Measure, monitor, and reduce sitting time in the workplace

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Ethics Declaration

The proposed research studies received human research ethics approval from JCU

Human Research Ethics Committee, approvals H5176, H6506 and H6654.

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Name and affiliation	TM designed the project, collected the survey responses and conducted the focus groups and analysed the findings. RS and FB assisted in the development of survey questions and interpretation of the data. TM drafted the manuscript and RS and FB provided editorial assistance.
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Chapter 4

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Name and affiliation	TM designed the project, collected the data and analysed the findings. RS and FB assisted in the development of intervention design and interpretation of the data. TM drafted the manuscript and RS and FB provided editorial assistance.
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Abstract

Occupational sedentary behaviour is a growing health concern with occupational sitting accounting for almost half of overall sedentary behaviour. Workers undertaking jobs that require minimal standing or physical activity are at higher risk of accumulating larger amounts of sedentary behaviour compared to blue-collar workers, which highlights the need to reduce sedentary behaviour in predominantly desk-based roles. The explicit use of theoretical frameworks to guide sedentary behaviour change interventions is limited; additionally, follow-up of multi-component sedentary behaviour interventions is rare thus producing a gap in sedentary behaviour research. A mixed-method embedded intervention design was implemented in order to investigate occupational sedentary behaviour. The first aspect of the thesis was to explore the perceptions of office-based workers prior to a sedentary behaviour change intervention (Chapter 2 & Chapter 3). Based on the initial findings, qualitative and quantitative data were collected to explore the outcomes of a low-cost, multi-component, theory-informed, individually-tailored, six week intervention to reduce occupational sitting time (Chapter 4). Finally, a six month follow-up including quantitative and qualitative data were incorporated to evaluate the long-term effectiveness of the intervention (Chapter 5).

The first study (Chapter 2) aimed to explore office workers' perceptions of sedentary behaviour, identify potential behavioural strategies to reduce sedentary behaviour in the workplace, and identify barriers which may hamper behaviour change. Office-based workers from a higher education institution were recruited for the study. The perceptions were explored via an online survey and focus groups which were thematically analysed. One hundred and forty office workers were recruited and surveyed from the same workplace. Following the survey, 12 employees also participated in focus groups. One hundred employees perceived a negative association between sitting time and their health. The most prominent theme identified was musculoskeletal complaints, followed by poor general health, and weight gain. The focus

groups identified that interventions (behaviour change strategies) targeting reducing sitting time should include education, supportive and knowledgeable managers. These behaviour change strategies should all be offered to address individual preferences and barriers.

The second study (Chapter 3) aimed to explore the perceptions of office-based workers who have successfully modified their occupational sedentary behaviour without a formal intervention. In particular, the study explored the employees' stage of change, strategies used to reduce sedentary behaviour in the workplace, and barriers, which prevented behaviour change from occurring. A qualitative in-depth interview design was used for this study. Participants who regularly undertook office-based tasks during work hours were recruited from a higher education institution. Participants were invited to participate in a semi-structured interview if they currently self-identified as modifying their occupational sedentary behaviour in any way. The interviews were audio recorded, transcribed verbatim and were thematically analysed to identify key themes. Nine participants volunteered for the study and all participants were in the action or maintenance stage of the Transtheoretical Model with two recent replases. A variety of strategies were used by the participants to reduce occupational sedentary behaviour such as having access to a sit-to-stand workstation, developing specific strategies around how the workstation was used, purposeful walking, and peer and managerial support. The participants identified barriers to success such as soreness, fatigue and illness; attending seated meetings, not enough desk space when using the workstation, and the need to be seated to complete work tasks which required high levels of concentration.

Following study one and study two, the key findings suggested there was a negative perception regarding sitting time and health, indicating that increased sitting time was a problematic behaviour. Additionally, employees suggested that barriers were likely to occur when attempting to change sedentary behaviour and that a variety of strategies would be useful

to reduce these barriers, thus changing occupational sedentary behaviour. This exploratory phase of the research informed the design and implementation of the intervention.

The third study (Chapter 4) aimed to evaluate the effectiveness of a low-cost, theory-informed, multi-component, individually-tailored, six week intervention for the reduction of occupational sedentary behaviour of office workers. Full-time office-based workers from a higher education institution were invited to participate in the study. Participants were asked to complete the online survey from study one to explore their perception of sedentary behaviour. Following this, pre-intervention behaviour patterns were collected for five days via an ActivPAL™ activity monitoring device and a self-report workbook. The Theory of Planned Behaviour (TPB), the Transtheoretical Model (TTM), and the Social Cognitive Theory (SCT) guided the development and implementation of the intervention. The first stage of the intervention included a face-to-face meeting between the participant and the investigator to discuss information identified from the online survey including the key themes, which were negatively associated with sitting time and health, and the individual ActivPAL™ and self-report data, which relates to consciousness raising of the TTM, self-reflection and self-regulation of the SCT. During this meeting, participants set goals for the six week intervention, signed a commitment contract, and were asked about their stage of change and their self-efficacy to change behaviour which relates to self-regulation of the SCT, self-liberation of the TTM, and perceived behavioural control of the TPB. Participants were provided with another self-report workbook which included their goals for the six week intervention which relates to the self-regulation of the SCT. Participants received a weekly follow up from the investigator, which relates to verbal persuasion of the SCT, and helping relationships of the TTM. During the final week of the intervention, participants wore an ActivPAL™ and were invited to participate in a follow-up semi-structured interview. Open-ended responses from the online survey, the individual weekly goals, and the post intervention interviews were transcribed

verbatim and were thematically analysed. Pre and post intervention ActivPAL™ data, self-reported workbook sitting time and self-efficacy were analysed via paired samples *t*-tests. Forty-nine participants volunteered for the study however 27 office-based workers had sufficient data to be included in the analysis. Occupational sitting time was reduced by an average of 45.2 ± 60.7 min/work day (p = .001) based on ActivPAL™ data. Self-efficacy towards goal achievement increased post intervention (pre: 69 ± 21%; post: 82 ± 16%; p = .002). The follow-up interviews indicated that the intervention increased awareness of occupational sedentary behaviour and identified the key behaviour change strategies utilised in the intervention.

The fourth study (Chapter 5) aimed to explore participant experiences six months post intervention to evaluate the long-term effectiveness of the intervention. Participants who completed the intervention were contacted via email and invited to participate in a six month follow-up data collection phase. Participants were provided with an ActivPAL™ and instructed to wear it for five days during work hours. Following the ActivPAL™ data collection, participants were invited to complete a semi-structured interview conducted by the principal investigator which explored successful behaviour change strategies, barriers to changing sedentary behaviour, self-efficacy towards goal achievement, and stage of change in relation to current sedentary behaviour patterns. The open-ended responses from the follow up interviews were transcribed verbatim and were thematically analysed. The six month follow up ActivPAL™ and self-efficacy data were compared to the pre-and post-intervention data and analysed via paired samples *t*-tests. A total of 25 out of 27 eligible participants volunteered to participate in the follow up study. Occupational sitting time was reduced by an average of 40.6 ± 76.1 min/work day (p = .018) based on ActivPAL™ data for 23 participants who had sufficient data. Twenty-three participants indicated that they had continued with their occupational sedentary behaviour change in some form. Self-efficacy towards goal

achievement remained high at the six month follow-up (post: $83 \pm 15\%$; six month: $81 \pm 19\%$). The most prominent goal identified by the participants to reduce occupational sedentary behaviour was walking. This included walking at lunchtime, walking to visit colleagues, and walking further to the bathroom, to fill their water bottle, or to empty their rubbish. The reduction in occupational sitting time was likely the result of the multi-component and individually-tailored aspects of the intervention which matched the level of willingness of the participants. Including participants in the planning stages may have enhanced their perceived behavioural control over their own sedentary behaviour change. The participants identified that attending seated meetings, perceived workloads or work tasks, and work environments were the key barriers to reducing occupational sitting time. To overcome some of these barriers, a variety of strategies were suggested including changing the work environment by installing sit-to-stand workstations or creating a standing space, and providing prompts by installing computer software, having campaigns or competitions especially with the support from management. At the six month follow-up, 13 participants were in the action stage of change as they continued to work towards their goals. Seven participants had moved to the maintenance stage as they indicated that they were able to successfully reduce their occupational sedentary behaviour for six months or longer. Five participants had relapses and returned to the contemplation or preparation stages as they were not regularly attempting to change their behaviour.

In conclusion, the theory-informed, low-cost, individually-tailored, multi-component six week intervention resulted in reduced occupational sedentary behaviour, increased awareness of sedentary behaviours and an increase in self-efficacy to change sedentary behaviour patterns. As expected, there were barriers identified by the participants, which included long or numerous meetings, increased workloads, and poorly planned workstations. These barriers are the likely cause of the relapses identified during the interviews. The findings

of the current study suggest short-term sedentary behaviour change is possible with appropriate theory-informed strategies, and further research could explore strategies to overcome barriers which may impact long-term adherence to sedentary behaviour change.

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Abbreviations

Abbreviation	Full term
BMI	Body mass index
CI	Confidence interval
ES	Effect size
$kg.m^{-2}$	Kilogram/metre squared
km/h	Kilometre per hour
MET	Metabolic equivalent
mmol/L	Millimole per litre
r	Pearson correlation coefficient
SCT	Social Cognitive Theory
SD	Standard deviation
SE	Standard error
TTM	Transtheoretical Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action

Research Outputs

Peer-reviewed publications

McGuckin, T., Sealey, R., & Barnett, F. (2017). Planning for sedentary behaviour interventions: office workers' survey and focus group responses. *Perspectives in Public Health, 137*(6), 316-321. doi:10.1177/1757913917698003

McGuckin, T., Sealey, R., & Barnett, F. (2017). The use and evaluation of theory-informed, multi-component intervention to reduce sedentary behaviour in the workplace: a preliminary study. *Cogent Psychology*, *4*(1), 1-17. doi:10.1080/23311908.2017.1411038

McGuckin, T., Sealey, R., Barnett, F. Six month follow-up of a theory-informed, multi-component intervention to reduce sedentary behaviour in the workplace. *Cogent Psychology* (under review).

Peer-reviewed conference presentations

McGuckin, T., Sealey, R., & Barnett, F. (2017). Goal-setting intervention to reduce occupational sedentary behaviour. Health and Health Behaviour Change: From Research to Practice and Back, 13-15 July 2017, Gold Coast, QLD, Australia.

McGuckin, T., Sealey, R., Leicht, A., & Barnett, F. (2015). Reliability and validity of the ActivPAL activity monitor for office-based tasks. In: Abstracts from ICDAM9. From: ICDAM9: International Conference on Diet and Activity Methods, 1-3 September 2015, Brisbane, QLD, Australia.

Chapter 1

Introduction and Literature Review

1.1 Introduction

Sedentary behaviour is a problematic behaviour and an emerging public health concern (Dunstan et al., 2013; Chu et al., 2016). Research surrounding sedentary behaviour has included a variety of populations such as the early years of childhood (LeBlanc et al., 2012), school-aged children and adolescents (Tremblay et al., 2011), adults (Rhodes, Mark, & Temmel, 2012), and older adults (Harvey, Chastin, & Skelton, 2013). Sedentary behaviour occurs in many domains such as leisure time activities, transportation, and in the workplace (Owen, Healy, Howard, & Dunstan, 2012). The workplace is therefore considered to be an appropriate setting for sedentary behaviour interventions for adults due to the large amounts of sitting that occurs with office or desk-based work (Clemes et al., 2015; Parry & Straker, 2013). Theory-informed interventions are effective for behaviour change (Gourlan et al., 2016) however the existing literature surrounding sedentary behaviour interventions is limited in regards to theory-informed research or the use of theories to explore outcomes (Gardner, Smith, Lorencatto, Hamer, & Biddle, 2016; Prapavessis, Gaston, & DeJesus, 2015; Rhodes et al., 2012). This literature review provides an overview of current research surrounding the prevalence and health concerns associated with sedentary behaviour, occupational sedentary behaviour, sedentary behaviour guidelines, measurements of sedentary behaviour patterns, theories and models which are associated with behaviour change, and strategies and processes which are effective for behaviour change.

1.2 Sedentary Behaviour Origins, Prevalence and Health Concerns

The concept of sedentary behaviour originates from the Latin term 'sedere' which means 'to sit' (Latin dictionary, 2013). Sedentary behaviour has been defined as 'high volumes of time that adults spend sitting in their non-exercise waking hours', and the energy expenditure during this time is very low, approximating 1.0-1.5 MET (Owen, Bauman, & Brown, 2009, Tremblay et al., 2017). Early evidence of sedentary behaviour being problematic occurred in the 1950's, and was even mentioned in 1713 by Bernardino Ramazzini (Pronk, 2010) who identified that tailors and cobblers were likely to suffer general ill health as a result of the sedentary nature of their jobs. Morris, Heady, Raffle, Roberts, and Parks (1953) explored the mortality rates in the first three months of a clinical episode of coronary heart disease. The authors determined that bus drivers (low activity levels) had higher levels of immediate mortality following an episode (44 deaths) compared to their more active conductor counterparts (12 deaths). This seminal research suggested that the health issues were thought to be linked with physical activity or inactivity. It is now clear that sedentary behaviour is a unique category of behaviour, and sedentary behaviour itself was likely to be the problematic behaviour which caused the poor health outcomes for these sedentary workers.

Sedentary behaviour is distinct from physical inactivity which has been conceptualised as a lack of moderate-to-vigorous physical activity (Pate, O'Neill, & Lobelo, 2008). For example, when a person does not meet the physical activity guidelines they are considered to be sedentary, however this is not an accurate classification as they may be able to accumulate large proportions (75%) of light activity throughout the day (Pate et al., 2008). To explain this further, based on MET values, sedentary behaviour is classified at the intensity of 1.0 -1.5 MET however light activities (1.6 – 2.9 MET), such as cooking food or

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washing dishes are often incorrectly grouped with sedentary behaviour (Pate et al., 2008).

Subsequently, there is a distinction between too much sitting and too little physical activity

(Leon-Munoz et al., 2013). Additionally, sleeping is not considered a sedentary behaviour

due to the essential physiological restorative functions it provides therefore, only behaviours

during the waking hours are considered to be sedentary (Owen et al., 2012).

While regular physical activity has many known health benefits (Penedo & Dahn,

2005; Warburton, Nicol, & Bredin, 2006), research evidence varies regarding whether or not

physical activity mitigates the health risks associated with sedentary behaviours. For

example, adults aged between 50-71 years who viewed television for $\geq$ 7 hr/day had an

elevated risk of all-cause and cardiovascular mortality at both low (< 1 hr/week) and high ($\geq$

7 hr/week) levels of moderate to vigorous physical activity (Matthews et al., 2012). Even

those individuals who exceeded the physical activity guidelines but also viewed television for

$\geq$ 7 hr/day were at an increased risk of all-cause mortality. This suggests that achieving the

recommended levels of physical activity of 30 min of moderate intensity physical activity on

five days per week or 20 min of vigorous intensity physical activity on three days per week

(or a combination of both) (Haskell et al., 2007) may not be protective against high levels of

sedentary behaviour such as television viewing (Matthews et al., 2012). A large-scale study

investigated the relationship between sitting time and all-cause mortality for 222, 497

Australian adults (van der Ploeg, Chey, Korda, Banks, & Bauman, 2012). The study

categorised sedentary behaviour into four categories of sitting time; 0 to less than 4, 4 to less

than 8, 8 to less than 11, and 11 or more hr/day. There was an 11% increase in all-cause

mortality for each category above the first category (0 to less than 4 hr/day). The relationship

between sitting time and mortality was considered to be independent of physical activity

levels as well as gender, age, body mass index (BMI), or diabetes or cardiovascular disease status (van der Ploeg et al., 2012). A systematic review by Chau and colleagues (2013) suggested that adults who sit for 10 hr/day would have a 34% increased risk of all-cause mortality when physical activity levels were met, and a 52% increased risk of all-cause mortality when physical activity levels were not met. Similarly, Ekelund and colleagues (2016) explored the relationship between sitting time and physical activity. The authors suggested that being physically active for 60-75 min/day eliminated the risk of death associated with high levels of sedentary behaviour. It was also found that being physically active for 25-65 min/day attenuated the risk of death compared to those who were active for less than 5 min/day (Ekelund et al., 2016). The levels of activity purported to eliminate the risk of death associated with high levels of sitting is higher than that recommended by the Australian Department of Health (2014) where adults are advised to participate in a minimum of 150 min of activity/per week. This equates to approximately 21 min/day and therefore the likelihood of eliminating the risk of death associated with high levels of sedentary behaviour is reduced due to the low levels of activity being achieved. In light of the variety of findings associated with the health benefits of reducing sedentary behaviour, both in conjunction with, and independent of physical activity, reducing sedentary behaviour may be just as important as structured exercise for all-cause mortality benefits (Hamilton, Hamilton, & Zderic, 2007). Additionally, based on the findings of two systematic literature reviews, the aim for effective sedentary behaviour interventions must be specifically to reduce sedentary behaviour rather than to increase physical activity (Gardner et al., 2016; Prince, Saunders, Gresty, & Reid, 2014).

Worldwide levels of sedentary behaviour have increased over the years (Hamilton, et al., 2007) with the United States (US) increasing sedentary time from 26 hr/week in 1965 to 38 hr/week in 2009; and the United Kingdom (UK) increasing from 28 hr/week in 1961 to 42 hr/week in 2005 (Ng & Popkin, 2012). This suggests that sitting time has increased since the 1960s (Rohm Young et al., 2016) and is attributed to advancements in transportation, workplace environments, communication, and technology (Owen, Healy, Matthews, & Dunstan, 2010). For example, this may include sitting during transportation (e.g. driving or on a bus), sitting while at work (computer work or talking on the phone), sitting while at home (watching television, listening to music, eating, or reading), and using other screen-based entertainment or communication devices for leisure (Owen, Salmon, Koohsari, Turrell, & Giles-Corti, 2014; Rohm Young et al., 2016).

The Australian Bureau of Statistics (ABS, 2013) reported that based on the findings from the 2011-2013 Australian Health Survey, Australian adults (18 years and over) spent an average of 39 hr/week being sedentary. Within the 39 hr, 10 hr were associated with workplace sitting, and 29 hr associated with leisure, for example transportation, watching television, social activities, and using technology. Television viewing accounted for approximately 13 hr/week for adults (ABS, 2013). When separating working adults from the larger population, working adults spent an average of 16 hr sitting at work per week. This amount increased to 22-23 hr/week for clerical, professional or administrative workers (ABS, 2013). Clerical and administrative workers were the most sedentary occupational group who reportedly sat for at least three quarters of their work hours (ABS, 2013) which is likely to be a result of the work environment and the type of work tasks completed. Due to the recent inclusion of sedentary behaviour as a health risk factor in the Australian Health Survey, it is

likely that Government bodies are concerned about the increasing levels of occupational and leisure sitting time. This is highlighted by the Australian Federal Government providing tips for reducing sedentary behaviour such as walking around while using a mobile phone, and moving the rubbish bin at work further away to encourage standing more frequently (The Australian Department of Health, 2014). Additionally, the National Heart Foundation (2017) is also promoting the notion of sitting less and moving more with free posters available to download from their website.

In other developed countries, the average sitting time is comparable to Australia. For example, Scottish adults sit for approximately 39 hr/week and English adults sit for approximately 34 hr/week with 13% of the UK reported to be sedentary for 8.5 hr or longer per day (Townsend, Wickramasinghe, Williams, Bhatnagar, & Rayner, 2015). For the US population, adults aged 20-59 years objectively reported sitting for approximately 7.5 hr/day (Matthews et al., 2008) which suggests the levels of sedentary behaviour (52.5 hr/week) are higher compared to Australia, England and Scotland. More recently, smaller amounts of sitting were reported by Harrington, Barreira, Staiano, and Katzmarzyk (2014). The findings were based on self-report measures, which suggested that American adults reportedly sit for 4.7 hr/day. The findings suggest American adults sit for approximately 33 hr/week and produced similar findings to Australian adults however the authors concluded that this is unlikely to be accurate. If the reported sedentary time was correct, it would suggest that other than sleeping for approximately 6 hr/day, adults would be standing or moving for the remaining ~13 hr/day. Under reporting of sitting time may be associated with education and knowledge of the health messages disseminated for sedentary behaviour and participants reporting what they perceive as the recommended amount, rather than the actual time.

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Sedentary behaviour has been associated with poor health outcomes. In the absence

of comparing to physical activity or irrespective of physical activity levels, a high prevalence

of sitting has been associated with elevated risks of mortality from all causes and from

cardiovascular disease (Katzmarzyk, Church, Craig, & Bouchard, 2009), reduced life

expectancy (Katzmarzyk & Lee, 2012) and poor cardiometabolic health outcomes (Henson et

al., 2013). In a large-scale study, the mortality rates associated with sitting time was

investigated for 17, 013 Canadian male and female adults where the hazard ratio for sitting

for almost none of the time was 1, whereas sitting for almost all of the time was 1.54

(Katzmarzyk et al., 2009). The trend in the gradual increase in hazard ratio for increasing

sedentary time was significant (p = <.0001) (Katzmarzyk et al., 2009). Katzmarzyk and Lee

(2012) evaluated sitting time and television viewing as two separate variables as part of a

meta-analysis based on the National Health and Nutrition Examination Survey which yielded

five full-text articles from the database search. Sitting time was categorised as < 3, 3-5.9, and

$\geq$ 6 hr/day and television viewing was categorised as < 2, 2-3.9, and $\geq$ 4 hr/day. The

analysis suggested that by reducing sitting time to < 3 hr/day and television viewing to < 2

hr/day, life expectancy can increase by 1.4 - 2 years (Katzmarzyk & Lee, 2012). For young,

middle-aged, and older adults who have known risk factors for type II Diabetes Mellitus,

sedentary behaviour has been detrimentally associated with 2 hr glucose (.220 $\pm$ .060

mmol/L), triacylglycerol (.206 $\pm$ .061 mmol/L) and high-density lipoprotein (-.123 $\pm$ .056

mmol/L) levels (Henson et al., 2013). The authors suggest that sedentary behaviour is

negatively associated with cardiometabolic health and may be a greater concern than a lack of

moderate to vigorous intensity physical activity (Henson et al., 2013). See Figure 1.1 for a

diagrammatic comparison of postprandial glucose and insulin response profiles between

sitting and standing. These findings indicate that high levels of sitting may cause detrimental

health outcomes, although both Katzmaryk et al. (2009) and Katzmarzyk & Lee, 2012 incorporated self-report data which can be over- or under- estimated by participants; while Henson et al. (2013) objectively measured sedentary behaviour and physical activity levels.

Conversely, the protective nature of physical activity has the potential to attenuate the risk of cardiovascular incidences and all-cause mortality (Bjørk Petersen et al., 2014). An unadjusted measure of risk of myocardial infarction and all-cause mortality for 71 363 Danish men and women aged 18-99 years suggested that, people who sit for 10 or more hr/day have a 38% higher risk of myocardial infarction and a 31% higher risk of all-cause mortality compared to those who sit for less than 6 hr/day. High levels of sitting (10 hr/day) and low levels of physical activity exacerbated the risk, however being physically active by participating in light-vigorous activities such as cycling or walking for transport, exercise, and endurance events attenuated the risks (Bjørk Petersen et al., 2014). Another detrimental factor which can lead to morbidity and mortality is weight gain, which was explored via mailed surveys to 8071 middle-aged female participants (Brown, Williams, Ford, Ball, & Dobson, 2005). There is potential for weight gain of > 5kg over a 5 year period when women are physically inactive, have high levels of sitting time, quit smoking, have high levels of energy intake, have a hysterectomy or menopause. In regards to sedentary behaviour as an independent factor, a significant increase in weight gain occurred for women who sat for > 8 hour/day compared to lower levels of sitting time (< 8 hr/day) (Brown et al., 2005). Gierach et al. (2009) explored endometrial cancer risk of 109 621 post-menopausal American women via mailed questionnaires. High levels of sitting (> 3 hr/day) was associated with an increased risk of endometrial cancer. This risk could be slightly attenuated by undertaking vigorous physical activity (exercise or sport for ≥ 20 min) (Gierach et al., 2009). It should be noted

that the data collected by Brown et al., (2005), Bjørk Petersen et al. (2014), and Gierach et al. (2009) was self-reported and therefore there is potential for participants to over- or under-estimate their behaviours.

Although physical activity may eliminate or attenuate the risks associated with sedentary behaviour (Bjørk Petersen et al., 2014; Ekelund et al., 2016), only 43% of Australian adults participate in 30 minutes of moderate intensity physical activity on most days (ABS, 2013) which suggests that high levels of sedentary behaviour are likely to be problematic for greater than half of the adult population in Australia. Consequently, Owen and colleagues (2010) predict that the deleterious health impacts caused by too much sitting time will continue to accumulate and there is a need for practical and policy changes to reduce sitting time as a population health concern. It is suggested that during bouts of prolonged sitting the muscles of the legs, back and trunk are used considerably less than when standing as they are not required to work to keep the body upright (Hamilton et al., 2007; see Figure 1.2 for an example of muscle activity during stepping, standing, standing up, and sitting). This reduction in muscle activity is believed to have an adverse effect on cardiac stroke volume and output (Saltin et al., 1968), glucose tolerance (Lipman et al., 1972), and lipoprotein lipase activity (Bey & Hamilton, 2003).
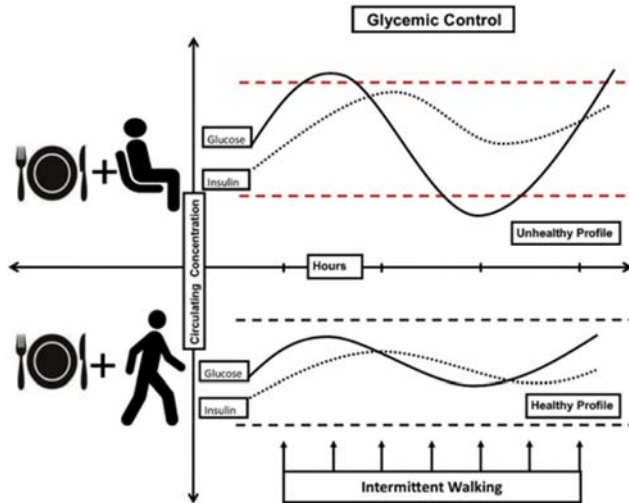
Figure 1.1 Postprandial glucose and insulin response. The dashed lines represent the optimal glucose range. Source: Wheeler et al. (2017).
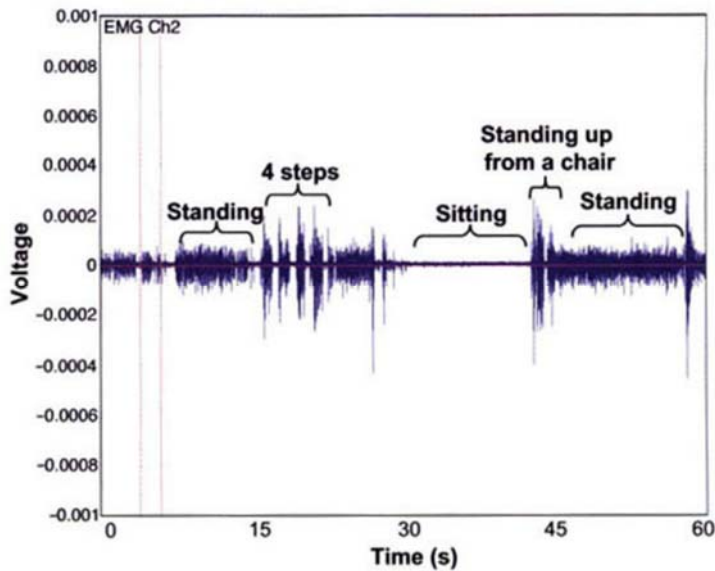
Figure 1.2 Local contractile activity of leg muscle. Source: Hamilton et al. (2007).

In summary, sedentary behaviour is a distinct classification of behaviour (Pate et al., 2008) which may cause deleterious health outcomes (Chau et al., 2013; Matthews et al., 2012; van der Ploeg et al., 2012) dependent on physical activity levels (Bjørk Petersen et al.,

2014; Ekelund et al., 2016). As a result of advancements in technology in a variety of domains (Owen et al., 2010), sedentary behaviour now accounts for approximately 37 hr/week from global statistics (ABS, 2013; Townsend et al., 2015). In Australia, office based workers spend the majority of their working hours in a seated position (ABS, 2013) which provides an appropriate setting to address this problematic behaviour.

1.3 Sitting Time in the Workplace

Due to the increasingly sedentary nature of occupations (Miller & Brown, 2004), workplace sitting patterns contribute substantially to overall sitting time (Gilson, Burton, van Uffelen, & Brown, 2011) and therefore, sedentary behaviour. Occupational sedentary behaviour of Danish workers has increased from 33.1% of workers sitting for greater or equal to three quarters of their work hours in 1990 to 39.1% of workers sitting for greater or equal to three quarters of their work hours in 2010 (van der Ploeg, Visbjerg Moller, Hannerz, van der Beek, & Holtermann, 2015). Professional staff ($n = 554$) such as managers and administrators in regional Queensland, Australia, self-reported that they sit for 4.15 ± 2.92 hr/day during work hours (Mummery, Schofield, Steele, Eakin, & Brown, 2005). Western-Australian clerical and professional staff ($n = 50$) wore an accelerometer for seven days. Results indicated that the workers were sedentary for 7.3 ± 0.86 hr/day during work hours (Parry & Straker, 2013).

Objective activity monitoring (device-based monitoring) of 21 office workers for a 10 day period found that workers sat more on work days (9.95 ± 2.03 hr/day) compared to leisure days (8.07 ± 1.38 hr/day), and achieved less standing and walking time on work days (5.68 ± 1.62 hr/day) compared to leisure days (6.95 ± 1.68 hr/day) (McCrady & Levine, 2009). Similarly, young female workers (31-36 years; $n = 4650$) and middle-aged workers (59-64 years; $n = 3185$) in managerial and professional roles reported that they spent greater

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amounts of time sitting on work days (young: 8.99 ± 4.08 hr/day; mid-aged: 7.99 ± 4.06 hr/day) compared to non-work days (young: 8.20 ± 3.82 hr/day; mid-aged: 7.74 ± 3.79 hr/day) (Clark, Kolbe-Alexander, Duncan, & Brown, 2017). The same outcome was found for females in clerical and sales roles with work days (young: 8.76 ± 4.09 hr/day; mid-aged: 7.81 ± 4.06 hr/day) consisting of more sedentary behaviour than non-work days (8.21 ± 3.89 hr/day; 7.50 ± 3.68 hr/day) (Clark et al., 2017).

When comparing occupations, Miller and Brown (2004) found that professional workers such as medical officers, librarians and directors; and administrative staff including administrative assistants or secretaries reported more sitting time at work (6.2 ± 1.55 hr/day; 5.7 ± 1.31 hr/day respectively) compared to technical workers such as laboratory technicians and assistants (3.3 ± 1.46 hr/day), and blue-collar workers including cleaners and maintenance staff (1.6 ± 1.85 hr/day). This finding has been supported by Vandelanotte and colleagues (2013) who telephone interviewed 1194 households in Queensland, Australia. The authors suggested that white-collar workers or workers undertaking jobs that require minimal physical activity are at higher risk of accumulating larger amounts (3.34 ± 2.87 hr/day) of sedentary behaviour compared to blue collar workers (1.46 ± 2.42 hr/day). They recommended that workplace behaviour change interventions are needed to reduce sedentarism for those in white-collar or low physically demanding jobs.

Office-based workers such as executives, administrators, managers, and secretaries are considered to undertake low occupational activity (Steeves et al., 2015). This was determined by using the National Health and Nutrition Examination Survey which categorised occupations on the amount of occupational activity from one being higher levels of occupational activity and 40 being low levels of occupational activity. The results

indicated that executives, administrators, and managers were ranked 33/40 as they had high

levels of occupational sedentary behaviour with waiters and waitresses (1/40) having the least

amount of occupational sedentary behaviour based on accelerometry data (Steeves et al.,

2015). Due to the increased sedentary time during work hours; office workers may be more

susceptible to an increased risk of cardiometabolic disorders and mortality (Parry & Straker,

2013) unless they achieve 60-75 min/day of moderate intensity exercise (Ekelund et al.,

2016).

