Declaration

Name of candidate: Sheehan Robb

This thesis entitled The Standing Study: Participant experience and acceptability of using a standing desk is submitted in partial fulfilment for the requirements for the Unitec degree of Master of Osteopathy.

Candidate’s declaration

I confirm that:

- This thesis represents my own work
- Research for this work has been conducted in accordance with the Unitec Research Ethics Committee Policy and Procedures, and has fulfilled any requirements set for this project by the Unitec Research Ethics Committee
- Ethics Approved by the Unitec Ethics Committee (Reference: 2013-1029)

Candidate Signature: ……………………………………………..Date: …………………

Student number: 1326613
The Standing Study: Participant experience and acceptability of using a standing desk

Sheehan Robb

A research project submitted in partial fulfilment of the requirements for the degree of Master of Osteopathy, Unitec Institute of Technology, New Zealand, 2014.
Abstract

**Background:** Sedentary behaviour (including prolonged sitting) is associated with increase in common chronic diseases, such as diabetes, cardiovascular disease, and all-cause mortality. Due to the prevalence, and risks, of prolonged sitting for office workers standing desks have been proposed as strategy to reduce sedentary time in the work place.

**Objective:** This study aimed to identify and understand perceptual and subjective factors pertaining to the experience and acceptability of adapting to and working from a standing desk.

**Method:** This generic qualitative study was part of a two armed study which collectively measured biological blood marker changes throughout the 16 week trial and how the desks were perceived, used, and accepted by the participants. Participants (n=6) were recruited via online media. They were selected for their age (25-40), weight, hip-waist ratio, and BMI measurements. Three semi-structured interviews were conducted at weeks 1-2, 14-16, and 21-22 of the trial. Data analysis generated themes and subthemes.

**Results:** Theme one: The physical, mental, and environmental experience of using a standing desk encompassed perceived improvement in physical, mental, and environment experience and reveals a process of adjustment. Physical improvements included energy and vitality, increased tolerance to standing, posture and decrease in discomfort with standing. Mental improvements include enhanced emotional experience, improved tolerance to stress, and feeling proactive about health, along with improved self-awareness, cognitive function and productivity. Improved perception of office environment included aspects of/due to perceived interaction with others and improved work station set- up. There was a process of adjustment which involved and adjustment period, initial discomfort, (other subthemes included too much too soon and standing full time) Theme Two: Conclusion judgements, and acceptability: sitting and standing in an office environment. There were changes to the participants perception of sitting and it was identified that there were many reasons not to sit It was identified that there was a need to alternate sitting and standing. There was a high acceptability and affinity for using the standing desk as all participants wanted to continue to use the standing desk

**Conclusion:** The experience of using a standing desk resulted in a strong acceptability for its use in the work place in this group of participants.

**Key words:** Standing desk; Sit-Stand desk; Qualitative research; Acceptability of using a standing desk; Experience of using a standing desk
Acknowledgements

I would like to acknowledge all the people who helped me on this rollercoaster of a journey.

Firstly, thank you Dr. Elizabeth Niven for your constant dedication to keeping me on track. Your support and expertise have been amazing throughout this project and I am deeply grateful for your efforts. It has been a privilege to have worked with such an intelligent and kind hearted person.

Secondly, to James Hutchinson, thank you for your time and advice.

Thirdly to my family, and friends- the best in the world. I am appreciative of all the support, and advice. I love you all to the moon and back! If not for your belief in my abilities I would not be where I am today.

Thank you Lana Whiting for all your help in my time of need. You are a true friend and I will treasure our friendship forever.

This project is dedicated to my mum for being the most supportive person I have ever known. You have always believed in me even when I did not believe in myself. I appreciate your ability to have undying faith in my abilities. I am grateful you have taught me the arts of patience, perseverance, and grit. I love you and thanks for being my number one cheerleader.
Preface

This 90 credit thesis is submitted in partial fulfilment of the requirement for the Master of Osteopathy degree at Unitec Institute of Technology. It has explored the experience of six participants using a standing desk for sixteen weeks. This thesis is presented in three main parts. Part one is comprised of two chapters. Chapter one is a literature review to familiarise the reader with the background of sedentary behaviour, its health risks and the interventions associated with reducing it in an office environment. Chapter two describes the methodology and research methods used.

Part two is presented as a manuscript in the required format for publication to the Journal of Applied Ergonomics.

Part three is the appendices which contains documentation of ethics approval, information and consent forms, interview schedules, examples from the data analysis process and journal publication guidelines.
# Table of Contents

Abstract ............................................................................................................................ iii
Acknowledgements .......................................................................................................... iv
Preface .............................................................................................................................. v
Table of Contents ........................................................................................................... vi
Abbreviations ................................................................................................................ viii

**Part One** ..................................................................................................................... 1

**Chapter One: Introducing the research** ........................................................................ 1

Introduction ...................................................................................................................... 1

Personal background ....................................................................................................... 2

Literature Review ............................................................................................................. 3

- Literature search and strategy ....................................................................................... 3
- Interventions to address sedentary behaviour in office environment ............................ 11
- Point of choice software .............................................................................................. 14
- Dynamic workstation .................................................................................................. 14
- Summary .................................................................................................................... 14

**Chapter Two: Conducting the research** ...................................................................... 17

Methodology ..................................................................................................................... 17

- A qualitative approach ................................................................................................. 17

Methods ........................................................................................................................... 20

- Participant recruitment ............................................................................................... 21
- The participants ........................................................................................................... 21
- Equipment ..................................................................................................................... 22
- Ethical considerations ................................................................................................. 22
- Data Collection ........................................................................................................... 23
- Data set ......................................................................................................................... 24
- Data analysis ................................................................................................................. 24

References ........................................................................................................................ 28

**Part 2: Manuscript** ...................................................................................................... 34

Abstract ............................................................................................................................ 36

2. Methods and Materials................................................................................................. 38

- 2.1 Methodology ........................................................................................................... 38
- 2.3 Participants ............................................................................................................. 39
- 2.4 Data Collection ...................................................................................................... 39
- 2.5 Ethics ....................................................................................................................... 40
- 2.6 Data Analysis ......................................................................................................... 40
- 2.7 Rigour ...................................................................................................................... 41
8. References...........................................................................................................................................60

Part Three: Appendices ..........................................................................................................................66

Appendix A: Ethics Approval..................................................................................................................67
Appendix B: Information sheet ............................................................................................................68
Appendix C: Participant consent form.................................................................................................72
Appendix D: Interview schedule one .....................................................................................................74
Appendix E: Interview Schedule Two ................................................................................................67
Appendix F: Interview Schedule Three A- Going back to seated desk ............................................75
Appendix G: Interview Schedule Three B- Continued use of standing desk ..................................76
Appendix H: Example of data analysis matrix ......................................................................................78
Appendix I: Excerpt from research journal .........................................................................................79
Appendix J: Applied Ergonomics: Research submission guidelines ....................................................80
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRC</td>
<td>Colorectal Cancer</td>
</tr>
<tr>
<td>CVD</td>
<td>Cardiovascular Disease</td>
</tr>
<tr>
<td>METs</td>
<td>Metabolic equivalent units</td>
</tr>
<tr>
<td>MVPA</td>
<td>Moderate to vigorous physical activity</td>
</tr>
</tbody>
</table>
Part One

Chapter One: Introducing the research

Introduction

Chapter one familiarises the reader with current knowledge of the research topic. This chapter contains an in-depth literature review focused on sedentary behaviour and how it may affect health. Furthermore, it will examine the interventions aiming to reduce sedentary behaviour in an office environment.

Sedentary behaviour has become an increasingly recognised problem. It is suggested that occupational and non-occupational sitting such as use of screen-based electronics (television, computers, tablets, and smart phones) (Atkin et al., 2012; Pinto Pereira, Ki, & Power, 2012), desk-based jobs (Healy, Lawler, & Thorp, 2012) are contributing factors. Sitting totalling more than four hours per day is related to increase risk of cardiovascular disease (CVD) and other chronic disease in addition to increased mortality despite physical activity participation (George, Rosenkranz, & Kolt, 2013; Stamatakis, Hamer, & Dunstan, 2011). Cardiovascular disease (heart attack and stroke), is considered a chronic disease, alongside type two diabetes, chronic respiratory disease (COPD and asthma), and some cancers. The World Health Organisation (2014b) defines chronic disease as an individual disease process that cannot be transmitted between people and usually has slow progression and is of long duration.

Due to the potential negative consequences associated with sedentary behaviour strategies to reduce occupational sitting have become a popular area for research. These include standing desks (Reiff, Marlatt, & Dengel, 2012; Robertson, Ciriello, & Garabet, 2013; Straker, Abbott, Heiden, Mathiassen, & Toomingas, 2013), dynamic work stations such as treadmill, elliptical, trainer and cycle workstations and computer software that alerts the worker when they need a break from their computer work.

Two studies to date have used qualitative methods to gain a sense of parts of the experience of using a sit-stand desk or workstation. Experience of using a standing desk will determine how viable of an option it would be to introduce into the office environment. One study looked at attitudes, compliance and satisfaction of introducing sit-stand workstations into the workplace.
(Wilks, Mortimer, & Nylén, 2006). Another study looked at the usability and acceptability of using both electronic and manual sit-stand desks (Grunseit, Chau, van der Ploeg, & Bauman, 2013). These studies are further examined in the ‘interventions’ section of the literature review. The current study is part of a two arm study that studied different aspects of the same participants. It intended to further explore experiences of using a standing desk from the perspectives of the participants. In addition it aimed to reveal the subjective factors that pertained to acceptability of use. The other arm of the study, done by Daniel Archer, studied biological markers in the blood and the changes over the sixteen week trial.

**Personal background**

I am a twenty five year old osteopathic student who has worked with patients for two years. I have a Bachelor of Applied Science in Human Biology and am currently studying for my Masters in Osteopathy. I am very interested in the health of my patients and have become aware of the number of people who lead sedentary lifestyles. I like to encourage my patients to become more active as there are many physical and emotional benefits one can experience from leading a more active life.

The idea of standing desks interested me because I feel they are unusual. I wanted to explore the experience of what it was like to use one. I hoped the research may help inform my future recommendations for reducing occupational sedentary behaviour in my patients.
Literature Review

Standing desks have been proposed as a way to reduce sedentary behaviour (SB) that has become a widespread problem throughout the world. There has been increasing evidence that there is a relationship between sedentary behaviour and chronic disease despite the amount of physical activity that the sitting person may undertake in a day. The following is a review of the literature that examines current evidence around the use of standing desk and why there is a need to combat the ubiquitous nature of sedentary behaviour. This chapter will explain how the literature was found, what is currently known about sedentary behaviour and the interventions to reduce SB in an office setting.

Literature search and strategy

The literature search was conducted firstly by using the multi-database search bar "article- express" which searched EBSCO Host, Global Issues in context, MANTIS, PEDro, Sage Premier, Science Direct, Science in Context, and Scopus. Following that, a manual search of Google Scholar, Science Direct, EBSCO Host, PubMed, and Cochrane Database was performed. Keywords used included combinations of 1) standing/sit-stand/adjustable height and 2) Desk/workstation. This search was aimed to find all the standing desk literature. Nineteen relevant studies were chosen to be used as part of this literature review. These papers were selected for relevance by the abstract, key words, and discussion relating to use or intervention of a standing desk. Both quantitative and qualitative studies were included. Other searches were done for sedentary behaviour, physical activity and their relation to chronic diseases and obesity. Furthermore other interventions to reduce SB in an office environment were searched. A number of studies were found on these subjects and review and discussion have been included in the "Interventions to address sedentary behaviour in office environment" section.

Standing desk

A standing desk is much what it sounds like. It is a taller version of a traditional desk that a person is able to stand at. There are different types and shapes: fixed height; adjustable height; electronic height adjustable; manual height adjustable; wind up or crank handle adjustable; cardboard portable; treadmill desks. Sit-stand desks are adjustable and can be used in both the sitting and standing positions.

The standing study trial used two types of standing desks. Four electrical height adjustable desks and two non-adjustable height desks were used. The electrical height desks had a button to allow change of height. There was no storage space in the electrical desks, however there was in the static standing desks.
There has been an increasing interest in standing desks as a way to reduce sedentary behaviour in the last decade. This coincides with the emergent evidence of the relationship of prolonged sitting to chronic disease and its independence of physical activity (PA).

Sedentary behaviour, risk factors and interventions

What is sedentary behaviour?

Sedentary behaviour refers to "activities that do not increase energy expenditure substantially above resting levels" (Pate, O’Neill, & Lobelo, 2008; Sedentary Behaviour Research Network, 2015). It includes restful activities such as sleeping, sitting (Schofield, Quigley, & Brown, 2009), lying down, watching television (Schofield et al., 2009; Shields & Tremblay, 2008), other forms of screen-based entertainment (Schofield et al., 2009; Stamatakis et al., 2011), and office work (Parry & Straker, 2013; Schofield et al., 2009; Stamatakis et al., 2011). These activities expend energy at the level 1.0-1.5 metabolic equivalent of task units (METs) (Pate et al., 2008; Sedentary Behaviour Research Network, 2015). One METs is the metabolic or energy cost of resting quietly often defined in terms of oxygen uptake as 3.5mL-kg-1-min-1 (Pate et al., 2008).

There are different intensities of physical activity. Light physical activity is a distinctly different activity construct although it is often grouped with sedentary behaviour. It involves energy expenditure at the level of 1.6-2.9 METs (Pate et al., 2008). It includes activities such as slow paced walking, sitting, writing, cooking food and house hold duties (Pate et al., 2008). Moderate to vigorous intensity exercise expends 3-6 METs, and includes activities such as brisk walking, dancing, and active games with children are included in this criterion (The World Health Organisation, 2015). Vigorous activity includes such activities as running or lifting more than 20kgs and burns more than 6 METs (The World Health Organisation, 2015).

Over the last 30 years there has been a decline in occupational and commuting physical activity amongst Finnish Adults (Borodulin, Latikainen, Juolevi, & Jousilahti, 2008). It was also found that adults from the United States spent the majority of their time doing sedentary activities (Matthews et al., 2012). Furthermore sedentary behaviours appear to replace light intensity activities of daily living (standing, slow walking, housework and picking up objects) thus decreasing daily energy expenditure and increasing health risks that are associated with sedentary behaviours (Dunstan, Howard, Healy, & Owen, 2012).

Sedentary behaviour is prevalent in all age groups but appears to increase with age (George et al., 2013). In children it has been linked with increased weight, obesity, cardiovascular risk (elevated systolic blood pressure), and poorer cognitive development such as language delay (Owen et al.,
In adults it is associated with metabolic syndrome, obesity, heart attack, stroke, colon and rectal cancers, depression, poor sleep, cognitive decline. A systematic review of research on older adults found when measured both subjectively and objectively, the majority of older adults were sedentary (Harvey, Chastin, & Skelton, 2013). Screen time specifically television time is a large contributor to this (Harvey et al., 2013). In the adult population ‘too much sitting’ increases the risk of diabetes (type II), cardiovascular disease, breast and colon cancer, poor mental health outcomes and all-cause mortality (Dunstan et al., 2012; Owen, Salmon, Koohsari, Turrell, & Giles-Corti, 2014; Owen, 2012; Shields & Tremblay, 2008).

Office work is a common low activity occupation thus it is considered a sedentary behaviour. Parry & Straker et al. (2013) found that sedentary time accounted for 81.8% of work hours in a group of 50 office worker whose activity was measured by accelerometer for one week. They concluded that office work is characterised by sustained sedentary time and contributes significantly to sedentary exposure in office workers (Parry & Straker, 2013).

An increasing body of evidence is pointing towards prolonged sitting being a population wide, ubiquitous health risk (Healy, Lawler, & Thorp, 2012; G. N. Healy et al., 2013; Owen et al., 2014). This review article argues that too much sitting should be a stand- alone component of the physical activity and health equation, particularly in relation to cardiovascular risk and diabetes type II (Dunstan et al., 2012). In the adult population ‘too much sitting’ (>4hrs) increases the risk of diabetes (type II) (Dunstan et al., 2012; Stamatakis et al., 2011), cardiovascular disease (Dunstan et al., 2012; E. George et al., 2013; Stamatakis et al., 2011), poor mental health outcomes (Biddle & Asare, 2011; Hamer, Coombs, & Stamatakis, 2014) and all-cause mortality (Bjørk Petersen et al., 2014; Dunstan et al., 2012; Owen et al., 2014; Shields & Tremblay, 2008; Stamatakis et al., 2011) These have become widely accepted concepts amongst researchers although Maher et al 2014 disagrees.

