

The applicability of the constructs of SCT to sedentary behaviour was assessed in two ways: 1) through thematic analysis of focus group transcripts using the 5 key constructs of SCT; and 2) analysis of SCTQs completed at three measurement points, giving a single score for each of the 5 constructs at each of the measurement points.

SOC of participants was scored from one to five for each participant according to the statement circled on the SOCQ which was completed at three different measurement points.

The objectives with respect to changes in objectively measured sedentary behaviour were measured using the same outcome measures as the feasibility study, to allow comparison, which were:

- Total sitting time as a proportion of time activPAL was worn during waking hours
- Total sitting time as a proportion of time activPAL was worn during work hours
- Number of sitting events per hour of time activPAL was worn during work hours
- Mean event duration of sitting events occurring during work hours
- Proportion of wear time during work hours spent in sitting events >20 minutes
- Proportion of wear time during work hours spent in sitting events >30 minutes

These outcome measures were extracted from activPAL outputs from each of the four measurement periods. Wear time was calculated using information provided by participants in their diaries about times the monitor was not worn, which was cross-checked during the validation process (section 5.2.15). See section 5.3.2.1 for details of non-wear time.

As in the feasibility study, response to prompts were also analysed by comparing the times that prompts were scheduled, to the time of the next standing event.

5.2.15 Data validation & processing

Data were validated and processed by the same process previously described in section 4.2.14. As with the feasibility study, the minimum data required for inclusion was 3 days of data, including at least one working day, for at least two of the four measurement periods. For participants that met this criteria, but also had collected data for any other measurement period that only included two days of working data, these data were also included in the analysis. Issues with compliance in collecting data are discussed in section 5.3.2.1.

5.2.16 Data analysis

Descriptive analyses of the key feasibility outcomes were made with regard to issues experienced uploading and using the prompts, recruitment, and retention rates and compliance with validation rules. Acceptability of the prompt and education interventions were reported descriptively and narratively.

Focus group transcripts were analysed using thematic analysis with the 5 key constructs of SCT as broad themes under which all quotes were categorised before being sub-divided further. In addition, the SCTQs completed at three measurement points were analysed by entering all completed questionnaires into SPSS and then scoring the answers given by participants in accordance with the scoring matrix (annex 9.15) adapted from the matrix used by Dewar et al. (2012). Scores were then collated for each of the 5 scales: situation/environment; outcome expectations; self efficacy; self-regulation (behavioural strategies); and observational learning. An exploratory approach was used to examine correlations between SCT scores and sedentary behaviour outcomes at different measurement points.

SOC questionnaires were scored one to five according to the statement selected, and entered into SPSS. An exploratory approach was used to examine changes to SOC scores and correlations between SOC and sedentary behaviour outcomes at different measurement points.

The six key sedentary behaviour outcomes (section 5.2.14) data were exported into SPSS (Statistics Package for Social Sciences IBM version 22) which was used to perform descriptive statistics and tests appropriate to the nature and distribution of the data.

Response to prompts were analysed by comparing timings of standing events against time that the prompt was delivered. Pseduo-prompts were also created to provide comparison of normal standing patterns (section 5.3.7).

After commencement of the study, it was discovered that some study participants were also participating in an organisation-wide walking challenge. Step counts and sedentary behaviour outcomes were therefore compared for those who participated in the challenge and those would did not, in order to assess any impact this had on the results (section 5.3.8).

5.2.17 Feedback to participants

Following both focus groups, all participants in the study were presented with a personal activity report illustrating their activity patterns on the least and most sedentary days of each data collection period (annex 9.17). Participants were also invited to request a more detailed breakdown of their activity data if they desired.

5.3 Results

5.3.1 Sample

5.3.1.1 Participant retention

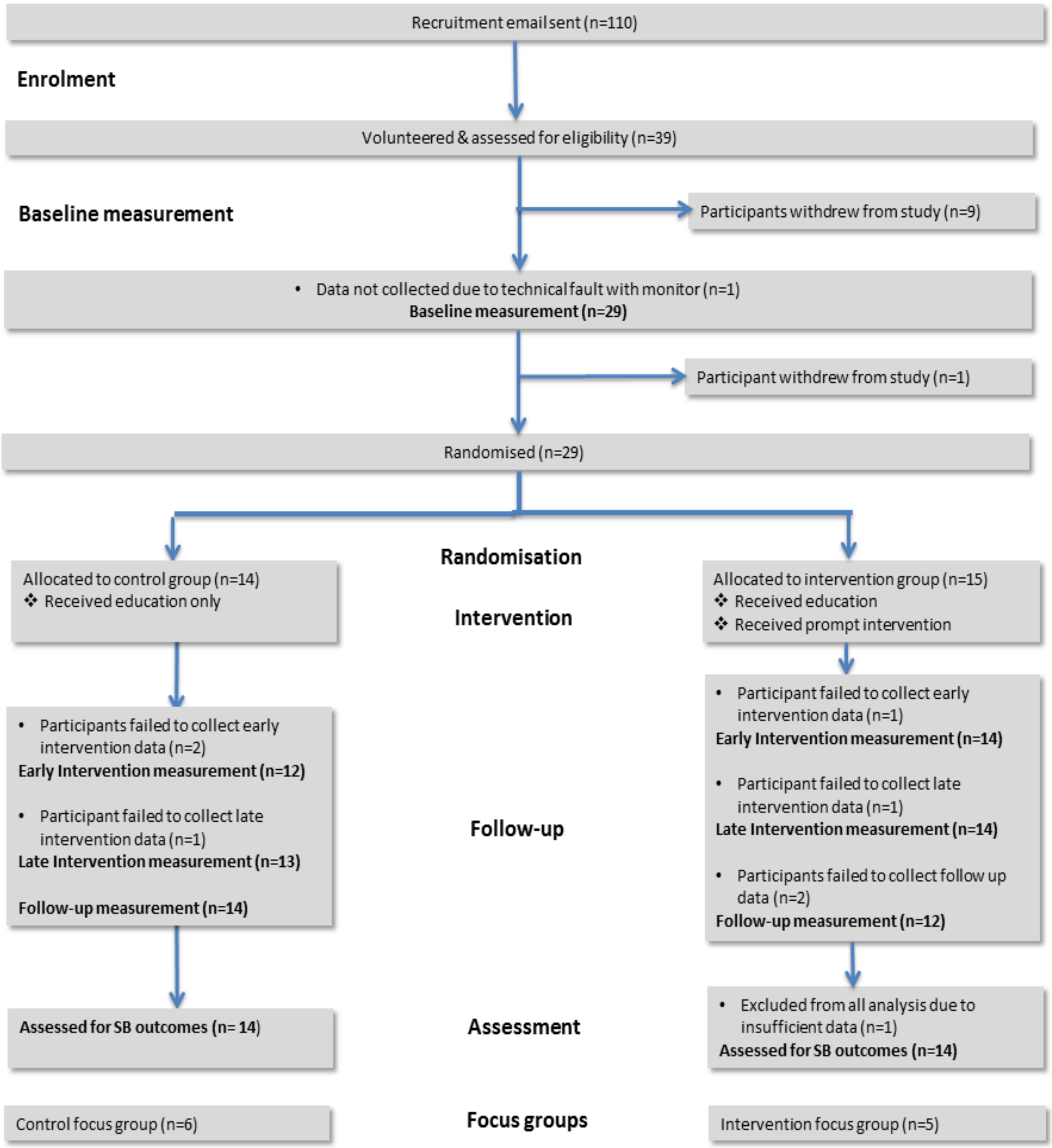


Figure 5.1 CONSORT Flow diagram illustrating participant retention in the PAWS study, adapted from Eldridge et al. (2016)

Over a six week recruitment period in March and April 2016, 39 participants (35% of those who received the recruitment email) expressed an interest in volunteering for the study and all met the eligibility criteria. Nine volunteers withdrew from the study prior to signing consent and collecting baseline data. Of these nine volunteers, five attended an information session at which their role as participants was outlined and information was given regarding how to wear the activPAL monitor. The other four volunteers did not turn up to the session. No reasons were given for withdrawing from the study by any of these volunteers.

Thirty participants signed a consent form indicating their willingness to participate in the project and attempted to collect baseline data, however one participant wore the monitor for the 7 day period, but the activPAL did not record any activity data. This participant remained in the study. The number of participants collecting baseline data was therefore 29 (Figure 5.1). One participant withdrew following collection of baseline activity data as they experienced problems attaching the activPAL monitor to their leg securely and, despite offers of support with this issue, felt this would continue to be a problem for future data collection.

Following the education session, fourteen participants were randomised to the control group and fifteen to the intervention group. Two participants from the control group and one from the intervention group did not collect data for the early intervention measurement. One participant from each group did not collect data for the late intervention measurement and three participants from the intervention group failed to collect any data for the follow-up measurement. Often participants were absent from work at the time of data collection, although some failed to collect data without giving a reason. All of these participants remained in the study, but were excluded from analysis where appropriate. One intervention group participant missed data collection for two measurement periods and failed to meet minimum data requirements for another measurement period, and was therefore excluded from data analysis (Figure 5.1). The participant whose monitor failed to collect baseline data, was randomly allocated to the intervention group and collected data for all subsequent measurement periods. Their data was excluded from all analysis requiring baseline comparison, but was included in all other analyses. The number of participants therefore included in the analysis of sedentary behaviour outcome measures was twenty-eight.

Six participants from the control group and five participants from the intervention group volunteered to take part in focus groups specific to their group allocation.

5.3.1.2 Participant Demographics

The sample contained slightly more females (57%) than males (43%) and were aged between 29-62 years. This represents a higher proportion of males than participated in the feasibility study and a slightly older population (section 4.3.1.2). All participants reported their health to be good, very good, or excellent. The group mean Body Mass Index (BMI) was 26.0kg/m^2 which is categorised as 'over-weight' (World Health Organisation 2000). However, it is worth noting that there was a wide range of BMI amongst participants, ranging from 'healthy' to 'obese class III (very severely obese)' (BMI range 19.8-42.2kg/m^2) (Table 5.1). All participants (100%) identified their ethnicity as 'white'.

Table 5.1 Participant demographics at baseline

	Control group	Intervention group	Whole sample
Number of participants	14	14	28
Mean age [years]	49	47	48
Age range [years]	34-62	29-58	29-62
Male/ Female	36%/64%	50%/50%	43%/57%
Self-reported general health:			
Excellent	14%	50%	32%
Very good	43%	36%	39%
Good	43%	14%	29%
Mean BMI kg/m^2 (SD)	27.1 (±7.5)	25.1 (±3.4)	26.0 (±5.6)
BMI range (kg/m^2)	19.9-42.2	19.8-29.6	19.8-42.2
Number of smokers	0	1	1
Employed full time/part time	71%/29%	100%/0%	86%/14%
Education level obtained:			
Up to Higher level	7%	14%	11%
HNC or degree level	65%	65%	64%
Postgraduate	28%	21%	25%

As in the feasibility study, the majority of participants were employed full time (86%) and all participants met the criteria of being employed in a role that required them to spend the majority of their working hours at their desk. The majority of participants (89%) had obtained educational qualifications above Higher or 'A' level, with a slightly higher proportion of control group participants achieving a postgraduate qualification, than intervention group participants. This level of educational attainment was higher than the UK average of 43% of 25-64 year olds obtaining a tertiary (higher than secondary education) qualification (OECD

2016). The intervention group tended to be younger than the control group and more likely to rate their health as ‘excellent’.

As part of the questionnaire completed at baseline (annex 9.14), participants answered three multiple choice questions to ascertain their understanding of the potential impact of sedentary behaviour on health. The results showed that whilst almost all participants (n=27) recognised there were benefits to breaking up long periods of sitting, 32% of those that answered the question were not aware that the health risks associated with sedentary behaviour were independent to the amount of physical activity an individual undertook. All participants correctly identified a link between prolonged sitting and back pain, but fewer were aware of links with depression (n=17, 61%), cancer (n= 7, 25%), and heart disease (n= 20, 71%). In comparison to the feasibility study, the PAWS sample were less aware of sedentary behaviour as an independent health risk, but more likely to recognise its association with conditions other than back pain.

5.3.2 Feasibility of intervention

5.3.2.1 Data compliance.

As outlined in 5.2.15, the minimum data required for inclusion was 3 days of data, including at least one working day, for at least two of the four measurement periods. For participants that met this criteria, but also had collected data for one measurement period that only included two days of working data, these data were also included in the analysis to maximise use of the data collected from a small sample. Only one participant from the intervention group failed to meet this minimum requirement and was excluded from all analysis.

The majority of participants collected five or more days of validated data for each measurement period (Table 5.2). Two participants from the control group, and one from the intervention group failed to collect data at the early intervention measurement. ActivPAL monitors were returned to the researcher unworn, and absence from the office cited as reason for not complying. One participant from the control group failed to collect late intervention data, and one participant from each group failed to collect follow-up data. Again activPAL monitors were returned unworn, but with no reason given for non-wear or absence from the office. Apart from the participant excluded from analysis, no participants failed to collect data on more than one occasion. It is worth noting that participants were contacted in advance of data collection periods and asked to inform the researcher if they anticipated being absent or any other reasons for not being able to collect data, in order for an alternative date for data collection to be arranged.

Table 5.2 Percentage of sample collecting total number of days of validated activPAL data for each measurement period

Measure-ment period	Total number of days of validated data collected								% ≥ 3 days
	7	6	5	4	3	2	1	0	
Baseline	57.1%	10.7%	10.7%	10.7%	3.6%	7.1%	0.0%	0.0%	92.9%
Early int	64.3%	14.3%	3.6%	3.6%	3.6%	0.0%	0.0%	10.7%	89.3%
Late int	60.7%	10.7%	10.7%	7.1%	3.6%	3.6%	0.0%	3.6%	92.9%
Follow-up	75.0%	0.0%	7.1%	0.0%	3.6%	7.1%	0.0%	7.1%	85.7%

Data displayed in cells are percentage of whole sample (n=28) who collected validated data for total number of days indicated, for each measurement period. Early int = early intervention, Late int = late intervention

When activPAL monitors had been removed for some, or all of a day, a validation rule was imposed which excluded days during which the activPAL monitor had been worn for less than 10 hours or for less than 70% of waking hours. The threshold of 10 hours wear time has been adopted by similar studies using continuous measurement by activPAL (Edwardson et al. 2016), but by also adding the 70% threshold, this allowed days in which waking hours were less than 10, to be included. In total 75 days of data, across the four measurement periods, were excluded from analysis due to failing to meet the minimum daily wear-time. This equates to 11% of the total number of days processed. Table 5.3 breaks down the different reasons for this, giving insight into how compliance might be increased in future studies.

Where monitors had been temporarily removed, put on late, or removed early and wear-time exceeded 10 hours in a day or 70% of wake time, data was included but non-wear time was logged, subtracted from wake time and the remaining time was used in the calculation of the six key outcome measures of sedentary behaviour. On average, non-wear time accounted for 14.2 ± 24.1 minutes (mean ±SD) for each participant, for each measurement period, and an average of 5.3 ± 14.6 minutes a day (mean ±SD) during work hours for each measurement period.

As in the feasibility study, during focus groups participants expressed discomfort at wearing the monitors, but this was not cited in the diaries as a reason for removing monitors early. One participant withdrew from the study, after experiencing problems keeping the monitor attached during baseline measurement.

Table 5.3 Reasons for data not meeting minimum wear time criteria

Reason for minimum wear-time not met	**Number of days excluded during study**
Monitor removed before end of monitoring period	31 (41.3%)
Monitor stopped working before end of monitoring period	26 (34.6%)
Put on late on day 1 of monitoring	4 (5.3%)
Illness	4 (5.3%)
Removed to go through airport security	4 (5.3%)
Not worn – reason unknown	4 (5.3%)
Removed to go to a spa	1 (1.3%)
Removed before bed	1 (1.3%)
Total	**75 (100%)**

Figures given are for number of days excluded from study for each reason and in brackets proportion of total exclusions for each reason.

5.3.2.2 Feasibility and acceptability of prompts delivered by Microsoft Outlook

As with the feasibility study, no issues were experienced with regard to uploading or delivering the prompts (see appendix 8.1 for list of prompts). The onsite IT team at the worksite were informed about the plan to upload Excel files to Microsoft Outlook, and any security issues with imported files, were pre-empted. All intervention group participants were contacted at the start of the intervention period and weekly during the intervention period to ensure that the prompts were being received.

Key

C1-C6 = focus group participants from the control group.

I1 –I5 = focus group participants from the intervention group.

Similar to the feasibility study, intervention focus group participants spoke favourably about the prompts and the messages they delivered.

> I3: *"I think they were perfect. I think they were good"*

Some participants appreciated the variety, and at times the direction, given by prompt messages, whilst others felt this was less important, and that receiving a prompt was what mattered, regardless of the message content.

> I1: *"I don't think it mattered so much what they said. They were just reminding you"*

Again, focus group participants felt that as time went on, they were less likely to respond to prompts.

> I1: *"Yeah, I think initially I did do it, I did respond to the prompts. I'd think 'Oh prompt right, I need to get up and do something' but I think as time went by I would tend to just go 'yeah right, OK, I'll get up in a wee while but I'm in the middle of doing something' and you just deleted it. Well, you know, I did get more conscious of getting up, probably, and moving about, but I didn't respond to the prompts as time went on. Whereas I did initially."*

For some participants this was due to work-tasks taking priority over a break from sitting, but for others it was because most of the time they had got into the habit of breaking their sitting and had done so independently to the prompts.

> I5: *"The first couple of weeks having them, I think that's what made me sort of take notice and actually get up and walk whereas through time you were actually getting used to it so you knew that sort of every hour you had to get up, sometimes you were doing it just before the prompt come up, as* [other participant] *says. You would just come back to your desk to a prompt and you'd think 'I just done that' and sometimes it would come up and you'd not realise you'd actually sat the hour and you'd be like 'alright I'll move now type thing'. "*

Others did not respond to prompts because they objected to being dictated to

I2: *"Sometimes it was just annoying though….. Prompt. I'll decide!"*

5.3.2.3 Acceptability of education intervention

Participants in both groups were shocked by the health risks associated with sedentary behaviour outlined in the education session. As in the feasibility study, it was the fact that the risks were independent to levels of physical activity that were especially surprising.

> C2: *"I thought it was fairly surprising because I started off with the impression that if you were doing a lot of exercise out-with work, the fact that you sat for most of the day at work somehow would be counteracted. So, it was interesting to realise that that wasn't true. You might go for a run in the morning, you might go to the gym at night, but if in-between you sit for 8 hours there are still dangers or disadvantages in that."*

Most focus group participants felt that the education session had made them more conscious of their own patterns of sedentary behaviour and this had prompted them to change behaviour at home and at work.

> C4: *"I didn't realise there was such a problem, or health risk just with sitting. I've done it for years, sitting at a desk for hours on end. I didn't realise the risks. It makes sense, I didn't realise it. So it was after the first education that I went away and did something."*
>
> I2: *"Personally it* [education session] *forced me to move around more in the evenings. Because quite often I would be at work all day, go to the gym after work, get into my house at half past 6, shower, have my tea, TV time and that would be me until maybe 10 o'clock at night or whatever."*

Participants also valued the feedback they had received on their baseline activity patterns, often feeling surprised at how sedentary they had been.

> I3: *"Sometimes you thought I've been really active and you get your chart back and you're like 'Oh what happened there?' I thought I'd done* [better]"

The impact of the education session may also have been wider reaching. After attending the education session, one participant highlighted the fact that she was unable to leave her desk on conference calls as her phone was hard-wired. This lead to her being given a wireless headset, which was justified financially, using the health arguments presented in the education session.

C4: *"It's made a big difference, going from the wire to the wireless headset for me."*

Following the education session another control group participant embarked on making a number of changes towards a healthier lifestyle, including breaking up their workplace sitting with short walks around the office. This had contributed to weight loss of 27kg in the previous 8 months.

C6: *"[I have] lots more energy. I felt that I had been tired staring at the screen. What I was doing was, I was getting out my way to go long ways about things, not very productive I know, but it probably was overall. So even setting up to the wrong printer etc probably actually helps you over the day. Might be slightly longer at the time, but actually gives you more energy, more focus. "*

Despite the positive evaluation of the education session, it was apparent that some focus group participants were still confused over some of the key messages, such as whether it was essential that they moved during sitting breaks, and conflicting advice they had read about the dangers of too much standing.

C4: *"But I'm confused…. I do try and walk away from my desk, but sometimes I can't, I just stand, is that significantly like a big improvement between walking? That's what I don't quite understand"*
C1: *"Reading about this stuff, I heard about the negative effects of standing too long and, you know, …the contradictory information that you receive. I would imagine that's for long periods of standing?"*

5.3.3 Focus group analysis of motivations, barriers and facilitators behind sedentary behaviour

Six participants from the control group took part in one focus group, and five participants from the intervention group took part in a second focus group. Table 5.4 displays the keys demographics of focus group participants which were representative of the overall sample (Table 5.1), with the exception of no part-time workers from the control group being present. It is worth noting that a member of staff from the intervention group was present in the control focus group as they were involved in organising the groups and refreshments provided. Although it was intended that they were only there to oversee attendance, refreshments etc, they did contribute to discussions in the control focus group and also later in the intervention focus group.

Table 5.4 Key demographics of participants attending two focus groups

	Control focus group	Intervention focus group
Number of participants	6	5
Mean age [years]	53	47
Age range [years]	41-62	38-56
Male/ Female	33%/67%	40%/ 60%
Employed full time/part time	100%/0%	100%/0%

As SCT had been identified as a useful framework in the feasibility study, this was used as a structure for analysing the focus group transcripts of the PAWS study. In addition to the content analysis used to discuss the feasibility of the study (sections 5.3.2.2 and 5.3.2.3), the focus group results are presented under five key themes in line with the main constructs of SCT: i) situation/environment, ii) outcome expectations, iii) self-efficacy, iv) self-regulation, v) observational learning.

5.3.3.1 Situation/environment

This theme refers to the influence of the physical environment and context of sitting on sedentary behaviour.

Participants spoke of a worksite that encouraged and promoted physical activity and well-being of its employees through organisation-wide walking challenges and a well-attended on-site gym. This, however, had not previously extended to recognition of the risks of sedentary behaviour. One participant felt that it was a shame that the health and safety risks for office workers were not as well recognised as their counterparts who worked in the manufacturing section.

> C4: *"I think that's a shame actually because you have the proven thing about long-term standing, and the issues that you have with that and it's not transferred to sitting down which is our population because we are not on the shop floor so we are the opposite, and yet the focus isn't directed on that. Again, that's lack of education, I suppose isn't it, but it's a shame. After we retire, several years, they will probably know."*

Similar to the feasibility study, focus group participants felt that their sitting was linked directly to their environment and that they generally sat more at work than they did in their home environment. Some recognised that this also varied between their own work environment and when visiting other workplaces on business.

> C4: "*It depends, with me I visit suppliers a lot, but then I find it more easy to get up and do my own thing because I am the customer, so I don't have to sit there for 8 hours and listen to them, I can say actually guys I'm going to pop to get water, I'm going to pop to the ladies, or we have breaks. Because you're in that position. You are in control"*

Again, work tasks often took priority over taking breaks and breaking focus was cited as a key reason to remain seated.

> C1: *"I keep saying to myself I really need to get up but I need to get this finished first. So I know I need to do it, and I do go and get a glass of water or a cup of tea or something, and I keep moving around but there's times you just have to sit and focus for an extended period."*

Others were concerned that moving around the office would be a distraction to others.

> I5: "*For me it was just being on conference calls. That was the only time that I felt I just couldn't* [break up sitting]*, only because I know how annoying it is for me if I've got my work colleague walking around on the phone, I think well if it annoys me, I am not doing it to annoy anybody else."*

For some the nature of the physical environment dictated how and if they took breaks away from their office. Participants in an office deemed as 'more pleasant', with good daylight, tended not to take an official afternoon break, whilst those in a different environment, took breaks in order to change their surroundings.

> C5: "*As well, I don't have a window where I am, I sometimes feel I want to get away as I want to see the daylight. I think because of the dark nights I think 'God I never see the daylight'….I like to break it up because of that."*

5.3.3.2 Outcome expectations

Outcome expectations is the anticipation and value placed on the outcomes of reducing sedentary behaviour.

Similar to the feasibility study, participants in both groups were shocked and concerned about the health risks of sedentary behaviour presented to them in the education session.

> I2: "*I think it was quite alarming when you see it spelt out straight in front of you, rather than you maybe just hear snippets of information back and forward. There's obviously more and more people who are sitting behind their desk 8, 10, 12 hours a day and what that kind of behaviour is doing to your body. So yeah I found it, some of it quite alarming.*"

For many, being armed with this information prompted them to take action.

> C4: "*I know the dangers now, it's a bit like smoking, I know the dangers of smoking so I don't do it. I have to sit, I have no choice, but I try and break it up as much as I can.*"

Most participants said they had told friends and family about the study and warned them of the risks associated with sedentary behaviour, although often this message was dismissed.

> I1: "*I said it to my wife and my daughters and they kind of went 'yeah, whatever. Just get on with it and stop talking about it'*"

5.3.3.3 Self-efficacy

Self-efficacy refers to an individual's belief that they can successfully reduce their sedentary behaviour.

As previously highlighted, for some participants, control over sedentary behaviour was linked to their physical work environment and as such their role within the organisation. Many participants spoke of being able to arrange work tasks or comfort breaks around breaking their sitting, whilst others perceived their role and work tasks prohibited this.

> C3: *"It's a wee bit easier for me at work because I've got people that I work beside that work down in the shop floor. Sometimes I find in the afternoon, if I get a wee bit tired, I find I get tired in the afternoon after lunch, that I think that I'll maybe just pop down the stairs and see them for half an hour, just get me away from my desk. I tend to get a wee bit sleepy sometimes if I'm sitting typing away on the computer, but it's easier for me because I can get myself away from the desk."*

> C2: "*Yes it is really prohibitive* [work]. *I'd say overall for me the study made me much more conscious of the fact that I should be breaking up the sitting, but there was*

nothing that made it easy for me to actually do that. I'm conscious of it, but I still find it difficult to put it into practice."

This contrast in self-efficacy linked to roles within the organisation, was almost exclusively discussed by the control group. The intervention focus group did not speak negatively about self-efficacy, speaking of behavioural strategies they had adopted both at work and at home, in addition to the prompts (see section 5.3.3.4).

5.3.3.4 Self-regulation

Self-regulation refers to the behavioural strategies adopted by individuals in order to achieve the goal of reducing sedentary behaviour at work.

Participants in both groups spoke about strategies that they had adopted since the education session to break-up their sedentary behaviour, both at work and at home. At work some strategies were linked to role-related tasks e.g. visiting colleagues instead of emailing, or going to the printer, other strategies were related to comfort e.g. toilet breaks, fetching drinks. Such strategies were purposely spread out throughout the day.

> I3: *"I used to fill a jug up, a container up, with water and I never moved until that was finished. Now it's a glass at a time, I do have to get up and fill it up and I like to drink a lot of water."*
>
> I1: *"Yeah you might have planned your day to avoid walking about previously, whereas now you plan your day to walk around, yeah"*

Some participants had adopted strategies at home, such as making themselves get up off their seat during TV advert breaks or after a programme, or purposely leaving objects on different floors of the house to make themselves climb stairs to retrieve them.

> I2: "*It forced me to do more things, kind of, in the evening. Even psychologically leaving stuff upstairs that I needed and knew I needed it, it would force me to get up and go back upstairs to get it"*

One participant in the control focus group downloaded prompt software on their phone following the education session and was still using it at the time of the focus group. The researcher is also aware of another control group member who downloaded and used the same software during the study.

C4: *"I put an app on my phone called rise and recharge which prompts me as many times as I want, and I've set it to one hour."*

Participants appreciated the feedback they had received in the form of an activity report regarding their baseline activPAL data and felt it was useful in motivating them to change behaviour. One participant saw it as a challenge to ensure they had improved their sedentary patterns when they received their final activity report.

I4:*"I just made it a competition with myself because that's what I do, because I'm really competitive"* [laughs]

There was a desire to receive immediate feedback and praise for their behaviour, noting disappointment when activity had not been logged.

C4: "*Ah that was a shame, the first time I got it* [activPAL monitor] *when the water got in, I was doing so much between the Friday and the Monday. I was so upset. I was like 'Oh that's not flashing anymore, why's it not flashing anymore' and when I went to investigate I saw 2 holes in the outer layer. I was like 'no, I've put so much work into this'"*

C1*: "I felt like that when I forget to put my fitbit on. It's not recorded!"*

C4: "*I went all the way up the Pentland hills yesterday, all the way to the top, all the way through the hills. It took me, 2 hours. No fit bit on. Devastated."*

C5: "*You feel cheated."*

C4: "*I do feel cheated. I do. That was at least 10,000 steps!"*

5.3.3.5 Observational learning

Observational learning refers to how individuals learn behaviour from observing others and how they believe their own behaviour is perceived.

Participants spoke of a workplace culture in which physical activity before and after work, and during breaks was encouraged. People had observed others participating in activity challenges and walking groups, and even within focus group discussions were encouraging each other to go to an exercise class at the gym later that day.

I2: *"Some of the people who are now walking you would never have thought would be involved in that group. So that peer pressure has maybe been rubbing off on a few people as well, which is really good."*

I3: " *I do encourage I1 to go to the gym. It sometimes falls on deaf ears but I do make sure I have a daily nag at him"*

Unlike the workplace in the feasibility study, there was a culture of eating lunch away from the desk with colleagues.

C3: "*Yeah, I go down to the canteen every day with the people I work with. We take a break at a certain time. We usually have 3 breaks, morning and the afternoon breaks as well I go down to the canteen and have my coffee."*

This culture of regular breaks and participating in physical activity was limited to official breaks and times outside of work. During productive working hours, movement away from desks was dependent on specific occupational roles.

I3: "*The two offices are very different. So the offices that we work in there's always somebody walking about whereas here, hardly anybody leaves their desks and this is mainly the group that actually didn't get the prompts, so what they were saying was when they did see another girl moving about they are like 'she must be in that PAWS group'"*

Participants spoke of feeling self-conscious doing stretches in the office that they had been advised to do as part of a workplace initiative.

C5: "*I started doing it [stretches] in my office and I .."*
C4: "*Got stared at, ridiculed* "[laughs]
C5*:"..people stopped. One morning, I came in early in the morning and I thought, 'I'll go through this', after that session, I was doing all this and they were stopping and they were like 'what are you doing?'"*
C4: "*'what are you doing, you should be in the gym doing that'"*
C5: "*Exactly it put me off. I just thought I'll do 2 minutes here, I didn't realise, that everyone was like , 'what's she doing?', but after that I thought* [shrugs dismissively]"

They likened desk-based exercises to the exercises recommended on long haul flights, and agreed that they only participated in the in-flight exercises which were not visible to other passengers.

C4: "*The ankle ones though, you do the ankle ones I bet you don't do the arms above your head. I don't do anything above the head, ankles yes"*

One control group participant spoke about visiting a worksite in Mexico where the entire workforce broke their sitting to participate in exercises being instructed over the tannoy. The group agreed they thought that such activity was not suited to British culture.

> C5: "*That doesn't happen here, people would be mortified. 'I'm not doing that'."*

However, some conceded that if it was made the norm, people would participate and breaking sitting as a group would be less distracting over the course of the day.

> C4: *"It's difficult because it comes to the invasive thing again. But also, you know if you saw more people doing it, then it's OK for you to do it."*
> C1: "*There is going to need to be a cultural change either within the company or the country where sitting for long periods is no longer acceptable. It's like smoking was no longer acceptable so…."*

On the whole, participants had not observed others standing during the study, although one participant in the control group admitted to being influenced by a colleague's behaviour, and an intervention group participant stood with a neighbouring colleague when they had a prompt, so they could take a break together.

> C2: *"I'm not in the open plan, but there was one person that I could see from my office. Sometimes if I saw her standing up, I'd stand up."*
> I3:" *I must admit, I had the prompts and XX who sits opposite me had the prompts. And the timing was such that he would get his about 20 seconds before me, so he'd stand up and I'd go 'Oh I'm going to get a prompt in a minute, so I may as well just go and get me water now'. Because I'd use it to get water. So, we'd both go up to the water fountain and come back and that's how it worked every single time."*

5.3.4 Measuring social cognitive theory constructs – analysis of questionnaires

Average scores for each of the five constructs of SCT were calculated using the scoring matrix (annex 9.15) for the SCTQ administered at baseline, early intervention, and follow up (Table 5.5, Figure 5.2 and Figure 5.3). In this section self-regulation is referred to as 'behavioural strategies' in line with the questionnaire from which the SCTQ was adapted (Dewar et al. 2012).

There was a tendency for those in the intervention group to score higher than the control group in self-efficacy at baseline. The scores for all constructs increased at early intervention with the exception of outcome expectations which decreased slightly. Independent t-tests, revealed no significant difference between mean scores of each SCT construct, between groups, at any measurement point.

Paired t-tests revealed significant increases in mean score for self-efficacy between baseline and early intervention in the control group (+0.8, p=0.000) and intervention group (+0.6, p=0.040) followed by a significant reduction between early intervention and follow up in the control group (-0.4, p=0.005). Statistically significant differences between mean score for behavioural strategies measured at baseline and early intervention were also found in the intervention group only (0.7, p=0.019).

Table 5.5 Average SCT construct scores for control and intervention group as measured by the SCTQ at 3 measurement points

Measurement point	Baseline		Early Intervention		Follow-up	
Group	**C (n=14)**	**I (n=14)**	**C (n=12)**	**I (n=13)**	**C (n=13)**	**I (n=12)**
Self-efficacy	**2.58 ±0.71**	**3.42 ±0.93**	**3.38 ±0.84**	**4.05 ±0.66**	**2.95 ±0.62**	3.83 ±1.1
Situation	3.59 ±0.5	3.30 ±0.56	3.65 ±0.27	3.33 ±0.59	3.71 ±0.35	3.46 ±0.7
Behavioural strategies	1.99 ±0.57	2.19 ±0.77	2.4 ±0.43	2.92 ±0.7	2.31 ±0.61	2.48 ±0.83
Observational learning	2.75 ±0.55	2.84 ±0.58	2.92 ±0.65	3.08 ±0.45	2.73 ±0.58	3.06 ±0.49
Outcome expectations	4.41 ±0.5	4.37 ±0.31	4.29 ±0.52	4.28 ±0.38	4.25 ±0.42	4.42 ±0.37

Figures in cells are mean score for questions relating to each construct ± standard deviation. C= control group, I = intervention group. Scores range from 1-6. A higher score indicates individuals are more likely to identify with that particular construct. Figures in red indicate where significant within group differences between measurement points were found.

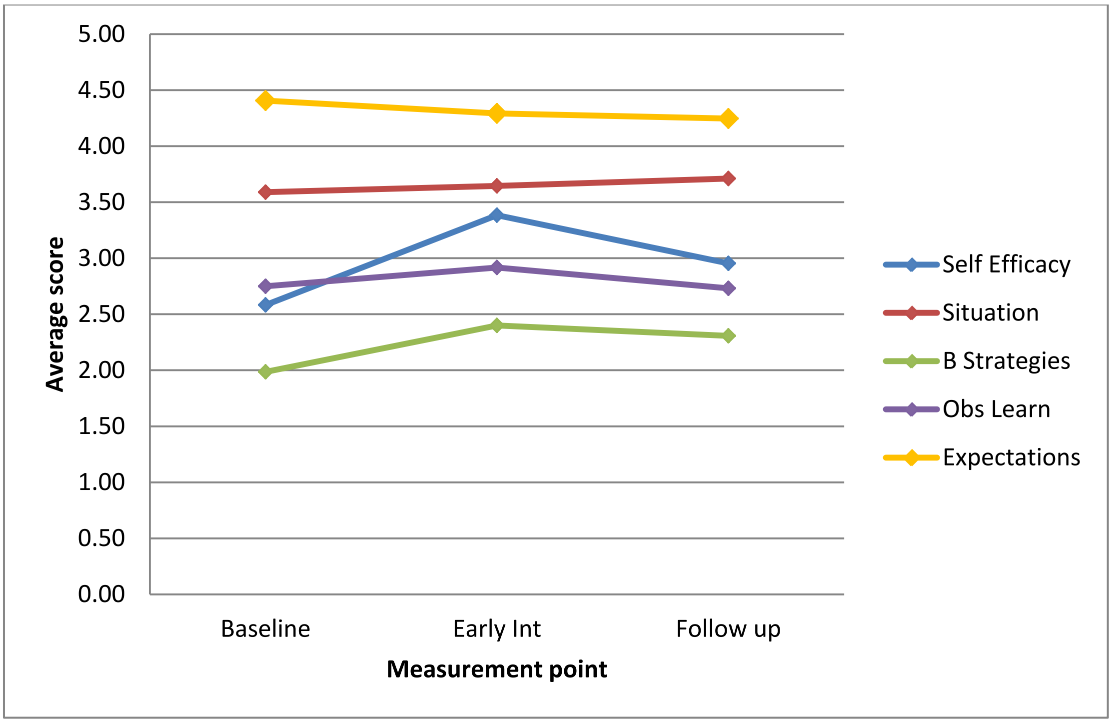


Figure 5.2 Social Cognitive Theory constructs as measured by SCTQ in control group at 3 measurement points

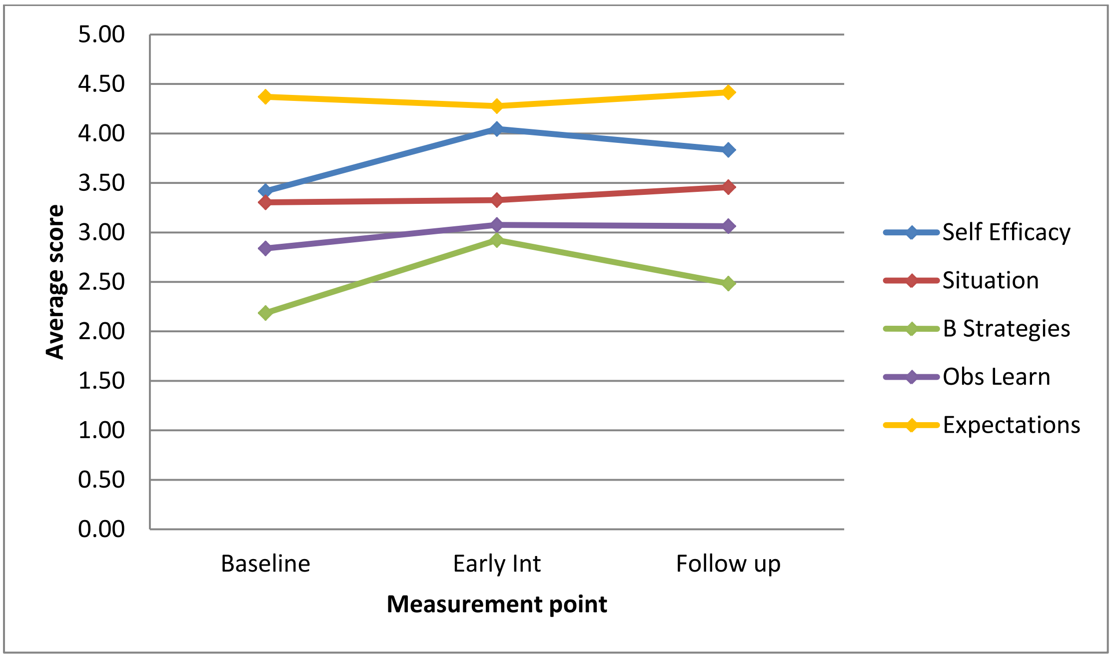


Figure 5.3 Social Cognitive Theory constructs as measured by SCTQ in intervention group at 3 measurement points

5.3.4.1 SCT constructs and baseline sedentary behaviour

Table 5.6 presents the correlations between average scores for SCT constructs at baseline and baseline sedentary behaviour outcomes, as there were no differences between groups, correlations were examined in the sample as whole. Correlations were examined using Pearson's correlation to determine the strength of association between each SCT construct and each key sedentary behaviour outcome. A statistically significant correlation was found between the average score for behavioural strategies at baseline and four of the sedentary behaviour outcomes: total sitting, mean event duration and proportion of time spent in events greater than 20 and 30 minutes. The correlation between behavioural strategies and sitting during work hours was also approaching significance, but no other constructs shared significance. Scatterplots were produced for all correlations in order to check for the influence of outliers, these can be found in Appendix 8.3. Those, relating to significant, or approaching significant, correlations at baseline are also displayed in Figure 5.4- Figure 5.8.

Table 5.6 Correlation between average score for each SCT construct and mean values for sedentary behaviour (SB) outcomes at baseline for whole sample

SCT construct	Self-efficacy		Situation		Behavioural strategies		Observational learning		Outcome expectations	
SB outcome	**R value**	**P value**	**R value**	**P value**	**R value**	**P value**	**R value**	**P value**	**R value**	**P value**
Total sitting all days [a] [%]	0.155	0.44	-0.274	0.17	**-0.644**	**0.00**	-0.377	0.052	-0.255	0.2
Total sitting work hours [b] [%]	0.034	0.87	0.000	1.0	**-0.362**	**0.06**	0.153	0.45	0.098	0.63
Sitting events per hour at work [b] [number]	0.169	0.4	0.033	0.87	0.316	0.11	0.035	0.86	-0.113	0.57
Mean sitting event duration work hours [b] [minutes]	-0.05	0.81	-0.061	0.76	**-0.470**	**0.013**	-0.041	0.84	0.167	0.41
Time in event >20 minutes work hours [b] [%]	-0.009	0.96	0.000	1.0	**-0.491**	**0.009**	0.024	0.91	0.140	0.49
Time in event >30 minutes work hours [b] [%]	0.008	0.97	0.048	0.81	**-0.418**	**0.03**	0.045	0.82	0.115	0.57

R value represents the correlation coefficient and P value the probability of differences between pairs being significant (2 tailed) as calculated using Pearson's correlation. Outcomes are calculated using data on amount of time the activPAL was worn during waking hours [a] and working hours [b]. Figures in bold represent significant differences at p ≤ 0.05, those in bold represent differences approaching significance.

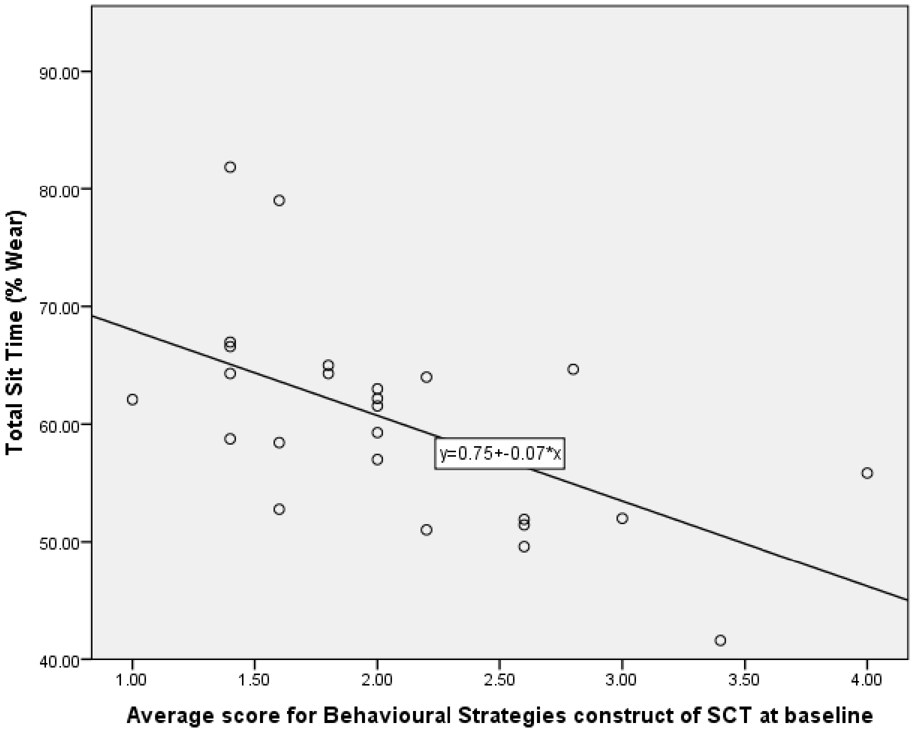


Figure 5.4 Scatterplot illustrating correlation between average score for Behavioural Strategies and total sitting time (all days) for the whole sample at baseline

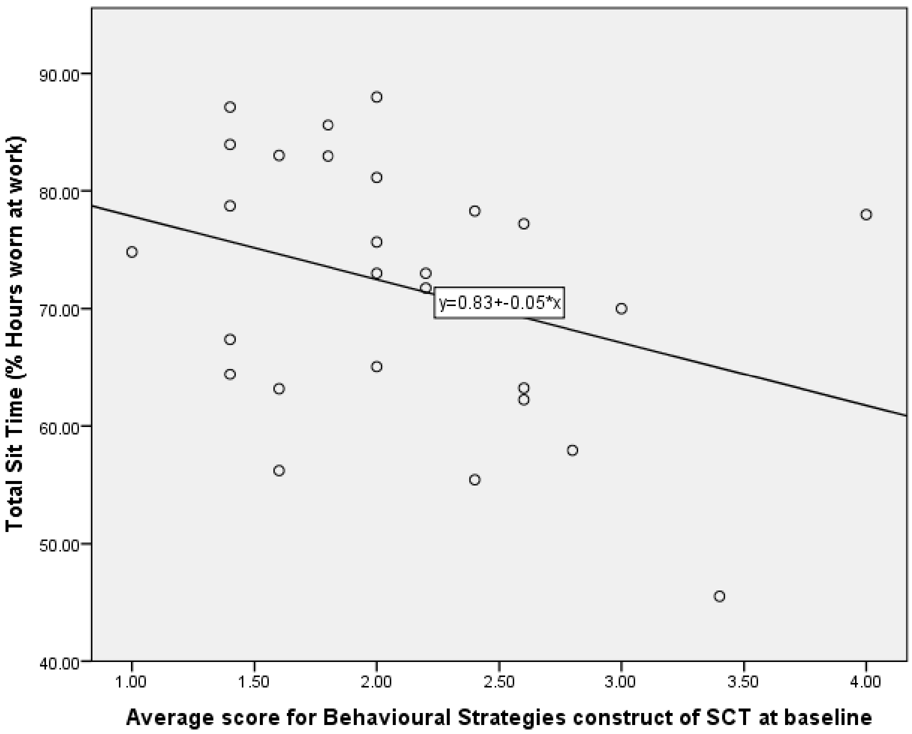


Figure 5.5 Scatterplot illustrating correlation between average score for Behavioural Strategies and total sitting time (work hours) for the whole sample at baseline

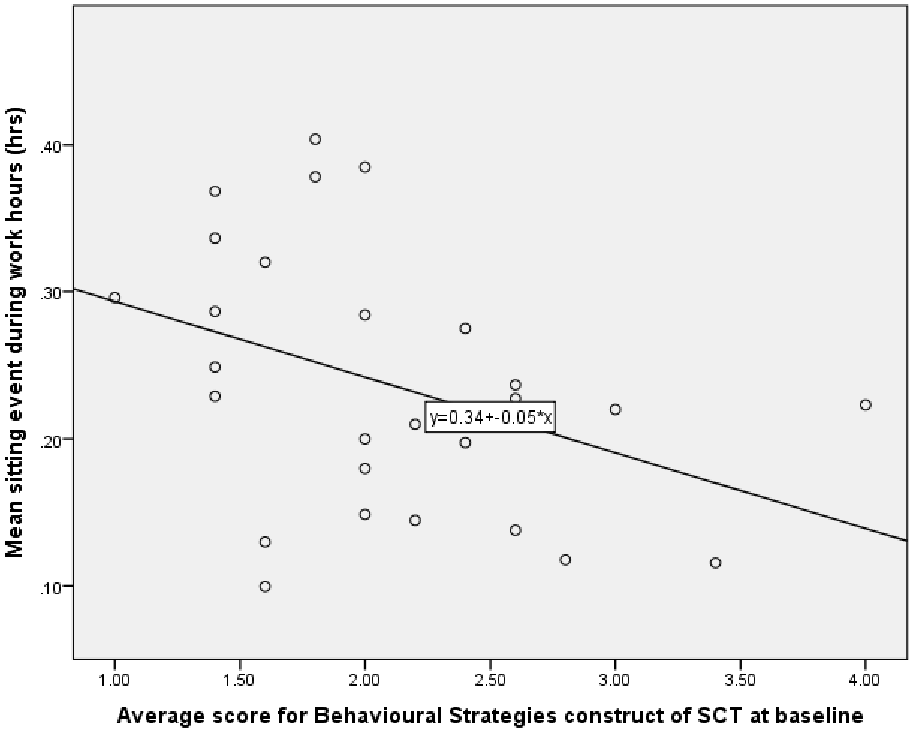


Figure 5.6 Scatterplot illustrating correlation between average score for Behavioural Strategies and duration of mean sitting event for the whole sample at baseline

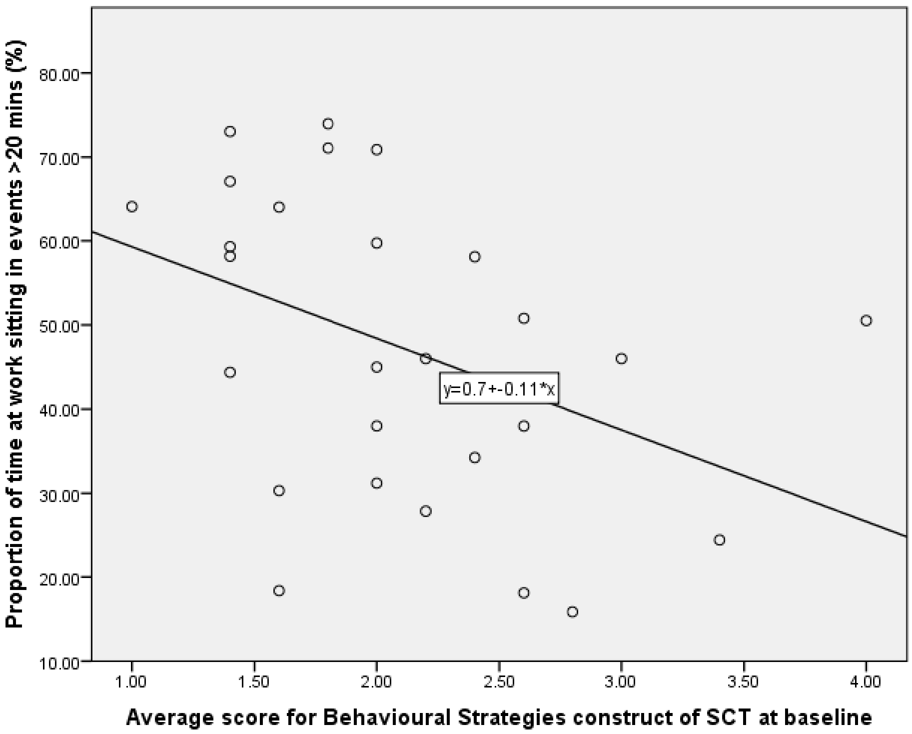


Figure 5.7 Scatterplot illustrating correlation between average score for Behavioural Strategies and proportion of work hours spent sitting in events >20 mins for the whole sample at baseline

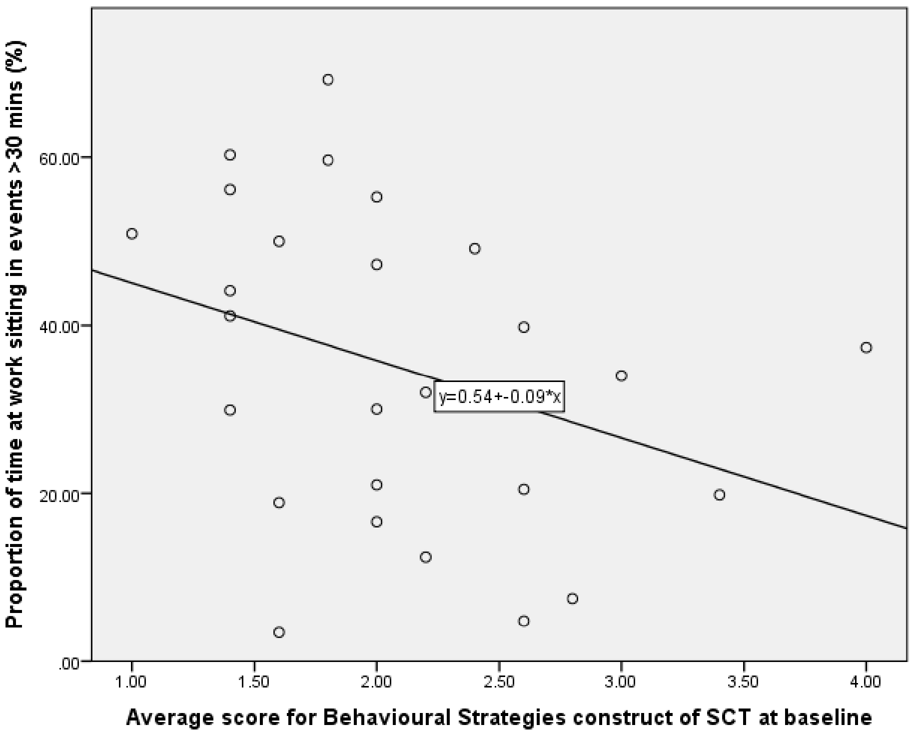


Figure 5.8 Scatterplot illustrating correlation between average score for Behavioural Strategies and duration of proportion of work hours spent sitting in events >30 mins for the whole sample at baseline

5.3.4.2 Correlation between changes to SCT constructs and sedentary behaviour outcomes

Correlations between changes in average scores for SCT constructs were examined against changes in sedentary behaviour outcomes between baseline and early intervention (Table 5.7) and baseline and follow-up (Table 5.8). Scatterplots were also produced in order to check the influence of outliers on the correlation coefficient (Appendix 8.4). The only statistically significant correlation found, was between the change in score for behavioural strategies and change in mean duration of sitting event between baseline and early intervention. Correlations between changes in SCT constructs from baseline to intervention against changes in sedentary behaviour outcomes from baseline to follow-up, were also examined, but no statistically significant correlations were found.