An example of the risk is outlined in the study by Mummery et al. (2005), where 1579

adults located in regional Australia with occupational sitting time of greater than 5 hr/day had

a significantly greater likelihood of having a BMI $\geq$ 25 kg.m^{-2} which has been linked to

increased mortality (Whitlock et al., 2009). In addition to an increased likelihood of an

elevated BMI, a large-scale analysis of British workers highlighted that sedentary

occupations were associated with an increased risk for all cause and cancer mortality in

females compared to those who had higher levels of occupational physical activity

(Stamatakis et al., 2013). The evidence suggests that increased occupational sitting time may

lead to increases in weight gain and potentially increased mortality rates especially if physical

activity recommendations are not met.

Prolonged sitting time within the workplace is associated with other health concerns

such as the musculoskeletal impact of sedentary posture. Previous literature has suggested

that there is an increased prevalence of musculoskeletal disorders when the duration of

computer-based keyboard use is increased, with the most prevalent concerns for office

workers involving the neck and shoulders (Gerr, Marcus, & Monteilh, 2004) or the shoulders,

neck and upper back (Cho, Hwang, & Cherng, 2012). Other office workers were reported to

have an increased prevalence of developing musculoskeletal disorders due to ergonomic factors including mouse use, prolonged sitting, and uncomfortable postures (Ortiz-Hernandez, Tamez-Gonzalez, Martınez-Alcantara, & Mendez-Ramırez, 2003). To address the musculoskeletal concerns of computer-based work, Davis and Kotowski (2014) investigated the use of sit-to-stand workstations compared to traditional desks with or without software as a prompt to stand. The authors determined that postural changes associated with sit-to-stand workstations or with prompts to stand were positively linked to decreased discomfort in the shoulders, lower back and upper back regions (Davis & Kotowski, 2014). Similarly, Gao, Nevala, Cronin, and Finni (2016) suggested that neck and shoulder discomfort was significantly lower in sit-to-stand workstation users compared to traditional desk users ($p = .024$).

In summary, work days result in greater amounts of sitting compared to non-work days (Clark et al., 2017; McCrady & Levine, 2009), and office-based environments or roles which require workers to perform a majority of their tasks seated increases occupational sitting time (Mummery et al., 2005; Parry & Straker, 2013). It is likely that an intervention may be suitable for executives, administrators and managers as their roles consist of mainly office-based tasks and high levels of sedentary time (Steeves et al., 2015).

1.4 Sedentary Behaviour Guidelines

There are no specific recommendations available that prescribe how long sitting bouts should last, how often sitting bouts should be interrupted, or the intensity of the activity that would be sufficient to interrupt the sitting bouts (Dunstan, Howard, Healy, & Owen, 2012; Owen et al., 2012). As previously mentioned, a systematic review indicated that life expectancy may be increased by 1.4 – 2 years if extended sitting and television viewing is limited each day

(Katzmarzyk & Lee, 2012). Additionally, a large scale (n = 16,586) self-report study indicated that there is a significantly strong relationship between standing time and cumulative survival from all cause (p = <.0001), cardiovascular (p = .02) and other cause (p = <.001) mortality, especially for individuals who are physically inactive (Katzmarzyk, 2014). These findings suggest that there may be positive health outcomes as a result of standing and/or moving, however Katzmarzyk and Lee (2012) indicated that further research is needed to explore recommendations or guidelines for sedentary behaviour levels.

Emerging literature has investigated some negative health implications of sitting and whether they are attenuated by standing or light activity in an attempt to determine timeframes in which this may occur. For example, when desk-based workers (n = 10) stood for 3 hr after lunch, there was a 43% lower excursion of blood glucose and higher levels of energy expenditure (728 ± 276 kilojoules difference) compared to sitting (Buckley, Mellor, Morris, & Joseph, 2014). Additionally, Thorp et al. (2014b) conducted laboratory trials on 23 office-based workers who were classified as overweight or obese, based on anthropometric data. The trials explored the postprandial plasma glucose concentrations between sitting for 8 hr as a control condition and the intervention condition which involved alternating between sitting and standing every 30 min, resulting in 4 hr of standing (and 4 hr of sitting). The results found a significant difference in plasma glucose concentrations between the two conditions in favour of the intervention condition. Similarly, postprandial glucose and insulin levels were lowered when overweight and obese participants (n = 19) completed light (treadmill walking at 3.2 km/h) or moderate (treadmill walking between 5.8 – 6.4 km/h) activity breaks every 20 min compared to uninterrupted sitting for 5 hr (Dunstan et al., 2012). These findings suggest that interrupting or reducing sedentary behaviour may

improve metabolic health, and subsequently cardiovascular health, particularly in overweight or obese persons. However further research may be useful to explore the long-term effects of standing for improved cardio-metabolic health.

Some literature recommends interrupting sitting time every 20 min to improve postprandial glucose and insulin levels (Dunstan et al., 2012), or every 30 min to improve lower back pain (Atlas & Deyo, 2001). The general recommendations of interrupting sitting every 20-30 min was assessed within an office-based population who sat for approximately 66% of their work day. The workers ($n = 83$) did not achieve the 20-30 min recommendations however some (8%) achieved an interruption to their sitting bout every 55 min (Ryan, Grant, Dall, & Granat, 2011). The authors indicated that the reason for the non-adherence to the recommendations was unclear however they suggested it may be due to the poor awareness of the guidelines as they are not publicised and that the recommendations are not achievable in a modern workplace (Ryan et al., 2011).

The Australian Department of Health (2014) has suggested that adults aged 18-64 years should 'minimise the amount of time spent in prolonged sitting, and break up long periods of sitting as often as possible', however further clarification is required. An international group of sedentary behaviour experts have developed some recommendations for sedentary workplaces including initially achieving standing or moving for 2 hr/day progressing to 4 hr/day (Buckley et al., 2015). The experts also suggest that sitting time should be interrupted as much as possible by undertaking standing-based work however static standing for long periods is also not recommended due to musculoskeletal issues (Buckley et al., 2015). While the recommendations are justified by some evidence (for example Buckley et al., 2014, Dunstan et al., 2012; Katzmarzyk, 2014; Katzmarzyk & Lee, 2012; Thorp et al.,

2014b), the authors and other researchers suggest that further research is required to add greater certainty to the recommendations or to modify them (Buckley et al., 2015; Chau, McGill, Freeman, Bonfiglioli, & Bauman, 2017). More recently, energy expenditure was explored over three different conditions for 18 working adults via indirect calorimetry (Barone Gibbs, Kowalsky, Perdomo, Grier, & Jakicic, 2017). The conditions included sitting for 60 min, standing for 30 min plus sitting for 30 min, and standing for 60 min. Compared to sitting, the standing and sitting condition resulted in 23.0 ± 51.9 kilojoules/hr increase in energy expenditure, and the standing condition resulted in a 34.3 ± 66.5 kilojoules/hr increase ($p = <.001$) (Barone Gibbs et al., 2017). These findings suggest that energy expenditure can be increased simply by standing or alternating standing with sitting. The authors suggest this may have the potential to improve health.

The emerging literature suggests that there are potential health benefits of reducing sedentary behaviour and therefore attempts to achieve the recommendations by The Australian Department of Health (2014) and Buckley et al. (2015) are likely to result in some positive health outcomes.

1.5 Measuring and Monitoring Sedentary Behaviour

Workplace interventions that target sedentary behaviour appear to be in the early stages of investigation, and some methodological limitations such as the devices' sensitivity to detect changes in sitting time have been highlighted in reviews (Chau et al., 2010; Plotnikoff & Karunamuni, 2012). Additionally, Rohm Young et al. (2016) suggested that there is no gold standard for assessing sedentary behaviour. One of the most widely used objective activity monitoring devices to assess sedentary behaviour is the ActivPAL™ (Kim & Welk, 2015). The ActivPAL™ (PAL Technologies Ltd., Glasgow, Scotland) is a lightweight device which

attaches to the thigh via adhesives and records movement patterns such as sitting, standing, stepping or walking based on acceleration and inclination data (PAL Technologies Ltd., 2015). The ActivPAL™ physical activity monitor has been validated in free-living and controlled conditions (Grant, Ryan, Tigbe, & Granat, 2006; Harrington, Welk, & Donnelly, 2011; Kim, Barry, & Kang, 2015; Kim & Welk, 2015; Kozey-Keadle, Libertine, Lyden, Staudenmayer, & Freedson, 2011; Lyden, Kozey-Keadle, Staudenmayer, & Freedson, 2012; Ryan, Grant, Tigbe, & Granat, 2006). For example, the device has previously been described as a valid and reliable measure of movement patterns that are associated with everyday activities such as hanging clothes on a clothesline, ironing, applying bed linen, vacuuming, watching a video, and preparing food and drinks (Grant et al., 2006). Similarly, the device is considered a valid and reliable measure of walking in healthy adults irrespective of walking speed (Ryan et al., 2006). The ActivPAL™ has also been used as the criterion measure in another study where the Actical accelerometer was compared to the ActivPAL™ (Oliver, Schofield, Badland, & Shepherd, 2010). As a result of the reliability and validity of the ActivPAL™, the activity monitoring device has been utilised in sedentary behaviour studies to monitor sitting and movement patterns (Alkhajah et al., 2012; Hadgraft et al., 2017; Healy et al., 2013; Neuhaus, Healy, Dunstan, Owen, & Eakin, 2014a; Neuhaus et al., 2014b; Swartz et al., 2014).

In addition to objective measures of sedentary behaviour, self-report subjective measures are available. For example, administrative workers' sitting time was investigated via an objective (ActiGraph) measure and self-report (logbook and questionnaire) measures (Lagersted-Olsen et al., 2014). For the 25 workers, there was no statistical difference between objective and self-reported total sitting hours at work (5.6 hr for both measures)

which suggests that there is good agreement between both measures on a group level. Similarly, Clark et al. (2011) found positive correlations (r_p = .39, 95% CI = .22–.53; r_s = .29, 95% CI = .11–.44) between self-reported sitting (7.05 ± 1.31 hr) and objectively (ActiGraph) measured sitting (6.60 ± 0.94 hr) in the workplace for 121 office-based workers, call-centre workers, and customer service workers. Although both studies resulted in similar outcomes for both self-report and objectively measured sitting time in an office-based environment, the questionnaire used was retrospective. The issue with using retrospective data is that recall of sedentary behaviour can be difficult due to the passive nature of the behaviour (Rhodes et al., 2012). Biddle, Gorely, Marshall, and Cameron (2009) implemented a 15 min diary for four days for adolescents. Twelve percent of participants completed the diary entry within 5 min of the 15 min time period however the majority (61%) of participants completed the diary entry within 60 min of the 15 min time period. Therefore, it is suggested that the use of real-time subjective measures such as log books should be utilised as a preference to recall measures.

To assist with the decision-making process with respect to selecting an appropriate measuring tool for the assessment of sedentary behaviour in young people, Hardy et al. (2013) designed a flow chart (Figure 1.3). Objective measures such as accelerometers, inclinometers, and direct observation usually produce less measurement error however the resource cost is high and therefore the sample size is likely to be small. Conversely, subjective measurements such as log books, diaries, and questionnaires are cheaper and can be used with large sample sizes. Unfortunately, there are limitations in using self-report methods such as the difficulty with recall (Owen, Leslie, Salmon, & Fotheringham, 2000) however Hardy et al. (2013) found that log books or diaries which incorporate a specified,

regular reporting timeframe (e.g. every 30 min) can reduce measurement error but can be

arduous for the participant.
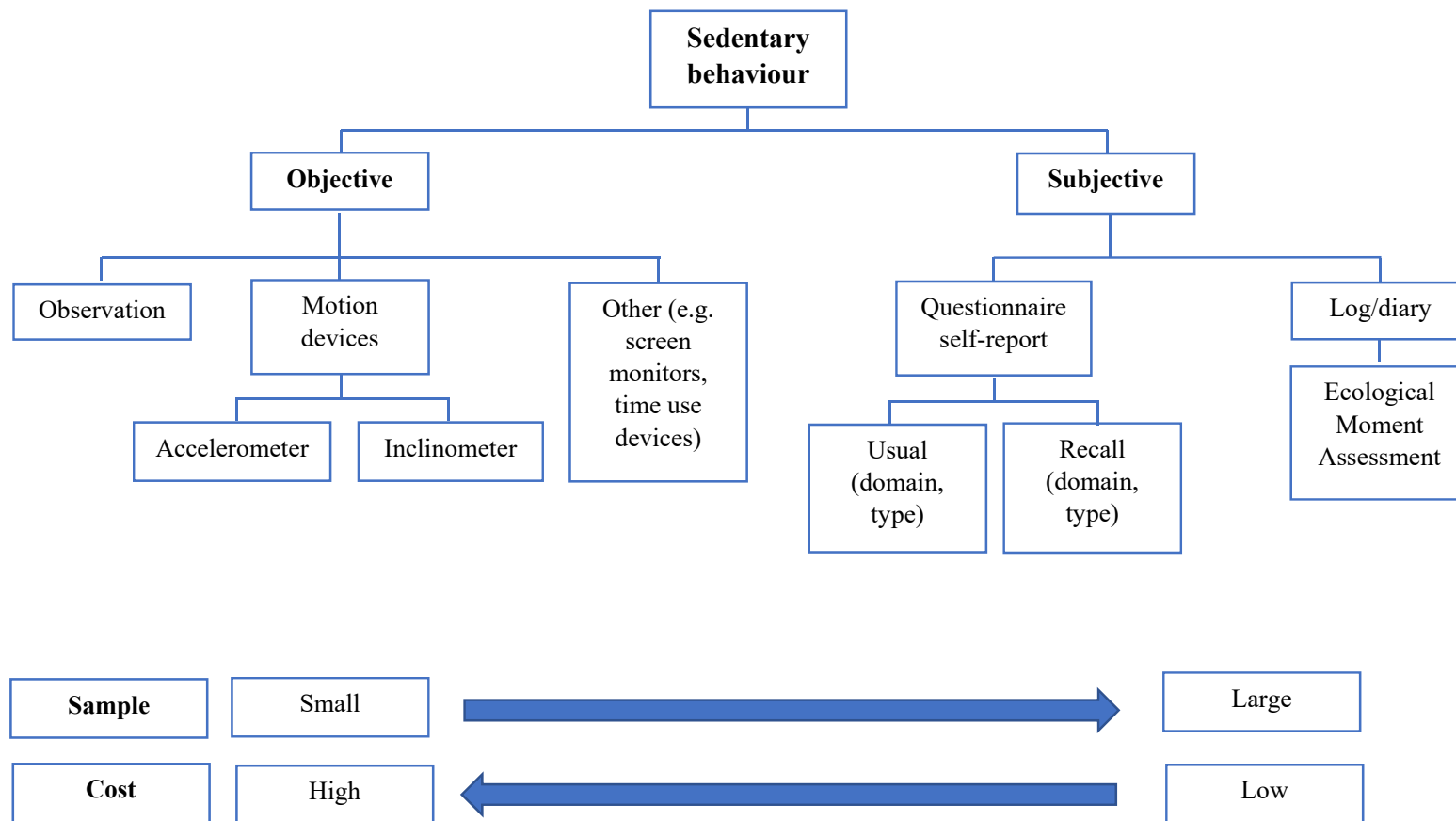
Figure 1.3. Flow chart of methods of measuring sedentary behaviour. Source: Hardy et al. (2013).

Using the ActivPAL™ monitoring device to collate movement patterns provides valid and reliable data (Grant et al., 2006; Harrington et al., 2011; Kim et al., 2015; Kim & Welk, 2015; Kozey-Keadle et al., 2011; Lyden et al., 2012; Ryan et al., 2006). However, the data produced by the ActivPAL™ can only be used retrospectively once downloaded and collated and is therefore unable to provide real-time monitoring and feedback. In contrast, the use of self-report can provide real-time feedback about movement patterns and prompt an individual to change their postural position. Therefore, the use of both objective and subjective measures can provide detailed data and information relevant to the participant and is suggested that future research incorporate both.

1.6 Behaviour Change Theories

Theory-informed interventions are effective for promoting activity (Gourlan et al., 2016), and can assist in describing the likely processes that result in behaviour change (Gardner, Whittington, McAteer, Eccles, & Michie, 2010). Prapavessis and colleagues (2015) suggest that behaviour change theories are able to provide valuable insight into the relationship between psycho-social factors and sedentary behaviour. Behaviour change theories provide the framework of how humans think and feel (their attitudes, beliefs, and values) and therefore behaviour change theories are used to develop, execute, and interpret research as well as explain and predict behaviour (Buckworth, Dishman, O'Connor, & Tomporowski, 2013). Previous literature suggests that there is limited use of explicit theories in behaviour change interventions for reducing sedentary behaviour (Gardner et al., 2016; Prapavessis et al., 2015) with few studies exploring the relationship between social cognitive factors and sedentary behaviour (Hadgraft et al., 2017). Similarly, Rhodes and colleagues (2012) suggested that emerging research should include psychological and social theories or models

to provide a more in-depth analysis of sedentary behaviour therefore highlighting a gap in the literature which requires further investigation.

Some emerging literature has explicitly incorporated behaviour change theories into the planning and evaluation of sedentary behaviour interventions. Hadgraft et al. (2017) integrated theory-informed behaviour change strategies based on the Social Cognitive Theory (SCT) into a multi-component intervention. The intervention was delivered for office-based workers from an organisational level, environmental level, and an individual level. The organisational and individual level strategies (emails and health coaching) were implemented for three months while the environmental level strategy (sit-to-stand workstations) was implemented for 12 months. The targeted social-cognitive factors included perceived behavioural control, barrier self-efficacy, social norms, and knowledge. Perceived behavioural control was the mediating factor to have an intervention effect at three months which accounted for a reduction in workplace sitting of 9 min/8 hr day; whereas barrier self-efficacy contributed at the 12 month assessment period by being the mediator for reducing workplace sitting time by 10 min/8 hr day compared to control participants (Hadgraft et al., 2017). This suggests that participants were confident they could overcome barriers and had greater control over their behaviour change in the workplace compared to their control counterparts. It may also indicate that the participants considered perceived behavioural control as an influential factor at the commencement of the intervention, and overcoming barriers contributed to behaviour change in the long term. The authors suggested that future interventions should consider perceived behavioural control strategies such as a brainstorming session for participants to identify opportunities to reduce sitting time or installing sit-to-stand workstations and self-efficacy strategies such as goal setting or problem

solving when developing workplace interventions to reduce sedentary behaviour (Hadgraft et al., 2017).   Prior to the Hadgraft et al. (2017) study, Neuhaus et al. (2014b) incorporated essentially the same format for the intervention (organisational, environmental, and individual level) for 43 office workers who worked for a Government agency. The study was designed to have three phases of the research including a conceptualisation stage, formative research stage, and pilot studies. From a behaviour change theory perspective, the intervention incorporated SCT components of self-efficacy, outcome expectancies, and social-structural factors however this was only discussed in the conceptualisation stage and was not explored in great detail as key factors relating to the intervention outcomes. Similarly, Danquah et al. (2017) incorporated SCT, Rogers' diffusion of innovations theory and goal setting theory. This was referred to in the design phase of the strategies utilised however the theoretical framework was not discussed in regards to the successful outcome of reducing occupational sitting time by 71 min as a result of the multi-component intervention.

Further exploration of the use of behaviour change theories in the planning and implementation of sedentary behaviour interventions is needed (Rhodes et al., 2012), and the current literature surrounding sedentary behaviour is in its infancy compared to exercise interventions (Keadle, Conroy, Buman, Dunstan, & Matthews, 2017). Although Rollo, Gaston, & Prapavessis (2016) have recently systematically reviewed the cognitive and motivational factors associated with sedentary behaviour and suggested that a variety of factors are associated with sedentary behaviour, the authors suggest that further theory-driven research is needed to explore sedentary behaviour in more detail. Furthermore, the review provided limited findings regarding occupational sedentary behaviour. The following sections describe the SCT, the Transtheoretical Model (TTM), the Theory of Planned

Behaviour (TPB), and some specific behaviour change strategies including goal setting, commitment, and self-monitoring.

1.6.1 Social Cognitive Theory – self-efficacy. Social Cognitive Theory (Bandura, 1986) proposes that behaviour is a purposeful action, and is under the control of an individual where self-reflection and self-regulation occurs. The theory involves developing skills through mastery modelling, strengthening a person's self-efficacy, and enhancing motivation through goal setting (Bandura, 1988). Self-efficacy is a key construct of the SCT and explains behaviour via two factors: one's self-efficacy and one's outcome expectations (Bandura, 1977). Self-efficacy surrounds the concept that an individual may be "more likely to engage in a behaviour if they are confident that they will be successful and will thus be able to enhance their sense of self" (Buckworth et al., 2013, p. 298). Self-efficacy influences the paths that people pursue, the effort exerted, perseverance and resilience associated with the endeavour or adversity, as well as coping with stressful situations, and the level of recognition of their accomplishments (Bandura, 1997). Outcome expectations by definition is a one's estimate that a given behaviour will result in certain outcomes (Bandura, 1977).

Factors which influence self-efficacy and outcome expectancy include mastery experiences, vicarious experiences, verbal persuasion, and physiological and affective states (Bandura, 1997). Bandura (1997) considered mastery experiences to be the most influential source of self-efficacy as it provides evidence to indicate if a person can do whatever is needed to succeed. Successful experiences can positively build self-efficacy; conversely failures can undermine it (Bandura, 1997). If a person considers their capabilities as superior in comparison to group norms or similar associates, self-efficacy will be heightened through vicarious experiences while there is always the alternative of achieving lower than the

standards and decreasing self-efficacy (Bandura, 1997). Verbal persuasion can produce greater and sustained efforts if provided by someone who is considered to be significant to the person, knowledgeable, credible, and the feedback is realistic (Bandura, 1997). Lastly, physiological states associated with stressful situations are often interpreted as signs of vulnerability, and can negatively affect self-efficacy. Similarly, mood states can cause poor judgement of self-efficacy (Bandura, 1997). Rollo et al. (2016) systematically reviewed the cognitive and motivational factors associated with sedentary behaviour, and suggested that having high self-efficacy towards physical activity and social support to change behaviour were likely factors to lower sedentary behaviour.

1.6.2 The Transtheoretical Model (TTM) (Stage of Change Model). The TTM (Prochaska & DiClemente, 1983) was originally developed for smoking cessation but has been applied to many settings including exercise (Clarke & Eves, 1997; Marcus & Simkin, 1994), back pain prevention (Keller, Herda, Ridder, & Basler, 2001), and occupational health (Cassidy, 1997). The TTM is one of the most widely used models incorporated into health promotion (Spencer, Adams, Malone, Roy, & Yost, 2006). The model comprises of five stages of change which include precontemplation (lack of awareness or desire to change behaviour), contemplation (growing awareness of the problematic behaviour), preparation (some behaviour change has occurred and the intention to change has become proximal), action (where observable changes occur), and maintenance (long-term behaviour change) (Prochaska & DiClemente, 1983; Prochaska, Norcross, & DiClemente, 2013). The model is cyclical in nature and relapses can occur at any stage (Prochaska, DiClemente, & Norcross, 1992). Once an individual's stage has been assessed, appropriate processes can be

implemented to change problematic behaviour (Marcus & Simkin, 1994).   Figure 1.4

depicts the Transtheoretical Model.
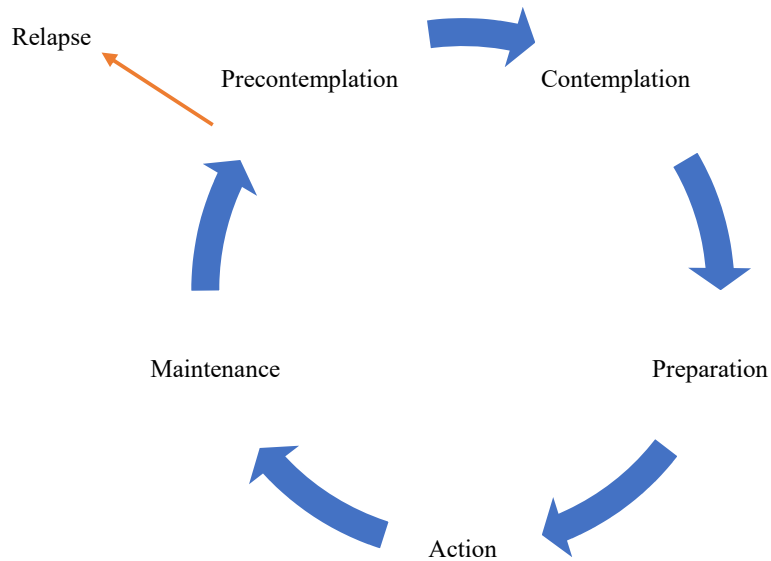
Figure 1.4. Stages of change included in the Transtheoretical Model. Adapted from

Prochaska and DiClemente (1982) and Prochaska et al. (1992).

The TTM has 10 processes of change, and these involve activities which are used to

modify behaviour via experiences and/or environmental changes (Marcus & Simkin, 1994)

across the different stages of change (Prochaska & DiClemente, 1982). The processes of

change involve experiential and behavioural factors and include consciousness raising, self-

liberation, social liberation, self-reevaluation, environmental reevaluation,

counterconditioning, stimulus control, reinforcement management, dramatic relief or

emotional arousal, and helping relationships (Prochaska & DiClemente, 1983; Prochaska et

al., 1992). As described by Prochaska and colleagues (1992) consciousness raising involves

increasing the information about oneself and the problem, self-liberation involves choosing to

commit to act or a belief in the ability to change, and social liberation surrounds the

advocating for non-problematic behaviours in society. Self-reevaluation assesses how one

may feel or think about a problem with respect to themselves, environmental reevaluation

incorporates the problematic behaviour and how it may affect the physical environment.

Counterconditioning involves the substitution of alternatives for a problematic behaviour,

stimulus control is where one may avoid or counter the stimuli that elicits a problem

behaviour, and reinforcement management involves being rewarded by one's self or by

others for making a change. Dramatic relief or emotional arousal is where one may

experience and express feelings about the problems and solutions and helping relationships in

which one needs to be open and trusting about the problem with someone who cares. These

processes of change can be covert or overt and are considered to be strong predictors of

behaviour change (Prochaska et al., 1992). The processes can be used throughout each stage

of change however self-liberation, contingency management, helping relationships, counter

conditioning, and stimulus control are considered to be the most prominently used processes

during the action and maintenance stages (Prochaska, et al., 1992). Table 1.1 represents the

processes of change that are predominantly used by self-change individuals who are quitting

smoking or losing weight (Prochaska et al., 1992).

Table 1.1 Processes used most prominently at different stages of change

Precontemplation	Contemplation	Preparation	Action	Maintenance
	Consciousness raising			
	Dramatic relief			
	Environmental reevaluation			
		Self-reevaluation		
			Self-liberation	
				Reinforcement management
				Helping relationships
				Counterconditioning
				Stimulus control

Source: Prochaska et al. (1992) and Prochaska & Velicer, (1997).

In addition to the processes of change, decisional balance (Janis & Mann, 1977) and self-efficacy (Bandura, 1997) have been purported to influence the decision to move between the stages of the TTM. Decisional balance includes five stages of decision making: 1) appraising the challenge; 2) surveying alternatives; 3) weighing alternatives; 4) deliberating about commitment; 5) adhering despite negative feedback (Janis & Mann, 1977). This can be seen as weighing the pros and cons of a behaviour change, which has been considered as a promising behaviour change strategy for reducing sedentary behaviour (Gardner et al., 2016).

In regards to behaviour change or moving between the stages of the TTM, a person

must believe they can motivate themselves and have control of their behaviour to even begin

the process of changing a detrimental health habit (Bandura, 1997). Quite often people will

not attempt to change if they believe they do not have what it takes to succeed, however

people are more inclined to make changes to prevent health decrements rather than changing

for the potential health benefits (Bandura, 1997). Changes in behaviour can be a result of

expert advice (Prochaska et al., 1992), however successful change can occur for those who

wish to change on their own (self-changers) without formal treatment (Cowen, 1982;

Prochaska et al., 1992). The TTM is yet to be applied to a sedentary behaviour setting

however as mentioned previously, there is potential that a variety of theoretical frameworks

could be utilised to explore sedentarism (Wong, Gaston, DeJesus, & Prapavessis, 2016). In

this instance, a variety of processes such as consciousness raising surrounding sedentary

behaviour, self-liberation by committing to changing occupational sitting patterns, and

helping relationships by having supportive managers or peers could be implemented into an

intervention. This may enhance the likelihood that each stage of change in the TTM is

addressed.

     1.6.3 Theory of Planned Behaviour. The TPB is an extension of the Theory of

Reasoned Action (TRA) (Ajzen, 1988). The TRA includes the intention to perform a

behaviour which is dependent on a person's attitude and subjective norms, however the TPB

includes a third determinant, that of perceived behavioural control (Ajzen, 1988). Intentions

encapsulate the motivation to perform a behaviour, the willingness to perform a behaviour,

and the effort a person is willing to exert to perform a behaviour (Ajzen, 1991). The

intention to change behaviour must be under volitional control to enact the desired behaviour,

whereby an individual has the decision to perform (or not perform) the behaviour (Ajzen, 1991). Attitude is where an individual has a positive or negative appraisal of a specific behaviour (Ajzen, 1991), and subjective norms involves the social norms to perform or not to perform a behaviour (Ajzen, 1991). Perceived behavioural control surrounds the perception of the 'ease or difficulty of performing the behaviour of interest' (Ajzen, 1991, pg. 183). Perceived behavioural control can directly influence behaviour when a person does not have complete control of the behaviour (Godin & Kok, 1996). Perceived behavioural control is related to perceived self-efficacy (Bandura, 1977) due to the similarities between the two concepts. In some situations, the magnitude of each determinant influencing a behaviour will vary such that it could be one, two or all three determinants influencing intention (Ajzen, 1991; Figure 1.5).

As the TPB can help to predict and understand the tendencies to perform specific actions (Ajzen, 1988), the TPB can also be applied to sedentary behaviour such that 'an individuals' intention to engage in sedentarism is the main determinant of actual sedentary time' (Prapavessis et al., 2015; p. 24). The authors suggest that intentions are determined by attitude (perceived costs and benefits of sitting), subjective norms (perceived expectations of significant others regarding sitting), and perceived behavioural control (perceived control over the time spent in sedentary behaviours) (Ajzen, 1985; Prapavessis et al., 2015). Additionally, the TPB has been incorporated into sedentary behaviour research by Umstattd Meyer, Wu, and Walsh (2016). Their findings suggest that when workers have increased perceived behavioural control, it is likely to influence the workers' intentions to stand. Further research is required to confirm the use of the TPB as an appropriate framework for sedentary behaviour interventions (Prapavessis et al., 2015).
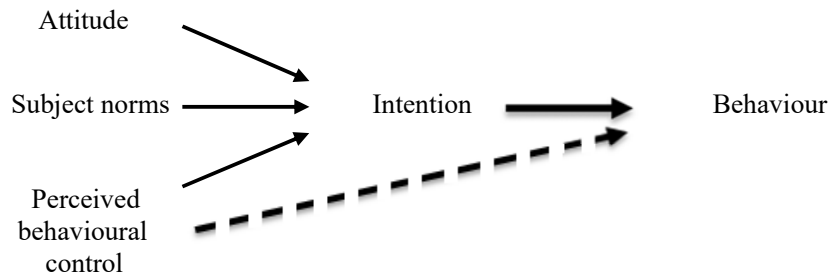
Figure 1.5. Theory of Planned Behaviour. Source: Ajzen (1991).

1.7 Behaviour Change Strategies

Behaviour change strategies are underpinned by theoretical frameworks, and are applied to achieve a variety of outcomes. As previously mentioned, a variety of behaviour change strategies provide promising results for reducing sedentary behaviour. Self-monitoring, problem solving, modifying the social and physical environments, and education were considered to be the most effective strategies for behaviour change (Gardner et al., 2016). The most promising interventions used a larger number of techniques (7 ± 5 techniques) for example, a combination of prompts/cues, goal setting, the provision of feedback, pros and cons, and social reward (Gardner et al., 2016).