Maher et al (2014) claims that there is no association between sedentary behaviour and cardio-metabolic risk factors once adjustments have been made for total physical activity. This cross-sectional study of 4,618 people found that sedentary behaviour had a detrimental association with eight of eleven cardio-metabolic risk factors however, when were adjusted for moderate to vigorous physical activity (MVPA) had little association (Maher, Olds, Mire, & Katzmarzyk, 2014). These associations disappeared, except for c-reactive protein (which showed a small favourable association) and triglycerides (small detrimental association) when adjusted for total physical activity (including light intensity PA). Maher et al.,(2014) concluded that once adjusted for total physical activity there is virtually no association between sedentary behaviour and cardio-metabolic biomarkers thus SB may not have health effects independent of physical activity. This is the only study that has come to this conclusion thus more research in this area is needed to draw definitive conclusions.
Why is sedentary behaviour detrimental to health?

Sedentary behaviours such as too much sitting, and office work, have a negative impact on health (Bjørk Petersen et al., 2014b; D. W. Dunstan et al., 2012; David W. Dunstan et al., 2012; Pulsford, Stamatakis, Britton, Brunner, & Hillsdon, 2013; Shields & Tremblay, 2008). The health impacts related to sedentary behaviour are discussed in the following section.

Metabolic syndrome

Metabolic syndrome is referred to as a “cluster of the most dangerous heart attack risk factors: diabetes and pre-diabetes, abdominal obesity, changes in cholesterol and high blood pressure” (International Diabetes Foundation, 2014). There are many proposed causes for metabolic syndrome with sedentary behaviour being just one. Other causes are being overweight or obese (Bradshaw, Monda, & Stevens, 2012; Pan & Pratt, 2008; Simmons & Thompson, 2004); poor diet (Kouki et al., 2012); aging (Schofield et al., 2009); smoking (Sun, Liu, & Ning, 2012); sympathetic nervous system over activation (Lambert, Straznicky, Lambert, Dixon, & Schlaich, 2010); psychiatric disorders; and rheumatic diseases (de Oliveira, Medeiros, de Cerqueira, de Souza Quixadá, & de Oliveira, 2015). Non-alcoholic fatty liver disease is a strong determinant for the development of metabolic syndrome (Lonardo, Ballestri, Marchesini, Angulo, & Loria, 2015). To be considered as having metabolic syndrome, requires a person to have central obesity, and two of the following four additional factors: raised triglycerides (TG), reduced HDL-cholesterol, elevated blood pressure or raised fasting plasma glucose level (International Diabetes Foundation, 2014).

A meta-analysis concluded that people who spend higher amounts of time participating in sedentary behaviours have a greater chance of having metabolic syndrome and that reducing sedentary behaviours is potentially important for preventing metabolic syndrome (Edwardson et al., 2012). These findings are supported by two large studies, that furthered the research of Edwardson et al., (2012), which found sitting more than 4 hours per day increases the risks of acquiring metabolic syndrome (George et al., 2013; Pulsford, Stamatakis, Britton, Brunner, & Hillsdon, 2013). Both television and office work had increased risk of acquiring metabolic syndrome (82 % increase risk for television and 33% increase risk for office work), in the participants surveyed, however the higher risk sedentary behaviour was television watching (Pinto Pereira et al., 2012). It is not clear why both these seemingly similar behaviours had different outcomes for metabolic syndrome. Pinto Pereira et al (2012) found for television viewing there was a higher trend for low fruit and high chip intake, smoking and infrequent MVPA which are likely contributing factors to these differences.

Obesity increases the risk of developing metabolic syndrome however not all obese people develop this condition (Bradshaw et al., 2012). Some obese individuals are metabolically healthy (have no
metabolic complications) whilst others are at risk of CVD and other diseases. It is argued that lifestyle factors are more likely to have a stronger role in metabolic syndrome in normal weight people than obese people and that metabolically healthy obesity may not be a stable condition (Bradshaw et al., 2012). However results of this study do not support the hypothesis that diet and/or physical activity account for metabolic anomalies in metabolically healthy obese (Hankinson et al., 2013). Normal weight and metabolically unhealthy normal weight (have metabolic complications) individuals had higher risk factors for heart failure than metabolically healthy obese individuals thus BMI was not associated with heart failure (Voulgari et al., 2011).

Metabolic syndrome is a health risk because it can increase risk of developing detrimental cardiovascular events and diabetes type two. Insulin resistance, and inflammation, are features of metabolic syndrome that were independently associated with increased heart failure incidence (Voulgari et al., 2011)

Maori and Pacific Islanders have high prevalence for conditions associated with metabolic syndrome such as cardiovascular disease and type 2 diabetes (Simmons & Thompson, 2004). A study conducted by Simmons and Thompson (2004), found the Maori and Pacific population (≥ 40 years of age), had a total prevalence of metabolic syndrome below showing at least two components of metabolic syndrome. Participants (n=4022) in Auckland, NZ were measured to find the ethnic differences in metabolic syndrome and to identify the main causes for this difference. This cross sectional study surveyed 1006 Maori, 996 Pacific islanders, and 2020 'others' (mainly Europeans). Age range was between 35-75 years of age (Gentles et al., 2007). Gentles et al., (2007) found the Maori group had twice the likely risk of having metabolic syndrome as the 'other' group, and the pacific island group were two and a half times more likely than the others to have metabolic syndrome. The higher risk of metabolic syndrome was attributed to the higher prevalence of obesity in the Maori and Pacific Island groups (Gentles et al., 2007).

Evidence that physical activity will reduce the risk of metabolic syndrome is unclear (Pan & Pratt, 2008). A study of 483 Japanese men and women showed moderate physical activity expending more than 26 METs hr/week was adequate to reduce the risk of metabolic syndrome and pre metabolic syndrome in the studied population (J. Kim, Tanabe, Yokoyama, Zempo, & Kuno, 2011). These findings were replicated by a larger cross sectional study in Ethiopian men but not women. This was attributed partly due to small sample of women (n= 726) (Workalemahu, Gelaye, Berhane, & Williams, 2013). American adolescents were also found to have decreased risk of metabolic syndrome when undertaking high levels of physical activity compared with those of low or moderate levels (Kouki et al., 2012; Pan & Pratt, 2008)This evidence suggests increasing in physical activity may reduce the risk of acquiring metabolic syndrome however there is a need for more research in this area.

Diet is shown to have some influence on the risk of metabolic syndrome. A moderate sample of American (US) adolescents who completed the National Health and Nutrition survey found those with
high health eating index and fruit scores which are based on the food pyramid (1992) and dietary guidelines for Americans (1990) were linked to decreased risk in metabolic syndrome (Pan & Pratt, 2008). A dietary change that included two or more of the following ≥400g Vegetables per day, ≥ 2 Servings of fish per week, 14≥ Fibre per 100 Kcal and <10 E% of daily saturated fat as associated with decreased risk of metabolic syndrome (Kouki et al., 2012). However exercise had more of an effect on metabolic syndrome than diet (Kouki et al., 2012).

**Obesity**

Many factors play a role in the development of obesity. These include sedentary behaviour, diet, and genetics. This section will discuss obesity and its relation to physical activity and sedentary behaviour.

Another widespread health risk of sedentary behaviour is obesity though this is not the only cause. The prevalence of obesity has risen over the last 25-50 years (Church et al., 2011; Shields & Tremblay, 2008). Decreased energy expenditure in the form of physical activity and increased sedentary behaviours are thought to be major contributing factors to this. Over the last 50 years in the USA it is estimated that occupational energy expenditure has decreased by more than 100 calories in both men and women, furthermore it is estimated that this has counted for a large portion for the increase in mean average weight gain in the U.S (Church et al., 2011) A large study has found there has been increasing numbers of overweight and obese Czech children in addition to declining PA rates (Sigmundová, Sigmund, Hamrik, & Kalman, 2014).

Screen time (Time spent watching television or at the computer) is a sedentary behaviour that is considered by some to be associated with obesity. Six million Canadians live with clinical obesity (Canadian Obesity Network, 2011). A large Canadian study found that 25% of men and 24% of women who watched more than 21 hours of television per week were classified as obese (BMI ≥ 30 kg/m²) (Shields & Tremblay, 2008). They also discovered for those of who watched fewer than five hours of television per week were less likely to be obese by 11% in Males and 13% in females. Regular computer users of more than 11 hours per week also had higher prevalence of obesity compared with those who used the computer fewer than 5 hours per week (Shields & Tremblay, 2008). Four years of data suggest that those who spent more time commuting in the car tended to gain more weight than those who did not. This relationship was especially pronounced in individuals who were physically active during leisure time thus suggesting that physically active individuals who reduce sedentary time could prevent weight gain (Sugiyama, Ding, & Owen, 2013). However a recent systematic review suggest detrimental relationships between sedentary behaviour and physical activity were weak to moderate and supports the idea that SB displaces light intensity activity (Mansoubi, Pearson, Biddle, & Clemes, 2014).

There are different phenotypes of obesity; healthy obese, and non-healthy obese (Bell, Kivimaki, David Batty, & Hamer, 2014; Hankinson et al., 2013; Pan & Pratt, 2008; Voulgari et al., 2011). The phenotypes are in relation to the metabolic state of the individual. A recent study found that there was
no significant difference in the amount of sedentary behaviour and the healthy obese and non-healthy obese groups (Bell et al., 2014). Pulsford, Stamataki, Britton et al. (2013) concluded sitting behaviour was not cross-sectionally or prospectively associated with obesity. However, previously obesity was prospectively associated with time spent watching TV (Pulsford et al., 2013). These studies suggest that sedentary behaviour is not the only factor contributing to unhealthy obesity.

**Diabetes**

Sedentary behaviours such as office work and television watching have been linked to increased diabetes, cardiovascular disease, and metabolic syndrome. Cardiovascular and diabetes biomarkers differ between television watching and office work (Pinto Pereira et al., 2012). The findings of a large longitudinal cohort study, of males (n=62,048) aged 45-64, suggest higher volumes of sitting are associated with diabetes and overall chronic disease independently of physical activity, and other co-variables (George et al., 2013). These authors recommend more prospective studies are needed to explain these relationship and causes. This study is limited by self-reported measures of the 45 and Up Study which can be subject to under and over reporting thus decreasing validity of the research. Self-reporting tends to favour under reporting in people with infectious disease (Merk et al., 2013) thus suggesting the possibility of an even stronger relationship between sedentary behaviours and chronic diseases. Other limitations of this study could be the possibility of over-estimation of MVPA which could have been light to moderate physical activities. This prospective study suggests that reducing sedentary behaviour may partly counteract the effect of increasing body weight on glucose-insulin homeostasis (Lahjibi et al., 2013). Interrupting sitting time with short bouts of light-moderate intensity exercise lowers postprandial glucose and insulin levels in overweight and obese participants (Dunstan et al., 2012).

**Cardiovascular disease and all-cause mortality**

Research into cardiovascular disease and all-cause mortality and their link to sedentary behaviours has had varied findings. It appears that television and other screen based activities are more detrimental to health than occupational sitting although it is not clear why (Pinto Pereira et al., 2012). Suggestions for this are varied leisure and work domains (Pinto Pereira et al., 2012). Stamatakis et al (2011) had a moderate population sample who participated in the Scottish health survey and found that recreational sitting was related to all cause mortality and cardiovascular event risk despite physical activity. This was adjusted for multiple co-variables (age, sex, obesity, smoking, ethnicity, social-class, long-standing illness, marital status, diabetes, hypertension). Participants who spent more than four hours on sedentary screen-based activities were more 125% more at risk of a cardiovascular event such as stroke or heart attack than those who spent fewer than four hours (Stamatakis et al., 2011). It is reported that 25% of the association between screen time and CVD
events can be characterised collectively by BMI, C-reactive protein, and high-density lipoprotein cholesterol (Stamatakis et al., 2011).

All-cause mortality relationship with total daily sitting time was consistent with Stamatakis et al. (2011) results however the link between heart attack and coronary heart disease findings were unclear in this large Danish study (Bjørk Petersen et al., 2014a). Findings in a large sample of Australian men aged 45-64 found higher sitting times were significantly associated with diabetes and overall chronic disease which includes CVD (George et al., 2013) These finding are consistent with those of Koster et al., (2012), Katzmarzyk (2010) and Dunstan et al., (2010). Television viewing was more detrimentally linked with increased cardio-metabolic risk factors than computer and reading type sedentary behaviours. This study suggests that dietary habits, whilst watching television, may explain these differences (Nang et al., 2013). This very large multi-ethnic study concluded that leisure spent sitting, especially watching television, may increase overall cardiovascular mortality, however occupational and transportation sitting were not related to increased mortality (Kim et al., 2013).

**Association between sedentary behaviour and cancer**

Current literature is unclear regarding a relationship between some types of cancer and sedentary behaviours. Regular physical activity is associated with decreased incidence of colorectal cancer (CRC) (Nilsen & Vatten, 2001; Slattery, Edwards, & Curtin, 2003). Routine activity during the day including heavy lifting and carrying versus mostly sitting may reduce chances of invasive breast cancer (George et al., 2010). A meta-analysis that examined 23 cohort studies reports an association between sedentary behaviour and increased risk of colorectal cancer (CRC) and rectal cancer (Cong et al., 2014). Cong et al suggest that reducing sedentary behaviour is potentially important for reducing the risk of CRC. However, Kim et al. (2013) found TV viewing was not associated with cancer in their large multi-ethnic cohort study. Furthermore Dunstan et al (2010) found there was no significant relationship between television viewing and cancer mortality was not significant. A Netherlands cohort study included 120,853 participants aged between 55-69 years of age (Simons et al., 2013). Non occupational physical activity was inconsistently associated with colorectal cancer endpoints in males, and it was inversely associated with colon cancer in women particularly distal colon cancer. They conclude that regular physical activity and fewer sitting hours could help protect against colon cancer, however there was a mixed result for rectal cancer (Simons et al., 2013) The results from Simons et al (2013) were adjusted for age, smoking status, alcohol intake, BMI, and dietary factors.

Nilsen & Vateen (2001) found that an inverse association of leisure time physical activity and colorectal cancer in men in addition to the positive association with diabetes, blood glucose and colorectal cancer in women, at least partly support the hypothesis that insulin may act as a tumour promoter in the formation of colorectal cancer. Obesity and poor diet are also contributing factors to colorectal cancer (Nilsen & Vatten, 2001).
Mental health outcomes

There is mixed evidence about the effect of sedentary behaviour and mental health outcomes such as anxiety, depression, or stress. This large cross-section study found there was an association between sedentary behaviour and poor mental health (Hamer et al., 2014). Furthermore, meeting the recommended guideline for physical activity along with sedentary behaviours fewer than 5 hours per day are associated with reduced psychological stress (Sloan et al., 2013). An overview study concluded that there is an evident relationship between physical activity and mental health outcomes in young people, however study designs are frequently weak and effect sizes are small to moderate (Biddle & Asare, 2011). Conversely evidence has shown small but consistent associations between sedentary behaviour (in the form of screen time) and adverse mental health in young people (Biddle & Asare, 2011).

Interventions to address sedentary behaviour in office environment

There are many types of interventions that have been tested to reduce sedentary behaviour in an office environment. Point of choice software, treadmill desks, standing desks, standing work stations, elliptical trainer desks, and cycle desks are proposed strategies for reducing sedentary behaviour in the office. These will be discussed in the following sections.

Standing desk

There is increasing evidence in the field of sit-stand desk research. Both quantitative and qualitative research has been explored although there still is a need for further research in this field.

Effectiveness of workplace interventions

Chau (2010) reports a dearth of evidence for the effectiveness of workplace interventions. Introducing standing or sit-stand desks have been proposed as a way to reduce sedentary behaviour in the office environment. It is reported that sit- stand desks or workstations can be effective at reducing sitting time (Alkhajah et al., 2012; Chau & Daley, 2014; Grunseit et al., 2013; Hinckson et al., 2013; Koepp et al., 2012; Macewen, Macdonald, & Burr, 2015; Parry, Straker, Gilson, & Smith, 2013). However Gilson et al. (2012) found standing “hot desks” did not significantly alter sedentary time in their population of Australian employees in an open plan office. This study was two weeks in length thus more time may have been needed for people to get used to the idea of using the hot desk. They also
express there may have been sensitivity issue with the accelerometers they used to measure sedentary time as there were discrepancies between the log book times (using the hot desk) and accelerometer data.