Table 5.7 Correlation between mean changes in SCT construct and mean changes in sedentary behaviour (SB) outcomes between baseline and early intervention in whole sample

Changes in SCT construct	Self-efficacy B - EI		Situation B-EI		Behavioural strategies B-EI		Observational Learning B-EI		Outcome expectations B-EI	
Changes in SB outcome B-EI	**R value**	**P value**	**R value**	**P value**	**R value**	**P value**	**R value**	**P value**	**R value**	**P value**
Total sitting all days [a] [%]	.035	0.88	-0.092	0.68	0.17	0.45	0.356	0.1	0.084	0.71
Total sitting work hours [b] [%]	-0.152	0.5	-0.246	0.27	-0.348	0.11	-0.165	0.46	-0.106	0.64
Sitting events per hour at work [b] [number]	-0.094	0.68	0.321	0.15	0.258	0.25	-0.004	0.99	0.081	0.72
Mean sitting event duration work hours [b] [minutes]	0.291	0.19	0.283	0.20	**0.428**	**0.047**	0.385	0.08	0.085	0.71
Time in event >20 minutes work hours [b] [%]	0.084	0.71	-0.169	0.45	-0.283	0.20	0.084	0.71	-0.155	0.49
Time in event >30 minutes work hours [b] [%]	**0.395**	**0.07**	0.045	0.84	-0.076	0.74	0.043	0.85	0.123	0.59

Data in cells show R value = correlation coefficient and P value = probability as calculated using Spearmans test for correlation. Figures in red represent significant differences at $p \leq 0.05$, those in bold represent differences approaching significance.B-EI = change from baseline to early intervention

Table 5.8 Correlation between mean changes in SCT construct and mean changes in sedentary behaviour (SB) outcomes between baseline and follow up in the whole sample

Changes in SCT construct	Self-efficacy B - FU		Situation B-FU		Behavioural strategies B-FU		Observational learning B-FU		Outcome expectations B-FU	
Changes in SB outcome B-FU	**R value**	**P value**	**R value**	**P value**	**R value**	**P value**	**R value**	**P value**	**R value**	**P value**
Total sitting all days [a] [%]	0.240	0.28	-0.166	0.46	-0.049	0.83	-0.192	0.39	-0.072	0.75
Total sitting work hours [b] [%]	0.94	0.68	-0.014	0.95	0.040	0.86	-0.245	0.27	-0.158	0.48
Sitting events per hour at work [b] [number]	-0.403	0.063	0.405	0.062	-0.195	0.38	0.203	0.36	0.27	0.22
Mean sitting event duration work hours [b] [minutes]	0.215	0.34	-0.218	0.33	0.095	0.67	-0.30	0.18	-0.330	0.13
Time in event >20 minutes work hours [b] [%]	0.312	0.16	-0.148	0.51	0.219	0.33	-0.236	0.29	-0.228	0.31
Time in event >30 minutes work hours [b] [%]	0.313	0.16	-0.109	0.63	0.196	0.38	-0.26	0.24	-0.24	0.28

Data in cells show R value = correlation coefficient and P value = probability as calculated using Spearmans test for correlation. B-FU = change from baseline to follow-up

5.3.5 Stage of change

Participants rated their stage of change at baseline, early intervention, and follow up by selecting one of five statements that they felt best described their current behaviour with regard to making changes to their sedentary patterns at work (annex 9.11). These statements represented one of the five stages of change as follows:

Table 5.9 Stage of change statements and corresponding stage allocation

Value	Statement	Stage of change
1	I currently engage in sedentary behaviour at work and do not intend to reduce or break up my sedentary behaviour in the next six months	Pre-contemplation
2	I currently engage in sedentary behaviour at work, but I am thinking about reducing or breaking up my sedentary behaviour in the next six months	Contemplation
3	I currently undertake some measures to reduce or break up my sedentary behaviour at work, but not regularly	Preparation
4	I currently undertake some measures to reduce or break up my sedentary behaviour at work, but have only begun doing so within the last six months	Action
5	I currently undertake measures to reduce or break up my sedentary behaviour at work and have done so for more than six months	Maintenance

The proportion of participants allocated to each stage are displayed for the control group (Figure 5.9) and intervention group (Figure 5.10). The pie charts illustrate that at baseline the majority of participants in the intervention group considered themselves to already be in the maintenance stage of change (35.7%), whilst the majority of those in the control group considered themselves to be contemplative (50%), with none considering themselves to be in maintenance. Figure 5.9 shows progression of the control group through the stages with the number of participants in the preparation and action stages increasing from baseline to early intervention and from early intervention to follow-up, whilst the proportion in the contemplative stage decreased. Figure 5.10 shows a large increase in the proportion of intervention group participants in the action stage from baseline to early intervention (+50%), with a corresponding decrease of those in contemplation, preparation, and maintenance. The proportion of those in maintenance then increased from early intervention to follow-up. It is also worth noting that one intervention group participant identified as being precontemplative at early intervention and follow-up measurement when they had previously identified as being in a higher stage at baseline.

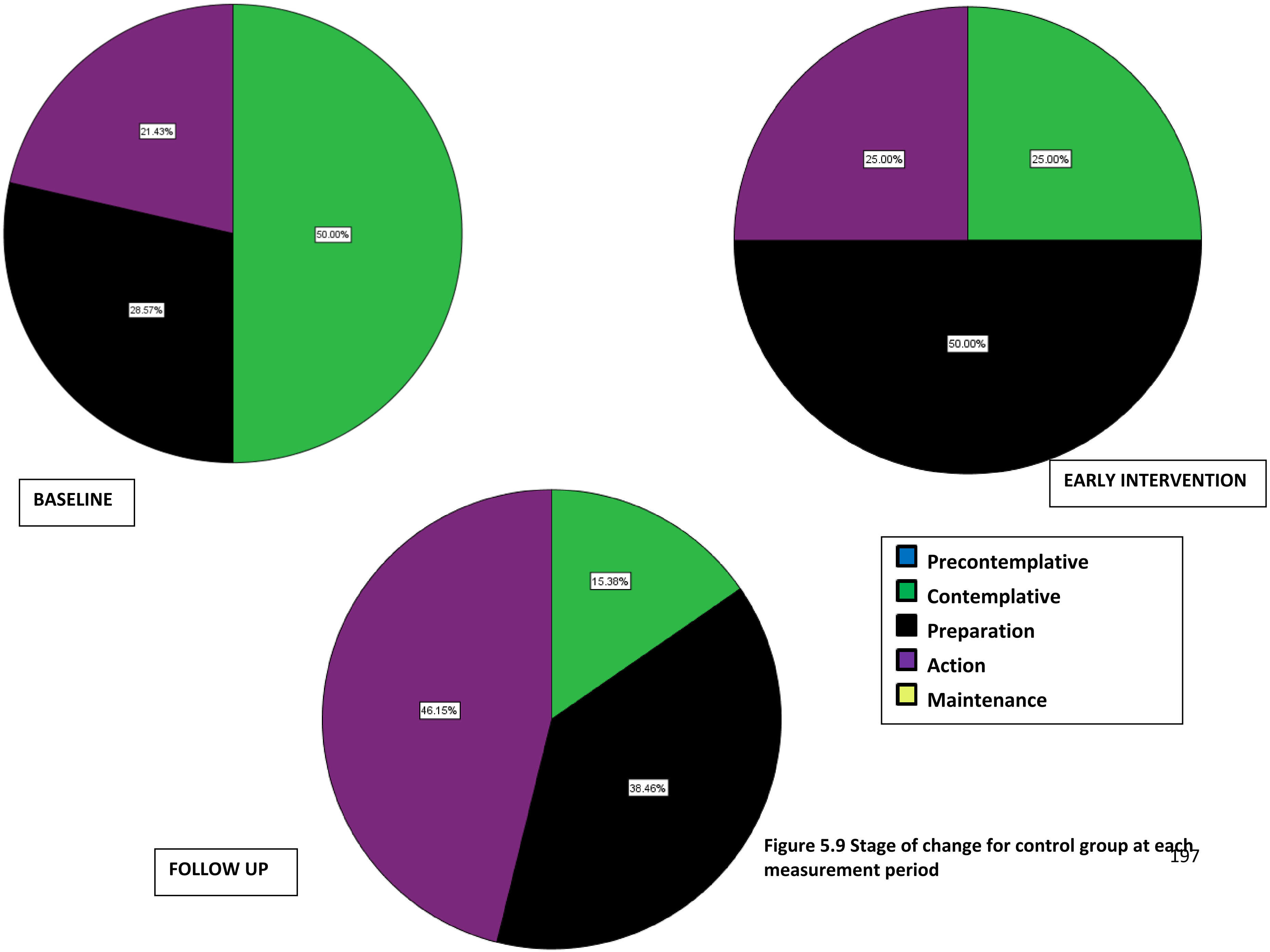
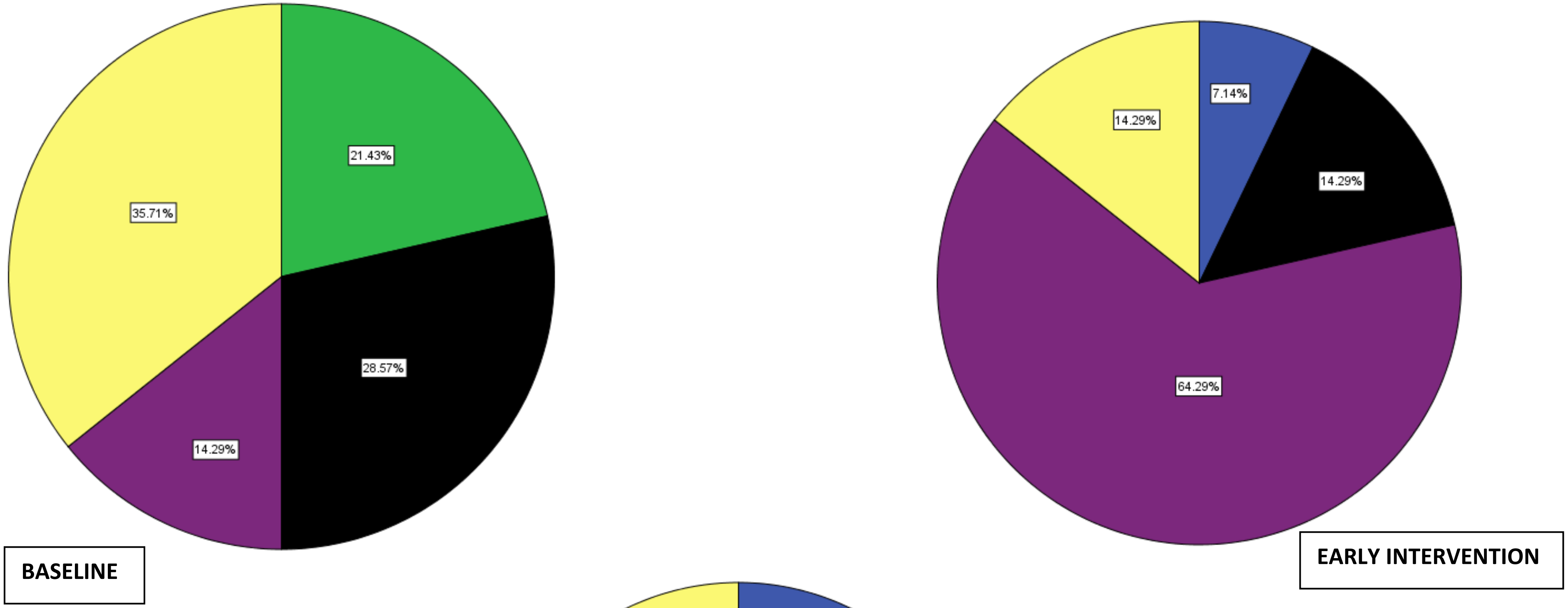
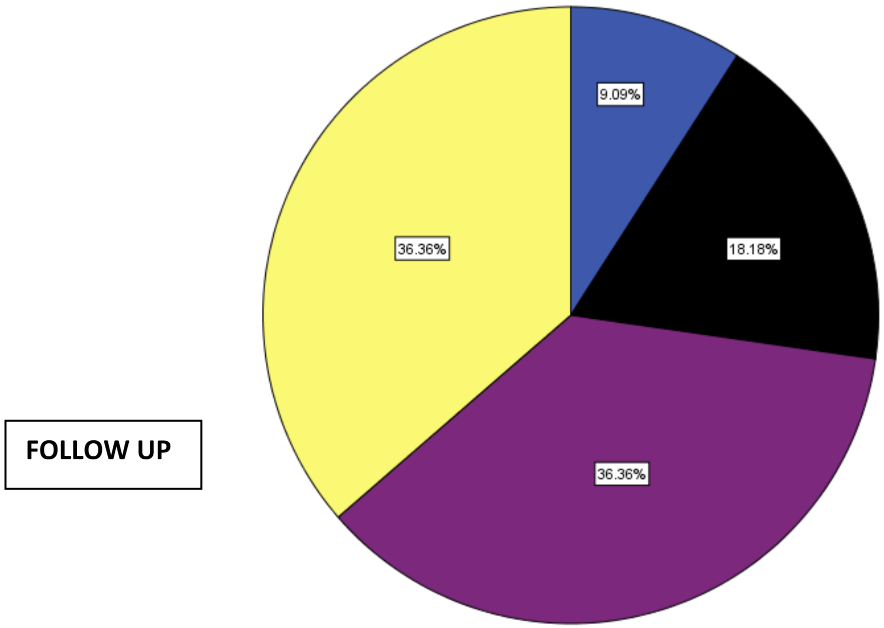


Figure 5.9 Stage of change for control group at each measurement period





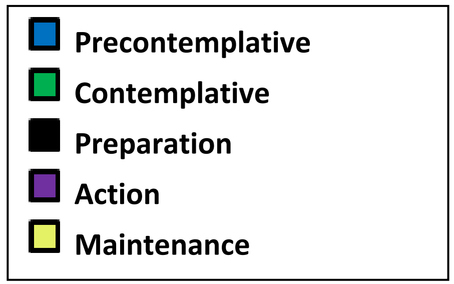


Figure 5.10 Stage of change for intervention group at each measurement period

Scatterplots were produced to examine correlations between stage of change, and sedentary behaviour outcomes were examined at three measurement points (Annex 8.5). Pearson's correlations were performed to examine the relationship between stage of change at each measurement point with each sedentary behaviour outcome at the same measurement point. The only statistically significant correlation was found between SOC and total sitting time (all days) at baseline r = -0.456, p = 0.017 (Figure 5.11.).

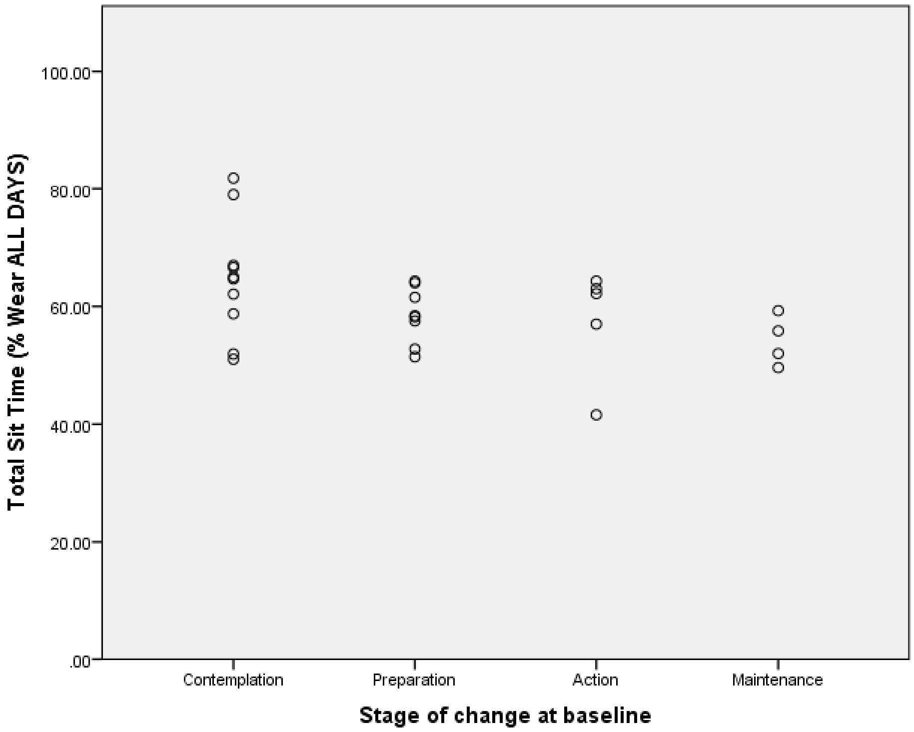


Figure 5.11 Correlation between stage of change at baseline and total sitting time (all days)

Dividing stages into pre-action: pre-contemplation, contemplation and preparation, and action: action and maintenance, illustrates that those randomly assigned to the intervention group were more likely to see themselves in action phases of change compared to the control group. There was progression in both groups into action phases over the course of the study, with the intervention group showing a small reduction in those allocating themselves to action phases between early intervention and follow-up (Table 5.10).

Table 5.10 Proportion of control and intervention group in pre-action and action stages of change

Measurement period	Control group		Intervention group	
	Pre-action	Action	Pre-action	Action
Baseline	78.57%	21.43%	50.00%	50.00%
Early intervention	75.00%	25.00%	21.43%	78.57%
Follow up	58.33%	41.67%	22.27%	72.73%

Pre-action = precontemplative, contemplative & preparation SOC, Action = action & maintenance SOC

A Cochran's Q test was chosen to examine the differences across the three measurement points as it is designed to test significance of a dichotomous variable in three or more related groups (Field 2013). Cochran's Q test did not indicate any significant differences between the three time periods for action and pre-action phases for either group. Control group $\chi^2(2) = 0.333$, $p = .85$. Intervention group $\chi^2(2) = 4.67$, $p = .097$.

Changes to participants' stage of change status was not always as simple as progressing from pre-action to action phases. It often involved regression through stages, or no movement between the three measurement periods (Table 5.11).

Table 5.11 Progression and regression through stages of change

	Regression ⟵		Static		⟶ Progression
Number of stages moved	**-2**	**-1**	**0**	**1**	**2**
Baseline – early intervention					
Control group	0	4	2	3	3
Intervention group	0	4	5	4	1
Early intervention – Follow-up					
Control group	0	2	5	3	1
Intervention group	1	1	7	2	0
Baseline – Follow-up					
Control group	0	2	5	3	3
Intervention group	0	2	6	2	1

Numbers in cells represent the number of participants who moved SOC or remained static from baseline SOC to Early Intervention and/or Follow-up. Based on completed questionnaires. Control: Baseline n=14, Early int n= 12, Follow-up n= 13. Intervention: Baseline n=14, Early int n= 14, Follow-up n= 11

Mean changes to sedentary behaviour outcomes between baseline and early intervention, and baseline and follow-up were used as a comparison to movement between pre-action and action phases in the sample as a whole (Table 5.12). This was achieved by dividing the sample into four categories:

1. **Pa-Pa** = participants who were in a pre-action stage of change at baseline and remained in pre-action at early intervention or follow-up (baseline-early intervention n= 9, baseline - follow-up n= 8)
2. **A-A =** participants who were in an action stage of change at baseline and remained in an action stage at early intervention or follow-up (baseline-early intervention n= 7 , baseline - follow-up n= 7)
3. **Pa-A** = participants who were in a pre-action stage of change at baseline and moved to an -action stage at early intervention or follow-up (baseline-early intervention n= 7, baseline - follow-up n= 7)
4. **A-Pa =** participants who were in an action stage of change at baseline and moved to a pre-action stage at early intervention or follow-up (baseline-early intervention n= 3, baseline - follow-up n= 2).

These changes are also depicted in terms of the proportion of participants moving between pre-action and action stages, or remaining static in their SOC, who demonstrated an increase (>15 minutes a day or >1.5 minutes mean sit event) or decrease (<15 minutes a day or <1.5 minutes mean sit event) or remaining static (within ± 15 minutes a day ± 1.5 minutes mean sit event) in each of the key sedentary behaviour outcome measures (Figure 5.12 - Figure 5.22). Fifteen minutes and 1.5 minutes were chosen as the cut-off point to be considered static as it represented between 1-2% of the average daily wear time and average sitting event length, respectively.

Note that number of sit events were not examined as it was felt that this did not give a clear indication of improvement in sedentary behaviour when considered in isolation.

Table 5.12 Changes to sedentary behaviour outcomes (SB) compared to changes between pre-action and action stages of change for whole sample

	Movement between pre-action (PA) and action (A) stages of change			
	Pa-Pa (n=9)	**A-A (n=7)**	**Pa-A (n=7)**	**A-Pa (n=3)**
Mean change in SB outcomes	**Change in SOC Baseline – Early Intervention**			
Total sitting all days [a] [%]	+0.8±4.4	+9.8±21.9	-15.9±25.1	-1.2±6.6
Total sitting work hours [b] [%]	+1.6±5.6	+3.4±14.6	-12.8±20.0	-12.9±4.9
Sitting events work hours [number]	+0.1±1.0	-0.2±0.6	-0.1±0.8	-0.5±0.7
Mean sitting event duration work hours [b] [minutes]	+0.7±2.7	+3.5±7.0	-3.2±3.5	+0.4±1.4
Time in event >20 minutes work hours [b] [%]	+3.7 ±12.5	+2.9±12.7	-3.3±19.3	-15.6±11.7
Time in event >30 minutes work hours [b] [%]	+0.2±6.7	+1.1±5.2	-2.6±10.2	-6.3±1.0
	Change in SOC Baseline –Follow-up			
	Pa-Pa (n=8)	**A-A (n=7)**	**Pa-A (n=7)**	**A-Pa (n=2)**
Total sitting all days [a] [%]	-2.5±15.11	-1.8±17.9	-4.0±19.1	+6.0±14.0
Total sitting work hours [b] [%]	+1.9±10.5	-1.4±3.3	-7.9±14.5	-1.5±1.6
Sitting events work hours [number]	-0.5±0.6	+0.2±1.1	+0.3±0.5	-0.8±0.3
Mean sitting event duration work hours [b] [minutes]	+3.2±7.3	-0.8±3.4	-3.3±6.0	+3.6±0.8
Time in event >20 minutes work hours [b] [%]	-0.3±10.0	-3.8±14.2	+3.3±31.0	+24.0±7.0
Time in event >30 minutes work hours [b] [%]	+0.8±5.7	-1.6±5.9	-2.4±11.2	+3.8±0.6

Figures in cells represent mean changes ± standard deviation based on amount of time the activPAL was worn during waking hours [a] and working hours [b]. Pa-Pa indicates no movement from pre-action stages, A-A indicates no movement from action stages, Pa-A indicates movement from pre-action stages to action stages, A-Pa indicates movement from action to pre-action.

Table 5.12 shows that between baseline and early intervention, reductions (non-significant) in sedentary behaviour outcomes were mostly, but not exclusively, seen in those that moved stages of change during that time-frame, either from pre-action stages of change to action stages, or action stages to pre-action. These reductions in sedentary behaviour outcomes tended to be small. Categorising them into reductions or increases in sitting of over 15 minutes (mean sit event ± 1.5 minutes) or remaining static (levels of sitting within 15 minutes/1.5 minutes mean sit event, of baseline level) illustrates how sitting changed in relation to movement or non-movement between pre-action and action stages of change from baseline to early intervention (Figures 5.12, 5.14, 5.16, 5.18, 5.20).

Between baseline and follow-up, reductions (non-significant) in sedentary behaviour outcomes were mostly, but not exclusively, seen in those that had remained in action stages of change from baseline to follow-up (Table 5.12). This is also illustrated in Figures 5.13, 5.15, 5.17, 5.19 & 5.21.

It is worth noting the small and varied numbers of individuals in each of the stage of change groups n=2-9 (Table 5.12).

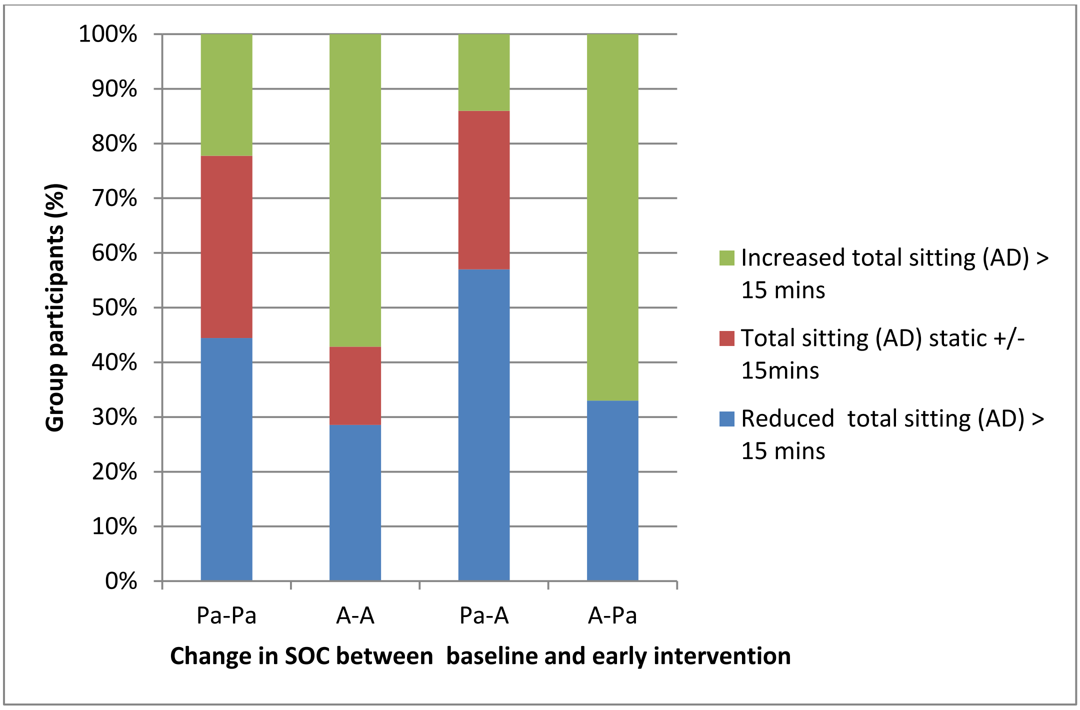


Figure 5.12 Proportion of participants whose total sitting (all days) increased/decreased/ remained static between baseline and early intervention

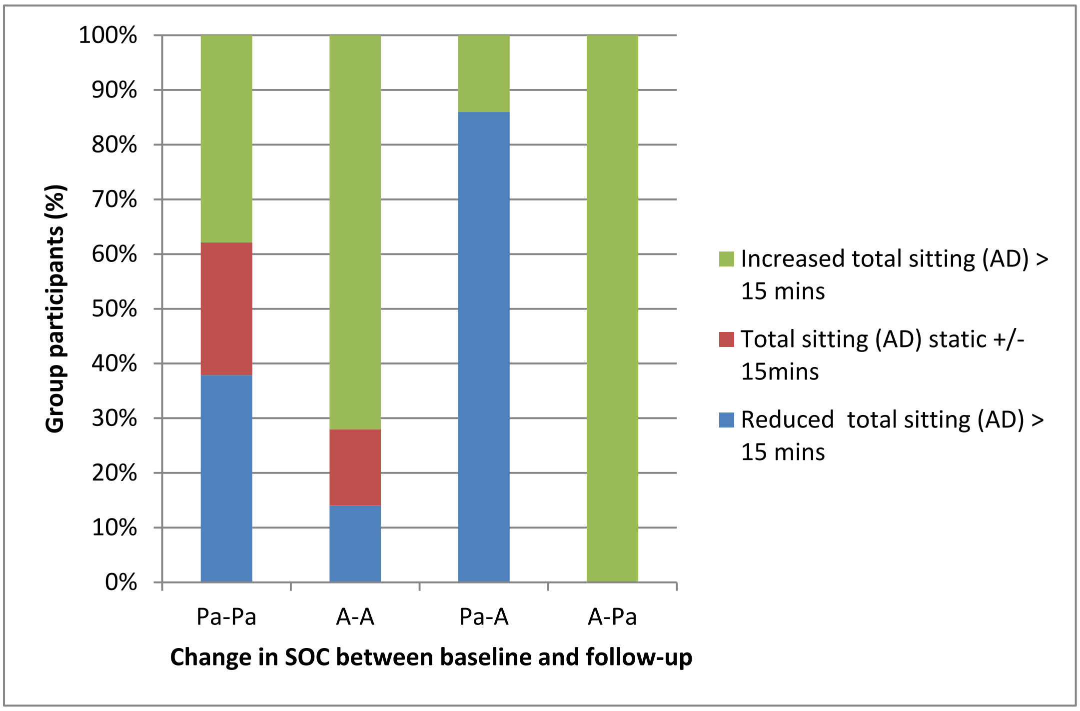


Figure 5.13 Proportion of participants whose total sitting (all days) increased/decreased/ remained static between baseline and follow-up

<u>Key for figures 5.12-5.19</u>

Pa-Pa no movement from pre-action; **A-A** no movement from action phases;
Pa-A movement from pre-action to action phases; **A-Pa** movement from action to pre-action phases

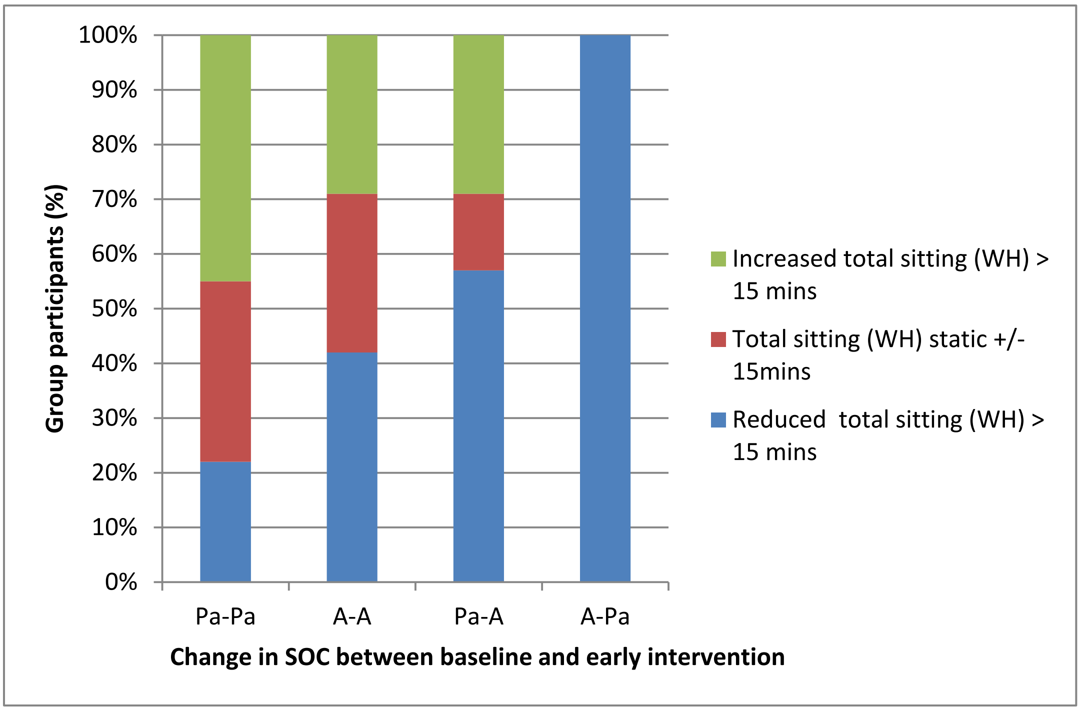


Figure 5.14 Proportion of participants whose total sitting during work hours increased/decreased/remained static between baseline and early intervention

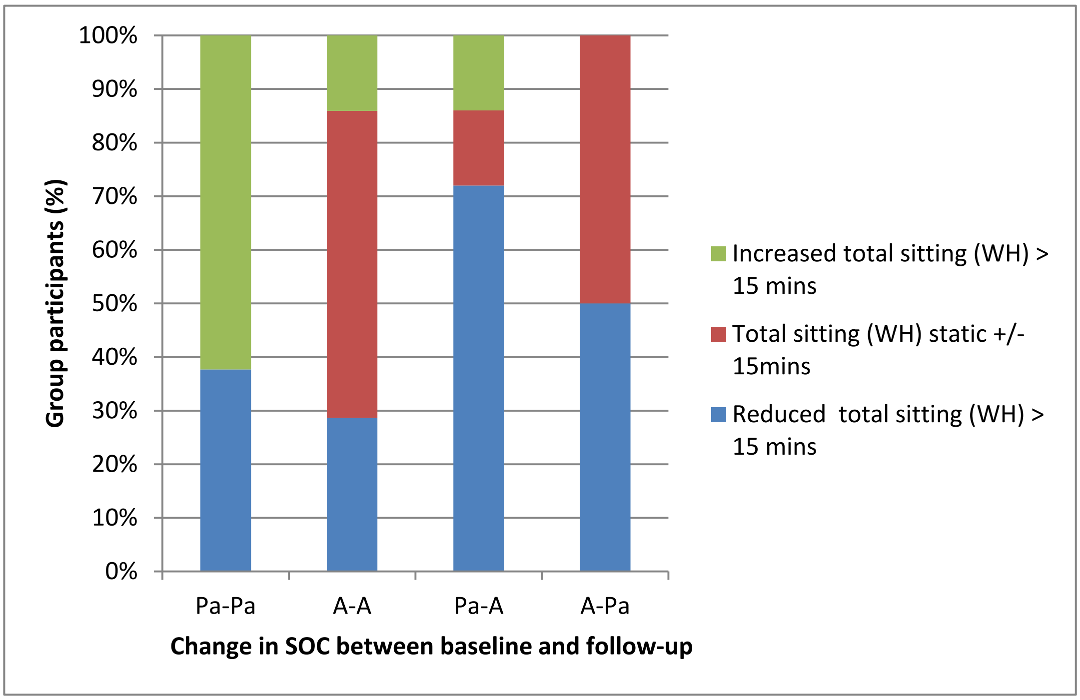


Figure 5.15 Proportion of participants whose total sitting during work hours increased/decreased/remained static between baseline and follow-up

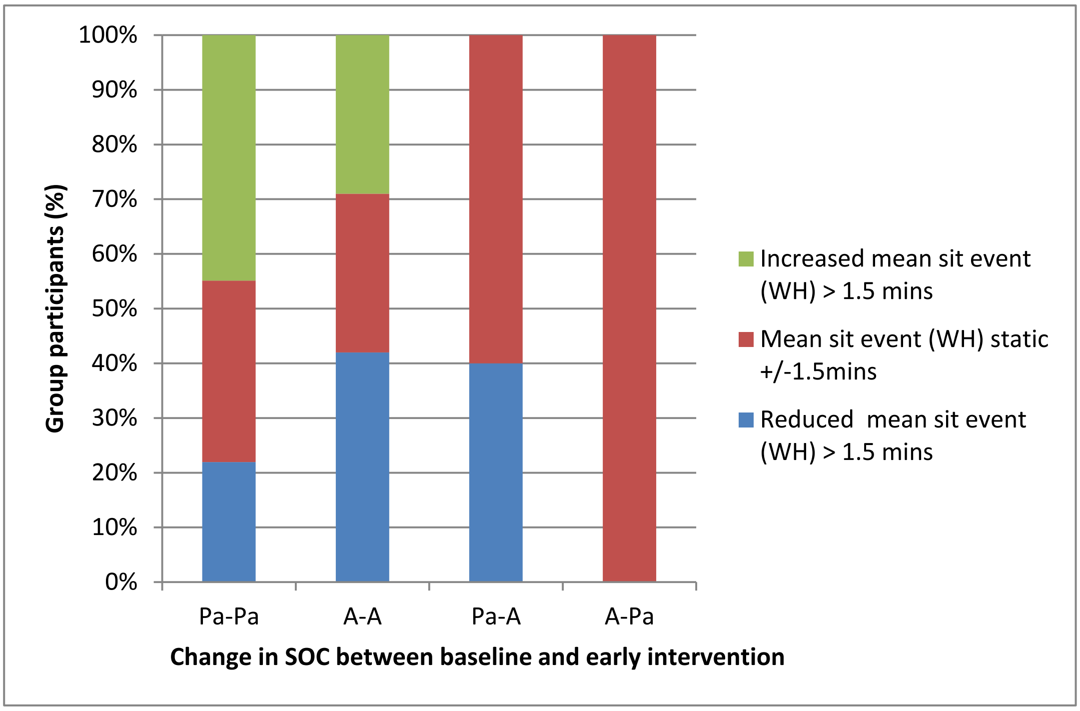


Figure 5.16 Proportion of participants whose mean sitting event duration during work hours increased/decreased/remained static between baseline and early intervention

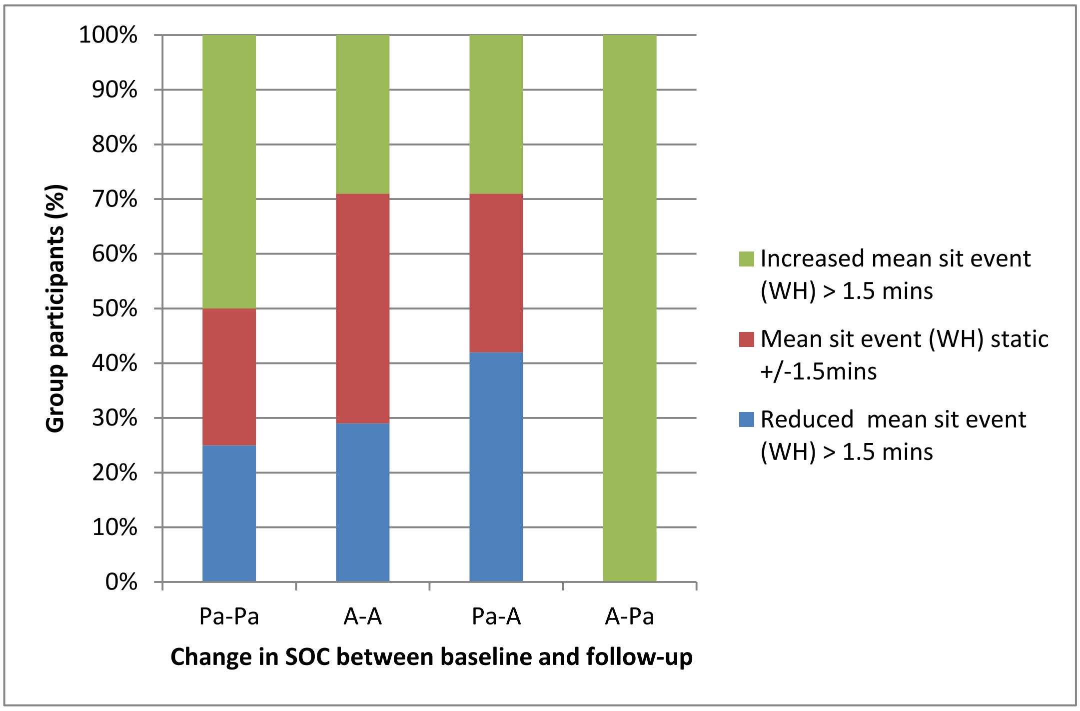


Figure 5.17 Proportion of participants whose mean sitting event duration during work hours increased/decreased/remained static between baseline and follow-up

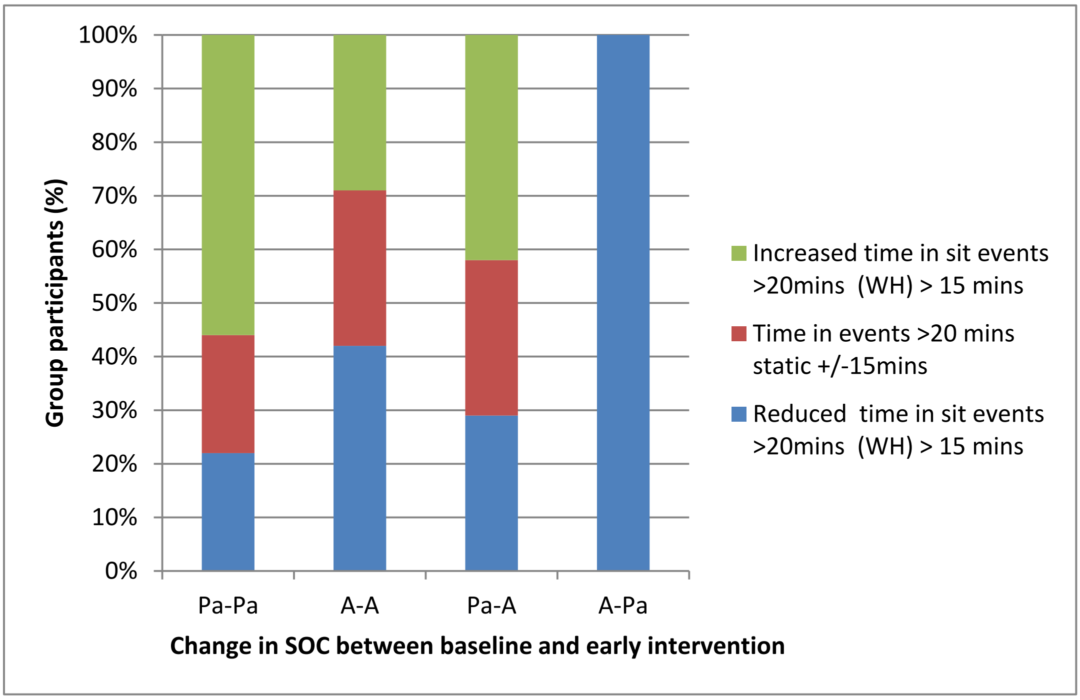


Figure 5.18 Proportion of participants whose time in sitting events >20 minutes during work hours increased/decreased/remained static between baseline and early intervention

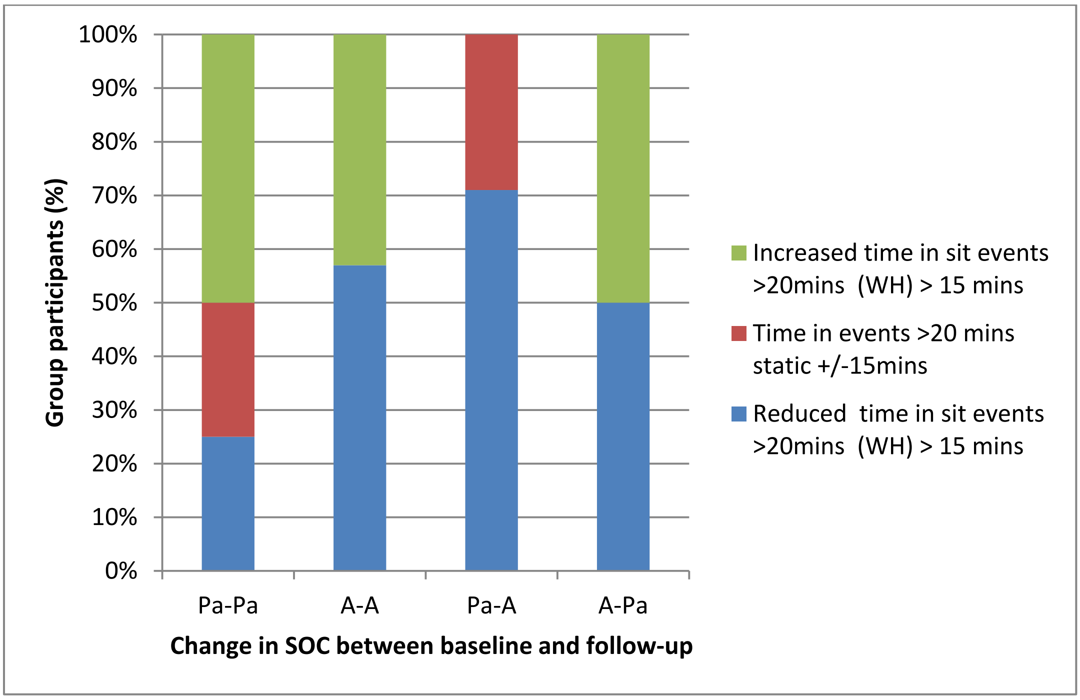


Figure 5.19 Proportion of participants whose time in sitting events >20 minutes during work hours increased/decreased/remained static between baseline and follow-up

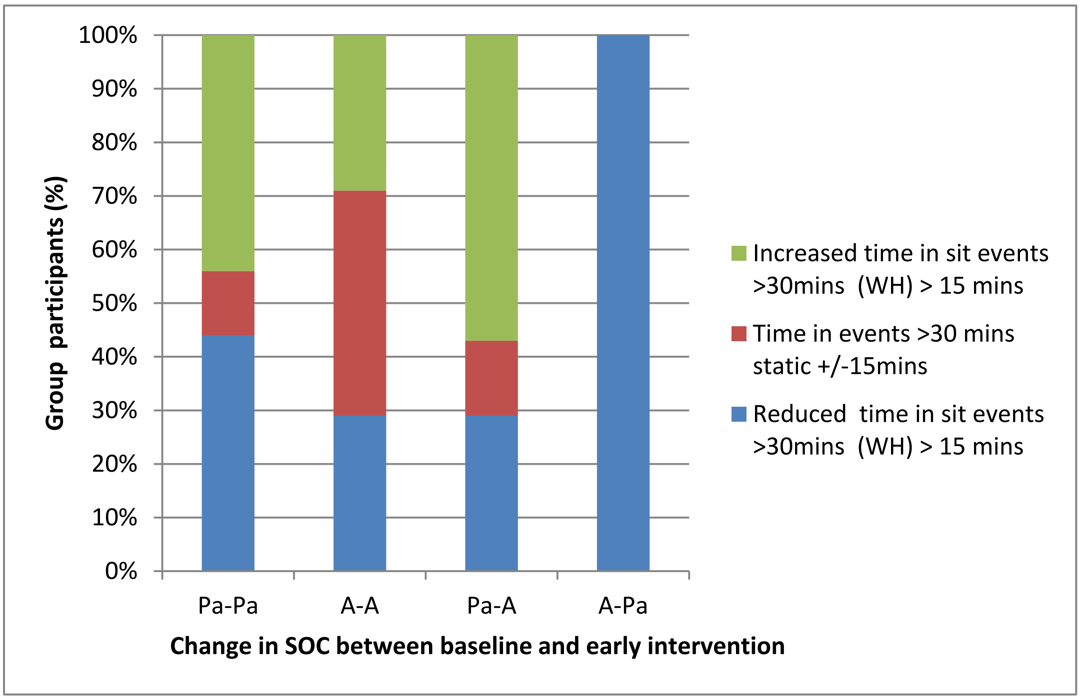


Figure 5.20 Proportion of participants whose time in sitting events >30 minutes during work hours increased/decreased/remained static between baseline and early intervention

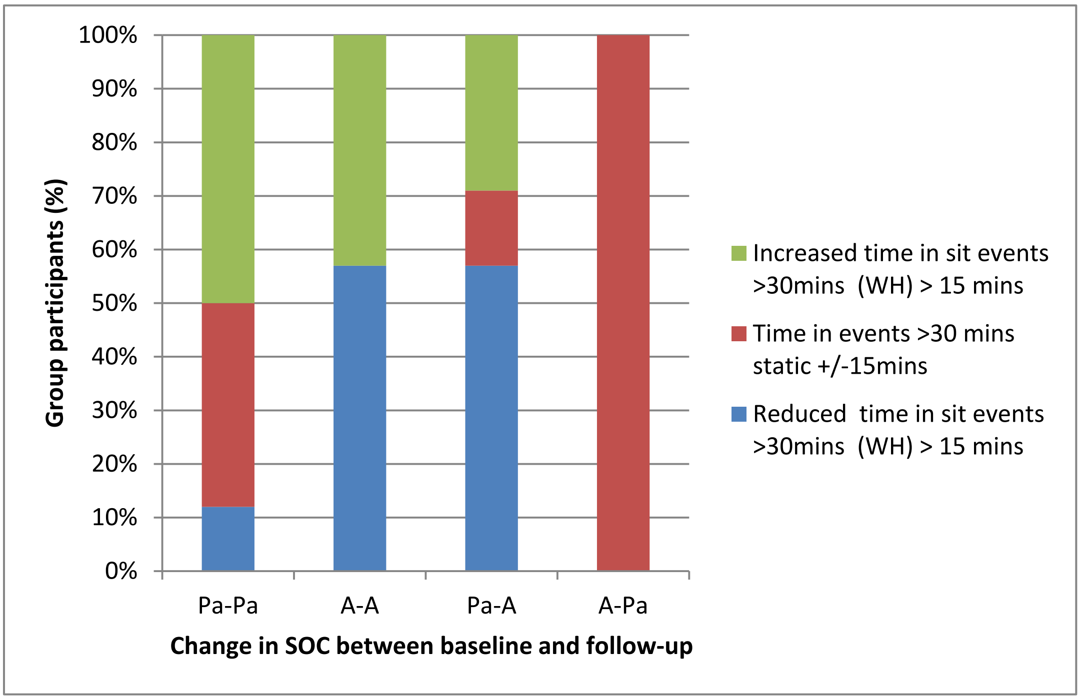


Figure 5.21 Proportion of participants whose time in sitting events >30 minutes during work hours increased/decreased/remained static between baseline and follow-up

5.3.6 Sedentary behaviour outcomes

Shapiro-Wilk tests identified that all outcome measures of sedentary behaviour were normally distributed at all four measurement points. Parametric tests were therefore used to examine differences between groups and measurement points.