 1.7.1 Goal setting. A goal is defined as "that which one wants to accomplish; it concerns a valued, future end state" (Lee, Locke, & Latham, 1989 in Stretcher et al., 1995). Goal setting provides a strong sense of purpose and direction (Bandura, 1988). Additionally, goals can increase interest in a task and reduce boredom (Locke, 1996), while challenging goals can result in increased levels of performance compared to not having set goals or setting vague goals (Latham & Locke, 1991). For goals to be effective, a participant needs to be committed to achieving the goal, perceive that the goal is important and that the goal is considered to be achievable (Locke, 1996). When people actively play a role in the goal

setting process, they will be strongly invested in the goals (Bandura, 1988). Feedback is

essential to assess the progress of goal attainment, and this may lead to an individual setting

higher goals to beat or better their previous performance (Locke, 1996). Setting sub-goals or

short-term goals is a form of providing frequent feedback however external information on

attainment may be required as some individuals may not be able to self-evaluate or track

progress (Strecher et al., 1995).   Setting goals does not automatically increase motivation as

the stage of change of an individual needs to be considered; as does whether or not the goal

conflicts with an existing or additional goal (Strecher et al., 1995).

Goal setting is associated with self-efficacy whereby individuals with high self-

efficacy are likely to set challenging goals, commit themselves to achieving goals, have the

ability to overcome adverse set-backs, and develop strategies to achieve their goals (Locke,

1996). Additionally, high self-efficacy is linked to being able to learn more from feedback

and personal experiences (Strecher et al., 1995). Self-efficacy can influence the selection of

goals and commitment to achieving a goal (Latham & Locke, 1991). A study conducted by

Bandura and Cervone (1983) involved providing goals and performance feedback, goals

only, performance feedback only, and no condition to groups of 20 participants (10 for the

control group) in regards to ergometer physical activity. Participants who received goals and

performance feedback were able to double their performance compared to those who received

goals only, performance feedback only or neither factor (Bandura & Cervone, 1983).

Therefore, the combination of goal setting and performance feedback is likely to improve

performance through self-evaluation and self-efficacy (Bandura & Cervone, 1983).

Goal setting has been researched extensively and has resulted in effective behaviour

change (90% success rate) in a variety of settings and populations (Locke, 1996). Previously,

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goal setting has been implemented as a key strategy (Lewis, Rowlands, Gardiner, Standage, & Olds, 2016), and as part of a multi-component intervention (Fitzsimons et al., 2013) to reduce sedentary behaviour in older adults, with positive outcomes. Within both studies, participants were actively engaged in the selection and/or design of the goals (Fitzsimons et al., 2013; Lewis et al., 2016) however Latham and Locke (1979) suggest that goal attainment can be achieved irrespective of whether the goal is assigned or participant selected as long as the goal is challenging and specific. Goal setting has also been used within workplace settings as a successful behaviour change technique to reduce occupational sitting (Chu et al., 2016; Green Sigurdsson, & Wilder, 2016).

     1.7.2 Commitment. In the context of goal attainment, "commitment refers to the degree to which the individual is attached to the goal, considers it significant or important, is determined to reach it, and keeps it in the face of setbacks and obstacles" (Latham & Locke, 1991). For goal commitment to take place, two factors influence the decision; the importance of the outcome as a result of working to attain a goal, and the belief that the goal is attainable (Locke & Latham, 2002). This does not automatically mean that being committed to achieving the goal will result in reaching it (Latham & Locke, 1991). Locke, Frederick, Lee, and Bobko (1984) suggested that when self-belief in one's capabilities is strengthened, the more likely a person is to have high levels of commitment to achieving goals. This relates to the decisions people make regarding their behaviour which can influence self-efficacy (Bandura 1988) and also self-liberation of the TTM, whereby a person commits to change their behaviour and has the belief that change can occur (Prochaska et al., 1992).

     Previously commitment to exercise programs have shown increased rates of compliance and lower dropout rates (Oldridge & Jones, 1983). More recently, Fitzsimons et

al., (2013) incorporated commitment as a specific strategy within a multi-component intervention to reduce sedentary behaviour in older adults with decreased levels of sedentary behaviour identified. It is likely that commitment to behaviour change is required to enhance the chances of attaining goals and modifying behaviour.

1.7.3 Self-monitoring. Self-monitoring is considered to be an effective behaviour change strategy linked to the SCT for reducing sedentary behaviour (Gardner et al., 2016), and may be as simple as recording daily sitting time or setting achievable and measurable goals (Owen et al., 2011). For example, Judice, Hamilton, Sardinha, and Silva (2015) incorporated self-monitoring of step count to evaluate goal attainment for overweight/obese adults. This method provided the participants with daily feedback about their progression towards their goals, and also acted as a method for data collection. Similarly, Nicklas et al. (2014) added self-monitoring to a weight loss intervention which included a diet and exercise regime. The intervention group ($n = 20$) decreased body weight after 10 months compared to the diet and exercise group alone. The self-monitoring occurred via accelerometer feedback which participants were asked to record. This data were then compared to goals set for activity achievement (Nicklas et al., 2014). Additionally, Lewis et al. (2016) incorporated self-monitoring by asking the participants if they achieved their set goal each day and if not, why not. Self-monitoring via recording behaviour patterns or goal setting appears to be an effective behaviour change strategy.

1.8 Summary of Behaviour Change Theories and Strategies

Including theories as a framework for interventions are likely to evoke behaviour change (Gourlan et al., 2016) and in conjunction, theories can explain the likely processes that caused behaviour change to occur (Gardner et al., 2010). This can assist in the planning of a

behaviour change intervention but also to describe the intervention outcomes. Many theories

exist, however in the context of this thesis, self-efficacy as the key component of the SCT,

the stages of change from the TTM, and the perceived behavioural control and intentions

from the TPB are the most appropriate concepts for behaviour change as there are many

interrelated components such as self-efficacy and the intention to change behaviour. The

inclusion of multiple strategies is important as they are interrelated. For example,

commitment is needed to achieve goals and to monitor goal attainment.

1.9 Workplace Interventions to Reduce Sitting Time

The workplace is an appropriate setting to provide an intervention to reduce sitting time (Chu

et al., 2016; Das et al., 2016) as a large proportion (49%) of sedentary behaviour occurs in the

workplace (Parry & Straker, 2013). Multi-component interventions targeting sedentary

behaviour are often successful (Chu et al., 2016) as a 'one size fits all' approach to behaviour

change in the workplace is considered inappropriate due to the varying roles undertaken by

workers (Gilson et al., 2011). A variety of approaches to reduce sitting time allow for

individual worker preferences such as job tasks or work environment (Gilson, Straker, &

Parry, 2012). Chau et al., (2010) highlighted that there is a need for interventions to

specifically target reductions in sitting time in the workplace however it is unclear whether

workplace interventions should aim to decrease total sitting time or to interrupt the sitting

bouts. This was explored in the research conducted by Swartz and colleagues (2014) where

two intervention groups were incorporated. The interventions were implemented to disrupt

60 continuous minutes of sitting time with the one group ($n = 29$) prompted to stand without

instructions on what to do while standing or for how long, the other group ($n = 31$) was

prompted to walk 100 steps using a pedometer to monitor their steps. The findings suggested

that the standing group significantly reduced total sitting time (baseline = 380.2 (SE 8.7) min; intervention = 355.2 (SE 8.9) min; p = .009) and the duration of the sitting bouts (baseline = 14.3 (SE 1.2) min; intervention = 11.9 (SE 1.0) min; p = .005) however there was no significant difference in sitting time in the stepping group (baseline = 377.2 (SE 14.6) min; intervention = 366.3 (SE 14.8) min; p = .16) even when the duration of sitting bouts decreased (baseline = 15.2 (SE 1.4) min; intervention = 12.2 (SE 0.9) min; p = .001). The authors highlighted that the focus of the intervention may influence the outcome, which suggests that those in the stepping group were focused on increasing physical activity levels but not decreasing sitting time.

As the workplace is considered to be an ideal setting for reducing sedentary behaviour, a variety of studies have explored different strategies to target the problematic behaviour. The strategies include changing the environment such as installing sit-to-stand workstations, using prompts with or without a sit-to-stand workstation, providing information or education, goal setting, self-monitoring, providing feedback, and problem solving. The majority of the existing literature does not specify if behaviour change theories have been used as frameworks for developing these intervention strategies. For example, environmental changes such as sit-to-stand workstations or activity-permissive workstations are considered to be related to the perceived behavioural control constructs of the TPB and SCT whereby participants have perceived control over their sitting time in the workplace. Therefore, while not explicitly outlined within most studies, the strategies can be assumed to be developed as a result of prior theory-based planning. There is however limited evaluation of the strategies or intervention outcomes in terms of the overarching frameworks. The occupational based strategies will be described in further detail in the following sections.

1.9.1 Sit-to-stand workstations. A review of behavioural strategies suggested that the introduction of sit-to-stand workstations or similar workspace design elements provide the most promising outcome for reducing occupational sedentary behaviour (Chu et al., 2016). Another review suggested that those who are able to install sit-to-stand workstations or treadmill workstations for their workplace are likely to find positive health benefits and reduced sedentary behaviour (MacEwen, MacDonald, & Burr, 2014), without impacting on worker productivity (Thorp, Kingwell, Owen, & Dunstan, 2014a). Examples of health benefits included reduced fatigue levels and decreased lower back pain (MacEwen et al., 2014; Thorp et al., 2014a).

One of the first interventions to objectively show a decrease in sedentary behaviour using a sit-to-stand workstation in the workplace compared to a control group was conducted by Alkhajah et al. (2012). The study involved the installation of sit-to-stand workstations for the intervention group ($n = 18$), whereas the control group ($n = 14$) was asked to continue with their usual workplace activity. The intervention group relative to the control group were able to reduce their occupational sitting time by 2.28 hr/day during the first week, and by 2.08 hr/day at the three month follow up. Additionally, relative to the control group, high density lipoprotein levels significantly increased by 0.26 mmol/L in the intervention group indicating a positive shift in lipid profile however the small sample size may have influenced the interpretation of the findings (Alkhajah et al., 2012). Similar decreases in occupational sitting time have been reported. For example, the installation of sit-to-stand workstations for 24 faculty employees resulted in reduced self-reported proportion of work time spent sitting from $75.5 \pm 15.9\%$ at baseline to $68.9 \pm 16.2\%$ at the completion of the six month intervention (Gao et al., 2016). Similarly, the installation of sit-to-stand workstations for

Government employees (*n* = 13) significantly reduced their daily sitting time at work from 6.9 hr ± 1.2 hr to 5.4 hr ± 2.3 hr without additional behaviour change strategies (Grunseit, Chau, van der Ploeg, & Bauman, 2013). Interestingly, Pronk, Katz, Lowry, and Rodmyre Payfer (2012) indicated that sit-to-stand workstations can reduce sitting time by 16.1% in the workplace based on survey responses however these changes in behaviour were essentially negated when the sit-to-stand workstations were removed.

Neuhaus et al. (2014a) installed sit-to-stand workstations as one strategy within their office-based intervention. The workstation group did not statistically change their sitting time in comparison to a control group. When regular information provided via email to the participants regarding health information, face-to-face coaching, and regular phone calls were included with the provision of a sit-to-stand workstation, the intervention resulted in reduced occupational sitting time by 89 min in comparison to the control group, and by 56 min in comparison to the sit-to-stand workstation only group (Neuhaus, et al., 2014a). Although the intervention was successful, the authors noted that both the purchasing and installation of the adjustable workstations were resource intensive. Similarly, Cooley and Pedersen (2013) suggested that within a workplace setting, employees are limited by the existing environment. In particular, chairs and desks which may be the incorrect height for individuals, and the financial costs of ergonomic equipment may prohibit the workplace from supplying all staff with new equipment. Therefore, although sit-to-stand workstations provide promising reductions in occupational sedentary behaviour (Karol & Robertson, 2015; Tew, Posso, Arundel, & McDaid, 2015), a business or organisation may not be able to retrofit their workplace to install the workstations. Additionally, Biddle and Bennie (2017) suggested that

although sit-to-stand workstations are effective for environmental changes, other alternative options to reducing sedentary behaviour require further investigation.

1.9.2 Active workstations. Koren, Pisot, and Simunic (2016) installed a cycle ergometer placed under a modified desk and chair to increase physical activity levels in the workplace for office workers. The trial resulted in the participants ($n = 13$) being able to achieve the recommended physical activity levels of 30 min/day of moderate to high intensity exercise (World Health Organisation, 2010) while having minimal impact on work performance. Reducing sedentary behaviour was not a key outcome for the study however the authors suggest that an active workstation may assist in reducing passive sitting during work hours. Additionally, male and female office workers ($n = 19$) participated in a five month bike-desk intervention (Torbeyns, de Geus, Bailey, Decroix, & Meeusen, 2017). Participants were instructed to cycle for eight 25 min bouts or four 50 min bouts during the work week. An email was sent every four weeks updating the participants of their duration and distance cycled in the four week period. The participants were able to cycle for an average of 98.1 ± 55.3 min/week with 32% of participants suggesting they had improved work performance, 58% indicated that there were no effects on work performance, and 11% experienced a negative effect. Although the authors suggested the bike-desks could be used to reduce occupational sedentary behaviour, sitting time was not evaluated in the study. Similarly, shared treadmill workstations were installed to reduce the amount of low-intensity activity or sedentary behaviour for nurses and dieticians (Bouchard et al., 2016). The participants were asked to perform continuous walking on the treadmill for 2 hr/work day for three months. For the 13 participants who completed the study, there was a 20% reduction in sedentary time or low-intensity activity with improvements in systolic and diastolic blood

pressure, and sleep quality. Another study which involved the installation of treadmill desks in an office-based environment over 12 months resulted in reduced sitting time by more than 1 hr/day. Additionally, the light activity (up to 3.2 km/h) resulted in increased energy expenditure by 309 kilojoules/day (Ben-Ner, Hamann, Koepp, Manohar, & Levine, 2014). Although the installation of active workstations appears to increase light levels of physical activity in the workplace, and reduce sitting time, there is a cost associated with installation which may be prohibitive for organisations. For example, Ben-Ner et al. (2014) indicated that the workstation set-up cost $4000.

     1.9.3 Prompts/cues. Prompts/cues are reminders that provide an alternative behaviour to an existing behaviour or habit (Cooley, Pedersen, & Mainsbridge, 2014), and have been utilised as a technique to decrease sedentary behaviour. One prompt-based sedentary behaviour study incorporated wrist watches that beeped or vibrated every hour, and computer reminders that would pop-up on the participant's screen to prompt them to get out of their chair to interrupt their sitting bout or to walk at least 100 steps depending on the intervention group allocation (Swartz et al., 2014). The results of the study suggested that the prompts were effective for the interruption of sedentary behaviour by reducing overall sitting time by 6.6%, the duration of the sitting bout by 16%, and the number of sitting bouts of longer than 60 min by 54% (Swartz et al., 2014). Similarly, a computer-based software program was used to prompt desk-based workers to stand up every 45 min (Cooley et al., 2014). The prompt deactivated the computer screen and therefore could not be ignored. The self-selected activity completed during the computer screen deactivation was recorded and stored in the program. Qualitative data suggested that the employees were able to interrupt their occupational sitting time with regular activity breaks (Cooley et al., 2014). Similarly,

using the same software, Mainsbridge, Cooley, Fraser, and Pedersen (2016) reported that using a prompt-based intervention which included educational sessions reduced sedentary time for desk-based workers by 7.51 ± 4.06 min/day.

The use of computer-based software was included in the intervention conducted by Evans et al. (2012). The study included two intervention groups, one group received the point-of-choice prompts and an education session about sedentary behaviour, and the other group received the education session only. The prompts reminded workers to take a short break from sitting (1 min) every 30 min whereas the education session involved information about prolonged sitting with an information pamphlet provided. There was no difference between the two interventions for total occupational sitting time, however there were reductions in the number of prolonged bouts of sitting (-0.14 events/hr [-0.25, -0.03], $p =$ .012) and the time spent sitting in those bouts (-15.4% [-26.2, -4.5], $p =$.007) for the point-of-choice prompts and education group (Evans et al., 2012). Similarly, Gilson et al. (2016) provided an information workshop and invited office workers to develop occupational strategies to 'sit less and move more' which were used in a five month intervention. Fifty-seven office workers were provided with the list of strategies and a subsample ($n = 24$) provided with a real-time computer-based prompt to stand for 5 min which was activated through a sitting pad. The sitting pad registered how long the sitting bouts occurred, and a traffic light system appeared on the computer screen with amber visible when the participant was sitting for 30 min and red when 60 min was approaching. The group with strategies only decreased their occupational sedentary behaviour by 2% however the group who were provided with the strategies and the computer-based prompt resulted in an 8% statistically significant reduction (Gilson et al., 2016).

1.9.4 Multi-component strategies. As previously mentioned, multi component interventions are successful in reducing occupational sedentary behaviour (Chu et al., 2016). Gardner et al. (2016) suggests that combining a variety of strategies provides promising reductions in sedentary behaviour. Strategies include self-monitoring of behaviour, environmental changes, instructions on how to perform the behaviour, reviewing goals, and providing information on health consequences and behaviour. The strategies can be implemented at an individual, social, environmental or organisational level. Examples of the different levels include having individual commitment towards behaviour change (individual level), having a peer champion (social level), having access to stairwells (environmental level), and having managers support or provide funds towards the intervention (organisational level) (Gilson et al., 2011). Combining multiple strategies across different levels caters for individual differences and capabilities (Gilson et al., 2011).

Prior to implementing an intervention, exploring the views of employers and employees can provide valuable insight into the acceptability and feasibility of strategies which could be included in a sedentary behaviour intervention. DeCocker and colleagues (2015) conducted research within companies where workers completed their work in a predominantly seated position during work hours. The study involved separate focus groups with executives and employees. Overall the participants suggested that interventions should be multi-component and should focus on providing information, raising awareness, and incorporating motivational techniques at an individual, social, environmental, and organisational level. Examples of the strategies included computer reminders (individual), walking to visit colleagues (social), adjustable work stations (environmental) and standing meetings (organisational). Employees suggested that they thought some strategies could be

mandated while the executives suggested that undertaking the strategies should be self-selected (DeCocker et al., 2015). This highlights that individual preference may require multiple implementation strategies.

Previous literature such as Healy et al. (2013) incorporated a variety of strategies such as the provision of health-related information, prompts to "stand up, sit less, move more", instructions on how to perform the behaviour, goal setting, self-monitoring, feedback, problem solving, and the installation of a sit-to-stand workstation into a four week intervention (Healy et al., 2013). The multi-component intervention resulted in a reduction in sedentary behaviour of approximately 2 hr/work day. The authors indicated that it was unclear which intervention component was utilised successfully by participants. Another multi-component intervention was conducted by Stephens and colleagues (2014) which incorporated specific behaviour change techniques into their four week intervention including information sessions, goal setting and motivational interviewing, and the installation of a sit-to-stand workstation. The study included a control group who were asked to continue with their usual workplace activities. The multicomponent intervention reduced total workplace sitting time (baseline = 338.5 ± 35.3 min; intervention = 215.4 ± 12.6 min) and the total workplace sitting time for the intervention group was significantly less than the control group (-125.2 min; p = .001).

Some multi-component interventions include lower-cost options without the provision of a sit-to-stand workstation. Mackenzie, Goyder, and Eves (2015) implemented a low-cost multi-component intervention for university employees (n = 17). The pre-post intervention included individual, social, environmental, and organisational level strategies. For example, weekly emails containing information or tips to reduce sedentary behaviour were provided at

the individual level, workplace champions to promote standing/walking meetings at the social

level, encouragement to use different printers at the environmental level, and management

support for standing/walking meetings at the organisational level. The four week intervention

reduced sedentary behaviour by 26 ± 54 min/day (95% CI = -2 to 53) based on self-report

data. Participants indicated that standing/walking meetings were helpful as well as reminder

software and posters. Conversely, the least effective strategies were reminders, twitter, and

posters. Another study suggested that sedentary behaviour can be reduced by incorporating

short breaks of 1-2 min every half hour rather than longer breaks of two 15 min breaks from

sitting throughout the work day (Mailey, Rosenkranz, Casey, & Swank, 2016). In the study,

the female participants ($n = 49$) were allocated to either short breaks or long breaks and

consulted with the research assistant to plan strategies for the eight week intervention. The

strategies that were included in the study were goals, planning to overcome barriers,

computer or application based prompts (optional), educational emails surrounding sedentary

behaviour in the workplace, support from the research team, and self-monitoring. The

reduction in sedentary time was approximately 36 min/work day ($p = .03$) for the short break

group however sedentary time did not change for the long break group (Mailey et al., 2016).

The study did not explore the most effective strategies of the intervention however the

authors suggested that short breaks are likely to be feasible in a real-world setting.

Additionally, Green et al. (2016) incorporated education regarding the negative effects of

sedentary behaviour, a prompt in the form of a vibrating watch, feedback about sedentary

behaviour patterns, and goal setting at different stages of the intervention. Although the

study had a very small sample size ($n = 3$), the authors indicated that prolonged sedentary

bouts were decreased by 41% when participants received prompts, feedback, and goal setting.

Based on the literature, low-cost multi-component strategies can effectively reduce

occupational sedentary behaviour by approximately 26-36 min/day during work hours although further evaluation of the specific strategies is required.

It appears that the use of multi-component interventions to reduce sedentary behaviour in the workplace can be successful in a relatively short assessment period (4 – 8 weeks) irrespective of whether or not a sit-to-stand workstation is provided. However, it should be highlighted that the magnitude of change is substantially smaller in sedentary behaviour interventions which do not include sit-to-stand workstations (average reduction of 31 min/day compared to 2 hr/day for sit-to-stand workstation inclusion). Furthermore, behaviour change needs to be evaluated for long-term adherence, and to identify potential barriers.

1.10 Barriers to Sedentary Behaviour Change

Although many interventions aimed at reducing sedentary behaviour in the workplace have been successful at reducing sedentary behaviour (see above), there are limiting factors which may prevent the occurrence of long-term changes in the behaviour. Barriers to changing sedentary behaviour such as the need to use a computer to complete tasks, lack of time or time pressures to complete tasks, increased or excessive workloads, bad weather, not realising how much time was spent sitting, and feeling frustration by the interruption to workflow have been identified by office workers (Bort-Roig et al., 2014; Cooley et al., 2014). Additionally, workplace social norms and the office furniture and layout are considered to be potential barriers to reducing sedentary behaviour (Hadgraft et al., 2016). Some employees perceived that taking short breaks from work would be seen by management as they are not working hard enough (Gilson et al., 2011). For example, it is a social norm to send emails for communication purposes rather than speaking face-to-face with a colleague (Waters et al.,

2016). The cost of installing sit-to-stand workstations have also been identified as a potential limitation (Gilson et al., 2011).

It is likely that barriers will be specific to an individual or work position such that different workers perceived that some aspects of a workplace intervention could be mandated while others suggested the strategies should be self-selected (DeCocker et al., 2015). Additionally, barriers to achieving a desired behaviour change can be described as lacking one or more of the following factors: capability, opportunity, or motivation (Gardner et al., 2014; Michie, van Stralen, & West, 2011). A person may lack the capacity to modify the behaviour (capability), there may be external factors which prevent behaviour change to occur (opportunity), and there are internal factors which influence behaviour change (motivation) (Gardner et al., 2014).   Therefore, a variety of strategies are needed to address occupational sedentary behaviour to provide participants with an opportunity to overcome some of the perceived or real barriers previously identified (Bort-Roig et al., 2014; Cooley et al., 2014; Hadgraft et al., 2016).

1.11 Overall Aims of the Project

Sedentary behaviour is a problematic behaviour which occurs at high levels in occupational settings, especially in office workers. Therefore, the aim of the current thesis was to implement and evaluate a theory-informed, low-cost, individually-tailored, multi-component intervention to reduce sedentary behaviour in the workplace. The specific project aimed to address the following objectives:

1) To explore the relationship between sitting time and health as perceived by office workers;

2) To explore potential strategies which may be useful to reduce sedentary behaviour in the workplace;

3) To explore behaviour change strategies and processes used by office workers who have already modified their occupational sedentary behaviour;

4) To identify barriers which may limit the reduction of occupational sedentary behaviour;

5) To evaluate the effectiveness of a theory-informed, low-cost, individually-tailored multi-component intervention for the reduction of sedentary behaviour of office workers; and,

6) To explore participant experiences six months post intervention to evaluate the long-term effectiveness of a theory-informed, low-cost, individually-tailored multi-component intervention to reduce sedentary behaviour of office workers.

1.12 Gaps in the Literature

When implementing change into the workplace to reduce sedentary behaviour it has been suggested that a 'one size fits all' approach to behaviour change may be unsuccessful due to the varying tasks within the workplace (Gilson et al., 2011). Therefore, future interventions need to consider individually tailoring interventions to allow for personal preference (Marcus et al., 1998; Marcus et al., 2007) and matching strategies with the level of willingness to change behaviour (Prochaska & DiClemente, 1983).

The use of sit-to-stand workstations provides promising behaviour change outcomes as a result of changing the environment (i.e. stimulus control) (Karol & Robertson, 2015; Tew, et al., 2015), however, employees are limited by the existing environment such as chairs and desks. Due to the financial costs associated with purchasing sit-to-stand workstations it may

not be feasible for a workplace to purchase new equipment (Cooley & Pedersen, 2013; Neuhaus et al., 2014a). Therefore, low-cost options for interventions need to be explored with some promising results beginning to emerge (Cooley et al., 2014; Mailey et al., 2016; Swartz et al., 2014).

Rhodes and colleagues (2012) suggested that emerging research should include psychological and social theories or models as this will provide a more in-depth analysis of sedentary behaviour. However, recent literature suggests the use of behaviour change theories is rare in sedentary behaviour interventions (Gardner et al., 2016; Prapavessis, et al., 2015). This provides a significant gap in the literature and future research could incorporate theories or models to explain the processes or mechanisms which result in sedentary behaviour change (Gardner et al., 2010).

1.13 Significance of the Project

Research surrounding sedentary behaviour is in its infancy compared to the plethora of research surrounding exercise (Keadle et al., 2017). Sedentary behaviour is now considered a public health concern (Chu et al., 2016; Dunstan et al., 2013) which may be attributed to the increased occupational sitting time observed over the past 25 years (van der Ploeg, et al., 2015). The majority of previous literature surrounding occupational sedentary behaviour is not based on a specific theory or does not explore the theoretical mechanisms behind the behaviour change (Gardner et al., 2010; Gardner et al., 2016; Prapavessis, et al., 2015). The current project is expected to contribute to the existing literature by exploring the planning and evaluation of low-cost, individually-tailored, theory-informed strategies to reduce occupational sedentary behaviour, thus specifically addressing the identified gaps in the

literature. The thesis will provide specific recommendations for strategies which may be utilised in future workplace interventions.

1.14 Research Questions

1.14.1 Overall research question

Can the use of individually-tailored, theory-informed strategies reduce occupational sedentary behaviour?

1.14.2 Overall research hypothesis

The use of individually-tailored, theory-informed strategies will successfully reduce sedentary behaviour in a workplace setting.

1.14.3 Individual research questions

RQ1. What are the employee perceptions of the relationship between workplace sitting and health?

RQ2. What strategies do employees perceive as effective methods to reduce occupational sedentary behaviour?

RQ3. What do successful sedentary behaviour changers incorporate into their workplace to reduce occupational sedentary behaviour?

RQ4. Can a low-cost, theory-informed, individually-tailored intervention reduce sedentary behaviour in the workplace?

RQ5. What are the perceptions of office workers in regards to a theory-informed intervention?

RQ6. What is the long-term effectiveness of a theory-informed intervention?

RQ7. What are the barriers to changing occupational sedentary behaviour?

RQ8. Will the reduction in workplace sedentary behaviour meet the current recommendations of 2 – 4 hr of standing or moving during work hours?

1.15 Thesis Format

Using a mixed methods embedded intervention design (Creswell, 2015; Doyle, Brady, & Byrne, 2016) the thesis will explore the perceptions of the target population group prior to the intervention (Chapter 2, study 1 & Chapter 3, study 2). The intervention will include qualitative and quantitative data to explore the findings with more detail such as the contributing factors which may or may not lead to behaviour change (Chapter 4, study 3). Finally, there will be follow-up quantitative and qualitative data to evaluate the long-term effectiveness of the intervention (Chapter 5, study 4). A final chapter (Chapter 6) includes additional findings not presented elsewhere, an overall summary of the findings and concluding statements. The use of an embedded intervention design includes a 'human element' which suggests the findings may be more meaningful (Creswell, 2015). The use of the embedded intervention design will aim to add to the existing literature by incorporating a mixed methods approach.

The thesis is presented as six chapters with chapters 2-5 written in publication format. The thesis structure is presented in Figure 1.6 with associated methods of data collection and research questions.

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                    │   Measure, monitor, and reduce sitting time in the workplace │
                    └─────────────────────────────────────────────────────┘

┌──────────────────────────┐          ┌───────────────────────────────┐
│ Embedded intervention design │       │  Overall RQ: Can the use of   │
└──────────────────────────┘          │  individually-tailored, theory-│
                                       │  informed strategies reduce   │
         ┌──────────────────────────┐ │  occupational sedentary behaviour? │
         │  Chapter 1               │ └───────────────────────────────┘
         │  Introduction and literature review │

┌──────────────────┐   ┌──────────────────────────────────┐   ┌──────────────┐
│ Qualitative data │ → │  Chapter 2 / Study 1             │ ← │  RQ 1 / RQ 2 │
└──────────────────┘   │  Planning for sedentary behaviour│   └──────────────┘
                       │  interventions: office workers'  │
                       │  survey and focus group responses│

┌──────────────────┐   ┌──────────────────────────────────┐   ┌──────────────┐
│ Qualitative data │ → │  Chapter 3 / Study 2             │ ← │  RQ 3 / RQ 7 │
└──────────────────┘   │  Successful sedentary behaviour  │   └──────────────┘
                       │  change in the workplace:        │
                       │  perspectives of successful self-changers │

┌──────────────────┐   ┌──────────────────────────────────┐   ┌──────────────┐
│ Quantitative data│ → │  Chapter 4 / Study 3             │ ← │ RQ 4 / RQ 5 /│
│ & qualitative data│  │  The use and evaluation of a     │   │  RQ 8        │
└──────────────────┘   │  theory-informed, low-cost,      │   └──────────────┘
                       │  individually-tailored, multi-component │
                       │  intervention to reduce sedentary behaviour │
                       │  in the workplace                │

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│ Quantitative data│ → │  Chapter 5 / Study 4             │ ← │ RQ 5 / RQ 6 /│
│ & qualitative data│  │  Six month follow-up of a        │   │  RQ 7/ RQ 8  │
└──────────────────┘   │  theory-informed, low-cost,      │   └──────────────┘
                       │  individually-tailored, multi-component │
                       │  intervention to reduce sedentary behaviour │
                       │  in the workplace                │

                       ┌──────────────────────────────────┐
                       │  Chapter 6                       │
                       │  Additional Findings, Overall Summary, and │
                       │  Conclusions                     │
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Figure 1.6. Thesis structure

Planning for sedentary behaviour interventions: office workers' survey and focus group responses

2.1 Abstract

Aims: As sedentary behaviour is becoming more prominent in office-based work environments, this study aimed to explore office workers' perceptions of sedentary behaviour, explore potential behavioural strategies to reduce sedentary behaviour in the workplace, and identify barriers which may hamper behaviour change.

Methods: One hundred and forty office workers were recruited and surveyed from the same workplace. The survey included questions regarding perceptions of the relationship between sitting time and health. Following the survey, 12 employees also participated in focus groups to identify potential sedentary behaviour intervention strategies and barriers. The responses from the survey and focus groups were thematically analysed.

Results: Eighty-eight percent of all participants surveyed agreed that there was a relationship between sitting time and health. The most prominent theme identified was musculoskeletal complaints, followed by general health, and weight gain or obesity. The focus groups identified that interventions targeting reducing sitting time should include education,

supportive and knowledgeable managers, and a variety of behaviour change strategies to address individual preferences and barriers.

Conclusions: Multiple behavioural strategies were identified which appear to be appropriate for sedentary behaviour change.