**Biological changes whilst using a standing desk**

It has been shown that energy expenditure was significantly higher when using a combination of the sitting and standing positions throughout the work day (Buckley, Mellor, Morris, & Joseph, 2014; Thorp et al., 2013). Energy expenditure was shown to be 174kcals greater than sitting for the same period of time in addition to reduction/attenuated blood glucose by 43% after 185 minutes of working at a standing desk (Buckley et al., 2014). In the class room environment no significant changes in BMI, step counts, and behavioural markers were found (Koepp et al., 2012) but caloric expenditure increased significantly (Reiff et al., 2012). There were physiological changes during the use of both a standing desk and a tread desk however the tread desk had higher physiological benefit.

**Musculoskeletal issues**

Musculoskeletal problems have been associated with prolonged seated positions thus the standing desk has been tested to identify differences between sitting and standing. Whilst using a sit-stand desk in the low sitting, high sitting and standing function there was decreased muscle activity in the upper trapezius muscle and left wrist extensor muscle group (Nevala & Choi, 2013). There was also reduced perceived strain in the muscles compared with a low sitting position at a traditional seated desk (Nevala & Choi, 2013). It is likely that use of a sit-stand paradigm reduces worker discomfort and musculoskeletal complaints (Husemann, Von Mach, Borsotto, Zepf, & Scharnbacher, 2009; Karakolis & Callaghan, 2014), however, this is disputed by Ebara et al. (2008) who found the sit stand desk adversely affected musculoskeletal complaints. Thus further research is needed (Husemann et al., 2009).

**Standing desk and its influence on worker productivity**

Mixed results have been shown for the influence of a standing desk on worker productivity. Husemann et al. (2009) found there was a small but insignificant reduction in the efficiency of data entry. It was shown that work performance was not affected by the use of a standing desk (Alkhajah et al., 2012; Commissaris et al., 2014), with the exception of high precision work tasks (Commissaris et al., 2014), however workers perceived there to be a reduction in productivity. Conversely work performance tended to be steadily high compared to other conditions such as standard desk, and sitting at the standing desk (Ebara et al., 2008). Furthermore the sit-stand workstation allowed for steady alertness (Ebara et al., 2008). Karakolis et al (2014) had mixed results with their review of eight studies. Grunseits’ et al. (2013) qualitative analysis found that the majority of their participants
felt their productivity had improved. This was self-reported thus it is unclear if worker productivity is objectively affected by the standing desk.

**Acceptability and motivation of using a standing desk**

Qualitative analyses have revealed a number of aspects that related to the use and acceptability of using a standing desk. There is increasing evidence that use of a standing desk or workstation has a strong acceptability for use in an office (Grunseit et al., 2013; Healy, Alkhajah, Winkler, Owen, & Eakin, 2012; Neuhaus, Healy, Dunstan, Owen, & Eakin, 2014; Wilks et al., 2006). This small sample (n= 18 at base line and n=13 follow-up) formative research by Grunseit et al. (2013) introduced sit-stand desks to a government office for three months. This research aimed to reduce sitting times and ascertain experience of using the desk by group interviews. Sitting times decreased (mean decreased 1.7 hours per day) p=0.014. Group interviews and one key informant interview revealed potential health benefits, willingness to experiment and external prompting were factors in initiating use of the standing desk. Factors for continued use of the standing desk included concern for and experience of long and short term health benefits; perceived productivity whilst sitting compared with standing; practicality of transitions between sitting and standing; electric or manual height adjustment. The sit-stand desk had high usability and acceptability in this sample. They were successful at reducing sitting times at work. Furthermore use could be promoted by emphasizing health benefits, providing guidance on appropriate set up, and normalizing standing in the workplace Grunseit et al. (2013).

Chau et al. (2014) aimed to qualitatively examine the acceptability and feasibility of using sit-stand workstations in office worker who were part of the Stand@work randomised control cross over pilot trial. 42 participants were interviewed during nine focus groups after a 4 week intervention period with a table top sit-stand workstation. Results showed that participants were mostly intrinsically motivated to try the sit-stand workstation due to curiosity to try something new, interest in potential health benefits, and relevance to the participants own and organisational work. Three usage pattern were found for the sit-stand workstation: task based routine; time based routine; no particular routine. Open plan offices and the design of the sit-stand workstation were identified as barriers of use. A supportive work environment conducive to standing, perceived health and work benefits were facilitative aspects of using the sit-stand work station.

Healy et al. (2012) aimed to examine the efficacy of a sit-stand workstation to decrease office workers sitting time and the acceptability of health and work related outcomes. Participants (n=18) were interviewed during their first week of the three month intervention and three months post intervention. They also wore a device to monitor activity whose results were compared with those of a control group (n=14). There was a significant reduction in sitting times both during the first week and three months post intervention (-184 mins/day 1 week and -179 at the three month post intervention). The Sit-stand work station had a high acceptability (i.e. no one wanted the workstation removed). It was found that 94% of the participants in this study found the desk easy to use and enjoyable. 83% found
that it was comfortable. Problems were identified with lack of wrist support, decreased mouse manoeuvrability and footwear choice.

Point of choice software

There is limited evidence for the efficacy and reliability for point of choice software and its effect on sedentary behaviour. This software causes a message to appear on the screen every thirty minutes to remind the worker to get up. Evans’ et al. (2012) research aimed to reduce uninterrupted sitting time and overall sedentary behaviour. They found that the intervention group had fewer sitting events of more than half an hour, but no significant difference was found in total sitting time between control and intervention group. More research is required in this area.

Interventions to reduce sedentary behaviour are on the rise. These interventions include standing or sit-stand desks or workstations, dynamic workstations, and computer software. Stand and sit-stand desks are currently most popular intervention in the work place.

Dynamic workstation

Evidence for dynamic workstations, with the aim of reducing sedentary behaviour, is limited in current literature. Dynamic workstations include treadmill desks, semi-recumbent elliptical trainer desks, and cycle desks. A one year prospective trial found that treadmill desks may improve aspects of health (Koepp et al., 2013). Access to a treadmill desk significantly reduced sedentary behaviour in the office environment and an increase in physical activity (Koepp et al., 2013). However typing tasks are less efficient with a tread desk compared with a traditional desk (Commissaris et al., 2014). Cycle desks were shown to facilitate physical activity during the work day in this small study (Elmer & Martin, 2014). Elliptical trainer and cycle desks showed no significant effect on mouse, typing or reading tasks (Commissaris et al., 2014) which supports Elhmer and Martin’s (2014) findings for the cycle desk. Straker et al (2009) also found no significant effect on typing tasks, however there was deterioration in high precision mouse tasks.

Summary

Sedentary behaviours include sleeping, sitting, office work, watching television and other forms of screen based entertainment. There is a significant health risk with sitting more than 4 hours in a day, despite amount of physical activity that is done. Standing desks have been proposed as a way to reduce occupational sedentary behaviour.
Occupational physical activities levels have been decreasing (Borodulin et al., 2008) and conversely both occupational and leisure time sedentary behaviour has been on the rise (Matthews et al., 2012). An increasing body of evidence is pointing towards prolonged sitting being a ubiquitous health risk (G. Healy, Lawler, et al., 2012; G. N. Healy et al., 2013; Owen et al., 2014). People participating in higher amounts of sedentary behaviours have a greater chance of developing metabolic syndrome (Edwardson et al., 2012; E. George et al., 2013; Pinto Pereira et al., 2012; Pulsford et al., 2013) which leads to higher risk of developing chronic diseases such as diabetes and cardiovascular disease (Voulgari et al., 2011). Moreover higher levels of sedentary behaviour are thought to be linked to obesity (Shields & Tremblay, 2008), cardiovascular disease (George et al., 2013; Stamatakis et al., 2011), diabetes (type II) risk factors (Pinto Pereira et al., 2012; Stamatakis et al., 2011), poor mental health outcomes (Bell et al., 2014) and all-cause mortality (Stamatakis et al., 2011; van der Ploeg et al., 2014). It is unclear if sedentary behaviours are associated with cancer as there has been mixed results thus definitive conclusions have yet to be drawn.

It is argued that prolonged sitting increases the risk of chronic disease and all-cause mortality (David W. Dunstan et al., 2012; Owen et al., 2014; Shields & Tremblay, 2008; Stamatakis et al., 2011). Whilst Mahar et al. (2014) reports no association between sedentary behaviour and cardio metabolic risk factors once adjustments are made for total physical activity rather than MVPA alone. Furthermore television time has higher risk factors than office work however the mechanism for this is unknown at this time.

Interventions to reduce occupational sitting time include standing or sit stand desks or workstations, dynamic workstations, and point of choice software. Currently, standing desks appear to be the most popular choice for research. Standing desks have mostly had good feasibility and strong acceptability with introduction into work places and schools (Grunseit et al., 2013; G. Healy, Alkhajah, et al., 2012; Neuhaus et al., 2014; Wilks et al., 2006). They do not appear to have a detrimental effect on work productivity (Alkhajah et al., 2012; Commissaris et al., 2014; Husemann et al., 2009). Energy and caloric expenditure increased whilst using the standing desk especially when using a combination of sitting and standing postures (Buckley et al., 2014; Reiff et al., 2012).

More research is needed to investigate the effect of using a standing desk has on musculoskeletal complaints (Husemann et al., 2009). There is a small evidence base with mixed results in this area of research (Ebara et al., 2008; Husemann et al., 2009; Karakolis & Callaghan, 2014; Nevala & Choi, 2013).

A small number of studies have examined the possibility of sit-stand workstations and are effective at reducing sitting times at work (Chau et al., 2014; Healy et al., 2012; Grunseit et al., 2013) Sit-stand workstations have had a high acceptability in office workers despite some problems with lack of wrist support, decreased manoeuvrability Healy et al., (2012). There are currently no studies whose main focus are the qualitative aspects. These aspects are important as they would be of
interest to people interested in using standing, or already using, desks in the workplace. This study may assist employers who are interested in the health of their employees.

The current study aims to explore subjective and perceptual factors pertaining to the experience of using a standing desk and will determine acceptability in a small population of office workers over a five month time period. It goes in depth about barriers and facilitators to use, changes that participants noticed (physical, mental, environmental, and perception of sitting).

This chapter has explored the current literature relating to sedentary behaviour, and its health impacts, in addition to the available research on the use of standing desks. The following chapter is concerned with the methodology and methods of the current study.
Chapter Two: Conducting the research

Chapter two explores the methodological framework that underlies this research project. Qualitative research methods and the generic qualitative methods which are used are outlined. This is followed by a discussion of the principles or rigor in qualitative research and how it was built and maintained. Furthermore the methods of this project are explained which include participant recruitment, ethical considerations, data collection, and analysis.

Aim

The aim of this research project was to reveal the subjective factors pertaining to the experience and acceptability of using a standing desk. Therefore a qualitative research method was chosen to fulfil this purpose. It allowed the researcher to gain deep insight into the participants’ experience, thus allowing themes to emerge from the data and evaluate acceptability.

Methodology

A qualitative approach

Qualitative research is used for "exploring individual experience, describing phenomena and developing theory" (Tracy, 2012). It allows the investigation of human experience from a holistic, in-depth perspective and is suited to examining the complex problems encountered in clinical practice (Vishnevsky & Beanlands, 2004). Few qualitative and mixed method studies have explored experience and acceptability of using a standing desk.

One qualitative study has explored aspects of experience and acceptability pertaining to the use of a sit-stand desk (Grunseit et al., 2013). Another study has done the same for a sit-stand workstation which is placed on top of the traditional sitting desk (Chau, Daley, Srinivasan, et al., 2014). Grunseit et al. (2013) evaluated the usability and acceptability of both manual and electronic sit-stand desks. The qualitative portion of this research was specifically concerned with ease of use, barriers of use and satisfaction (Grunseit et al., 2013). Using the insight gained from the current literature study helped inspire the research interview schedules to investigate a wider range of experience. Recommendations for exploration of productivity and absenteeism were suggested by Grunseit et al.
(2013) and investigating the feasibility for long term use of the standing workstation. Therefore these were incorporated into the current study.

There are multiple methods for approaching qualitative research. The most common are phenomenology, ethnography, and grounded theory (Tracy, 2012). However the approach taken for this project was the generic qualitative approach, as it incorporates parts of phenomenology, and mixed-methods, whilst still giving the researcher freedom to gain insight for the research purpose. The section below will discuss the generic qualitative method. Ethnography considers patterns and alterations and of a phenomenon, generally related to culture. The systematic and structured nature of grounded theory seeks to describe and explain a phenomenon (Starks & Trinidad, 2007). However is arguably too time-consuming for a 90 credit thesis and would go further than the aim of the current research project (Starks & Trinidad, 2007). Phenomenology gives meaning and insight into a phenomenon (Kleiman, 2004). While the current study aimed to investigate the experience of using the standing desk it was not the purpose to find the meaning of why particular experiences occurred. Thus this study incorporated some phenomenological principles, though the method used was a generic qualitative method.

**Generic qualitative methods**

Generic qualitative research method is defined as “that which is not guided by an explicit or established set of philosophical assumptions in the form of one of the known qualitative methodologies" (Caelle & Mill, 2003). It aims to discover and understand a phenomenon, a process, or the perspective, and world views of the people involved (Cooper & Endacott, 2007; Merriam, 2002). Generic qualitative studies are those that exhibit some or all characteristics of qualitative venture but rather than following a specific methodology they use a combination of approaches or claim no methodological stance (Cooper & Endacott, 2007). Caelle et al. (2003) argues that a generic qualitative approach must address four key areas. Firstly the theoretical positioning of the researcher must be established. Secondly there must be congruency between the methodology and methods. Thirdly the researcher must explain their strategies to establish rigor. Finally the trustworthiness of the analytical lens the researcher has used.

Qualitative data is usually captured by means of interviews, documentary analysis and observation (Endacott, 2008). Interviews were chosen over focus groups because they allow participants to explain their own experience without being influenced.

**Addressing rigour in qualitative research**

Rigour in qualitative research represents the trustworthiness or goodness of a study of a study (Koch, 1994; Murphy & Yielding, 2010). The following section will explain specifically how rigor was maintained in this research project. Rigour is established if the reader is able to follow the "decision
trail” of the researcher (Koch, 1994). Furthermore the foundation, approach, how the researcher interprets and represents the participants all play a role in the rigor building process (Murphy & Yielder, 2010). Credibility, dependability, confirmability, and transferability are the building blocks of rigor (Cope, 2014; Koch, 1994; Murphy & Yielder, 2010; Polit & Beck, 2012). Each of these aspects is explored below.

**Credibility**

Credibility refers to the truthfulness of the data and the 'fit' between the participants' view points and the researcher’s interpretation and representation of them (Cope, 2014; Murphy & Yielder, 2010; Polit & Beck, 2012). Credibility is strengthened by member review to see if there is consistency between the participants and the researcher (Murphy & Yielder, 2010; Polit & Beck, 2012). Furthermore to support credibility researcher should demonstrate prolonged engagement, methods of observations and audit trails (Cope, 2014; Murphy & Yielder, 2010).

Credibility has been established in multiple ways. Data collection, engagement, and analysis took one year. This has given the researcher enough time to reflect on ideas and themes that emerged from the data. The researcher attended regular meetings with the researcher's supervisor to discuss research process, ideas and themes. In addition the researcher conferred with colleagues and peers throughout the research process. This was especially utilized during development of interview schedules, and data analysis.

**Dependability**

Dependability refers to the constancy of the data over similar situations (Polit & Beck 2012). Dependability is achieved by an audit trail that shows how decisions were made and conclusions were drawn (Cope, 2014; Koch, 1994). The reader does not necessarily need to agree with the researcher however the reader needs to be able to see how the researcher came to those decision for research to be deemed dependable (Koch, 1994) This audit trail should be in the form of comprehensive notes throughout data collection and analysis. Furthermore, dependability can be achieved by the use of rich quotes from the participants.

Dependability was generated in this study by an audit trail including examples of data collection and analysis. In addition the results section contains quotations from the participants. Appendix H presents a large analysis table which was generated using all the lumped codes or categories. Appendix I shows a section of the research diary kept by the researcher throughout the process of collection and analysis. Analytical memos and code book were added to throughout the analysis process. Reflections of research process including meetings with the supervisors, data collection and analysis were either hand written in the research journal or audio recorded.
Confirmability

Confirmability is the degree to which this can be confirmed by others (Murphy & Yelder, 2010). It is concerned with the accuracy and neutrality of the data (Houghton, Casey, Shaw, & Murphy, 2013). As with dependability a clear audit trail demonstrates this principle of trustworthiness (Cope, 2014; Murphy & Yelder, 2010). Moreover confirmability can be improved through suitable research questions, design and data reporting, in addition to presenting data that contradicts previous interpretations (Schneider & Whitehead, 2013).