5.3.6.1 Baseline sedentary behaviour

At baseline, participants (n=27) spent on average 60.0% ± 8.5% (mean ± SD) of their waking hours (daily average 15.94hrs ± 1.13), in sedentary postures, which equated to a daily average of 9.4± 1.4 hours spent sitting. During working hours (daily average 8.59hrs ± 1.35) this rose to 72.0% ± 10.9% of the time the monitor was worn at work, which equated to an average of 6.2 ± 1.4 hours spent sitting at work a day. The mean duration of sitting events during work hours for the whole sample at baseline was 14.2 ± 5.3 minutes, with a mean of 3.4 ±1.1 events per hour. Prolonged sitting in events of 20 minutes or more accounted for 47.4% ± 18.1% of time at work, and events of 30 minutes or more 34.9% ± 18.3% of time at work (Table 5.15).

5.3.6.2 Changes to sedentary behaviour - between group differences

Independent t-tests revealed no statistical differences [p>0.05] between groups for key outcome measures at any measurement point (Table 5.13).

At baseline there was a tendency (though non-significant) for the intervention group to sit slightly more during work hours, with a higher mean sitting event length (Figure 5.22 and Figure 5.23). Both groups made initial, non-significant, reductions to their total sitting during work hours from baseline to early intervention (control = -4.5%, intervention = -7.8%) and, despite a small increase at late intervention, these remained below baseline levels at 12 week follow-up (control = -2.0%, intervention = -3.1%). However, when examining sitting across both work and non-work days the intervention group significantly increased their total sitting between baseline and follow up (+3.4%, p=0.03) (Table 5.13).

In terms of prolonged sitting events, little change was made to mean event duration. Although some non-significant reductions were made in events >20 minutes in the intervention group from baseline to early intervention measurement (-6.3%), these were not maintained at follow up (Figure 5.24). Conversely the intervention group increased (non-significant) the proportion of time at work spent sitting in events >30 minutes across the four measurement periods (Figure 5.25)A two-way ANOVA was conducted to examine the effect of measurement point and group on each of the key outcomes. No statistically significant interaction between the effect of time and group was found for any outcome.

Table 5.13 Sedentary behaviour key outcomes for control and intervention group at 4 measurement points

Time point	Baseline		Early Intervention		Late intervention		Follow-up	
Group	**C (n=14)**	**I (n=13)**	**C (n=12)**	**I (n=13)**	**C (n=13)**	**I (n=14)**	**C (n=13)**	**I (n=13)**
Total sitting all days [a] [%]	59.1±8.9	61.0±8.2	60.3±9.5	57.9±12.1	60.8±7.7	60.9±10.5	58.6±8.9	64.9±9.7
Between group differences	*p=0.56*		*p=0.59*		*p=0.98*		*p=0.10*	
Total sitting work hours [b] [%]	70.6±12.5	73.5±9.3	66.1±16.5	65.7±19.3	66.9±14.5	67.5±17.2	68.6±18.2	70.4±17.0
Between group differences	*p=0.5*		*p=0.96*		*p=0.92*		*p=0.80*	
Sitting events per hour at work [b] [number]	3.6±1.3	3.2±0.9	3.4±1.6	3.2±1.0	3.5±1.4	3.0±1.0	3.7±1.7	3.1±1.0
Between group differences	*p=0.37*		*p=0.67*		*p=0.34*		*p=0.29*	
Mean sitting event duration work hours [b] [mins]	13.2±5.6	15.0±5.2	13.8±6.4	14.7±7.6	14.0±7.0	14.6±6.5	13.0±6.3	15.4±7.6
Between group differences	*p=0.47*		*p=0.75*		*p=0.82*		*p=0.38*	
Time in event >20 minutes work hours [b] [%]	44.8±16.6	50.1±19.8	43.4±21.3	43.8±22.0	42.5±21.1	46.0±22.5	44.0±22.8	49.2±23.6
Between group differences	*p=0.45*		*p=0.96*		*p=0.68*		*p=0.57*	
Time in event >30 minutes work hours [b] [%]	33.0±18.6	30.0±19.8	31.9±18.3	31.0±20.4	31.4±19.6	34.2±21.2	32.1±19.8	37.8±24.3
Between group differences	*p=0.56*		*p=0.71*		*p=0.72*		*p=0.52*	

Data displayed in each cell are Mean ±standard deviation were calculated using data on amount of time the activPAL was worn during waking hours [a] and working hours [b]. C = control group, I = Intervention group. P values are the result of independent t-tests measuring differences between control & intervention groups.

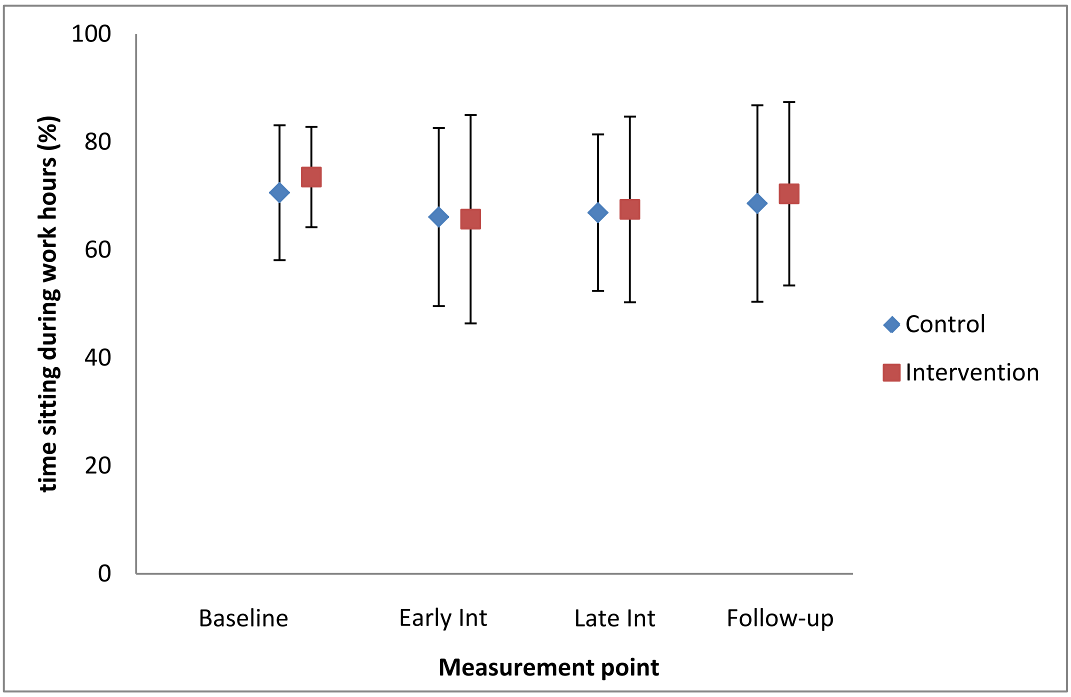


Figure 5.22 Mean & confidence intervals for percentage of sitting during work hours for control and intervention groups across 4 measurement points

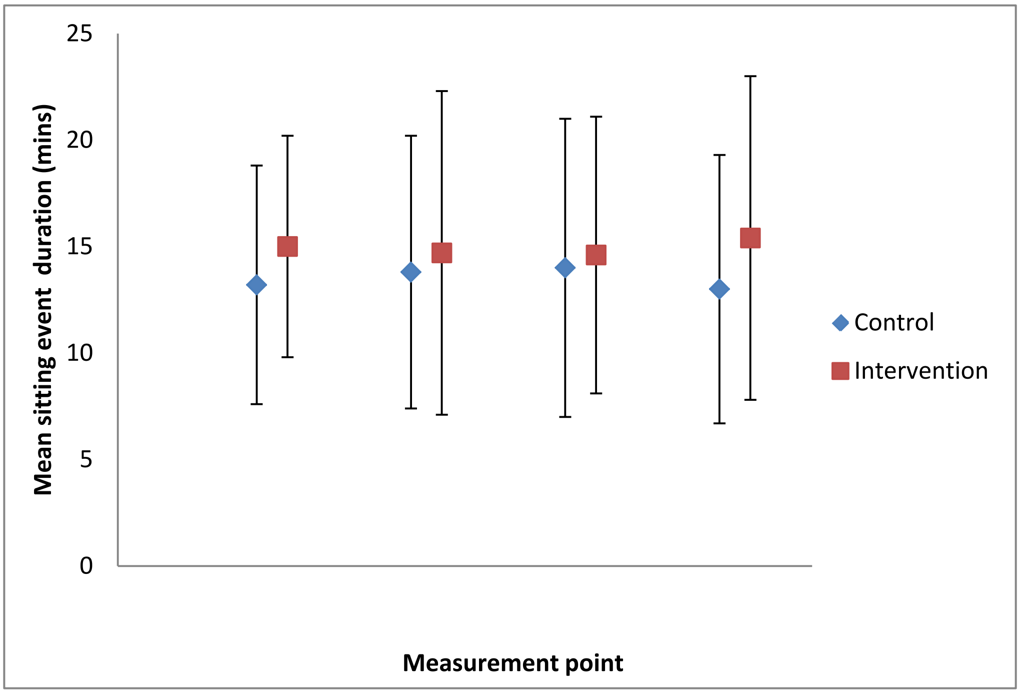


Figure 5.23 Mean & confidence intervals for mean duration of sitting event for control and intervention groups across 4 measurement points

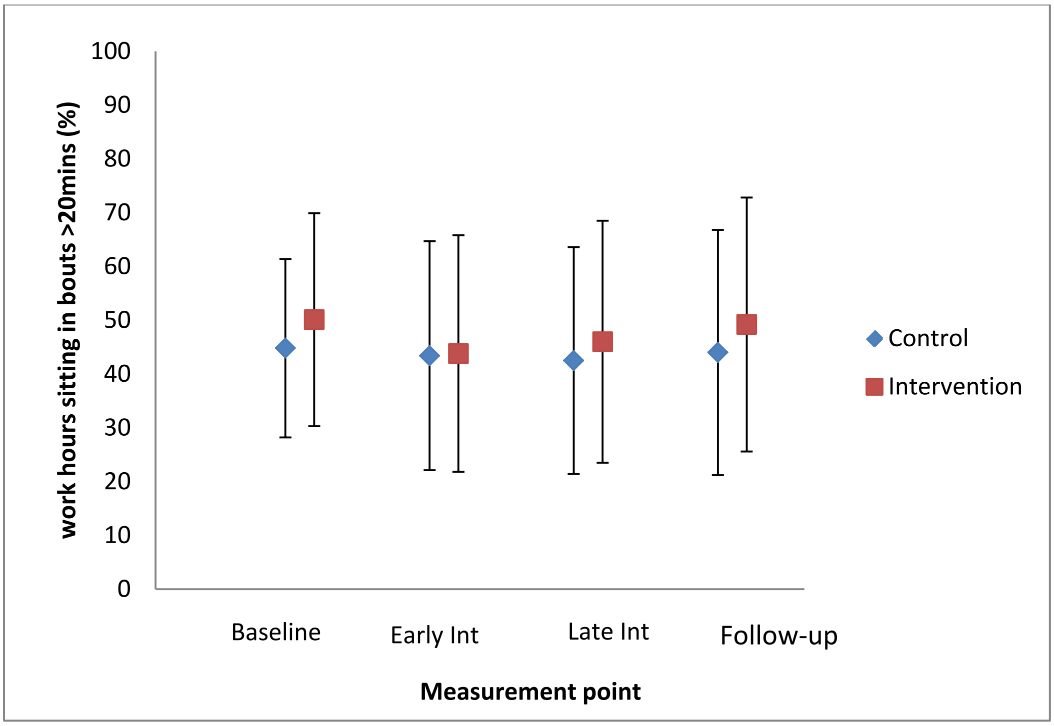


Figure 5.24 Mean & confidence intervals for proportion of time sitting in events >20 minutes for control and intervention groups across 4 measurement points

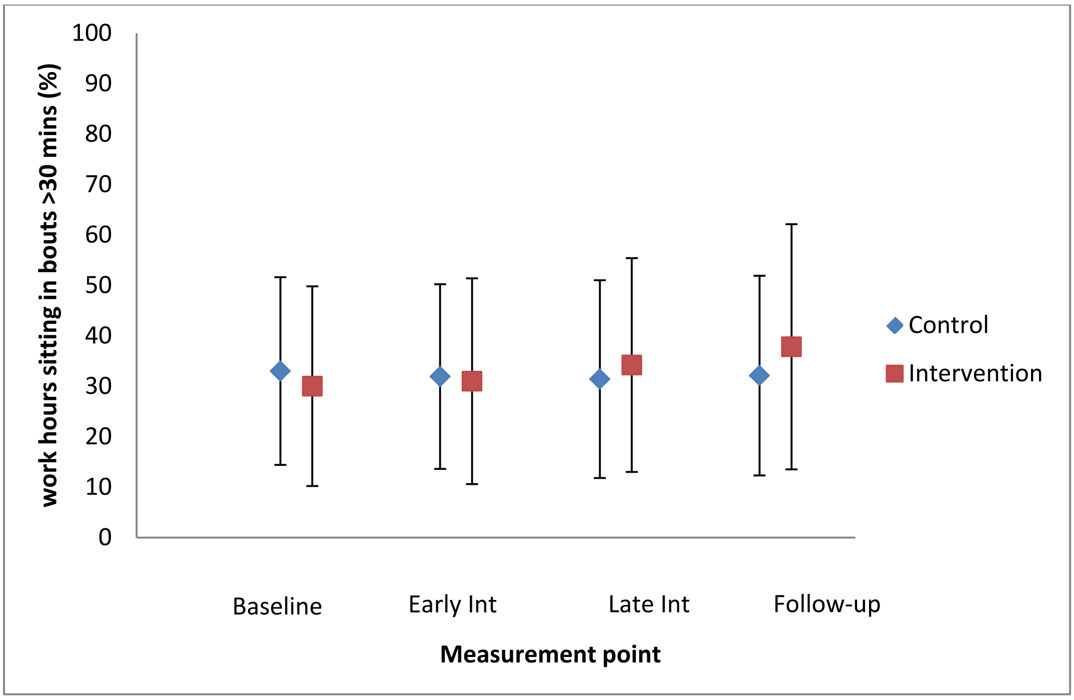


Figure 5.25 Mean & confidence intervals for proportion of time sitting in events >30 minutes for control and intervention groups across 4 measurement points

5.3.6.3 Changes to sedentary behaviour – individual behaviour change

Whilst the small sample size may explain the absence of significant differences between the groups over time, it was noted that reductions in sitting were seen in both groups between baseline and intervention. Looking at the data for changes in individuals' sitting behaviour allowed the sample to be split into 'improvers' - those that reduced their sitting from baseline, and 'non-improvers' who showed no reduction or an increase in sitting during working hours (Table 5.14). It is worth noting that improvers include both those that improved at early or late intervention and maintained their reduction in sitting at follow-up, those that improved at early or late intervention and did not maintain the improvement, and those that did not show improvements until follow-up.

Table 5.14: Number of participants improving and not-improving sitting outcomes by group

Outcome	Improvers			Non-improvers		
Group	C	I	All	C	I	All
Total sitting all days [a] [%]	12	11	**23**	2	2	**4**
Total sitting work hours [b] [%]	9	11	**20**	5	2	**7**
Mean sitting event duration work hours [b] [minutes]	11	10	**21**	3	3	**6**
Time in event >20 minutes work hours [b] [%]	11	9	**20**	3	4	**7**
Time in event >30 minutes work hours [b] [%]	12	13	**25**	2	0	**2**

Data displayed in cells are for number of individuals (n=27). Outcomes were calculated using data on amount of time the activPAL was worn during waking hours [a] and working hours [b]. Improvers are those that have reduced % sitting time from baseline. Non-improvers have shown no reduction, or an increase in sitting. C = control group, I = Intervention group

Overall, more participants were improvers than non-improvers in terms of reducing their sitting for all outcomes, with similar numbers of each in both the control and intervention groups. Almost half of all individuals from each group improved in all sedentary behaviour outcomes (Control n=6, Intervention n=6) and the remainder improved sitting for some, but not all, outcomes (Control n=8, Intervention n=7). All individuals improved on their baseline sitting for at least one outcome during the course of the study.

Note that the number of sitting events was not examined for this purpose as this outcome in isolation does not provide an insight into sitting improvement e.g. an increase in the number of sitting events might indicate more sitting, or might be indicative of more frequent events of shorter duration.

5.3.6.4 Changes in sedentary behaviour across the whole sample

As the majority of participants showed some improvement in their sitting outcomes (Table 5.14), the differences between the key outcomes at different measurement points were examined in the sample as a whole (Table 5.15). Paired t-tests showed that there were no significant differences between means for each outcome at each measurement point. The greatest reduction in sitting was seen in the proportion of time at work spent sitting between baseline and early intervention (-5.6% ± 14.5, p=0.07) which subsequently increased slightly by late intervention (+1.0% ± 13.6), and again at follow up (+2.2% ± 12.7) but still remaining below baseline levels (-2.8% ± 14.2, p =0.33). Whilst the duration of mean sitting events remained static across measurement periods, proportion of time at work spent in events >20 minutes followed a similar pattern to total sitting time at work: initially decreasing from baseline to early intervention (-3.1% ± 12.6, p =0.23) before increasing at late intervention and follow up to a mean level slightly below that recorded at baseline (-0.4% ± 17.3, p = 0.39). A similar reduction was made in the proportion of time spent in events >30 minutes (Table 5.15).

Table 5.15: Difference in means between measurement points for whole sample

Outcome	Baseline (n=27)	Early Int (n= 25)	Late Int (n=27)	Follow-up (n=26)	Difference baseline – early int (n=24)	Difference baseline – late int (n=26)	Difference baseline – follow-up (n=25)	Difference early int – late int (n=24)	Difference early int – follow up (n=23)	Difference late int – follow up (n=25)
Total sitting all days [a] [%]	60.0 ± 8.5	59.1±10.7	60.8±9.1	61.47±9.7	-1.4 ± 8.7 *p = 0.43*	+1.6±6.9 p=0.26	+1.7 ± 7.9 *p = 0.30*	+2.4 ± 8.1 *p = 0.15*	+3.2±9.2 p=0.10	+1.6±9.8 p=0.43
Total sitting work hours [b] [%]	72.0±10.9	65.9±17.6	67.2±15.6	69.5±17.3	-5.6 ± 14.5 *p = 0.07*	-3.9±13.4 p=0.15	-2.8 ± 14.2 *p = 0.33*	+1.0 ±13.6 *p = 0.72*	+1.9±12.4 p=0.46	+2.2±12.7 p=0.39
Sitting events per hour at work [b] [number]	3.4 ± 1.1	3.3± 1.3	3.2±1.2	3.4 ± 1.4	-0.1±0.8 p=0.58	-0.1±1.0 p=0.47	+0.1 ± 0.8 *p = 0.64*	- 0.1 ± 1.5 *p = 0.74*	-0.02±1.2 p=0.91	+0.1±0.9 p=0.56
Mean sitting event duration work hours [b] [mins]	14.2 ± 5.3	14.3 ± 6.9	14.3±6.6	14.2 ±7.0	+0.2 ± 4.7 *p = 0.83*	+0.2±3.7 p=0.84	+ 0.2 ± 6.0 *p=0.88*	-0.1 ± 6.3 *P=0.93*	-0.1±7.5 p=0.87	+0.1±5.8 p=0.98
Time in event >20 minutes work hours [b] [%]	47.4±18.1	43.6±21.2	44.3±21.5	46.5±22.9	-3.1 ± 12.6 *p = 0.23*	-2.7±13.8 p=0.32	- 0.4 ± 17.3 *p = 0.39*	+ 0.5 ± 15.5 *p = 0.88*	+1.7±15.1 p=0.60	+2.6±15.1 p= 0.40
Time in event >30 minutes work hours [b] [%]	34.9±18.3	31.4±18.9	32.9±20.1	34.9±21.9	-3.2 ± 9.6 *p = 0.11*	-1.7±11.7 p=0.46	+0.07 ± 15.1 *p = 0.82*	+1.7 ± 13.9 *p = 0.54*	+2.5±14.5 p=0.43	+2.4±13.8 p=0.39

Data displayed in cells are for means and standard deviations or difference between means and standard deviations at 2 measurement points for the whole sample. P values are the result of paired t-tests at 95% confidence interval. Outcomes are calculated using data on amount of time the activPAL was worn during waking hours [a] and working hours [b]. C = control group, I = Intervention group. Early int = early intervention. Late int = late intervention

5.3.7 Response to prompts

Participants' responses to prompts were examined in the same way as in the feasibility study, by comparing standing time following a real prompt to standing times compared to pseudo-prompts (Section 4.3.5).

The amount of time taken to stand following prompts was not normally distributed, and therefore the median time to stand (and inter-quartile range) following pseudo (non-existent) and real prompts was examined (Table 5.16).

Table 5.16 Time taken to stand following random and real prompts by group

Time point: Pseudo/real prompts Group	Median time to stand following prompt (mins)	Shortest time to stand following prompt (mins)	Longest time to stand following prompt (mins)
Baseline: pseudo-prompts **C (n=14)** **I (n=13)**	12.4 (5.8-16.5) 14.1 (8.4-16.6)	0.08 (0.03-0.27) 0.02 (0.02-0.13)	143 (50 –243) 221 (167-267)
Early Int: pseudo-prompts **C (n=12)** **I (n=13)**	7.5 (4.2–12.8) 8.0 (5.3-12.2)	0.05 (0.02–0.11) 0.07 (0.01-0.14)	87 (44–154) 74 (53-113)
Early Int: real prompts **I (n=13)**	10.3 (2.2-12.4)	0.03 (0.01-0.07)	75 (61-120)
Late Int: pseudo prompts **C (n=13)** **I (n=14)**	11.0 (9.1 – 15.8) 10.1 (5.4-15.6)	0.12 (0.01 – 0.37) 0.12 (0.02-0.19)	73 (48–157) 103 (58-136)
Late Int: real prompts **I (n=14)**	8.9 (5.8-16.0)	0.07 (0.04-0.14)	69 (58-148)
Follow-up: pseudo prompts **C (n=13)** **I (n=13)**	9.4 (6.3 – 17.7) 9.9 (5.8-21.6)	0.13 (0.05–0.34) 0.07 (0.02-0.1)	53 (31–93) 92 (61-178)

Data in each cell is for median time in minutes (inter-quartile range). Pseudo refers to non-existent prompts created after data collection for the purposes of comparison. Real refers to the actual prompts received by the intervention group. C = control group, I = Intervention group

Time to respond to pseudo-prompts was higher in the intervention group than the control group at baseline (+ 1.7 minutes), with intervention group participants longest time to stand after a pseudo prompt exceeding the control group by 78 minutes. Both groups reduced their median response to prompts (C=-4.9mins: 40%, I=- 6.1mins: 43%) from baseline to early intervention (Figure 5.26) and their longest time to stand (C= -

56min: 39%, I= -147min:67%) (Figure 5.28). The control group continued to decrease their longest time to stand at late intervention and follow-up (-90 mins, 63% at follow up from baseline) whilst the intervention group increased longest stand time but at a level below baseline (-129 mins, 58%). There was little change to the shortest response time in both groups (Figure 5.27).

For the intervention group, median response times to real prompts were slightly longer (+2.3 minutes) than a 'response' to the pseudo-prompts at early intervention and slightly quicker at late intervention (-1.2 minutes) (Figure 5.29). There was a tendency for the shortest time to stand to be less following real prompts than pseudo prompts at both early and late intervention measurement points (Figure 5.30). Longest time to stand was similar for both pseudo and real prompts at early intervention, but 34 minutes less for real prompts than pseudo prompts at late intervention (Figure 5.31). Wilcoxon signed ranks tests showed these differences to be non-significant at any measurement point. This suggests that the standing events occurring in the intervention group during the intervention period were not necessarily as a direct response to the prompts they were receiving.

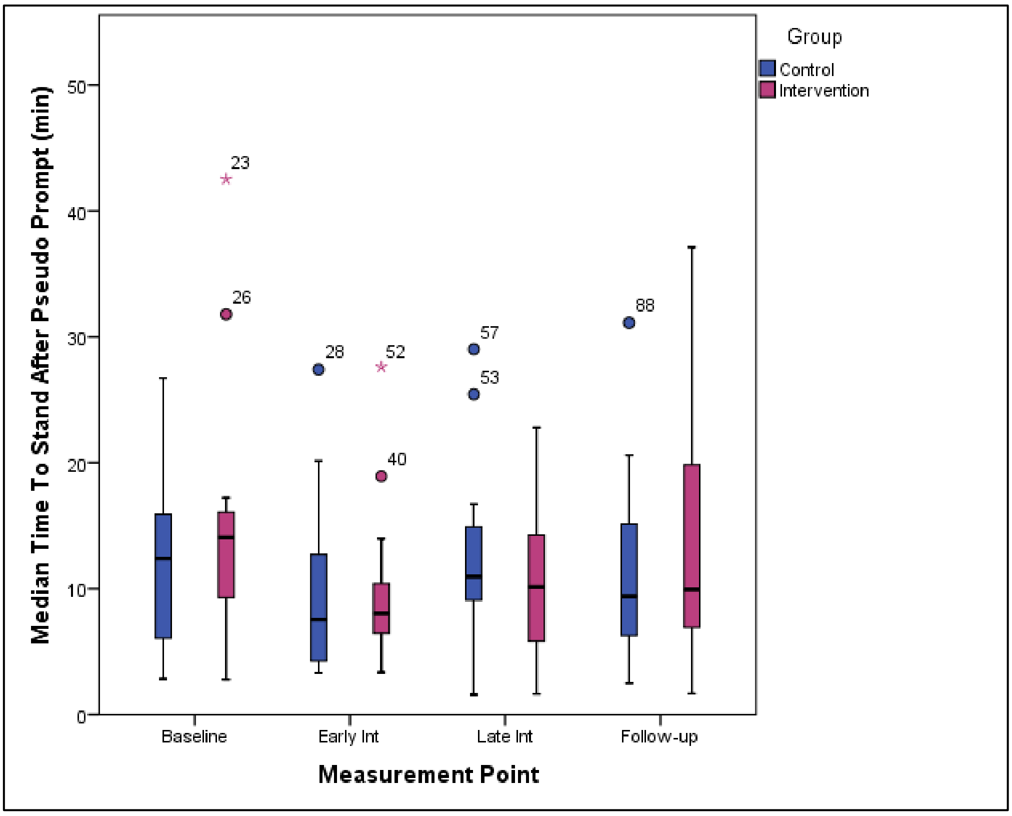


Figure 5.26 Boxplots of the median and range of time to stand after pseudo prompts at each measurement point

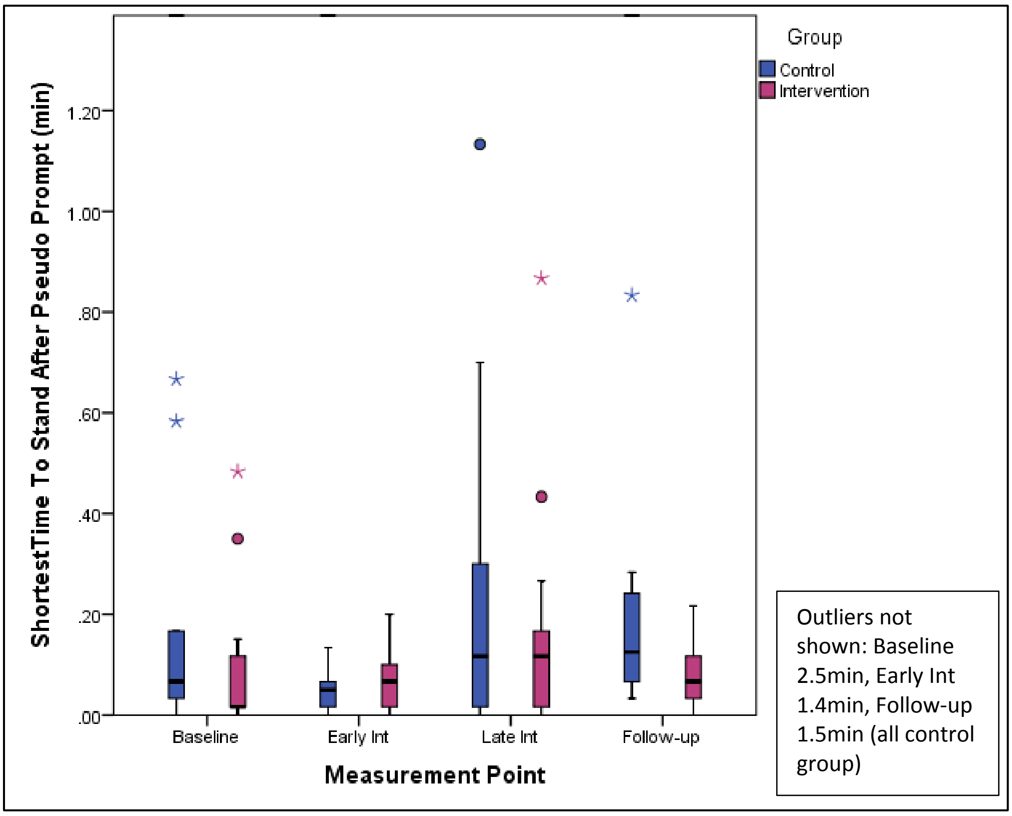


Figure 5.27 Boxplots of the median and range of shortest time to stand after pseudo prompts at each measurement point

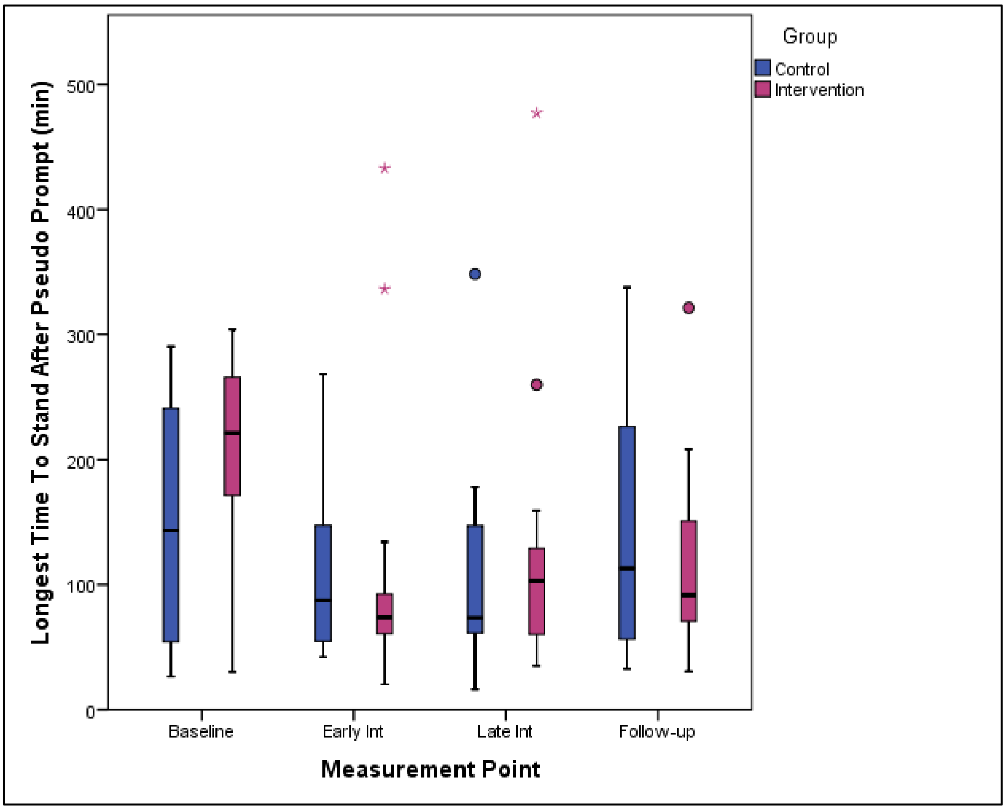


Figure 5.28 Boxplots of the median and range of longest time to stand after pseudo prompts at each measurement period

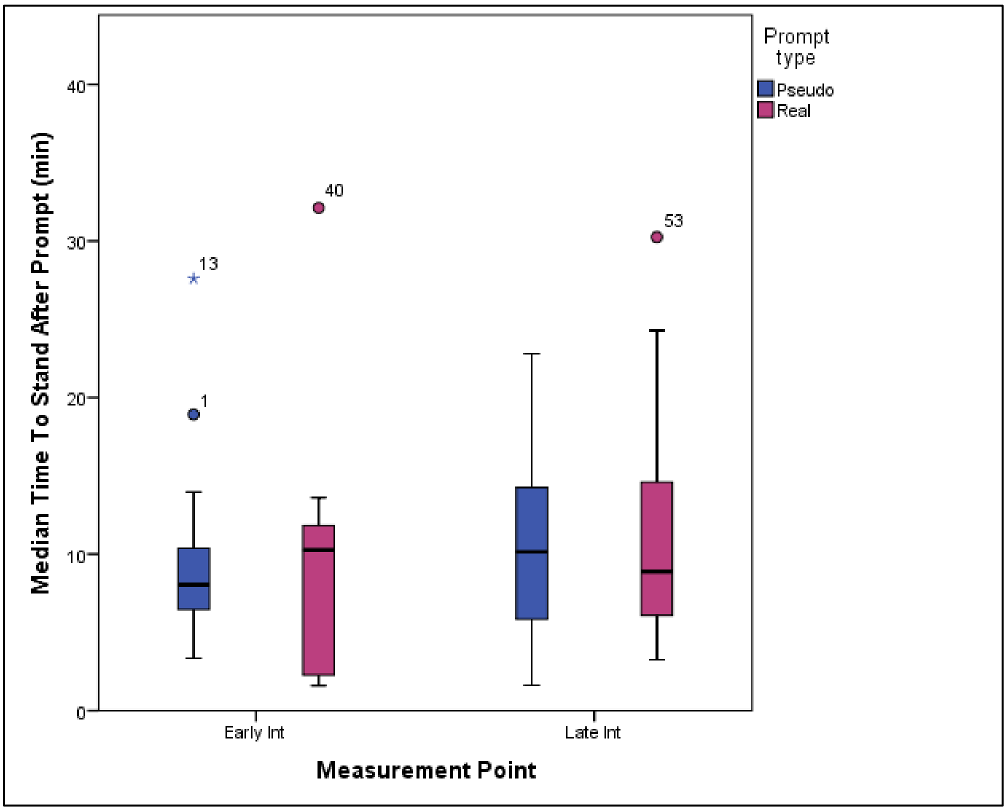


Figure 5.29 Boxplots of the median and range of time to respond to pseudo and real prompts by intervention group

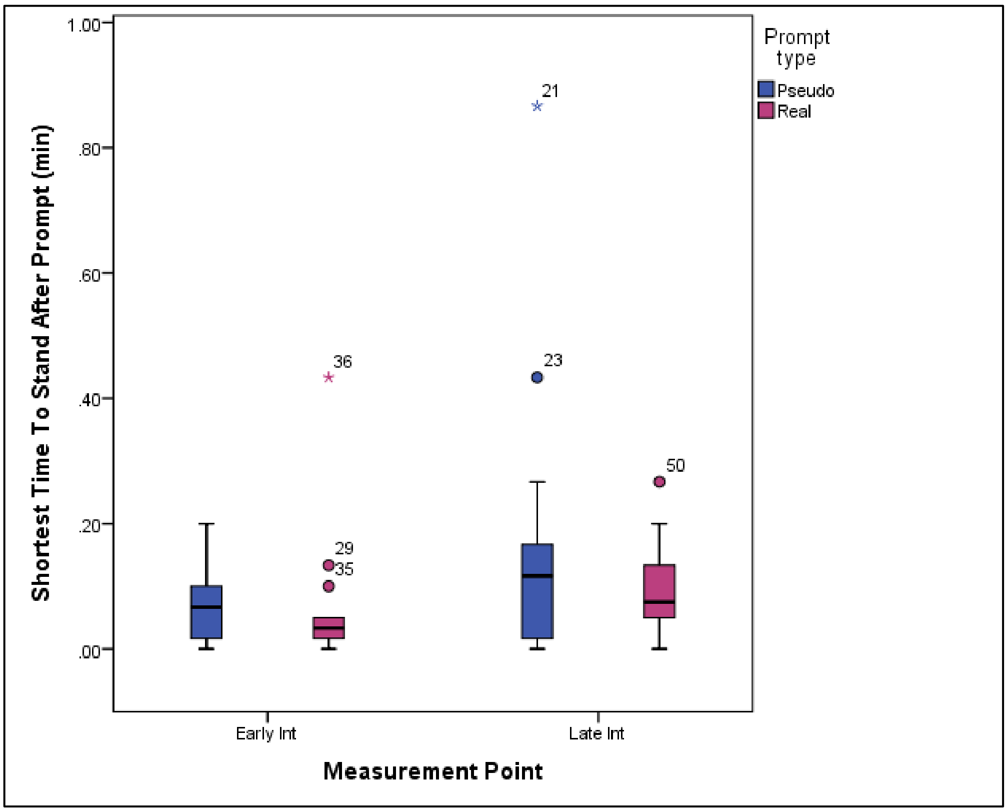


Figure 5.30 Boxplots of the median and range of shortest time to stand after pseudo and real prompts by intervention group

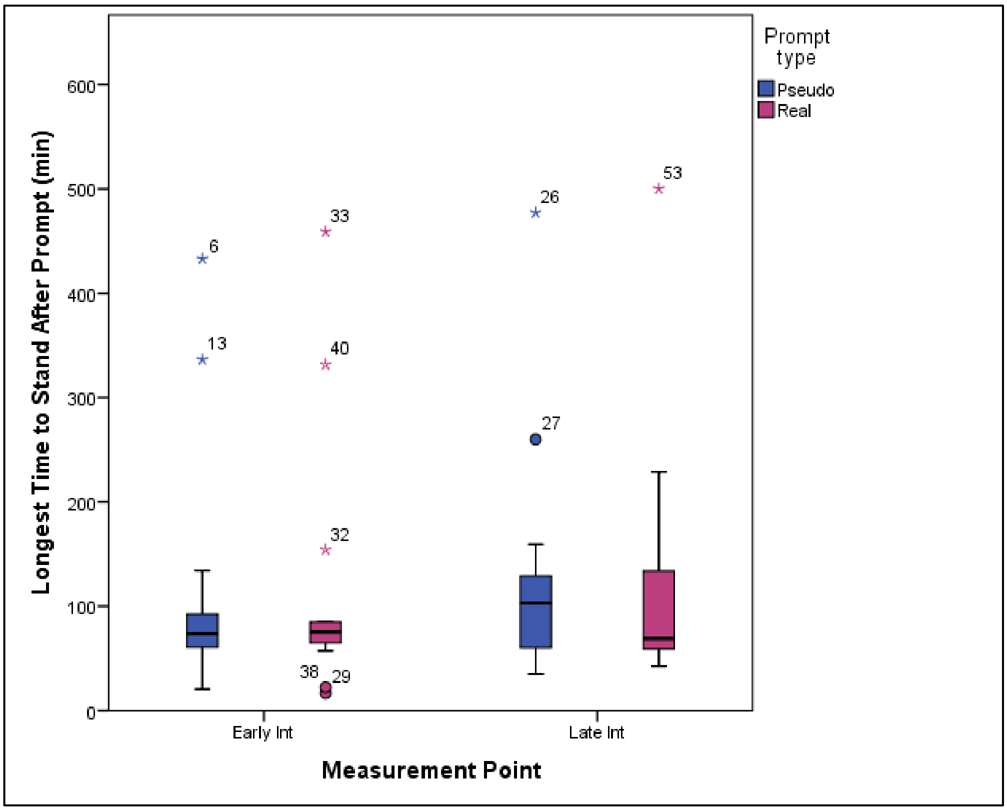


Figure 5.31 Boxplots of the median and range of longest time to stand after pseudo and real prompts by intervention group

5.3.8 Impact of participation in walking challenge

After baseline measurement had commenced, the researcher was made aware of a company-wide walking challenge that some of the PAWS participants were also enrolled in. This involved participants competing in teams to achieve the highest number of steps, recorded by a hip-worn 'Jawbone' pedometer linked to an online website, over a 2-week period. Based in branches of the organisation throughout the world, teams competed to achieve the highest number of steps and win the chance to nominate a charity to receive a $25,000 financial grant awarded by the company. Participants were also incentivised by receiving a free pedometer, which they were allowed to keep, and the fact that the challenge was supported and encouraged by management who wanted to have a winning team from their branch. The walking challenge ran from the 2^{nd}- 15^{th} May 2016 and therefore, for some participants, this overlapped the baseline measurement period by four days. The walking challenge had finished before the early intervention measurement period, although participants spoke of intentionally increasing their step count prior to commencement of the challenge, and maintaining higher step counts after the challenge. Thirteen PAWS participants took part in the walking challenge, 8 from the intervention group and 5 from the control group.

Analysis of step counts showed that those study participants who also participated in the walking challenge, walked significantly more steps during working hours than those who had not participated in the challenge (Figure 5.32 and Table 5.17).

Increased step counts in challenge participants were also significantly higher during non-work hours on work days, at late intervention and follow up (Table 5.17). Increases in walking duration were relative to increased step counts as average cadence remained the same.

In order to ascertain whether differences in step counts had any impact on sedentary behaviour during work hours, the six key sedentary behaviour outcomes were examined for participants and non-participants in the walking challenge (Table 5.18). Walking challenge participants tended to sit less, and spend less time in prolonged events of sitting during work hours, than those that did not participate in the challenge at baseline, early intervention, and follow-up. These differences were not statistically significant, but suggested that challenge participants substituted sitting time for walking time during both work and non-work hours.

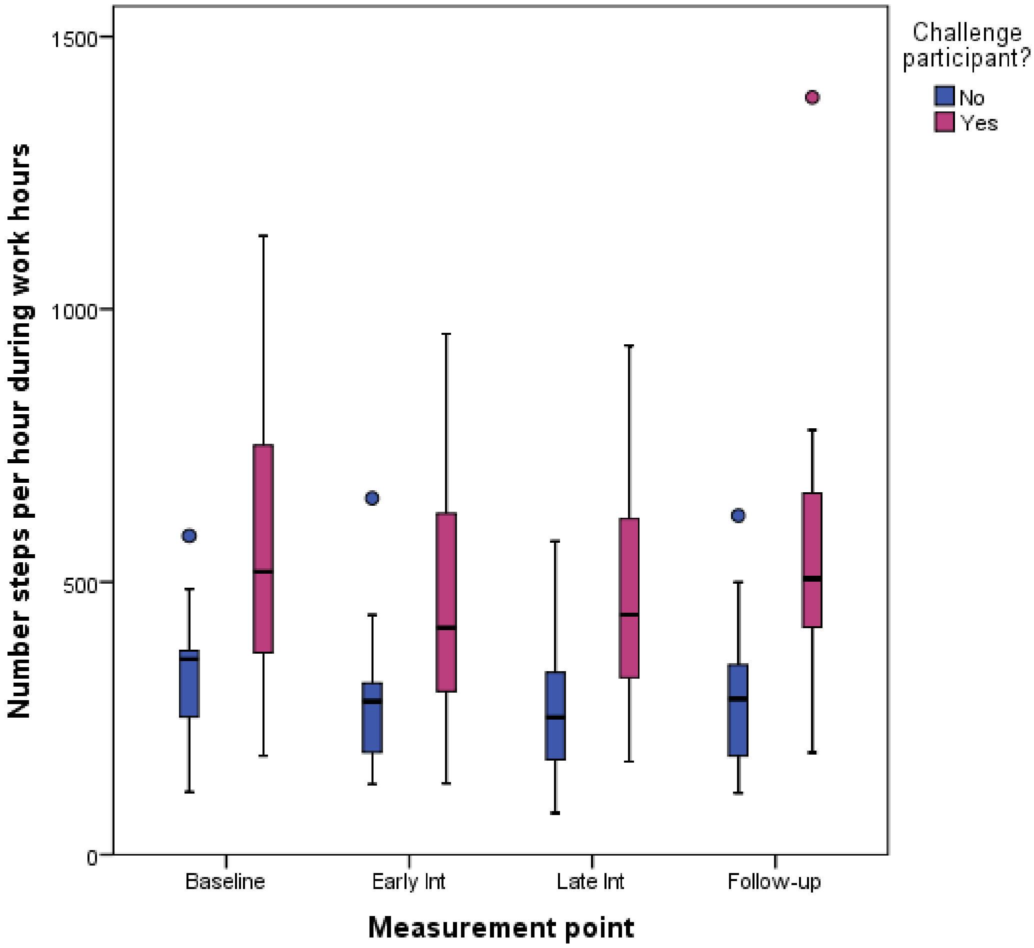


Figure 5.32 Median and range of step counts during working hours for participants and non-participants in company led walking challenge

Further exploration of the outlier seen at follow-up by a participant who took part in the walking challenge (Figure 5.32), identified that the majority of steps at work were accumulated in three distinct bursts of brisk walking over 45-60 minute periods within a 12 hour work shift, presumably during work breaks.

Table 5.17 Step counts for participants and non-participants in the company-led walking challenge

Time point	**Baseline**		**Early Intervention**		**Late intervention**		**Follow-up**	
Challenge participant?	**Y (n=12)**	**N (n=15)**	**Y (n=12)**	**N (n=13)**	**Y (n=13)**	**N (n=14)**	**Y (n=13)**	**N (n=13)**
Steps/ hours worn ALL DAYS	793±238	639 ±227	689±255	556±252	637±178	439±133	623±218	478±188
Between group differences	*p=0.09*		*p=0.20*		***p=0.003***		*p=0.082*	
Steps/ hours worn WORK DAYS	730±262	531.5±212	670±321	453±205	620±224	394±143	617±232	397±166
Between group differences	***p=0.04***		***p=0.05***		***p=0.004***		***p=0.01***	
Steps/ hours worn WORK HOURS	583±299	330±131	485±263	290±140	479±207	268±124	564±301	303±149
Between group differences	***p=0.007***		***p=0.028***		***p=0.03***		***p=0.01***	
Steps/ hours worn WORK DAYS, NON WORK HOURS	914±356	754±399	892±421	639±373	816±355	556±246	710±213	487±197
Between group differences	*p=0.29*		*p=0.125*		***p=0.035***		***p=0.01***	
Steps/ hours worn NON-WORK DAYS	904±322	816±385	727±281	781±461	621±189	554±279	665±322	610±283
Between group differences	*p=0.55*		*p=0.745*		*p=0.50*		*p=0.67*	

Y= Yes, participants took part in walking challenge, N= No, participants did not take part in walking challenge. Numbers in cells represent average number of steps ± standard deviation.
p values represent the result of independent t-tests for between group differences. P values in red are significant differences between groups p≤0.05.