2.2 Introduction

Due to the increasingly sedentary nature of occupations through advancements in technology (Miller & Brown, 2004), workplace sitting patterns have contributed substantially to overall sitting time for people who work (Dunstan et al., 2012; Gilson, Burton, van Uffelen, & Brown, 2011; Miller & Brown, 2004; Mummery et al., 2005). Office workers have been reported as being sedentary or seated for between 4.1 hr and 7.3 hr/day during work hours (Mummery et al., 2005; Parry & Straker, 2013). Additionally, office workers average two more hours of sitting time, and achieve less standing and walking time on work days compared to leisure days (McCrady & Levine, 2009), indicating a need to target workplace sitting time when addressing sedentary behaviour. Chu and colleagues (2016) have determined that effective interventions can reduce occupational sitting by 40 min over an 8 hr work day, however further research is required to explore behavioural perceptions of standing in an office based work environment and the long-term adherence of behaviour change (Buckley et al., 2015).

Increased sitting time has been associated with elevated risk of mortality from all causes including cardiovascular disease (Katzmarzyk et al., 2009; Proper, Singh, van Mechelen, & Chinapaw, 2011; Wilmot et al., 2012) and reduced life expectancy (Katzmarzyk & Lee, 2012). Additional links to health impediments such as weight gain (Brown et al., 2005), some cancers (Gierach et al., 2009), type II Diabetes Mellitus (Hu, Li. Colditz, Willett,

& Manson, 2003; Proper et al., 2011), and breathing difficulties (Peeters, Burton, & Brown, 2013) have also been identified. Recent studies have demonstrated that a higher frequency of sitting time interruptions may reduce associated health risks such as high adiposity, and elevated triglyceride and plasma glucose levels (Buckley et al., 2014; Healy et al., 2008; Thorp et al., 2014b).

Recently the Australian Sedentary Behaviour Guidelines have been developed and recommend minimising the amount of time spent in prolonged sitting by breaking up long periods of sitting as often as possible (The Australian Department of Health, 2014). Although these generic guidelines have been developed and reduced/interrupted sitting time has produced benefits in health outcomes (Buckley et al., 2014; Healy et al., 2008; Thorp et al., 2014b), further investigation is required to determine the most appropriate behavioural strategies to encourage workers to adopt these guidelines. Previous literature has indicated that there are many factors contributing to behaviour change in a workplace such as cultural context, physical environment, and personal factors (Cole, Tully, & Cupples, 2015). Due to the range of potential contributing factors a 'one size fits all' approach to behaviour change in the workplace may be sub-optimal (Gilson et al., 2012). Gilson and colleagues (2012) highlighted that a variety of approaches that cater for individual worker preferences may be essential for successful reduction of occupational sitting time.

Previously, only a few studies have focused on the perceptions of office workers in preparation for sedentary behaviour change interventions (De Cocker et al., 2015; Gilson et al., 2011; Hadgraft et al., 2016). These studies have provided participants an opportunity to be involved in the decision-making process of behaviour change (Bandura, 1988). The participant inclusion may positively influence an individual's self-efficacy by incorporating

behavioural strategies which they perceive as being achievable (Bandura, 1988). Therefore, the aims of the current study were 1) to explore the relationship between sitting time and health as perceived by office workers; 2) to explore potential strategies to reduce sedentary behaviour in the workplace; and 3) to identify barriers which may limit the effectiveness of the strategies suggested.

2.3 Subjects and Methods

A convenience sample of full-time and part-time office workers who were employed at a large workplace across two regional cities in Australia were recruited via email for the study. The email was sent to all professional staff who performed administrative roles as defined by the workplace Enterprise Agreement (James Cook University, 2013) with non-administrative staff (for example, laboratory technicians) excluded from the study. The participants were invited to complete an online survey regarding workplace sitting time (Appendix A). One-hundred and forty workers (age: 40 ± 11 years; 114 females and 26 males; 110 full-time and 30 part-time employees; self-reported work hours: 8.6 ± 0.7 hr for full-time employees and 7.6 ± 1.3 hr for part-time employees) volunteered to participate.

Within the survey, participants were asked 'do you think there is a relationship between sitting time and your health' which required a 'yes' or 'no' response. Participants were then prompted to provide a free-text explanation of their response. This question was adapted from a previous study (Gilson et al., 2011).

After the survey responses were collected and analysed, further exploration was required to gain a richer understanding of the workers' perceptions. Survey responders were invited to participate in focus groups. The focus groups explored the concepts of sitting time and the relationship with their health, and practical methods to reduce occupational sitting

including potential workplace interventions and barriers. Focus groups have previously been used successfully to explore sedentary behaviour in an occupational setting (Cole et al., 2015; Gilson et al., 2011; Grunseit et al., 2013; Hadgraft et al., 2016), and are an effective method to highlight attitudes, group norms, and to allow for debate within a group surrounding specific topics (Kitzinger, 1995). Twelve (11 female, 1 male) participants volunteered for this phase of the study, representing approximately 10% of the survey population; and participated in one of two focus group sessions. The participants were 'naturally occurring' work groups, and the participant numbers (four and seven) in the focus group were considered to be appropriate (Kitzinger, 1995). Focus groups were facilitated by the principal investigator and were audio recorded for subsequent transcription.

The focus groups were semi-structured and lasted between 40 and 60 min. Examples of the open-ended questions asked during the focus groups are: do you think there is a relationship between sitting time and your health? What do you think you could do in your current work environment to change your sedentary behaviour? Based on the responses from the previous question, the group was asked if they could successfully achieve the suggested interventions, and whether they could identify any barriers to achieving the behaviour change. All questions were explored with additional discussion depending on the responses provided by participants.

2.3.1 Ethical approval Ethics approval for the study was obtained from the James Cook University Human Research Ethics Committee (approval number H5176; Appendix B). All participants were informed about the objectives of the research, and provided informed consent prior to participation via acceptance on the first page of the survey, to proceed with

the survey. Participants provided written consent for their participation in the focus groups.

      2.3.2 Analysis. The free text responses to the survey question about the relationship between sitting time and health, and the focus group transcriptions were analysed separately by two researchers via qualitative thematic analysis using the following process outlined by Braun and Clarke (2006): 1) familiarisation of data set; 2) generated initial codes; 3) searched for themes; 4) reviewed themes; and 5) defined and named themes. The themes were generated based on the content of the survey responses and focus group transcriptions in relation to the aims of the study. Responses which did not appear to answer the question asked were not included in the analysis.

2.4 Results

Eighty-eight percent of respondents perceived that there was a relationship between sitting time and their health. A total of 118 participants provided explanation about the relationship. One hundred responses indicated that more sitting time equated to worsening health outcomes. Five responses linked sitting time to rest and recuperation as a positive health outcome. Thirteen responses were excluded from the analysis due to lack of relevant information. Seventeen health themes were identified by thematic analysis from the survey responses; and the number of responses for each health theme is recorded in Table 2.1. Some responses identified multiple health themes therefore the total in Table 2.1 exceeds 118 (participant responses). The themes are presented in descending order of frequency and are described by quotes from the survey and the follow-up focus groups.

Table 2.1 Health themes identified from free text survey responses for the relationship between sitting time and health.

Health concern	Total responses
1. Musculoskeletal complaints/conditions/function	44
2. General health	32
3. Weight/obesity/BMI	30
4. Tired/fatigued/less energy	22
5. Circulation/cardiovascular health	19
6. Posture/biomechanics	11
7. Fitness/physical ability/stamina	8
8. Activity level	7
9. Boredom/motivation	7
10. Eye health	6
11. Mental health/depression	5
12. Headaches	4
13. Rest/recovery/relax	4
14. Metabolism	4
15. Wellbeing (physical and mental)	4
16. Concentration/alertness	3
17. Life expectancy	3

2.4.1 Musculoskeletal complaints, conditions, or function. Musculoskeletal complaints, conditions, or function was the most prominent health theme identified in the survey. The major contributors to this health concern was back complaints ($n = 21$) including back pain or stiffness, lower back pain, or an aching back, for example, *"sitting for long periods seems to put pressure on my lower back..."* (survey response). Other issues included neck complaints ($n = 10$), for example *"...Too much sitting at my computer increases level of neck/shoulder strain..."* (survey response) and decreased muscle tone or wastage ($n = 10$), for example, *"...My muscle tone is wasting..."* (survey response). Throughout the focus groups, the perception that a negative relationship existed between sitting time and musculoskeletal health was reiterated with the theme characterised by responses such as *"...I've found that certain muscles aren't being used so they're not strong and you sort of start to seize up..."* (focus group response).

2.4.2 General health. Following musculoskeletal complaints, general health was the next most commonly identified theme that was linked to sedentary behaviour. This suggests that participants believe that there is an association between increased sitting time and poor health. Often the theme was described as a generic statement such as *"the more I sit, the unhealthier I become"* (survey response), *"sitting for long periods is not good for your health"* (survey response), *"the more you sit, the more unhealthy you are"* (survey response), or *"when you're sitting for long periods of time, it doesn't help your body - the older you get too"* (focus group response). More specifically, some participants linked sitting time with poor health outcomes such as cardiovascular disease or diabetes which was characterised by responses such as, *"there is a direct relationship between time spent sitting (i.e. immobile) and increased risk of health problems including cardiovascular disease, joint/muscle*

problems, circulatory problems, weight gain, fatigue" (survey response).

2.4.3 Weight gain/obesity/BMI. Participants described the emergent theme of weight gain/obesity/BMI as a health concern and this was characterised by responses such as *"since my job has become more sedentary I have put on a lot more weight"* (survey response), *"the more sedentary I am, the greater the excess weight I carry, the higher risk I have for health problems like heart disease and diabetes"* (survey response), *"I have had significant weight gain (about 10 kg) since being employed in a 'desk job'…"* (survey response), and *"[the impact of sitting has a] bad impact on your bum"* (focus group response).

2.4.4 Other identified themes. Participants indicated that feeling tired, fatigued, or having less energy was a result of sedentary behaviour and was characterised by responses such as *"sitting too much can cause me to be unmotivated and make me very lethargic…"* (survey response), and *"…I think you mellow out. When you sit down for a long time, you just feel like you don't want to do any work…"* (focus group response). The health theme of circulation and cardiovascular health received similar response rates and was characterised by responses such as *"I believe sitting for long periods is bad for my circulation"* (survey response), and *"I think the effects of [sedentary behaviour] are physical and psychological. Physical in many ways so that could be temporalised health in terms of your circulation and that has literally flow on effects"* (focus group response). Posture and/or biomechanics was identified and characterised by responses such as *"[sedentary behaviour] will cause stress on your spinal cord and causes bad body posture"* (survey response).

2.4.5 Identified behavioural strategies. The focus groups explored potential interventions whereby the participants were asked to provide ideas that could be implemented

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into their workplaces to reduce sitting time. A variety of lower-cost options were identified. Alarms or alerts to stand were suggested such as *"I'd like a message telling me to stop and have a stretch"* (focus group response). Using computer software which freezes the computer for a selected period of time was suggested, for example *"I think [organisation] has a computer program that shuts down your computer and stops you from being able to go on and work for a couple of minutes so you actually have to go and do something"* (focus group response). Participants also suggested standing during or walking to meetings such as *"…all of our meetings should be stand up and they won't take so long"* (focus group response). Having cordless phones and having office competitions aimed at reducing sitting time was also identified, as characterised by responses such as *"a competition, I think, would be a good way to get people start"* (focus group response). Removing chairs from the morning tea rooms so that everyone must stand during their breaks was also mentioned. Other higher-cost suggestions for reducing sitting time included standing desks and having portable devices to work at *"a standing desk"* (focus group response) which was followed promptly by another participant suggesting there is a need to be able to transition between sitting and standing if required, characterised by the response *"or the ability to go between as required"* (focus group response).

Additionally, participants suggested that education would assist in reducing sedentary behaviour in the workplace. This was characterised by responses such as, *"I think it's a bit about education, like educating people that [reducing sedentary behaviour] is beneficial for them"* (focus group response). Participants also suggested that they need to feel supported by managers or the organisation in changing their behaviour. Example responses included, *"it needs to come from, or people up the top need to understand it first and what the benefits are*

to us…" (focus group response), *"the education might have to start at the top [of the organisation]"* (focus group response), *"so [managers] are not wondering why you're taking extra-long because you're taking breaks…"* (focus group response), and *"the 'smoke break' thing is really frowned upon so, you know, getting up and going for a walk or you know going and having a conversation with someone, will be on the same par"* (focus group response).

2.4.6 Barriers. Most of the intervention ideas were met with barriers for success. For example, when one participant suggested *"we could take all of the chairs out and we'd stand there and eat rather than sit"* another participant remarked that *"they would just sit on the [table]"*. A participant suggested to *"set an alarm every hour or so"* however when asked if that would be functional for everyone to use an alarm or prompt another participant said *"I guess it depends on what you are doing. If the prompt comes up and I'm right in the middle of doing something that needs to be done, then no. But if I had the time, yes"* (focus group response). Similarly, walking meetings were discounted as *"it's too hot to do that, you'd have to do it internally, you wouldn't be able to do it externally as meetings usually have to be confidential"* (focus group response). Interestingly, two participants indicated that sitting was considered positive due to previous work experience and the chance to rest after exercise, *"I've gone from a standing up for 10 hr a day job, so I enjoy the sitting…"* (focus group response) and *"if I'm exercising a lot, I like to sit down at work because I'm sore"* (focus group response). Incorporating the higher-cost option of standing desks was met with *"I wouldn't like that"* (focus group response), *"I would end up with a back ache"* (focus

group response), and *"I don't think I could handle standing up all day"* (focus group response).

2.5 Discussion

Overall, the majority of participants perceived a negative relationship between sitting time and their health with musculoskeletal complaints identified as the most prominent health concern followed by general health, and weight gain/obesity/BMI. The focus group responses suggested that for an intervention to be successful, it should include education on the benefits of reducing sedentary behaviour, and if an intervention was implemented, participants indicated that they require the behaviour change to be normalised by management. Specific intervention strategies identified in the focus groups included computer software, walking or standing meetings, cordless phones, adjusting furniture, and office competitions however the most prominent strategy surrounded education.

Gardner et al. (2016) suggest that an intervention which is targeting the reduction of sedentary behaviour should include education. While some participants suggested that they preferred to sit as they were sore from exercising or that they enjoyed sitting, the lack of knowledge surrounding sedentary behaviour may influence their decisions. Tasdemir-Ozdes, Strickland-Hughes, Bluck, and Ebner (2016) highlighted that our beliefs about future health related events can influence or motivate behaviour change, and therefore the participants may not perceive that sedentary behaviour can lead to poor health outcomes such as cardiovascular disease (Katzmarzyk et al., 2009; Proper et al., 2011; Wilmot et al., 2012, weight gain (Brown et al., 2005), some cancers (Gierach et al., 2009), type 2 Diabetes (Hu et al., 2003; Proper et al., 2011), and breathing difficulties (Peeters et al., 2013). These

statements reinforce the notion that education is imperative when implementing an intervention.

Owen et al. (2014) suggest there is a potential link between social support, role modelling, and social norms, and the development of chronic diseases attributable to increased sedentary behaviour. This is especially true when dealing with work environments as social norms can influence the feasibility of interrupting or reducing sedentary behaviour in a workplace (Hadgraft et al., 2016) and therefore influence an individual's self-efficacy (Bandura, 1988). There is often a perceived need to justify absences from the desk or computer (Hadgraft et al., 2016) with a concern of being viewed as not completing set tasks if not seated at a computer (Gilson et al., 2011). The current study reports similar findings as the participants indicated that they want breaks in sedentary behaviour to be a normal activity in the workplace without receiving criticism for being away from their desk which requires support from management and/or the organisation. Previous literature has highlighted that there needs to be a shift in culture within a workplace to support short breaks without criticism (Cole et al., 2015). Based on the current findings and previous literature (Cole et al., 2015), there needs to be support to reduce or interrupt their sitting time and create a work social environment that is accepting of changing sedentary behaviour, with short breaks being encouraged by managers and/or the organisation.

Although the participants identified some ideas including external prompts such as alarms, short standing or walking meetings, and/or computer software for reducing or interrupting sedentary behaviour in the workplace, many of the suggestions were discounted due to a number of barriers highlighting that there are many individual preferences to achieving successful behaviour change. This finding suggests that a 'one size fits all'

approach to behaviour change will be unlikely to succeed due to personal preferences (Cole et al., 2015; Gilson et al., 2012), which suggests multiple options should be offered in the intervention (Gardner et al., 2016). Therefore, future interventions should include a variety of strategies that are individually-tailored (Marcus et al., 1998; Marcus et al., 2007) to match the level of willingness to engage in behaviour change (Prochaska & DiClemente, 1983), and to provide the opportunity for participants to contribute to the development of the intervention as it may lead to the perceived control of the behaviour being targeted (Bandura, 1997).

The current study has limitations, such that the findings may only be representative of people working in regional Australia, the specific workplace, and those who agreed to participate as they may be aware of some of the health implications of sitting compared to those who did not participate in the study.

2.6 Conclusions

Office workers were actively involved in the decision-making process of planning for an intervention targeting the reduction of sedentary behaviour. The workers perceived that sitting time negatively affected their health with the majority of responses related to musculoskeletal complaints, general health, and weight gain/obesity/BMI. The findings suggest that an intervention targeting reducing sitting time should include education, having supportive managers which will contribute to changing the social norms of the workplace, and having multiple strategies to address personal preferences could be implemented in this specific workplace however similar research is required for other worksites prior to implementing a workplace intervention to reduce sitting time.

Chapter 3

Successful sedentary behaviour change in the workplace: perspectives of successful self-changers.

3.1 Abstract

Aims: This study aimed to explore the perceptions of office-based workers who have successfully modified their occupational sedentary behaviour. In particular, the aims of the current study were to identify the stage of change of individuals who have modified their occupational sedentary behaviour; to explore behaviour change strategies and processes used to reduce sedentary behaviour in the workplace; and to explore barriers to behaviour change.

Methods: A qualitative in-depth interview design was used for this study. Participants were recruited from a higher education institution who regularly undertook office-based tasks during work hours. Participants were invited to participate in a semi-structured interview if they currently self-identified as modifying their occupational sedentary behaviour in any way. The interviews were audio recorded and transcribed verbatim. The transcriptions were thematically analysed to identify key themes.

Results: Nine participants volunteered for the study. All participants were in the action or maintenance stage of the TTM. A variety of strategies were incorporated by the participants to reduce occupational sedentary behaviour such as a sit-to-stand workstation including specific strategies around how the workstation was used, purposeful walking, and peer and managerial support. The participants identified barriers to success such as soreness, fatigue and illness, attending seated meetings, not enough desk space, and work tasks requiring concentration.

Conclusions: The participants who were in the action or maintenance stage utilised a variety of strategies and processes to modify their occupational sedentary behaviour however barriers were also identified.

3.2 Introduction

The TTM (Stages of Change Model) (Prochaska & DiClemente, 1982) has been suggested as an appropriate framework to evaluate chronic behavioural risks such as sedentary behaviour (Marcus & Simkin, 1994). The stages of change include pre-contemplation, contemplation, preparation, action, and maintenance (Prochaska & Velicer, 1997). The stages are cyclical in nature (Prochaska et al., 1992) and therefore it may take an individual multiple attempts to change their behaviour and successfully move through to the maintenance stage (Marcus & Simkin, 1994). The pre-contemplation stage is where an individual has no intention to change their behaviour, while contemplation is where an individual is aware that a problem exists and they are considering ways to change their behaviour but have not yet taken action (Prochaska et al., 1992). The preparation stage involves the intention to take action within the next month and there may have been previous unsuccessful attempts to take action in the past (Prochaska et al., 1992). The action stage is achieved when an individual adopts behaviour change over a period of one day to six months (Prochaska et al., 1992). Finally, the maintenance stage is a continuation of adoption of the modified behaviour where an individual aims to prevent a relapse (Prochaska et al., 1992).

Transitioning between the stages of change requires the use of behavioural or experiential processes to modify behaviour (Cassidy, 1997). Self-liberation, contingency management, helping relationships, counter conditioning, and stimulus control are the most prominently used processes when transitioning into the action and maintenance stages

(Prochaska et al., 1992). In addition to the processes of change, individuals are likely to

undertake and continue with behaviour change if they have perceived control and intention to

change their behaviour (Ajzen, 2012). Individuals also need to perceive that they can

confidently perform the desired task or behaviour (Bandura, 1988). Furthermore, successful

behaviour modification can occur with or without expert advice (Prochaska et al., 1992). A

variety of social and/or physical environmental factors may become barriers to achieving

behaviour change success (Weinberg & Gould, 2015), and therefore should be taken into

consideration when assisting individuals who are attempting to change behaviour.

Sedentary behaviour is linked to an increased risk of diabetes, cardiovascular disease,

cardiovascular mortality, and all-cause mortality (Wilmot et al., 2012), and has been

identified as an emerging public health concern particularly in the workplace setting (Dunstan

et al., 2013). The workplace is considered to be a promising environment to change

sedentary behaviour due to the existing community framework (Das et al., 2016). Promising

behaviour change strategies to reduce occupational sedentary behaviour include self-

monitoring of behaviour, environmental changes, instructions on how to perform the

behaviour, reviewing goals, and providing information on health consequences and behaviour

(Gardner et al., 2016). Some strategies can be implemented successfully as a result of self-

change which occurs when individuals implement their own strategies to change behaviour or

seek advice without formal treatment or therapies (Cowen, 1982). Although successful self-

change has previously been investigated for other health concerns such as smoking (Cohen et

al., 1989; DiClemente & Prochaska, 1982) and alcohol consumption (Witbrodt, Borkman,

Stunz, & Subbaraman, 2015), there is limited literature which explore how self-changers in

the workplace setting successfully changed their sedentary behaviour without organisational intervention.

The aims of the current study were to 1) identify the stage of change of individuals who have modified their occupational sedentary behaviour; 2) explore behaviour change strategies and processes used to reduce sedentary behaviour in the workplace; and 3) explore barriers to behaviour change.

3.3 Methods

A qualitative semi-structured interview design was used for this study to explore the perceptions of office-based workers who have modified their occupational sedentary behaviour. Prior to data collection, ethics was obtained from the James Cook University Human Research Ethics Committee (approval number H6506; Appendix C). Participants who regularly undertook office-based tasks during work hours were recruited from a higher education institution. An email was sent to recruit participants and a snowball effect occurred. Participants were invited to participate in a semi-structured interview (Gill, Stewart, Treasure, & Chadwick, 2008) if they currently self-identified as modifying their occupational sedentary behaviour in any way. Semi-structured interviews were used as they can provide an insight into participant thoughts and experiences (Peters & Halcomb, 2015). Participants were provided with an information sheet and if they volunteered to participate, written informed consent was obtained.

3.3.1 Participants. Participants were individually interviewed by the first author to ensure consistency between interviews. The interviews were a maximum of 30 min in duration. The participants could withdraw from participating in the interview at any stage without prejudice or explanation. The interview topics included identifying their stage of

change, initial prompts to change behaviour, general understanding of sedentary behaviour, strategies used to reduce sedentary behaviour in the workplace, and any barriers which hampered the behaviour change. The interview questions included: do you think occupational sedentary behaviour is a problem for you at the moment? When do you intend to change your occupational sedentary behaviour? Both questions have been adapted from Prochaska et al. (2013). These questions were asked to determine that participants were in the action or maintenance stage, and the recommendation of 2-4 hr/work day of non-sitting time as outlined by Buckley et al. (2015) to identify successful behaviour change. To explore successful behaviour change, participants were asked to explain 1) what prompted them to change their previous sitting patterns; 2) their knowledge or understanding of sedentary behaviour; 3) the specific strategies that they use to reduce their occupational sedentary behaviour; and 4) the barriers which may impact upon their behaviour change. Further exploration of the participant's behaviour modification depended on the responses to the questions above.

3.3.2 Analysis. For the purpose of this study, successful behaviour change was considered to be when a participant met or exceeded the recommendation of reducing sedentary behaviour by 2-4 hr/day in the workplace (Buckley et al., 2015). The interviews were audio recorded and transcribed verbatim. The transcriptions were thematically analysed to identify key themes following the procedures as outlined by Braun and Clarke (2006). Results are presented as themes with examples provided as direct quotes in text.

3.4 Results

3.4.1 Participants. Nine participants (eight female) volunteered for the study. Of the nine participants, five were in the action stage as they had modified their behaviour for

between one day and six months. Two participants were in the maintenance stage as they had changed their behaviour for longer than six months without relapse; and two participants had recently recommenced the action stage following a relapse. For one participant, relapse had occurred due to an injury which prevented the participant from standing frequently, while the other participant had relapsed due to low mood associated with a tragic event. All participants were included in the analysis as they were considered successful self-changers by meeting the recommendation as outlined by Buckley et al. (2015).

3.4.2 Duration of behaviour change. The average timeframe of the participants' behaviour change was 35 ± 28 weeks, ranging from 10 to 104 weeks. Prior to the participants' behaviour change, the average self-reported sitting time was 7.5 ± 1.3 hr (range $6 - 10$ hr) per work day. The participants self-reported that they had reduced their sedentary behaviour by 4.6 ± 1.1 hr/work day (average work day 7.8 ± 1.3 hr, range 6 - 10 hr) through a combination of increased standing and/or walking.

3.4.3 Initial prompt to change behaviour. There were four themes identified regarding what prompted the participants to change their behaviour, and these were: 1) musculoskeletal complaints; 2) referral from a medical professional or close associate to purchase a sit-to-stand workstation; 3) perception of high amounts of sedentary behaviour; and 4) access to a sit-to-stand workstation.

The musculoskeletal complaint theme was characterised by responses such as:

"… I was getting a lot of sciatic pain and that was coming mainly from sitting down for anything over an hour." (Participant 4)

"I use to get a lot of back pain with prolonged sitting at work…" (Participant 1)

"I have lower back issues, well a lot of lower limb issues so standing resolves that a lot." (Participant 6)

"I don't have the best back, and sitting down made it quite uncomfortable and I just thought I'd try standing up and see how it would go and if it would help me in my daily life…" (Participant 7)

The referral from a medical professional or close associate to purchase a sit-to-stand workstation theme was characterised by responses such as:

"Well my sister has one, she works down in Brisbane and she had recommended them to me…" (Participant 2)

"My doctor actually suggested that I got the desk in the first place…" (Participant 4)

The perceptions of high amounts of sedentary behaviour theme was characterised by responses such as:

"It was being aware of the reduced number of steps during the day when I'm at work. And sitting in a lot of meetings as well so you become very aware of how much sitting you're doing in those situations, but because my work is predominantly at the computer, I've noticed it." (Participant 9)

"I was already aware of [my sedentary behaviour] and I had already tried sitting on an exercise ball for a while, and I didn't find that that made any difference at all…" (Participant 3)

The access to a sit-to-stand workstation theme was characterised by responses such as:

"There were other colleagues in the hallway who had [sit-to-stand workstations], so when the opportunity was afforded to me, I was very grateful and yes love it." (Participant 8)

"The [sit-to-stand workstation] was there to stand up and if you get a sore back, you just stand up." (Participant 5)

3.4.4 Understanding of sedentary behaviour. The participants were asked to explain their understanding of sedentary behaviour. Five participants reported they were aware of the potential deleterious health implications of increased sedentary behaviour. The responses varied but generally included a specific health outcome, such as:

"…There's the reported links of sedentary behaviour causing many different chronic conditions I guess the big one being obesity and I guess cardiovascular type diseases so for me personally, musculoskeletal conditions." (Participant 1)

"The human body was never designed to be sedentary and that's out biggest problem. We've evolved over hundreds of thousands of years to a point where we're supposed to be active all the time and in such a short period of time for us to become so sedentary we're going to have an enormous burden of disease, and we're seeing it already aren't we." (Participant 9)

"I know that it's good for metabolism not to be seated as well as the posture and concentration at work." (Participant 3)

Four participants suggested they had limited knowledge of sedentary behaviour which was characterised by responses such as:

"I would classify myself as very low knowledge. I know it's good for you, to not be sedentary all of the time…" (Participant 8).

"Probably not a huge knowledge base. I know that there were a lot of articles that came out at the time in peer reviewed journals... I think I read one..." (Participant 2)

To explore the understanding or knowledge surrounding sedentary behaviour, participants were asked if they perceived any health benefits of reducing sedentary behaviour with three themes noted. The themes included reduced musculoskeletal pain, improved musculoskeletal function and increased alertness.

Reduced musculoskeletal pain included back pain, neck and shoulder pain, lower limb pain and sciatic pain, and was characterised by responses such as:

"Certainly, less incidence of back pain and kinked neck, that's been quite a substantial change for me" (participant 1).

"When I'm [using the sit-to-stand workstation], I [don't] have as many aches and pains... I use to get a bit of lower back pain, or ache but I think that when I stand its better." (Participant 2)

"I think that reduced pain is certainly a great benefit of it." (Participant 4)

Improved musculoskeletal function included improved posture and/or movement which was characterised by responses such as:

"For me I found that it just makes me concentrate on my posture and I'm less slumped over a desk..." (Participant 6)

"[My poor posture] doesn't seem to be as bad. Don't know if you sort of hold yourself a bit differently [when standing]." (Participant 5)

"I don't have the best posture when I'm sitting so standing corrects that a little bit."
(Participant 7)

"You find yourself swapping from one foot to the other, and it's just that slight movement does add up over the course of the day." (Participant 8)

Increased alertness which included feeling less tired or less sluggish was characterised by responses such as:

"The key thing is you get that slump at 2:30/3pm, and I've found that I don't have that anymore, I'm feeling more alert at that time of the afternoon, whereas I use to get quite sluggish. So, I think that might be one of the bigger things for me, standing is just the feeling a bit more alert and not getting that slump in the afternoon." (Participant 7)

"I probably don't feel like I need to have a sleep at three o'clock in the afternoon."
(Participant 1)

3.4.5 Behaviour change strategies. The behaviour change strategies which were incorporated by multiple participants included a sit-to-stand workstation including specific strategies around how the workstation was used, purposeful walking, and peer and managerial support.

The incorporation of a sit-to-stand workstation and specific use strategies was characterised by responses such as:

"I try to stand for at least two or three hr, and then I might sit…. Then I leave here just after 4[pm] so I try to stand for that last part." (Participant 6)

"I kind of just leave it set up the day before, when I leave so I don't come in in the mornings and sit down straight away." (Participant 3)

"I stood for most of the afternoon but sometimes for 10 or 15 min on and off [I] just keep swapping" (Participant 5)

The purposeful walking behaviour change strategy was charaterised by responses such as:

"I do also try to go for walks occasionally throughout the day, whether that be to a meeting or just walking for the sake of stretching the legs" (Participant 1)

"I'll walk down the hallway, or whether it's a bathroom break, I'll take my coffee cup to the bin, or whatever it happens to be, go to the printer... That's a walking break." (Participant 8)

Peer and managerial support was characterised by responses such as:

"[Colleague] raised the idea of getting a [sit-to-stand desk]" (Participant 8)

"It's been good having someone else in the same office doing it..." (Participant 3)

"Some people in the [work area] bought [sit-to-stand workstations], and I think [colleague] thought that'd be a good idea and they had some extra money so [colleague] put it to [manager] to buy them for us." (Participant 2)

3.4.6 Barriers to successful behaviour change. Barriers to reducing sedentary behaviour were identified, and included: soreness, fatigue, and illness; attending seated meetings; not enough desk space; and work tasks requiring concentration.