The researcher achieved confirmability by using detailed descriptions of the methods used supported by literature. Support from well-practiced research supervisors helped to think about aspects of a project not thought about by the novice researcher. An extensive audit trail as mentioned in the 'dependability section' was also used to demonstrate confirmability.

Transferability

Transferability refers to the generalizability of findings that can be applied to other settings or groups (Houghton et al., 2013; Murphy & Yelder, 2010; Polit & Beck, 2012). Within the qualitative paradigm a study should only meet this if the research aim is to make generalisations about a subject or phenomenon (Sandelowski, 1986). However Houghton et al. 2013 reports transferability can be established by any qualitative study by giving "thick descriptions" of research process including the research methods, the context, and excerpts of raw data.

Transferability was established by incorporating the detailed methods section below. This outlines the steps taken so the reader can make their own judgements about the reliability of the process. The results section in the manuscript below contains rich examples of raw data that represents a theme or subtheme. These are direct quotes that have come from the audio which has been transcribed verbatim.

Methods

The previous section explained the methodology used for this study. This section will outline how the study was carried out. This section includes information on participants and the recruitment of these participants, data collection and analysis.
Participant recruitment

Sample size is not usually predetermined in qualitative research (Tracy, 2012). Instead the aim is to include as many participants as necessary to give a comprehensive understanding of the phenomena (Tracy, 2012). However for this study participants were recruited for a two-arm study. The other part of the study was a quantitative analysis of the standing desk on metabolic blood markers. Participants were recruited by a variety of methods. An article was put into the newspaper and on the front page of the website stuff.co.nz. One participant was recruited via the newspaper. Four participants were recruited through the article on stuff.co.nz and the last participant was recruited by word of mouth through the student osteopathic clinic at Unitec NZ. Random selection was used to recruit participants thus everyone who met the inclusion/exclusion criteria had an equal chance of being chosen for this study (Tracy, 2012). The current study used all participants from the quantitative study. The inclusion and exclusion criteria are explained in the section below.

The participants

Six people participated in this study. Three of these participants withdrew before completion thus only three of the participants completed all three interviews. Two participants completed two interviews and the other completed one interview.

Inclusion criteria

Participants were required to be aged between 25 and 40 years with a self-reported height and weight that resulted in a BMI of between 25 and 30 kg/m^2. A minimum self-estimated daily sitting time of 5 hours was a requirement with a low expectance of time away from work over a 5 month period. All participants were required to be registered with a General Practitioner (GP) in case of the need for referral due elevated risk of metabolic events.

Exclusion criteria

Potential participants were excluded if they had been previously diagnosed with cardiovascular disease, diabetes, or metabolic syndrome. Any history of angina or stroke resulted in ineligibility, as well as smoking or current medication that may alter blood pressure, blood glucose, triacylglycerol or cholesterol concentration, or be currently taking weight loss medication.
**Equipment**

Two large fixed height desks, designed by the design students at Auckland University of Technology (AUT) students, were loaned to the researchers for the study. These were able to be adjusted to the appropriate height for the participant and then left at that height for the duration of the study. The desks had two built-in storage compartments. A stool was supplied for participants to sit when necessary.

Four large electric adjustable sit-stand desks were loaned by LINAK who manufacture the hydraulic adjustment mechanism. The desks were Metalon sit to stand desks (1800 x 700 cm). They were able to be easily adjusted to both sitting and standing positions by the touch of a button. These desks had no storage compartments. The chairs were provided by the participants themselves. Purchase of the desks as requested by the participants was organised by the researchers.

**Ethical considerations**

Permission for this study was granted by Unitec Research Ethics Committee (UREC) in 2013. Appendix A presents a copy of the UREC approval letter. The participants were given information sheets that disclosed information on what the study involved (can be seen in Appendix B). It was ensure that all participants read the information sheet and signed consent forms (Appendix C). Verbal consent was gained at the start of each interview to ensure the participant was still willing to participate.
Data Collection

Data was collected by two methods. Firstly, the primary data set was collected by semi-structured interviews. Qualitative interviews provide discovery, understanding, reflection, and explanation of a lived experience and/or viewpoint from a participant’s perspective (Tracey, 2012). The semi-structured nature of the interviews was used to provide flexibility and stimulate conversation rather than dictate it (Tracey, 2012). The majority of the semi-structured interviews were conducted face to face at either the participant’s work place or at Clinic 41 at Unitec. Two of the interviews were conducted over Skype. The location and method of interview was the participants choice so they felt at ease for telling their story (Kleiman, 2004). Face to face interviews are useful because the researcher can hear tone of voice and see gestures that help make up the observation of the participants to determine their reliability and credibility.

Six participants were enrolled in the study however all did not complete the three interviews. Participants one, two and five completed all three interviews. Participant three and six took part in two semi-structured interviews. One participant completed one semi-structured interview. These interviews lasted between 18 minutes and 47 minutes long. Interview one took place at weeks two to four of using the standing desk. Interview two was conducted in weeks 12-13 of using the standing desks. The last interview was carried out three to four week after the intervention period had stopped. These interviews aimed and exploring the experience of the participants and to identify subjective factors relating to acceptability of using the standing desk. The interviews at different time points aimed to collect the entire experience to see if it had changed throughout time. Through qualitative analysis it was found that there were no clear patterns of change at different points in time. The interview schedules are in Appendices D to G.

The secondary data set consisted of questionnaires whose purpose was objectively measure possible changes that may have occurred whilst using the standing desk. The twenty one-item depression anxiety stress scale (DASS-21) and the thirty six-item short form health survey (SF-36) were given monthly to the participants. DASS-21 and SF-36 have been shown to be reliable measures of depression anxiety and stress (Henry, and Crawford, 2005) and well-being (McHorney, Ware, Rachel Lu, and Donald 1994). These were returned between 4-7 weeks due to busy schedules of participants however an effort was made to keep it close to four weeks as possible.
Thirdly each of the participants was offered a diary or to email any thoughts they had about the desk or experience. This was an optional third set of measures which was aimed to collect the participants experience throughout the study whilst it was fresh in the mind. It was made optional so as to not overload the participants. Participant one sent one email with information about experience otherwise this option was not used. This one entry was incorporated into the data analysis stage.

Table 1. Timeline

<table>
<thead>
<tr>
<th>Weeks</th>
<th>1-2</th>
<th>3-4</th>
<th>5-6</th>
<th>7-8</th>
<th>9-10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interviews</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DASS 21 SF-36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weeks</th>
<th>11-12</th>
<th>13-14</th>
<th>15-16</th>
<th>17-18</th>
<th>19-20</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interviews</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DASS 21 SF-36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Data set**

Data sets included semi structured interviews, a 21 question depression, anxiety, stress scale (DASS-21), and a thirty six question SF-36 general health and wellbeing questionnaire. While there was the option of diary entries none of the participants chose to use them.
Data analysis

Data analysis and interpretation aimed to gain insight into the experience and identify common themes of the participants whilst they used a standing desk. In addition it was used to draw conclusions around the acceptability of introducing a standing desk into an office environment. Due to the lack of guidelines within the generic qualitative method of analysis Tracy’s (2012) analysis process was followed to maintain rigor as best as possible. There are many ways to analyse data in the qualitative context (Tracy, 2012). This analysis process consisted of a manual method as described by Tracy a well practised and credible researcher. Table 2 outlines the process of analysis taken in this study.

Data analysis was a six month reflective process. This was to reduce bias and stop the researcher deciding on themes too quickly. Interview audio was transcribed verbatim by the researcher. The audio was checked and re checked, against the transcript, for accuracy. The researcher re-listened to the audio and wrote down the 3-5 main points or interesting findings from each interview to help start the thinking process. These were then incorporated into the coding process. Codes are words or short phrases formed to capture the essence or meaning of a section of the transcription. Each page of every transcript was numbered and sectioned into parts that consisted of one to two paragraphs. These parts contained data of a similar nature. From here the coding process began. Each section contained one or more codes. Codes capture the essence of a portion of data (Tracy, 2012). The majority of the initial codes were in vivo i.e. using the words of the participants (Tracy, 2012). Observations of the researcher were also included in these. 772 primary codes were established. These were put into a word document with the location of the code in the transcript alongside.
Table 2. Phases of data analysis

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description of the process</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Acquaintance and emergence to the data</td>
<td>Reading and re-reading of the data. Listening to the data. Noting down main features or interesting points within the data</td>
</tr>
<tr>
<td>2. Generating codes</td>
<td>Manual coding approach was taken. Primary cycle coding examines data and assigns phrases to capture the essence of a section of data. A code book was created where coded could be defined and examples that illustrate the code are kept</td>
</tr>
<tr>
<td>3. Creating categories</td>
<td>Codes were lumped into categories with codes of similar meanings. These are further defined and refined in a constant comparative method.</td>
</tr>
<tr>
<td>4. Secondary cycle coding, analytical memos, exemplars</td>
<td>Critically examines codes and organises, synthesizes and categorizes them into concepts, patterns and themes. Analytical memos help make meanings from the code and are added to the code book. Exemplars are significant and multi-factorial examples of what is going on in the data</td>
</tr>
<tr>
<td>5. Advanced data analysis</td>
<td>Loose analytical outline is produced whilst thinking about emergent themes and the research question. Matrix for organising results and findings was created. This very detailed copy is in the appendix section of this research project</td>
</tr>
<tr>
<td>6. Reviewing themes</td>
<td>A cleaner, more compact, version of the results matrix was formed in which themes and subthemes had been reviewed and lumped further. This matrix is below</td>
</tr>
<tr>
<td>7. Refining and defining themes</td>
<td>Themes and subthemes were defined and refined throughout the writing of the results. These were cross checked to make sure this worked with the research question</td>
</tr>
</tbody>
</table>

This table is an adapted version of one of the processes outlined by Tracey (2012).
Each transcript was analysed separately using phases 1-3. Codes from each transcript were grouped together into categories and further analysed using phases 4-7. Re-defining and rewriting codes lead to revising of potential themes. Analytical memos and matrix allowed for deeper analysis. A research journal, constant reflection and talking to others aimed to reduce bias. In addition it allowed the researcher to explore all possible themes rather than settling on to themes too early. There were multiple versions of this table as items became grouped, moved and changed to better fit the emerging themes. Below is a condensed version of the analysis matrix which occurred at the end stage of analysis. This condensed table contains only the largest subthemes An earlier and full version of this table is presented in appendix H. It has been inserted to show the reader an example of the process of analysis. This process of analysis allowed the researcher to understand subjective factors pertaining to the experience and acceptability of using a standing desk.

This section has discussed the generic qualitative methodology that has guided the research and outlined the steps taken to collect and analyse the data. The following chapter will present and discuss the findings, of this research project, within the context of relevant literature in the form of a publishable manuscript.
References


Chau, J. Y., & Daley. (2014). The effectiveness of sit-stand workstations for changing office workers’ sitting time: results from the Stand @ Work randomized controlled trial pilot.


Merriam, S. B. (2002). Introduction to qualitative research. *Qualitative Research in Practice: Examples for Discussion and Analysis.*


Pinto Pereira, S. M., Ki, M., & Power, C. (2012). Sedentary behaviour and biomarkers for...


Note: This manuscript was prepared in general accordance with the guidelines for authors (See thesis Appendix I) for the *Applied Ergonomics*, however, there are three main deviations: i) the manuscript exceeds the prescribed word count of 5000 words in the journal guidelines in order to address the learning outcomes as part of a research thesis; ii) for ease of reading the tables and figures are typeset in the text; iii) the style of the headings and subheadings also differs from that prescribed for ease of reading.
The Standing Study: Participant experience and acceptability of using a standing desk

Sheehan Robb
Department of Osteopathy
Unitec Institute of Technology
Private Bag 92025, Auckland 1142

Email: sheehan28@hotmail.com
Phone: +64 210403042
Abstract

**Background:** Sedentary behaviour (including prolonged sitting) is associated with increase in common chronic diseases, such as diabetes, cardiovascular disease, and all-cause mortality. Due to the prevalence, and risks, of prolonged sitting for office workers standing desks have been proposed as strategy to reduce sedentary time in the work place.

**Objective:** This study aimed to identify and understand perceptual and subjective factors pertaining to the experience and acceptability of adapting to and working from a standing desk.

**Method:** This generic qualitative study was part of a two armed study which collectively measured biological blood marker changes throughout the 16 week trial and how the desks were perceived, used, and accepted by the participants. Participants (n=6) were recruited via online media. They were selected for their age (25-35), weight, hip-waist ratio, and BMI measurements. Three semi-structured interviews were conducted at weeks 1-2, 14-16, and 21-22 of the trial. Data analysis generated themes and subthemes.

**Results:** Theme one: The physical, mental, and environmental experience of using a standing desk encompassed perceived improvement in physical, mental, and environment experience and reveals a process of adjustment. Physical improvements included energy and vitality, increased tolerance to standing, posture and decrease in discomfort with standing. Mental improvements include enhanced emotional experience, improved tolerance to stress, and feeling proactive about health, along with improved self-awareness, cognitive function and productivity. Improved perception of office environment included aspects of/due to perceived interaction with others and improved work station set-up. There was a process of adjustment which involved and adjustment period, initial discomfort, (other subthemes included too much too soon and standing full time) Theme Two: Conclusion judgements, and acceptability: sitting and standing in an office environment. There were changes to the participants perception of sitting and it was identified that there were many reasons not to sit. It was identified that there was a need to alternate sitting and standing. There was a high acceptability and affinity for using the standing desk as all participants wanted to continue to use the standing desk.

**Conclusion:** The experience of using a standing desk, resulted in a strong acceptability for its use in the work place in this group of participants.

**Key words:** Standing desk; Sit-Stand desk; Qualitative research; Acceptability of using a standing desk; Experience of using a standing desk

**Abbreviations**

*SB* Sedentary behaviour
Highlights

- A Participants perceived to have improved physical, mental, and environment experience and revealed a process of adjustment.
- B There were changes in participant perception and experience of sitting, There was a need to alternate sitting and standing.
- C High acceptability for continued use of the standing desk

1. Introduction and background

Sedentary behaviour refers to "activities that do not increase energy expenditure substantially above resting level" (Atkin et al., 2012; Katzmarzyk, 2010; Pate et al., 2008). Sedentary behaviours include sleeping, sitting, office work, watching television and other forms of screen based entertainment. Standing desks have been proposed as a way to reduce occupational sedentary behaviour.

Occupational physical activities levels have been decreasing over the last thirty years (Borodulin et al., 2008) and conversely both occupational and leisure time sedentary behaviour has been on the rise (Matthews et al., 2012). An increasing body of evidence is pointing towards prolonged sitting being a ubiquitous health risk (Healy, Lawler, et al., 2012; Healy et al., 2013; Owen et al., 2014). People participating in higher amounts of sedentary behaviours have a greater chance of developing metabolic syndrome (Edwardson et al., 2012; George et al., 2013; Pinto Pereira et al., 2012; Pulsford et al., 2013) which leads to higher risk of developing uncommunicable chronic diseases (Voulgaris et al., 2011). Moreover higher levels of sedentary behaviour are thought to be linked to obesity (Shields & Tremblay, 2008), cardiovascular disease (George et al., 2013; Stamatakis et al., 2011), diabetes (Type II) (Pinto Pereira et al., 2012; Stamatakis et al., 2011), poor mental health outcomes (Bell et al., 2014) and all-cause mortality (Stamatakis et al., 2011; van der Ploeg et al., 2014).

It has been argued that prolonged sitting can increase the risk of chronic disease and all-cause mortality (David W. Dunstan et al., 2012; Owen et al., 2014; Shields & Tremblay, 2008; Stamatakis et al., 2011). Whilst Mahar et al. (2014) reported no association between sedentary behaviour and cardio metabolic risk factors once adjustments are made for total physical activity rather than moderate to vigorous physical activity (MVPA) alone. Furthermore television time has higher risk factors than office work however the mechanism for this is unknown at this time.

Interventions to reduce occupational sitting time include standing or sit-stand desks or workstations, dynamic workstations, and point of choice software. Standing desks have mostly had good feasibility and strong acceptability with introduction into work places and schools (Grunseit et al., 2013; Healy,
Alkhajah, et al., 2012; Neuhaus et al., 2014; Wilks et al., 2006). They do not appear to have a detrimental effect on work productivity (Alkhajah et al., 2012; Commissaris et al., 2014; Husemann et al., 2009). There has been promising evidence reported for reducing office sitting time and improving office standing time. Energy and caloric expenditure increased whilst using the standing desk especially when using a combination of sitting and standing postures (Buckley et al., 2014; Reiff et al., 2012).