Table 5.18 Differences in key sedentary behaviour outcomes between participants and non-participants in the company-led walking challenge

Time point	Baseline		Early Intervention		Late intervention		Follow-up	
Challenge participant?	**Y (n=12)**	**N (n=15)**	**Y (n=12)**	**N (n=13)**	**Y (n=13)**	**N (n=14)**	**Y (n=13)**	**N (n=13)**
Total sitting all days [a] [%]	58.3±9.4	61.4±7.7	55.5±13.5	62.3±6.3	58.5±8.9	63.0±9.0	60.0±8.8	63.5±10.5
Between group differences	*p=0.36*		*p=0.12*		*p=0.20*		*p=0.37*	
Total sitting work hours [b] [%]	70.5±12.1	73.1±10.2	60.3±20.8	71.1±12.8	69.5±14.7	65.1±16.7	66.8±16.5	72.2±18.2
Between group differences	*p=0.54*		*p=0.13*		*p=0.47*		*p=0.43*	
Sitting events per hour at work [b] [number]	3.3±0.8	3.5±1.3	3.1±1.2	3.5±1.4	3.3±1.2	3.2±1.3	3.5±1.1	3.3±1.7
Between group differences	*p=0.63*		*p=0.45*		*p=0.86*		*p=0.81*	
Mean sitting event duration work hours [b] [mins]	13.8±5.4	14.3±5.1	14.4±8.8	14.1±4.9	14.8±7.5	13.8±5.9	13.16.5	15.4±7.5
Between group differences	*p=0.93*		*p=0.93*		*p=0.72*		*p=0.41*	
Time in event >20 minutes work hours [b] [%]	46.5±18.4	48.0±18.4	38.7±22.8	48.2±19.5	46.7±21.5	42.0±22.0	43.1±21.6	50.0±24.4
Between group differences	*p=0.83*		*p=0.27*		*p=0.58*		*p=0.45*	
Time in event >30 minutes work hours [b] [%]	34.3±18.9	35.4±18.4	25.7±19.8	36.7±17.2	34.1±20.7	31.8±20.2	30.9±21.2	38.9±22.8
Between group differences	*p=0.88*		*p=0.15*		*p=0.77*		*p=0.37*	

Y= Yes, participants took part in walking challenge, N= No, participants did not take part in walking challenge. Data displayed in each cell are Mean ±standard deviation were calculated using data on amount of time the activPAL was worn during waking hours [a] and working hours [b]. P values are the result of independent t-tests measuring differences between participants taking part/not taking part in the walking challenge

5.4 Discussion

5.4.1 Feasibility of intervention

5.4.1.1 Recruitment and retention

In the weeks immediately prior to recruitment, the worksite announced redundancies and closure of the sales and marketing department. Following completion of the study the company has announced complete closure of the site. This is likely to have impacted on recruitment, in terms of reducing the number of potential participants, and also the impact on the morale of the workforce, and the recruitment target of 60 participants was not met. Thirty-nine office workers volunteered (35% of those approached directly), and all met the eligibility criteria, however nine (23%) withdrew prior to baseline data collection. Reasons were not given for withdrawal, but it transpired that the week of the baseline measurement coincided with the start of a company-wide walking challenge for which many workers were enrolled. Those participating in the challenge had been given a hip-worn pedometer and were competing in teams to record the highest number of step counts over a period of 2 weeks. It may have been that participating in this challenge took priority over participating in PAWS, and for those that participated in both, this potentially impacted on baseline measurement. This is discussed further in section 5.4.4.1.

Recruiting from, and conducting interventions in, a workplace faced with job losses and job uncertainty, is not an ideal scenario for research studies. However, it is not an uncommon situation and represents day-to-day work life for many. Once baseline measurement was complete, retention was good, with only one participant withdrawing from the study. As in the feasibility study, good communication with participants was maintained throughout and if participants missed a data collection measurement, they were encouraged to remain in the study and participate in subsequent data collection. Whilst this meant that participant numbers varied between measurement periods it maximised the data available for a small-scale study.

Increasing participant numbers by recruiting from multiple worksites was not considered for this pilot study, as the benefits of a larger sample size were not thought to outweigh the issue of introducing bias in the form of different work environments, cultures, and practices. As recruitment, rather than retention, was the issue in this study, future studies may wish to consider using multiple sites in order to increase the sample size. A sample size calculation from the feasibility study estimated that a sample size of 27 participants per group would have allowed any statistical differences between groups to be demonstrated. Collecting information regarding potential differences in environments, such as work roles, office configuration, and size of organisation, may help control or explain differences in behaviour or intervention impact between different worksites. It is worth noting that cluster analysis to control for such differences would again require a larger sample size.

5.4.1.2 Collecting activity data

Participants were, on the whole, compliant with collecting data that met or exceeded the minimum requirement, with only one participant excluded from analysis for not meeting this criterion. Levels of compliance were similar to those achieved in the feasibility study (section 4.3.2.1) and other studies using continuous monitoring (Edwardson et al. 2016), with over 86-93% of participants collecting three or more days data at any of the four measurement periods (section 5.3.2.1).

Despite communication from the researcher aimed at minimising non-wear time (emails before and during measurement periods reminding participants when to wear and remove monitors), 75 days (11%) of data were excluded due to minimum wear time not being met, slightly less than in the feasibility study (14%). As in the feasibility study, the main cause of this was the monitor being removed before the end of the monitoring period (41.3%) and monitors ceasing to record before the end of the programmed 14 days due to insufficient battery charge (34.6%). Efforts were made to ensure that monitors were fully charged prior to distribution and only given to participants the day before monitoring was due to begin. However, further tests of the battery health of monitors should be made in future studies and the importance of not removing them prematurely, re-enforced.

Although, it had no known impact on compliance with collecting data, discomfort wearing monitors was once again raised in both focus groups. Alternative materials for waterproofing and attaching monitors should be explored for future studies, in order to improve participants' experience and potentially reduce premature removal of monitors.

5.4.1.3 Prompts delivered by Microsoft Outlook

As with the feasibility study, the upload and delivery of prompts via Microsoft Outlook proved to be a feasible, low cost method of providing office workers with randomly timed reminders to break-up their sitting. The content and variety of messages were evaluated favourably by most intervention group participants, although some admitted to ignoring the content. As with the feasibility group, participants spoke of prompts being initially effective, but their impact diminishing over time. This is discussed further in section 5.4.4.3, in the context of changes to sedentary behaviour outcomes during the intervention.

5.4.1.4 Education session

Similar to the feasibility study, the education sessions were evaluated favourably by participants in both focus groups, and had prompted some to take action regarding their patterns of sedentary behaviour. Participants were in favour of receiving feedback on their baseline sedentary behaviour, and felt that this was valuable in prompting them to make changes to their behaviour. Providing a videoed presentation of the education session for those unable to attend in person, proved to be a convenient way of reaching all participants in a short time-frame. It was also cost-effective in terms of reducing the need for additional travel for those delivering the session. All participants who received the education session in video format, emailed the researcher to confirm that they had watched the presentation, although this cannot be independently corroborated. Future studies might attempt to look at the level of understanding from education sessions delivered in person and in video format to ascertain if there are any differences in understanding from the two modes of delivery. Further clarification of the key messages may also be required given that some focus group participants were still uncertain regarding key facts. The potential impact of education on sedentary behaviour is discussed further in section 5.4.4.4 in the context of changes to sedentary behaviour outcomes during the intervention.

5.4.2 Applying Social Cognitive Theory to understand occupational sedentary behaviour

Initial thematic analysis of the focus groups conducted in the feasibility study, identified several broad themes in line with the key constructs of SCT (Bandura 1997) which led to further analysis within the precepts of this theoretical framework. The five constructs were as follows: i) situation/environment, ii) outcome expectations, iii) self-efficacy, iv) self-regulation, and v) observational learning. To further investigate the applicability of SCT to occupational sedentary behaviour, PAWS participants also completed a questionnaire (SCTQ) designed to measure these five constructs. This was completed at baseline, early intervention and follow-up. Mean scores were then calculated for each of the constructs and analysed in relation to sedentary behaviour outcomes. The results of this analysis are discussed in sections 5.4.2.1 - 5.4.2.5 alongside the results of the qualitative analysis from the focus groups conducted in both studies.

5.4.2.1 Situation/environment

Participants from both studies were very aware that their immediate environment had an impact on their sedentary behaviour. The physical environment of the office was generally considered not conducive to standing whilst continuing to work, and taking time-out from work to break up sitting, outside of formal breaks, was not always an option. PAWS participants were much more likely to spend formal breaks away from their desks, to escape the office, describing a culture of colleagues having lunch and coffee breaks together in the canteen. However, one office group, who were described as having a more pleasant office environment in terms of light and vista, stated they remained in their office during afternoon break as they did not feel the need to escape their immediate environment. This illustrates the potential for physical environments to be both facilitators and barriers to sitting, in ways other than simply providing or removing seating. Yet beyond the provision of sit-stand desks the relationship between the office environment and sitting behaviour is seldom explored (Duncan et al. 2013).

PAWS participants who travelled to other worksites recognised that they had more control of such breaks when they were in the role of 'customer' in another work environment. Though this is more linked to differences in self-efficacy and perceived behavioural control which are discussed further in section 5.4.2.3

Following the education session, some changes were made by the company's health and safety team to the office environment in which the PAWS study took place, such as replacing unsuitable chairs and providing wireless headsets. Those that had benefited from these changes had felt they had made a positive impact on their sedentary behaviour, but they still encountered barriers of the wider office environment such as feeling unable to walk around speaking into their wireless headset for fear of disturbing others. This demonstrates that changing people's movement within an office is not as simple as changing equipment or furniture that facilitates more standing, such as wireless headsets or sit-stand desks. People's behaviour is also influenced by the behaviour and perceptions of others around them. This is discussed further under the construct of observational learning (section 5.4.2.5).

In terms of the SCTQ, average scores for situation/environment increased slightly (non-significant) for both groups, across all three measurement periods (control group: 3.59-3.71, intervention group: 3.30-3.46). This suggests that participants became more aware of the link between their environment and their sedentary behaviour, but does not necessarily mean that the environment had a greater impact on their sitting. Further adaptation and expansion of the SCTQ questions regarding the perceived impact of the environment on current sitting patterns, may lead to better understanding of how to make facilitative changes to the office environment. For example, probing whether office furniture or office configuration prohibits or facilitates standing.

5.4.2.2 Outcome expectations

Focus group participants spoke of the education session increasing their expectations regarding the negative consequences of sedentary behaviour. That is, they placed value on such outcomes and perceived themselves to be at risk. Increasing an individual's outcome expectations, is thought to increase the likelihood of them taking action related to a health behaviour (Nutbeam et al. 2010). A recent review of behaviour change techniques to reduce sedentary behaviour rated persuasion and education to be amongst the 'most promising' (Gardner et al. 2016). However, whilst participants in both focus groups spoke about being shocked and convinced of the health risks associated with sedentary behaviour presented to them in the education session, the scores for expectation in the SCTQ decreased slightly (non-significant) from baseline to early intervention (Figure 5.2 & Figure 5.3). This may be due to the fact that the average scores for expectation, as measured by the SCTQ, were the highest of all the constructs at baseline (4.41 for the control group and 4.37 for the intervention group, out of a maximum score of 5) and therefore were not likely to increase further. Similar results were found in a recently published study that used an non-validated SCT questionnaire to determine the mediating effect of some social-cognitive constructs, on changes to sedentary behaviour in a multi-component intervention to reduced workplace sitting time (Hadgraft et al. 2017). It found that whilst there were significant intervention effects on perceived behavioural control, barrier self-efficacy and perceived organisational norms at three months, no significant effects were observed for their measure of knowledge/outcome expectations. The authors concluded that this may have been due to a high level of knowledge at the start of the project which could have been attributed to media coverage of the topic. This could be the case in both the feasibility and PAWS study, with participants commenting about reading recent coverage of sedentary behaviour in the media. It may also be that the SCTQ, as an un-validated questionnaire, was not accurately measuring outcome expectations, or that any impact of education was mediated through a different pathway.

5.4.2.3 Self-efficacy

Self-efficacy refers to an individual's belief that they can successfully carry out a behaviour (Bandura 1997). The majority of discussion in the feasibility focus groups centred around negative self-efficacy in that participants felt that they did not have the ability to reduce their sedentary behaviour. The exceptions were two individuals in the control group who described roles with a greater level of autonomy than others, and had put strategies in place to break their sitting using tasks that they carried out within these roles. In PAWS, individuals in the control group spoke in similar ways to the feasibility study participants about negative self-efficacy, but the intervention group did not. Whilst recognising barriers to taking breaks, such as becoming immersed in work, they did not frame this in the context of believing themselves unable to take action. This may be because they had been provided with prompts – a solution to help address barriers such as losing track of time. The SCTQ scores for self-efficacy show that the intervention group scored higher at follow-up (close to the timing of the focus groups) than the control group, but, interestingly, they also scored higher at baseline (differences between groups were non-significant at all time points). Both the control and intervention groups showed a significant increase in mean SCTQ self-efficacy scores from baseline to early intervention (control group: +0.8, p=0.00, intervention group +0.6, p=0.04) followed by a significant decrease between early intervention and follow up in the control group (-0.4,p=0.005) and a non-significant reduction in the intervention group to a level above that of baseline (+0.41). This suggests that the education component was responsible for increasing participants' belief that they were able to reduce their sedentary behaviour at work. However, in the absence of regular reminders in the form of prompts, this belief diminished. No correlation was found between changes in self-efficacy and changes to sedentary behaviour outcomes (Table 5.7 & Table 5.8), which implies that increased self-efficacy did not lead to a reduction in sedentary behaviour. However, as changes to sedentary behaviour outcomes in the PAWS study were small, it is likely that any impact increased self-efficacy had on sedentary behaviour would be too small to detect.

Studies have shown that greater self-efficacy is linked to participation in physical activity (Bauman et al. 2012), however such links have yet to be made with sedentary behaviour. The multi-component "Stand Up Victoria" intervention that linked constructs of SCT to changes in sedentary behaviour, found significant intervention effects at 3 and 12 months for both perceived behavioural control (PBC) and barrier self-efficacy (BSE) (Hadgraft et al. 2017). Distinguishing between the perception of control or choice a participant had over changing their sedentary behaviour (PBC), and their belief that they could overcome the barriers that made it difficult to change sedentary behaviour difficult at work (BSE) may be important. Studies have shown, that whilst the two are often correlated, they can have varying and distinct influences on intention (Trafimow et al. 2002). Further adaptation of the SCTQ used in this study should therefore seek to distinguish between the elements of perceived control and self-efficacy in order to better understand how components of an intervention may mediate behaviour change.

5.4.2.4 Self-regulation

Self-regulation describes the ability to get past short-term negative outcomes in pursuit of a long-term goal through the use of behavioural strategies. Like participants in the feasibility study, PAWS participants spoke of developing strategies for prompting a break in sitting, based on work tasks or utilities – such as visiting the toilet, water cooler or canteen. In doing so, participants were potentially regulating the decision to break sitting to a lower control system in which behaviour was automatic, and less consciously thought about (Stevens et al. 2003, Bandura 1997). In PAWS, two participants in the control group also downloaded commercially available prompt software onto their PC or phone to set reminders to break their sitting during the course of the study.

Goal setting and feedback are common behavioural strategies associated with self-regulation (Bandura 1986) and a frequently cited behavioural change technique in interventions aimed at reducing sedentary behaviour (Gardner et al. 2016). Participants in the feasibility study were only given feedback on their sedentary behaviour at the end of the study, whilst PAWS participants also received a summary of their objectively measured baseline sedentary behaviour after the education session. This feedback was intended to give participants a clear picture of their current sedentary behaviour in order for them to be able to set goals with regards to reducing it, although specific direction to do so was not given. Focus group participants welcomed the sedentary behaviour feedback, but also expressed a desire for immediate feedback and praise that they received from other devices they used such as a Fitbit or the Jawbone pedometer they had been given for the organisation's walking challenge. Such real time feedback has been recognised as facilitating engagement in physical activity (Bort-Roig et al. 2014a) and recently sedentary behaviour, through the use of a mobile phone app (Bond et al. 2014) or smart-cushion (Gilson et al. 2016) to generate prompts in response to unbroken periods of sitting.

Self-regulation was referred to as 'behavioural strategies' in the SCTQ in line with the questionnaire from which it was adapted. Analysis of mean scores for behavioural strategies showed a significant negative correlation between total sitting on all days ($R=-0.644$, $p=0.00$), mean duration of sitting events at work ($R=-0.470$, $p=0.013$), proportion of time spent in prolonged events > 20 minutes ($R=-0.491$, $p= 0.009$) and >30 minutes ($R=-0.418$, $p=0.03$), for the whole sample at baseline. The correlation between mean score for behavioural strategies and total time spent sitting during work hours at baseline also approached significance ($R=-0.362$, $p=0.06$). It was the only construct measured by the SCTQ to show any significant correlation with sedentary behaviour outcomes. All correlations were negative: the greater the score for behavioural strategies, the smaller the sedentary behaviour outcome. Both the control and intervention group increased their mean score for behavioural strategies between baseline and early intervention, but this increase was only significantly higher in the intervention group (+0.7, p=0.019). This suggests that the education session was effective at prompting some participants in both groups to adopt behavioural strategies, but that the intervention group had the additional strategy of receiving prompts, given to them as part of the intervention. At follow-up, both groups had reduced their mean behavioural strategies score from early intervention, but it remained higher in both groups than at baseline. This suggests that those strategies adopted as a result of the education session, lasted longer than the prompt strategy imposed as part of the intervention, lending support to the use of a participatory approach to designing future workplace sedentary behaviour interventions (Parry et al. 2013, Goh et al. 2009, Farag et al. 2010).

5.4.2.5 Observational Learning

Observational learning is the understanding that individuals will learn behaviour from observing others and the rewards they associate with it (Bandura 1986). Whilst participants in the feasibility focus groups spoke about feeling 'weird' and 'strange' standing in the office when it was not the norm to do so, this was not the case with participants in the PAWS study. They spoke of an organisational culture in which it was common to witness others taking part in new initiatives and challenges centred around health and well-being. It was evident that there was a lot of peer support for taking part in initiatives or attending classes at the onsite gym. Feelings of unease were described, however, when discussing a previous health promotion exercise that promoted workers doing stretching exercises at work. It was agreed that such behaviour was not the cultural norm, although it may be in some other countries. In terms of this study, people standing or moving around the office wasn't noticed, as it fitted with the social norm. Unlike in the feasibility study, the intervention group did not feel they needed to explain their standing behaviour to colleagues.

Mean scores for observational learning, as measured by the SCTQ, increased slightly from baseline to early intervention (control = +0.16, intervention = +0.24) then decreased to levels just below baseline for the control group (-0.2 mean score) and just above baseline for the intervention group (+0.22 mean score). These changes were non-significant, but it is possible that the education session, and participation in the project, increased people's awareness of co-workers sitting and standing behaviour in the short-term. Perceived organisational norms were a construct measured in the Stand Up Victoria study (Hadgraft et al. 2017) and referred to both the organisational and social support felt by participants, for sitting less. Significant intervention effects were seen on perceived organisational norms at 3 months, but not at 12-month follow up, most likely due to the organisational-level intervention components ceasing at 3 months. Organisational norms were not directly measured by the SCTQ in the PAWS study, but undoubtedly had an impact on the social norms captured within the observational learning questions and discussed in the focus groups. Examining differences in perceived organisational norms and social norms of co-workers would give insight into whether an ecological approach, involving management at a high level, is required if a behaviour change intervention within its workforce is to be a success.

5.4.2.6 Summary of applying SCT to occupational sedentary behaviour

The explorative approach to analysing data collected regarding SCT constructs in the feasibility study through analysis of focus groups and questionnaires, provided useful insight into barriers and motivations for changing sedentary behaviour at work as well as highlighted possible mechanisms for effecting change. Analysis of focus group discussions illustrated that the five key constructs of SCT were far from distinct from each other, but instead inter-woven with one construct dependent upon factors within another. This meant analysing distinct components, as measured by the SCTQ, a difficult task, but one which allowed some correlations between constructs and sedentary behaviour outcomes to be observed. Increasing self-efficacy and behavioural strategies seemed to occur as a result of the education component of the intervention, with those that received the prompts seeing a bigger increase in behavioural strategies and longer-term maintenance in elevated self-efficacy. Though changes to SCT constructs, as measured by the SCTQ, were made, these were not correlated with changes to sedentary behaviour outcomes, most likely because the changes to sedentary behaviour outcomes were too small. No mediating effects could therefore be determined. This was also an issue in the Stand Up Victoria trial which demonstrated an intervention effect on all but one construct measured, but only perceived behavioural control significantly mediated the intervention effects on workplace sitting and that only explained 7.5% of the total effect (Hadgraft et al. 2017). It is also worth noting that, unlike the SCTQ used in this study, the questionnaire in the Stand Up Victoria trial did not account for environmental factors or self-regulation/behavioural strategies, inclusion of which may have changed the scoring, and therefore impact, of other items. Given the complex interaction of the different constructs of SCT it is unlikely that changes to one in isolation will have a significant effect on behaviour. However, by isolating the different components and their value in terms of changing sitting behaviour, behaviour change techniques to best facilitate change could be identified. The SCTQ would benefit from further refinement and validation to take into consideration measurements of perceived control, as well as distinguishing between social and cultural norms. The combined impact of different combinations of these elements could then be examined against changes in sedentary behaviour outcomes in order to weight their importance and in turn determine which behavioural change techniques interventions should seek to emphasise. In doing so, care should be taken not to constrain the outcome to one theoretical framework, but potentially allow the emergence of a new theory to underpin occupational sedentary behaviour.

5.4.3 Transtheoretical model: Identifying participants' stage of change

The Transtheoretical Model (TTM) identifies the different stages that people go through on the path towards changing behaviour, based on the premise that behaviour change is a dynamic process and that people have varying levels of motivation or readiness to change (Prochaska & DiClemente 1983). The TTM has been widely applied to a variety of behaviours including addiction, physical activity, weight control and preventative screening (Nutbeam et al. 2010), but to date has not been used to specifically examine how individuals may progress towards reducing their sedentary behaviour. PAWS participants were therefore asked to choose one of five statements relating to the five stages of change (Table 5.9) they most identified with at baseline, early intervention, and again at follow-up. The statements were adapted from those used in the readiness for physical activity stages of change scale (Haakstad et al. 2013).

5.4.3.1 Movement between the five stages of change

Interestingly no participants reported being pre-contemplative at baseline, which may be indicative of the motivation required for people to volunteer for this type of study. The majority of the control group (50%) identified as being in the contemplative stage, and the majority of the intervention group (35.7%) as being in maintenance (Figure 5.9 & Figure 5.10). As contemplation describes individuals considering making a change to a specific behaviour, and maintenance as sustaining changes already made, it may be expected that these differences would be reflected in difference in sedentary behaviour outcomes at baseline. However, the sedentary behaviour outcomes for the intervention group showed higher levels of sedentary behaviour than the control group at baseline, with the exception of sitting events greater than 30 minutes (Table 5.13). As the exact focus and purpose of the study were not revealed to the sample prior to the education session, there may have been differences in understanding with regard to the meaning of the statements in the SOCQ. In other words, participants may not have been aware that they should make changes to their sedentary behaviour at work, until this was highlighted to them in the education session and through feedback in their baseline activity reports. Whilst there was no correlation at baseline between SOC and sedentary behaviour outcomes during work hours, there was a correlation for the sample as a whole, between SOC and total sitting on all days. Participants in the later stages of change such as action or maintenance, tended to sit less than those in the early stages of change ($r = -0.456$, $p = 0.017$) (Figure 5.11). Thus, giving some evidence to their declaration that they were taking action to reduce their sedentary behaviour, but not necessarily during working hours.

Following the education session and feedback on baseline sedentary behaviour, there was some reduction in total sitting time at work and an increase in those in the preparation stage of change in the control group (+21%). For the intervention group, the greatest change between baseline and early intervention was the proportion of participants identifying as being in the action stage (+50%). This can be explained by the fact that the intervention group were receiving the intervention at the time the second SOCQ was completed. The control group had therefore only received the education component, which had resulted in an increase in participants preparing to change their behaviour, whereas the intervention group were receiving prompts, an action to reduce sedentary behaviour whether it was being complied with or not. It is also worth noting that there was an increase in the proportion of participants identifying as 'pre-contemplative' in the intervention group (+7%) although in real terms this represents one individual who had previously rated themselves as 'contemplative' at baseline.

At follow-up, the proportion of the control group in the action phase was at its highest (46%) although none identified as being in 'maintenance' (Figure 5.9). For the intervention group, the proportion in maintenance returned to baseline levels of 36%, with a higher proportion of those also in 'action' than previously (36%) (Figure 5.10). This suggests that the majority of participants in each group progressed through stages of change during the course of the study. Those that had received the prompt intervention were more likely to identify themselves as in a 'maintenance' phase at follow-up, but this cannot necessarily be attributed to the intervention as more participants in the intervention group identified as being in this stage at baseline.

5.4.3.2 Dichotomising stages into pre-action and action

Stage of change is commonly conceptualised as the proportion of individuals moving to the action and maintenance stages (Welk 2002). By splitting the five stages into pre-action (including pre-contemplation, contemplation, and preparation stages) and action (action and maintenance stages) it can be seen that the proportion of participants in action phases increases from baseline to follow up (C=21-42%, I=50-73%) (Table 5.10). Taking baseline levels into consideration, this suggests a similar amount of movement towards action stages in both groups. However, the cyclical nature of the TTM (section 2.6.12) means that individuals vary in how quickly they move through the stages, and how many times they may repeat different stages before reaching long-term maintenance of behaviour change (DiClemente 2005). This was demonstrated in both groups who showed progression, regression and non-movement through stages (Table 5.11). Exploring this further, the sample was divided into those who progressed from pre-action to action phases (Pa-A), those that regressed from action phases to pre-action (A-Pa), those that began and remained in pre-action (Pa-Pa) and those that began and remained in action (A-A). Looking at changes in sedentary behaviour outcomes for participants in each of these groups showed that there was a great deal of variation in terms of individuals increasing/decreasing their sedentary behaviour (Table 5.12, Figures 5.12-5.21). There was, however, a tendency for a greater proportion of those in the Pa-A group to decrease their sitting (total sitting, work hours total sitting, mean sitting event and prolonged events >30 minutes) more than any other group from baseline to follow-up. Those that regressed from A-Pa also had a greater proportion of participants reducing sitting (work hours total sitting, prolonged events >20 and 30minutes) than any other group between baseline and early intervention, but also had the greatest proportion of participants increasing their total sitting and mean sitting event from baseline to follow-up. Although it should be noted that this group only contained 3 individuals (baseline-early intervention) and 2 individuals (baseline-follow-up). Longer term reductions in sedentary behaviour at follow-up were therefore more likely to be associated with individuals who had moved from pre-action to action stages of change. A greater proportion of those that remained static in action phases (A-A) were more likely to improve their sedentary behaviour outcomes than those who remained static in pre-action phases (Pa-Pa), although this was not exclusively the case for all outcomes. What is also noticeable is the high proportion of participants from all groups remaining, relatively, static in their levels of sedentary behaviour which is illustrated in the small changes seen in the overall sample (Table 5.15).

The variation of improvement in sedentary behaviour outcomes across all four groups, and the small numbers of participants in each group, does not allow any definitive conclusions to be drawn from this analysis. Also, by dichotomising the phases into pre-action and action some of the movement between phases is lost, with over 50% of participants falling into one of the two static phases. This may be particularly important given that the time frame for follow-up may be insufficient to capture all movement from pre-action to action phases.

5.4.3.3 Processes facilitating movement through stages

As important to the movement through the different stages are the processes that facilitate or encourage such movement. Each stage represents a group of tasks that form the foundation for progressing change and in this way interventions can be tailored to help individuals' repeatedly carry out these tasks, moving towards behavioural change (Prochaska et al. 1992). DiClemente (2005) argued that these dynamic processes of change are evidence that education or awareness raising is not enough to produce change, but instead the repetition of tasks is required until the new behaviour becomes a habit that does not require conscious thought. However, this implies that education does not equip individuals with the ability to define their own tasks and take steps towards making change. Some participants in the control group of this study, for instance, progressed as far as identifying themselves in the action stage. Perhaps if they were followed up at 12 months, and had maintained the tasks that they had identified as putting them into action, they would be scored as being in 'maintenance'. The answer probably lies in what is defined as 'education'. Simply informing individuals that sedentary behaviour puts them at risk of health problems, may not be enough to evoke behaviour change. However, the comprehensive description of the evidence behind the health risks of sedentary behaviour, and embedding behavioural change techniques into the education and strategies for changing sedentary behaviour in the workplace taught to participants in both studies, may well have impacted on individuals' motivation to change. Looking at the ten processes of change defined by Prochaska, et al. (1992), and the stages between which they are most emphasised (Table 2.3), the education session in this intervention aimed to evoke consciousness raising, environmental re-evaluation, self-re-evaluation, and self-liberation. In this way, the education session provided participants with almost all of the tools required to move from pre-contemplation stages to action stages, and may explain the overall movement through stages displayed by the control group. The prompt intervention may have also contributed to the processes of counterconditioning, reinforcement management, and stimulus control, which are emphasised in moving people between action and maintenance stages. The process of 'helping relationships' is also believed to be important in securing maintenance of behaviour change. Social support was something discussed as being important in all focus groups in terms of its absence in the feasibility study and presence in the PAWS study. Ways of fostering peer support for reduced sedentary behaviour should therefore be a consideration alongside other processes in the development of future interventions to address sedentary behaviour in the workplace.

5.4.3.4 Summary of applying TTM to motivations to change occupational sedentary behaviour

The analysis of SOC in the PAWS study illustrates the complexity of motivation within the sample and how it can vary for individuals across the relatively short time-span of the study. This suggests that only including participants who were ready to change sedentary behaviour at baseline, as in the study by Pedersen, et al. (2014), is flawed in terms of not accounting for those that may revert to pre-action stages and vice-versa, within the course of an intervention. The results of this study also illustrates the frequent dis-harmony between motivations and intentions to change behaviour, and measurable behaviour change (Rhodes & Dickau 2012, Sniehotta et al. 2005). Critics of the TTM argue that its focus on personal motivation for change does not take into account external and social factors such as age, gender, and socioeconomic position (Adams & White 2005). Possibly more important in this context, is that it does not take into account environmental factors and the pressures of work. A workplace intervention may therefore be successful in motivating an individual to change, and demonstrate that change in terms of which statement they identify with on the SOCQ, but if environmental, task-related, and social barriers in the workplace are too great, then motivation will not be translated into behavioural change. This lends support to DiClemente's postulation that the TTM should contain a 3rd dimension; context of change (DiClemente 2003) which recognises the impact of both an internal and external environment on moving through the stages of behaviour change. This, alongside the processes of change, should be addressed as part of any intervention designed to facilitate movement through stages to ultimately achieve long-term reductions in occupational sedentary behaviour.

5.4.4 Sedentary behaviour outcomes

5.4.4.1 Baseline sedentary behaviour

Levels of sedentary behaviour at baseline (Table 5.15) were similar for PAWS participants and those measured in the feasibility study sample. The PAWS participants accumulated slightly less total sitting at work (72.0% of working hours compared to 75.2%) and time spent in events greater than 20 minutes (47.4% compared to 49.4%), and 30 minutes (34.9% compared to 36.0%). This puts participants in both studies towards the higher end of the proportion of time spent sitting at work as measured by other studies whose results fall within the range of 65-75% (Smith et al. 2015, Clemes et al. 2014a, Ryde et al. 2013, Ryan et al. 2011, Miller & Brown 2004). Variations in baseline sitting between samples are likely to be due to a number of factors including: differences in work tasks and levels of autonomy between occupational roles; differing office environments; and variation between individuals involved in the studies.

Whilst it is not possible to control for all such differences at baseline, it is worth considering that they will exist if analysing a sample recruited from multiple work-sites.

Although not significant, there were differences between the control and intervention group in the PAWS study, at baseline. The intervention group had a tendency to sit slightly more during work hours (C= 70.6% ± 12.5, I=73.5% ± 9.3), with a higher mean sitting event length (C= 13.2 ± 5.6 minutes, I=15.0 ±5.2 minutes) and greater proportion of time spent in events > 20 minutes (C= 44.8% ± 16.6, I=50.1% ± 19.8). The reasons for these differences is not clear. More people in the intervention group than the control group, participated in the company-led walking challenge which overlapped with the baseline measurement period. However, comparing sedentary behaviour outcomes for participants and non-participants in the challenge showed that despite statistically significantly higher step counts, those who participated in the challenge were more likely to sit less. Higher sitting at baseline in the intervention group is also at odds with the higher level of stage of change as previously discussed in section 5.4.3.1.

5.4.4.2 Changes to sedentary behaviour

It should be noted that the sample size of the pilot study was not sufficiently powered to detect significant differences in sedentary behaviour outcomes, based on the sample size calculation performed using data from the feasibility study data which estimated that a sample size of at least 27 participants per group would be required to show statistical differences between groups (section 4.3.4.2). However, overall, more PAWS participants made improvements to their sedentary behaviour during the study, than did not (Table 5.14). Reductions from baseline to early intervention were made in total sitting during work hours (C= -4.5%, I = -7.8%) which equated to an average daily reduction (non-significant) in sitting of -9 minutes in the control group and -49 minutes in the intervention group. Some of this difference can be attributed to differences between the groups in terms of variation in how long the activPAL was worn. The control group showed a greater variance in the amount of time the activPAL was worn during work hours compared to the intervention group (baseline: C= 8.26 ± 1.76 hrs, I=8.79 ± 0.4hrs; early intervention: C = 8.60 ± 1.9 hrs, I=8.61 ± 0.6 hrs). Therefore when reductions in sitting time during work hours is examined as a proportion of total work hours, the difference between groups is not significant.

Slight reductions (non-significant) were also made to total sitting on all days, mean sitting event duration (intervention group only) and time spent in events > 20 minutes and > 30 minutes (control group only) between baseline and early intervention. Sedentary time then increased across almost all outcomes from early intervention to late intervention, and again at follow-up (Table 5.13). This confirms, as postulated in the feasibility study discussion, that any intervention effect in terms of reduced sedentary behaviour, was more likely to be evident closer to the start of the intervention.

At 12 week follow-up, mean total sitting time at work remained below baseline levels equating to a reduction from baseline of -13.8 minutes in the control group, and -30 minutes in the intervention group (non-significant). Again, a greater variation in the number of hours the monitor was worn at work, can make these figures misleading (C=8.17 ± 2.14 hrs, I=8.47hrs ± 1.0 hrs). However, it is worth considering these reductions in terms of those achieved in other workplace intervention studies. For example, the Cochrane Review of workplace interventions to reduce sedentary behaviour (Shrestha et al. 2015) pooled together the results of two studies (Donath et al. 2015, Evans et al. 2012) investigating computer prompts and education study to give a non-significant reduction in work time sitting of -17 minutes at short-term follow-up. Whilst another study of similar design, showed a significant reduction of in work time sitting of -55 minutes a day at 13 week follow up (Cooley & Pedersen 2013). The review concluded that the quality of evidence was low for computer prompts and information provision, but the results show some promise for this type of intervention. As these results are similar to those achieved in this study, there is still a case for further investigation into the use of prompts to reduce sitting time.

The proportion of time spent in sitting events >30 minutes duration increased (non-significant) across all four measurement periods for the intervention group, whilst mean sitting event remained within 0.4 minutes of baseline levels of 15.0 ± 5.2 minutes. This suggests that increases in the percentage of time in periods longer than 30 minutes is the result of a number of long-uninterrupted sitting events by some of the group. The reason for these long events during work hours is not known i.e. whether they were due to travel, attendance of conferences etc, or why this was only seen in the intervention group. However, it is important to note that at baseline the average sitting event length in both groups was relatively short, falling beneath standard measures of prolonged sitting of 20 or 30 minutes. It could therefore be argued that this cohort of office workers did not require an intervention to break up prolonged events of sitting, despite their overall high level of total sitting at work. It would be valuable to collect information on tasks carried out by participants, at specific times, in order to determine how specific work tasks related to prolonged events of sedentary behaviour, in order to potentially develop strategies to break up sitting in specific problematic situations.

5.4.4.3 Impact of prompts

Analysis of participants' response to prompts (section 5.3.7) showed great variance in sitting patterns between individuals and within individuals at different times. This was demonstrated by the high IQR range and number of outliers. However, the absence of a pattern in standing soon after prompts does suggest that, for the intervention group, standing during the intervention period was not necessarily as a direct response to prompts they were receiving. This echoes the findings of the feasibility study and it also demonstrates, from the additional measurement period, that there was no difference between how participants responded to the prompts early in the intervention and late in the intervention. This was contrary to participants perceptions given in the focus groups of both studies, in which they believed they were initially standing in direct response to prompts at the beginning of the intervention, but this became less so as time progressed. It is possible, however, that this initial response had already worn off before early intervention monitoring which occurred between weeks 2-4 of the 10-week prompt- intervention period. In the study by Evans et al. (2012) which reported a significant reduction in the number and length of prolonged sitting events in the prompt intervention group, the follow-up measurement was made during the entire 5 day intervention period. It is therefore possible that such a significant intervention effect is only present when prompts are first received.

Analysing response to prompts by comparing prompt-time to stand-time for real and pseudo-prompts is a novel way of attempting to determine the mechanism by which, if at all, prompts impact on sitting. The analysis performed in both studies suggests that any small impact prompts have on reducing sedentary behaviour, is likely to be by providing reminders to stand which are not necessarily acted on immediately. This is probably not surprising in an office environment, given that focus group participants spoke of not wanting to, or not being able to interrupt the flow of work tasks to break-up sitting. This once again raises the question of whether prompts should force participants to take a break by locking or obscuring the computer screen (passive prompts) as previously discussed in section 4.4.3. There is currently no evidence to show whether more invasive prompts that lock computer screens have a greater impact on reducing sedentary behaviour or if the prompts themselves are more likely to be responded to, compared to prompts that are easily dismissed like those used in this study (active prompts).

Potentially another way of improving response to prompts, is the provision of real-time feedback. Focus group participants spoke favourably with regard to receiving immediate feedback on their step count and their own activity monitoring devices. Intervention group participants also spoke of the annoyance of receiving at prompt via Microsoft Outlook when they had just returned to their desks. A recently published study, showed a group that received prompts on a computer screen, triggered when workers sat on a pressure sensor cushion continuously for periods of 30 and 60 minutes, significantly reduced total sitting (-72 minutes/day) and sit event length (-15 minutes/day mean longest event) compared to those who did not receive prompts (Gilson et al. 2016). Response times to such prompts would also be valuable to investigate as well as comparing sedentary behaviour impacts of passive, active and real-time prompts.

5.4.4.4 Impact of education and feedback

As small reductions in sedentary behaviour outcomes were seen in both the control and intervention group between baseline and early intervention, and there were no significant differences between the two groups, it could be concluded that any intervention effect, is a result of the education session and feedback on baseline sedentary behaviour. Examining paired changes in sedentary behaviour in the PAWS study as a whole shows a reduction in total sitting during work hours of -5.6% ± 14.5 between baseline and early intervention which is approaching significance ($p=0.07$) (Table 5.15). In the feasibility study, significant reductions in mean length of sitting events (-2.1 ± 3.3 minutes, $p=0.02$) and time spent in sitting events longer than 20 minutes (- 7.7% ± 12.8, $p=0.03$) were seen during work hours. Whilst these results are not consistent enough to be conclusive, it does suggest that the education session received by all participants had some effect on sedentary behaviour, and as sitting increased from early intervention to follow-up in both studies, this effect can be considered short-term.

It is possible that such small changes in sedentary behaviour could be attributed to a measurement effect, in that, following baseline measurement, participants were aware they should be reducing their sedentary behaviour and so behaved differently whilst wearing the activPAL monitor. This is almost impossible to control for. Using self-reported sedentary behaviour measures is likely to be affected by the same bias, and 3rd party observational monitoring of sitting, as well as having ethical issues, would not be able to detect the small changes in sitting measured by the activPAL. Taking averages across a 7-day period of continuous wear is helpful in reducing measurement bias and is another reason that future studies should aim to maximise wear time, as discussed in 5.4.1.2.

The model of selective optimisation with compensation (Baltes & Baltes 1990) proposes that at all stages of development, individuals regulate their behaviour via the processes of selection, optimisation, and compensation. Selection involves choosing a behaviour or behaviours on which to focus ones resources, optimisation involves investing time and effort in order to achieve or exceed behavioural goals, while compensation describes adoption of an alternative behaviour(s) to maintain a level of functioning (Freund & Baltes 2002). It is possible that both control and intervention group participants, having been encouraged to select the behaviour of reducing occupational sedentary time during the education session, felt unable to optimise this change during work hours as a result of the barriers of work tasks and time, as discussed in the focus groups. What is not clear from the sedentary behaviour outcomes measured, is the impact on sitting patterns outside of work hours, and whether reducing sitting in leisure time was selected as an alternative behaviour to change, or whether the small reductions in sitting during work hours was compensated by more sitting outside of work. Examination of sitting patterns both during and outside of work hours may benefit future studies in terms of understanding how behaviours were selected, optimised and compensated for, and the impact that this had on sitting overall.

Changes to scores within the SCTQ and SOCQ, though not necessarily directly correlated to sedentary behaviour outcomes, indicated an intervention effect occurred between baseline and early intervention. Readiness, or motivation to change as measured by the SOCQ showed that participants from both groups, but especially the control group, had progressed through stages from baseline measurement and increased scores for self-efficacy and behavioural strategies in both groups suggested the education session was responsible for this. Including a no-education group in the design of future studies would help ascertain the impact of education on both SCT and SOC measures, as well as sedentary behaviour outcomes.

5.4.5 Limitations

5.4.5.1 Sample

Failing to reach the target sample size for this study did not allow for definitive conclusions to be made with regard to the efficacy of the intervention in terms of having large enough numbers to detect statistically significant differences between groups. However, the study was still able to fulfil its objectives with regard to feasibility of the study design and pilot the use of the SCTQ and SOCQ.

The generalisability of the sample, in terms of the working general public, is questionable. The pilot study sample differed slightly, in terms of demographics, from the feasibility study. The majority of the sample were female (57% in the pilot study, compared to 76% in the feasibility) and non-smokers (96% in the pilot study, compared to 88% in the feasibility study) with only

35% of those approached within the organisation, volunteered to take part (14% in the feasibility study). It is also unclear from the information given on job title by participants, how representative the sample were, regarding different roles and staff grades within the organisation, which may be important when considering the potential impact of behavioural control on sedentary behaviour. The sample had, on average, obtained higher level qualifications than the national average (OECD 2016), and in this way it could be argued were not truly representative of the overall working population. This could be important as lower educational attainment is associated with poorer health status (Mackenbach 2012), and higher levels of unhealthy behaviours including inactivity (Friis et al. 2016). If those with higher health literacy are more likely to volunteer to participate in studies aimed at reducing sedentary behaviour in the workplace, then there is the potential that the most vulnerable, in terms of poorer baseline health, will not benefit. However, it may be the case that higher levels of educational attainment were representative of the workforce at this particular worksite. Future studies should therefore seek to recruit participants from a variety of workplaces, with the aim of including participants from all educational and socioeconomic backgrounds.

5.4.5.2 Differences in baseline measurement

Although not statistically significant, there were differences between the control and intervention group at baseline in terms of levels and patterns of sedentary behaviour, and readiness to change as measured by the SOCQ. The reasons for these differences is not clear, but may have had some impact on the efficacy of the intervention. Whilst participation in the walking challenge was not correlated to differences in sedentary behaviour outcomes, it may have altered the focus and priorities of the participants in terms of how they responded both to the education and prompt component of the intervention. Walking challenge participants were not evenly spread across the control and intervention group and therefore any impact of this challenge on the results of the PAWS study cannot be dismissed. The researcher was not made aware of the walking challenge until after baseline measurement had begun, and therefore was unable to re-schedule the study accordingly, but future studies should seek to gain knowledge of any such events or challenges that could potentially impact results, during the project planning stage. However, in using such real-world settings it is often difficult to ensure that research takes place in the absence of all external influences and seasonal fluctuations.

5.4.5.3 Lack of overall control group

As discussed in section 5.4.4.4, the absence of an overall control group, that received no intervention, precludes definitive conclusions to be drawn about the impact of the educational component on sedentary behaviour. It was evident that members of the control group had developed their own strategies to reduce sedentary behaviour, for example downloading prompt software, following the education session. Having a group that had not received the education session, and had the focus of the study kept from them until after follow-up, would allow the impact of such actions resulting from the education to be compared to both the prompt intervention and no intervention at all. Having a third group in such a study has implications with regard to recruiting adequate participant numbers and ethically such a control should be provided with the opportunity to receive a component of the intervention at a later date, which has implications regarding funding. In addition, care would need to be taken to prevent contamination of information being shared between groups.

5.4.5.4 Impact of working conditions

As reported in section 5.4.1.1, the workplace from which participants were recruited were facing recent and upcoming redundancies at the time of the study. This reduced the total number of staff available to recruit from, and the likely impact on morale and behaviour may have also had an effect on both recruitment and the sedentary behaviour of the remaining workforce. Whilst this scenario could not have been planned for, and represents the working conditions for many workforces, its impact should be considered when interpreting the results.

5.4.5.5 Measures of stage of change and social cognitive theory

Both the questionnaires used to measure social cognitive theory and stage of change, whilst adapted from previously validated questionnaires, were un-validated for measuring constructs relating to sedentary behaviour. Future studies should therefore seek to validate both of these tools for use in the context of occupational sedentary behaviour and, in the case of the SCTQ, make adaptations to include different constructs as previously discussed in section 5.4.2.6.

6 OVERALL CONCLUSIONS

6.1 Developments within the field of sedentary behaviour research

It is worth noting that developments in the field of sedentary behaviour research have remained far from static during the 36 months taken to complete this PhD. The Sedentary Behaviour Research Network (SBRN) gained consensus from its members to propose definitions for a number of terms including: sedentary behaviour; sitting; reclining; lying; and sedentary behaviour patterns, as well as suggesting a uniform way in which the terms bouts, breaks and interruptions should be used within the context of sedentary behaviour (Tremblay et al. 2017). Large-scale transdisciplinary consensus work was also carried out by the DEDIPAC (Determinants of Diet and Physical Activity) consortium to develop a Systems Of Sedentary behaviours (SOS) framework for the determinants of sedentary behaviour across the lifespan, in order to identify research and policy priorities (Chastin et al. 2016). The influence of Institutional and Home Settings, including the workplace, was agreed by the consortium to be the greatest current priority for sedentary behaviour research.

Large scale population studies based on both self-reported sedentary behaviour (Strain et al. 2017, Milton et al. 2015), and objective measures (Diaz et al. 2017) have re-affirmed the high levels of sedentary time measured in similar previous studies, with the latest published Eurobarometer data also suggesting that prolonged sitting may, overall, be declining in European countries (Milton et al. 2015). Isolating the precise contribution of workplace sitting to sedentary time measured in these studies is problematic, but the recently published results of the Scottish Health survey recommended targeting workers because early-to-middle aged Scottish adults in employment self-reported some of the highest levels of weekday sedentary behaviour in the adult population (mean 7+ hours), almost half of which was accumulated during work hours (Strain et al. 2017).

A systematic review which aimed to evaluate and classify self-report tools for sedentary behaviour (Dall et al. 2017), highlighted a lack of accuracy in all existing tools, which both under-and over-estimated sedentary behaviour in comparison to objective measures. However, the review also concluded that tools using previous-day recall, or calculating sedentary behaviour as a sum of behaviours, showed the most promise in terms of accurately quantifying sedentary behaviour (Dall et al. 2017). In larger scale studies, such tools may therefore be useful in terms of the time, cost, and lack of behavioural context associated with objective measures.

During the timeframe of this PhD, the media have reported on numerous studies on sedentary behaviour published in peer-review journals, in doing so, disseminating their findings to a wider audience often not reached by such publications. In particular two, potentially conflicting, sedentary behaviour studies received high levels of media attention as calculated by Altmetric statistics, which collates online activity relating to a research outputs (Altmetric 2017). One was the results of a 16 year follow up study of a cohort of working adults (Whitehall civil servants), published in October 2015, which concluded that sitting was not associated with all-cause mortality (Pulsford et al. 2015). This article had an Altmetric score of 1211 online media mentions (as of 17th November 2017) including blogs, social media and 115 news items internationally. A month later, guidelines on how and why to reduce sitting at work, commissioned by Public Health England, were published (Buckley et al. 2015) obtaining an almost as high Altmetric score of 1085, including 78 news items (as of 17th November 2017). Within the space of a month, the general public were therefore faced with the conflicting, and potentially confusing, newspaper headlines of 'New Study Says Sitting Won't Kill You After All' (Drum 2015), and 'Office workers' should stand up for two hours per shift to combat serious health issues' (Beech 2015). How, or if, the general public evaluates such conflicting evidence presented in the media, is unclear, but it is likely to have an impact on behavioural choices. Gardner et al. (2017) studied the public's online responses to the media's coverage of the recommendations for reducing workplace sitting (Buckley et al. 2015) and found that there was a great deal of both mistrust and misunderstanding of the advice being given. This is not helped by the media 'cherry picking' the research it covers, or the specific findings it highlights, often out of context. For example, following the Whitehall study by Pulsford et al. (2015), a review of systematic reviews analysing the causal relationship between sedentary behaviour and all-cause mortality, found reasonable evidence to link the two (Biddle et al. 2016). It also criticised the Whitehall study for using a cohort in their mid-40s who were likely to be too young to show any significant mortality effects. This article had a much lower Altmetric score of 87 (as of 17th November 2017) than the Pulsford article, despite the fact that the evidence presented within the article linking sedentary behaviour with all-cause mortality could be considered more robust .