The soreness, fatigue, and illness theme was characterised by responses such as:

"My heels of my feet would be sore by the end of the day." (Participant 7)

"…the only time at work where I won't have [the sit-to-stand workstation] up is if I'm unwell or have a cold or something like that…" (Participant 9)

However, participants also identified that having an anti-fatigue mat reduced the negative effects which was characterised by responses such as:

"The mats we only got recently, a couple of weeks ago and they made a huge difference. Standing of the hard floor was yeah, killer but those mats that are designed to take away all that pressure so it's a lot better." (Participant 6)

"I have the [anti-fatigue] mat…it works very well" (Participant 4)

Attending seated meetings was characterised by responses such as:

"Typically when people come for meetings, they have lots of paperwork to go through so it's an expectation that we'll be sitting at a table where they can go through the paperwork." (Participant 1)

"I'm in and out of meetings where I go and sit on my backside for an hour or something like that and then come back [to my office] for an hour, half an hour, maybe two hr, and then go again." (Participant 4)

Not having enough desk space was characterised by responses such as:

"[Not] being able to utilise the desk space, is probably the only downfall of it." (Participant 7)

"…The only disadvantage is not being able to fit the phone on [the sit-to-stand workstation] as well." (Participant 9)

Having work tasks which require concentration was characterised by responses such as:

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"The only time I drop [the sit-to-stand workstation] down and use the chair is when I'm doing some fairly intricate or complicated spreadsheets and stuff like that." (Participant 4)

"I do sit down to proof read, so when I proof reading something I find that I need a printed-out version, I can't do that on the screen, and the space on my workstation doesn't allow me to do that. So I find that I print something out and I'll sit at an alternative table take myself away from that workspace and read away from the computer and away from that desk." (Participant 8)

3.5 Discussion

The current findings provide evidence that for this cohort of office-based workers, sedentary behaviour patterns can be successfully changed by utilising a variety of strategies to meet the guidelines of standing or moving for 2-4 hr/per day (Buckley et al., 2015). Successful self-changers are likely to achieve their desired behaviour change if they select the most effective processes at the relevant stage within the TTM (Prochaska et al., 1992). Based on the findings of the interviews, the self-changers were successful in changing their sedentary behaviour habits even if they had experienced a relapse during the action stage, with some participants entering the maintenance stage of the model (Prochaska & Velicer, 1997). This is likely due to the implementation of behavioural processes to modify their behaviour. Consciousness raising occurred as participants reported an understanding of sedentary behaviour either from knowledge they may have acquired or from their own personal experiences (Prochaska, Velicer, DiClemente, & Fava, 1988). Self-liberation was evident through the participants choosing their own strategies to reduce sedentary behaviour (Prochaska et al., 1988). The participants exhibited stimulus control by restructuring their environment to include sit-to-stand workstations (Prochaska et al., 1988). Additionally, it

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was identified that participants received support from helping relationships (Prochaska et al., 1988) either from a manager as financial support or close associates as they were influential in the request for a sit-to-stand workstation, or provided encouragement to continue with the behaviour change. Furthermore, as all participants determined their own behavioural strategies to implement, they are likely to continue with the chosen behaviour as they had perceived control of the changes (Ajzen, 2012; Rollo et al., 2016), and were capable of achieving the desired outcome (Bandura, 1988; Rollo et al., 2016).

Successful behaviour change occurred as a result of all participants having access to a sit-to-stand workstation, with the workplace sourcing and funding the workstations with support obtained from managers. Sit-to-stand workstations have previously shown promising results for decreased sedentary behaviour in occupational settings (Grunseit et al., 2013; Neuhaus, Healy, Dunstan, Owen, & Eakin, 2014a), however the workstations are considered to be resource intensive (Neuhaus et al., 2014a), and may be prohibitive for workplaces to provide new equipment to all staff (Cooley & Pedersen, 2013). Due to the costs associated with the purchasing and installation of the sit-to-stand workstations it may reduce the applicability of this behaviour change strategy to all workplaces or interventions. Purposeful walking was the most common lower-cost option identied by the participants. The participants incorporated walking to visit colleagues, walking to meetings, and going for a walk to avoid extended bouts of sitting. This strategy is not resource intensive and strategies including stair walking and walking meetings have previously been suggested to reduce occupational sitting (Commissaris et al., 2016; Straker, Coenen, Dunstan, Gilson, & Healy, 2016). Walking or walking meetings may therefore be a viable, low-cost alternative to the sit-to-stand workstations for reducing sedentary behaviour in the workplace.

The most prominent barrier to reducing sedentary behaviour in the workplace was soreness, fatigue, and illness, and in particular, having sore lower limbs due to the hard floor. The lower limb soreness was overcome by the participants purchasing an anti-fatigue mat which reduces discomfort (King, 2002). The participants acknowledged the barrier however they modified their environment which suggests they were incorporating stimulus control (Prochaska et al., 1988) to ensure they could successfully continue with their behaviour change. This aspect also required managerial support as they were involved in the purchasing process, which may be considered to be a helping relationship (Prochaska et al., 1988).

The reduced desk space of the sit-to-stand workstations also appeared to be a barrier. Previous literature has also indicated that sit-to-stand workstations can be awkward and uncomfortable (Leavy & Jancey, 2016), which suggests job tasks need to be considered when purchasing new office equipment such as a sit-to-stand workstation. Having the ability to go between a standing and sitting position may be useful to account for tasks which require concentration, therefore a workstation that enables easy transition is recommended. Similarly, Leavy and Jancey (2016) suggested that complex tasks are difficult to complete in a standing position. Standing based work should be interrupted just as sitting based work should be (Buckley et al., 2015) which provides an opportunity to plan work tasks so that the tasks which participants perceived as 'seated' tasks could be used to interrupt prolonged standing bouts.

It is likely that social norms may be an influential factor (Hadgraft et al., 2016) when addressing the barrier related to the sitting culture in meetings. Das and colleagues (2016) suggest that encouragement and incentives may assist when implementing standing meetings,

and standing breaks during meetings could be included to change the social norms of the workplace. Additionally, a workplace champion who can model the behaviour and encourage others may be a suitable strategy (Healy et al., 2016). Having a workplace champion or model, can assist in increasing an individual's self-efficacy levels through vicarious experiences (Bandura, 1977). By observing the model, the individual will see that there are no adverse effects of participating in the behaviour change and if they too persist with their behaviour change they will see improvements (Bandura, 1977).

This study offers interesting insights into successful self-change of sedentary behaviour in the workplace however there are some limitations. These include that the findings may not be representative of other workplaces or behaviour change strategies due to the small sample size which is predominantly female. Even though the study investigated successful self-changers for this particular area of interest, it does not necessarily mean that they are or will be more successful than others who may follow a formal intervention (Cohen et al., 1989). A clear distinction between strategy use for the different stages of change cannot be drawn from the current study. Therefore, further sedentary behaviour change research could examine all stages of change in regards to strategies utilised with an increased sample size. Future research could investigate successful behaviour change surrounding sedentary behaviour in various workplace settings and strategies to overcome perceived barriers. Additonally, future research could evaluate the effectiveness of workplace interventions via qualitative methods to gain a deeper understanding of the behavioural strategies implemented by participants.

3.6 Conclusion

The results of the current study suggests that successful behaviour change can occur in an occupational setting for people who have motivations or intentions to change, and who have control over their strategies which they perceive they are capable of achieving. The participants who were in the action or maintenance stage utilised a variety of proccesses such as conciousness raising by having an understanding of the effects of sedentary behaviour or the benefits of standing, self-liberation by being involved in the decision making process, stimulus control by changing the environment and having helping relationships such as supportive managers or colleagues. Further research is necessary to explore successful change in other work environments including strategies to overcome perceived barriers.

Chapter 4

The use and evaluation of a theory-informed, low-cost, individually-tailored, multi-component intervention to reduce sedentary behaviour in the workplace

4.1 Abstract

Background: Occupational sedentary behaviour is a growing health concern with occupational sitting accounting for almost half of overall sedentary behaviour. Multi-component interventions are considered to be an effective method to reduce occupational sedentary behaviour. The aim of the current study was to evaluate the effectiveness of a theory-informed, personalised intervention for the reduction of occupational sedentary behaviour of office workers.

Methods: Full-time office-based workers were invited to participate in the study. Participants were asked to complete an online survey to explore their perception of sedentary behaviour. Following this, pre-intervention behaviour patterns were collected for five days via an ActivPAL™ and a self-report workbook. The participants had a face-to-face meeting with the investigator to discuss information surrounding the key themes identified from the online survey and the individual ActivPAL™ and self-report data. During this meeting, participants set goals for the six week intervention, signed a commitment contract and were asked about their stage of change and their self-efficacy to change behaviour. Participants were provided

with another self-report workbook which included their goals for the six week intervention. Participants received a weekly check in from the investigator. During the final week of the intervention, participants wore an ActivPAL™ and were invited to participate in a follow-up interview. Open-ended responses from the online survey, the individual weekly goals and the post intervention interviews were transcribed verbatim and were thematically analysed. ActivPAL™ data, self-reported workbook sitting time and self-efficacy was analysed via paired samples t-tests.

Results: Twenty-seven office based workers participated in the study. Occupational sitting time was reduced by an average of 45.2 ± 60.7 min/work day based on ActivPAL™ data. Self-efficacy increased post intervention (pre: $69 \pm 21\%$; post: $82 \pm 16\%$). The follow-up interviews indicated that the intervention increased awareness of occupational sedentary behaviour and provided insight into the key behaviour change strategies utilised in the intervention.

Conclusions: The theory-informed, goal-based, personalised intervention resulted in reduced occupational sedentary behaviour, increased awareness of sedentary behaviours and an increase in self-efficacy to change sedentary behaviour patterns.

4.2 Introduction

Occupational sedentary behaviour is considered to be an emerging public health concern (Chu et al., 2016; Dunstan et al., 2013). The workplace is an ideal setting to reduce sedentary behaviour (Bennie et al., 2015; Chu et al., 2016; Das et al., 2016) as occupational sedentary behaviour contributes to a large proportion (49%) of overall sitting time (Parry & Straker, 2013). Prolonged sitting is associated with many detrimental health outcomes (Katzmarzyk et al., 2009; Katzmarzyk & Lee, 2012) however emerging evidence suggests that some of

these health concerns may be attenuated by reducing sedentary behaviour. For example, desk-based workers decreased their postprandial blood glucose excursion following 3 hr of standing with additional energy expenditure compared to sitting (Buckley et al., 2014). As a result of positive health outcomes associated with interrupting and reducing sedentary behaviour, Buckley and colleagues (2015) suggest individuals who are employed in predominantly desk-based occupations should work towards achieving 2 hr/day of standing or moving during work hours, gradually progressing to 4 hr/day during work hours.

To address the increasing risk of occupational sedentary behaviour, a variety of interventions and strategies have been investigated with varying results. A recent review (Chu et al., 2016) suggests that a multi-component intervention including some behavioural, and educational, and environmental components are the most effective when addressing workplace sedentary behaviour.   Behavioural and educational strategies include motivational interviewing, goal setting, self-monitoring behaviour, providing information about the consequences of the behaviour, and prompts or cues (Chu et al., 2016; Gardner et al., 2016). The most effective environmental change is to introduce sit-to-stand workstations or other movement-based changes such as a treadmill desk (Chu et al., 2016). Although environmental changes produce significant reductions in sedentary time (Alkhajah et al., 2012), there is a cost associated with installing sit-to-stand workstations (Neuhaus et al., 2014a) and therefore it may not be feasible for workplaces to retrofit their work environments. Furthermore, Biddle and Bennie (2017) suggested that further research is needed to explore alternative options to reduce sedentary behaviour. Additionally, it has been suggested that a larger number of behaviour change strategies (7 ± 5 strategies) are associated with successful behaviour change (Gardner et al., 2016).

The majority of the existing literature surrounding sedentary behaviour does not explicitly map the theoretical frameworks to the development and implementation of the intervention strategies (Gardner et al., 2016; Prapavessis et al., 2015; Rhodes et al., 2012). Presumably previous research has referred to behaviour change theoretical frameworks for example, environmental changes such as sit-to-stand workstations or activity-permissive workstations are likely to be considered as being related to the perceived behavioural control constructs of the TPB and SCT, whereby participants have perceived control over their sitting time in the workplace. Therefore, while not explicitly outlined within most studies, the strategies can be assumed to have been developed as a result of prior theory-based planning. There is however limited evaluation of the strategies or intervention outcomes in terms of their overarching frameworks. Such evaluation may be particularly useful as theoretical frameworks can be used to explain the likely processes and mechanisms of a desired behaviour change (Gardner et al., 2010). Planning prior to implementing behaviour change interventions should consider the following components: capability, opportunity, and motivation (Michie et al., 2011). Modifications to one or more of the components can lead to potential behaviour change (Michie et al., 2011). To explain the components further, capability relates to the ability to modify behaviour, opportunity relates to external factors which can make the behaviour change possible, and motivation refers to the internal factors which can influence behaviour change (Michie et al., 2011).

Some emerging literature has begun to include theoretical frameworks in the planning and evaluation stages of sedentary behaviour interventions (Hadgraft et al., 2017; Neuhaus et al., 2014b). The TPB has recently been utilised in sedentary behaviour research (Umstattd Meyer et al., 2016). The premise of the TPB involves attitude, subjective norms, and

perceived behavioural control which can influence an individual's intentions to change

behaviour (Ajzen, 1991). Prapavessis et al. (2015) suggests that the TPB is relevant to the

intentions of sedentary behaviour linking attitudes to the perceived cost or benefits of sitting,

subjective norms by the expectations of others in regards to sitting, and perceived behavioural

control as the control over time spent sitting. Additionally, the SCT has been used as the

framework for a sedentary behaviour intervention (Hadgraft et al., 2017). The SCT proposes

that behaviour is a purposeful action and is under the control of an individual where self-

reflection and self-regulation occurs (Buckworth et al., 2013). The SCT involves developing

skills through mastery modelling, strengthening a person's self-efficacy, and enhancing

motivation through goal setting (Bandura, 1988). Hadgraft et al. (2017) suggested that future

interventions should consider perceived behavioural control strategies such as brainstorming

sessions for participants to identify opportunities to reduce sitting time, or installing sit-to-

stand workstations, and self-efficacy strategies such as goal setting or problem solving when

developing workplace interventions to reduce sedentary behaviour.

The TTM (Prochaska & DiClemente, 1982) is another appropriate framework to

explore sedentary behaviour (Marcus & Simkin, 1994) as intervention strategies can be

tailored to the relevant stage of change (Prochaska et al., 1992). The stages of behaviour

change include precontemplation, contemplation, preparation, action, and maintenance

(Prochaska et al., 2013). To progress through the stages a variety of processes can be applied

such as consciousness raising, dramatic relief, self-re-evaluation, environmental re-

evaluation, self-liberation, social liberation, counter-conditioning, stimulus control,

contingency management, and helping relationships (Prochaska & Velicer, 1997). The most

prominently used processes in the action and maintenance stages include self-liberation,

contingency management, helping relationships, counter conditioning, and stimulus control (Prochaska et al., 1992). Additionally, for successful behaviour change to occur an individual needs to have self-confidence that they can successfully perform the desired behaviour change (Bandura, 1988). As the TTM has been successfully used for various health promotion interventions (Clarke & Eves, 1997; Keller et al., 2001; Marcus & Simkin, 1994; Spencer et al., 2006), the framework is likely to be appropriate for inclusion in sedentary behaviour change interventions.

Office workers have been reported to sit for 82% of their working hours (Parry & Straker, 2013) which provides an ideal workplace setting for intervention. Additionally, office workers have suggested that interventions need to include education, provide a supportive environment to change behaviour, and encompass a variety of strategies to ensure each worker can have an individually-tailored behaviour change process (McGuckin, Sealey, & Barnett, 2017a). Some theory-based interventions which included multiple behaviour change strategies such as tailored goal setting and the provision of information regarding the target behaviour have resulted in reduced sedentary behaviour in older adults (Fitzsimons et al., 2013; Gardner, Eakin, Healy, & Owen, 2011). Michie et al. (2013) suggests that further research is needed to link behaviour change strategies to specific theoretical frameworks to explore the likely mechanisms behind behaviour change. Therefore, the aims of the present study were to evaluate the effectiveness of a theory-informed, personalised intervention for the reduction of occupational sedentary behaviour of office workers. It was hypothesised that sedentary behaviour change based on theoretical frameworks would result in reduced occupational sedentary behaviour.

4.3 Methods

4.3.1 Participant recruitment. Participants were recruited from James Cook University via email invitation. The inclusion criteria for participation in the project included a) employed full-time b) working in an office-based environment c) not performing any face-to-face teaching duties during the study period. There were no restrictions on gender, age, or position as long as the above criteria were met. Participants who met the aforementioned criteria were provided with an information sheet and informed consent form.

4.3.2 Procedures. The study was a pre-post design and was implemented between September and December 2016. Ethics was approved by the James Cook University Human Research Ethics Committee (approval number H6654; Appendix D). Figure 4.1 provides an overview of the study design.

Step 1. Informed consent followed by online survey	Step 2. Pre-intervention assessment meeting with five days of data collection (ActivPAL™ & workbook)	Step 3. Face-to-face meeting to discuss ActivPAL™ data, provide information and to plan goals	Step 4. Commence six week intervention (ActivPAL™ & individualised workbook) including weekly contact from principal investigator	Step 5. ActivPAL™ and workbook collection and post intervention interview

Figure 4.1 Study design

4.3.2.1 Step 1. Initial data collection. After the return of the informed consent form, participants were asked to complete an online survey (Appendix E) to ascertain demographic information such as age, gender, height and body mass, their perception of daily occupational sitting time, and their perception of sitting and their health. The participants were asked "do you think there is a relationship between sitting and your health" which required a "yes" or "no" response followed by an open-ended section for further comments adapted from Gilson

et al. (2011) previously used by McGuckin et al. (2017a) to explore perceptions of sitting behaviour.

4.3.2.2 Step 2. Pre-intervention data collection. An initial face-to-face meeting was held between each individual and the principal investigator. During the meeting, each participant was provided with an ActivPAL™ (PAL Technologies Ltd., Glasgow, Scotland). The ActivPAL™ is one of the most widely used objective activity monitoring devices to assess sedentary behaviour (Kim & Welk, 2015). The ActivPAL™ is a lightweight activity device which attaches to the thigh via adhesives as per the manufacturers recommendations, and records activity patterns such as sitting, standing, stepping, or walking based on acceleration and inclination data. Participants were instructed how to wear the ActivPAL™ during work hours with multiple adhesion options provided. Participants were asked to remove the ActivPAL™ at the end of the work day and leave it on their desk for the following day. The ActivPAL™ has previously been used in multiple sedentary behaviour interventions (Stephens et al., 2014; Swartz et al., 2014; Urda, Lynn, Gorman, & Larouere, 2016).

A workbook (Appendix F) was also provided to each participant during the pre-intervention data collection stage. The workbook had a separate page for each day of data collection and provided space for participants to indicate their sitting and non-sitting time every 30 min. Participants were also asked to provide details of the time they started wearing their ActivPAL™ and the time of removal. The use of log books provides an economical and easily disseminated tool for data collection (Hardy et al., 2013).

All participants were asked to wear the ActivPAL™ and record their self-report data in the workbook for five days (pre-intervention) period.

4.3.2.3 Step 3. Planning for the intervention and implementation of key behaviour change strategies. After the completion of the pre-intervention data collection, a second face-to-face meeting between each individual and the principal investigator took place. This was an individualised consultation similar to those conducted by Fitzsimons et al. (2013). During this consultation, participants were provided with a sample of their pre-intervention data collection (i.e. one day of their ActivPAL™ data compared to their self-reported workbook data) (Appendix G), a generic information sheet about sedentary behaviour, and another information sheet (Appendix H) including information surrounding the three main themes for the relationship between sitting and health, as identified from the online survey. From this, participants were asked to develop six weekly goals focusing on strategies to reduce occupational sedentary behaviour for their individualised intervention, as previously conducted by Lewis et al. (2016). The goals were incremental such that all participants set one goal for week one and would complete six goals by the end of the six week intervention (i.e. week two would include week one goal plus week two goal and so forth) (example goals available in Appendix I). If participants were unsure of what goals to set, example goals were suggested with a clear message that they may not be appropriate for every participant, and that careful consideration should occur before the inclusion of a suggested goal. The goals were evaluated by the participant and principal investigator during discussions for achievability within their current work environment. Six participants had access prior to or were likely to acquire a sit-to-stand station during the intervention phase and therefore their goals included how and when to use the sit-to-stand station as they had high levels of sitting time at pre-intervention (354.7 min/work day).

In addition to the goals, participants were asked to sign a self-contract adapted from Kotecki (2014) (Appendix J) which indicated that they would achieve their goals during the

intervention period. Commitment has previously been included as a strategy in the consultation process of Fitzsimons et al. (2013). Participants were asked to state their self-efficacy to complete their goals as a percentage as adapted from McAuley (1993) (Appendix K). To identify stage of change, participants were asked the following questions "do you think prolonged sedentary behaviour is a problem for you at the moment?" (why/why not) and "when do you intend to change your sedentary behaviour?" (Prochaska et al., 2013).

Following the consultation and before the commencement of the goal-based sedentary behaviour intervention, participants were provided with another self-report activity workbook for the next six weeks with specific reference to their goals (Appendix L). The workbook consisted of 1) the individual's goal/s, 2) the work day broken into 30 minute intervals to record sitting and non-sitting time, and 3) an evaluation of whether their goal was achieved for each day, previously utilised as a behavioural strategy by Lewis et al. (2016).

4.3.2.4 Step 4. The intervention. During the intervention period, participants received a weekly phone call, email or personal visit to ask if they were achieving their goals and if not, what were the difficulties in achieving these goals. Support was offered if the participant felt they were unsure if their goals were achievable due to changed circumstances, and modifications were made to the goals if needed. During the final week of the six week intervention in addition to completing their workbook, participants again wore the ActivPAL™ for five working days. The strategies used throughout the intervention are described in relation to the relevant theoretical framework in table 4.1.

Table 4.1 Link between intervention strategies and theoretical framework

Strategy	Link to theoretical framework
Education	To assist in stage progression of TTM from preparation to action
	Consciousness raising process of change (TTM)
Individual feedback from ActivPAL™	Self-reflection and self-regulation component of SCT
	Consciousness raising process of change (TTM)
Workbook (prompt)	Self-regulation component of SCT
	Mastery experiences of self-efficacy component of SCT
Goal setting	Self-regulation component of SCT
	Perceived behavioural component of TPB
	Mastery experiences of self-efficacy component of SCT
Self-contract	Self-regulation component of SCT
	Self-liberation process of change (TTM)
Weekly phone call/email/visit (prompt)	Verbal persuasion and mastery experiences of self-efficacy component of SCT
	Helping relationship process of change (TTM)

SCT – Social Cognitive Theory, TTM – Transtheoretical Model, TPB – Theory of Planned Behaviour.

The intervention addressed capability, opportunity, and motivation components for changing behaviour (Michie et al., 2011) by providing the knowledge and skills via education, feedback, and goal setting to change behaviour (capability), prompts to address external

factors (opportunity), and self-monitoring, and commitment to address internal factors (motivation).

4.3.2.5 Step 5. Follow up interviews. After the completion of the intervention participants were invited to take part in an interview. The interview included questions surrounding their motivations to participate in the project and to complete their goals, self-efficacy for the continuation of behaviour change, whether goals were achieved or not, which goals were the most effective or least effective for behaviour change, feasibility of using the workbook, usefulness of interactions with the principal investigator, the usefulness of receiving information at the commencement of the intervention, and their overall perception of the intervention in regards to reducing sedentary behaviour in the workplace. The workbook and ActivPAL™ were collected during this final meeting.

4.3.3 Statistical analysis. The open-ended responses from the online survey, the individual weekly goals, and the post intervention interviews were transcribed verbatim and were thematically analysed according to Braun and Clarke (2006). Thematic analysis consisted of six phases: (1) familiarisation with the data; (2) create initial coding; (3) identify themes; (4) review themes; (5) define and name themes; and (6) produce the results.

All pre- and post- intervention data were analysed using SPSS version 22 (SPSS Inc. Chicago, IL, USA). Paired samples *t*-tests were used to analyse ActivPAL™ and self-reported sitting time and self-efficacy with statistical significance set at $p < 0.05$; with 95% confidence intervals (CI) and effect sizes (ES) also presented. A Pearson's correlation was used to analyse ActivPAL™ and self-reported post intervention data.

4.4 Results

     4.4.1 Participants. Forty-nine participants provided informed consent and were

eligible to participate in the intervention and completed the survey. The average age of

participants was 45 ± 10 years with a body mass index of 27.4 ± 4.9 kg/m^2 which is classified

as overweight (American College of Sports Medicine, 2014). Thirty-eight participants

completed the intervention (78% completion rate) however only 27 participants (4 males, 23

females; 55% of original sample group) had sufficient data to be included in the analysis.

Eleven participants (all female) withdrew or were excluded from the intervention, six prior to

the study, and five during the intervention phase. Several reasons were provided for

withdrawing from the intervention. Two participants suggested they were unable to

commence the intervention due to a change or increase in workload. One participant had

received a lower limb injury, two participants had to travel for work during the intervention

period, which would significantly interrupt their goals, two withdrew from the intervention

without explanation, one participant resigned from their job, and three participants did not

respond to the principal investigator during data collection and were therefore excluded from

the study. Data sets from 11 participants were unable to be included as there were

ActivPAL™ monitoring errors or insufficient data. While the ActivPAL™ is reported to last

for periods of 7 days or longer (PAL Technologies Ltd., 2010), some data was not collected

due to low batteries and therefore only three work days were included in the analysis.

     4.4.2 Pre-intervention survey. The pre-intervention survey indicated that the group

average estimate of sitting time was 6.5 ± 1.6 hr/work day. The majority ($n = 44$) of

participants associated sitting with negative health outcomes with one participant indicating

that there was no relationship due to being physically active outside of work, although the

participant mentioned that an active job would increase health benefits. Key themes identified from the survey responses suggests that participants perceived sedentary behaviour was related to musculoskeletal complaints. This was characterised by responses such as *"I regularly feel a stiffness in my neck and I know that is from sitting in front of the computer for hours."* Another theme included weight gain characterised by responses such as *"I have gained weight and find it very difficult to reduce this since working in this role. I have low energy levels and don't think the inactivity helps this."* Additionally, fatigue was characterised by responses such as *"I feel that the long hours of sitting leave me feeling tired and drained."* The themes identified from the initial survey formed the basis for the specific information to participants during their individualised consultation. For example, information was provided highlighting the link between increased computer and keyboard use and the prevalence of musculoskeletal disorders (Cho et al., 2012; Gerr et al., 2004).

4.4.3 Goals. The most prominent theme for goal setting was purposeful walking ($n = 20$) for example, *'during the work day I will walk around the building to get to the tearoom'* (participant goal). Participants also incorporated colleagues into their goals ($n = 17$) for example *"during the work day I will stand while speaking with [colleague]'* (participant goal). Similarly, walking further to amenities was often incorporated ($n = 16$) for example, *'during the work day I will walk to the bathroom on [a different level]'* (participant goal). Standing for the duration of a phone call ($n = 16$) was also used, for example *'during the work day I will stand for the duration of each phone call'* (participant goal).

4.4.4 Pre-intervention stage of change. As a result of already changing their sedentary behaviour patterns, five participants indicated that they were already in the action stage. Two participants suggested changes would be unlikely to occur until they retire but

were willing to attempt to reduce their sedentary behaviour in the workplace (preparation). The remaining 20 participants acknowledged that sedentary behaviour was problematic placing them in the preparation stage and were ready to move into action.

4.4.5 Pre- and post- intervention self-efficacy. There was a significant difference (p = .002) between pre-intervention self-efficacy (69 ± 21%; range 30 – 100%) and post-intervention self-efficacy (82 ± 16%; range 50 – 100%; CI = 5.3 – 19.9; ES = 0.68). All participants reported that they intended to continue with their behaviour change.

4.4.6 Intervention. Twenty-seven participants provided three days of ActivPAL™ data from the five day sampling period. The data were calculated as a daily average over a three day data collection period. There was a significant difference (p = .001) between daily pre-intervention sitting time (341.6 ± 57.9 min) and post-intervention sitting time (296.4 ± 71.5 min) with a mean difference of 45.2 ± 60.7 min/work day (CI = 21.2 – 69.3; ES= 0.74).

As larger amounts of standing are likely to occur with access to a sit-to-stand workstation, the paired samples t-test was also run excluding six participants with sit-to-stand workstations. There remained a significant difference (p = .004) between pre-intervention three day daily average sitting time (337.9 ± 62.4 min) and post-intervention three day daily average sitting time (312.9 ± 62.6 min) with a mean difference of 25.0 ± 35.4 min/work day (CI = 8.9 – 41.1; ES = 0.71).

Ten of the 27 participants who completed the intervention provided complete self-report workbook data. There was no statistical significance (p = .118) between pre-intervention (380.1 ± 42.0 min) and post intervention self-report workbook data (347.3 ± 58.9 min) with a mean difference of 32.8 ± 60.0 min (CI = -10.2 – 75.7; ES = 0.55). The

correlation between the ActivPAL™ post-intervention data and workbook post-intervention data ($n = 10$) is $r = .438$ ($p = .205$).

Figure 4.2 indicates the pre- and post- intervention ActivPAL™ data for each individual participant. Four participants increased their sedentary time at post assessment (participants 5, 14, 15, 26) and two participants remained the same (participants 9, 23). Table 4.2 represents the participants who achieved the recommendations of 2 hr or 4 hr of standing per work day on one or more of the evaluated days (Buckley et al., 2015). Of the five participants who met or exceeded the 4 hr recommendation, two had sit-to-stand workstations installed.
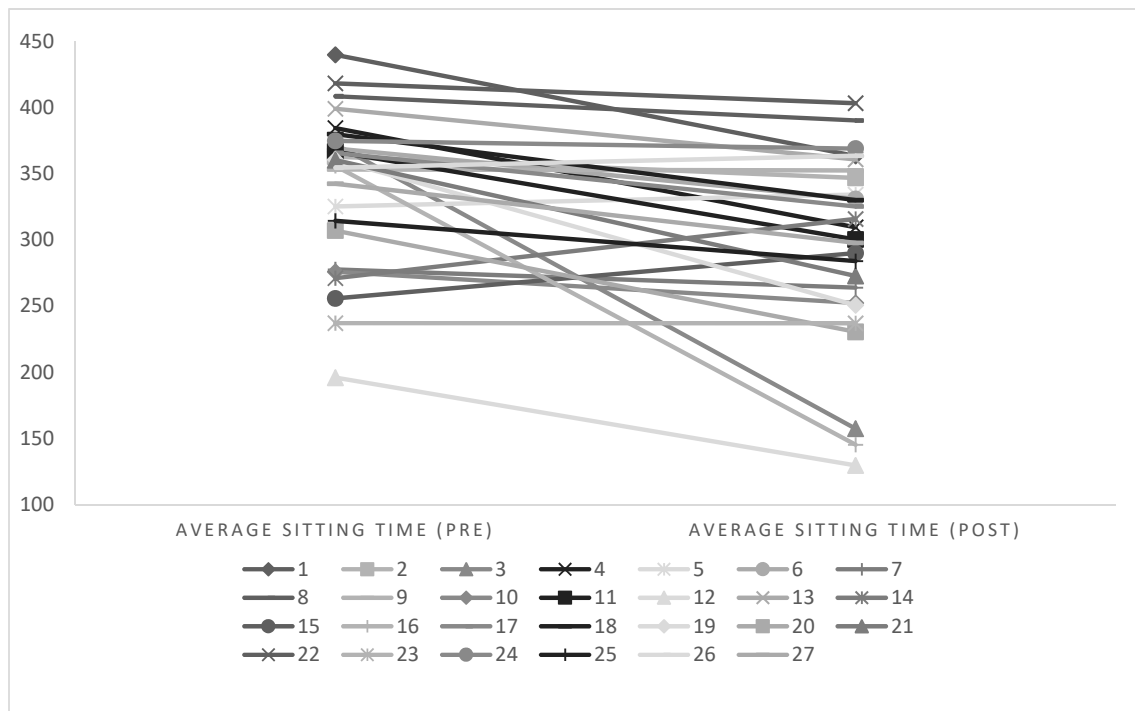
Figure 4.2 Pre- and post- intervention three day ActivPAL™ data for sitting time (min) for each individual participant.

Table 4.2 Participants who met the recommendations of 2 hr and 4 hr of standing/moving pre- and post- intervention on one or more days during the ActivPAL™ data collection period.