More research is needed to investigate the possible effect the standing desk may have on musculoskeletal complaints (Husemann et al., 2009), the effect on the office environment, and potential health benefits of using the standing desk. There is a limited evidence base with mixed results in this area of research (Ebara et al., 2008; Husemann et al., 2009; Karakolis & Callaghan, 2014; Nevala & Choi, 2013). Two studies have researched acceptability of sit-stand workstations (sits on the desk top) (Chau et al., 2014; Healy et al., 2012) and one study assessed acceptability of electronic and manual height adjustable desks (Grunseit et al., 2013).

2. Methods and Materials

2.1 Methodology

Qualitative research is used for “exploring individual experience, describing phenomenon, and developing theory” (Tracy, 2012). It allows the investigation of human experience from a holistic, in-depth perspective and is suited to examining the complex problems encountered in practice (Vishnevsky & Beanlands, 2004). The aim of this research project was to reveal the subjective factors pertaining to the experience and acceptability of using a standing desk. Therefore a qualitative research method was chosen to fulfil this purpose. A qualitative research method allowed the researcher to gain deep insight into the participant’s experience, thus enabling themes to emerge from the data.

A generic qualitative method is not guided by an established set of guidelines but rather follows either a combination of approaches or no specific approach (Caelle et al (2003); Cooper & Endacott, 2007). This methodology was selected over others due to the descriptive nature of the aims and purposes of this research. It is argued that there is no clarity of process due to its nature thus how can the research be trusted. The researcher followed the criterion suggested by Caelle et al (2003) for generic qualitative studies to improve trustworthiness.

The current study utilised qualitative interviews for data collection as they are judged to be a good way to provide discovery, understanding, reflection, and explanation of a lived experience or viewpoint from a participants perspective (Endacott, 2008; Kleiman, 2004; Tracy, 2012).

2.2 Equipment
Two fixed height and four electronic adjustable height standing desks were used for this study. An iPad and phone were used to capture interview audio.

2.3 Participants

Participants (n=6) were recruited for a two arm study. The following are the criteria for the quantitative evaluation of metabolic blood markers. The qualitative part of 'The Standing Study' interviewed the same participants.

Inclusion criteria

Participants were required to be aged between 25 and 40 years with a self-reported height and weight that resulted in a BMI of between 25 and 30 kg/m². A minimum self-estimated daily sitting time of 5 hours was a requirement with a low expectancy of time away from work over a 5 month period. All participants were required to be registered with a General Practitioner (GP) in case of the need for referral due to elevated risk of metabolic events.

Exclusion criteria

Potential participants were excluded if they had been previously diagnosed with cardiovascular disease, diabetes, or metabolic syndrome. Any history of angina or stroke resulted in ineligibility, as well as smoking or current medication that may alter blood pressure, blood glucose, triacylglycerol or cholesterol concentration, or be currently taking weight loss medication.

2.4 Data Collection

Primary data were collected by face to face semi-structured interviews. Participants one, two and five took part in all three interviews. Participants three and six withdrew after the second interview. Participant three withdrew from the qualitative part of 'The Standing study' after the first interview. The interviews lasted from 18 minutes- 47 minutes.

Secondary data were collected by the DASS-21 and SF-36 questionnaires. The data from the questionnaires was not analysed due to missing and late data sets which would have affected the reliability and validity of the data.
Table 1. Timeline of intervention and data collection

<table>
<thead>
<tr>
<th>Weeks</th>
<th>1-2</th>
<th>3-4</th>
<th>5-6</th>
<th>7-8</th>
<th>9-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interviews</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DASS 21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF-36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weeks</th>
<th>11-12</th>
<th>13-14</th>
<th>15-16</th>
<th>17-18</th>
<th>19-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interviews</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DASS 21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF-36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.5 Ethics

Permission for this study was granted by Unitec Research Ethics committee in 2013. The participants were given information sheets that disclosed information on what the study involved. It was ensured that all participants read the information sheet and signed consent forms. Verbal consent was gained at the start of each interview to ensure the participant was still willing to participate. All consent forms were stored in a lockable filing cabinet. All audio interviews were stored in password protected files on the researcher’s personal computer. All printed transcriptions were stored in a locked filing cabinet only accessible by the research team. These will be stored securely for seven years then destroyed.

2.6 Data Analysis

The interviews were transcribed verbatim and anonymised by the researcher. Analysis and interpretation of the data aimed to identify and describe the participants' experiences, identify common themes, and draw conclusions referring to the acceptability of using a standing desk. The process of data analysis was guided by the process outlined by Tracy (2012). Primary and secondary
cycle coding was used to draw out meaning from the data. Analytical memos and matrixes explored the patterns emerging from the data (Tracy, 2012).

2.7 Rigour

Rigour represents the trustworthiness of the research process (Houghton et al., 2013; Koch, 1994; Murphy & Yelder, 2010). The building blocks of rigor are credibility, dependability, confirmability and transferability (Cope, 2014; Koch, 1994; Murphy & Yelder, 2010; Polit & Beck, 2008). These were demonstrated in the following ways. Firstly, data collection, engagement, and analysis took one year thus giving enough time to build trustworthy research. Secondly, regular meetings and conversations with supervisors and peers reduced the potential for researcher bias. Thirdly, audit trails allow the reader to follow the process to see how decisions were made. The audit trail constitutes recorded and structured meetings with supervisors and daily-weekly entries into research journal. Finally, the direct quotes presented in the results section are evidence of honesty of data.

3. Results

Interviews were conducted of which three participants took part in all three interviews. Of these participants, two bought the standing desk and thus their third interview was still about their experience of using the standing desk and why they bought the desk. One participant completed all three interviews and went back to a sitting desk. Three participants withdrew early from the study, one participant completed one interview and two completed two interviews.

The table below gives information of the characteristics of the participant. Four females and two males participated in the study. They were between 25-40 years of age. They weighed between 58-83 kgs and had body mass index (BMI) ranging between 24.6-32.7 kg/m². The participants’ waist circumferences ranged from 82-104 cm.
Table 1. Participant Characteristics

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Gender</th>
<th>Weight (kg's)</th>
<th>BMI (kg/m²)</th>
<th>Waist Circumference (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>31</td>
<td>Female</td>
<td>68</td>
<td>28.6</td>
<td>87</td>
</tr>
<tr>
<td>Participant 2</td>
<td>40</td>
<td>Male</td>
<td>81</td>
<td>28.7</td>
<td>104</td>
</tr>
<tr>
<td>Participant 3</td>
<td>34</td>
<td>Male</td>
<td>79</td>
<td>24.6</td>
<td>82</td>
</tr>
<tr>
<td>Participant 4</td>
<td>40</td>
<td>Female</td>
<td>58</td>
<td>24.8</td>
<td>78</td>
</tr>
<tr>
<td>Participant 5</td>
<td>30</td>
<td>Female</td>
<td>83</td>
<td>32.7</td>
<td>97</td>
</tr>
<tr>
<td>Participant 6</td>
<td>25</td>
<td>Female</td>
<td>80</td>
<td>27.2</td>
<td>85</td>
</tr>
</tbody>
</table>

To convey the experience and acceptability of using a standing desk the data were arranged into two themes. Theme one: the physical, emotional-cognitive, and environmental experience of using a standing desk. Theme two: conclusions, judgements, and acceptability: sitting desk vs. standing desk.

3.1 Theme 1: The physical, mental and environmental experience of using a standing desk

Through the process of analysis it became clear that the participants had a physical, mental, and environmental experience whilst they were using a standing desk. The physical experience pertained to changes within the body. Mental changes happened within the mind and included emotional and cognitive changes. The environmental experience included the physical interaction with the surrounding environment including other people.

Improved physical experience

Four aspects of perceived physical improvement were revealed. The participants perceived to have experienced improved energy and vitality, improved tolerance to standing, decreased aches and pains, and other changes.
Improved energy and vitality

Five of the six participants felt that they experienced more physical energy whilst using a standing desk this may have contributed to the participants perceiving to have improved approach to work, possibly inspired more interaction with other people and helped their cognitive function. Five participants mentioned multiple times about how energetic they had been feeling since using the standing desk. One participant made no mention of changes in energy levels at all.

“I’ve definitely noticed that I have been able to cut down the amount of coffee I drink at work…and feel less need for afternoon pick me ups and things like that. I guess I kind of feel more in tune with what I’m doing. I feel like if I’m sitting, I’ve spent longer… It’s kind of slacking off….checking websites or whatever, though everyone does.” (P1.2pg2d)

Increased tolerance to standing

The participants felt that over time their tolerance to standing had improved. Their bodies had been trained to the physical act of using a standing desk. Furthermore they felt standing had become their "normal" now. This suggests that it may be easy to get used to the standing desk even though there might be some initial discomfort.

"ah really good, it's become second nature really. I've got to the point where the only time I take a break is when I am somewhere other than my standing desk. I just stand all day and when the study ended I had to scramble to find a replacement for the one I was using so I managed to do that" (P2.2pg1a).

Improved posture and decreased discomfort whilst standing

All six participants had perceived improvements in posture whilst using the standing desk.

“I think I have just become more conscious of things. I remember somebody… no I saw a video… no something for TV…sorry… I was on TV for something and I looked at my posture and I was quite stooped, shoulders hunched… someone in the news room actually remarked that I have quite an upright posture (now) and probably that’s been helped (using the standing desk)…. More of the posture thing I certainly feel that has improved” (P2pg2d)
Three participants felt they experienced less physical discomfort than at their sitting desk. This included less back, hip and shoulder pain. However participants also experienced some minor musculoskeletal aches that appeared to be associated with prolonged standing at the desk. This will be explained further into the results section

“I guess it probably feels a bit more natural. I like that I can walk over to my desk... I just stay standing up... and particularly where I've had an issue with my hip, the movement of sitting up to standing up really aggravates it. So for example yesterday I noticed there was a bit of niggling in that hip, where it didn't get worse because I wasn't doing that movement. There would of course be sometimes where I would sit down, but previously when I had that I was constantly out of my seat, so I'm not surprised that it got aggravated.” (P6.pg5h)

**Other physical results**

**Perceived body weight**

Participant one, two and five believed using the standing desk had a neutral to positive effect on their weight. The participants believed either they had lost a little bit of weight or had maintained the same weight despite it being winter. Participant two had also been dieting and is training for a marathon thus the weight loss he has experienced may be due to those other factors. Participant one was really happy and surprised that she had not gained weight over the winter despite not watching her eating habits and doing limited exercise. She is now back to her sitting desk and is confident that the weight will come on if she does not start exercising. Participant five also felt she had not gained weight over the winter despite being sporadic with her gym classes. This study did not objectively measure weight thus these results are the participant perception

“I’m not sure how much of the weight loss I’ve experienced is a result of the desk, because I also run and I’ve been doing a lot more...apart from last week (pleurisy attack), which was like just comfort food at home and no exercise... I’ve been really careful with my diet” (P2.pg1b)
Participant three, four, and six felt like they had gained weight. This discrepancy could be due to the many factors contributing to weight such as hormone, lifestyle, nutrition and others. Quantitative data taken from Archer (2015) supported and contradicted some of these findings. Participants one (WC $d=5.21$, BMI $d=1.87$), two (WC $d=3.35$, BMI $d=1.87$), and four (WC $d=2.24$, BMI $d=2.94$) had significant decreases in waist circumference and BMI of large effect size. Thus under reporting may have been an issue with participant one and four. Participant three and five had no significant changes in waist circumference or BMI. Participant six was correct in thinking she had put on weight. She had a large effect size for increased BMI ($d=4.83$).

“the weird thing is, is that when I’ve been sitting down for the first month, I actually, when he measured me next time, I went down a kg. Today I’ve gone up two kgs, and I was standing up, but that may not necessarily be a result of…admittedly probably eating had something to do with it, but also we’re…I could be building up muscle as a result of some exercise that I am doing, that could be part of it. So, I guess, weight is not always a reliable factor” (p6pg7m)

Sleep

Participant 5 and 6 found they perceived to have improved sleep. Participant one and two and didn’t notice any obvious change in sleep. Participant four did not mention sleep at all.

“Sleep is probably deeper…I’m more rested…just thinking back to this time last year it’s sort of easier to go off to sleep” (P5.2pg5h)

Participant three had a change in sleep that was different to his normal sleeping pattern he has experienced in the past. He wakes more during early sleep, and is remembering his dreams in the early morning when compared to the past. The remaining participants noticed no significant difference in their sleeping patterns or habits.

“Sleep…. I’ve been kind of waking … I am sleeping really well but I suppose I have been waking in the evening, probably more than I have in generally over the years. Not for long periods of time but it is noticeable. I’ve been dreaming a lot more. I’ve noticed that because I don’t normally remember my dreams but I’ve been remembering them” (P3.2pg4i)
Improved mental experience

The participants all commented multiple times on how they perceived an improved emotional state whilst using the standing desk. They felt more positive within themselves. They felt the experience of using a standing desk was a positive experience.

“Standing, quite literally, gives you a better perspective” (P2pg3h)

Enhanced emotional wellbeing

The sub-theme of perceived enhanced emotional well being was made up of four areas. These are enhanced emotional experience, increased tolerance to stress, feeling proactive about own health and increased self awareness

Enhanced emotional experience

“This pertains to the participants feeling more positive and better about themselves and their work environment. One participant felt more confident within himself which resulted in him taking on a new project he normally would have stepped back from.

I don’t know if I was necessarily expecting myself to feel better about myself doing it (the study). It was a kind of psychological boost. I wasn’t expecting them but they were nice surprises” (P3.2pg6n)

Improved tolerance to stress

Their tolerance to stress appeared to be stronger as they compared to their stress levels this time last year. One participant started a jewellery business on the side and was surprised that she was not more stressed. Another participant took on study whilst she was working and she believed she was coping well. Her boss commented that she thought that she was less stressed than she had been in the past even though she was doing more work. She feels the standing has helped her to get on with her work even though she is stressed with exams.

"yup, yup. So that's really cool. I talked to her about it because I have a bit of stress about exams and things and she said [her boss] "I would have been interested to see how you coped without it [the standing desk]" because she said to me " you haven't seemed too
stressed about it"...Its helped me with the coping of it. I am able to just switch off and focus on work". (P2.2pg1a)

Participant four had more stress with her job as she was asked to cover another employee’s job thus her increased stress may not have been correlated with the standing desk.

Feeling proactive about health

Five of the six participants felt that using the standing desk made them feel proactive about their own health.

"I've been pretty slack with exercise most of my life. I feel like at least I am doing something towards my health... Especially over the winter.... The only exercise I get is biking to work and over winter that's pretty much gone out the window." (P1.2pg1b)

Improved self-awareness

All participants felt their self-awareness had improved. They had started noticing more how their body and mind felt. This could have been due to knowing they had interviews so they made a conscious effort to remember.

“I have been a lot more mindful of the need to be more confident in the things that I do. I've always had the tendency to hold back, even though I know that I can do certain things, I quite happily will sit back and let someone else do it. Let them take care of it.... But I suppose, like with project I am working on that I have decided to take on board I feel I can do it even though initially developed by a friend of mine who is a professor who has go all the academic expertise required to undertake the project.. I've put my hand up even though I don’t have the credentials and said I'll do it... I know I can do it.. I think a level of that has helped with that. I have noticed a confidence boost during the duration of the study” (P3.2pg6n)

Improved productivity and focus

Five participants perceived improvement in concentration, focus, and motivation which potentially lead to the perceived improved approach to work tasks and productivity.
“Yep, definitely able to achieve more. I guess I can focus better on especially report writing, ’cause it’s really complex and difficult. In my work that’s a really hard part of it and so I’m able to focus on that for longer.. yeah and get more done at a time” (P1.2pg4n)

Participant four hadn’t noticed any changes so far in concentration at their first interview, however she already she felt she was good at concentrating and getting the work she needed done. She was positive that she would notice a difference the longer she continued to use the desk.

“I’m pretty good at getting into the zone because I have to…. I just have to power through work. I’ve got a pretty good knack of …everything is blocked out and I just do my work. I don’t think that has changed yet” (p4pg5n)

Improved experience of office environment

Improved interaction between the participants and the other people in their office in addition to better workstation setup were the ways in which the office environment was perceived to be improved.

Improved interaction with others

All of the participants experienced greater interaction with people in their office. Interaction was in one or more of the following forms: Colleague comments; more approachable; colleague support ; easy and efficient interaction due to freedom of movement; looks or actions that show the participant they are going "against the norm" ; colleague jealousy ; and influencing others.