The content of the public health messages conveyed, either through the media or targeted interventions, are likely to impact on behaviour change (Gardner et al. 2017). The debate concerning whether physical activity does attenuate the detrimental impact of sedentary behaviour (Ekelund et al. 2016, Rao et al. 2016) or not (Biswas et al. 2015), continues. Whilst it is important that public health messages regarding physical activity and sedentary behaviour are clarified, evidence from systematic reviews suggests that if reducing sedentary behaviour is the aim, then interventions should target this alone without also aiming to increase activity levels (Martin et al. 2015, Prince et al. 2014). Spence et al. (2017) also argued that a 'dual hinge' approach of replacing sitting with MVPA, rather than replacing sitting with standing, is not effective nor helpful in terms of improving health outcomes. This may be particularly pertinent to a workplace environment where replacing sitting with MVPA is not necessarily practical in terms of performing work tasks.

Greater understanding is needed regarding the impact of reducing sitting during work hours on overall sedentary behaviour. A study of sit-stand desk users found that whilst there had been a mean reduction in sitting (-23%) and an increase in standing (+13%) during work hours, there was also an increase in sitting (+6%) and a decrease in light activity (-2%) outside of work hours (Mansoubi et al. 2016). Such compositional data analysis, in which all activities simultaneously occurring within a 24-hour day are examined, is important in understanding any health benefits of workplace interventions to reduce sitting, as it accounts for all changes in behaviour. Recently, compositional analysis was used to examine changes in cardio-metabolic markers of office workers in the Stand Up Victoria trial – a multicomponent workplace intervention aimed at reducing sedentary behaviour (Winkler et al. 2017). The results revealed that whilst reductions in workplace sitting produced favourable changes to cardio-metabolic markers, these changes were greater in those that had replaced sitting with ambulatory activities as opposed to replacing sitting with standing throughout their entire day (Winkler et al. 2017). Such overall changes in behaviour are likely to differ in terms of the precise nature of the intervention being offered to break up sitting. A recent workplace study found that short, frequent breaks (1-2 minutes every half hour) from sitting at work resulted in improvements regarding measurements of cholesterol, triglycerides, and fasting blood glucose, whereas less frequent breaks (15 minutes twice a day) showed no improvements (Mailey et al. 2016). Compositional data analysis was not used in the study by Mailey et al., but it would have been interesting to see what impact the short breaks had on overall sitting, standing and stepping behaviour, in comparison to the longer breaks, and how this translated to changes in the metabolic markers measured.

Despite the publication of guidelines, commissioned by Public Health England, suggesting office workers should aim to reduce their sitting at work (Buckley et al. 2015), little has changed in workplace policies or legislation with regards to sitting. Similar to the findings of the review of UK policy and legislation covering sedentary behaviour in the workplace, conducted as part of the literature review of this thesis (section 2.4.3), a recent review of legislation across 9 countries, found nothing that legally protected workers from the dangers of sitting (Coenen et al. 2017). The authors of that review recommended that policies should be developed specifically addressing occupational sedentary behaviour in order to protect the health of the workforce.

The field of sedentary behaviour research is still seeking a theoretical underpinning to help explain sedentary behaviour and design interventions to address it (Spence et al. 2017). A qualitative examination of barriers and facilitators to taking micro breaks identified 22 potential behaviour change techniques that they recommended be incorporated into the development of future break promoting software, but how this will be achieved and how such software would function, was not specified (Huang et al. 2017). Developing technologies are likely to play a huge role in shaping the direction of future prompt interventions to reduce sedentary behaviour. During the timeframe of this PhD study, studies using smartphone apps to target sedentary behaviour have shown success at breaking prolonged sitting in adults with diabetes when linked to real-time feedback on posture from an accelerometer (Pellegrini et al. 2015) and increasing standing in sit-stand desk users (Donath et al. 2015). Such approaches need further testing in a workplace setting, but represent one way in which a workplace intervention can potentially be delivered both during and outside work hours.

6.2 Key findings of this thesis

Both the feasibility and pilot study described in this thesis, have demonstrated that using Microsoft Outlook to deliver customised messages prompting office workers to reduce and break up their sedentary behaviour is feasible, low-cost, easy-to-use, and considered acceptable by recipients. The education session was also evaluated favourably. Circulating a videoed presentation of the education session ensured consistency of delivery and enabled participation of those whose work-schedule prohibited them from attending in person. It also opens the possibility for wide-spread dissemination at little cost.

Analysis of focus group discussions provided valuable insight into the barriers and motivations of office workers with regard to changing their sedentary behaviour patterns. Participants were, on the whole, motivated to change their sedentary behaviour with some of those allocated to the control groups developing their own prompt strategies to break up the sedentary time at work. Barriers to changing sedentary behaviour were found at a cultural and individual level with low self-efficacy, often expressed as lack of control over behaviour at work, and a desire to conform with the cultural norm of sitting in the office, frequently expressed.

Five themes emerged that reflected the key constructs of Social Cognitive Theory (SCT) and analysis showed that these constructs were interactive and inter-dependent of each other in terms of how they influenced behaviour. Analysis of a novel questionnaire to further explore and isolate the SCT constructs in relation to sedentary behaviour, confirmed this, but also suggested that the education component of the intervention was successful at increasing self-efficacy and behavioural strategies in the short-term, whilst the prompt component further increased behavioural strategies leading to longer-term maintenance of elevated self-efficacy. This intimates that whilst the prompt intervention did not significantly impact on sedentary behaviour during the study, it may have had a longer-term impact of increasing individuals' belief that overcoming the perceived barriers to breaking up sedentary behaviour in the workplace, were possible.

Examining participants readiness to change their sedentary behaviour using an adapted Stage of Change questionnaire illustrated the variability of motivation across the relatively short time-span of the study. Overall, participants did progress towards action stages in both the control and intervention group, suggesting that the educational component was responsible for this shift. Such shifts in intention to change did not, however, translate to sizable reductions in sedentary behaviour during the course of the study. Addressing the intention-behaviour gap therefore represents an issue to be addressed in future intervention design.

In terms of the impact of the prompt intervention reducing sedentary behaviour during working hours, the evidence was not conclusive. Small, short-term reductions were made to key sedentary behaviour outcomes from baseline levels, but there was a tendency for reductions not be maintained, with sedentary behaviour increasing back towards baseline levels over the course of the intervention period and at follow-up. As reductions occurred in both the control and intervention groups in both studies, it is likely that receiving education was responsible for most of the short-term improvements in sedentary behaviour. The novel analysis of how participants responded to the prompts, suggested that any additional impact the prompts had, did not result in an immediate response to stand following a prompt, rather, any increase in standing was made at unrelated times.

6.3 Implications for future research

The results of both studies provide a valuable contribution to research into the development of interventions to reduce sedentary behaviour in office workers, and have indicated a number of directions for future research, the most important of which are outlined below.

The use of Microsoft Outlook to deliver timed prompts to reduce and break up sitting in office workers is cheap and easily-replicable on a large scale. Further research is needed to determine whether such prompts, combined with education, significantly improve sedentary behaviour outcomes compared with education alone, and future studies should seek to recruit a larger sample, and include a group that do not receive any education, in order to be able to draw such conclusions. Given the poor accuracy associated with existing self-report tools to measure sedentary behaviour, such larger scale studies should, where possible, seek to gain objective measures of sedentary behaviour outcomes.

There would be benefit to exploring different messages delivered by prompts, such as the impact on sedentary behaviour of giving participants specific instructions what to do following a prompt e.g. stand for 2 minutes, take a short walk. Also, examining whether changing the content of messages over the course of the intervention, as people adapt to receiving them, might help sustain short-term changes into longer-term reductions in sedentary behaviour. Prompts based on real-time feedback of behaviour are also worth further exploration, as participants objected to being prompted to stand when they had just returned to their desks. With many participants making reference to using personally owned activity monitors, such as a FitBit or Applewatch, there would be value to objectively measuring how effective such devices are at changing patterns of sedentary behaviour both during, and outside, of work hours. Future studies should therefore also aim to measure patterns of sedentary behaviour outside of work hours to ascertain whether any intervention effect extends to behaviour change outside of work, or if reductions in sedentary behaviour during work hours is compensated for by increasing sedentary time or length of sedentary events outside work hours.

As the small sample size in both studies was a result of recruitment, not retention, future studies may wish to consider different ways of maximising recruitment such as giving large-scale presentations to workers on the nature and purpose of the study, or taking further steps to engage with management who may in turn encourage participation. Future studies might also consider using multiple work-sites in order to meet recruitment targets. In order to analyse such multi-site study populations, data should be collected regarding potential differences in work environments, and individual differences such as educational attainment, socioeconomic group, and self-reported health status.

The novel analysis of how individuals responded to real-prompts compared to pseudo-prompts has given valuable insight into the mechanism by which they might work, or not work. Such analysis should be deployed in future prompt studies in order to corroborate or dismiss the findings of the studies described in this thesis, that participants do not tend to stand as a direct response to receiving a prompt. It would also be valuable to compare responses to active, passive and real-time prompts to see whether response times differ and whether one of these mechanisms of prompt delivery is more successful at reducing sedentary behaviour in office workers, than others.

Future studies might attempt to look at the level of understanding from education sessions delivered in person and in video format to ascertain if there are any differences in understanding from the two modes of delivery. Use of the education session delivered in these two studies should be updated in line with the most recent research findings and to ensure coverage of issues raised in the PAWS focus groups that were still causing confusion (e.g. negative effects of prolonged standing). Once identification of behavioural change techniques that have the greatest potential of initiating and maintaining sedentary behaviour change is established, it would be pertinent to also include these in future education materials.

Validation of the SCTQ and SOCQ for measuring constructs related to sedentary behaviour would allow more definitive conclusions to be drawn about the applicability of social cognitive theory and the transtheoretical model to patterns of occupational sedentary behaviour. Exploring and measuring the applicability of additional constructs to SCT, such as perceived control, social, and cultural norms, may, in fact, lead to defining a new theoretical model to explain occupational sedentary behaviour.

It has been an exciting experience to be involved in research in this emerging field, at a time when the health implications of sedentary behaviour are reaching the public consciousness. Whilst great progress has been made, the future development of effective workplace interventions to reduce sitting and their theoretical underpinning, coupled with changes in working policies and practice, will ultimately lead to improved health for a large proportion of working adults.

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8 APPENDICES

8.1 Prompt messages

List of prompt messages used:

1. Use your bones .. stand
2. Stand up … you look better
3. For core strength … stand
4. Smile and stand
5. Who can you see when you stand?
6. Ease your body … stand up
7. Stand up … it's good for your heart
8. Sit less .. stand more
9. Standing is cool
10. Sit less .. think core
11. Stand up … it's good for you
12. Use your muscles .. stand
13. Stand and smile
14. Standing :)
15. Are you an upright citizen?
16. Stand up … tone those muscles
17. Improve your circulation … stand
18. Help [company name] make a stand for better health
19. Make it a new habit .. stand more often
20. Calories - burn up to 40% more when standing
21. Everything seems better if standing
22. Be nice to your body .. stand
23. Stand up … and sleep better
24. Sit less .. it's healthier
25. You burn 50 more calories an hour by just standing
26. Stand up … burn calories
27. When did you last stand up?
28. Stand up … Glasgow/Livingston!
29. Stand up … Scotland
30. Winston Churchill stood at his desk
31. Stand up … it's healthier for you
32. Are you sitting comfortably .. time to move
33. Stand up and take the weight off
34. Boost your metabolism … stand up
35. Stand up … and stretch
36. Take the healthy option … stand up
37. Take a break … stand
38. Making a phone call standing can improve voice quality
39. Stand up … improve your posture
40. Treat yourself … stand up
41. Time to move .. Stand up
42. Be an upright citizen
43. Give yourself a boost. Stand now!
44. Feeling stressed? Then stand up!
45. Stand up for health
46. It's good to stand
47. Look down on your work .. stand up
48. Stand up … [Company name]
49. Unchain yourself from your chair
50. Be nice to your heart .. stand
51. Stand up … keep your blood moving
52. Stand … it's a lifestyle choice
53. Give your body a treat and stand
54. Be bold, take a stand
55. Stand up … and be happy
56. Lift your mood … stand each hour
57. Stretch your legs … stand
58. Use your legs .. stand
59. Don't lose your legs … stand on them!
60. Improve your health .. stand more often
61. Are you still sitting?
62. Be smart … stand
63. Move on the hour .. every hour
64. Change for life .. stand more often
65. Stand up … it's hard to lose weight sitting
66. Stand up … make your bones happy
67. Treat time … stand up
68. Stand up for the right to stand
69. Stand to support healthy living
70. Sitting :(

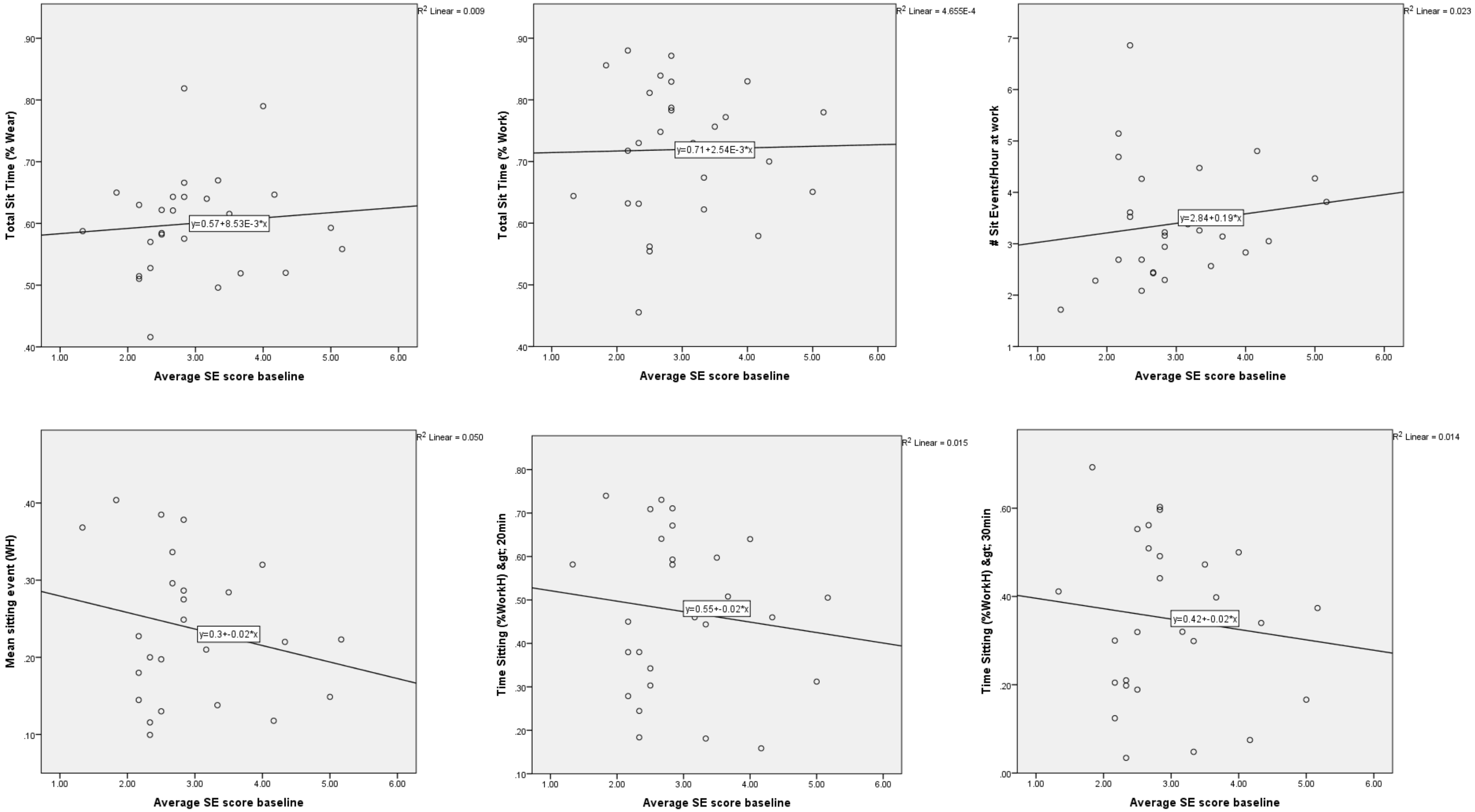
8.2 Validation rules

The following validation rules were applied to datasets from both studies, prior to data processing.

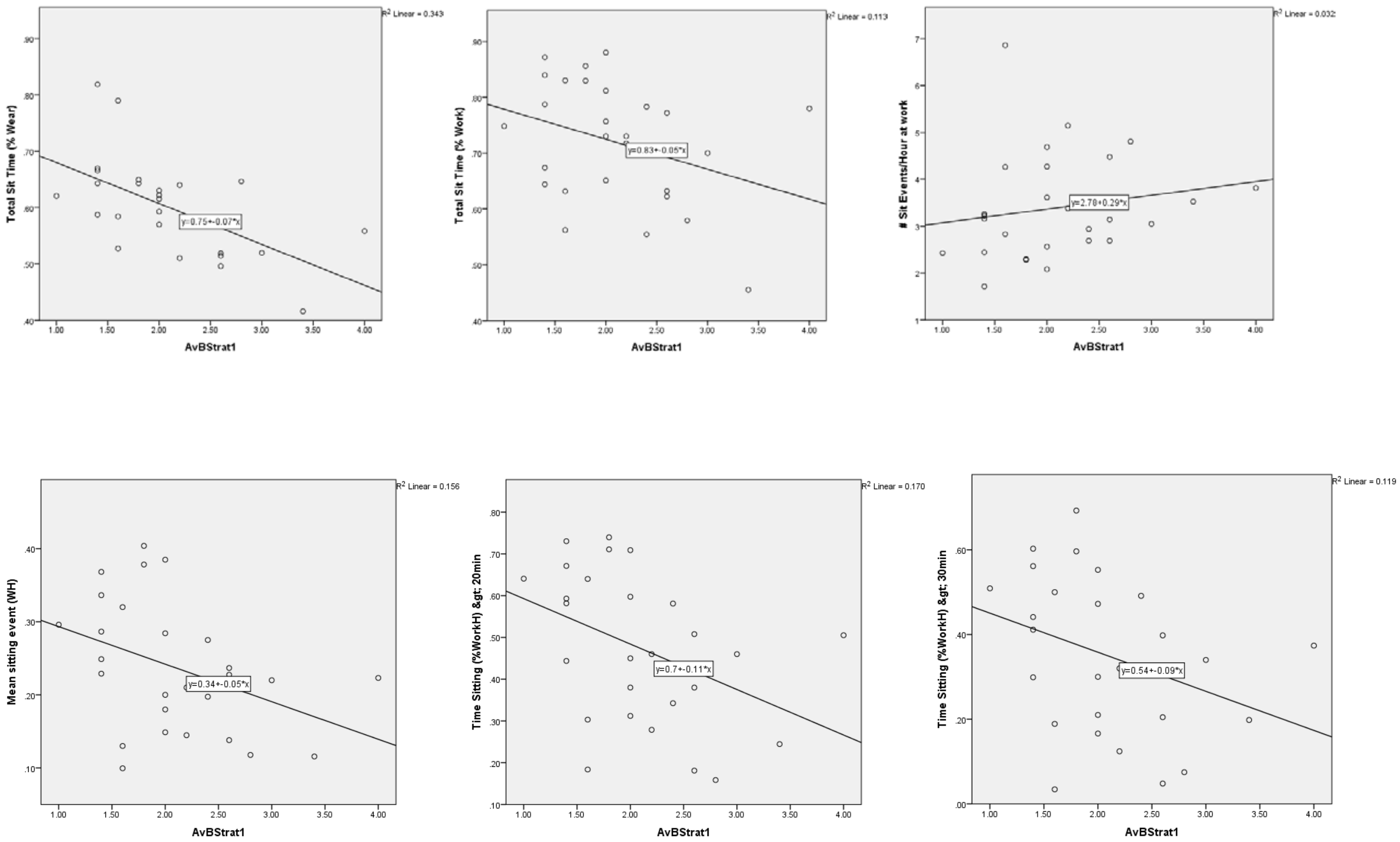
Validation rule	Description	Exclusion/inclusion/ action
1	Monitor worn for less than 10 hours of waking day/70% of waking hours	Exclude whole day
2	Monitor not worn whole day but more than 10 hours/70% of waking hours	Include day, but adjust wake time and non-wear time after processing
3	One but not both of 10 hours/70% rule applies	Include day
4	Work start/finish time not recorded	Include day. Mark error in work diary field
5	Bed or wake time not recorded	Where possible estimate using activPAL and highlight in diary
6	No reason given for day off	Leave incomplete
7	Working from home field not completed	Include day, leave field incomplete
8	Monitor worn upside down for day or part of day	Correct data using software
9	In hospital/ in bed ill all day	Exclude whole day
10	Participant withdrawn	Exclude data
11	Monitor removed briefly (<5mins) to reattach	Include data, not adjustment needed
12	Monitor put on before bed time day 1	Include but note not to include sleep time
13	Night time standing	Include but note not to include sleep time
14	Noted that work days contained unusual activity e.g. driving all day	Include and note
15	Days/times on diary do not correspond to activPAL data - out by one day	Adjust diary days
16	Activity ceased over an hour before stated bed time	Include data as written in diary but note
17	No diary data but activity data	Exclude
18	Told to rest leg but still wearing monitor and at work	Include
19	Monitor removed, not replaced & withdrawn	Exclude whole data set
20	Removed overnight	Check activPAL and include day (adjust if using sleep time) non-wear time doesn't need adjustment if removed after bed time
21	Monitor appears to have been attached after waking	Use activPAL data to estimate start time and apply rules 1-3
22	Monitor stopped recording prematurely	apply rules 1-3 on data available
23	Foreign travel	adjust diary times to correct for time difference

8.3 Scatterplots of SCT construct and sedentary behaviour outcomes at baseline

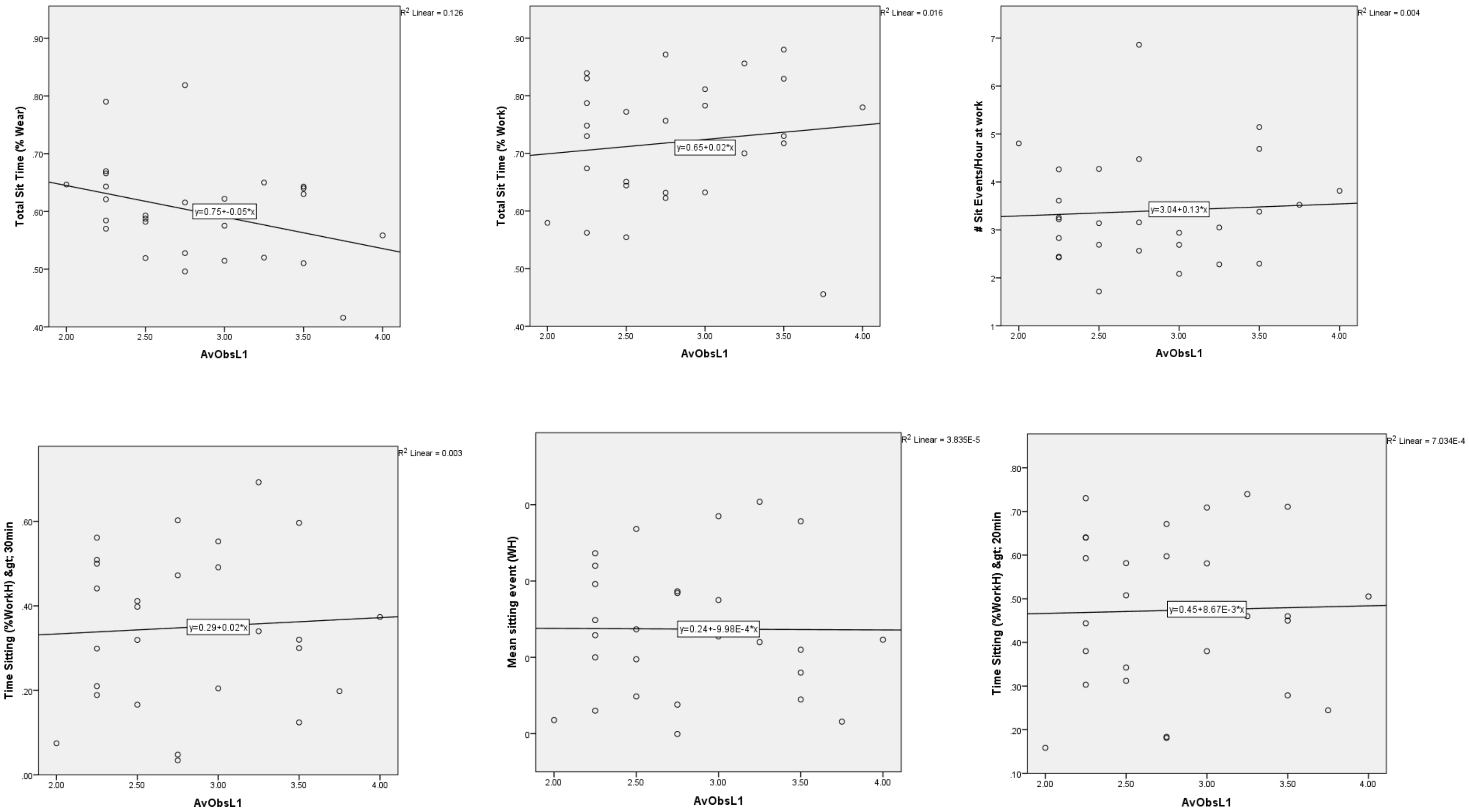
i. Correlation between average score for Self Efficacy (SE) and key sedentary behaviour outcomes at baseline



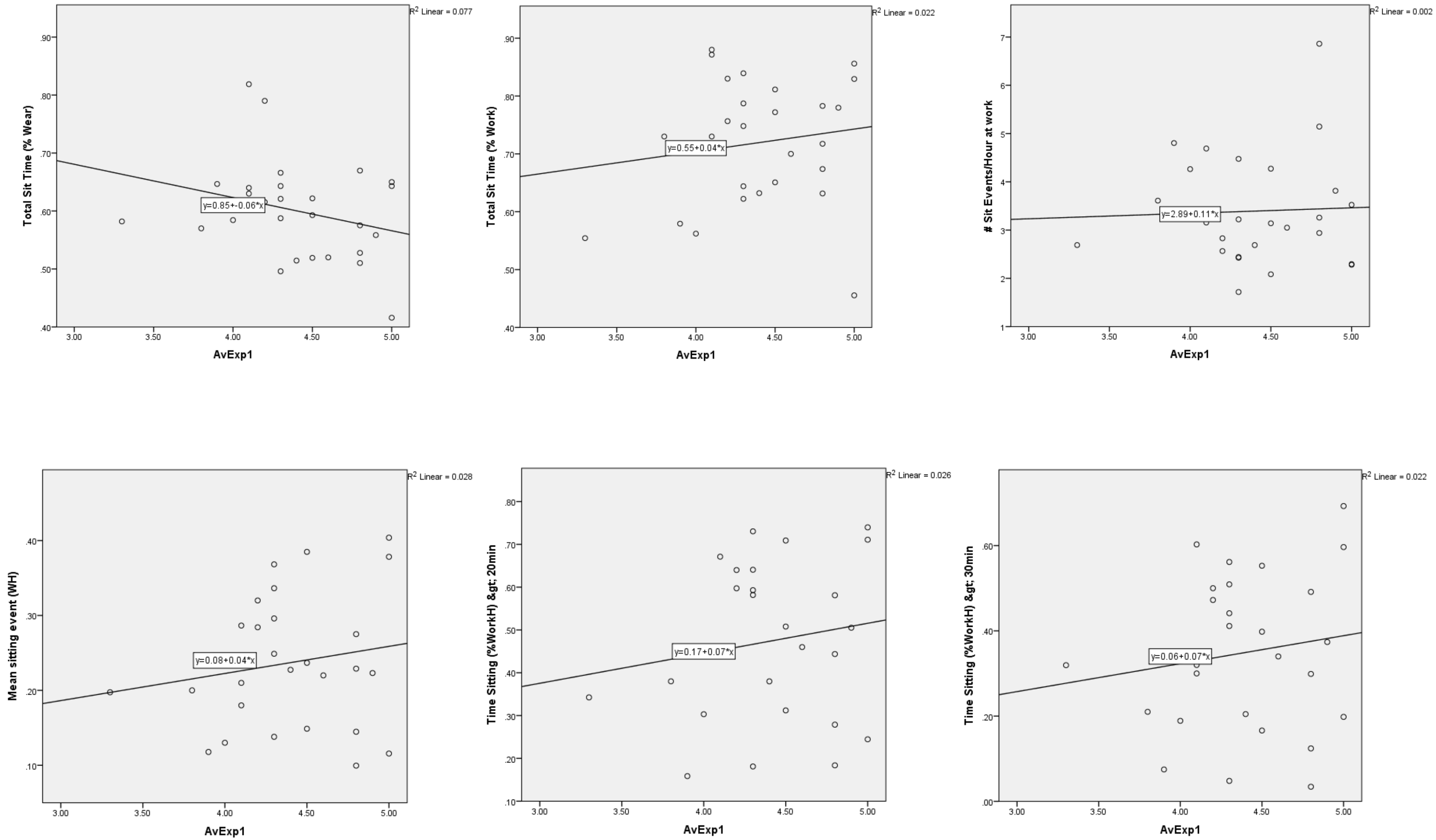
ii. Correlation between average score for Behavioural Strategies (BStrat) and key sedentary behaviour outcomes at baseline



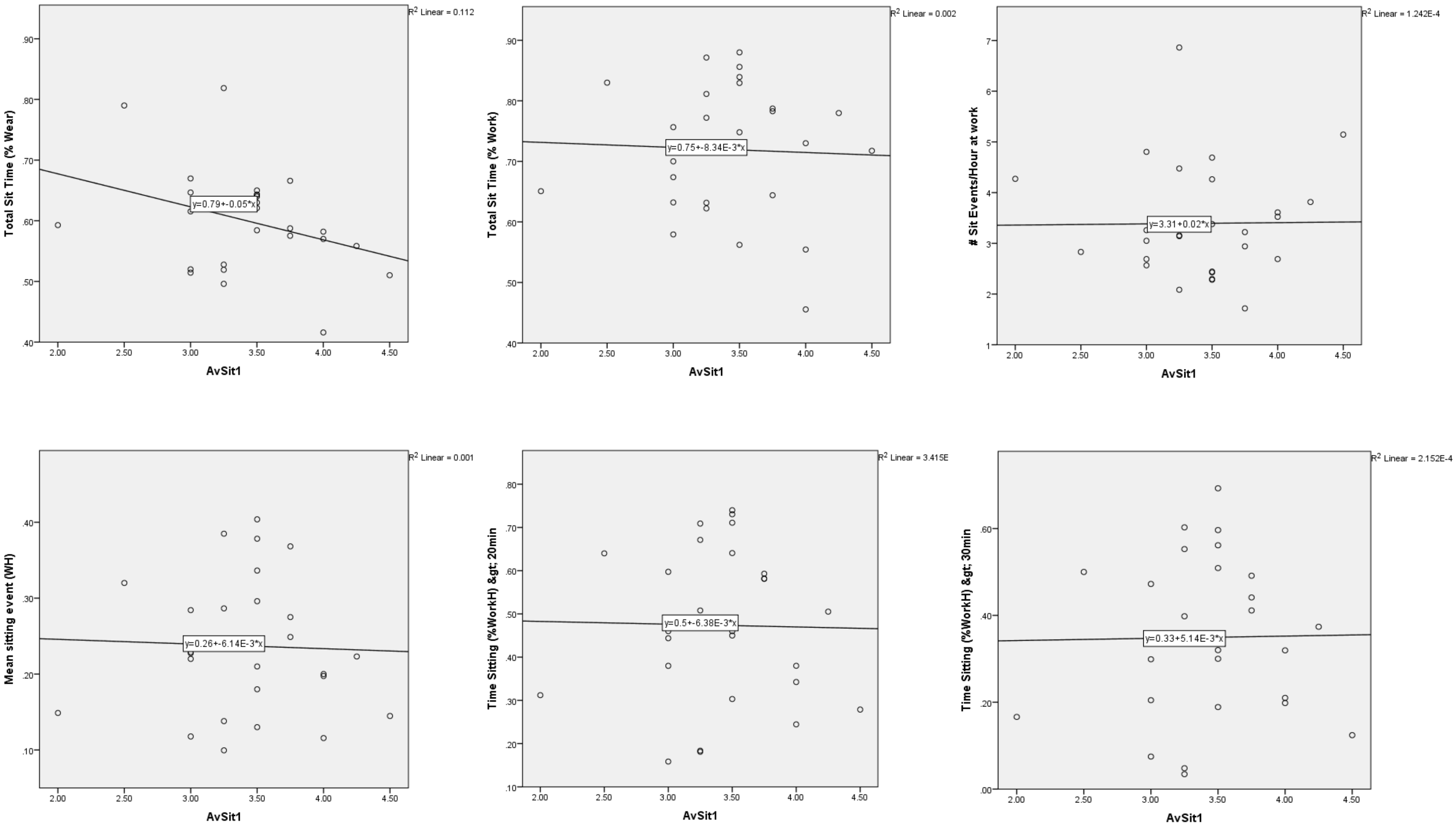
iii. Correlation between average score for Observational Learning (ObsL) and key sedentary behaviour outcomes at baseline



iv. Correlation between average score for Outcome Expectations (Exp) and key sedentary behaviour outcomes at baseline

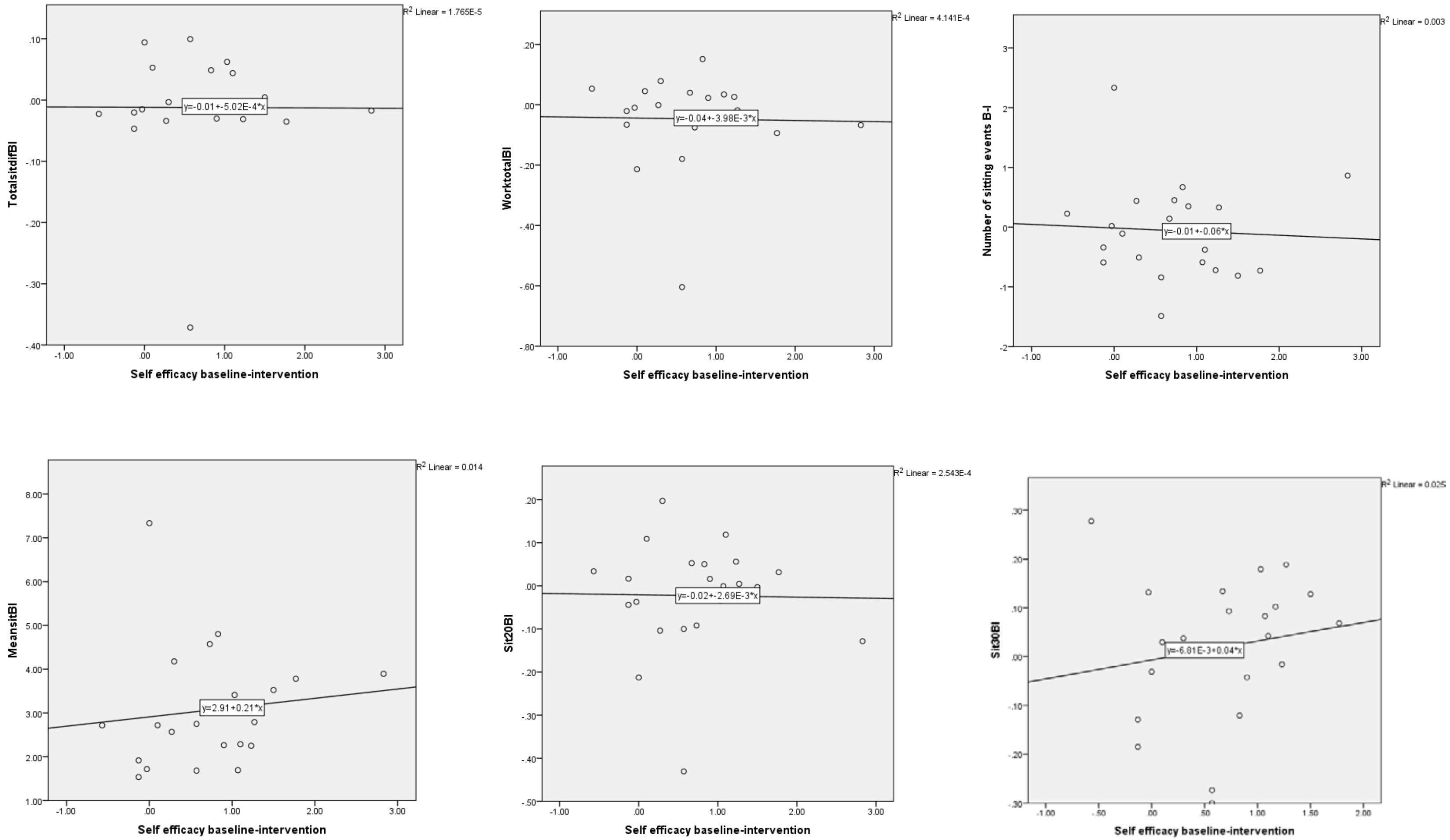


v. Correlation between average score for Situation (Sit) and key sedentary behaviour outcomes at baseline

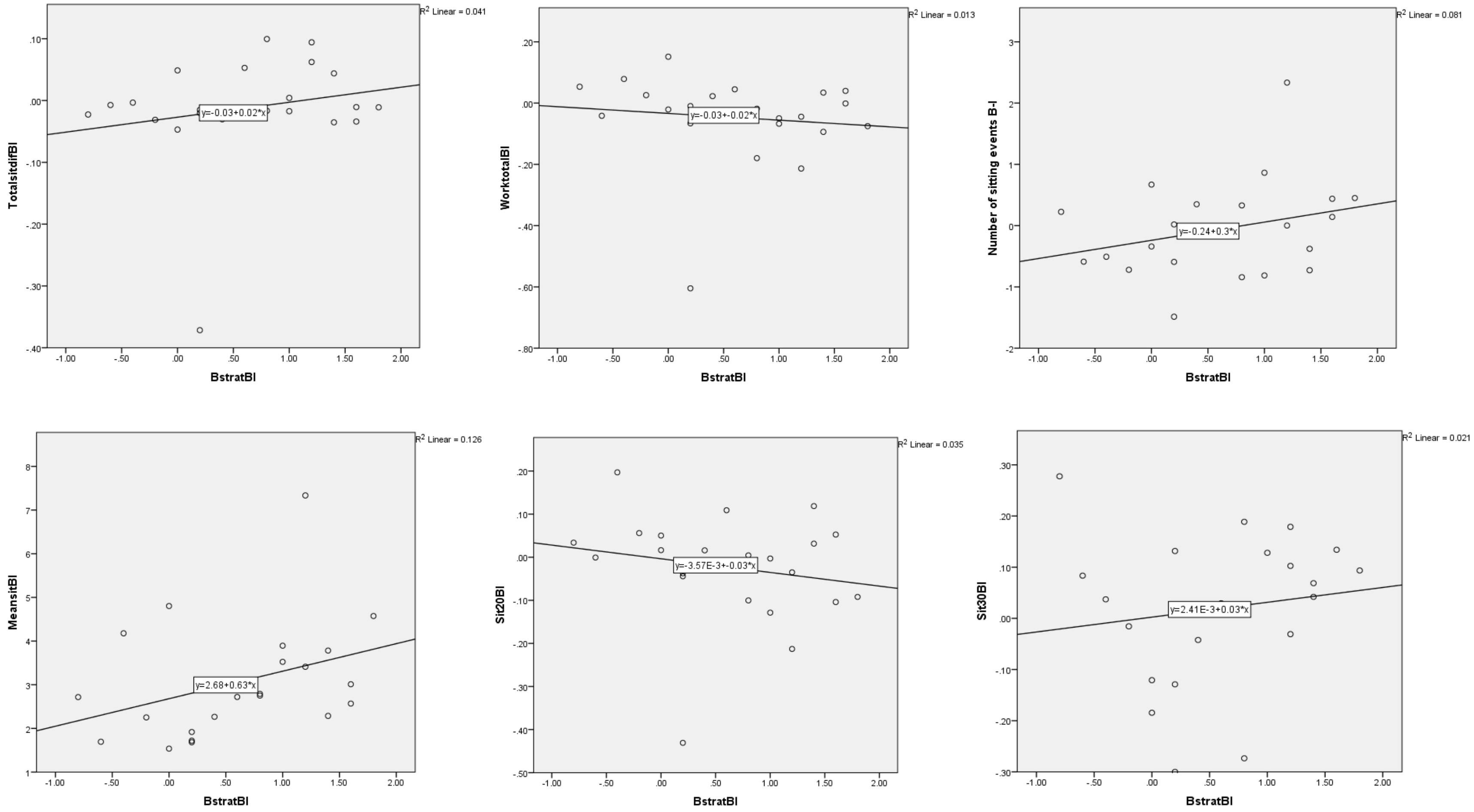


8.4 Scatterplots of changes of SCT constructs and sedentary behaviour outcomes between baseline and early intervention and baseline and follow-up

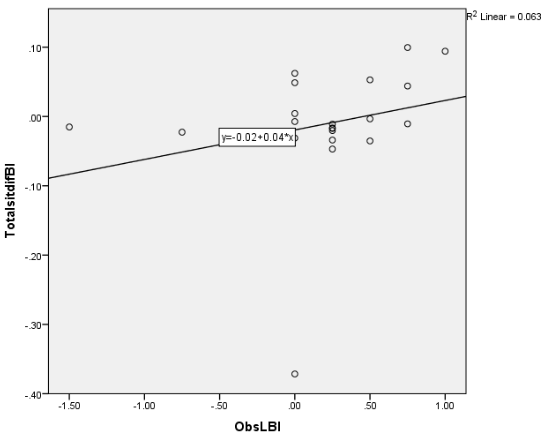
i. Changes in Self Efficacy and key sedentary behaviour outcomes from baseline to early intervention

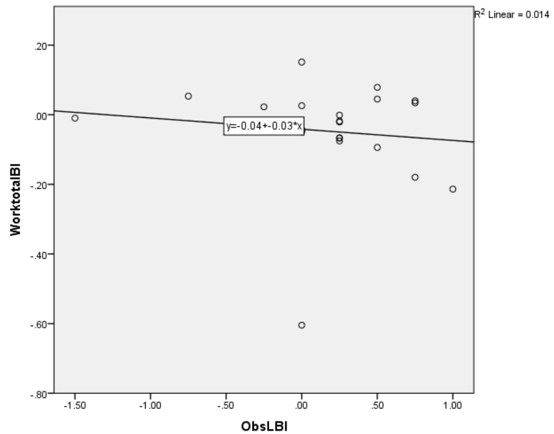


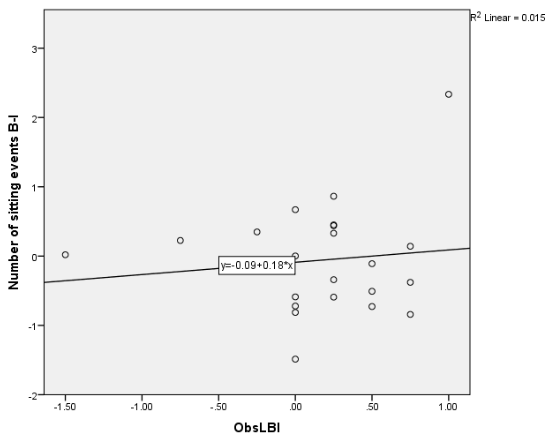
ii. Changes in Behavioural Strategies (Bstrat) and key sedentary behaviour outcomes from baseline to early intervention

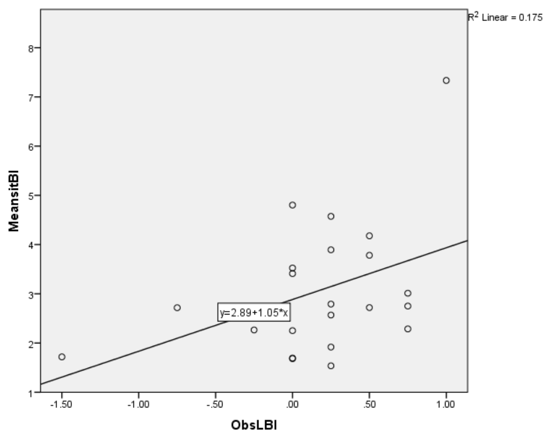


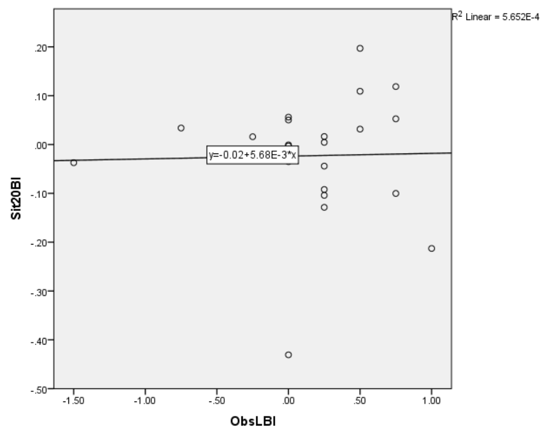
iii. Changes in Observational Learning (ObsL) and key sedentary behaviour outcomes from baseline to early intervention