Recommendation	Pre-intervention participant number	Post-intervention participant number
2 hr of standing/moving during the work day	15	20
4 hr of standing/moving during the work day	2	5

4.4.7 Post intervention interviews

4.4.7.1 Decision to participate in the current project. The most prominent theme for taking part in the project was that participants were aware of their sitting behaviour and wanted to change their current behaviour ($n = 11$), followed by interest in the project or being involved in the data collection process ($n = 7$). This was characterised by responses such as:

Theme - awareness:

"I was very aware that I had become probably the most sedentary in my life and having previously been quite active, so I needed to have a little bit of a wake-up call." (Participant 13)

"I thought that I was sitting a little bit too much at work and I wanted to look at methods of changing that." (Participant 24)

"I felt like I was really feeling the effects of being sedentary at work and I wanted to see if I could do something about it." (Participant 10)

Theme - interest:

"I thought it would be an interesting experiment to undertake." (Participant 26)

"I like to be involved in the research that our staff do." (Participant 22)

4.4.7.2 Motivation to complete goals. A variety of responses were provided for the motivations behind achieving goals. The two most prominent themes were wanting to improve health (n = 8), and having the self-determination to complete the goals (n = 5). This was characterised by responses such as:

Theme - health:

"My motivation I guess was to get moving and improve my health." (Participant 26)

"Healthy lifestyle and to feel better and not as tired." (Participant 21)

Theme - determination to complete project:

"To actually just finish it and see the difference between the beginning and the end." (Participant 7)

"Because I set them I knew that I had to reach them and I'm very determined. I don't like to lose." (Participant 14)

4.4.7.3 Goal achievement. The majority of participants (n = 23) indicated that they achieved their goals or achieved some of their goals. This was characterised by responses such as:

Theme - goal achievement:

"Yes, nearly every day I think there's only one day where I forgot to go down and fill up my water bottle, I just went to the kitchen." (Participant 16)

"Probably 65%, standing for lunch is really challenging because I knew that [colleagues were in the office space] and had lunch together." (Participant 12)

    4.4.7.4 Most effective goals. Individual goals were set during the consultation period. As a collective group, there were some themes which indicated that walking further or up/down stairs to attend amenities ($n = 7$), standing when the phone rang and/or standing for the duration of the phone call (n = 8), walking further to fill a water bottle ($n = 5$), walking during a break ($n = 4$), and walking to visit colleagues or to a specific area ($n = 5$) were the most effective goals. This was characterised by responses such as:

Theme - walking based goals:

"Probably just walking to a different floor to go to the toilet or fill a water bottle."
(Participant 2)

"Walking at lunch definitely… I think it helps you sort of get you mind back into what you're doing." (Participant 15)

"Going longer distance to the bathroom … visiting colleagues were the most useful."
(Participant 12)

Theme - phone based goals:

"The [goals] linked to the phone for sure, it's much easier to stand up and talk." (Participant 22)

"Standing up each time I sent an email and [answered the] phone because I didn't realise how often I did those things." (Participant 23)

4.4.7.5 Least effective goals. There were some goals which were perceived as the least effective behaviour change goals for participants. These included standing while on the phone ($n = 6$), and walking during the day ($n = 7$). This was characterised by responses such as:

Theme - phone based goals:

"Standing with the phone was a little challenging, because I monitor two phones. I have to move across the desk, which was probably easier but I actually had to remember to stand up and walk across the desk rather than just roll over." (Participant 7)

"Standing when the phone rings extremely difficult to do it was only because it's not a natural reaction … For me I knew someone was ringing about a purpose I needed to be organized so there were a couple times where if the phone rings my reaction is more about getting myself ready for the phone call rather than standing up." (Participant 8)

Theme - walking based goals:

"When it was disgustingly hot and I didn't go for a walk, but I did a couple of laps around the building just to get me up away from my desk and have a break." (Participant 19)

"The [goal] that I chose to walk to [another building] each time I got a [request specific to role] wasn't effective because for some reason, things went well and I didn't get to walk to the [building]." (Participant 23)

4.4.7.8 Contact with principal investigator. Participants were asked to reflect on their thoughts regarding receiving regular communication with the principal investigator.

Participants ($n = 17$) identified that receiving a weekly phone call, email or visit was a good reminder of the project and their goals, and to keep them on track. This was characterised by responses such as:

Theme - accountability and prompt:

"Yes, it truly did prompt me and helped me remember..." (Participant 27)

"It just reinforces to us that we need to be on track." (Participant 16)

"I think it's good to have that reminder especially in the early stages as of once you get past the first week I would think you are okay." (Participant 22)

"It was (not) so much that I was doing anything wrong but to keep on track and to keep motivated with it, the end is in sight." (Participant 26)

"I found that helpful because it made me think I am accountable for this and am I on track." (Participant 6)

Conversely, some participants ($n = 6$) indicated that they did not need to be contacted as they would continue with their goals in a self-directed manner. This was characterised by responses such as:

Theme - internal motivation:

"I don't think it would have influenced me because I'm committed to do it, so I do it." (Participant 11)

"Not so much, but probably just to make sure that if you are having issues with the intervention that you've chosen that you think about something else along the way so that

would probably be the only thing but I'm fairly self-sufficient so emails were fine for me."
(Participant 13)

       4.4.7.8 Information/education. Participants were provided with information based on the key health outcomes determined from the initial online survey, and a sample of their baseline ActivPAL™ data. Participants were asked to reflect on their experience regarding receiving information. Participants found the information interesting ($n = 7$), they thought the ActivPAL™ data was particularly useful ($n = 7$), and that the information was read at the beginning of the intervention but was not referred to later ($n = 7$). This was characterised by responses such as:

Theme - interesting:

"[The information] was really interesting…" (Participant 10)

Theme - individualised ActivPAL™ data was useful:

"Those red lines [on the ActivPAL™ graph] that is very good to see and actually I thought that could improve…it's quite good to see it visually." (Participant 21)

"I did find [the ActivPAL™ data] very interesting… I thought that I was probably walking around a lot more… so it was a little bit of an eye open up to realise I was so inactive…" (Participant 27)

Theme – useful but not revisited:

"I read it after the discussion I sat it on my desk and I've walked away and not read it since." (Participant 11)

"I did refer to it when you came to me, but I don't know, I don't recall going back to it during the time." (Participant 6)

4.4.7.9 Workbook. Participants were asked about the feasibility of using a workbook to record their sitting and standing behaviours. Sixteen participants suggested that completing the workbook was difficult or monotonous. This was characterised by responses such as:

Theme – difficult or monotonous:

"To be honest that was the hardest part because you're wanting to be accurate but at the same time as you're doing it [thinking] 'I think I did this'." (Participant 26)

"The workbook is hard… I had to set reminders on my phone about the workbook and people would get annoyed." (Participant 24)

Although the workbook was perceived as a difficult task, 22 participants suggested that the workbook was a helpful reminder or prompt to complete their goals.

Theme - reminder or prompt:

"It was a reminder that if I hadn't stood up for an hour then I had to write down 30 min of not doing anything, it was like, I should probably get up! So yeah it was good in prompting me to actually get up and go to the toilet or kitchen." (Participant 7)

"Yeah particularly if I did [the workbook] at the end of the day because it gave me more time to think about what I need to do or do better tomorrow." (Participant 6)

"I'd have it right in front of me so I it would remind me to get up and try and do something so it did help." (Participant 27)

"Yep it was a reminder that if it's not written down then it didn't happen." (Participant 22)

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4.4.7.10 Overall perception of the intervention in regards to reducing sedentary behaviour in the workplace. Participants (*n* = 12) indicated that the intervention increased their awareness of their occupational sedentary behaviour. This was characterised by responses such as:

Theme - awareness:

"It's made me more conscious of it like knowing what you told me at the beginning, knowing I'm at work for seven hours I'm sitting for six of those hours and trying to get that to at least half and half... was always in the back of my mind somewhere so I'm conscious of that and that was an interesting figure to put on it." (Participant 10)

"It was good for awareness of the consciousness of being a bit more active and that you can be more active around the place and standing meetings we had a few times where I've run into people and they say let's go sit down for a bit but I would say no let's just keep standing." (Participant 8)

"It's made me think about it that bit more... even this week where I'm not doing [the intervention] I've still got those habits going on my own." (Participant 19)

4.5 Discussion

The aim of the current study was to evaluate the effectiveness of a theory-informed intervention for the reduction of sedentary behaviour of office workers. As a result of individualised consultations which included goal setting, the provision of information, self-commitment, and self-monitoring, there was a reduction in sedentary behaviour. Irrespective of the inclusion of sit-to-stand workstations in the goal setting process, a significant reduction in occupational sedentary behaviour occurred. The simplistic strategies have resulted in

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similar findings to those of Swartz et al. (2014), who observed a reduction in occupational sedentary behaviour as a result of prompt based behaviour change. These findings may be the initial steps to changing behaviour, which Buckley et al. (2015) suggests could be the early stages of achieving the recommendations of standing or moving for 2-4 hr/work day. This is evidenced by the increased number of participants reaching the minimum of 2 hr of standing or moving during the work day on one or more of the analysed days after the intervention. As three participants met the 4 hr recommendation on one or more of the analysed days without access to a sit-to-stand workstation, it is possible for this cohort of office workers to meet the guideline. Overall, the participants indicated that the intervention raised their awareness of their occupational sedentary behaviour.

Goal setting was a large focus of the intervention as previous literature has shown promising results (Fitzsimons et al., 2013; Green et al., 2016; Lewis et al., 2016). Goals provide a strong sense of purpose and direction (Bandura, 1988), and relate to self-efficacy where high self-efficacy is associated with commitment to achieving set goals (Locke, 1996). To reinforce the participants' commitment, they signed a self-contract which has previously been included as a behaviour change strategy in sedentary behaviour research (Fitzsimons et al., 2013). This aspect may enhance the self-liberation process of change, which is particularly useful when transitioning between the preparation and action stages (Prochaska et al., 1992). The majority of goals were prompt-based and surrounded purposeful standing or walking such as going for a walk at morning tea, standing or walking when interacting with colleagues instead of sending an email, walking further to amenities, and standing for the duration of a phone call. Participants in the current study identified walking further or up/down stairs to attend amenities, standing when the phone rang and/or standing for the

duration of the phone call, and walking further to fill water bottle, and walking during a break or visiting a colleague as the most effective goals within their work environments. Coincidentally, standing when the phone rang or while on the phone, and walking during the day were considered to be the least effective for participants. This suggests that goals and specific strategies need to be individually-tailored (Marcus et al., 1998; Marcus et al., 2007), match the level of willingness to change behaviour (Prochaska & DiClemente, 1983), and involve the participant in the development of individual goals to enhance perceived control (Bandura, 1997). The goals incorporated in the current study can be widely implemented to other work environments to match the desired outcomes of an individual worker. Similarly, other prompt based strategies such as wrist watches that vibrate (Swartz et al., 2014) or computer based software that inhibit computer work (Cooley et al., 2014) could offer low-cost solutions to occupational sedentary behaviour.

As a result of all participants completing at least one day of the desired behaviour change, it can be suggested that all participants moved to or remained in the action stage of the TTM (Prochaska & DiClemente, 1982). The key processes of change incorporated in the current study were consciousness raising, helping relationships, and self-liberation. As providing health related information is considered to be a promising behaviour change strategy (Gardner et al., 2016), consciousness raising was incorporated into the intervention. This was done by providing ActivPAL™ data and specific cohort information based on the online survey responses to the participants at the beginning of the intervention to increase knowledge and awareness (Prochaska et al., 1988), however it appeared that the ActivPAL™ data (individual data) was more useful than the cohort information. Consciousness raising may have commenced before the provision of early information as the participants indicated

that their most prominent reason for participating in the project was an awareness of their

sedentary behaviour. The principal investigator acted in a supportive role by discussing the

progress of the goals on a regular basis, as the participants were provided an opportunity to

express their thoughts and re-evaluate goals it is likely that this may be considered a helping

relationship (Prochaska et al., 1988). The participants acknowledged that the regular contact

was a useful reminder and kept them on track, although some participants recognised that

they could complete their goals independently and did not require regular contact. This

highlights that an intervention targeting behaviour change should be individually-tailored

(Marcus et al., 1998; Marcus et al., 2007) and multi-component (Chu et al., 2016) to address

personal preferences (Gilson et al., 2011; McGuckin et al., 2017a). Additionally, at the

commencement of the intervention, three participants had access to a sit-to-stand workstation,

and another three acquired a station as a result of the initial consultation whereby they asked

their managers to purchase a station or borrow one that was not being used. This could also

be seen as another instance of a helping relationship to assist and support occupational

behaviour change (Prochaska et al., 1988). As the participants were involved with the design

and implementation of their own goals, self-liberation may occur (Prochaska et al., 1988)

which may increase perceived control of their own behaviour change (Ajzen, 2012) although

these aspects were not directly assessed.

In regards to the TPB, it is likely that the participants intended to change their

behaviour (Ajzen, 2012) as a result of volunteering for the study, and by indicating a

timeframe for when they perceive the changes in behaviour to occur. The participants made a

decision to participate in the study suggesting they may have already been motivated to

decrease their sedentary behaviour. While not assessed, the author's postulate the

participants may have perceived their significant work colleagues would support their decision to participate otherwise they may not have volunteered for the study (Prapavessis et al., 2015). Although there are some preliminary suggestions based on the current work, further research is required to explore the TPB in the field of sedentary behaviour (Prapavessis et al., 2015).

As a result of completing the six week intervention, participants were able to reduce their occupational sedentary behaviour and increase their self-efficacy to sustain their behaviour change. Setting goals has been linked to increased beliefs in an individual's capabilities (Bandura, 1988). While not assessed, the positive behaviour change is indicative that the participants may have had successful personal mastery experiences by achieving their goals, which increased their self-efficacy levels (Bandura, 1997). The participants acknowledged that they intend to continue with their behaviour change, and increased self-efficacy is crucial for persisting with a desired behaviour change especially when facing obstacles (Bandura, 1997).

The use of self-reporting for occupational sedentary behaviour was not an effective monitoring tool as only 10 participants provided complete data sets. Almost half of the participant group also indicated that completing the workbook was difficult. This may be due to the arduous timeframes for reporting (Hardy et al., 2013) however this timeframe was chosen as previous literature has suggested sedentary behaviour should be interrupted every 20-30 min (Atlas & Deyo, 2001; Dunstan et al., 2012). Although no statistical significance between pre- and post- data were found, the use of self-reporting was successfully incorporated as a specific behaviour change strategy (Gardner et al., 2016) which involves consciousness raising by having direct feedback available (Prochaska et al., 1992). In the

current study, participants perceived the workbook as an effective prompting tool to monitor their behaviour and to plan or change their behaviour during the intervention period. Therefore, future studies may wish to use a self-monitoring strategy to prompt behaviour change however consideration is needed in regards to the time commitment associated with completing the workbook.

This study offers interesting insights into the use of theory-informed strategies for reducing occupational sedentary behaviour however there are some limitations. These include that the findings may not be representative of other workplaces, and the predominantly female participant sample. Additionally, the recruitment processes for the study was voluntary which may lead to a potential bias towards individuals who are already conscious of their health and prepared to change their behaviour. As changing behaviour is long-term, future research could investigate if the participants who successfully changed their behaviour have progressed to the maintenance stage of the TTM (Prochaska & DiClemente, 1982), and explore the reasons for withdrawals from the behaviour change intervention such as real or perceived barriers.

4.6 Conclusion

A theory-informed intervention including individualised consultations with the key behaviour strategies of goal setting, the provision of information, self-commitment, and self-monitoring, resulted in a reduction in occupational sedentary behaviour for office workers, increased awareness of sedentary behaviours, and an increase in self-efficacy to change sedentary behaviour patterns. The reductions in sitting time were irrespective of the inclusion of sit-to-stand workstations, and suggest that simplistic strategies can be incorporated into an intervention if they are individually-tailored. The potential bias towards the inclusion of

health conscious individuals may be a limitation when interpreting the results. Further

evaluation of the strategies is needed to explore if successful behaviour change can be

achieved long-term.

Chapter 5

Six month follow-up of a theory-informed, low-cost, individually-tailored, multi-component intervention to reduce sedentary behaviour in the workplace.

Under review: Cogent Psychology, December 2017

5.1 Abstract

Background: interventions to reduce occupational sedentary behaviour are effective in the short-term however there is limited evidence exploring the long-term effectiveness of sedentary behaviour interventions. This study aimed to explore participant experiences six months post intervention to evaluate the long-term effectiveness of a low-cost, theory-informed, multi-component, individually-tailored, six week intervention for the reduction of occupational sedentary behaviour of office workers.

Methods: participants who completed a sedentary behaviour intervention were invited to participate in a six month follow-up. Participants were provided with an ActivPAL™ activity monitoring device and were invited to complete a semi-structured interview which explored successful behaviour change strategies, barriers to changing sedentary behaviour, self-efficacy towards goal achievement, and stage of change in relation to current sedentary behaviour patterns. The open-ended responses from the follow up interviews were transcribed verbatim and were thematically analysed. The six month follow up quantitative data were compared to pre-and post-intervention data and analysed via paired samples t-tests.

Results: a total of 25 out of 27 eligible participants volunteered. Occupational sitting time was reduced by an average of 40.6 ± 76.1 min/work day at six months as compared to pre-intervention. Twenty-three participants indicated that they had continued with their

occupational sedentary behaviour change in some form. Thirteen participants were in the action stage of change, seven participants had moved to the maintenance stage and five participants had relapses. Self-efficacy towards goal achievement remained high at the six month follow-up (post: $83 \pm 15\%$; six month: $81 \pm 19\%$). The most prominent goal identified by the participants to reduce occupational sedentary behaviour was walking. Barriers included attending seated meetings, perceived workloads or work tasks and work environments. To overcome some of the barriers, a variety of strategies were suggested including changing the work environment, providing prompts, and receiving support from management.

Conclusions: the current study provides insight into the long-term adherence to and barriers of a low-cost, theory-informed, multi-component, individually-tailored occupational sedentary behaviour intervention.

5.2 Introduction

Occupational sedentary behaviour is a major contributor (49%) to overall sitting time (Parry & Straker, 2013). Consequently, the workplace is an ideal setting to implement an intervention to reduce sedentary behaviour, especially for those who work in an office setting (Clemes et al., 2015; Parry & Straker, 2013). For individuals who are employed in predominantly desk-based roles, the recommendation is to stand or move for 2-4 hr/work day (Buckley et al., 2015). In an attempt to reduce occupational sedentary behaviour, multi-component interventions have been implemented and have been found to be successful in reducing occupational sedentary behaviour (Chu et al., 2016), with numerous studies reducing or interrupting occupational sitting time with positive short-term outcomes. For example, a four-week multi-component intervention including the installation of sit-to-stand

workstations and other motivation based strategies was able to reduce sitting time by 2 hr/day for office workers (Healy et al., 2013). Additionally, a low-cost four week multi-component intervention which included support from managers, workplace champions to send emails, the installation of computer software, increased social media awareness, and point-of-decision prompts reduced sitting time by 26 min/day for office based workers (Mackenzie et al., 2015). Furthermore, an eight week intervention determined that short (1-2 min) frequent breaks every half hour were more effective in reducing occupational sedentary behaviour compared to longer (2 x 15 min) less frequent breaks (Mailey et al., 2016). It appears that interventions which aim to reduce occupational sitting time are effective in eliciting short-term behaviour change, however there is limited literature surrounding the long-term adherence to behaviour change following the completion of multi-component sedentary behaviour reduction interventions.

Long-term behaviour change can be associated with the maintenance stage of the TTM. During this stage of change, behaviour has been modified for at least six months and up to an unspecified time period where behaviour change has been consistent without relapse (Prochaska et al., 2013). It is unlikely that successful behaviour change occurs on the first attempt, and frequent relapses and recycling through the other stages of pre-contemplation, contemplation, preparation, and action may occur (Prochaska et al., 1992). There are barriers which may potentially cause relapses and therefore inhibit long-term reductions in occupational sitting time. Examples of these barriers include interruption to workflow, bad weather, and excessive workloads (Bort-Roig et al., 2014; Cooley et al., 2014). Additionally, workplace social norms are likely to present as a barrier (Hadgraft et al., 2016). For instance, sending emails is considered to be the most appropriate form of communication in the

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workplace rather than speaking face-to-face with a colleague (Waters et al., 2016). A lack of self-efficacy may also be a contributing factor to unsuccessful behaviour change as a person may not perceive they are capable of changing the problematic behaviour. Self-efficacy influences personal choices, the level of effort exerted to change behaviour, perseverance, and resilience in the face of barriers (Bandura, 1988). Therefore, if a worker is unable to overcome the potential barriers, they are unlikely to have high self-efficacy in their belief of successfully reducing their occupational sitting time.

A Cochrane review conducted by Shrestha et al. (2016) discussed the importance of continuing research in the area of occupational sitting time, particularly for long-term adherence. This is highlighted by Danquah et al. (2017) who suggested that no multi-component sedentary behaviour intervention had a follow-up of more than three months. This suggests that there is a gap in the literature regarding the evaluation of long-term effectiveness of theory-informed workplace interventions that specifically focuses on reducing sedentary behaviour. The aim of the current study was to explore participant experiences six months post intervention to evaluate the long-term effectiveness of a low-cost, theory-informed, multi-component, individually-tailored intervention to reduce sedentary behaviour in the workplace.

5.3 Methods

5.3.1 Ethics. Ethical approval for the study was obtained from the James Cook University Human Research Ethics Committee (H6654, appendix D). Participants were provided with an information sheet and signed an informed consent form to participate.

5.3.2 Recruitment. Participants ($n = 27$) who completed a six week theory-informed intervention to reduce occupational sedentary behaviour at a higher education institution

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(McGuckin, Sealey, & Barnett, 2017b) were contacted via email and invited to participate in a six month follow-up data collection phase. As reported in Chapter 4, participants who completed the six week intervention were able to reduce their sitting time by 45.2 ± 60.7 min/work day. Within the sample, participants who did not have access to sit-to-stand workstations, were able to successfully reduce their sedentary behaviour by 25.0 ± 35.4 min per work day with the use of education, individualised feedback, prompts, goal setting, and self-contracts as key strategies of the multi-component intervention.

5.3.3 Procedures. Participants were provided with an ActivPAL™ activity monitoring device (PAL Technologies Ltd., Glasgow, Scotland) and instructed to wear it for five days during work hours. Participants were familiar with wearing the ActivPAL™ and were provided with multiple adhesion options. Participants also recorded daily work hours and ActivPAL™ wear time to assist with data extraction points. The ActivPAL™ has been used extensively to collect quantitative movement patterns (Hardy et al., 2013; Kim & Welk, 2015; Swartz et al., 2014; Urda et al., 2016) and is a valid and reliable measurement tool (Grant et al., 2006; Ryan et al., 2006). The ActivPAL™ data were used to determine if the 2 and 4 hr recommendations by Buckley et al. (2015) were met at the six month follow-up.

Following the ActivPAL™ data collection, participants were invited to complete a semi-structured interview conducted by the principal investigator. The interviews were audio recorded and the interview topics are listed in Table 5.1.

Table 5.1 Semi-structured interview topics.

Interview topics
Continuation of behaviour change
Successful goals
Barriers to changing occupational sedentary behaviour
Strategies to overcome barriers
Identifying stage of change (Prochaska et al., 2013)
Identifying self-efficacy towards goal achievement (McAuley, 1993)

5.3.4 Statistical analysis. The open-ended responses from the follow up interviews were transcribed verbatim and were thematically analysed according to Braun and Clarke (2006). The six month follow up ActivPAL™ and self-efficacy data were compared to the pre-and post-intervention data and analysed via paired samples t-tests using SPSS version 22 (SPSS Inc. Chicago, IL, USA). Statistical significance was set at $p < .05$; with 95% confidence intervals (CI) and effect size (ES) also presented.

5.4 Results

5.4.1 Participants. One participant was no longer employed at the organisation and therefore could not be included in the study. Another participant declined to participate and indicated that their workload had prevented them from being "up and active". A total of 25 out of 27 eligible participants volunteered to participate in the follow up study.

5.4.2 ActivPAL™ data. Of the 25 participants who volunteered for the follow up study, 23 participants had three full days of data to analyse. Table 5.2 provides the average

daily sitting time over a three day sampling period for the total group and then separated into participants with and without sit-to-stand workstations. Table 5.3 represents the participants who met the 2 hr/day and 4 hr/day recommendation to stand or move during work hours to reduce occupational sitting time (Buckley et al., 2015) based on the ActivPAL™ data. Of the seven participants who met or exceeded the 4 hr recommendation, three had sit-to-stand workstations installed.

Table 5.2 Average ± standard deviation (*SD*) daily occupational sitting time (min), confidence intervals (CI) and effect size (ES) at pre-intervention, post-intervention and six month follow-up.

Average sitting time (min)	Mean ± *SD*			CI (ES)		
	Pre-intervention	Post-intervention	Six month follow-up	Pre-post	Pre-six month	Post-six month
All participants (*n* = 23)	344.4 ± 60.6	292.4 ± 76.3*	303.7 ± 79.4*	25.1, 78.7 (0.75)	7.7, 73.5 (0.58)	-30.0, 7.4 (0.14)
Participants without sit-to-stand workstation (*n* = 17)	340.7 ± 67.0	311.4 ± 68.8*	324.9 ± 63.1	11.6, 47.1 (0.43)	-6.9, 38.5 (0.24)	-37.8, 10.8 (0.20)
Participants with sit-to-stand workstation (*n* = 6)	354.7 ± 40.2	240.7 ± 76.1*	243.7 ± 95.6[a]	28.3, 199.6 (0.23)	.00, 221.9 (1.51)	-30.9, 24.9 (0.03)

* indicates significant difference ($p < .05$) from pre-intervention data.

[a] represents approaching significance ($p = .05$) compared to pre-intervention data.

Table 5.3 Number of participants who met or exceeded the 2 hr and 4 hr recommendation of standing and/or moving pre-,and post- intervention and at six month follow-up on one or more days during the ActivPAL™ monitoring period.

Recommended duration to stand or move during the work day	Pre-intervention	Post-intervention	Six month follow-up
2 hr	12	14	10
4 hr	2	5	7

5.4.3 Continuation of behaviour change. Of the 25 participants who volunteered for the follow up study, 23 participants indicated that they had continued with their occupational sedentary behaviour change in some form. This was defined as 'successful continuation of sedentary behaviour change' which was characterised by the following responses:

 "Definitely, at work and also at home" (Participant 16)

"Absolutely. And, for my birthday, I was bought a FitBit which I'm wearing and it's really made me pay attention." (Participant 11)

"I have with some of [the goals], some I haven't been able to [continue with]…" (Participant 13)

"I have [continued] with some, I think I have reverted a bit back to the old ways … because everything that is set up around me is for me to be sitting down…" (Participant 17)

Two participants said that they had not continued with their behaviour change. This was defined as 'unsuccessful continuation of sedentary behaviour change' and is characterised by the following response:

"Not particularly. You can see that I took the stand up desk away, only because the students were singing out for it – I mean they probably get way more use out of it." (Participant 18)

5.4.4 Effective goals for reducing occupational sedentary behaviour. The most prominent goal identified by the participants was 'walking' ($n = 24$ responses). This included walking at lunch time, walking to visit colleagues, and walking further to the bathroom or to fill their water bottle or to empty their rubbish. This was characterised by responses such as:

"I do take the long route to the toilet… [I] visit colleagues rather than phoning them." (Participant 12)

"The main thing I've done is tried to walk, if I don't have to go across campus for anything I've tried to walk at lunchtime a bit more." (Participant 2)

"I don't sit for any longer than about half an hour… Even if it's a matter of getting up and walking outside, I walk around the car park and come back and sit down again." (Participant 23)

5.4.5 Barriers to changing occupational sedentary behaviour. The participants identified that 'workloads or work tasks' ($n = 10$), 'attending meetings' ($n = 6$), and 'work environments' ($n = 5$) were the key barriers to reducing occupational sedentary behaviour. This was characterised by the following responses:

"I just fixate on [work task] and I don't really get up until I'm done." (Participant 13)

"Longer meetings... where you are not in control of the meeting...there almost needs to be a cultural change [in the workplace] to recognise when you have groups of people together for long lengths of time, you are actually promoting this unhealthy behaviour." (Participant 5)

"The difficulty with standing is you could stand at your desk using the monitor stands when you're just working on the keyboard. The minute you start to use the phone or spread out and do paperwork... you can't do it and it's really hard." (Participant 19)

5.4.6 Suggestions to overcome barriers. A variety of strategies to overcome some of the barriers were suggested. The suggestions included 'changing the work environment' by installing sit-to-stand workstations or creating a standing space ($n = 8$), and 'providing prompts' by installing computer software, having campaigns or competitions ($n = 8$). This was characterised by the following responses:

"Currently being stuck at the front desk is kind of my biggest drama. If I could have a standing desk, that would probably be the only option to relieve that..." (Participant 7)

"I think I could set reminders in my calendar or my phone or something to actually get up every hour at least." (Participant 22)

When discussing the behavioural norm surrounding sitting during meetings and feeling unable to stand during meetings, 'social norms' was explored with a participant responding with the following statement:

"...In the big picture, there could be a complaint through workplace health and safety around this kind of practice to try and make people more comfortable..." (Participant 27)

5.4.7 Stage of change. Thirteen participants were in the action stage of change at six month follow-up, as they continued to work towards their goals. Seven participants had

moved to the maintenance stage as they indicated that they were able to successfully reduce their occupational sedentary behaviour for six months or longer. Five participants had relapses and returned to the contemplation or preparation stages as they were not regularly attempting to change their behaviour.

5.4.8 Self-efficacy. There was no difference found for self-efficacy ($n = 24$) when comparing the six month follow-up (81.3% ± 19.1%) with the pre-intervention (72.9% ± 18.5%; CI [-18.6, 1.9]; 0.45) or the post-intervention (82.9 ± 14.9; CI [-5.3, 8.6]; 0.09) scores. Self-efficacy scores differ from that reported in chapter 4 due to the smaller sample size.

5.5 Discussion

The six month follow-up results highlighted that the average reduction in daily occupational sitting time between pre- and post-intervention (52 min/day for $n = 23$) was maintained at six months (41 min/day). Once removing those participants who had access to a sit-to-stand workstation, there were no statistically significant differences in occupational sitting time across the three time points (group average 14-29 min/day reduction). It should be noted that in Chapter 4, the reduction in sitting time of 25 min/day post-intervention for those without access to a sit-to-stand workstation was statistically significant for 21 participants however the significance is not observed with the 17 participants included at six months follow-up. Danquah et al. (2017) observed that the reduced sitting time after one month was 71 min, which decreased to 48 min at the three month follow-up. Although the data in the current study was not statistically significant, the long-term effectiveness of the intervention presents a similar pattern to Danquah et al. (2017). In addition to the whole participant group maintaining reduced occupational sitting time, 10 participants were able to meet the Buckley

et al., (2015) recommendation of progressively including standing or walking for 2 hr/work day, and seven participants were able to meet or exceed the target Buckley et al., (2015) recommendation of standing or walking for 4 hr/work day on one of the assessable days. Of the seven participants who met or exceeded the 4 hr/day recommendation, three participants had access to a sit-to-stand workstation. The number of participants who met the 4 hr/day recommendation increased at six months follow-up compared to immediately post-intervention with three participants being consistent with their behaviour change from post-intervention to the six month follow-up.

Without the use of a sit-to-stand workstation, the participants as a group were unable to significantly reduce their occupational sedentary behaviour six months after the intervention. This suggests that the use of low-cost, theory-informed, individually-tailored strategies such as education, individualised feedback, prompts, goal setting, verbal persuasion, and self-contracts were effective to modify short-term occupational sedentary behaviour however once the strategies were removed, the participants were unable to maintain their sedentary behaviour change. Most people attempting to change behaviour will recycle through the stages of change multiple times before a maintenance of the behaviour is achieved (Prochaska et al., 1992). It was evident that relapses occurred for the current participants however, the majority of participants resumed their attempt to reduce their sedentary behaviour change. Seven participants were able to successfully move to the maintenance stage by stabilising their interruptions to occupational sedentary behaviour and avoiding relapses (Prochaska et al., 2013). The majority of participants perceived that they had continued with their behaviour change strategies after the intervention finished, and had high self-efficacy towards their goal achievement. The strategies which were considered the

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most effective surrounded walking such as walking further to the bathroom/rubbish bin/water cooler, walking to visit a colleague, or walking during their lunch break. Previous literature has also indicated that stair walking and walking meetings are effective ways to reduce occupational sitting time (Commissaris et al., 2016; Gilson, et al., 2011). It should be noted that even though the participants indicated that they successfully progressed to the maintenance stage, the quantitative data did not fully support the same pattern. This suggests that the goals set by participants may not have been significant or challenging enough to elicit long-term sedentary behaviour change.