"It’s difficult to explain why I use it and the exact difference but ….you’re more approachable. I was actually asking people and they said ‘yeah, it’s much easier to come up to you with files.. you can just pop them up on the desk beside you’ “ (P5.3pg1a)

Improved workstation set up

Workstation set up was improved in many ways. These included participants becoming more organised thus they had a less cluttered desk except one who became messier due to lack of drawers. Adjustable height features allowed the choice and ease of sitting or standing. The size of the desk was a very popular aspect. There were some small issues with the desk and how it fits with the environment. One participant found the desk brushed against the wall, another found it needed router cuts to hide the computer cords. Two of the participants found that height adjustable monitor stands are needed. The remaining participants used height adjustable monitor stands already in their office.
“I like that you can adjust the height because I’m not the tallest person in the world, so you have the ability, then if you need to sit down you can” (P5pg3e)

Process of adjustment

It became clear that for the majority of the participants there was an adjustment period where they had to get used to using the standing desk. Discomfort was the main feature of the adjustment phase. Three participants used the phase in four weeks of the study to get used to the desk. The other three participants went to full time standing straight away, however they did take short breaks when needed.

Adjustment period

“At first it felt pretty good. Sort of where I was doing one to two hours a day. I was aiming for that straight. When I hit about three hours straight was where the discomfort set in. Upwards from four to six or slightly more was quite uncomfortable” (P6pg4g)

Participants one, four and participant six felt that there was a definite need for a transition phase where sitting and standing were alternated multiple times throughout the day. This was due to discomfort especially in feet. This discomfort was relieved by sitting and then the participant could stand again.

Stood full time

Participant two, four and five stood the majority of the day in the beginning of the study. Participants four and five felt like that was too much too soon. Participant one would have an hour or two sitting break and the rest of the time she would spend time standing within her 8.5 hour work shift.

All participants perceived themselves to be standing most of the day. Of these five participants still felt the need for a sitting break during the day. The numbers of these sitting breaks varied between participants. One participant stands all day at his desk and the only break he has is when he sits down for lunch. All participants had a significant decrease in sitting time and increase in standing time Archer (2015).
In answer to the question how did you find the transition from sitting to standing? “I did it straight away. It wasn’t that bad. I didn’t have to buy new shoes or any of that. I lasted a few weeks before I got the mat and that has made a difference” (P2pg1d)

Too much too soon

Participant four and five felt they over exerted themselves as they tried to stand as long as they could rather than easing themselves into. Fatigue and discomfort was experienced due to this over exertion.

“I got very excited the first day and did up till about three o’clock (from 8.30am). I was a bit like this was easy.. that was the first day the second or third day I was like maybe that wasn’t such a good idea. It was the Wednesday that it hit me” (P5pg1b)

Physical discomfort

All participants experienced discomfort or pain whilst using the standing desk. These ranged from wrist pain, back pain, foot heel and leg pain. All participants found the pain or discomfort was easily relieved and wouldn’t stop them using a standing desk. At the end of the study participants still felt some discomfort however it seemed to be less frequent and less intense. Five participants felt they needed small breaks due to discomfort, fatigue or boredom. Participant two stood all day with no breaks apart from when he was at lunch.

“Feet still get sore but nothing major. Some days I notice it and some days I don’t.” (P3.2pg6)
3.2 Theme Two: Conclusions, Judgements, and Acceptability: sitting vs. standing in an office environment

Three major subthemes made up theme two. These are Why I don't want to sit?; The need to alternate sitting and standing; Continued use of the standing desk.

Why I don't want to sit

*Physical reasons not to sit*

Poor posture, increased discomfort, and reduced energy levels were physical reasons why the participants did not want to use a traditional seated desk. They also found their tolerance to sitting had diminished. All of the participants mentioned one or more of these reason on why they prefer to use the standing desk over the sitting desk.

*Answer to the question “when you sit now how does it make you feel?”* - “Strange … uncomfortable, like it doesn’t feel natural. Feels like I don’t want to do it for too long, I want to get up and move or stand up and do it (work). Yeah it feel. I can’t think of how else to explain it yeah strange and unnatural. I suppose to add to that the reverse I found wasn’t true when I started standing you know it didn’t feel strange to be standing and working, you know sitting to standing but from standing to sitting feels weird” (P3.2pg3g)

*Mental reasons not to sit*

Negative emotional experience, decreased cognitive function, and finding they were no longer inspired to be seated were also reasons why the participants did not want to use a seated desk any longer. Five of the six participants mentioned one or more of these reasons.

*In answer to the question ”is there anything you will miss about using the standing desk?”*- “The energy levels and the feeling that I’m at least doing something for my health. Even if I’m not eating right or exercising at the moment that at least I’m going to work and standing for a while. One of the things too I think I will miss too when we go to the market to sell jewellery. I can stand for the whole time when were there. Like four or five hours I can stand up no problem, no pain what so ever. Where I’m noticing my husband’s like “I’ve got to go for a walk or sit or something”. That’s one of the things I will start to miss is the ability to stand for so long”(P1.3pg2c)
**Environmental reasons not to sit**

Participant one found there was decreased interaction with other people and found she became more frustrated with her work environment whilst using her seated desk. She was the only participant to complete all three interviews in which the final weeks of the study required going back to a traditional desk for comparison. Four of the others continue using the standing desks. Participant six moved overseas.

"I feel like I'm more disconnected from the office as well actually... 'cause before I was standing up... It's an open plan office, but we've got these half walls in front of our desks. Before I could see everyone and interact with everyone straight away. If people came over to my desk I'd be equal to them already, they're not standing over me and that kind of thing... Like my husband works one day a week at my work and he'd come over to ask me something and he's six foot, so he's towering above me... it feels ridiculous. I just found the standing desk was much nicer for interacting with people when they'd come over to ask me something." (P1.3pg4f)

**The need to alternate sitting and standing**

There were various reasons why there is a need to alternate sitting and standing.

Participants one, three, four, five and six would sit when they felt the need for a break, feel fatigued, or are getting distracted by discomfort. Participants one and four sat when they were in meetings. One participant found that sitting was better for reading as it helped him to absorb the information better. Participant five found it took too much energy for her to stand when she was sick. Participant six felt that when there was a slow work day as she found on her ten hour shifts she felt there was not enough work to keep her interested in standing. This is the nature of her job rather than inability to stand.

"I am standing as long as I am at my desk because if I have meetings with some other professionals I have to sit. I don't want to be the creepy person standing in the corner you know" (P1pg1b)
“I find where I am having to read a lot I’ll sit, I’ll take a seat to read. If I’m writing or researching something I’ll stand. I think it’s a relaxing thing because I don’t necessarily need to think, I need to absorb rather than to think about stuff, so I focus in a way that enables the information to come into me.” (P3.2pg3g)

“I did get a virus and I sat for a couple of days because I didn’t have the energy to stand. My body just told me to sit. It was like I was slouching, so I was like I’m just going to sit”

**Continued use of the standing desk**

All six participants wanted to continue using the standing desk if possible. Three participants purchased the electrically height-adjustable desk that they used during the study. One participant made his own fixed height standing desk before he received a crank handle adjustable height one through his company. Participant one desired a standing desk and is trying to get one through her company. She felt that whether she can get a standing desk could affect her job choice. Furthermore she “hates” her sitting desk. Participant six has left the country for a standing job at a ski resort. She said when she comes back from her trip she will opt for a standing desk or workstation platform if she comes back to an office job. This evidence points to strong acceptability for use of a standing or sit-stand desk in an office environment.

Answer to question “what are your reasons for buying a standing desk?” “Because I want to keep on doing it, it felt good. I was finding all these positives in it… I didn’t want it to be a flash in the pan “that was fun” right I am going back to sitting. The benefits of standing as I experienced far outweigh any of the negatives, there were too few negatives to even think of, so I thought it was a good investment. I opted for an adjustable one because I appreciated that you do need a rest sometimes. I wanted an adjustable one, which was far more money than most people would spend on a desk” (P3.2pg6.n)

Continued use of the standing desk was based on two factors. These were perceived benefits, and lack of drawbacks.

“ The benefits of it go well beyond the trendiness of them at the moment. It does have a major impact on your health” (P1.3pg9l)
Reflection on participant reliability

This section reflects on the reliability of the participants as part of the rigor building process. The researcher felt all participants’ information was reliable although there were varying degrees as some participants seemed to have trouble expressing what they wanted to.

Participant One

Participant one had very rich and clear explanations. The information she gave was deep and reflective. Her body language and tone of voice expressed an honest and genuine opinion. When the standing desk was taken away from her work after the trial had ended she was genuinely upset and angry that she no longer had the standing desk.

Participant Two

Participant two had reflective explanations. He spoke in a very matter of fact way which the researcher felt reflected his honesty. He was fast-spoken and thus explanations were not very deep; rather he covered a wide variety of information. The researcher felt this participant was not trying to please her, thus being a reliable witness.

Participant Three

Participant three's explanation were fruitful, thoughtful, and reflective, thus the researcher felt this participant was a reliable witness. However he has a job within the research sector thus he might have experience in what information would be helpful in a qualitative project. This has the potential for bias due to information manipulation, although the researcher felt this was not the case. Participant three withdrew after his second interview as he moved away. He purchased his standing desk as he wanted to continue using it. This participant completed two of the three interviews.

Participant Four

Participant four had clear explanations and was very matter of fact. Her body language and tone of voice showed she was enthusiastic. She said that she enjoyed using the standing desk and wanted to continue to use it - this was said with enthusiasm. However she highlighted many negative aspects of using the standing desk thus there were some discrepancy between what was said and her perceived attitude. She gave a wide variety of information. The researcher felt participant four was being truthful about enjoying the desk however she was revealing that there could be improvements with some aspects of the desk. This participant only completed one interview of the three. There was no explanation as to why thus she was treated as a withdrawn participant. This participant purchased a standing desk, at the end of Archer's trial, thus indicating she wanted to continue using it over her traditional desk.
**Participant Five**

The researcher felt that this participant was honest and genuine. However she found it hard to fully explain what she meant thus her information had the chance of not being interpreted exactly as she meant it. This participant often was unable to finish her sentences and the researcher felt as though this participant left her to interpret the answer. The researcher had to use clarification to make sure she was interpreting the information correctly. Participant five improved with her explanations through the second, and third interviews, thus the researcher thought nervousness may have played a role in this. This participant was excited and enthusiastic that her boss purchased the standing desk for her for continued use.

**Participant Six**

Participant six had clear and comprehensive explanations to contribute. The questions were answered thoughtfully and reflectively. Tone of voice, detail of explanation and the time she took to think about the question were all signs that she was answering with honesty. The researcher concluded that participant six was a very reliable witness.

**4. Discussion**

This study qualitative evaluated six participants about subjective factors pertaining to the experience and acceptability of using a standing desk in an office environment. This research represents useful formative work that can lead to future research that quantifies the subjective findings. Furthermore, it can assist employers, or employees, decisions to introduce standing desks into the workplace to reduce harmful occupational sitting times.

There were two major themes identified by the researcher. Theme one: the physical, mental and environmental experience of using a standing desk. This theme is made up of four subthemes. Theme two: conclusion, judgements and acceptability: sitting vs. standing desk. This theme is made up of three subthemes. This section will discuss how these themes and subthemes relate to the current literature. The first subtheme, is “improved physical experience using a standing desk”. This encompassed four main areas of physical improvement as perceived by the participants. There were perceived to be improved posture, energy levels/vitality, increased tolerance to standing, and decreased physical discomfort. Health and physical impacts such as improved posture and increased alertness were also reported in other studies (Chau, Daley, Dunn, et al., 2014; Grunseit et al., 2013; Karakolis & Callaghan, 2014). Husemann et al. (2009) found a decreased in musculoskeletal complaints without significantly affecting data entry in a randomised controlled trial of 60 males aged between 18 and 35. This suggests it is likely the sit-stand workstation could reduce worker discomfort and musculoskeletal complaints (Husemann et al., 2009). Chau et al., (2014) briefly mentioned that some participants had perceived improvements such as decreased back pain and fatigue, however
this was not the main focus of the study. Participants felt they had overall improved physical health despite also experiencing discomfort whilst using the standing desk for a prolonged period.

The participants described many ways in which to reduce their discomfort. No other studies have identified ways in which the discomfort experienced can be reduced whilst using the standing desk. These included standing on a mat, shifting weight from foot to foot, stretching, and standing in flat footwear or bare feet. Improved tolerance to standing is likely because of being trained towards this exercise as it is well known that physical training programs can have an effect on the physical capacity of workers (Hamberg-van Reenen, Heleen, Veisser et al, 2009; Hunt, 2003). It is clear that there is little evidence thus far to make conclusions about the effect of a standing desk on physical discomfort.

The second subtheme is "improved mental experience" which encompasses improved emotional experience and increased self-awareness, feeling proactive about health, increased positivity towards job/job satisfaction. These factors all helped an overall feeling of improved mental experience whilst using the standing desk. Puig-Rubera et al. (2015) found in highly active employees less total sitting time and less work related sitting time was associated with better mental well-being and work performance. Puig-Ribera et al., (2015) also found increased physical activity was associated with improved mental well-being and work performance. Page & Milner et al., (2014) found levels of well-being reduce as work stress increases and that work stress in the most reported cause of work-related illness and loss of work. Stress affects neuroendocrine, autonomic system and has an effect on neuroplasticity and can harmfully affect physical and mental health (Radley, Morilak, Vialou et al., 2015); thus more research is needed to find if standing desks can positively affect these aspects of the body.

The third subtheme of theme one is "improved office environment" which encompasses improved interaction with others and improved workstation set up. The participants found there was more interaction between people within their office. They found there were many comments and support from colleagues. Chau et al (2014) found that a supportive work environment facilitated the use of the sit-stand workstation. Workstation design was important for the use of standing desk and workstation (Chau, Daley, Srinivasan, et al., 2014; Grunseit et al., 2013). Furthermore, participants liked the freedom of choice and the flexibility it gave them. However some felt there were more distractions (Chau, Daley, Srinivasan, et al., 2014).

The final subtheme of theme one is "the process of adjustment". Some participants went into using the standing desk full-time straight away. Of these, two of the participants felt they might have gone into it a bit too fast and should have sat more.

The first subtheme of theme two is "why I don't want to sit". The participants perceived to have increased discomfort, aches or pains, decreased energy levels, less tolerant to sitting, poor posture,
and decreased cognitive function with sitting for long periods. These changes have been noticed or uncovered after using the standing desk. Grunseit et al., (2013) found that concern for and experience of short term health impacts, and perceived productivity whilst sitting and standing, were two factors in the continued use of a standing desk but did not examine the changes in perceptions of sitting. Physical discomfort and office work are detrimentally linked (Husemann, et al., 2009).

The second subtheme of theme two is "the need to alternate sitting and standing positions". There were varied reasons for this. The most common reason for needing to sit after an extended period of using the standing desk was the need for a break or rest. Being sick or injured were also warranted reasons to sit. This is supported by findings of Chau et al. (2014) and Grunseit et al. (2013).

The final subtheme of theme two is "continued use of the standing desk". All participants were keen to and would prefer to use the standing desk. Four participants did continue using a standing desk after the trial was over. One participant withdrew early from the study to work overseas but felt when she came back she would like to get one or at least get a standing work platform but would go back to a sitting desk if she had to. Participant one was not happy that she had to go back to a seated desk. This seemed to be attributed to the positive physical, emotional, cognitive and environmental experiences had by the participants. Furthermore, all the participants had a change in the way they viewed sitting and found there were more negative effects from prolonged sitting that prolonged standing. This was despite the discomfort that came from standing too long. Chau et al (2014) had mixed results for continued use of the standing desk. Some participants were interested in continuing to use the sit-stand workstation however others would prefer a better designed workstation (Chau, Daley, Srinivasan, et al., 2014). Perceived health and work benefit were reasons to continue using the standing desks which supports the current study's findings (Chau, Daley, Srinivasan, et al., 2014; Grunseit et al., 2013)

The study can provide information for employers or employees interested in buying standing desks as an idea of what effects the standing desk could have on health, and the office environment. It can also be used to inform readers on potential effect to reduce the health risk of occupational sitting. This study is important because it added to the research base investigating the usability and acceptability of employing a standing desk. It also identified areas for future research.

One of the limitations of this study was retrospective and nil returned DASS-21 and SF-36 forms that could potentially have quantified health, wellbeing, and stress findings. Generic qualitative methods have no particular set of instructions to follow. Drop outs were a problem in this study.

Future research could evaluate the changes perceived in a whole office environment. Quantitative measures to measure physical health, emotional wellbeing, and job satisfaction can be used to validate findings of this study. Biological mechanisms of why there were perceived changes found in this study particularly in relation to stress mechanisms would be an interesting area of future
research. Studying different populations to compare people with and without metabolic issues would also add information to understanding the use of standing desks.