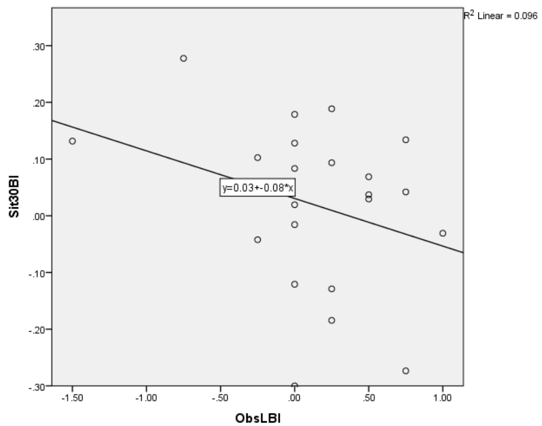




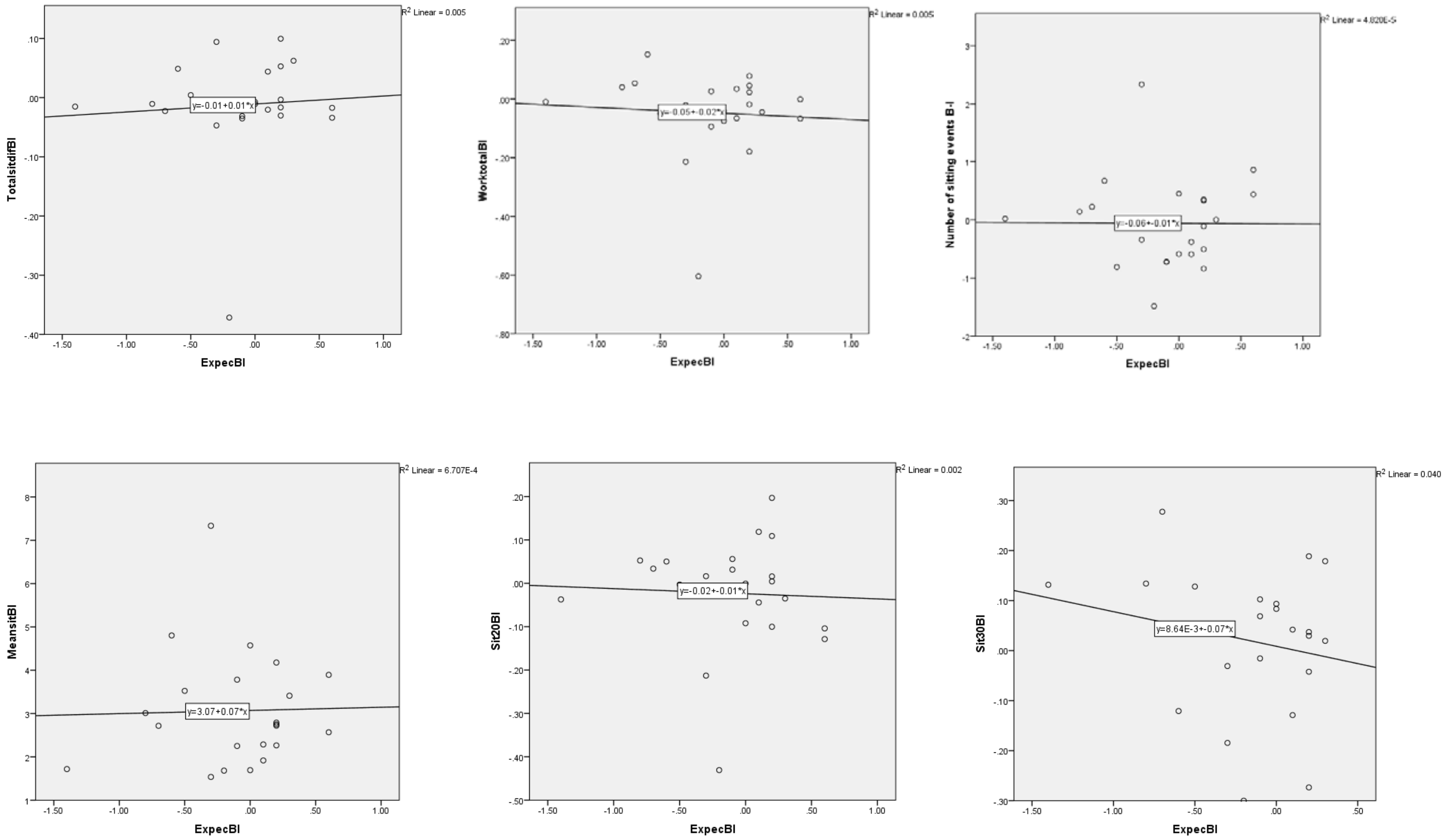




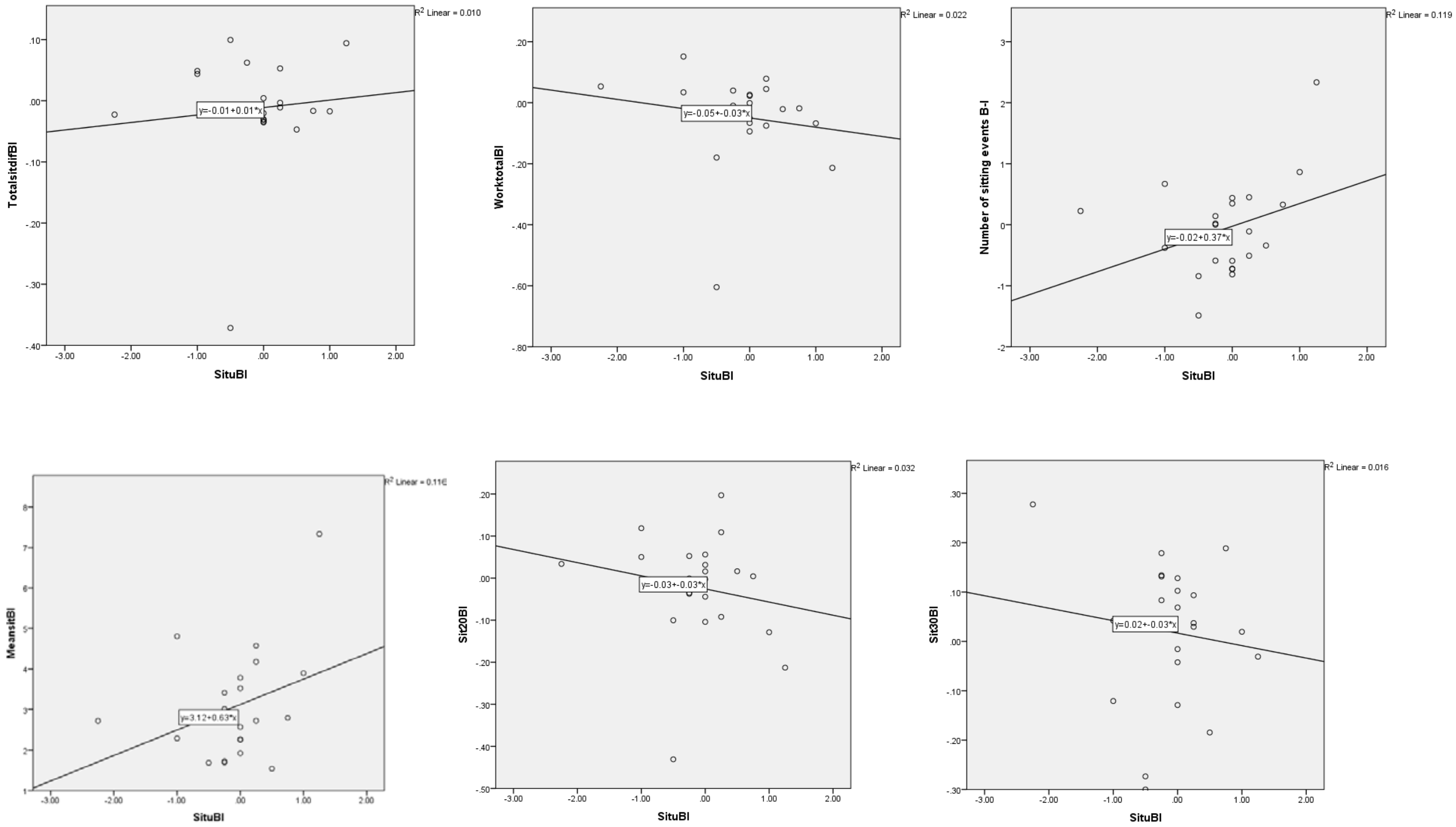




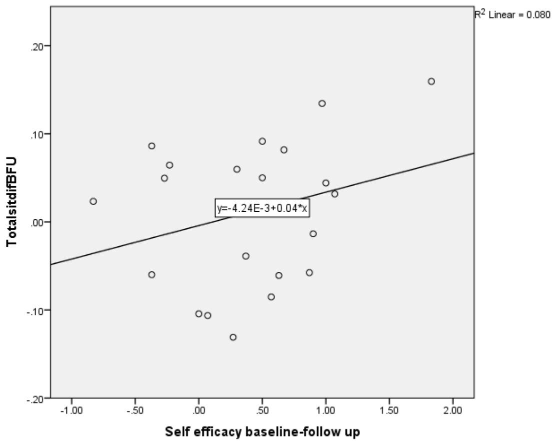
iv. Changes in Outcome Expectations(Expec) and key sedentary behaviour outcomes from baseline to early intervention

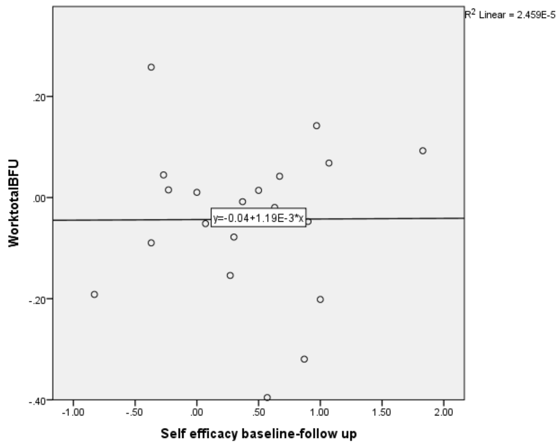


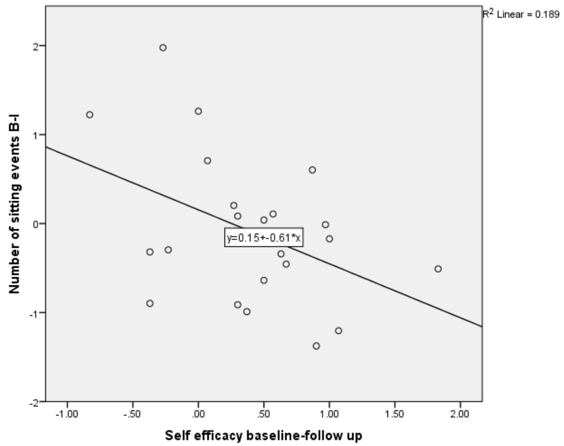
v. Changes in Situation (Situ) and key sedentary behaviour outcomes from baseline to early intervention

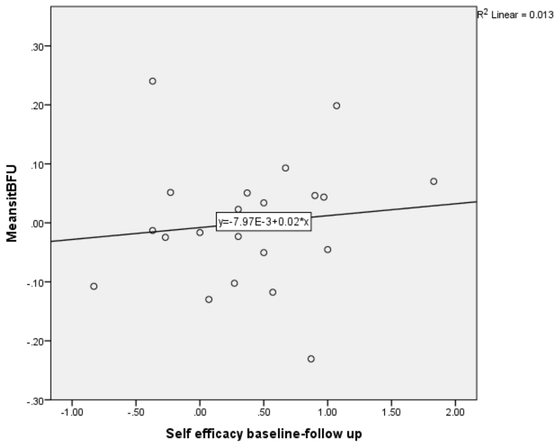


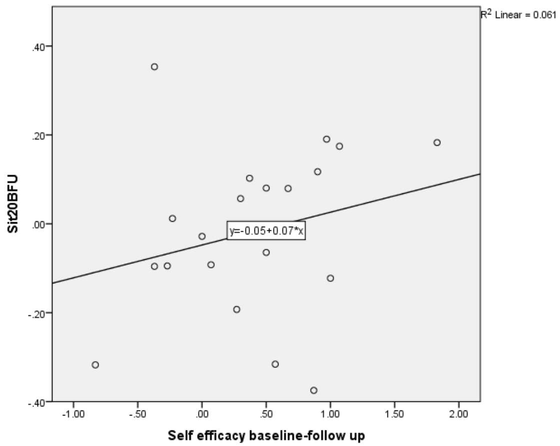
vi. Changes in Self Efficacy and key sedentary behaviour outcomes from baseline to follow-up

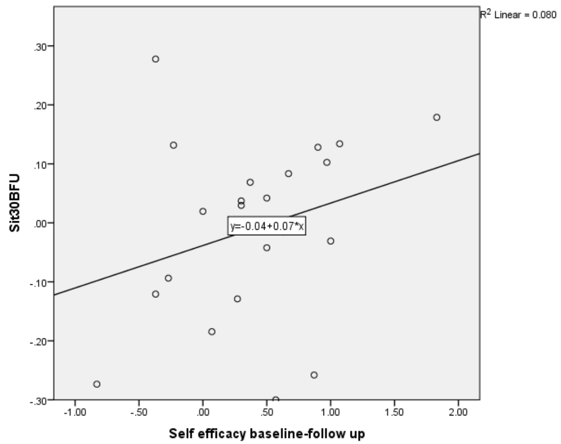




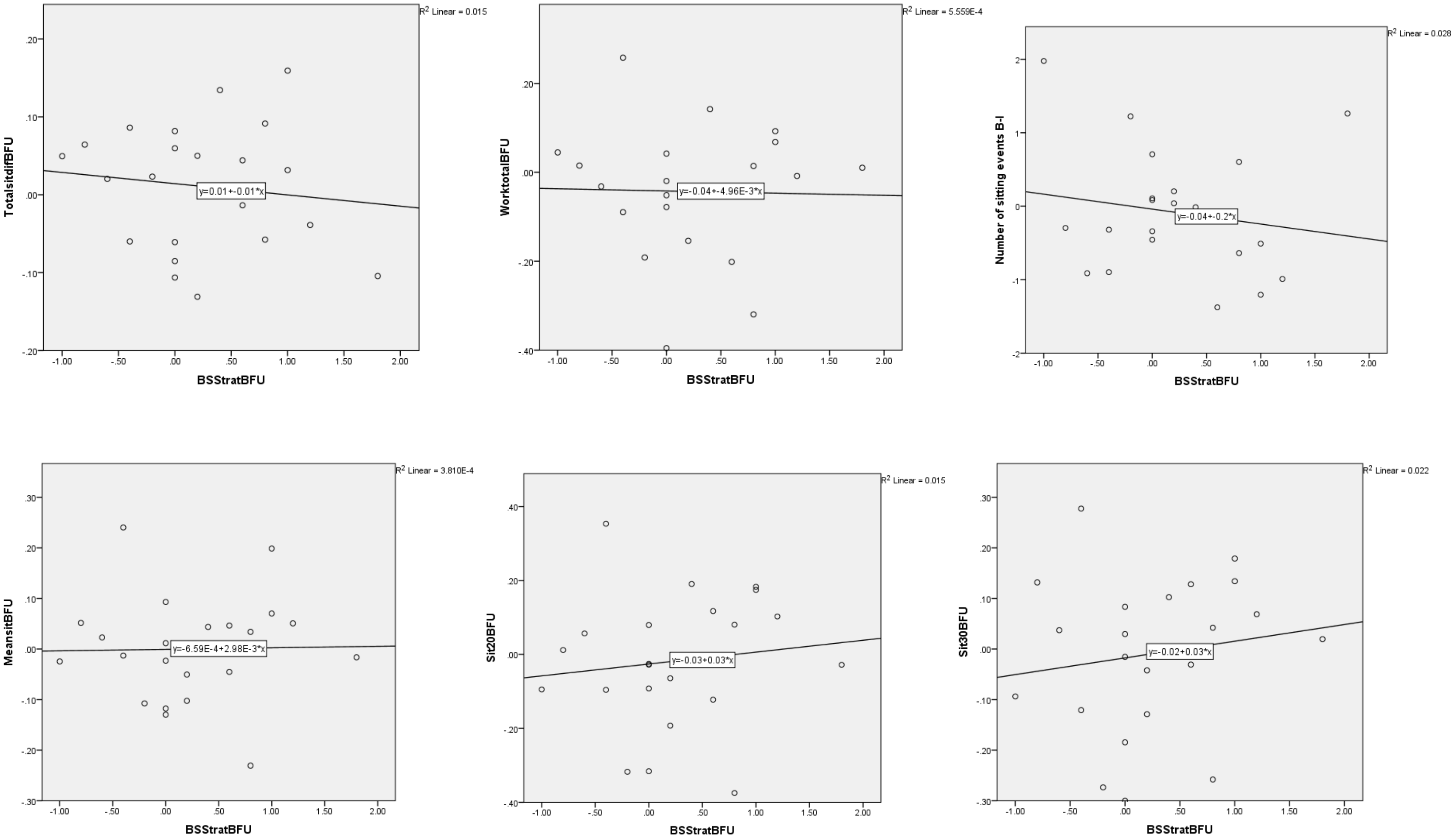




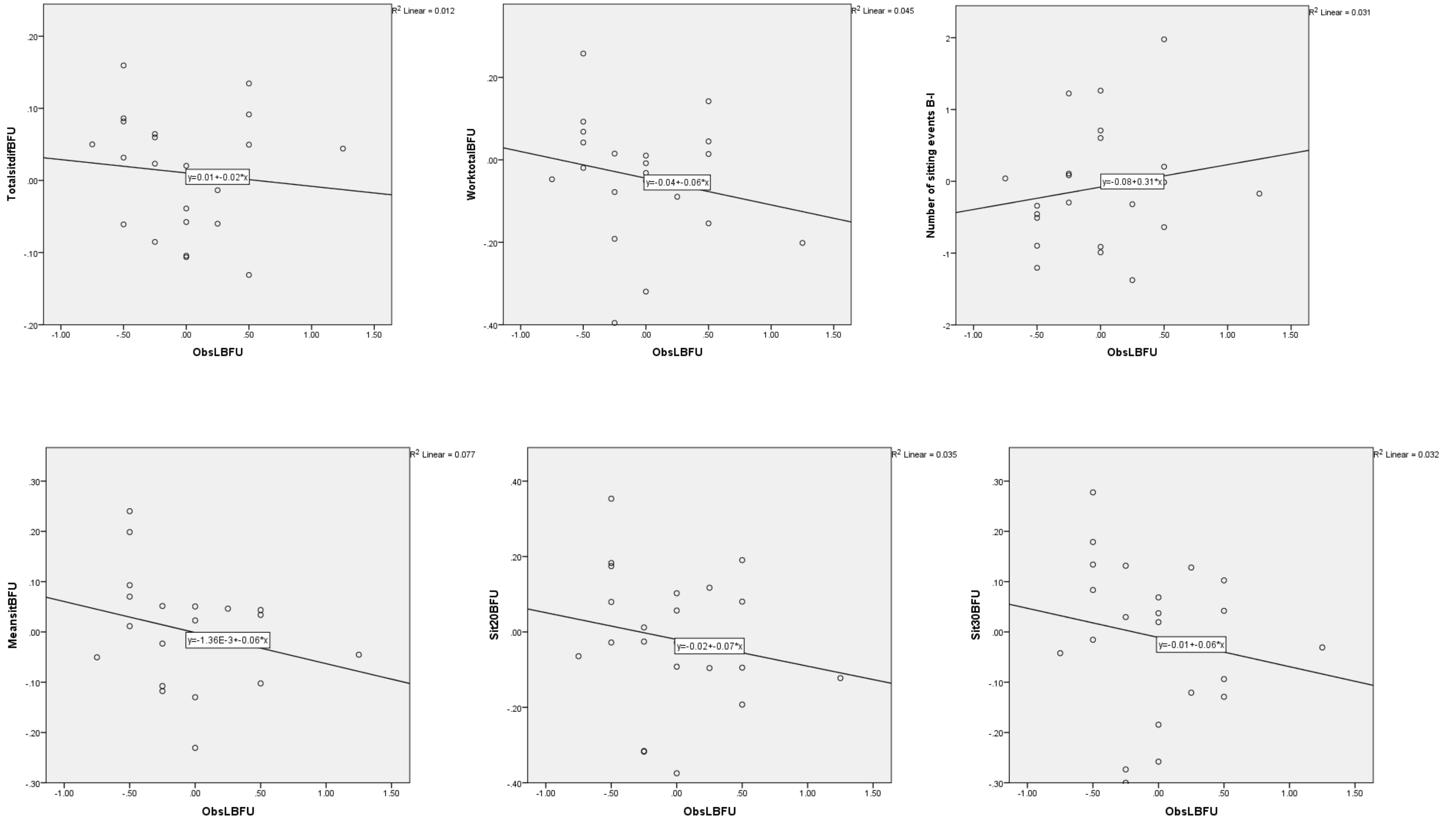




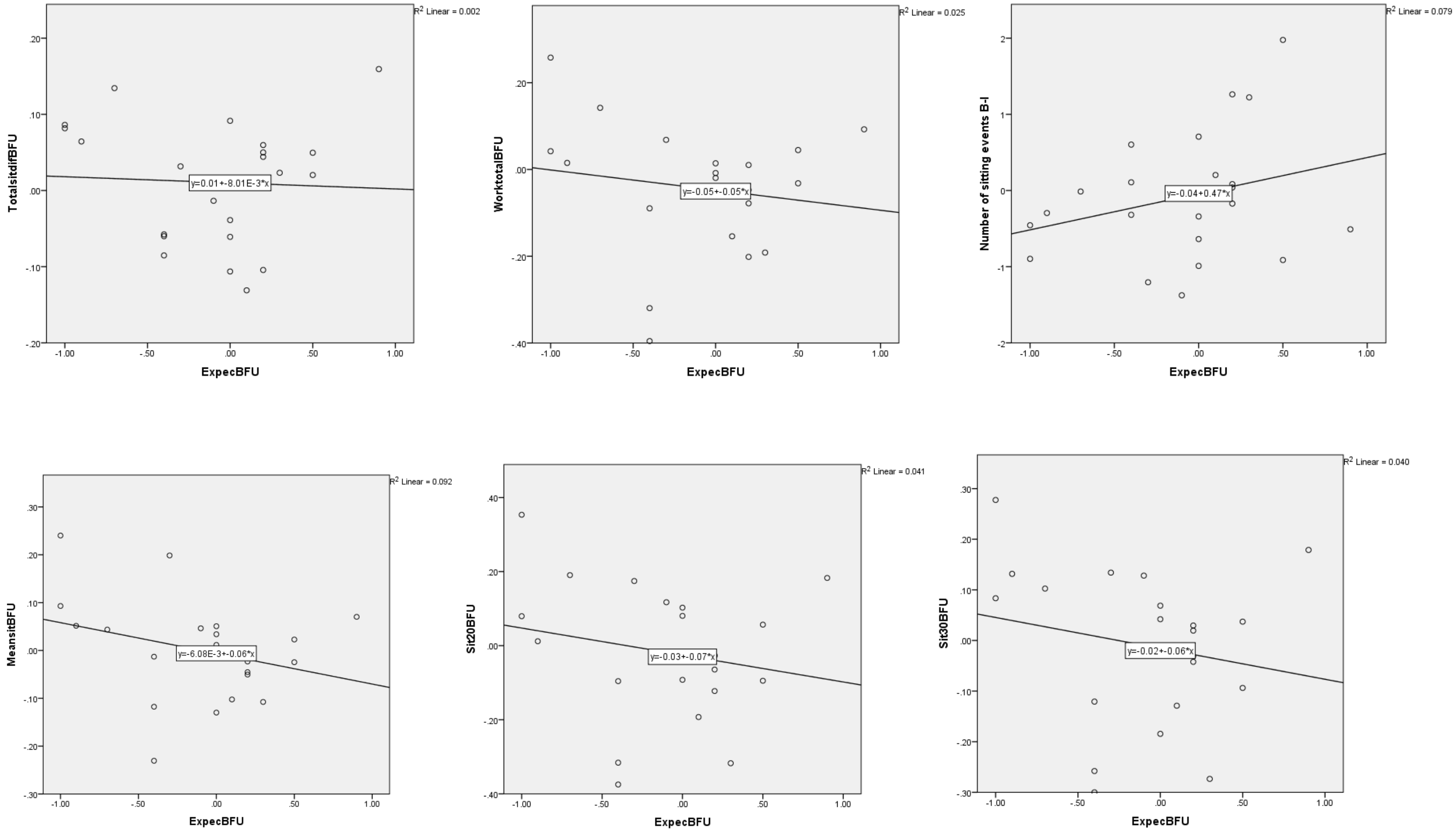
vii. Changes in Behavioural Strategies (BStrat) and key sedentary behaviour outcomes from baseline to follow-up



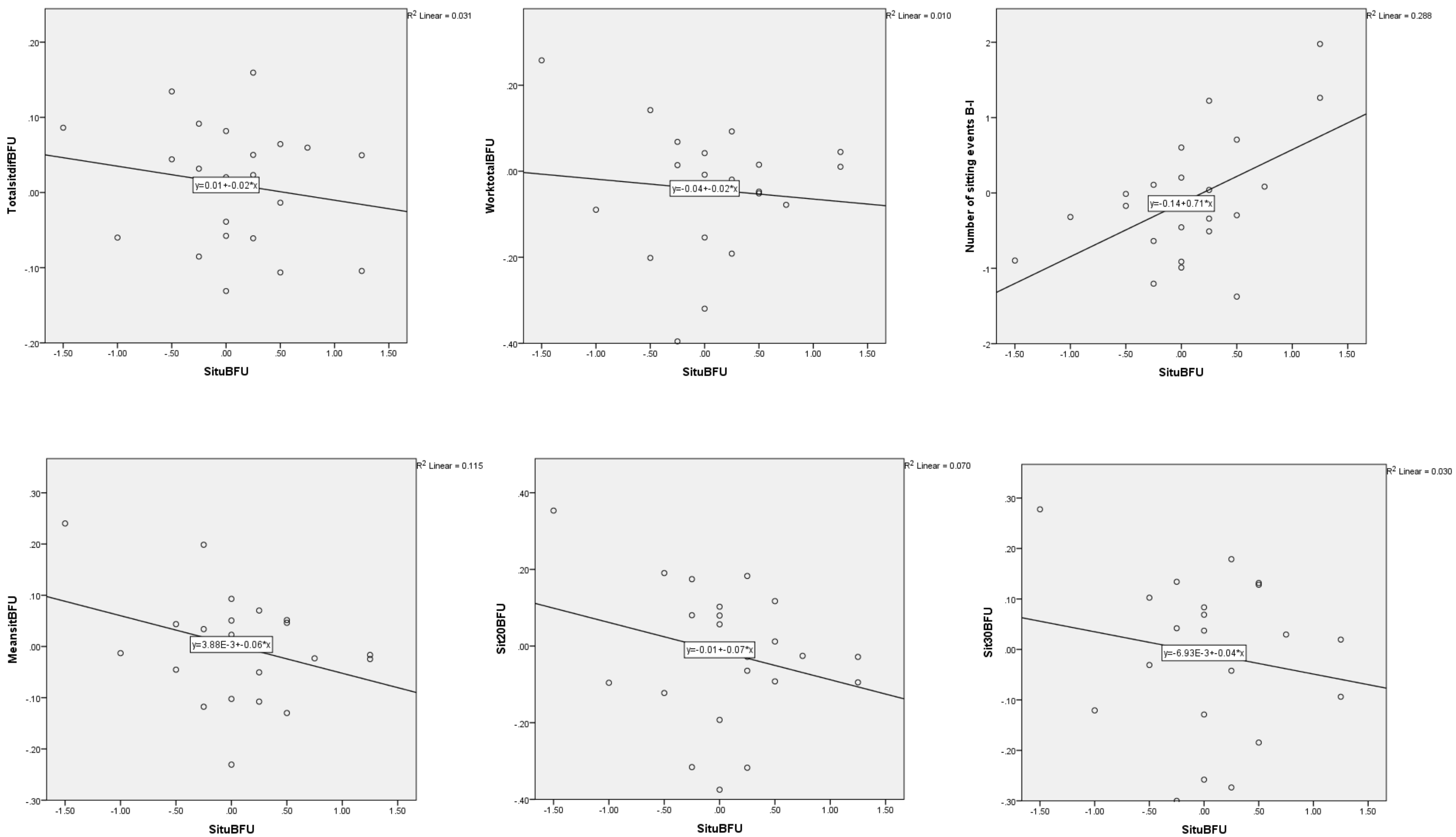
viii. Changes in Observational Learning (ObsL) and key sedentary behaviour outcomes from baseline to follow-up



ix. Changes in Outcome Expectations (Expec) and key sedentary behaviour outcomes from baseline to follow-up



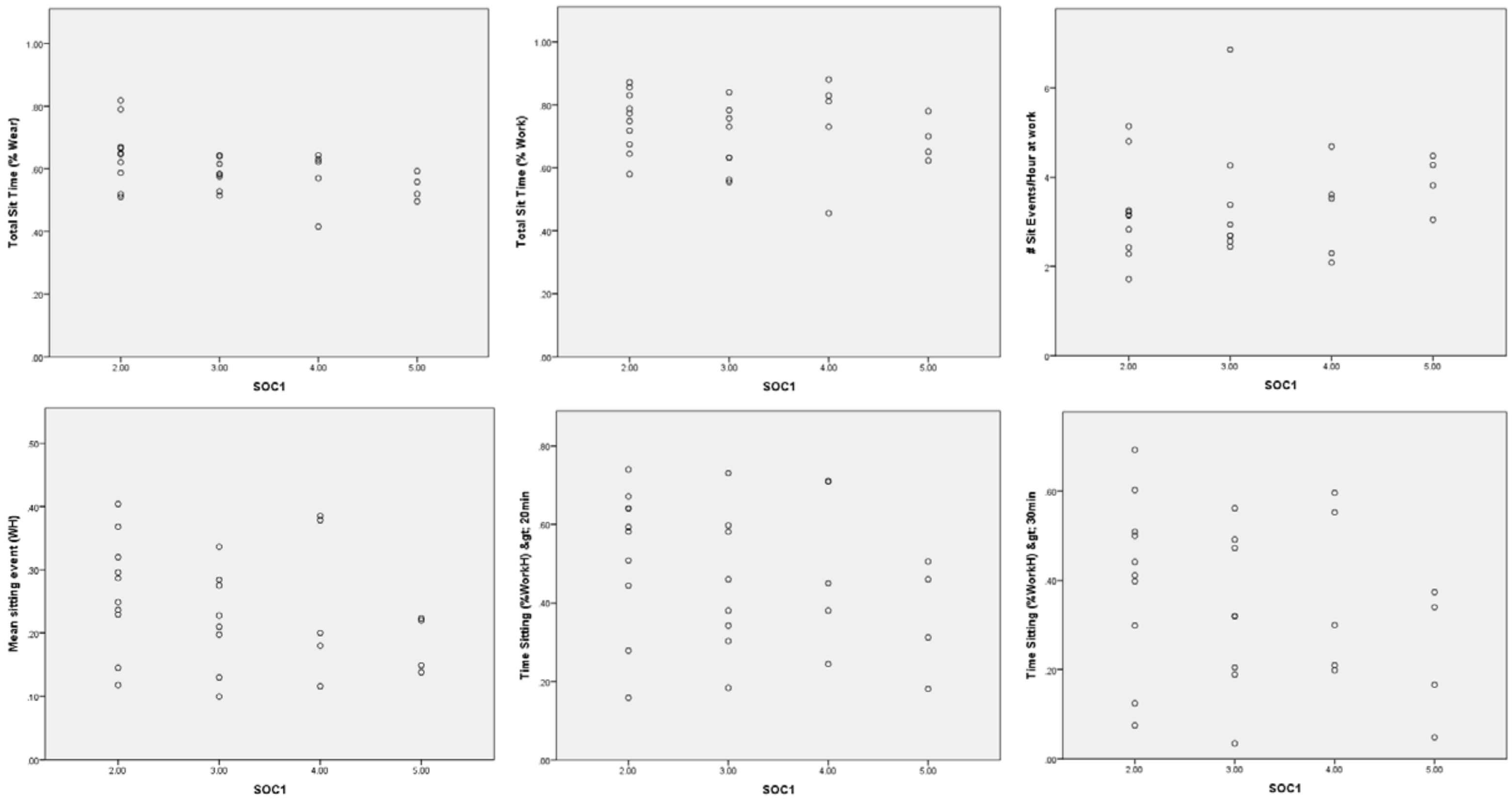
x. Changes in Situation (Situ) and key sedentary behaviour outcomes from baseline to follow-up



8.5 Scatterplots of SOC and sedentary behaviour outcomes at baseline, early intervention and follow-up

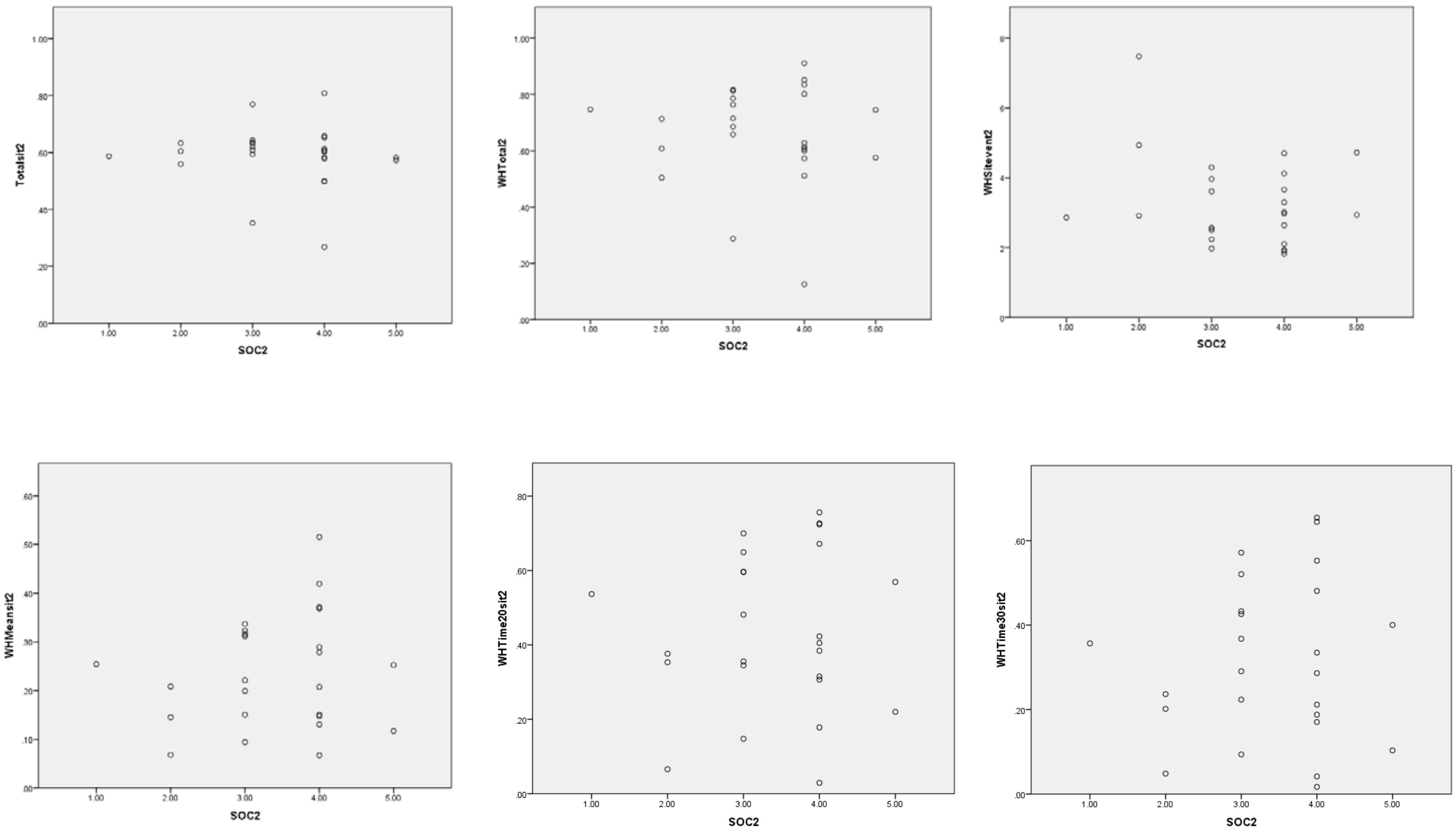
i. Scatterplots of stage of change at baseline against each of the key sedentary behaviour outcomes at baseline

1= precontemplation, 2= contemplation, 3=preparation, 4=action, 5=maintenance (Note no participants were precontemplative at baseline)



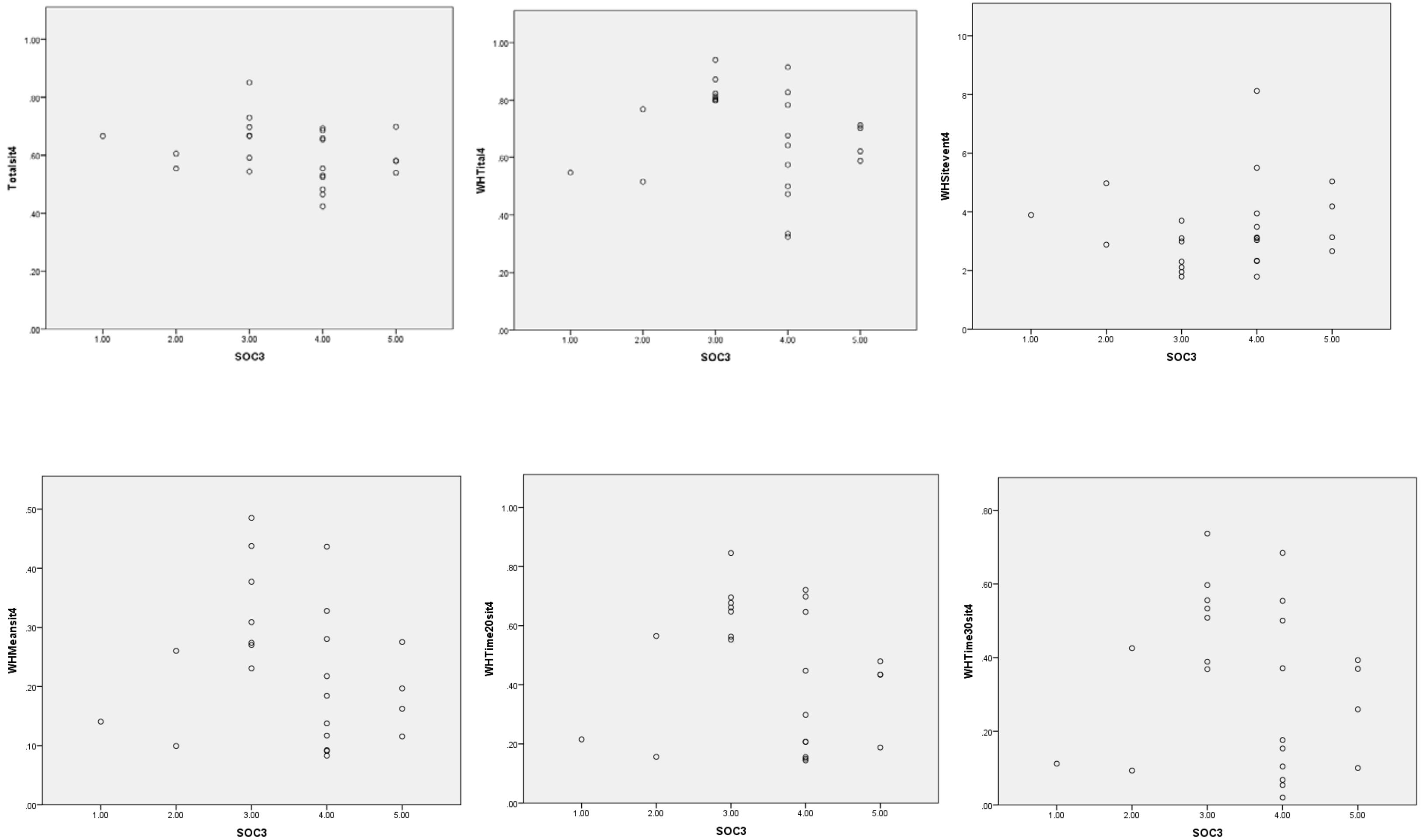
ii. Scatterplots of stage of change at early intervention against each of the key sedentary behaviour outcomes at early intervention

1= precontemplation, 2= contemplation, 3=preparation, 4=action, 5=maintenance



iii. Scatterplots of stage of change at early intervention against each of the key sedentary behaviour outcomes at early intervention

1= precontemplation, 2= contemplation, 3=preparation, 4=action, 5=maintenance



9 ANNEXES

9.1 Summary of employer consultation

Sitting at Work

Summary of Consultation with Employers' Representatives

Background

In collaboration with Healthy Working Lives NHS Greater Glasgow and Clyde, researchers from Glasgow Caledonian University (GCU) are planning to develop, implement and evaluate an intervention designed to reduce prolonged periods of sitting time in occupational settings. This study follows on from previous research which revealed that people employed in office and call centres in Greater Glasgow and Clyde were engaged in work which was largely sedentary.

Representatives from organisations involved with the Healthy Working Lives initiative were invited to meet with researchers to introduce and discuss the project. Two separate meetings, lasting one hour over lunchtime, were conducted on the 11th and 19th June 2014, at Healthy Working Lives Brand Street Offices. This report is a summary of the consultations.

Participants

Ten organisations were represented at the meetings (4 on 11th June and 6 on 19th June). Graeme Stevenson, Health Improvement Practitioner from Healthy Working Lives Greater Glasgow & Clyde, arranged the groups, invited the attendees and attended both consultation meetings. The researchers from Glasgow Caledonian University were Dr Philippa Dall (PD) (11th June), Dr Maggie Lawrence (ML) (19th June) and Dr Margaret Grant (MG) (11th and 19th June).

Structure

Although everybody was encouraged to participate in the discussion, the consultations were led by MG and notes were taken by PD and ML. Permission to record the conversations (to ensure accuracy in summarising information) was gained from participants and there was agreement reached that details of the conversations would not be discussed outside the meetings to prevent sensitive details relating to the participating organisations being divulged.

Although not scripted, there were several issues that the researchers included in both meetings. These were as follows:

- Background information on sedentary behaviour (SB)
    - Health risks of sedentary behaviour
    - Difference between sedentary behaviour and physical activity (PA)
    - Clarification and impact on health of total sitting time and prolonged sitting events (sitting patterns)
    - Findings from baseline study
- Introduction to research project
    - Purpose of consultation
    - Development of intervention
    - Pilot study
    - Current research
    - The need to develop evidence-based interventions
- Description of organisations represented
    - Workplace organisation and work practices
    - Current/past programmes to influence posture/activity and effect
    - Challenges faced within organisations
- Experience and/or Ideas for interventions to reduce sedentary behaviour
    - Barriers/challenges to implementation

Discussion

Background

Research has demonstrated that sedentary behaviour (primarily sitting) is harmful to health. It has been demonstrated that people who sit for a long time, particularly when the sitting is uninterrupted, are more at risk of certain diseases including some cardiovascular problems. Sedentary behaviour (SB) is separate from physical activity (PA) and, depending on a person's activity pattern, it is possible to meet physical activity guidelines while also be classified as sedentary as the individual may sit for prolonged periods throughout the day.

Introduction to research project

It has been reported in the literature that sedentary behaviour is prevalent in the workplace and researchers have proposed that employees should be encouraged to stand regularly for short periods and interrupt prolonged sitting events. Previous research involving office and call centre workers, conducted by Glasgow Caledonian University, supported these findings. In order to build on this research, GCU and Healthy Working Lives Greater Glasgow & Clyde are planning to undertake a pilot study to identify and evaluate, for effectiveness and feasibility, an intervention to improve sedentary practices in the workplace.

In order to ascertain current practice within workplaces and to identify issues that may facilitate or impede interventions, it was decided to consult with representatives from organisations already involved with the Healthy Working Lives initiative. This consultation took the form of two focus groups.

Description of organisations and practices

Representatives from a variety of organisations contributed to the focus groups and there was diversity in the number of employees and range of occupations represented. Most organisations had workers who were primarily desk-based although some occupations/tasks required workers to be standing and moving around most of the day.

All workplaces represented at the meeting were engaged in promoting PA interventions, but none of these were necessarily focussed on breaking SB. Some had knowledge and/or experience of measures used to reduce prolonged sitting (e.g. standing desks) but this was not common or universal. One example from the group described a member of staff (with low back pain) who had a standing desk –other than benefitting the individual it was found that meetings at the desk tended to be shorter (this observation was reinforced by a radio interview, heard by a member of the group, advocating the benefits of standing meetings).

All members of the groups described activities that had been introduced to benefit employees' health. The common theme from the groups was that there was no real appreciation of the difference between breaking SB and promoting PA and most initiatives had been to promote activity. In addition to promoting general activity, these initiatives included:

Walking groups and walking challenges;
Promoting active travel;
"Taster" sessions and/or classes at work eg Yoga, skipping, beat the goalie, aerobics, Zumba;
Subsidising gym fees;
Introducing equipment into work places eg rowing machines, table tennis equipment, bicycles;
Promoting stair use and avoiding elevators/lifts;
Adjusting workplace: moving photocopiers/printers/stationery supplies;
Office based initiatives eg encouraging walking to colleagues' desks rather than email/phone.

It was reported that some of these initiatives were designed to be inclusive of people with disabilities.

Several people described the challenges in promoting physical activity within organisations. Some barriers related to the work environment (lack of space, no shower facilities) and office culture where breaks in work may be perceived as "skiving" by managers who expect employees to be at their desks all of the time. Other difficulties centred around the individuals themselves. It was reported that it was often the same people who engaged in PA initiatives and, frequently, these employees were already active. Due to the wide cross section of workers in many organisations, it was found difficult to introduce activities which appealed to all. In addition, some found that over time people became disengaged and dropped out of activities and the value of promoting active workplaces was questioned. The challenge of keeping people engaged was discussed and it was felt in the past many campaigns pushed the negative message which was considered off-putting and not supportive (eg if you don't exercise daily you will become obese).

Experience and/or ideas for interventions to reduce sedentary behaviour

From their experience, the participants suggested that health messages are better received by employees when they come from a reliable source, with a credible background. There is the potential for “putting people off” with physical activity interventions, however, as the SB message is relatively gentle e.g. “stand up for a minute”, it was felt that the message itself would not deter people from taking part. Conversely, it was felt that other employees may not buy into the project due to the simplicity of the message and intervention as it may be perceived by the employee as not credible (people need to see a benefit from changing behaviour otherwise they question why they are doing it). Linked to this was the large volume of health messages reported in the media and it was suggested that the employees may consider this message to be another fad which would be replaced by a different message in the near future.

There was general agreement that Management buy-in would be required in order to introduce any intervention. Employers need to understand the science behind the initiative and to facilitate support, a no-cost/low-cost intervention which would reduce sick leave would be preferred. It was thought that a break of 1 minute per hour would be manageable.

It was noted that people tend to get engrossed in work and there may be a need for visual prompts eg message on the VDU. To be effective, it was thought a culture change in the workplace would be required. It was considered important that the message is simple and clear (danger of mixed messages) and should be reinforced (duration of campaign to result in behaviour change needs to be considered suggested 40 days to build a habit). Rather than promote negative messages, the positives of breaking sedentary behaviour should be conveyed (Improve your mental health - take breaks! Eat lunch!). To cater for all employees it was agreed that there requires to be range of options comprising both environment adaptions and prompts.

In discussing interventions, not everyone in the groups agreed on the same points – some suggestions were appropriate for one context by not another and advantages and drawbacks were discussed for all suggestions. The suggestions with some challenges included the following:

- Education and raising awareness is necessary – from an external expert or from person within the organisation with knowledge. Health benefits need to be highlighted and success stories promoted (is this evidence available – science suggests long term health is affected so difficult to illustrate with stories; facts, figures and positive messages desirable).
- Invite into the workplace expert speakers.
- Promote podcasts (Dr Mike Evans) (you tube not allowed in many work places, no sound cards, firewall issue).
- Information leaflets with positive messages and helpful advice “standing for 1 minute per hour is good for you”; “don't save up your printing to do in one session” (leaflets ignored by some).
- Posters – (effective but the effect may be short lived and so the message needs to be changed; in some places posters are considered wallpaper).
- Health messages included in pay cheques.

- Prompts: Email or outlook reminders in diary (not all have access to computers; frequent reminders may be annoying particularly when they build up, technology may be a barrier for some people).
- Email campaign; advertising on in-house TV, Company Newsletters - headline items.
- Screen savers (may be limited by IT requirements).
- Alarms on phones/desks (some companies do not allow mobiles in work - would not be acceptable; distracting to colleagues).
- Lead by example - champions are effective.
- Standing at start of meetings; team huddles at the start of day; buzz meetings.
- Take every third phone call standing; walk while on phone (may be annoying for colleagues)
- Re-organise office to force breaks in sitting – positioning of photocopiers, kettles, water coolers (employees may save up printing/photocopying tasks).
- Introduce balance balls to workplace (allows greater movement but still sitting).
- Encourage use of staff rooms/break out rooms for breaks/refreshments.
- Standing desks (additional expense; cumbersome or space saving?).

Summary

These meetings were very productive in that considerable information was exchanged and ideas/suggestions discussed. It was evident from the discussions that it is not feasible to introduce a single intervention to all workplaces due to the diverse nature of work and constraints of the individual organisations. Consequently, appropriate workplaces may need to be targeted for this pilot study.

From the information provided in the meetings, the research team will identify and discuss with colleagues from Healthy Working Lives an intervention that will be used in a pilot study.

A copy of this report will be provided to all people who attended the meetings with a summary of the evidence behind the project.

9.2 Feasibility study information sheet

Participant Information Sheet

Study Title:Pilot study to assess the impact of hourly prompts, delivered by Microsoft Outlook, on reducing prolonged sitting at work

We would like to invite you to take part in a study investigating how to reduce the amount of time people sit for when they are at work. Before you decide it is important for you to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the study?

The purpose of the study is to measure how long, and in what pattern, people sit for when they are at work and how best to encourage breaks in long periods of sitting. Participants in the study will be split into two groups. Both groups will receive information on the benefits of reducing prolonged sitting and tips on how to do this, but one group will also receive prompts on their computer reminding them to stand more. The prompts will take the form of a variety of brief messages about the benefits of sitting less that pop up on your screen every hour as a reminder on Microsoft Outlook and this will happen for 10 weeks. The prompts will be uploaded to your PC for you if you are part of this group. Participants will be randomly assigned to groups, that is, neither the participants or researchers will have any say which group you are put into.

An activity monitor will be used to collect information from all participants on how long you sit for at work over a week, on 3 different occasions. We will also ask some questions about yourself, your general health, and your current understanding of the risks of sedentary behaviour. The data collected will then be used to compare length and patterns of sitting over time.

Why have I been invited?

This study is looking to recruit 30 adults who are employed by Lloyds Commercial Finance to participate. Your employer has agreed to allow its members of staff to participate.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason.

What will happen to me if I take part? What will I have to do?

The study is expected to run for 6 months, in total, but the prompts will only be used for 10 weeks.

If you choose to take part, you will be asked:

1. To complete a brief questionnaire
2. Attend an information session on reducing sitting at work (approx. 1 hour)

3. Wear an activity monitor* and complete a brief diary of waking and working hours for one week on 3 separate occasions (at the start, after 10 weeks and at 6 months).
4. Depending on which group you are allocated to, you may receive hourly prompts on your computer reminding you to stand, for a period of 10 weeks.
5. Attend a focus group (approx. 1 hour) to tell us what you thought about the study.

* The activPAL™ activity monitor is worn on the front of your thigh, and is attached using a non-irritating adhesive pad, and a waterproof covering. After attaching the activity monitor, you will be left to continue with your everyday routine including wearing the monitor in bed and when bathing or swimming. Monitors and diaries will be collected from your place of work by a researcher at the end of each data collection week.

If you are interested in taking part in the research, you will be invited to meet researchers at your place of work and will have the opportunity to ask questions about the research and what it will entail. If you agree to participate you will be required to sign a consent form indicating that you have read this Participant Information Sheet document and have understood its contents. You will be given a copy of the information sheet and a signed consent form to keep.

At the end of the study you will receive a copy of your individual physical activity profile which will be sent out to you by a researcher.

Expenses and payments
You will not be paid to participate in this study. All research meetings will take place at your place of work, so you should not incur any additional costs by taking part in this research project.

What are the possible disadvantages and risks of taking part?
There is a small possibility that you may develop a minor skin irritation from the adhesive used to attach the activity monitor to your thigh. If this does happen, it is important you remove the monitor as soon as possible (it should just peel off like a plaster) and contact the researcher.

What are the possible benefits of taking part?
If you take part you will attend an education session delivered by a health expert which may help you change unhealthy patterns of sitting. In addition, at the end of the study we will provide you with your individual sitting and physical activity profile for each of the 3 weeks you wore the monitor.

What if there is a problem?
Any complaint about the way you have been dealt with during the study or any possible harm you might suffer will be addressed. If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, then you may have grounds for a legal action but you may have to pay for it. Regardless of this, if you wish to complain, or have any concerns about any aspect of the way you have been approached or treated during the course of this study, the normal Glasgow Caledonian University complaints mechanisms will be available to you.

Will my taking part in the study be kept confidential?
Yes. We will follow ethical and legal practice and all information about you will be handled in confidence.

By signing the consent form, you will be granting permission for the researcher to have restricted access to the information collected about you in the course of the study. All information collected about you will be kept strictly confidential and will be anonymised, meaning that information about you will have your name and address removed so that you cannot be recognised from it. Your data will be digitally stored and secured so only the researcher has access.

Your employer has agreed to let us invite you to take part in this research study. However the research is being carried out independently by researchers at Glasgow Caledonian University. No individual information collected about you during the study will be given to your employer, they will only receive non-identifiable, data about the group.