The participants identified multiple barriers for changing their occupational sedentary behaviour including long or numerous meetings, increased workloads, and poorly planned workstations. These findings are similar to previous research such as Bort-Roig et al. (2014) who identified that office workers perceived that screen-based work which required them to remain seated at their computer was the most prominent barrier. To overcome some of these barriers the participants in the current study suggested changing the work environment, providing prompts, and increasing support from managers or other relevant areas. Similar findings were presented by Waters et al. (2016) who described workplace culture and the physical environment as key strategies to improve the likelihood of reducing occupational sedentary behaviour for office workers. Based on the current findings and previous literature, it appears that being able to overcome barriers depends on financial support and cultural buy-in from management or the organisation. Due to the financial cost of installing sit-to-stand workstations or changing the environment, it is advised to promote goal setting surrounding walking or standing activities as the means of reducing occupational sedentary behaviour. Providing opportunities for employees to actively engage with their behaviour change by

planning goals to reduce occupational sedentary behaviour may increase the levels of perceived behavioural control experienced by the employees (Ajzen, 1991). This strategy however, requires support for a workplace culture change by those in senior management roles which may influence subjective norms and attitudes surrounding reducing occupational sedentary behaviour (Ajzen, 1991).

Previously, short-term occupational sedentary behaviour change has been linked to participants having perceived behavioural control over the behaviour; however barrier self-efficacy was linked to long-term (12 months) reductions in occupational sitting time (Hadgraft et al., 2017). During the intervention period of the current study, participants most likely perceived they were in control of their behaviour as a result of significant reductions in sitting time and high self-efficacy to achieve their goals. It is likely however, that the participants had low self-efficacy to overcome barriers that presented themselves after the intervention and therefore long-term behaviour change did not occur. The planning that the workers participated in was action planning rather than coping planning (Leventhal, Singer, & Jones, 1965; Sniehotta, Schwarzer, & Scholz, 2005). To explore this concept further with respect to the current study, the participants set goals on how they will perform their sedentary behaviour change in the workplace however they did not plan for strategies to overcome barriers other than discussing them with the principal investigator during the regular communication. Once the intervention ceased, the principal investigator did not contact the participants and therefore verbal persuasion was no longer provided. The lack of planning to overcoming barriers, and the removal of verbal persuasion may have hindered the long-term behaviour change adherence for some participants.

The current study provides interesting insight into the long-term adherence to and barriers of a theory-informed, multi-component intervention. The study is not without limitation, including the small sample size and predominantly female population group. Therefore, the findings may not be generalisable to other workplaces or population groups. However, the findings of the current study contribute to the literature which suggests further research is required to determine effective interventions to reduce occupational sedentary behaviour in the long-term (Shrestha et al., 2016). Future research should continue to explore long-term adherence to sedentary behaviour interventions, with a particular focus on strategies to overcome perceived barriers which would increase barrier self-efficacy.

5.6 Conclusion

The group average reduction in daily sitting time between pre- and post-intervention was maintained at six months. For participants without access to a sit-to-stand workstation, the reduction in sitting time was not maintained at the six month follow-up. Of the 23 participants, 10 participants were able to stand or walk for 2 hr/work day, and seven participants were able to reach the 4 hr/work day recommendation. As expected, there were barriers identified by the participants which included longer or numerous meetings, increased workloads and poorly planned workstations. These barriers are the likely cause of the relapses identified during the interviews. To overcome some of the barriers, participants suggested that there are a variety of strategies which could be implemented such as changing the work environment, providing prompts, and having support from managers or other relevant areas. The findings of the current study suggest that short-term behaviour change can occur as a result of a low-cost, theory-informed, multi-component, individually-tailored intervention however long-term adherence to sedentary behaviour is compromised once the

intervention strategies are removed. Further research is required to explore the long-term

effectiveness of theory-informed, multi-component interventions.

Chapter 6 Additional Findings, Overall Summary, and Conclusions

The following chapter provides additional findings not previously reported in chapters 2 – 5, including example case studies. Following this, overall key findings, practical recommendations, strengths and limitations, future research opportunities, and a conclusion for the thesis is provided.

6.1 Additional Findings

The additional findings include case studies, health and work benefits, barriers, and the negative impacts on health and work as a result of the intervention.

    6.1.1 Case studies. Due to the individualised nature of the intervention, this section includes case studies of two participants who were able to successfully reduce their occupational sedentary behaviour. Successful reduction of sedentary behaviour was considered if the participants were able to meet the recommendation as outlined by Buckley et al. (2015) for reducing occupational sitting time by standing or walking for 4 hr per day. Participant 5 did not have access to a sit-to-stand workstation, while participant 16 had access to a sit-to-stand workstation (prior to and during the intervention) but had high levels of sitting prior to the intervention. After the multi-component intervention was implemented, the participants were able to increase standing or walking time by four or more hours despite this not being a specific goal of the intervention.

    6.1.1.1 Participant 5. Participant 5 did not have access to a sit-to-stand workstation during the intervention or follow-up period however was able to meet or exceed the 4 hr recommendation of standing or walking during work hours on at least one day during the six

month follow-up monitoring period (Figure 6.1). Participant 5 was in the action stage at the
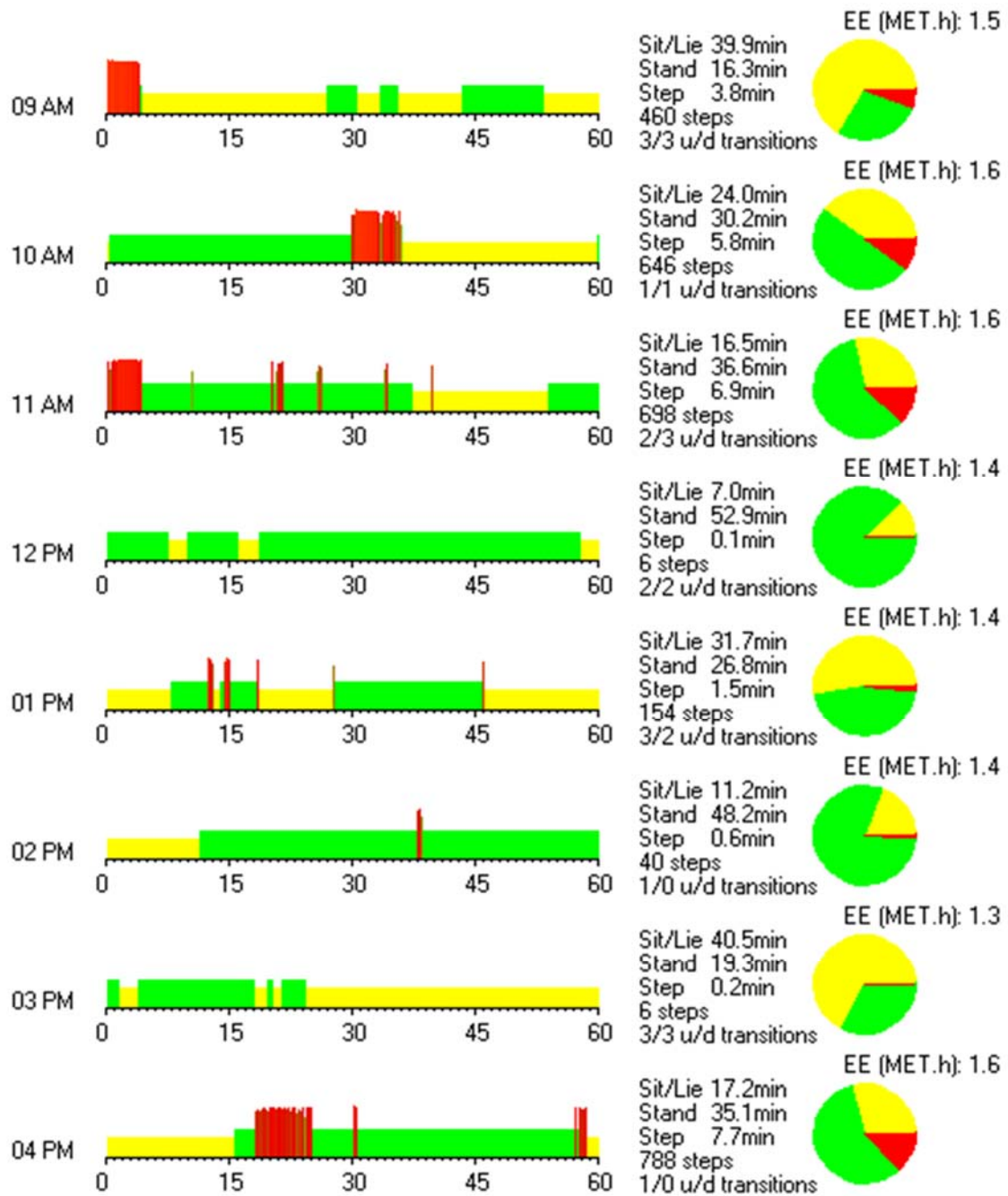
six month follow-up.

Figure 6.1 ActivPAL™ data for participant 5 who achieved standing or walking for 4 or more hr during the six month post intervention data collection phase.

Note: yellow = sitting, green = standing, red = walking.

The participant incorporated the following goals during the intervention period.

- Week 1 - Goal 1. During the work day I will empty my recycling bin

- Week 2 - Goal 2. During the work day I will stand every hour (plus Goal 1)

- Week 3 - Goal 3. During the work day I will stand while on the phone (including teleconferences) (plus Goals 1 & 2)

- Week 4 - Goal 4. During the work day I will walk to at least one meeting which will be scheduled outside of my office (plus Goals 1, 2 & 3)

- Week 5 - Goal 5. During the work day I will walk for 10 min at lunch or afternoon tea (plus Goals 1, 2, 3 & 4)

- Week 6 - Goal 6. During the work day I will walk during a meeting with a staff member (plus Goals 1, 2, 3, 4 & 5)

Participant 5 indicated that they were more aware of their sedentary behaviour as outlined by the following response *"I'm definitely a lot more conscious of [sitting] than I was previously...it's definitely front of mind."* Participant 5 also indicated they were proactive in reducing their sedentary behaviour such as incorporating standing during workshops as outlined by the following response *"last week we had a workshop over a couple of days and I did position myself to sit at the side of the rooms so that I could then every so often actually stand up and it wasn't in the way of anyone or walk across the room or bring attention to it in any way."* Participant 5 was able to achieve the 4 hr recommendation without the use of a sit-to-stand workstation on one day during the follow-up data collection period. Therefore, it is

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plausible for office workers to achieve the recommended reduction in occupational sitting time by utilising a multi-component intervention that include strategies such as receiving education and individualised feedback, prompts, goal setting, and self-commitment. It is unlikely however that the goals are effective for everyone as the very intent was to develop personalised goals (Chapter 4 findings), and it may be highly dependent on the work environment and support from others (e.g. social norms surrounding visiting colleagues instead of using electronic versions of communication).

   6.1.1.2 Participant 16. Participant 16 had access to a sit-to-stand workstation prior to the intervention, during the intervention and the follow-up period, and was able to meet or exceed the 4 hr recommendation of standing or walking during work hours on at least one day during both the post-intervention and the six month follow-up monitoring periods (Figure 6.2). Participant 16 was in the maintenance stage at the six month follow-up.
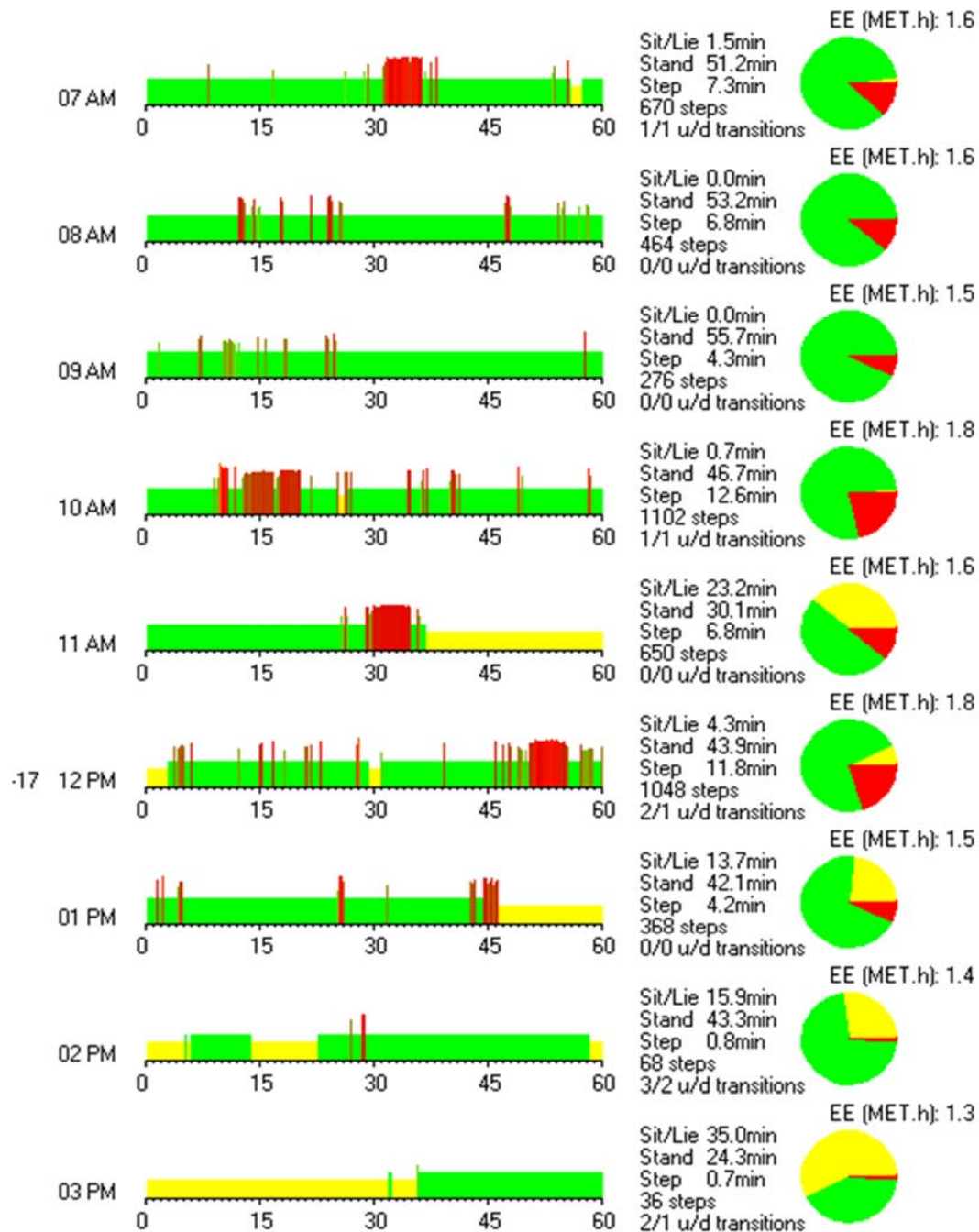
Figure 6.2 ActivPAL™ data for participant 16 who achieved standing or walking for 4 or more hr during the six month post intervention data collection phase.

Note: yellow = sitting, green = standing, red = walking.

The participant incorporated the following goals during the intervention period.

- Week 1 - Goal 1. During the work day I will stand each time the phone rings

- Week 2 - Goal 2. During the work day I will stand for the duration of each phone call (plus Goal 1)

- Week 3 - Goal 3. During the work day I will walk to another floor to fill my water bottle (plus Goals 1 & 2)

- Week 4 - Goal 4. During the work day I will stand each time I read an email from [department] (plus Goals 1, 2 & 3)

- Week 5 - Goal 5. During the work day I will stand each time I access a [specific] computer program (plus Goals 1, 2, 3 & 4)

- Week 6 - Goal 6. During the work day I will stand each time I change workbooks in excel (plus Goals 1, 2, 3, 4 & 5)

Participant 16 indicated that they were able to continue with some of the goals set for the intervention as outlined during the six month follow-up interview *"I've continued with some of the initial things like filling up my water bottles at different places... instead of getting on the phone actually walking to people and speaking to them."* The majority of the reduced sitting time was due to using the sit-to-stand workstation and has resulted in participant 16 suggesting *"I've continued standing up all day, every day"* as also evidenced by the predominance of green (standing) in the ActivPAL™ data example (Figure 6.2). Additionally, participant 16 added other strategies to reduce sitting time such as *"[I'm] making the effort to park away [from the office] and walk in, walk between the meetings, and with one of my other colleagues we've also implemented walking meetings now that it's a bit cooler. So we walk and talk rather than sit down and have a meeting."* This created a flow-

on effect where participant 16 changed activities at home to reduce sitting time as outlined by the participant during the follow-up interview *"I'm actually finding that I'm standing up and doing things standing up. While I'm sewing or working at home, it's more natural for me to stand up and do things rather than sit down."* Participant 16 had access to a sit-to-stand workstation prior to the intervention however their occupational sitting time averaged 5.9 hr/work day pre-intervention, which suggests they were unlikely to be using the workstation effectively. This has also been identified in previous literature which suggested that even though workers had access to a sit-to-stand workstation, the majority did not actively use them (Danquah et al., 2017). The current intervention reduced occupational sitting time by an average of 3.5 hr/day immediately post-intervention with a further reduction of 36 min/day at the six month follow-up data collection period for participant 16. This highlights the importance of increasing awareness for occupational sitting time, and the need to develop achievable goals to ensure sit-to-stand workstations can be effectively integrated into sedentary behaviour change interventions. This notion was reported by Neuhaus et al. (2014a), who found that installing sit-to-stand workstations alone did not result in reduced sedentary behaviour. When the intervention included education, coaching, and prompts, the use of the sit-to-stand workstations increased (Neuhaus et al., 2014a). Therefore, the inclusion of multiple strategies to reduce occupational sedentary behaviour appears to be the most effective intervention, and supports Chu et al. (2016) and Gardner et al. (2016). As participant 16 is in a managerial role, there is the potential that they could be a role model in their workplace and act as a workplace champion (Gilson et al., 2011; Healy et al., 2016) to encourage others to reduce their sitting time. This may increase others' self-efficacy through modelling and vicarious experiences (Bandura, 1977).

The similarities between the two case studies include achieving some of the goals set during the intervention period and the inclusion of additional strategies to reduce occupational sitting time once the intervention was completed. This may suggest that the participants engaged in the process of consciousness raising as they became more aware of their sedentary behaviour as a result of the intervention (Prochaska et al., 1988). The participants had high self-efficacy (participant 5 = 85%, participant 16 = 100%) towards reducing occupational sedentary behaviour at the six month follow-up. This is likely a result of experiencing successful mastery experiences (Bandura, 1997) for changing their behaviour during the intervention. Additionally, the participants were likely to have experienced perceived behavioural control (Ajzen, 1991) through their selection of behaviour change strategies, and self-liberation (Prochaska et al., 1992) by committing to changing their occupational sitting time.

6.1.2 Health and work benefits and negative impacts on health and work. The health and work benefits and negative impacts on health and work were explored immediately post-intervention via one-on-one interviews with the 27 participants who completed the intervention.

The two most prominent themes identified by the participant group regarding health benefits associated with the intervention ($n = 15$) were improved musculoskeletal health ($n = 7$), and improved mental health ($n = 8$). The benefits were attributed to the behaviour change goals that were associated with reducing sitting time via standing and/or moving. This was characterised by responses such as:

"I feel better – my shoulders aren't as tight... I was having a lot of issues with my shoulders and my neck from sitting so much so I haven't had any issues in the last couple of weeks." (Participant 7)

"Well my back was less sore, so the more I stand the better my back is, and I find that I tend to stand taller not so hunched." (Participant 14)

"I feel better just from being active I don't like being inactive and I think that has a big play on your mindset and how you deal with day to day stuff as it happens in the office.... Just to remove yourself from these four walls and look at something different you come back with a clearer head." (Participant 9)

"I feel better when I get up and move around I think the brain works better when I get up and move around." (Participant 8)

Fifteen participants identified that reducing their sitting time by completing their set goals helped them to remain focused at work, while six participants suggested that they could not identify any positive influence on their work or work tasks as a result of participating in the intervention. The work benefits that were reported are characterised by responses such as:

"I definitely think [standing/walking] kept me focused, if I would lose focus I would go and do one of my activities and then I would be able to come back and be refocused." (Participant 7)

"I find that in the second half of the day when you get up and do the lunch walk you are less tired. Maybe [standing] gives you that extra bit of concentration that helps... You come back refreshed in your mind so you can get started again." (Participant 8)

Improved musculoskeletal health benefits, increased energy levels, and being able to concentrate on work tasks have been similarly identified by Grunseit et al. (2013) as beneficial outcomes for reducing occupational sitting time for office workers. The participants identified that musculoskeletal pain would subside with increased standing, and that standing allowed the participants to feel more alert. Similarly, another group of workers indicated that they felt mentally refreshed and reported reduced musculoskeletal pain when occupational sedentary behaviour decreased via sit-to-stand workstations (Leavy & Jancey, 2016). The improved musculoskeletal health is likely due to the change in body position as sitting for prolonged periods increases the prevalence of musculoskeletal complaints (Cho et al., 2012; Gerr et al., 2004; Ortiz-Hernandez et al., 2003). Gruinseit et al. (2013) suggested that in addition to musculoskeletal improvements, the inclusion of other health benefits for educational purposes may be useful when encouraging participants or employees to stand more often. The current findings combined with previous findings suggest that irrespective of the intervention design, participants are likely to experience some improvements in musculoskeletal health and mental health as a result of reducing occupational sitting time, which could be included in future recommendations or education for workplaces. Those participants who did not indicate any positive influences of reducing their sitting time may not have reduced their occupational sedentary behaviour by a substantial amount to notice a change.

Fourteen participants indicated that there were no negative health impacts associated with the intervention. Some participants identified that reducing occupational sitting time was associated with 'musculoskeletal issues' such as sore feet or knees ($n = 4$). This was characterised by responses such as:

"I get sore feet so I sit down." (Participant 14)

"Just my knees were sore some days from standing up all day but I don't have good knees anyway." (Participant 16)

Similar findings were evident in a study conducted by Grunseit et al. (2013) who indicated that there are negative impacts of increased standing where physical complaints require participants to change to a seated position. It is likely that musculoskeletal injuries are pre-existing, and may be exacerbated by increased standing time. To reduce this concern, an anti-fatigue floor mat could be used to reduce discomfort while standing (King, 2002), or employees could alternate between sitting and standing activities throughout the work day (Buckley et al., 2015).

Eleven participants indicated that there were no negative impacts associated with work or work tasks, while seven participants identified negative elements. Participants perceived that often the goals would take them away from their desk or that completing the workbook was distracting which they perceived as adversely influenced their work output. This was defined as 'a distraction from work' ($n = 5$) and was characterised by the following responses:

"[Some goals] took me away from the desk. It's a little bit offset because I think getting away from it also makes you a bit more productive when you come back but there's more guilt associated with it and because you can see tangibly you're not at your desk it makes you think 'I've got to make up for that'." (Participant 13)

"I didn't want to feel like I was being unproductive… I am a very conscientious worker and have things to do, so is taking an extra couple minutes to go to the bathroom really worth it?" (Participant 22)

"I guess some days filling [the workbook] out was hard, …you just want to get on with your work." (Participant 1)

Previously, office workers perceived that being seated at their desk was a reflection of their work productivity (Cole et al., 2015; Gilson et al., 2011). Interestingly, the use of the words 'unproductive' 'guilt' and '[is doing the goal] really worth it' by participants in the current study when discussing completing work tasks could be seen as complying with the social norms. Previous literature suggests that workers feel the need to justify their absence from their desk (Hadgraft et al., 2016) and that they must remain seated to be seen as being productive (Gilson et al., 2011). This social/cultural norm concept is further explored in section 6.1.3.

The varied responses regarding the positive and negative effects of reducing sitting time for health and work suggests that there is a need to individually tailor interventions as previously supported by literature (Marcus et al., 1998; Marcus et al., 2007). This is particularly important for participants who perceived negative effects as potential barriers for reducing their occupational sedentary behaviour, and suggests their strategies should match their level of willingness to change (Prochaska & DiClemente, 1983) and barrier self-efficacy (Hadgraft et al, 2017). This ensures that a variety of strategies are offered to workers to suit their needs and circumstances and allows for ownership of their strategies.

6.1.3 Barriers. The key barriers that reoccurred throughout the chapters were workload or the perception of being too busy, seated meetings, and the environmental

configuration of the office space. The negative impact of workload and seated meetings, are likely to be related to the social or cultural norms, and the physical environment of the workplace, and is explored in more detail.

As identified in chapters 3 and 5, participants perceived seated meetings as a barrier to reducing occupational sitting time. This was also identified immediately post-intervention by participants responding with statements such as: *"when I've got meetings scheduled I'll be sitting in a chair for three hr or staff training sessions it's just not do-able. There is nothing you can do, you are just trapped."* (Participant 24).

This barrier is likely to be associated with the cultural norm and the physical environment of the organisation which encourages staff to sit during meetings by providing long and low-set tables and chairs with no area or desks to allow for standing to occur. This is described by one participant who suggested *"those longer meetings or when you are not in control of the meeting…there almost needs to be a cultural change in the [organisation] to recognise when you have groups of people together for long lengths of time you are actually promoting this unhealthy behaviour.…I have noticed that sometimes especially in those workshop type situations, other people were getting up and standing and that sort of thing so I figure it's more a modelling of the behaviour and then if a meeting is long, being conscious and maybe calling to have a break part the way through."* (Participant 5). Similarly, another participant indicated that their only barrier was seated meetings *"when I do have meetings with [group], I don't feel confident to stand up in their presence. Even though I think they would understand and be supportive of that"* (Participant 16).

Additionally, perceived workload was a consistent barrier across chapters 2, 3 and 5 and is discussed in the negative health and work outcomes (section 6.1.2). Modifying the

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environment was identified as a barrier for some participants even though it was a prominent

choice as a potential strategy to reduce occupational sitting time. When discussing the option

of obtaining a sit-to-stand workstation three participants indicated that unless they have a

medical condition which requires them to interrupt sitting time, they are unlikely to be

successful when asking management for support. This was characterised by responses such as

"unless there's a medical condition, the director is not going to [purchase a sit-to-stand

workstation], I know that, I don't have to ask, I know"(Participant 1), *"I did ask about the*

sitting/standing desks…to have access to one of those desks, we basically have to have a

medical condition" (Participant 6).

These barriers relate to the 'opportunity' component of the capability, opportunity or

motivation framework for understanding behaviour (Gardner et al., 2014; Michie et al., 2011)

and perceived behavioural control (Ajzen, 1988) whereby the participants are faced with an

external factor which they do not feel capable of overcoming to achieve their behaviour

change goals. The social or organisational norms are key barriers and need to be addressed

such that the behaviour change needs to be considered as a normal occurrence in the

workplace (Hadgraft et al., 2016). For example, managers could be viewed as role models

(Owen et al., 2014) and offer helpful relationships (Prochaska et al., 1992). As outlined by

the participants, seated meetings are unavoidable and this is a key situation where those in

managerial roles could change the cultural norms surrounding occupational sedentary

behaviour, and encourage employees to take short breaks from sitting throughout the

meeting. This would increase self-efficacy towards sedentary behaviour reduction through

modelling and vicarious experiences (Bandura, 1977). Additionally, at an organisational or

environmental level, it is important to consider the physical environment. The issues

surrounding not having access to a sit-to-stand workstation can be addressed by creating

standing spaces with existing furniture, and encouraging employees to set individually-

tailored goals that work in their work space to reduce their occupational sitting time.   This is

particularly useful when the budget does not allow the opportunity to provide all employees

with a sit-to-stand workstation. An example of this is outlined by one participant who

decided to change their environment to increase the likelihood of interrupting their sitting

with standing bouts *"I've created a work station... I just use my filing cabinet as a*

workstation to do stapling, punching holes, filing and that sort of stuff... I actually force

myself to stand up when I punch holes and staple things... So, I'm up and down a bit more…"

(Participant 8). As Biddle and Bennie (2017) and Cooley and Pedersen (2013) suggested that

there needs to be low-cost options available, the use of the existing environment and other

individually-tailored psychosocial behaviour change strategies to reduce occupational

sedentary behaviour can be implemented widely across a variety of workplaces.

6.2 Overall Key Findings of the Thesis

The aim of the current thesis was to implement and evaluate a theory-informed, low-cost,

individually-tailored, multi-component intervention to reduce sedentary behaviour in the

workplace. The overarching research question for the thesis was: can the use of individually-

tailored, theory-informed strategies reduce occupational sedentary behaviour? The key

findings of the thesis are outlined below with the relationship to the aims and research

questions provided as described in Chapter 1.

Sitting is problematic

Office workers perceived there is a negative relationship between sitting time and their health.

This was described in Chapter 2 and Chapter 4 and aligns with aim 1 and research question 1.

In regards to the TTM, the progression through the stages relates to participants acknowledging that the problematic behaviour is a concern (Cassidy, 1997). If the target population do not perceive that occupational sedentary behaviour is a problematic behaviour, they are unlikely to progress through the stages of the TTM. This finding indicates that the target population considers sedentary behaviour problematic and therefore providing an intervention to address the behaviour would be appropriate.

Intervention strategies need to be varied

Office workers indicated that planning for sedentary behaviour interventions should include education, supportive managers, and a variety of strategies. This was described in Chapter 2 and aligns with aim 2 and research question 2. Prior to the intervention, it was important to determine what the target population perceived would work in their workplace. Employees suggested that having a variety of strategies would be ideal. This would address individual preferences (Marcus et al., 1998; Marcus et al., 2007) and match the level of willingness of the participants (Prochaska & DiClemente, 1983). Of particular interest, employees thought education was crucial and this was used for consciousness raising during the intervention (Prochaska et al., 1988). Future support from management could be via role modelling, environmental changes, and encouragement to change sedentary behaviour.

Reductions in occupational sedentary behaviour is possible for self-changers

Successful self-changers in the target workplace, who were in the action or maintenance stage of change, modified their environment, included walking during their work day, and had support from managers and/or peers to change their occupational sedentary behaviour. This was described in Chapter 3 and aligns with aims 3 and 4 and research question 3. Prior to the intervention, it was important to determine strategies that were currently working for the

specific workplace. While all participants had access to sit-to-stand workstations, there were also other low-cost strategies which assisted in their sedentary behaviour reduction. The most prominent low-cost option was purposeful walking which has previously been identified in research (Commissaris et al., 2016; Gilson et al., 2011) and therefore was suggested as a useful goal during the intervention.

A theory-informed, low-cost, individually-tailored, multi-component intervention can reduce occupational sedentary behaviour

A simplistic six week theory-informed, low-cost, individually-tailored, multi-component intervention reduced occupational sitting time by 45.2 ± 60.7 min, or 25.0 ± 35.4 min/day for those without a sit-to-stand workstation, however further reductions (113.9 ± 81.6 min) occurred when participants had access to sit-to-stand workstations. This was described in Chapter 4 and aligns with aim 5 and research question 4. Six months post-intervention, the participants were able to reduce their occupational sitting time by 40.6 ± 76.1 min/day compared to pre-intervention, however those without a sit-to-stand workstation (15.8 ± 44.2 min/day) were unable to continue with their significant reduction from post-intervention. Those with access to a sit-to-stand workstation were able to reduce their occupational sitting time by 110.9 ± 105.7 min/day compared to pre-intervention which approached significance. This was described in Chapter 5 and aligns with aim 6 and research questions 4 and 6.

The findings of the current study are similar to previous literature (Mackenzie et al., 2015; Mailey et al., 2016). This suggests that short-term occupational sedentary behaviour can be modified, and may result in perceived positive health benefits such as reduced musculoskeletal complaints, improved mental health, and increased focus as outlined in section 6.1.2. The current study suggests that the varying components of the intervention were

effective when combined such that the strategies were theory-informed, low-cost, and individually-tailored. An example of an effective strategy included in the study is goal setting which was a large focus of the intervention. Goal setting is cost-effective because it requires limited use of resources, can be individually-tailored to the participant's needs and work environment, can be developed in conjunction with the participant, and has strong links with the TPB and the SCT. This strategy was effective as investment in achieving goals can be enhanced when participants play an active role in the goal setting process (Bandura, 1988), increasing their ownership of their behaviour and perceived behavioural control (Ajzen, 1991), as well as increasing their motivation and self-efficacy (Bandura, 1988). The monitoring of long-term sedentary behaviour change is limited (Shrestha et al., 2016) and therefore this study suggests that the strategies implemented during the six week intervention need to continue after the intervention ceases for long-term behaviour change to occur. Additionally, the follow-up indicated that environmental changes such as sit-to-stand workstations in conjunction with the behaviour change strategies provide further opportunities to reduce or interrupt sitting.