Some of the participants were asked to complete the surveys in retrospect which may possible affect the reliability and validity of the data. Two participants completed all four questionnaires and the rest had missing data sets creating a limitation for the study. Due to the extent of missing and late quantitative data, the scope of analysis was limited.

5. Conclusions

Two themes were uncovered by this research. Theme one was the physical, mental and environmental experience of using the standing desk. In the experience of the participants there was improved physical, mental, and office environmental experience. Improvements in posture, energy levels, tolerance to standing, and decreased discomfort were noticed as part of the physical experience of using a standing desk. Participants experienced improved emotional experience and productivity and focus. Furthermore, there was better interaction with the people within the office and improved workstation setup. However, there was generally a process of adjustment which included some discomfort after standing for a period of time.

Theme two was Conclusions, judgements, and acceptability: sitting vs. standing. Views and the experience of sitting had changed and there tended to be a more negative view of it once the participants started using the standing desks. There was strong acceptability for introducing and continued use of a standing desk in an office environment by all participants.

6. Conflicts of Interest

There were no conflicts of interest.

7. Acknowledgements

Thank you to everyone who helped get this project completed. To the participants who lent their valuable time I am deeply grateful. To the research supervisors thank you for your support and expertise.
8. References


Commissaris, D. a C. M., Könemmann, R., Hiemstra-van Mastrigt, S., Burford, E. M., Botter, J.,


Appendix A: Ethics Approval

Sheehan Robb
1772 South Head Rd
RD1
Helensville 0874

2.9.13

Dear Sheehan,

Re: Addendum to application 2013-1029.

Your request for the following sub-project: Participant Experience and Acceptability of Using a Standing Desk, to be added as an addendum to approved application 2013-1029 Archer, has been reviewed by the Unitec Research Ethics Committee (UREC) and has been approved for the following period:

Start date: 2.9.13
Finish date: 15.8.14

Please note that:

1. The above dates must be referred to on the information AND consent forms given to all participants.

2. You must inform UREC, in advance, of any ethically-relevant deviation in the project. This may require additional approval.

You may now commence your research according to the protocols approved by UREC. We wish you every success with your project.

Yours sincerely,

Sara Donaghey
UREC Deputy Chair

cc: Elizabeth Niven
Cynthia Almeida
Appendix B: Information sheet

Information for participants

Working from a standing desk: Experiences, acceptability, and the effects on markers of metabolic syndrome in sedentary office workers

What is this project about?
In today’s modern world people are become less physically active in their daily lives. Sedentary behavior can occur in three major phases of our daily lives: during our commute to work, at work, and in our personal leisure time.

Recent research shows us that people who are sedentary for large portions of their day have elevated risks of developing conditions such as type II diabetes and cardiovascular disease. Worryingly, the same research suggests that these risks may not be reduced by exercise; instead the risks have stronger links to how much we rest during the day.

What we are doing?
This project aims to reduce the amount of time spent sedentary in the office by asking our participants to use special stand-up desks during their office hours.

What will I be required to do?
Your participation in this research will mean a slight change in the way your work. We will provide you with a stand-up desk in your work place for the duration of this study. Instead of sitting for the day, we will ask you to stand up instead. We will also equip you with an ‘actigraph’ to wear on your thigh which will allow us to measure how much you are standing during your day. The data from this will be collected once per week. At the end of the study you will be required to return the stand-up desk as
well as the thigh-worn accelerometer. If after participating in the study you are interested in permanently changing to a stand-up desk, we will supply you with the details of local suppliers.

Every four weeks over the course of the study we will ask you to undergo some simple tests. These include your weight, your waist measurements, your blood pressure, your fasting blood sugar, blood cholesterol, and lipid levels. These tests will be performed free of change. Because these blood tests are ‘fasting’ tests, we will ask you to have them done before you eat breakfast or any food, on a day of your choice, at a Labtests location of your choice. There will be a total of six tests. We won’t test for anything else and the only people who will see these results will be the researchers, yourself, and your doctor if we, or you believe it is necessary.

There will also be fortnightly questionnaires on health related issues. There are two questionnaires that will take approximately 10-15 minutes each to complete. These can be completed online or on paper for your convenience. In addition it is asked that you participate in three interviews. These will be no longer than an hour. These will happen one week after you start using the standing desk, one week before you stop using the desk, and one week after you stop using the desk. The audio from these interviews will be recorded, analyzed, and used as data for the research report. These interviews and questionnaires will help us gain insight into your experiences using a standing desk which will help reveal any issues to be solved with future research.

You will be given a diary in which you can also record your experiences or note as you think of them. This does not require regular entries. These will be handed in at the last interview. This is considered an optional extra.

**What risks are there in taking blood samples?**

Having your blood taken may carry some risks. These risks include some bleeding at the site of the needle, fainting or light-headedness, blood accumulation under the skin or the possibility of a mild infection. Labtests uses only single-use sterile equipment to reduce any risks. Only trained and experienced phlebotomists can take blood in conditions designed to reduce infection.

**What are some of the difficulties in standing more than usual?**

Due to the nature of this project you may find yourself getting fatigued or uncomfortable during standing, especially in the early stages while you adapt. For the first 3 weeks after receiving the stand-up desk you will slowly phase in your standing time until you are able to comfortably stand for at least 6.5 hours in your working day. To reduce discomfort it is recommended that you wear good quality
and comfortable shoes to work. The researchers will also provide a number of exercises, stretches and strategies to stay comfortable during the day. We will also keep in regular contact to support and guide you and help you stay happy on your feet.

If something goes wrong how am I covered for injury?

In the rare chance that you experience an injury as a result of your participation you will be covered by ACC. ACC covers workplace injuries for New Zealand citizens and permanent residents, including those that may occur as a result of this study. To be eligible for this study you will need to provide evidence of your permanent residence or citizenship and allow us to make a copy for our records.

Will my GP need to be involved in this study?

In order to be eligible to participate in this study, we require you to be enrolled with a General Practitioner for the duration of this study. You will be free to discuss any aspect of this study with your GP, as well as any of the test results. You will not be eligible to participate if you have any history of cardiovascular disease or heart problems, if you have a history of diabetes, stroke or deep vein thrombosis, or if you are taking any drugs to control your cholesterol, blood lipids or blood pressure. If the researchers or Lab tests feel that your test results are concerning, your results will be automatically forwarded to your GP and we will recommend you schedule an appointment to see them.

Who will have access to my personal information?

All information collected from you will be stored on a password protected file and only you, the principal researcher and supervisors will have access to this information. Your name and any information that may identify you will be kept completely confidential. If you agree to participate, you will be asked to sign a consent form. This does not stop you from changing your mind if you wish to withdraw from the project at any time.

Who should I contact for more information?

Please contact us if you need more information about the project. At any time if you have any concerns about the research project you can contact us:

Dan Archer, 021 874913 or email: archer.dann@gmail.com

Thank you for taking the time to consider being a part of our research
Robert Moran, 815 4321 ext.8197 or 021 0739984 or email: rmoran@unitec.ac.nz

Sheehan Robb, 021 0403042 or email: sheehan28@hotmail.com

Jamie Mannion, 8154321 ext. 8404 or 0210629007 or email: jmannion@unitec.ac.nz

UREC REGISTRATION NUMBER: 2013-1029

This study has been approved by the UNITEC Research Ethics Committee from 19 August 2013 to 30 November 2014. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Committee through the UREC Secretary (ph: 09 815-4321 ext 6162. Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
Appendix C: Participant consent form

Participant Consent Form

Research Project Title: A standing desk intervention on the markers of metabolic syndrome in sedentary office workers

Participant Experience and acceptability of using a standing desk

I have had the research project explained to me and I have read and understand the information sheet given to me.

I understand that this 21 week project will occur in two phases. In the first five weeks I will sit at my regular desk after which point I will be supplied with a special stand-up desk and raised seating. For the remaining 16 weeks I will be asked to stand as much as possible while performing my normal daily tasks at work, and will be able to sit for a total of three 30 minute periods if I wish to. I also understand that I will be asked to wear a small device on my thigh for the entire day, every week day, which will measure how much movement I am doing.

I consent to undergoing periodic testing every four weeks during this project totalling six tests. In these tests my height, weight, and waist circumference will be taken.

I understand that at each of the test points I will consent to providing a blood sample at a Labtests collection centre of my choice. I know that this will test for fasting blood glucose (sugar) and blood lipids (cholesterol and fats), which means the test will be taken first thing in the morning before I have eaten breakfast. I have been informed that absolutely no other substances or chemicals will be tested during the entire project. I understand that all blood samples will be destroyed.

I hereby confirm that I am registered with a general practitioner and will remain registered for the duration of this project. I am free to provide any of the test results to them at any point. I acknowledge that should any of my tests warrant further investigation they will be forwarded to my doctor by Labtests automatically. I also understand that should the researchers feel concerned with my participation in the trial, or with my results, they will recommend I visit my general practitioner.

I am a New Zealand citizen or permanent resident. I can confirm that I have never been diagnosed with diabetes, cardiovascular disease, or hypertension. I have never suffered a stroke or a deep vein thrombosis. I can also confirm that I am not currently on any medication that alters my blood pressure or blood lipids or cholesterol.
I understand that I should consult my doctor if I am unsure of any of the information in this consent form.

I understand that I don’t have to be part of this if I don’t want to and I may withdraw at any time prior to the completion of the research project. If I do withdrawal, I give consent for all previously collected data to be used in the project and will not be expected to provide any more data. I know that I will be supplied with copies of all data upon my request.

At the end of the trial I agree to return all equipment previously supplied, including furniture and electronic movement monitors.

I understand that everything I say is confidential and none of the information I give will identify me and that the only persons who will know what I have said will be the researchers and their supervisors. I also understand that all the information that I give will be stored securely on a computer at Unitec for a period of 10 years.

I consent to being interviewed 3 times throughout the course of the research project and understand that these interviews will be recorded, analysed, and used in the research document. I understand that I will be supplied with transcriptions by written request. I understand and allow examples of my experience to be written in the research document.

I understand and agree to participate in fortnightly questionnaires.

I understand that my identity will be protected and I can see the finished research document.

I have had time to consider everything and I give my consent to be a part of this project.

Participant Signature: ………………………….. Date: ……………………………

Project Researcher: ……………………………. Date: ……………………………

UREC REGISTRATION NUMBER: 2013-1029

This study has been approved by the UNITEC Research Ethics Committee from 19 August 2013 to 30 November 2014. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Committee through the UREC Secretary (ph: 09 815-4321 ext 6162). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
Interview schedule one

How have you found the study so far?

How did you find the transition from
   a) sitting to standing part time
   b) standing part time to standing full time
(Was it an easy transition)

Can you tell me about your experience of using a standing desk?
   a) was there anything else you liked/disliked about using the standing desk?
   b) challenges/problems?

Have you noticed any changes in the amount of work you have been able to achieve?

Have you noticed any changes in the way you feel about your job?

Have you noticed any changes in your
   a) physical health
   b) mental health
   prompters - energy levels, concentration, appetite, sleep, weight,

Have you noticed any differences in the way you feel when using your standing desk
compared to your normal seated desk?
   prompters confidence, motivation, anxiety

Has anything in your life outside of work been affected since using the standing desk?

Is using a standing desk something you would consider using in the future?

Is there anything else you would like to tell me about your experience?
Appendix E: Interview Schedule Two

Interview Schedule Two

Tell me how the second half of the study has gone since last interview
   a) was there anything else you liked/ disliked about using the standing desk?
   b) challenges/ problems?

How did you find the transition from standing part time to standing full time?
   (Was it an easy transition)

In what ways has your work life changed since using the standing desk?

In what ways is your work life stayed the same?

Have you noticed any changes in the amount of work you have been able to achieve?

Have you noticed any changes in the amount of time you have had off work?

Have you noticed any changes in the way you feel about your job?

Have you noticed any changes in your
   a) physical health
      Promters: posture, energy levels, concentration, memory, appetite, sleep, weight, fitness
   b) mental health
      Promters if needed-stress, happiness

Have you noticed any differences in the way you feel when using your standing desk compared to your normal seated desk?
   Promters confidence, motivation, anxiety

Has anything in your life outside of work been affected since using the standing desk?

How has your quality of life changed since using the standing desk?

What were you expecting from the experience of using a standing desk
   a) how have your expectations met?
   b) have your expectations been different to what you expected?

Is using a standing desk still something you would consider using in the future?

Is there anything else you would like to tell me about your experience?
Appendix F: Interview Schedule Three A- Going back to seated desk

**Interview three- Going back to seated desk**

Tell me how the study has gone since you are back to your sitting desk.

a) was there anything else you liked?

b) disliked about using the sitting desk again?

How would you compare your sitting and standing desks?

Has your view on sitting changed and if so in what ways?

What changes have you noticed in your work life now that you have gone back to using your sitting desk?

- amount of work you have been able to achieve?
- amount of time you have had off work?
- feel about your job?

Have you noticed any changes in your

- physical health
- prompters- posture, energy levels, concentration, memory, appetite, sleep, weight, fitness
- mental health
- prompters if needed- stress, happiness, motivation

What have you missed about using the standing desk?

Would you recommend using a standing desk to others/ why/why not?

Is using a standing desk still something you would consider using in the future?

Is there anything else you would like to tell me about your experience?
Appendix G: Interview Three B- Continued use of standing desk

**Interview Three- Continued use of standing desk**

What are your reasons for buying or continuing to use a standing desk over your sitting desk?

How much time would you spend sitting now at your standing desk?

What are the changes that you have noticed since using the standing desk compared with the sitting desk?

Have your views on sitting changed and if so in what way?

Would you recommend a standing desk to others- Why/Why not?
Appendix H: Example of data analysis matrix and thematic development

<table>
<thead>
<tr>
<th>Physical Experience</th>
<th>Theme one: Experience</th>
<th>Theme two: Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved physical experience</td>
<td>Improved posture</td>
<td>Why I don't want to sit</td>
</tr>
<tr>
<td></td>
<td>energy levels/vitality</td>
<td>discomfort</td>
</tr>
<tr>
<td></td>
<td>increased tolerance to standing</td>
<td>Need to alternate sitting and standing</td>
</tr>
<tr>
<td></td>
<td>decreased aches and pains</td>
<td>• rest</td>
</tr>
<tr>
<td>Process of adjustment</td>
<td>Discomfort</td>
<td>• injured</td>
</tr>
<tr>
<td></td>
<td>Adjustment period</td>
<td>• sickness</td>
</tr>
<tr>
<td></td>
<td>Stood full time straight away with small breaks</td>
<td>Definite continued use of SD</td>
</tr>
<tr>
<td></td>
<td>Too much too soon</td>
<td>• Yes due to reasons outlined in theme one and two</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mental (emotional and cognitive) Experience</th>
<th>Improved emotional experience</th>
<th>Why I don't want to sit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Improved emotions</td>
<td>negative emotional experience</td>
</tr>
<tr>
<td></td>
<td>tolerance to stress</td>
<td>decreased energy</td>
</tr>
<tr>
<td></td>
<td>sense of power</td>
<td></td>
</tr>
<tr>
<td></td>
<td>increased self awareness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>feeling proactive about own health</td>
<td></td>
</tr>
<tr>
<td></td>
<td>increased job satisfaction/positivity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improved cognitive function</td>
<td></td>
</tr>
<tr>
<td></td>
<td>improved concentration and focus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improved motivation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>improved approach to work tasks and productivity</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environmental (office based) experience</th>
<th>Improved office environment</th>
<th>Definite continued use of SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Improved interaction with others</td>
<td>• Yes due to reasons outlined in theme one and two</td>
</tr>
<tr>
<td></td>
<td>Improved workstation setup</td>
<td></td>
</tr>
</tbody>
</table>
Appendix I: Excerpt from research journal

This has daily to weekly entries that describe and show the process of the research. This included thoughts and ideas that would be revisited to reduce bias and reduce risk of settling on themes too fast.
Appendix J: Applied Ergonomics: Research submission guidelines

Your Paper Your Way

We now differentiate between the requirements for new and revised submissions. You may choose to submit your manuscript as a single Word or PDF file to be used in the refereeing process. Only when your paper is at the revision stage, will you be requested to put your paper in to a 'correct format' for acceptance and provide the items required for the publication of your article.

To find out more, please visit the Preparation section below.

Before You Begin

Ethics in publishing

For information on Ethics in publishing and Ethical guidelines for journal publication see http://www.elsevier.com/publishingethics and http://www.elsevier.com/journal-authors/ethics.