What will happen to the results of the research study?

The results of the research will be written up as a journal article for publication in an appropriate journal, they will be disseminated to clinicians and professionals working in occupational health, and the data collected in this study may be used to form the basis of an application for future funding by the researchers. You will not be identified in any dissemination, application, report or publication.

Physical activity data and basic demographic data will be kept on a password protected database on a secure server. The data held on the database will not be identifiable. This information collected may be used for further analysis by staff and students in the School of Health & Life Sciences at Glasgow Caledonian University at a later date.

Who is organising and funding the research?

This research is being carried out by Dr Philippa Dall, Dr Maggie Lawrence, Dr Margaret Grant and Catriona O'Dolan researchers at Glasgow Caledonian University. The costs for this research project are being jointly met by Glasgow Caledonian University and Health at Work, NHS Greater Glasgow & Clyde.

Who has reviewed the study?

The study has been awarded ethical approval from Glasgow Caledonian University School of Health and Life Sciences Ethics Committee.

Contact for Further Information

For further information about this study, please contact one of the researchers:

Dr Philippa Dall:	Tel: 0141 3318003	Email: Philippa.dall@gcu.ac.uk
Catriona O'Dolan:	Tel: 0141 3318012	Email: Catriona.odolan@gcu.ac.uk

9.3 Feasibility study consent form

Title of Research Study: Pilot study to assess the impact of hourly prompts, delivered by Microsoft Outlook, on reducing prolonged sitting at work

Patient Consent Form

Please Initial Boxes

1. I confirm that I have read and understand the information sheet dated 8th December 2014 (version 2.0) for the above study and have had the opportunity to ask questions. ☐
2. I understand that my participation in this study is voluntary and that I am free to withdraw at any time, without giving a reason. ☐
3. I understand that my physical activity data and basic demographic data will be kept on a password protected database on a secure server. The data held on the database will not be identifiable. This data may be used for further analysis and in comparison with future data, by staff and students of the School of Health & Life Sciences at Glasgow Caledonian University. ☐
4. I understand that this is a research study and the results may be published in national and international medical journals but none of my personal details will be included. ☐
5. I agree to take part in the above study.. ☐

Name of Participant (PRINT)	Date	Signature
Researcher	Date	Signature
Name of Person taking consent (if different from researcher)	Date	Signature

9.4 Slides from education session

Slide 1

Sedentary Behaviour

Dr Margaret Grant

Slide 2

Content

Sedentary Behaviour …….

- What is it?
- When do we do it?
- How do we measure it?
- What is important?
- Why is it important?
- How does it relate to physical activity?
- How much do we do?
- What happens when we stand up?
- How can we change our behaviour?

Slide 3

What is it?

"Sedentary behaviour refers to any waking activity characterized by an energy expenditure ≤ 1.5 metabolic equivalents *and* a sitting or reclining posture".

Sedentary Behaviour Research Network. 2012. Standardized use of the terms "sedentary" and "sedentary behaviours". Apple Physiol Nutr Metab. 37: 540–542.

Slide 4

What is it?

Image courtesy of [ambro] at FreeDigitalPhotos.net

Slide 5

Too much sitting rather than too little exercise.

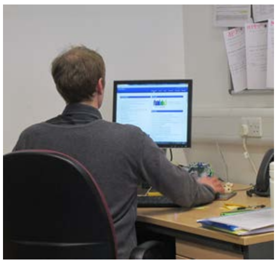
Slide 6

What is it?

Slide 7

When do we do it?

Work/school
Leisure/entertainment
Commuting

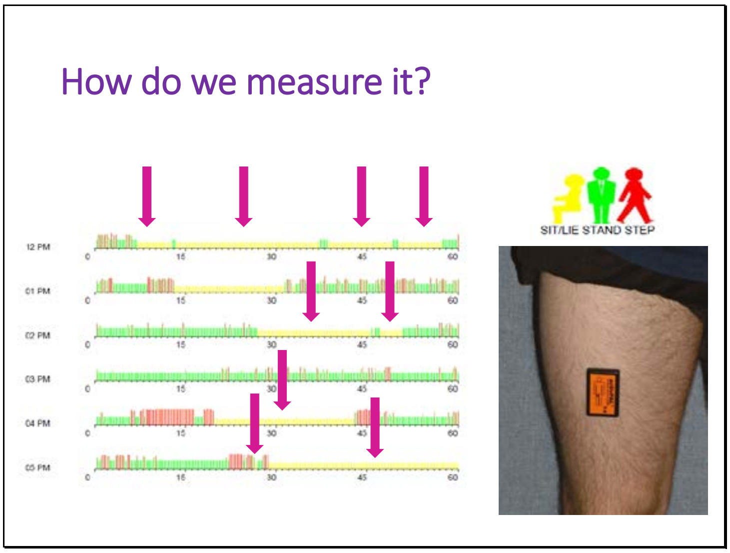


Slide 8

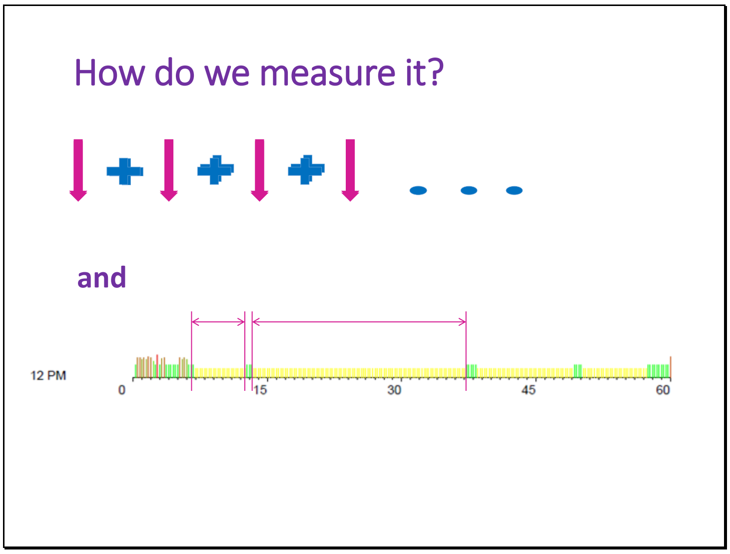
How do we measure it?

Image courtesy of [imagerymajestic] at FreeDigitalPhotos.net

Slide 9



Slide 10



Slide 11

What is it important?

Total sitting time

and

Prolonged, unbroken periods of sitting

(Healy et al, 2011)

Slide 12

Why is it important?

“Many research studies have consistently shown that spending excessive time engaged in sedentary behaviours may have a negative impact on several health outcomes, independently of moderate-to-vigorous physical activity”.

(de Rezende et al, 2014)

Slide 13

Why is it important?

Increased risk of a number of conditions including:

- All-cause mortality
- Cardiovascular disease (incidence and mortality)
- Some Cancers (Incidence and mortality)
- Type II diabetes (incidence)

(Biswas et al, 2015)

Slide 14

How does it relate to physical activity?

Sedentary behaviour is an independent risk factor for chronic disease

The increased risk of prolonged sitting appears to be **independent of overall physical activity levels.**

(Katzmarzyk et al., 2009)

Slide 15

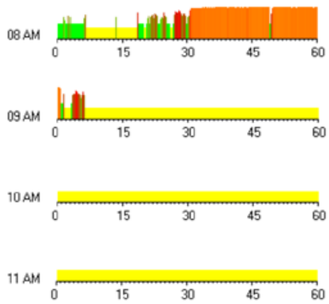
How does it relate to physical activity?

Meets physical activity guidelines

- 31 minutes of moderate-to-vigorous physical activity

Sedentary?

- 200 minutes (3.2 hours) sitting
- 170 minutes in a continuous prolonged event



Slide 16

How much do we do?

67 employees in Glasgow (primarily office and call centre)

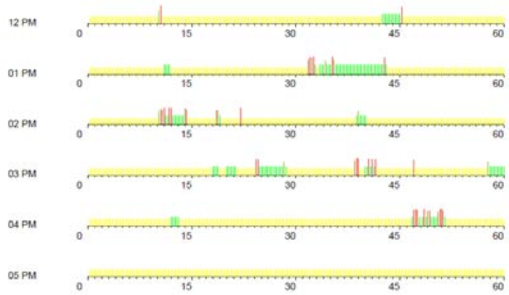
Average age 41 years (20-61) 70% women

- Sedentary 66% of the waking day (all days)
- Sedentary 69% of the waking day (working days)
- Sedentary 79% of time at work
- Prolonged sedentary events (≥ 30 minutes continuous sitting) 68% of time sedentary

Slide 17

How much do we do?

Sitting in an office: 6 hours of a typical worker



Female aged 56

In these 6 hours, this person sat for
5 hours 20 minutes (89% of the time)

They sat in **prolonged** bouts (> 30 minutes) for
2 hours 52 minutes (48% of the time)

Slide 18

What happens?

"When you have been sitting for a long period of time and then get up, at a molecular level, within 90 seconds of getting off your bottom, the muscular and cellular systems that process blood sugar, triglycerides, and cholesterol—which are mediated by insulin—are activated"

(Dr James Levine)

Slide 19

How can we change our behaviour?

Interventions increasing Physical Activity

- Small reductions in sedentary time

Interventions increasing Physical Activity and reducing Sedentary Behaviour

- Significant small reductions in sedentary time (≈ 35 mins/day)

Interventions reducing Sedentary Behaviour

- Significant large reductions in sedentary time (≈ 91 mins/day)

(Prince et al, 2014)

Slide 20

How can we change our behaviour?

Image courtesy of [imagerymajestic] at FreeDigitalPhotos.net

Slide 21

Summary

- Prolonged periods of sitting should be avoided.

- When you are involved in sitting activities stand up regularly!

Slide 22

Acknowledgements

Glasgow Caledonian University

Dr Philippa Dall

Dr Maggie Lawrence

Mrs Catriona O'Dolan

In collaboration with

NHS Greater Glasgow & Clyde Healthy Working Lives

Mr Graeme Stevenson

Mrs Catrina Henderson

9.5 Feasibility study baseline questionnaire

Participant ID:

Pilot study to assess the impact of hourly prompts, delivered by Microsoft Outlook, on reducing prolonged sitting at work

Baseline Questionnaire

> The information you provide here is confidential, and will be stored anonymously, separately from your name and address. Your data will be securely stored so only the researcher has access.

Please write your answers on the line, or circle the relevant answer. Please try and answer all the questions, if you are not sure please put the answer that you feel describes you best.

ABOUT YOU

1. **Age:**______________
2. **Gender:** Male Female
3. **Height:** ____________________
4. **Weight:**____________________
5. **Job title:**_______________________________________
6. **Do you work:** Full time Part Time
7. **Do you work from home?** Never Occasionally Most of the time
8. **Home Post Code (please provide only 1st part):** ☐☐☐ ☐
9. **Do you currently smoke?** Yes No
10. **In general, would you say your health is:**

excellent very good good fair poor

11. **Have you ever participated in health promotion activities AT WORK before? e.g. walk/cycle to work promotion, smoking cessation etc** Yes No

    If yes, please list:______________________________ **apx date**____________

    ______________________________ **apx date**____________

    ______________________________ **apx date**____________

The following questions are designed to ascertain your current understanding of the problems associated with sitting. You are not expected to know the correct answers, instead your answers (collectively) will be used to inform the content of the information session. Please try to answer all questions.

1. **Sally has recently moved house and needs to send "change of address" cards to all contacts. To complete the task involves sitting and working at a computer for 4 hours. Which ONE of the following options do you think would be best for her overall health? (please circle):**

   a) Complete and finish the task uninterrupted in 4 hours.

   b) Interrupt the task regularly with other chores and complete the task in 7 hours.

   c) No difference - the task involves 4 hours sitting, so either way, the sitting involved is the same.

2. **Peter works full time in a call centre, taking calls from members of the public whilst sat at a computer. He often works 4 hours at a time without a break, but goes to the gym in his lunch hour, 3 times a week as well as playing football at the weekend. For each of the statements mark whether you consider them to be true or false (please circle)?**

   a) Peter is meeting the recommended guidelines for weekly levels of physical activity and is therefore more likely to stay healthy TRUE FALSE

   b) Peter is meeting the recommended guidelines for weekly levels of physical activity, but this will not offset the damage to his health caused by sitting at work TRUE FALSE

   c) Peter should continue to exercise, but also interrupt prolonged periods of sitting at work in order to benefit his health TRUE FALSE

3. **Which of the following health problems, in adults, have been linked with prolonged sitting behaviour?** Please tick ALL that you think apply.

Reduced bone mass	☐	Weight loss	☐
Obesity	☐	Depression	☐
Type 2 diabetes	☐	Cancer	☐
Stomach ulcers	☐	Heart disease	☐
Back ache	☐	Hair loss	☐

9.6 Feasibility study diary

10 DAY:

Time got up

Time went to bed

Is today a work day?

YES NO

If a work day:

Time started work

Time finished work

Working from home?

YES NO

If a non work day, was it?

Day off (e.g. weekend/bank holiday) ☐

Annual Leave ☐

Unplanned (e.g. sick day) ☐

Did you remove the monitor at any time today?

YES NO

If YES, when?

DAY:

Time got up

Time went to bed

Is today a work day?

YES NO

If a work day:

Time started work

Time finished work

Working from home?

YES NO

If a non work day, was it?

Day off (e.g. weekend/bank holiday) ☐

Annual Leave ☐

Unplanned (e.g. sick day) ☐

Did you remove the monitor at any time today?

YES NO

If YES, when?

Participant Diary: ***Instructions***

1. Write the day in the box
2. Write the time you got up and went to bed
3. Circle if it is a work day or a non-work day. (circle yes even if you were only at work for part of the day)
4. If the day is a work day, please fill in the time that you started and finished work & whether you worked from home or not. (If not working at home use the time when you first get to your place of work, and when you leave the building to go home)
5. If the day is a non-work day, please tick why: tick *day off* for a day you don't usually work (e.g. a weekend, bank holiday or a usual day off); tick *annual leave* if you are scheduled to be on holiday tick *unplanned* if you are not at work for an unexpected reason, for example if you are not at work because you are unwell.
6. Finally, please circle YES if you removed the monitor (or if it came off unexpectedly). If the monitor didn't come off, please circle NO. If the monitor did come off, please give the start and end times for when this happened. (If you are not sure, please give your best guess)

EXAMPLE (of a work day)

DAY: MONDAY 1

Time got up 7 am 2

Time went to bed 10 30pm

Is today a work day? 3

YES NO

If a work day: 4

Time started work 8: 55 am

Time finished work 5 12 pm

Working from home?

YES NO

If a non work day, was it? 5

Day off (e.g. weekend/bank holiday) ☐

Annual Leave ☐

Unplanned (e.g. sick day) ☐

Did you remove the monitor at any time today? 6

YES NO

If YES, when?

DAY:	DAY:	DAY:	DAY:	DAY:
Time got up	Time got up	Time got up	Time got up	Time got up
Time went to bed	Time went to bed	Time went to bed	Time went to bed	Time went to bed
Is today a work day?	**Is today a work day?**	**Is today a work day?**	**Is today a work day?**	**Is today a work day?**
YES NO	YES NO	YES NO	YES NO	YES NO
If a work day:	**If a work day:**	**If a work day:**	**If a work day:**	**If a work day:**
Time started work	Time started work	Time started work	Time started work	Time started work
Time finished work	Time finished work	Time finished work	Time finished work	Time finished work
Working from home?	**Working from home?**	**Working from home?**	**Working from home?**	**Working from home?**
YES NO	YES NO	YES NO	YES NO	YES NO
If a non work day, was it?	**If a non work day, was it?**	**If a non work day, was it?**	**If a non work day, was it?**	**If a non work day, was it?**
Day off (e.g. weekend/bank holiday) ☐	Day off (e.g. weekend/bank holiday) ☐	Day off (e.g. weekend/bank holiday) ☐	Day off (e.g. weekend/bank holiday) ☐	Day off (e.g. weekend/bank holiday) ☐
Annual Leave ☐	Annual Leave ☐	Annual Leave ☐	Annual Leave ☐	Annual Leave ☐
Unplanned (e.g. sick day) ☐	Unplanned (e.g. sick day) ☐	Unplanned (e.g. sick day) ☐	Unplanned (e.g. sick day) ☐	Unplanned (e.g. sick day) ☐
Did you remove the monitor at any time today?	**Did you remove the monitor at any time today?**	**Did you remove the monitor at any time today?**	**Did you remove the monitor at any time today?**	**Did you remove the monitor at any time today?**
YES NO	YES NO	YES NO	YES NO	YES NO
If YES, when?	If YES, when?	If YES, when?	If YES, when?	If YES, when?

9.7. Feasibility study personal activity report

Your personal activity profile

Many thanks for taking part in the pilot study to assess the impact of hourly prompts on reducing prolonged sitting at work. This report contains activity data that we collected from you over the three data collection periods when you were wearing the activity monitor. Please note that this information is confidential. Any data made available to a third party will be amalgamated and your name will not be linked to your personal data.

Understanding your activity data

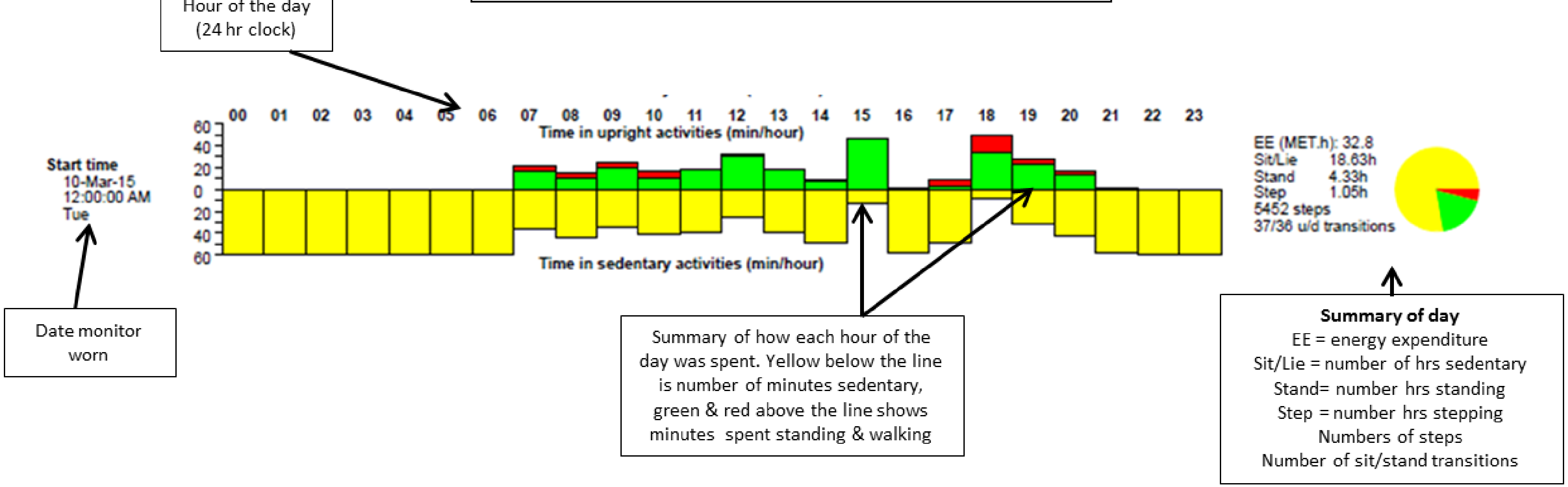
The activPAL monitor provides information on your posture. All the graphs in this report are colour coded as follows:

- YELLOW = time spent sitting or lying i.e. sedentary
- GREEN = time spent standing
- RED = time spent walking

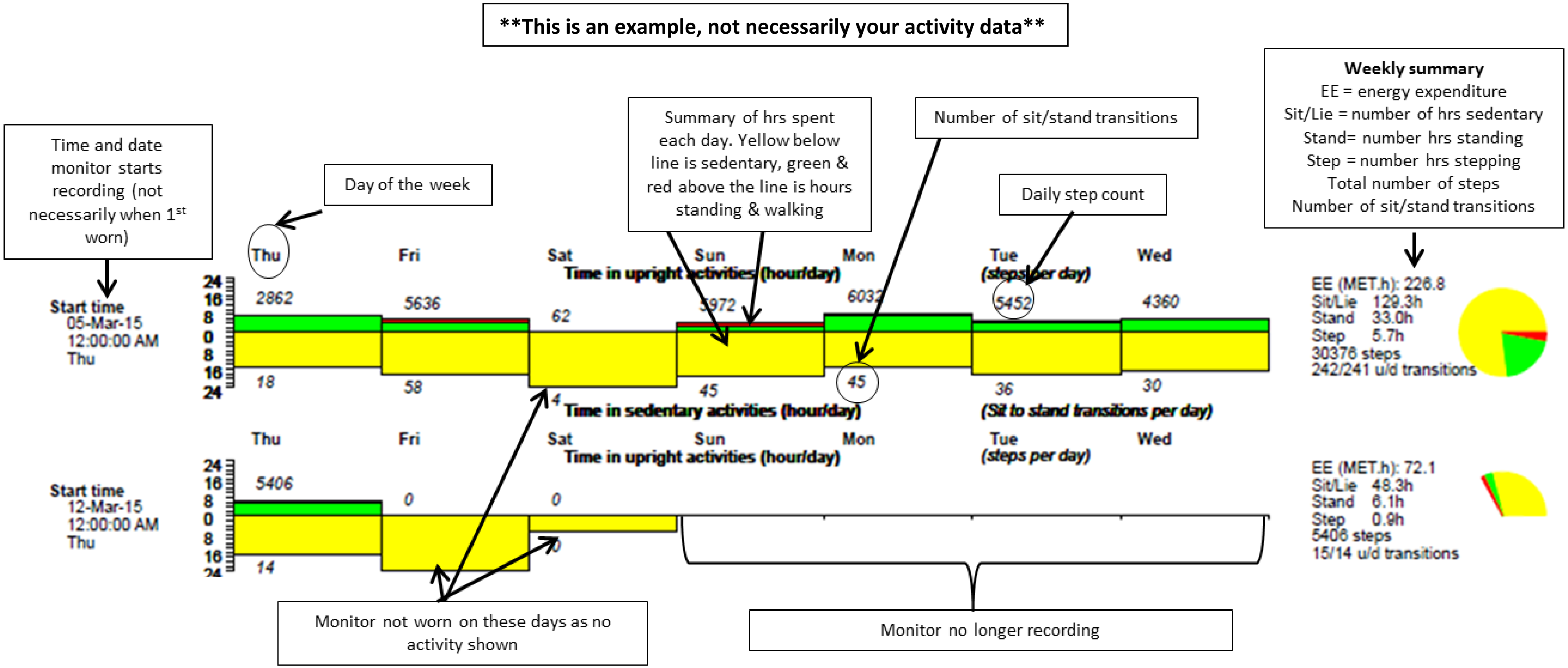
This report contains daily summaries of your most and least sedentary days for each measurement period and also a weekly summary.

Daily summaries look like this:

****This is an example, not necessarily your activity data****



Weekly summaries look like this:



NOTE: Least/most sedentary days are calculated on the basis of hours spent sitting & lying. It is therefore still possible for step counts to be higher on days when an individual is more sedentary.

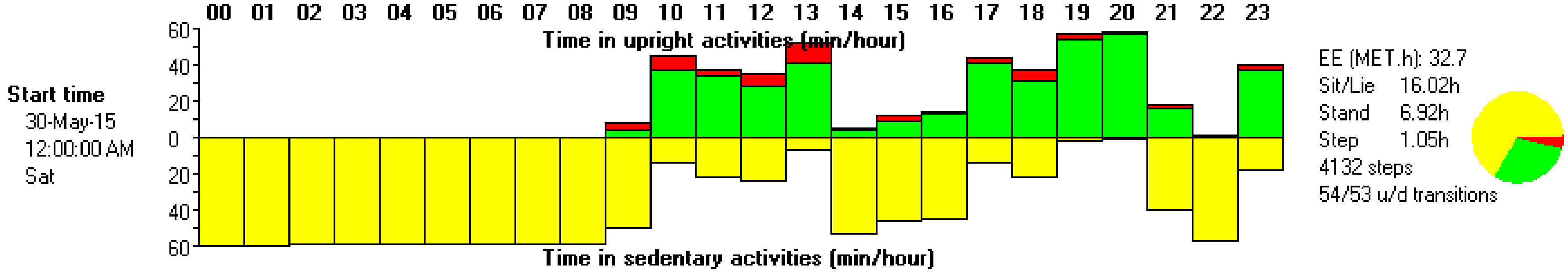
**NOTE: Weekly summaries contain information on the entire time for which the monitor was programmed. In the example above the activPAL was worn from Friday 6th March – Thursday 12th March (inclusive) with the exception of Saturday 7th March when the monitor was removed. The activity shown on the first day shows the monitor being delivered to the recipient and the recipient carrying it home to but on before bed as instructed. **

Your activity data – daily summaries

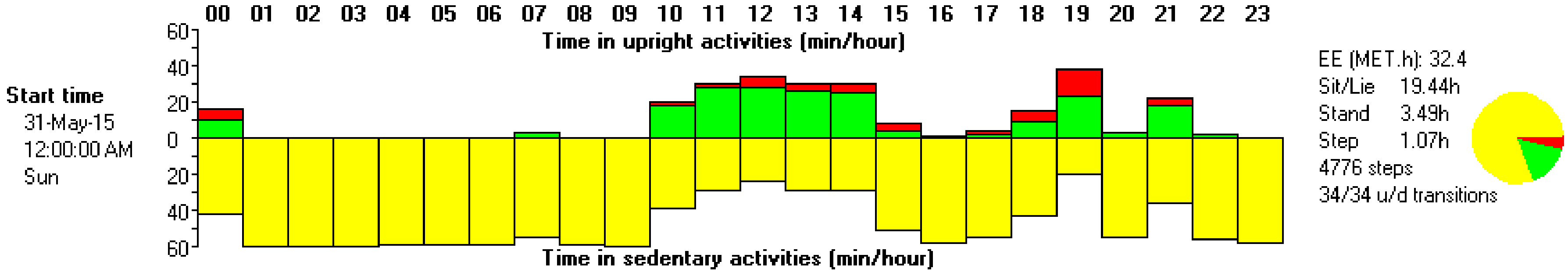
Data collection 1: March 2015. *No data found on the monitor. Apologies, appears to have been a monitor malfunction*

Data collection 2: May 2015. Daily summaries

Least sedentary day (this was NOT a working day)

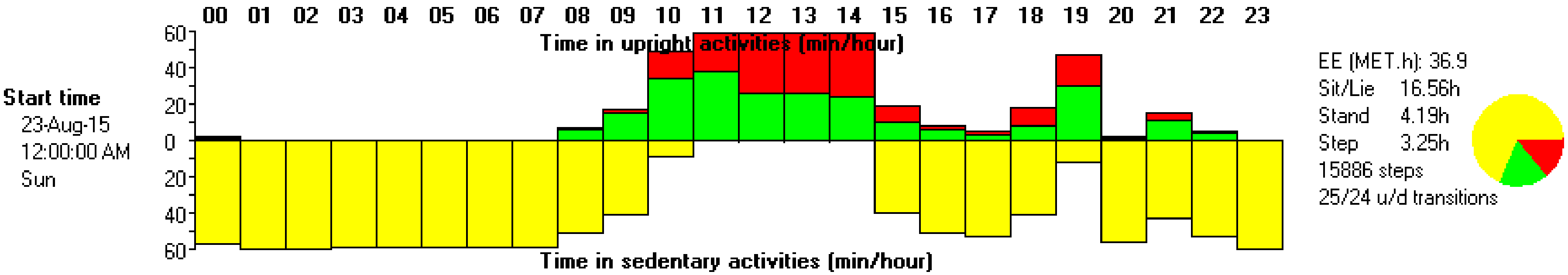


Most sedentary day (this was NOT a working day)

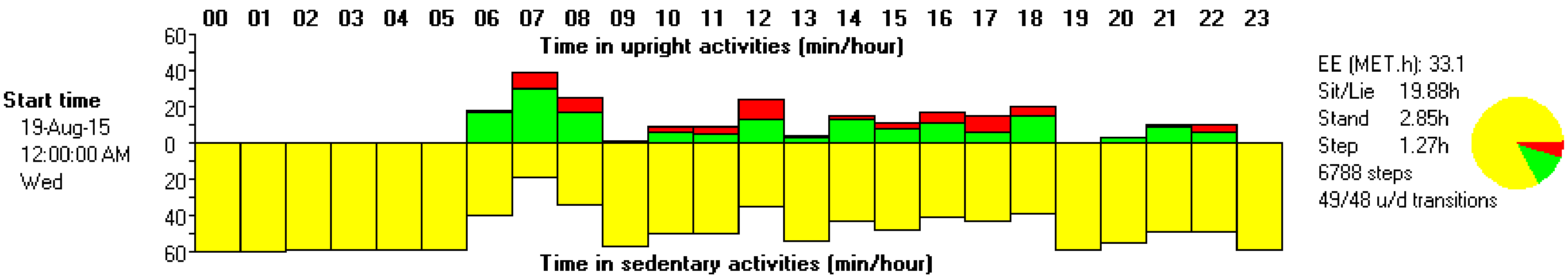


Data collection 3: August 2015.

Least sedentary day (this was NOT a working day)



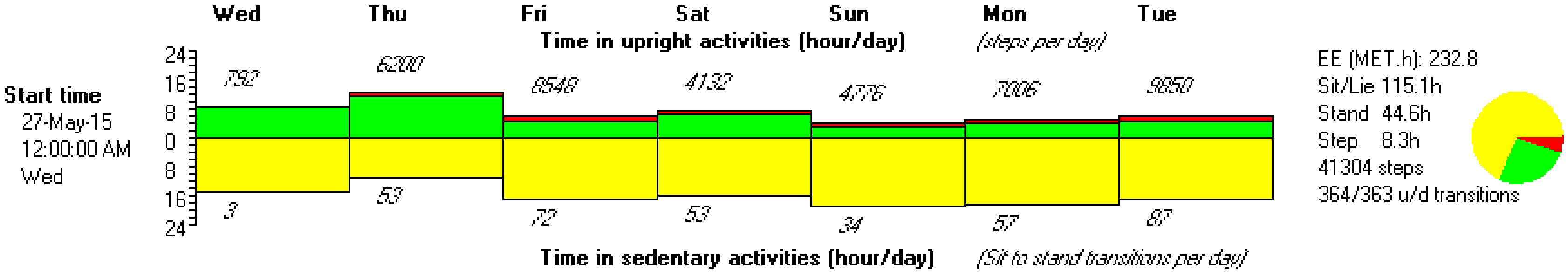
Most sedentary day (this was a working day)

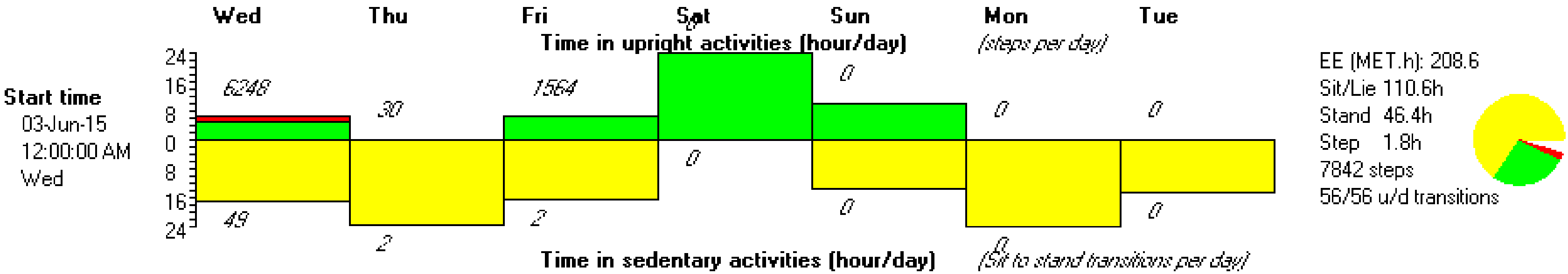


Your activity data – weekly summaries

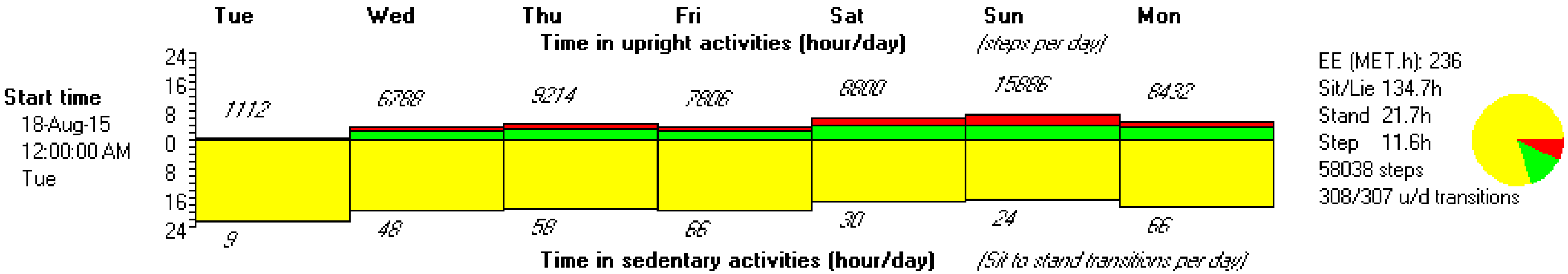
Data collection 1: March 2015. *No data found on the monitor. Apologies, appears to have been a monitor malfunction*

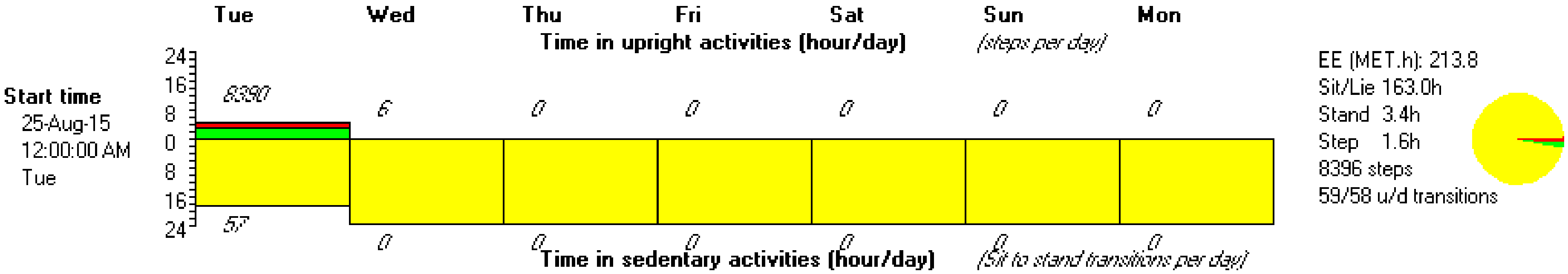
Data collection 2: May 2015





Data collection 3. August 2015





If you would like any clarification about the data in this report or would like to see more of your activity data please do not hesitate to get in contact: catriona.odolan@gcu.ac.uk

9.8. Feasibility study focus group schedules

Pilot study to assess the impact of hourly prompts, delivered by Microsoft Outlook, on reducing prolonged sitting at work

Post-intervention participant focus group topic guide

Ground rules & preamble

- What did you think about the information session on the effects of sitting and how to reduce sitting in the work place?
  Prompts: - Was it useful?

  - Was it what you expected?
  - Did it change the way you feel about sitting at work? How?

- Do you feel that you changed your patterns of sitting following the information session?
  Prompts: - How?

  - Were there any barriers to you making the changes you wanted to?

- For those that received the prompts on their computer to stand more, what did you think of these?
  Prompts: - The messages?

  - The frequency?
  - Did you stand when prompted? If not, what were the main reasons
  - Did it interfere with your work?

- How did you feel about standing up/moving around the office?

- How do you think others (colleagues/managers) not involved in the study reacted to any changes you made to your sit/stand behavior?

- What difference has being part of this study made to how you feel?
  Prompts: - Your health?

  - Your mood?

- Socialising in the office?

- What difference has being part of this study made to your working day?

- If you changed your sitting habits, do you think you will continue to do this long term – it's OK to give us an honest answer! ….?

- Do you think it has changed your sitting habits outside of work?

Bring the focus group to a close. Thank everyone for taking part. Let the group know what will happen next and when they will get feedback from the study.

9.9. PAWS baseline feedback report

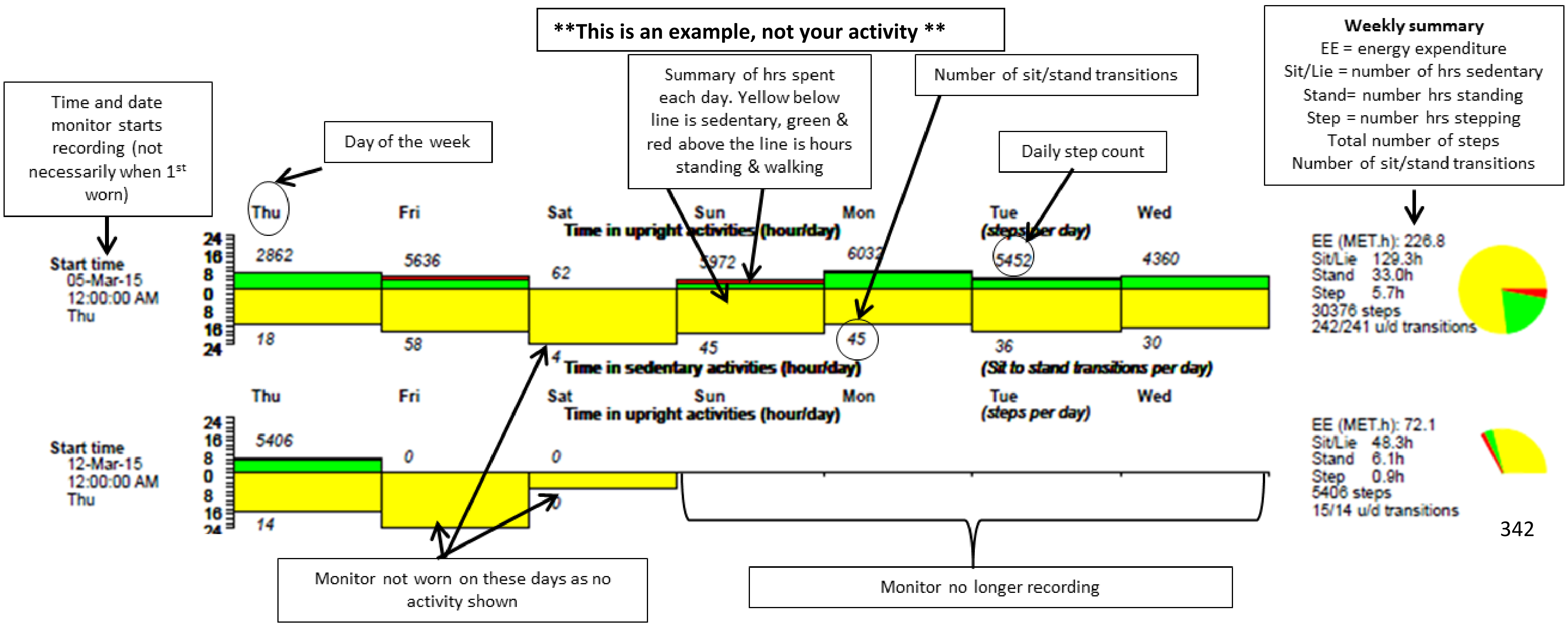
Your personal activity profile

Many thanks for taking part in this study investigating how best to improve activity patterns at work. This report contains activity data that we collected from you at the start of the project, you will receive a full report summarising all your activity data at the end of the project. Please note that this information is confidential. Any data made available to a third party will be amalgamated and your name will not be linked to your personal data.

Understanding your activity data

The activPAL monitor provides information on your posture. All the graphs in this report are colour coded as follows:

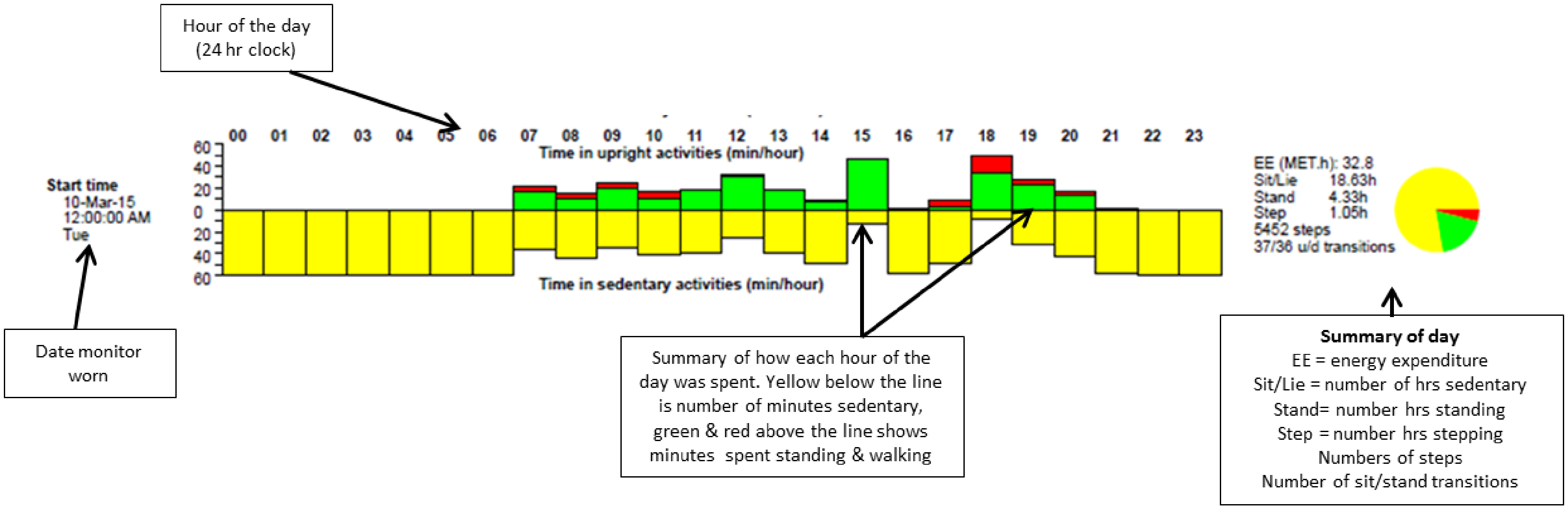
- YELLOW = time spent sitting or lying i.e. sedentary
- GREEN = time spent standing
- RED = time spent walking



This report contains a weekly summary and a summary of your most sedentary work day. Your weekly summary may look like this:

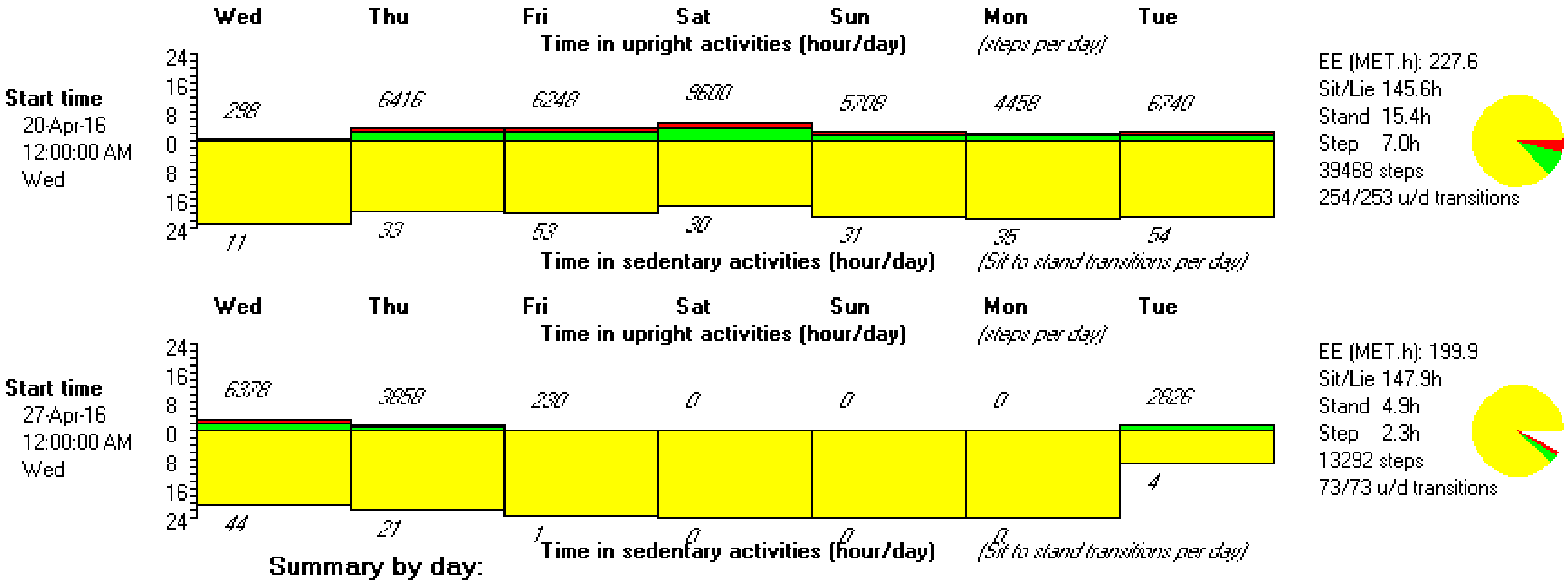
Your daily summary may look like this

****This is an example, not your activity data****

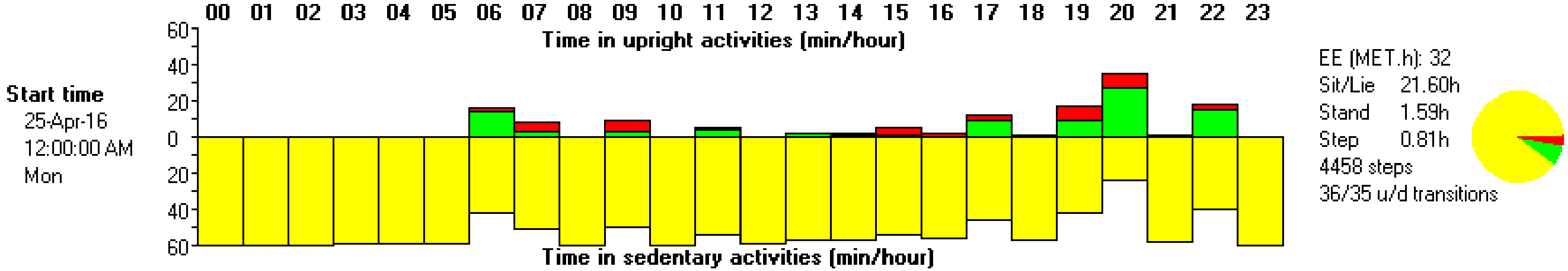


Your activity data

Weekly summary:



__Your most sedentary work day:__



Remember….

- On your most sedentary work day, you spent apx **86%** of your waking hours in sedentary postures
- Try to break up long periods of sitting by standing or moving for short amounts of time
- When at work, think of tasks that require you to get off your chair & space these out throughout the day
- Consider not eating lunch at your desk
- Aim to break your sitting at least once an hour, or once every 30mins if possible
- Reducing sedentary behaviour is important for your health!

9.10. PAWS Social Cognitive Theory questionnaire

Participant ID:

Glasgow Caledonian University

PAWS –Prompting Activity in a Workplace Setting
Social Cognitive Questionnaire

The information you provide here is confidential, and will be stored anonymously, separately from your name and address. Your data will be securely stored so only the researcher has access.

This questionnaire is designed to understand your experience of sedentary behaviour in the workplace and the factors that may influence it. Please answer all questions by circling the answer or ticking the box that best describes how you feel at this current time. Thank you for taking the time to complete this questionnaire

Self-efficacy scale
Please circle one option to indicate how much you agree or disagree with each statement

	Strongly disagree	Disagree	Disagree slightly	Agree slightly	Agree	Strongly agree
1. I find it difficult to sit less when at work	SD	D	DS	AS	A	SA
2. I believe I have the ability to break up my sitting regularly at work	SD	D	DS	AS	A	SA
3. I find it easy to have reasons to leave my desk regularly throughout the day	SD	D	DS	AS	A	SA
4. It would be easy for me to break my sitting without affecting my work	SD	D	DS	AS	A	SA
5. I find it difficult to remember to break my sitting when I am busy at work	SD	D	DS	AS	A	SA

<u>Situation scale</u>

Circle ONE option to indicate how much you agree or disagree with each statement:

	Strongly disagree	**Disagree**	**Disagree slightly**	**Agree slightly**	**Agree**	**Strongly agree**
1. It is easy to sit less when I am at home	SD	D	DS	AS	A	SA
2. It is easy to sit less when I am at work	SD	D	DS	AS	A	SA
3. It is hard to break up my sitting when I am at home	SD	D	DS	AS	A	SA
4. It is hard to break up my sitting when I am at work	SD	D	DS	AS	A	SA

<u>Behavioural strategies</u>

Circle ONE option for each question. In the past FOUR WEEKS….

	Never	**Rarely**	**Sometimes**	**Often**	**Always**
1. I have set myself goals for sitting less at work	N	R	S	O	A
2. I have spent my lunch break at my desk	N	R	S	O	A
3. I have spread out tasks throughout the day that make me stand or leave my desk	N	R	S	O	A
4. I have assigned certain work tasks to do whilst standing	N	R	S	O	A
5. I have set up regular reminders to help me break up my sitting	N	R	S	O	A

<u>**Social support/ observational learning scale**</u>

Circle ONE option for each question. In the past FOUR WEEKS how often….