Transitions in the TTM occurred

Participants successfully transitioned to the action stage of the TTM model by reducing their occupational sitting time for between one day and six months during the intervention with seven participants, indicating they had progressed to the maintenance stage at the six month follow-up. This was described in chapters 4 and 5 and aligns with aims 5 and 6 and research question 5. Relapses in sedentary behaviour change occurred due to perceived barriers and the cyclical nature of the TTM. These findings were described in chapters 2, 3 and 5 and aligns with aim 6 and research question 5 and 7. As a result of the intervention, participants were able to successfully move to the next stage of the TTM. This most likely occurred due to the

provision of individualised strategies in the intervention to ensure that the strategies matched the level of willingness of the participant (Prochaska & DiClemente, 1983). There were relapses evident throughout the studies which can be expected in behaviour change attempts (Prochaska et al., 1997).

Successful experiences can increase self-efficacy towards goal achievement

Self-efficacy towards goal achievement was increased over a six week intervention and remained high at six months post-intervention. These findings were described in chapters 4 and 5 and aligns with aims 5 and 6 and research question 4 and 5. This increase in self-efficacy was most likely due to the occurrence of mastery experiences due to the progressive nature of the goals. Once confidence to complete the task increased, the participant was able to continue with their behaviour change. Bandura (1977) suggests that people who perceive themselves as being capable of achieving or coping with the desired behaviour change, and having successful experiences will result in increasing mastery expectations. The successful experiences can reduce the negative feelings of the occasional failure and may strengthen self-efficacy for further efforts (Bandura, 1977).

Barriers prevented behaviour change

A variety of barriers were identified as potential inhibitors for reducing occupational sedentary behaviour. The major barriers surrounded the social norm to remain seated for example attending meetings or training, and poor environmental design for example workstations not being conducive to standing or not providing enough desk space. Additional barriers included feeling fatigued, perceived increases in workload or the need to sit while undertaking specific work tasks, and the climate for walking outdoors. Changing the work environment by installing sit-to-stand workstations or creating a standing space, providing prompts by installing

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computer software, having campaigns or competitions, and changing the culture surrounding seated meetings were suggested by participants to overcome some of the perceived barriers. This was described in chapters 2, 3, and 5 and the additional findings section 6.1.3 and aligns with aim 4 and research question 7. As previously mentioned, the perceived barriers are most likely the outcome of a lack of perceived control of the behaviour or situation. For example, not feeling capable of standing during a meeting due to the social norm to remain seated for the entirety of the meeting. Similar barriers have previously been reported (Bort-Roig et al., 2014; Cooley et al., 2014; Hadgraft et al., 2016). Verbal persuasion was included in the current study to assist with overcoming barriers and participant goals were modified if necessary. Unfortunately, verbal persuasion is weaker in comparison to mastery experiences (Bandura, 1977) and therefore may not have been sufficient to overcome the perceived barriers throughout the intervention. Having strategies to overcome perceived barriers was not included in the current study and therefore should be addressed in future interventions by providing strategies to enhance self-efficacy towards overcoming obstacles (Hadgraft et al., 2017).

The recommendations suggested by Buckley et al. (2015) can be met

Achieving the recommendation of reducing occupational sedentary behaviour by standing or moving for 2-4 hr during work hours can be achieved, and the likelihood of success is strengthened if environmental or cultural norm changes occur (i.e. provision of sit-to-stand workstations and inclusion of standing meetings). This is described in chapters 4 and 5 and aligns with aim 5 and 6 and research question 8. The recommendations set by Buckley et al. (2015) are still arbitrary due to the limited evidence surrounding occupational sedentary behaviour. While the current study suggests it is possible to meet the recommendations, Chau et al. (2017) highlighted that the recommendations are unlikely to be achieved in all

workplaces. This suggests that caution should be taken when promoting the recommendations during an intervention as they may be perceived as unreasonable or unachievable. The participants in the current study were not advised of the recommendations during the intervention, rather the quantitative data were compared post-intervention to the 2 and 4 hr guidelines.

6.3 Practical Recommendations

Based on the findings of the current thesis, practical recommendations have been developed to assist with the design and delivery of future occupational sedentary behaviour interventions.

- Prior to implementing an intervention, determine employee perceptions of occupational sedentary behaviour to ensure the strategies are appropriate for their needs; and explore what barriers may prevent behaviour change from occurring.

- Educate managers on the importance of reducing occupational sedentary behaviour and encourage them to support positive behaviour change in the workplace.

- Address cultural and social norms within a workplace to ensure that staff are encouraged to take short breaks rather than being criticised for being away from the desk and ensure colleagues are aware of behaviour change attempts. Employees can provide modelling of the behaviour such as the suggestions below:

  - Meeting convenors can lead standing bouts during meetings. For example, meeting convenors could stand every 30 min during training or meetings and encourage colleagues to participate and remain standing if possible. This may lead to increased self-efficacy of employees due to vicarious experiences,

modelling, verbal persuasion, and mastery experiences once the behaviour has been successfully completed.

- o Walk to visit colleagues rather than emailing. This could be encouraged by managers and could be modelled as acceptable and normal behaviour in the workplace.

- Encourage staff to set their own goals regarding sitting time as this provides a strong sense of purpose and direction.

- o Encourage staff to introduce walking goals as this was described as the most effective goal during the intervention and during the six month post-intervention period.

- Include self-monitoring in the form of a workbook or log book as the majority of the participants perceived self-monitoring as a helpful reminder to complete their goals, and prompts were suggested by participants as a strategy that could assist with long-term adherence to behaviour change.

- Where possible, support the purchase of sit-to-stand workstations or provide standing space as participants who had access to sit-to-stand workstations were able to reduce their sitting time by 111-114 min/work day. It is important to note that additional strategies such as goal setting, commitment and monitoring, need to be implemented in conjunction with the workstation for successful behaviour change to occur.

6.4 Strengths and Limitations

The majority of existing literature surrounding occupational sedentary behaviour interventions do not explicitly use theoretical frameworks in the implementation or evaluation of behaviour change strategies (Gardner et al., 2016; Prapavessis et al., 2015;

Rhodes et al., 2012). While the inclusion of strategies without reference to theoretical frameworks is a common occurrence in physical activity and sedentary behaviour interventions, the inclusion of theoretical frameworks in the current thesis is a novel aspect and provides insight into the theoretical underpinnings of sedentary behaviour change. The individually-tailored aspect of the intervention is a strength of the thesis as having ownership, a positive attitude, and increased effort towards one's own behaviour change can increase the likelihood of successful behaviour change occurring (Ajzen, 1991; Bandura, 1977; Locke, 1996). As long-term adherence to sedentary behaviour change interventions has not been extensively researched (Shrestha et al., 2016), this is another strength of the current thesis as the six month follow-up explores long-term effectiveness of the theory-informed, individually-tailored intervention. Finally, the data collected provides rich and detailed findings due to the qualitative component of the chapters whereby the qualitative data explores and explains the quantitative findings providing in-depth discussions surrounding occupational sedentary behaviour change.

The thesis is not without limitations, such that the findings may lack some generalisability. For example, the findings are specific to a geographical location, North Queensland, Australia. The participants indicated that the climate was a barrier to performing walking goals such as walking meetings outdoors during working hours. This is likely due to the tropical environment of the study location with mean temperatures for September to December months (the intervention period) ranging from 27.8-31.5°C and relative humidity ranging from 60-66% and thunderstorm build-up starting in late October (Bureau of Meteorology, 2017). Interestingly, the most effective goal as described during the six month follow-up interviews was walking goals. Therefore, the change in climate during the six

month period (January to June) after the intervention may have allowed more walking to occur, and hence the climate may not be an issue for geographical locations where the climate is comfortable to be outdoors for all months of the year. Another limitation is the predominantly female samples throughout the thesis and therefore the findings may not be applicable to male office workers. It can be argued that the predominantly female sample group is representative of office-based workers who undertake clerical and administrative work (Gabriel & Schmitz, 2007) and therefore, may be representative of the type of work tasks that female employees typically undertake but the findings may not be generalisable to workplaces who have a predominantly male workforce. Recently, Lakerveld and colleagues (2017) determined through a Chi-squared automatic interaction detection algorithm that females are at risk of sitting too much (>7.5 hr/day) especially females who had white-collar or manual jobs. Therefore, although there is a gender disparity of the participants in the studies, working females are an ideal target group due to the amount of sitting they undertake as outlined by Lakerveld et al. (2017).

The recruitment processes for each study within the thesis were voluntary, thus creating a potential bias towards individuals who were already conscious of their health and/or of the health impacts of sedentary behaviour. This is demonstrated by Gardner, Smith, and Mansfield (2017) who conducted qualitative analysis on the comments sections of media websites which discussed the guidelines (Buckley et al., 2015). The authors found that the guidelines would be adopted by those who were already aware of their health and physical activity and therefore failing to reach the target audience of people who sit for extended periods of time. This effect was described as "preaching to the converted" (Gardner et al., 2017). In the context of this thesis, although not assessed, the motivated individuals who are

able to reduce their occupational sitting time may have acted as role models, provided

education, and encouragement to their colleagues to reduce their occupational sitting time.

Therefore, the recruitment bias is important to highlight in regards to the findings of the

thesis however from a behaviour change focus, the willing participants may have provided

another level of support to other colleagues engaged in the intervention. Additionally, the

project did not include a control group for comparison due to the individually tailored aspect

of the intervention which required a pre-post evaluation.

Due to the qualitative nature of some of the data collection, the health benefits

associated with reducing occupational sedentary behaviour reported in the additional findings

were self-reported and not directly measured. Although the current findings may not provide

definitive results regarding health benefits of reducing occupational sedentary behaviour, the

perceived health benefits may provide motivation for an individual to continue with their

behaviour change. This related to the findings of Carpenter (2010) who suggested that

perceived benefits of performing a target behaviour is one of the strongest predictors of

behaviour. Therefore, the method of data collection may be a limitation of the current study

however the perceived benefits may strengthen the behaviour change process.

6.5 Future Research

Changing behaviour occurs over a long period of time and therefore future research should

further evaluate the long-term adherence of reductions in occupational sedentary behaviour.

More specifically, future research should include explicit theoretical frameworks to discuss

the potential reasons for intervention adherence and non-adherence for high- and low-cost

options, and what strategies may be useful to overcome the perceived barriers. Low-cost

options are of particular interest due to the financial burden of installing sit-to-stand

workstations (Cooley & Pedersen, 2013; Neuhaus et al., 2014a). Following this, successful

low-cost interventions should then be compared across a range of workplaces and

employment roles to determine if low-cost options are appropriate and financially viable for a

variety of workplaces. Some low-cost options which may be useful that were not included in

the current intervention include self-monitoring via free phone applications, and a buddy

system. The use of applications will be less arduous than the workbook utilised in the current

study and show some emerging evidence of their effectiveness (Schoeppe et al., 2016).

Previously buddy systems have been suggested as a strategy to increase physical activity

levels via mutual support, motivation, and accountability (Mayer, Nuzzo, & Dagenais, 2013).

All strategies incorporated in future interventions should be multi-component to address

individual preferences.

In the current thesis, it is unclear if there is one strategy in particular which resulted in

behaviour change for office-based workers. It is likely that behaviour change occurred as a

result of a combination of strategies which has also been found to be promising in recent

reviews of literature (Gardner et al., 2016). As participants from the design phase of the thesis

indicated that they would prefer a variety of strategies to reduce sedentary behaviour which

aligns with previous literature; it was concluded that this would be the best approach to

reduce occupational sedentary behaviour. Alternatively, Michie and Abraham (2004)

indicated that research could isolate behaviour change strategies to evaluate the effectiveness

of an intervention which may determine the most promising isolated component.

As the recommendations by Buckley et al. (2015) are still arbitrary, future research

could explore the benefits of achieving these recommendations to strengthen the scientific

rigour of the guidelines. The findings can then be used in the development of policies for

workplaces regarding occupational sedentary behaviour. This is particularly important as Coenen, Gilson, Healy, Dunstan, and Straker (2017) identified that there are currently no occupational safety and health policies at a national or international level regarding excessive occupational sedentary behaviour.

Finally, due to the prominent barriers surrounding workplace cultural or social norms identified throughout the thesis, future research could explore strategies to overcome this barrier. Although the thesis included action planning (Leventhal et al., 1965), where participants were involved in the how, where, and when (Sniehotta, Scholz, & Schwarzer, 2006) of reducing their occupational sedentary behaviour, the inclusion of coping planning (Leventhal et al., 1965) may assist in the participants' ability to overcome difficult situations or obstacles (Sniehotta et al., 2006). The inclusion of action planning and coping planning within the health action process approach (Schwarzer, 2008) has recently been shown to increase breaks from sitting for University students (Sui & Prapavessis, 2018). Therefore, future research should include strategies to overcome barriers that are relevant to the population being investigated. As previously mentioned, employers and managers need to provide a culture shift to ensure breaks in sitting time are perceived as acceptable behaviours (Cole et al., 2015). Future research could explore the acceptability and feasibility of having managers or leadership groups lead by example using simplistic, low-cost methods to reduce occupational sedentary behaviour such as walking or standing meetings in workplaces where seated meetings are common.

6.6 Conclusion

This thesis was able to measure, monitor, and reduce occupational sitting time for office-based workers and successfully answered the research questions as outlined in Chapter 1.

The thesis followed an exploratory approach whereby the participant group informed the intervention specifically in reference to appropriate behavioural strategies and potential barriers that may be faced when attempting to reduce occupational sitting time. Sedentary behaviour was perceived as detrimental to health, and was described as musculoskeletal complaints, weight gain, and fatigue however reducing sedentary behaviour was able to improve musculoskeletal health and mental health. The theory-informed, low-cost, individually-tailored multi-component intervention reduced occupational sitting time immediately following the six week intervention, irrespective of whether participants had access to a sit-to-stand workstation. As a result of this, self-efficacy to reduce sedentary behaviour increased and remained high at the six month follow-up. Many participants were able to progress through the stages of change however expectedly, there were also relapses. Interestingly, although many barriers were explored throughout the thesis including increases in workloads, attending seated meetings and work environmental configuration, the number of participants meeting or exceeding the 4 hr recommendation of reducing occupational sitting time increased at the six month follow-up compared to immediately post-intervention. Overall, this thesis has resulted in eight key findings that have enabled the development of detailed practical recommendations to reduce occupational sedentary behaviour for office workers.

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8.0 Appendix

8.1 Appendix A – online survey

Office-based workers are invited to complete the following survey. The survey includes questions based on work hours, sitting time, activities/tasks completed while at work and activity levels on both work days and non-work days.

The survey will take 10-15 min to complete.

The responses to this survey may be used for research purposes.

By filling out the survey you give consent to participate in the study.

Work days

Please answer the following questions with regards to the time you spend at work.

1. What time do you start work?

2. What time do you finish work?

3. On a typical work day, during work hours (excluding breaks), how long do you sit IN TOTAL?

4. On a typical work day, during work hours (excluding breaks), how long do the sitting bouts last? That is, how long would you remain seated between standing bouts?

5. Please indicate in the table below the tasks or activities you do during a typical work day

Work days

Run errands Yes / No

Typing emails/computer work Yes / No

Sending faxes Yes / No

Collect printing from printer Yes / No

Write on a whiteboard Yes / No

Make/take phone calls Yes / No

Attend meetings Yes / No

Filing Yes / No

Writing or paperwork Yes / No

Please specify any other activities

6. During the tasks/activities included in your typical work day, please indicate whether you typically sit, stand or walk during the tasks/activities. Please select all that apply.

Run errands Sit / Stand / Walk

Typing emails/computer work Sit / Stand / Walk

Sending faxes Sit / Stand / Walk

Collect printing from printer Sit / Stand / Walk

Write on a whiteboard Sit / Stand / Walk

Make/take phone calls Sit / Stand / Walk

Attend meetings Sit / Stand / Walk

Filing Sit / Stand / Walk

Writing or paperwork Sit / Stand / Walk

Please specify if you sit, stand or walk for the other activities you have identified.

7. How many scheduled breaks do you have each day?

8. How long are each of the breaks? (e.g. 10 min, 1 hr)

9. During your breaks, what do you typically do?

Buy meal/drink Yes / No

Eat lunch/snack Yes / No

Talk to colleagues Yes / No

Run errands Yes / No

Exercise Yes / No

Toilet/bathroom break Yes / No

Read Yes / No

Computer/device use (e.g. google, facebook, youtube, email) Yes / No

Make phone calls Yes / No

Other activities (please specify)

10. From the activities selected above, do you typically sit, stand or walk while completing these tasks/activities? Please select all that apply.

Buy meal/drink Sit / Stand / Walk

Eat lunch/snack Sit / Stand / Walk

Talk to colleagues Sit / Stand / Walk

Run errands Sit / Stand / Walk

Exercise Sit / Stand / Walk

Toilet/bathroom break Sit / Stand / Walk

Read Sit / Stand / Walk

Computer/device use (e.g. google, facebook, youtube, email) Sit / Stand / Walk

Make phone calls Sit / Stand / Walk

Please specify if you sit, stand or walk for the other activities you have identified

11. On a typical work day, during breaks, how long do you sit IN TOTAL?

Please answer the following questions with regards to your time prior to work and after work.

12. On a typical work day, when not at work (i.e. before and after work), how long do you sit IN TOTAL? Please include the time spent travelling, at home or at other events.

13. On a typical work day, when not at work, how long do the sitting bouts last? That is, how long would you remain seated between standing bouts?

14. What do you do while sitting outside of work hours? Please list all, eg. watch TV, use computer/device.

Non-work days

Please answer the following questions with regards to non-work days (for example, weekend days

or RDO's).

15. On a typical non-work day, how long do you sit IN TOTAL? Please include the time spent travelling, at home or at other events.

16. On a typical non-work day, how long do the sitting bouts last? That is, how long would you remain seated between standing bouts?

17. What do you do on non-work days? Please list all, eg. gardening, reading, watch TV/movies, play sport.

Sitting time and health

Please answer the following question with regards to sitting time and your health.

18. Do you think there is a relationship between sitting time and your health?

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Yes / No

Please explain the relationship between sitting time and your health.

Physical Activity

19. Do you participate in at least 150 min of moderate intensity exercise per week

either by participating in at least 30 min of moderate intensity exercise on five days per week

OR at least 20- 60 min of vigorous intensity exercise on at least three days per week?

Example activities might include walking, jogging, cycling, swimming and sports

participation.

Yes / No

20. Do you train each muscle group at least two or three days per week (e.g. resistance based

exercise using a variety of exercises and equipment)?

Yes / No

Demographics

21. What is your age?

22. What is your gender?

23. Which days of the week do you work?

Sunday/Monday/Tuesday/Wednesday/Thursday/Friday/Saturday

Thank you for participating in this survey.

8.2 Appendix B – ethics approval study one (Chapter 2)

This administrative form
has been removed

8.3 Appendix C – ethics approval study two (Chapter 3)

This administrative form
has been removed

8.4 Appendix D – ethics approval studies three & four (Chapter 4 & 5)

This administrative form
has been removed

8.5 Appendix E – online survey

Office-based workers are invited to complete the following survey. The survey includes questions based on work hours, sitting time and demographic information.

The survey will take 10-15 min to complete.

The responses to this survey may be used for research purposes however all responses will remain anonymous.

By filling out the survey you give consent to participate in the study.

Work days

Please answer the following questions with regards to the time you spend at work.

1. What time do you start work?

2. What time do you finish work?

3. Which days of the week do you work?

4. On a typical work day, during work hours, how long do you sit IN TOTAL?

5. On a typical work day, during work hours, how long do the sitting bouts last? That is, how long would you remain seated between standing bouts?

Sitting time and health

Please answer the following question with regards to sitting time and your health.

6. Do you think there is a relationship between sitting time and your health?

Yes   No

Please expand on your answer above.

Demographics

7. What is your age (in years)?

8. What is your height (in cm)?

9.What is your body mass (weight in kg)?

10. What is your gender?

Female / Male

11. What is your occupation classification?

Professional - administrative Professional - technical Professional - management

Academic - with face-to-face teaching within the next 12 weeks Academic - no face-to-face teaching within the next 12 weeks

Other (please specify)

Thank you for participating in this survey.
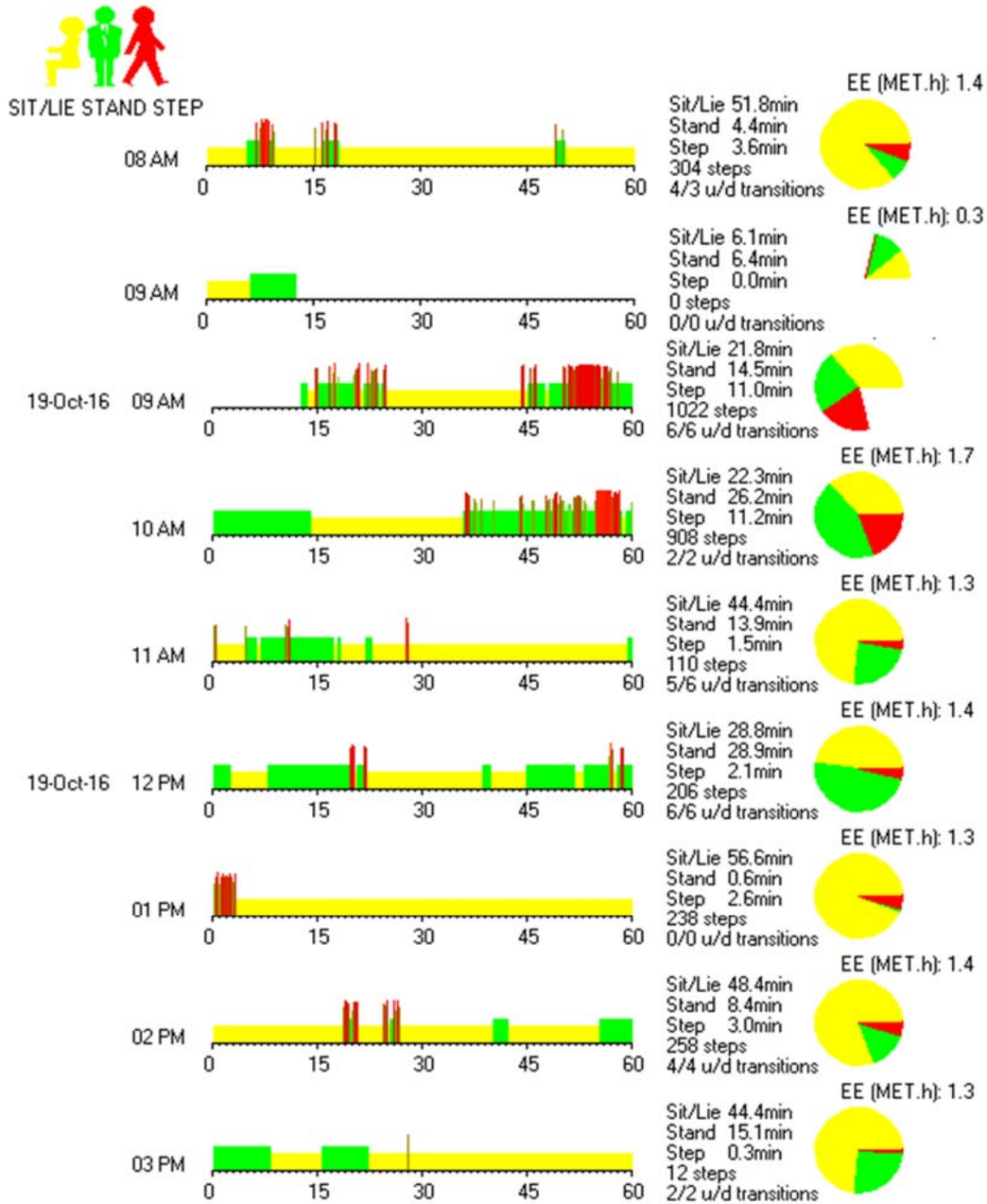
8.6 Appendix F – example workbook page

DATE:

Time	Movement pattern
8-8.30am ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
8.30-9am ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
9-9.30am ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
9.30-10am ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
10-10.30am ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
10.30-11am ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
11-11.30am ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
11.30am-12pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
12pm-12.30pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
12.30-1pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes

Time	Movement pattern
1-1.30pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
1.30-2pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
2-2.30pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
2.30-3pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
3-3.30pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
3.30-4pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
4-4.30pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
4.30-5pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes
5-5.30pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____minutes Sitting duration _____ minutes

What time did you start wearing your activPAL today? _____

8.7 Appendix G – example ActivPAL™ individual data

SIT/LIE STAND STEP

Time	Data	EE (MET.h)
08 AM	Sit/Lie 51.8min, Stand 4.4min, Step 3.6min, 304 steps, 4/3 u/d transitions	EE (MET.h): 1.4
09 AM	Sit/Lie 6.1min, Stand 6.4min, Step 0.0min, 0 steps, 0/0 u/d transitions	EE (MET.h): 0.3
19-Oct-16 09 AM	Sit/Lie 21.8min, Stand 14.5min, Step 11.0min, 1022 steps, 6/6 u/d transitions	
10 AM	Sit/Lie 22.3min, Stand 26.2min, Step 11.2min, 908 steps, 2/2 u/d transitions	EE (MET.h): 1.7
11 AM	Sit/Lie 44.4min, Stand 13.9min, Step 1.5min, 110 steps, 5/6 u/d transitions	EE (MET.h): 1.3
19-Oct-16 12 PM	Sit/Lie 28.8min, Stand 28.9min, Step 2.1min, 206 steps, 6/6 u/d transitions	EE (MET.h): 1.4
01 PM	Sit/Lie 56.6min, Stand 0.6min, Step 2.6min, 238 steps, 0/0 u/d transitions	EE (MET.h): 1.3
02 PM	Sit/Lie 48.4min, Stand 8.4min, Step 3.0min, 258 steps, 4/4 u/d transitions	EE (MET.h): 1.4
03 PM	Sit/Lie 44.4min, Stand 15.1min, Step 0.3min, 12 steps, 2/2 u/d transitions	EE (MET.h): 1.3

*Estimated sitting time (ActivPAL™): 4 hr and 55 min
*Estimated sitting time (self-report): 6 hr and 15 min

*Estimated non-sitting time (ActivPAL™): 2 hr and 34 min
*Estimated non-sitting time (self-report): 1 hr and 15 min
*7.5 hour work day

8.8 Appendix H – sedentary behaviour information

Sedentary Behaviour Fact Sheet

- Increased sitting time is associated with:
  - Reduced life expectancy (Katzmarzyk & Lee, 2012)
  - Elevated risks of mortality from all causes and cardiovascular disease (Katzmarzyk & Lee, 2012)
  - Weight gain (Brown et al., 2005)
  - Some cancers (Gierach et al., 2009)
  - Type II diabetes (Hu et al., 2003),
  - Breathing difficulties (Peeters et al., 2013)
  - Poor mental health (Proper et al., 2012)

- Achieving or exceeding the current physical activity guidelines (30 minutes of moderate intensity physical activity on 5 days per week or 20 minutes of vigorous intensity physical activity on 3 days per week) is unlikely to be fully protective against high levels of sedentary behaviour (Matthews et al., 2012).

- Reducing sedentary behaviour is just as important as structured exercise for health benefits (Hamilton et al., 2007).

- The National sedentary behaviour guidelines suggest to:
  - Minimise the amount of time spent in prolonged sitting
  - Break up long periods of sitting as often as possible
                                        (The Australian Department of Health, 2014)

- To reduce your sedentary behaviour in the office you could:
  - Take your lunch break outside or in another location instead of sitting and eating at your desk
  - Stand while you read at work
  - Move your rubbish bin away from your desk so you have to get up to use it
  - Use the speakerphone for conference calls, and walk around the room during the conference
  - Ask your boss for a 'walk and talk' meeting rather than a sit down meeting
                                        (The Australian Department of Health, 2014)

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Sedentary behaviour and musculoskeletal health

- There is an increased prevalence of musculoskeletal disorders when the duration of computer-based keyboard use is increased (Cho et al., 2012; Gerr et al., 2004).

- There is also an increased prevalence of developing musculoskeletal disorders with mouse use, prolonged sitting time and uncomfortable postures (Ortiz-Hernandez et al., 2003).

- The most prevalent musculoskeletal concerns for office workers include the neck, shoulders and upper back areas (Cho et al., 2012; Gerr et al., 2004).

- From an occupational health perspective, sedentary behaviour should be interrupted every 30 min (Atlas & Deyo, 2001).

Sedentary behaviour and weight gain

- The link between sedentary behaviour and weight gain is unclear and inconsistent (Thorp et al., 2011).

- With increased screen time, body mass index subsequently increases which potentially links computer use to unhealthy weight gain (Pedisic et al., 2014).

- To prevent weight gain, 150-250 min/week of moderate-intensity physical activity is recommended (Donnelly et al., 2009).

- For weight loss, greater than 250 min/week of moderate-intensity is recommended (Donnelly et al., 2009).

- Combined diet restriction and physical activity will increase weight loss compared to diet alone (Donnelly et al., 2009).

Sedentary behaviour and fatigue

- Reducing prolonged sedentary behaviour could reduce fatigue (Ellingson et al., 2014).

- Improvements in mental health may result from a reduction in sedentary time, especially for those who are not physically active (Ellingson et al., 2014).

8.9 Appendix I – example goals

<u>Goals for reducing sedentary behaviour in the workplace</u>

Week 1 - Goal 1. During the work day I will stand every time I send an email

Week 2 - Goal 2. During the work day I will stand for the duration of each phone call **(plus Goal 1)**

Week 3 - Goal 3. During the work day I will walk around the building every hour **(plus Goals 1 & 2)**

Week 4 - Goal 4. During the work day I will dance to my favourite song for 3-5 min **(plus Goals 1, 2 & 3)**

Week 5 - Goal 5. During the work day I will walk to the library at 2.30pm **(plus Goals 1, 2, 3 & 4)**

Week 6 - Goal 6. During the work day I will walk to talk to a colleague instead of calling or emailing **(plus Goals 1, 2, 3, 4 & 5)**

8.10 Appendix J – self-contract

Self-Contract

Name:_____

Start date:_____   Finish date:_____

Overall goal: To reduce or interrupt my sitting time (sedentary behaviour) in the workplace

I understand that it is my responsibility to achieve the goals I have set for myself. If the daily goal is not completed, I will do more the following day to reduce or interrupt my sitting time in the workplace.

I,_____, agree to work towards my overall goal by completing my incremental goals and in doing so shall comply with the terms and dates of this contract.

Signature:_____   Date:_____

Witness:_____   Date:_____

Adapted from Kotecki (2014).

8.11 Appendix K – self efficacy

Please indicate below how confident you are that you could successfully carry out the activity listed below by circling the appropriate %. Select the response that most closely matches your own, remembering that there are no right or wrong answers.

For example, in question 1 if you have complete confidence that you could successfully carry out the activity you would circle 100%. If however, you had no confidence at all that you carry out the activity, you would circle 0%.

| 0% | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% |

NOT AT ALL   MODERATELY   HIGHLY
CONFIDENT   CONFIDENT   CONFIDENT

I believe that I can reduce my sedentary behaviour:

1. By completing one set goal over the next 6 weeks

| 0% | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% |

2. By completing some but not all set goals over the next 6 weeks

| 0% | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% |

3. By completing all set goals over the next 6 weeks

| 0% | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% |

8.12 Appendix L – example workbook with goals

DATE:
During the work day, I will **stand every time the phone rings** to reduce my sedentary behaviour which I will record in my workbook below.

Time	Movement pattern
8-8.30am ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes
8.30-9am ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes
9-9.30am ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes
9.30-10am ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes
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11-11.30am ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes
11.30am-12pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes
12pm-12.30pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes
12.30-1pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes

Time	Movement pattern
1-1.30pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes
1.30-2pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes
2-2.30pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes
2.30-3pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes
3-3.30pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes
3.30-4pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes
4-4.30pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes
4.30-5pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes
5-5.30pm ☐	Breaks in sitting time: ☐☐☐☐☐☐☐☐☐☐ Standing duration _____ minutes Sitting duration _____ minutes

What time did you start wearing your activPAL today? _____

What time did you start work:_____

What time did you finish work:_____

Today, did you achieve your goal of standing every time the phone rang?   Yes / No / Sometimes
(please circle)

If not, why not? If sometimes. Why?_____