	Never	**Rarely**	**Sometim es**	**Often**	**Always**
1. Have you noticed colleagues standing or moving around the office whilst performing work tasks?	N	R	S	O	A
2. Have you noticed colleagues spending long periods sat at their desks without a break?	N	R	S	O	A
3. Have you been encouraged to break your sitting by a work colleague?	N	R	S	O	A
4. Have you discussed reducing sedentary behaviour with members of your family?	N	R	S	O	A

<u>**Outcome expectations and expectancies scale**</u>

Please tick one option to describe how much you agree or disagree with each benefit and how important each benefit is to you:

1a. Reducing my sedentary behaviour can reduce my risk of some illnesses and diseases such as heart disease, diabetes and cancer

Strongly disagree ☐

Disagree ☐

Partly disagree ☐

Partly agree ☐

Agree ☐

Strongly agree ☐

1b. How important is reducing your risk of illness and disease to you?

Not at all important ☐

Only slightly important ☐

Important ☐

Extremely important ☐

2a. Reducing my sedentary behaviour can make me feel better physically

Strongly disagree ☐

Disagree ☐

Partly disagree ☐

Partly agree ☐

Agree ☐

Strongly agree ☐

2b. How important is feeling better physically to you?

Not at all important ☐

Only slightly important ☐

Important ☐

Extremely important ☐

3a. Being less sedentary can help to control my weight

Strongly disagree ☐

Disagree ☐

Partly disagree ☐

Partly agree ☐

Agree ☐

Strongly agree ☐

3b. How important is controlling your weight to you?

Not at all important ☐

Only slightly important ☐

Important ☐

Extremely important ☐

4a. Reducing my sedentary behaviour during work hours can help to improve my concentration at work

Strongly disagree ☐

Disagree ☐

Partly disagree ☐

Partly agree ☐

Agree ☐

Strongly agree ☐

4b. How important is improving your concentration at work to you?

Not at all important ☐

Only slightly important ☐

Important ☐

Extremely important ☐

5a. Reducing my sedentary behaviour during work hours can help me to feel more energetic throughout the day

Strongly disagree ☐

Disagree ☐

Partly disagree ☐

Partly agree ☐

Agree ☐

Strongly agree ☐

5b. How important is feeling more energetic to you?

Not at all important ☐

Only slightly important ☐

Important ☐

Extremely important ☐

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS QUESTIONNAIRE

9.11. PAWS Stage of Change questionnaire

Participant ID:

PAWS –Prompting Activity in a Workplace Setting

Stage of Change Questionnaire

The information you provide here is confidential, and will be stored anonymously, separately from your name and address. Your data will be securely stored so only the researcher has access.

Please consider the following statements and circle which ONE best describes how you currently feel about your own sedentary behaviour DURING WORK HOURS. Sedentary behaviour refers to inactivity carried out in a sitting or reclining posture e.g. sitting at a desk.

1. I currently engage in sedentary behaviour at work and do not intend to reduce or break up my sedentary behaviour in the next six months

2. I currently engage in sedentary behaviour at work, but I am thinking about reducing or breaking up my sedentary behaviour in the next six months

3. I currently undertake some measures to reduce or break up my sedentary behaviour, but not regularly

4. I currently undertake some measures to reduce or break up my sedentary behaviour, but have only begun doing so within the last six months

5. I currently undertake measures to reduce or break up my sedentary behaviour and have done so for more than six months

9.12. PAWS participant information sheet

Participant Information Sheet

Study Title: PAWS –Prompting Activity in a Workplace Setting

We would like to invite you to take part in a study investigating how to improve people's activity patterns whilst at work. Before you decide it is important for you to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the study?

The purpose of the study is to measure patterns of sitting at work and how best to help people to adopt healthier patterns of activity whilst at work. All participants will receive feedback on their own activity during work time and given information on how patterns of activity can be improved and the benefits of doing so. Participants will be split into two groups with one group receiving prompts on their computer reminding them about the benefits of changing their activity patterns in work and the other receiving no prompts. The prompts will take the form of a variety of brief messages about the benefits of changing activity patterns that pop up on your screen every hour as a reminder on Microsoft Outlook and this will happen for 10 weeks. The prompts will be uploaded to your PC via an excel file and you will receive instructions on how to do this if you are part of this group. Participants will be randomly assigned to groups, that is, neither the participants or researchers will have any say which group you are put into.

An activity monitor will be used to collect information about activity patterns from all participants over a one week period, on 4 different occasions. We will also ask some questions about yourself, your general health, and how you feel about changing your activity patterns at work.

Why have I been invited?

This study is looking to recruit 60 adults, who are employed by Johnson & Johnson, Kirkton Campus,to participate. Your employer has agreed to allow its members of staff to participate.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason.

What will happen to me if I take part? What will I have to do?

The study is expected to run for approximately 6 months, in total, but the prompts will only be used for 10 weeks.

If you choose to take part, you will be asked:

1. To complete 3 brief questionnaires. You will be asked to complete 2 of these questionnaires on 3 different occasions.
2. Attend an information session on improving activity patterns at work (approx. 1 hour)
3. Wear an activity monitor* and complete a brief diary of waking and working hours for one week on 4 separate occasions (once at the start of the study, once around week 9 when the prompts start, once around week 17 and once around week 29).

4. Depending on which group you are allocated to, you may receive hourly prompts on your computer reminding you to stand, for a period of 10 weeks.
5. Attend a focus group (approx. 1 hour) to tell us what you thought about the study.

* The activPAL™ activity monitor is worn on the front of your thigh, and is attached using an adhesive pad, and a waterproof covering. After attaching the activity monitor, you will be left to continue with your everyday routine including wearing the monitor in bed and when bathing or swimming. Monitors and diaries will be collected from your place of work by a researcher at the end of each data collection week.

If you are interested in taking part in this study, you will be invited to meet researchers at your place of work and will have the opportunity to ask questions about the research and what it will entail. If you agree to participate you will be required to sign a consent form indicating that you have read this Participant Information Sheet document and have understood its contents. You will be given a copy of the information sheet and a signed consent form to keep.

At the end of the study you will receive a copy of your individual physical activity profile which will be sent out to you by a researcher.

Expenses and payments
You will not be paid to participate in this study. All research meetings will take place at your place of work, so you should not incur any additional costs by taking part in this research project.

What are the possible disadvantages and risks of taking part?
There is a small possibility that you may develop a minor skin irritation from the adhesive used to attach the activity monitor to your thigh. If this does happen, it is important you remove the monitor as soon as possible (it should just peel off like a plaster) and contact the researcher.

What are the possible benefits of taking part?
If you take part you will attend an education session delivered by a health expert which may help you change unhealthy patterns of activity. In addition, at the end of the study we will provide you with your individual activity profile for each of the 4 weeks you wore the monitor.

What if there is a problem?
Any complaint about the way you have been dealt with during the study or any possible harm you might suffer will be addressed. If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, then you may have grounds for a legal action but you may have to pay for it. Regardless of this, if you wish to complain, or have any concerns about any aspect of the way you have been approached or treated during the course of this study, the normal Glasgow Caledonian University complaints mechanisms will be available to you.

Will my taking part in the study be kept confidential?
Yes. We will follow ethical and legal practice and all information about you will be handled in confidence.

By signing the consent form, you will be granting permission for the researcher to have restricted access to the information collected about you in the course of the study. All information collected about you will be kept strictly confidential and will be anonymised, meaning that information about you will have your name and address removed so that you cannot be recognised from it. Your data will be digitally stored and secured so only the researcher has access.

Your employer has agreed for us to invite you to take part in this research study. However the study is being carried out independently by researchers at Glasgow Caledonian University. No individual information collected about you during the study will be given to your employer, they will only receive non-identifiable data about the group.

What will happen to the results of the research study?

The results of the research will be written up as a PhD thesis and as a journal article for publication in an appropriate journal. They will be disseminated to clinicians and professionals working in occupational health, and the data collected in this study may be used to form the basis of an application for future funding by the researchers. You will not be identified in any dissemination, application, report or publication.

Physical activity data and basic demographic data will be kept on a password protected database on a secure server. The data held on the database will not be identifiable. This information collected may be used for further analysis by staff and students in the School of Health & Life Sciences at Glasgow Caledonian University at a later date.

Who is organising and funding the research?

This research is being carried out by Dr Philippa Dall, Dr Maggie Lawrence, Dr Margaret Grant and Catriona O'Dolan, researchers at Glasgow Caledonian University. The costs for this research project are being met by Glasgow Caledonian University..

Who has reviewed the study?

The study has been awarded ethical approval from Glasgow Caledonian University School of Health and Life Sciences Ethics Committee.

Contact for Further Information

For further information about this study, please contact one of the researchers at Glasgow Caledonian University or, if you prefer, one of the study links at Johnson & Johnson Medical:

Glasgow Caledonian University researchers		
Catriona O'Dolan:	Tel: 0141 3318012	Email: catriona.odolan@gcu.ac.uk
Dr Philippa Dall:	Tel: 0141 3318003	Email: Philippa.dall@gcu.ac.uk
J&J Medical study links		
Susan Fyffe:	Tel: x4887	Email: sfyffe@its.jnj.com
Kevin Tesh:	Tel: x4581	Email: ktesh@its.jnj.com

9.13. PAWS consent form

Title of Research Study: **PAWS –Prompting Activity in a Workplace Setting**

Participant Consent Form

Please Initial Boxes

I confirm that I have read and understand the information sheet dated 19th January 2016 (version 1.0) for the above study and have had the opportunity to ask questions. ☐

I understand that my participation in this study is voluntary and that I am free to withdraw at any time, without giving a reason. ☐

I understand that my physical activity data and basic demographic data will be kept on a password protected database on a secure server. The data held on the database will not be identifiable. This data may be used for further analysis and in comparison with future data, by staff and students of the School of Health & Life Sciences at Glasgow Caledonian University. ☐

I understand that this is a research study and the results may be published in national and international medical journals but none of my personal details will be included. ☐

I agree to take part in the above study.. ☐

___________________________	_______________	____________________________
Name of Participant (PRINT)	Date	Signature
___________________________	_______________	____________________________
Researcher	Date	Signature
___________________________	_______________	____________________________
Name of Person taking consent (if different from researcher)	Date	Signature

9.14. PAWS baseline questionnaire

Participant ID:

PAWS –Prompting Activity in a Workplace Setting

Baseline Questionnaire

The information you provide here is confidential, and will be stored anonymously, separately from your name and address. Your data will be securely stored so only the researcher has access.

Please write your answers on the line, or circle the relevant answer. Please try and answer all the questions, if you are not sure please put the answer that you feel describes you best.

ABOUT YOU

12. **Age:**_____________

13. **Gender:** Male Female

14. **Height:** ___________________

15. **Weight:**___________________

16. **Ethnicity, choose one option that best describes your ethnic group or background:**

    White ☐ Asian ☐ African ☐

    Caribbean/ black ☐ Mixed ethnicity/other:_________________ (please specify)

17. **Education, what is the highest level of education you have achieved?**

    Standard grade, O grade/GCSE, SVQ level 1-2, or equivalent ☐

    Higher/advanced higher grade, AS/A level, SVQ level 3, or equivalent ☐

    HNC, HND, SVQ level 4, or equivalent ☐

    Degree, professional qualification (e.g. teaching, nursing, accountancy) ☐

    Post graduate qualification ☐

18. **Job title:**_____________________________________

19. **Do you work:** Full time Part Time

20. **Do you work from home?** Never Occasionally Most of the time

21. **Home Post Code (please provide only 1st part):**

22. **Do you have any dependents or care for anyone at home?** Yes No
    If yes, please give number of dependents & ages:

    Number:_______________
    Ages_______________________________

23. **Do you currently smoke?** Yes Yes e-cig/vapour No
    tobacco products cigarettes

24. **In general, would you say your health is:**

excellent very good good fair poor

25. **Do you have any pre-existing health conditions or diasbility? If so please list & indicate if and how they affect your mobility:**
    <u>Condition/disability</u> **<u>Does it affect your mobility? If so, how</u>**

    ____
    ____

    ____
    ____

    ____
    ____

26. **Have you ever participated in health promotion activities AT WORK before? e.g. walk/cycle to work promotion, smoking cessation etc** Yes No

    If yes, please list:______________________________ **apx date____________**

    _______________________________ **apx date____________**

    _______________________________ **apx date____________**

The following questions are designed to ascertain your current understanding of the problems associated with sitting. Do not worry if you do not know the answers, just give your best guess Please try to answer all questions.

3. **Sally has recently moved house and needs to send "change of address" cards to all contacts. To complete the task involves sitting and working at a computer for 4 hours.**

Which ONE of the following options do you think would be best for her overall health? (please circle):

a) Complete and finish the task uninterrupted in 4 hours.

b) Interrupt the task regularly with other chores and complete the task in 7 hours.

c) No difference - the task involves 4 hours sitting, so either way, the sitting involved is the same.

4. **Peter works full time in a call centre, taking calls from members of the public whilst sat at a computer. He often works 4 hours at a time without a break, but goes to the gym in his lunch hour, 3 times a week as well as playing football at the weekend. For each of the statements mark whether you consider them to be true or false (please circle)?**

d) Peter is meeting the recommended guidelines for weekly levels of physical activity and is therefore more likely to stay healthy TRUE FALSE

e) Peter is meeting the recommended guidelines for weekly levels of physical activity, but this will not offset the damage to his health caused by sitting at work TRUE FALSE

f) Peter should continue to exercise, but also interrupt prolonged periods of sitting at work in order to benefit his health TRUE FALSE

3. **Which of the following health problems, in adults, have been linked with prolonged sitting behaviour?** Please tick ALL that you think apply.

Reduced bone mass	☐	Weight loss	☐
Obesity	☐	Depression	☐
Type 2 diabetes	☐	Cancer	☐
Stomach ulcers	☐	Heart disease	☐
Back ache	☐	Hair loss	☐

9.15. PAWS SCT questionnaire scoring matrix

A study to assess the impact of a multicomponent intervention to reduce prolonged sitting in the workplace

Social Cognitive Questionnaire

The information you provide here is confidential, and will be stored anonymously, separately from your name and address. Your data will be securely stored so only the researcher has access.

This questionnaire is designed to understand your experience of sedentary behaviour in the workplace and the factors that may influence it. Please answer all questions by circling the answer or ticking the box that best describes how you feel at this current time. Thank you for taking the time to complete this questionnaire

Self-efficacy scale

Please circle one option to indicate how much you agree or disagree with each statement

'How confident are you at your ability to break sitting at work'. High score = confident

	Strongly disagree	Disagree	Disagree slightly	Agree slightly	Agree	Strongly agree
1. I find it difficult to sit less when at work	6	5	4	3	2	1
2. I believe I have the ability to break up my sitting regularly at work	1	2	3	4	5	6
3. I find it easy to have reasons to leave my desk regularly throughout the day	1	2	3	4	5	6
4. It would be easy for me to break my sitting without affecting my work	1	2	3	4	5	6
5. I find it difficult to remember to break my sitting when I am busy at work	6	5	4	3	2	1

<u>Situation scale</u> ‘Mental representation of how the environment effects sitting’ High =environmental impact on sitting

Circle ONE option to indicate how much you agree or disagree with each statement:

	Strongly disagree	Disagree	Disagree slightly	Agree slightly	Agree	Strongly agree
1. It is easy to sit less when I am at home	1	2	3	4	5	6
2. It is easy to sit less when I am at work	1	2	3	4	5	6
3. It is hard to break up my sitting when I am at home	1	2	3	4	5	6
4. It is hard to break up my sitting when I am at work	1	2	3	4	5	6

<u>Behavioural strategies</u> ‘ frequency of employing behavioural strategies to reduce sitting’ High = frequent use of strategies

Circle ONE option for each question. In the past FOUR WEEKS….

	Never	Rarely	Sometimes	Often	Always
1. I have set myself goals for sitting less at work	1	2	3	4	5
2. I have spent my lunch break at my desk	1	2	3	4	5
3. I have spread out tasks throughout the day that make me stand or leave my desk	1	2	3	4	5
4. I have assigned certain work tasks to do whilst standing	1	2	3	4	5
5. I have set up regular reminders to help me break up my sitting	1	2	3	4	5

Social support/ observational learning scale Frequency of social support received/ behaviour of others observed. High = frequent support

Circle ONE option for each question. In the past FOUR WEEKS how often….

	Never	Rarely	Sometimes	Often	Always
1. Have you noticed colleagues standing or moving around the office whilst performing work tasks?	1	2	3	4	5
2. Have you noticed colleagues spending long periods sat at their desks without a break?	1	2	3	4	5
3. Have you been encouraged to break your sitting by a work colleague?	1	2	3	4	5
4. Have you discussed reducing sedentary behaviour with members of your family?	1	2	3	4	5

Outcome expectations and expectancies scale Beliefs about the physical and cognitive benefits of reducing SB and how important the expected outcome is to an individual. High = strong belief and important

Please tick one option to describe how much you agree or disagree with each benefit and how important each benefit is to you:

1a. Reducing my sedentary behaviour can reduce my risk of some illnesses and diseases such as heart disease, diabetes and cancer

Strongly disagree	1	☐
Disagree	2	☐
Partly disagree	3	☐
Partly agree	4	☐
Agree	5	☐
Strongly agree	6	☐

1b. How important is reducing your risk of illness and disease to you?

Not at all important 1 ☐

Only slightly important 2 ☐

Important 3 ☐

Extremely important 4 ☐

2a. Reducing my sedentary behaviour can make me feel better physically

Strongly disagree 1 ☐

Disagree 2 ☐

Partly disagree 3 ☐

Partly agree 4 ☐

Agree 5 ☐

Strongly agree 6 ☐

2b. How important is feeling better physically to you?

Not at all important 1 ☐

Only slightly important 2 ☐

Important 3 ☐

Extremely important 4 ☐

3a. Being less sedentary can help to control my weight

Strongly disagree 1 ☐

Disagree 2 ☐

Partly disagree 3 ☐

Partly agree 4 ☐

Agree 5 ☐

Strongly agree 6 ☐

3b. How important is controlling your weight to you?

Not at all important ☐ 1

Only slightly important ☐ 2

Important ☐ 3

Extremely important ☐ 4

4a. Reducing my sedentary behaviour during work hours can help to improve my concentration at work

Strongly disagree 1 ☐

Disagree 2 ☐

Partly disagree 3 ☐

Partly agree 4 ☐

Agree 5 ☐

Strongly agree 6 ☐

4b. How important is improving your concentration at work to you?

Not at all important ☐ 1

Only slightly important ☐ 2

Important ☐ 3

Extremely important ☐ 4

5a. Reducing my sedentary behaviour during work hours can help me to feel more energetic throughout the day

Strongly disagree 1 ☐

Disagree 2 ☐

Partly disagree 3 ☐

Partly agree 4 ☐

Agree 5 ☐

☐

Strongly agree 6

5b. How important is feeling more energetic to you?

Not at all important	☐	1
Only slightly important	☐	2
Important	☐	3
Extremely important	☐	4

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS QUESTIONNAIRE

9.16. PAWS Focus group schedule

A study to assess the impact of a multicomponent intervention to reduce prolonged sitting in the workplace

Post-intervention participant focus group topic guide

Ground rules & preamble

- What did you think about the information session on the effects of sitting and how to reduce sitting in the work place?
  Prompts: **-** Was it useful?
  - Was it what you expected?
  - Did it change the way you feel about sitting at work? How?

- Do you feel that you changed your patterns of sitting following the information session?
  Prompts: - How?
  - Were there any barriers to you making the changes you wanted to?

- What did you think to the feedback on your activity data?
  Prompts: - Was the data surprising? In what way?
  - Did it change the way you felt about your sitting behaviour?

- For those that received the prompts on their computer to stand more, what did you think of these?
  Prompts: **-** The messages?
  - The frequency?
  - Did you stand when prompted? If not, what were the main reasons
  - Did it interfere with your work?
  - Did you feel your behaviour changed over the course of the intervention

- How did you feel about standing up/moving around the office?

- How do you think others (colleagues/managers) not involved in the study reacted to any changes you made to your sit/stand behavior?

- What difference has being part of this study made to how you feel?
  Prompts: **-** Your health?
  - Your mood?
  - Socialising in the office?

- What difference has being part of this study made to your working day?

- If you changed your sitting habits, do you think you will continue to do this long term?

- Do you think it has changed your sitting habits outside of work?

Bring the focus group to a close. Thank everyone for taking part. Let the group know what will happen next and when they will get feedback from the study.

9.17. PAWS Personal activity report

Your personal activity profile

Many thanks for taking part in the PAWS study to assess the impact of education and hourly prompts on reducing prolonged sitting at work. This report contains activity data that we collected from you over the four data collection periods when you were wearing the activity monitor. Please note that this information is confidential. Any data made available to a third party will be amalgamated and your name will not be linked to your personal data.

Understanding your activity data

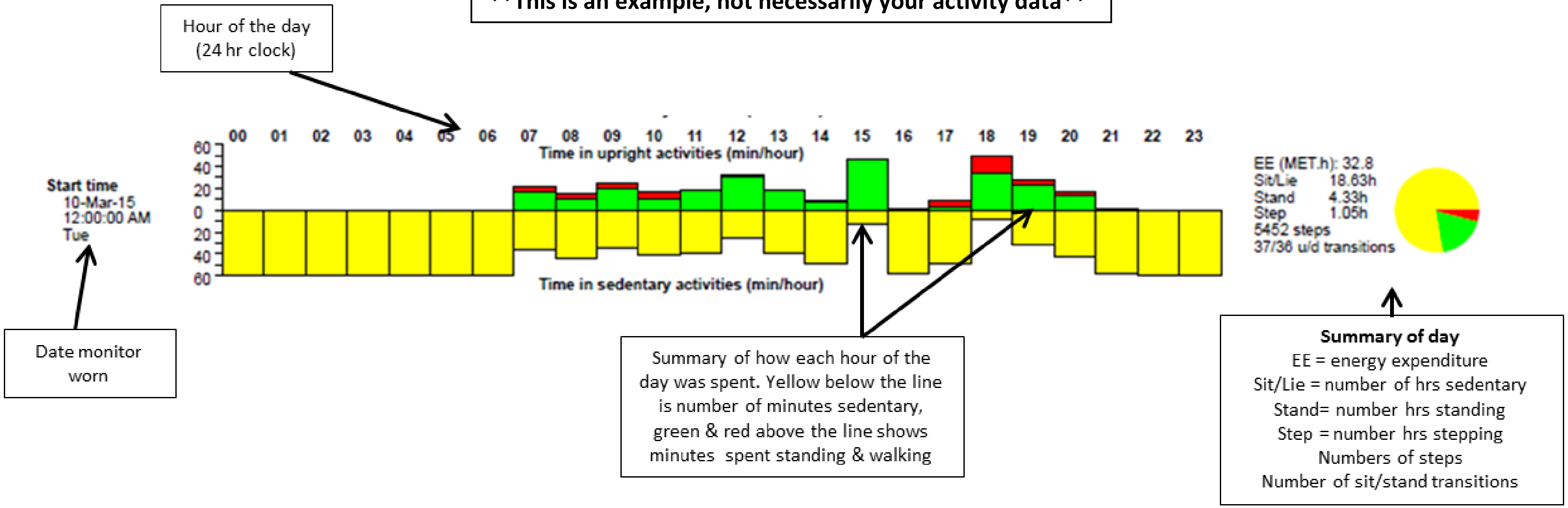
The activPAL monitor provides information on your posture. All the graphs in this report are colour coded as follows:

- YELLOW = time spent sitting or lying i.e. sedentary
- GREEN = time spent standing
- RED = time spent walking

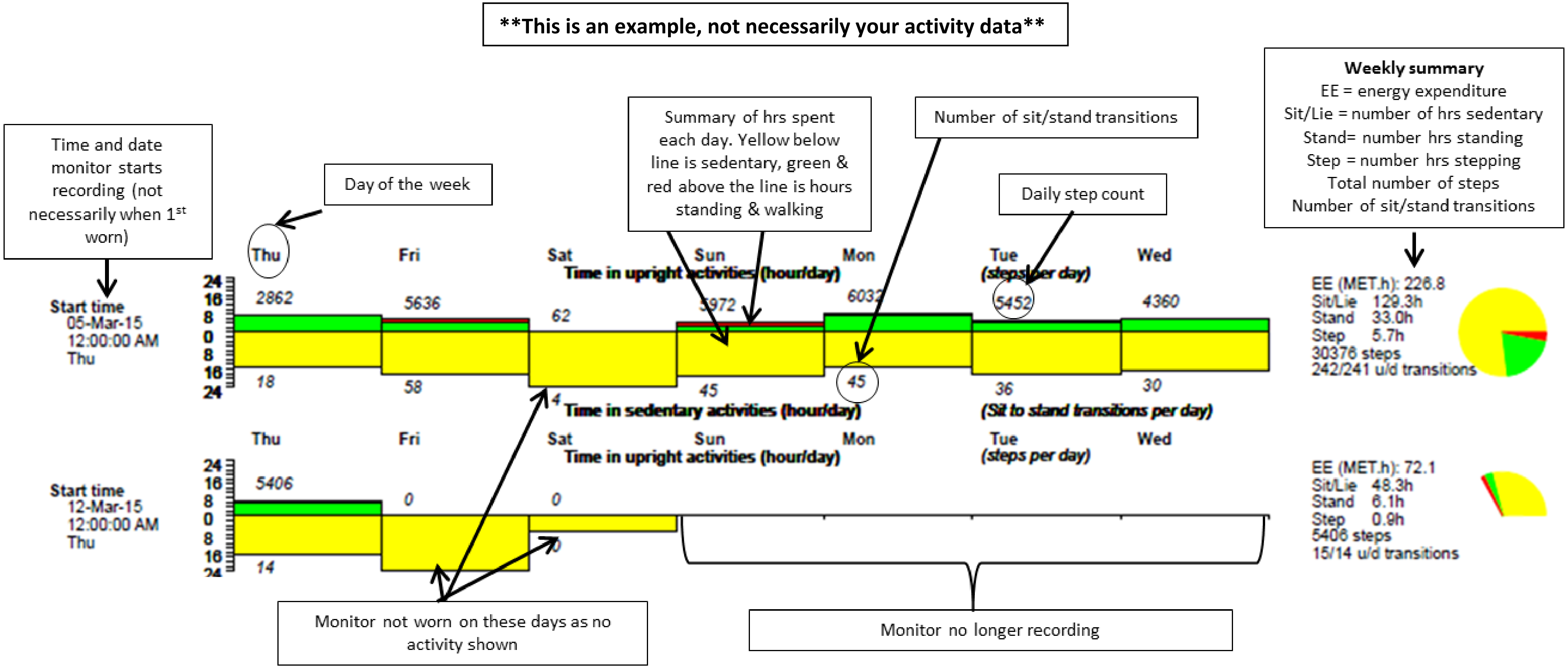
This report contains daily summaries of your most and least sedentary days for each measurement period and also a weekly summary.

Daily summaries look like this:

****This is an example, not necessarily your activity data****



Weekly summaries look like this:



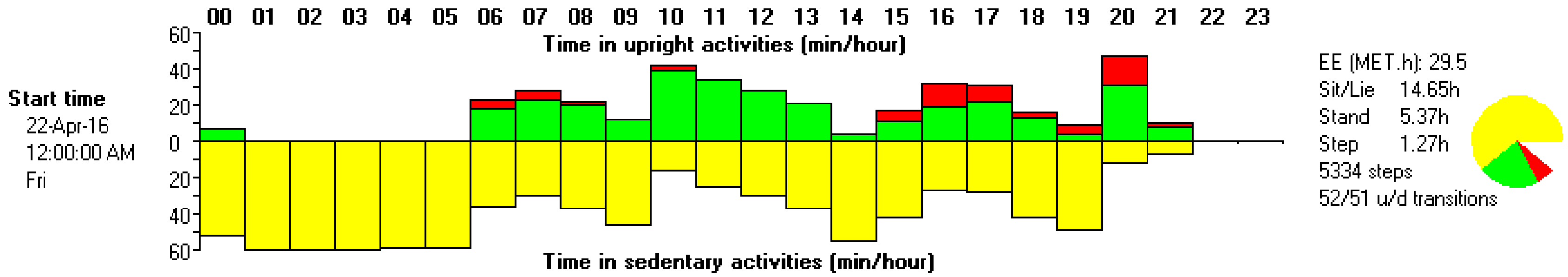
NOTE: Least/most sedentary days are calculated on the basis of hours spent sitting & lying. It is therefore still possible for step counts to be higher on days when an individual is more sedentary.

**NOTE: Weekly summaries contain information on the entire time for which the monitor was programmed. In the example above the activPAL was worn from Friday 6th March – Thursday 12th March (inclusive) with the exception of Saturday 7th March when the monitor was removed. The activity shown on the first day shows the monitor being delivered to the recipient and the recipient carrying it home to but on before bed as instructed. **

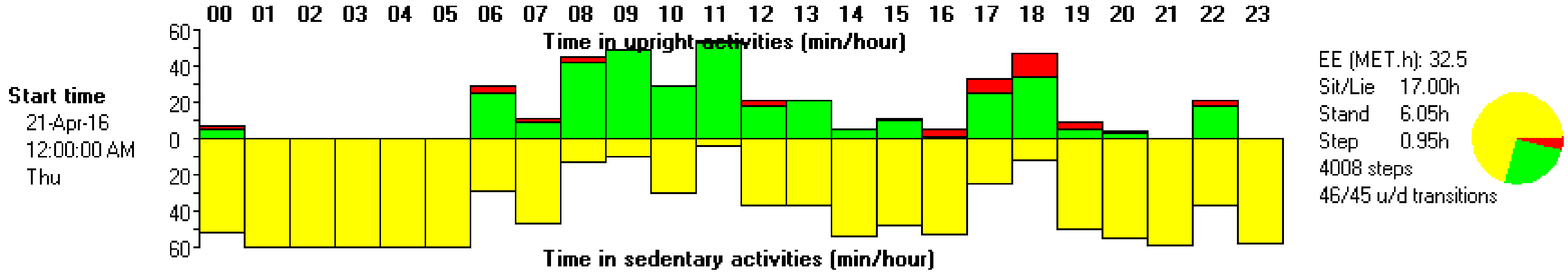
Your activity data – daily summaries

Data collection 1: April 2016.

Least sedentary day (this was a working day)

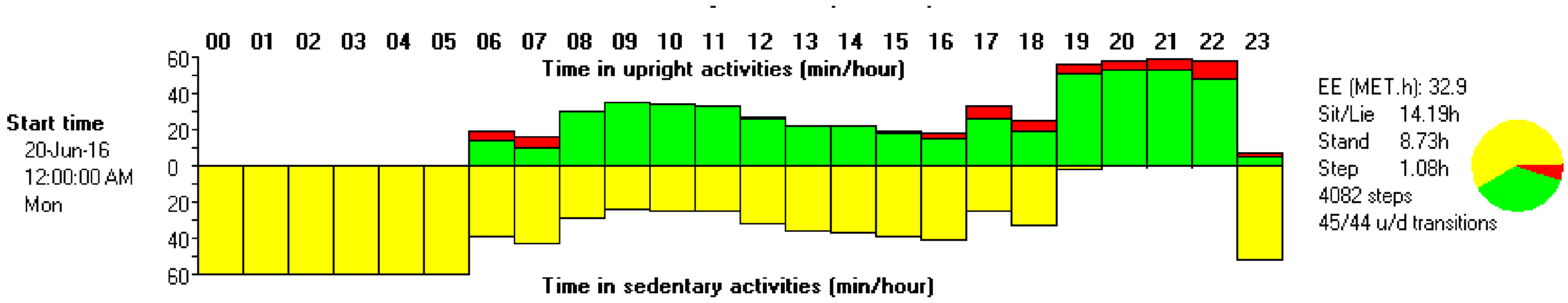


Most sedentary day (this was a working day)

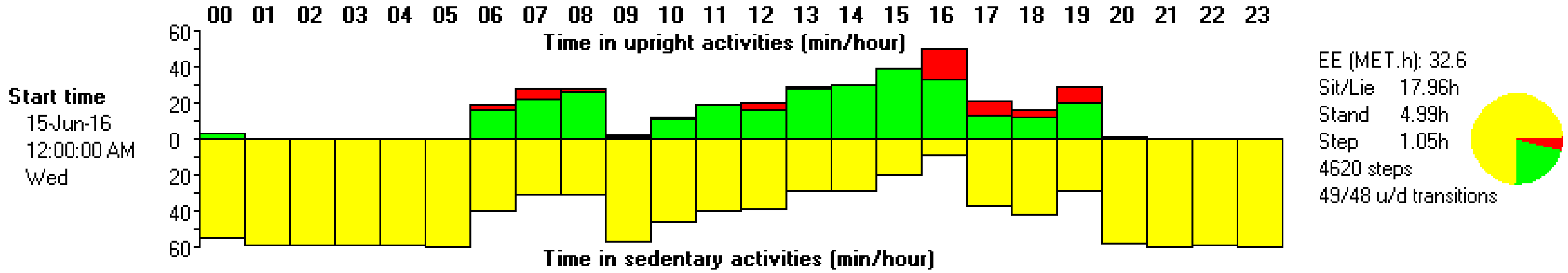


Data collection 2: June 2016. Daily summaries

Least sedentary day (this was a working day)

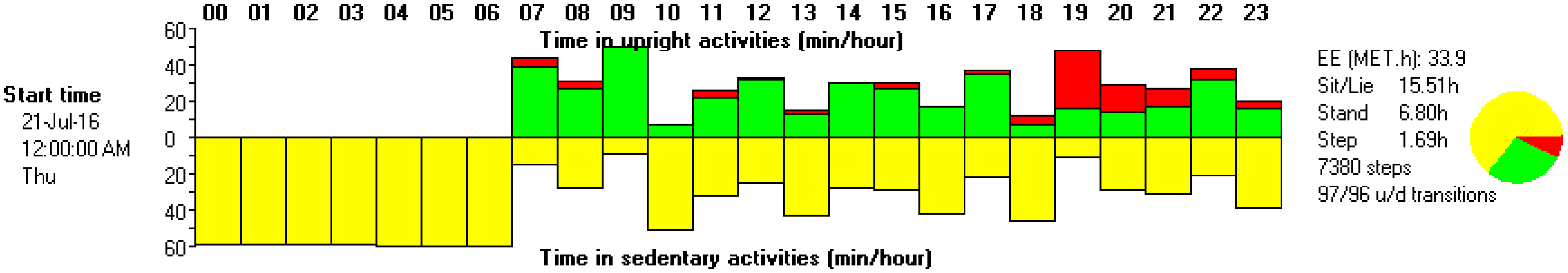


Most sedentary day (this was a working day)

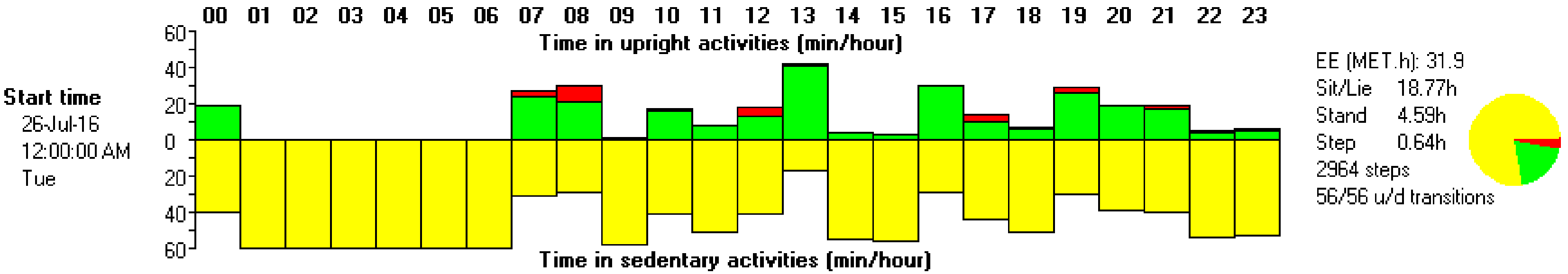


Data collection 3: July 2016.

Least sedentary day (this was a working day)

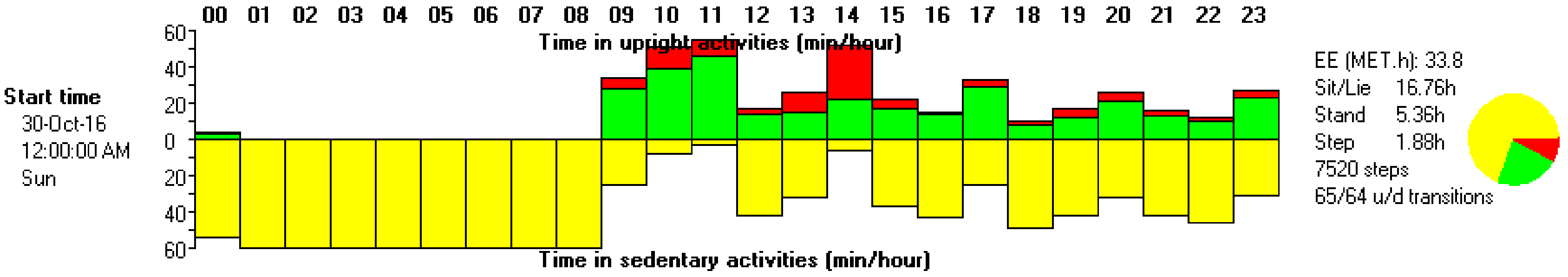


Most sedentary day (this was a working day)

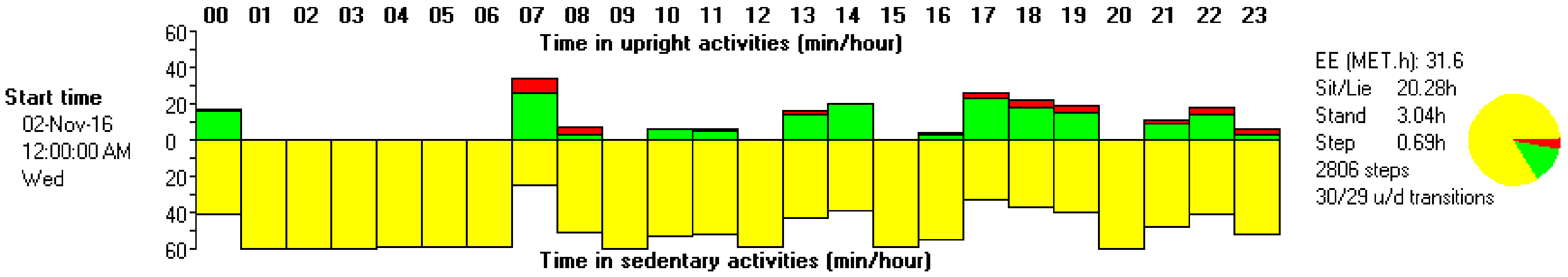


Data collection 4 : October 2016.

Least sedentary day (this was NOT a working day)

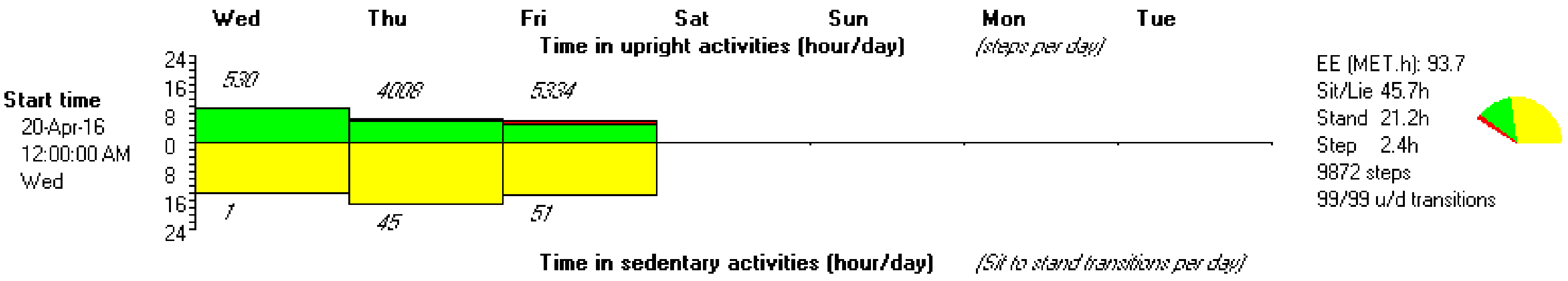


Most sedentary day (this was a working day)

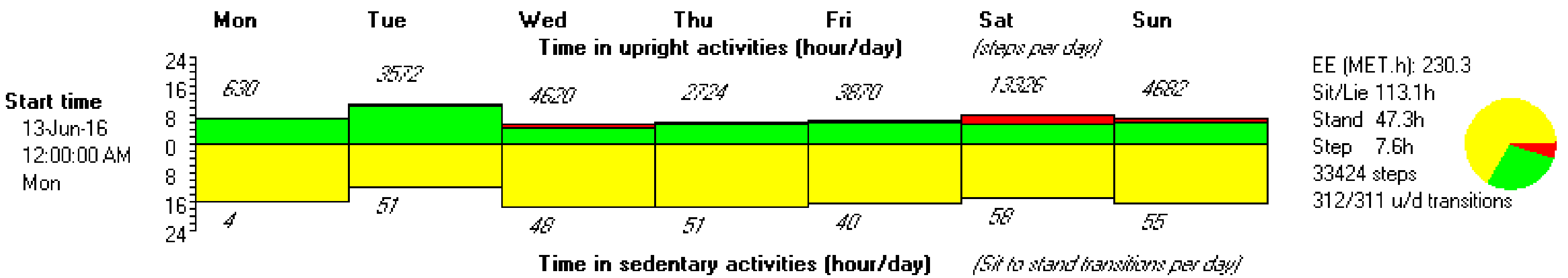


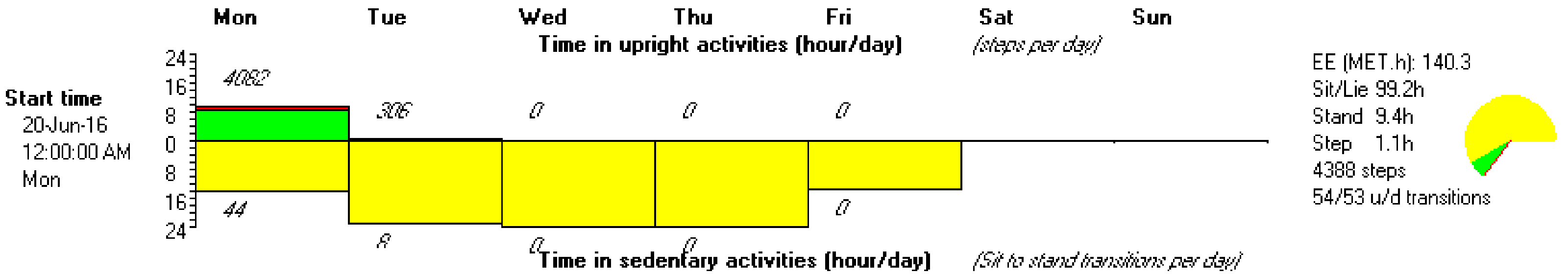
Your activity data – weekly summaries

Data collection 1: April 2016

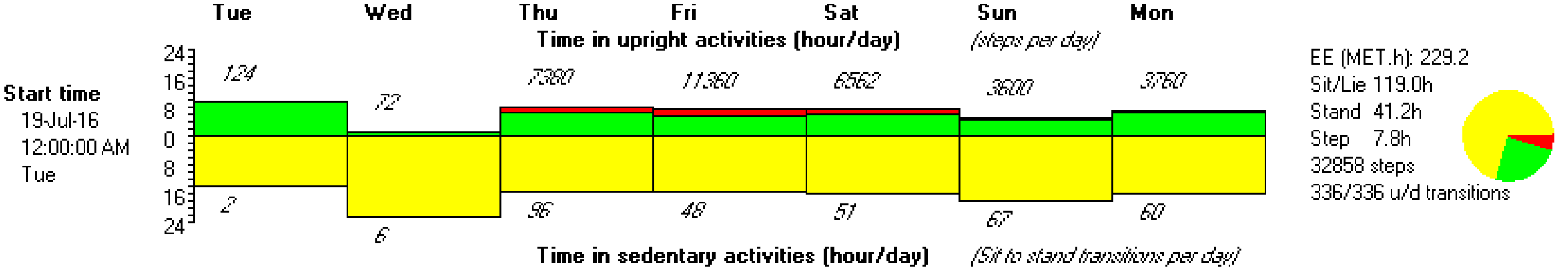


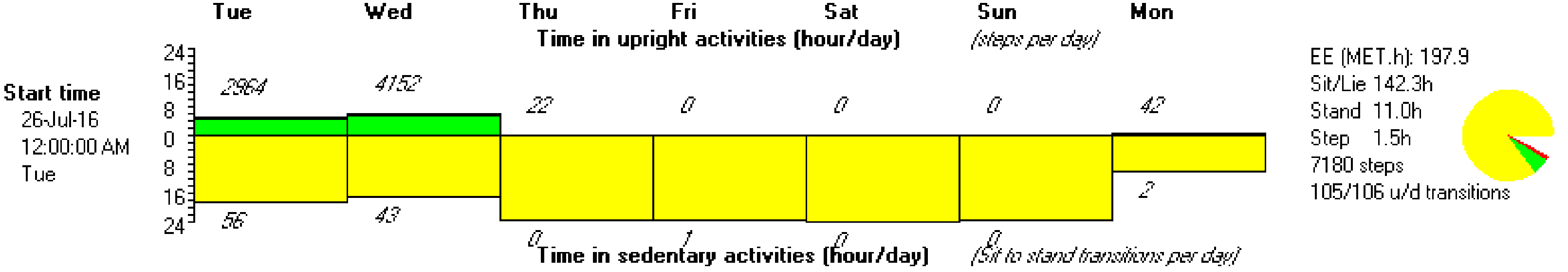
Data collection 2: June 2016



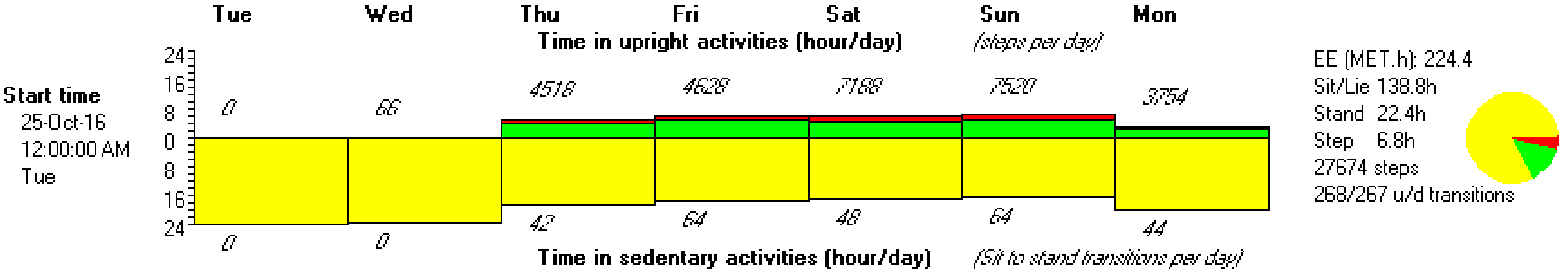


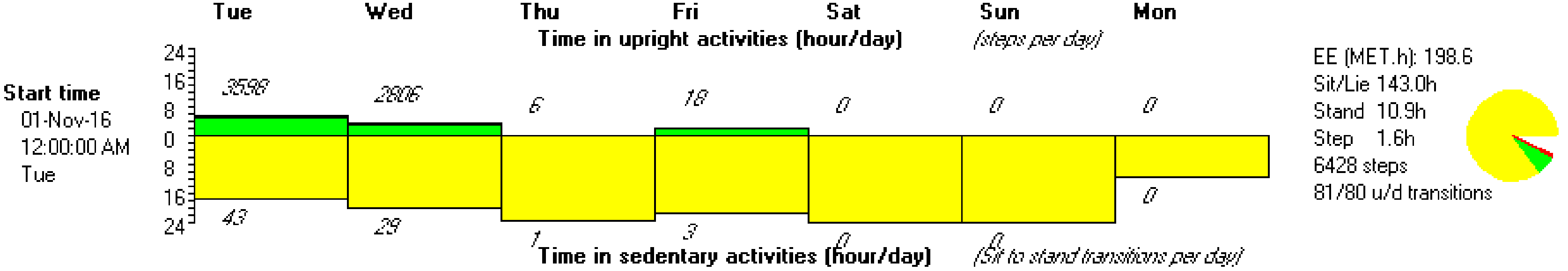
Data collection 3. July 2016





Data collection 4. October 2016





If you would like any clarification about the data in this report or would like to see more of your activity data please do not hesitate to get in contact: catriona.odolan@gcu.ac.uk

9.18. CONSORT checklist

CONSORT 2010 checklist of information to include when reporting a randomised trial*

Section/Topic	Item No	Checklist item	Reported?
Title and abstract			
	1a	Identification as a randomised trial in the title	√
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	√
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	√
	2b	Specific objectives or hypotheses	√
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	√
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	√
Participants	4a	Eligibility criteria for participants	√
	4b	Settings and locations where the data were collected	√
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	√
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	√
	6b	Any changes to trial outcomes after the trial commenced, with reasons	√
Sample size	7a	How sample size was determined	√
	7b	When applicable, explanation of any interim analyses and stopping guidelines	√
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	√
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	√
Allocation	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers),	√

concealment mechanism		describing any steps taken to conceal the sequence until interventions were assigned	
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	√
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	√
	11b	If relevant, description of the similarity of interventions	√
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	√
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	√
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	√
	13b	For each group, losses and exclusions after randomisation, together with reasons	√
Recruitment	14a	Dates defining the periods of recruitment and follow-up	√
	14b	Why the trial ended or was stopped	√
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	√
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	√
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	√
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	√
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	√
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	√
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	√
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	√
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	√

Other information			
Registration	23	Registration number and name of trial registry	√
Protocol	24	Where the full trial protocol can be accessed, if available	NA
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	√

*We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org