Conflict of interest

All authors are requested to disclose any actual or potential conflict of interest including any financial, personal or other relationships with other people or organizations within three years of beginning the submitted work that could inappropriately influence, or be perceived to influence, their work. See also http://www.elsevier.com/conflictsinterest. Further information and an example of a Conflict of Interest form can be found at: http://help.elsevier.com/app/answers/detail/a_id/286/p/7923.

Submission declaration and verification

Submission of an article implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see http://www.elsevier.com/sharingpolicy), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. To verify originality, your article may be checked by the originality detection service CrossCheck http://www.elsevier.com/editors/plagdetect.

Changes to authorship

This policy concerns the addition, deletion, or rearrangement of author names in the authorship of accepted manuscripts:

Before the accepted manuscript is published in an online issue: Requests to add or remove an author, or to rearrange the author names, must be sent to the Journal Manager from the corresponding author of the accepted manuscript and must include: (a) the reason the name should be added or removed, or the author names rearranged and (b) written confirmation (e-mail, fax, letter) from all authors that they agree with the addition, removal or rearrangement. In the case of addition or removal of authors, this includes confirmation from the author being added or removed. Requests that are not sent by the corresponding author will be forwarded by the Journal Manager to the corresponding author, who must follow the procedure as described above. Note that: (1) Journal Managers will inform the Journal Editors of any such requests and (2) publication of the accepted manuscript in an online issue is suspended until authorship has been agreed.

After the accepted manuscript is published in an online issue: Any requests to add, delete, or rearrange author
names in an article published in an online issue will follow the same policies as noted above and result in a corrigendum.

Copyright

Upon acceptance of an article, authors will be asked to complete a 'Journal Publishing Agreement' (for more information on this and copyright, see http://www.elsevier.com/copyright). An e-mail will be sent to the corresponding author confirming receipt of the manuscript together with a 'Journal Publishing Agreement' form or a link to the online version of this agreement.

Subscribers may reproduce tables of contents or prepare lists of articles including abstracts for internal circulation within their institutions. Permission of the Publisher is required for resale or distribution outside the institution and for all other derivative works, including compilations and translations (please consult http://www.elsevier.com/permissions). If excerpts from other copyrighted works are included, the author(s) must obtain written permission from the copyright owners and credit the source(s) in the article. Elsevier has preprinted forms for use by authors in these cases: please consult http://www.elsevier.com/permissions.

For open access articles: Upon acceptance of an article, authors will be asked to complete an 'Exclusive License Agreement' (for more information see http://www.elsevier.com/OAauthoragreement). Permitted third party reuse of open access articles is determined by the author's choice of user license (see http://www.elsevier.com/openaccesslicenses).

Author rights

As an author you (or your employer or institution) have certain rights to reuse your work. For more information see http://www.elsevier.com/copyright.

Role of the funding source

You are requested to identify who provided financial support for the conduct of the research and/or preparation of the article and to briefly describe the role of the sponsor(s), if any, in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication. If the funding source(s) had no such involvement then this should be stated.

Funding body agreements and policies

Elsevier has established a number of agreements with funding bodies which allow authors to comply with their funder's open access policies. Some authors may also be reimbursed for associated publication fees. To learn more about existing agreements please visit http://www.elsevier.com/fundingbodies.

The open access fee for this journal is $3100, excluding taxes. Learn more about Elsevier's pricing policy: http://www.elsevier.com/openaccesspricing.

Language (usage and editing services)

Please write your text in good English (American or British usage is accepted, but not a mixture of these). Authors who feel their English language manuscript may require editing to eliminate possible grammatical or spelling errors and to conform to correct scientific English may wish to use the English Language Editing service available from Elsevier's WebShop (http://webshop.elsevier.com/languagedit/) or visit our customer support site (http://support.elsevier.com) for more information.

Submission

Submission to this journal proceeds totally online. Use the following guidelines to prepare your article. Via the homepage of this journal http://ees.elsevier.com/jerg you will be guided stepwise through the creation and uploading of the various files. The system automatically converts source files to a single Adobe Acrobat PDF version of the article, which is used in the peer-review process. Please note that even though manuscript source files are converted to PDF at submission for the review process, these source files are needed for further processing after acceptance. All correspondence, including notification of the Editor's decision and requests for revision, takes place by e-mail and via the author's homepage, removing the need for a hard-copy paper trail.
Referees

Please submit the names and institutional e-mail addresses of several potential referees. For more details, visit our Support site. Note that the editor retains the sole right to decide whether or not the suggested reviewers are used.

Additional Information

Submissions should be between 3,000 and 5,000 words (excluding references, abstract, figures and tables). For submissions outside this range, please contact the Editor prior to submission.

NEW SUBMISSIONS

Submission to this journal proceeds totally online and you will be guided stepwise through the creation and uploading of your files. The system automatically converts your files to a single PDF file, which is used in the peer-review process.

As part of the Your Paper Your Way service, you may choose to submit your manuscript as a single file to be used in the refereeing process. This can be a PDF file or a Word document, in any format or lay-out that can be used by referees to evaluate your manuscript. It should contain high enough quality figures for refereeing. If you prefer to do so, you may still provide all or some of the source files at the initial submission. Please note that individual figure files larger than 10 MB must be uploaded separately.

References

There are no strict requirements on reference formatting at submission. References can be in any style or format as long as the style is consistent. Where applicable, author(s) name(s), journal title/book title, chapter title/article title, year of publication, volume number/book chapter and the pagination must be present. Use of DOI is highly encouraged. The reference style used by the journal will be applied to the accepted article by Elsevier at the proof stage. Note that missing data will be highlighted at proof stage for the author to correct.

Formatting requirements

There are no strict formatting requirements but all manuscripts must contain the essential elements needed to convey your manuscript, for example Abstract, Keywords, Introduction, Materials and Methods, Results, Conclusions, Artwork and Tables with Captions.

If your article includes any Videos and/or other Supplementary material, this should be included in your initial submission for peer review purposes.

Divide the article into clearly defined sections.

Figures and tables embedded in text

Please ensure the figures and the tables included in the single file are placed next to the relevant text in the manuscript, rather than at the bottom or the top of the file.

REVISED SUBMISSIONS

Use of word processing software

Regardless of the file format of the original submission, at revision you must provide us with an editable file of the entire article. Keep the layout of the text as simple as possible. Most formatting codes will be removed and replaced on processing the article. The electronic text should be prepared in a way very similar to that of conventional manuscripts (see also the Guide to Publishing with Elsevier: http://www.elsevier.com/guidepublication). See also the section on Electronic artwork. To avoid unnecessary errors you are strongly advised to use the ‘spell-check’ and ‘grammar-check’ functions of your word processor.

Article structure

Subdivision - numbered sections

Divide your article into clearly defined and numbered sections. Subsections should be numbered 1.1 (then 1.1.1,
1.1.2, ...), 1.2, etc. (the abstract is not included in section numbering). Use this numbering also for internal cross-referencing: do not just refer to "the text". Any subsection may be given a brief heading. Each heading should appear on its own separate line.

Introduction
State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

Material and methods
Provide sufficient detail to allow the work to be reproduced. Methods already published should be indicated by a reference: only relevant modifications should be described.

Theory/calculation
A Theory section should extend, not repeat, the background to the article already dealt with in the Introduction and lay the foundation for further work. In contrast, a Calculation section represents a practical development from a theoretical basis.

Results
Results should be clear and concise.

Discussion
This should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

Conclusions
The main conclusions of the study may be presented in a short Conclusions section, which may stand alone or form a subsection of a Discussion or Results and Discussion section.

Appendices
If there is more than one appendix, they should be identified as A, B, etc. Formulae and equations in appendices should be given separate numbering: Eq. (A.1), Eq. (A.2), etc.; in a subsequent appendix, Eq. (B.1) and so on. Similarly for tables and figures: Table A.1; Fig. A.1, etc.

Essential title page information
• Title. Concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible.
• Author names and affiliations. Please clearly indicate the given name(s) and family name(s) of each author and check that all names are accurately spelled. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lower-case superscript letter immediately after the author's name and in front of the appropriate address. Provide the full postal address of each affiliation, including the country name and, if available, the e-mail address of each author.
• Corresponding author. Clearly indicate who will handle correspondence at all stages of refereeing and publication, also post-publication. Ensure that the e-mail address is given and that contact details are kept up to date by the corresponding author.
• Present/permanent address. If an author has moved since the work described in the article was done, or was visiting at the time, a 'Present address' (or 'Permanent address') may be indicated as a footnote to that author's name. The address at which the author actually did the work must be retained as the main, affiliation address. Superscript Arabic numerals are used for such footnotes.

Abstract
A concise and factual abstract of between 100-150 words is required. The abstract should state briefly the purpose of the research, the principal results and major conclusions. An abstract is often presented separately from the article, so it must be able to stand alone. For this reason, References should be avoided, but if essential, then cite the author(s) and year(s). Also, non-standard or uncommon abbreviations should be avoided, but if essential they must be defined at their first mention in the abstract itself.

Graphical abstract
Although a graphical abstract is optional, its use is encouraged as it draws more attention to the online article. The graphical abstract should summarize the contents of the article in a concise, pictorial form designed to
capture the attention of a wide readership. Graphical abstracts should be submitted as a separate file in the online submission system. Image size: Please provide an image with a minimum of 531 × 1328 pixels (h × w) or proportionally more. The image should be readable at a size of 5 × 13 cm using a regular screen resolution of 96 dpi. Preferred file types: TIFF, EPS, PDF or MS Office files. See http://www.elsevier.com/graphicalabstracts for examples.
Authors can make use of Elsevier's Illustration and Enhancement service to ensure the best presentation of their images and in accordance with all technical requirements: Illustration Service.

Highlights

Highlights are mandatory for this journal. They consist of a short collection of bullet points that convey the core findings of the article and should be submitted in a separate editable file in the online submission system. Please use ‘Highlights’ in the file name and include 3 to 5 bullet points (maximum 85 characters, including spaces, per bullet point). See http://www.elsevier.com/highlights for examples.

Keywords

Immediately after the abstract, provide a maximum of 3 keywords, using American spelling and avoiding general and plural terms and multiple concepts (avoid, for example, "and", "of"). Be sparing with abbreviations: only abbreviations firmly established in the field may be eligible. These keywords will be used for indexing purposes.

Abbreviations

Define abbreviations that are not standard in this field in a footnote to be placed on the first page of the article. Such abbreviations that are unavoidable in the abstract must be defined at their first mention there, as well as in the footnote. Ensure consistency of abbreviations throughout the article.

Acknowledgements

Collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.).

Math formulae

Please submit math equations as editable text and not as images. Present simple formulae in line with normal text where possible and use the solidus (/) instead of a horizontal line for small fractional terms, e.g., X/Y. In principle, variables are to be presented in italics. Powers of e are often more conveniently denoted by exp.
Number consecutively any equations that have to be displayed separately from the text (if referred to explicitly in the text).

Footnotes

Footnotes should be used sparingly. Number them consecutively throughout the article. Many word processors build footnotes into the text, and this feature may be used. Should this not be the case, indicate the position of footnotes in the text and present the footnotes themselves separately at the end of the article.

Artwork

Electronic artwork

General points
- Make sure you use uniform lettering and sizing of your original artwork.
- Preferred fonts: Arial (or Helvetica), Times New Roman (or Times), Symbol, Courier.
- Number the illustrations according to their sequence in the text.
- Use a logical naming convention for your artwork files.
- Indicate per figure if it is a single, 1.5 or 2-column fitting image.
- For Word submissions only, you may still provide figures and their captions, and tables within a single file at the revision stage.
- Please note that individual figure files larger than 10 MB must be provided in separate source files.
A detailed guide on electronic artwork is available on our website: http://www.elsevier.com/artworkinstructions.
You are urged to visit this site; some excerpts from the detailed information are given here.

**Formats**
Regardless of the application used, when your electronic artwork is finalized, please 'save as' or convert the images to one of the following formats (note the resolution requirements for line drawings, halftones, and line/halftone combinations given below):
- EPS (or PDF): Vector drawings. Embed the font or save the text as ‘graphics’.
- TIFF (or JPEG): Color or grayscale photographs (halftones): always use a minimum of 300 dpi.
- TIFF (or JPEG): Bitmapped line drawings: use a minimum of 1000 dpi.
- TIFF (or JPEG): Combinations bitmapped line/half-tone (color or grayscale): a minimum of 500 dpi is required.

**Please do not:**
- Supply files that are optimized for screen use (e.g., GIF, BMP, PICT, WPG); the resolution is too low.
- Supply files that are too low in resolution.
- Submit graphics that are disproportionately large for the content.

**Color artwork**
Please make sure that artwork files are in an acceptable format (TIFF (or JPEG), EPS (or PDF), or MS Office files) and with the correct resolution. If, together with your accepted article, you submit usable color figures then Elsevier will ensure, at no additional charge, that these figures will appear in color online (e.g., ScienceDirect and other sites) regardless of whether or not these illustrations are reproduced in color in the printed version. For color reproduction in print, you will receive information regarding the costs from Elsevier after receipt of your accepted article. Please indicate your preference for color: in print or online only. For further information on the preparation of electronic artwork, please see [http://www.elsevier.com/artworkinstructions](http://www.elsevier.com/artworkinstructions).

Please note: Because of technical complications that can arise by converting color figures to 'gray scale' (for the printed version should you not opt for color in print) please submit in addition usable black and white versions of all the color illustrations.

**Figure captions**
Ensure that each illustration has a caption. A caption should comprise a brief title (not on the figure itself) and a description of the illustration. Keep text in the illustrations themselves to a minimum but explain all symbols and abbreviations used.

**Tables**
Please submit tables as editable text and not as images. Tables can be placed either next to the relevant text in the article, or on separate page(s) at the end. Number tables consecutively in accordance with their appearance in the text and place any table notes below the table body. Be sparing in the use of tables and ensure that the data presented in them do not duplicate results described elsewhere in the article. Please avoid using vertical rules.

**References**

**Citation in text**
Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Any references cited in the abstract must be given in full. Unpublished results and personal communications are not recommended in the reference list, but may be mentioned in the text. If these references are included in the reference list they should follow the standard reference style of the journal and should include a substitution of the publication date with either 'Unpublished results' or 'Personal communication'. Citation of a reference as ‘in press’ implies that the item has been accepted for publication.

**Reference links**
Increased discoverability of research and high quality peer review are ensured by online links to the sources cited. In order to allow us to create links to abstracting and indexing services, such as Scopus, CrossRef and PubMed, please ensure that data provided in the references are correct. Please note that incorrect surnames, journal/book titles, publication year and pagination may prevent link creation. When copying references, please be careful as they may already contain errors. Use of the DOI is encouraged.

**Web references**
As a minimum, the full URL should be given and the date when the reference was last accessed. Any further information, if known (DOI, author names, dates, reference to a source publication, etc.), should also be given.
Web references can be listed separately (e.g., after the reference list) under a different heading if desired, or can be included in the reference list.

**References in a special issue**
Please ensure that the words 'this issue' are added to any references in the list (and any citations in the text) to other articles in the same Special Issue.

**Reference management software**
This journal has standard templates available in key reference management packages EndNote (http://www.endnote.com/support/enstyles.asp) and Reference Manager (http://refman.com/support/rmstyles.asp). Using plug-ins to wordprocessing packages, authors only need to select the appropriate journal template when preparing their article and the list of references and citations to these will be formatted according to the journal style which is described below.

**Reference formatting**
There are no strict requirements on reference formatting at submission. References can be in any style or format as long as the style is consistent. Where applicable, author(s) name(s), journal title/book title, chapter title/article title, year of publication, volume number/book chapter and the pagination must be present. Use of DOI is highly encouraged. The reference style used by the journal will be applied to the accepted article by Elsevier at the proof stage. Note that missing data will be highlighted at proof stage for the author to correct. If you do wish to format the references yourself they should be arranged according to the following examples:

**Reference style**
Text: All citations in the text should refer to:
1. **Single author:** the author's name (without initials, unless there is ambiguity) and the year of publication;
2. **Two authors:** both authors’ names and the year of publication;
3. **Three or more authors:** first author's name followed by 'et al.' and the year of publication.

Citations may be made directly (or parenthetically). Groups of references should be listed first alphabetically, then chronologically.

Examples: ‘as demonstrated (Allan, 2000a, 2000b, 1999; Allan and Jones, 1999). Kramer et al. (2010) have recently shown ....’

List: References should be arranged first alphabetically and then further sorted chronologically if necessary. More than one reference from the same author(s) in the same year must be identified by the letters ‘a’, ‘b’, ‘c’, etc., placed after the year of publication.

Examples:
Reference to a journal publication:
Reference to a book:
Reference to a chapter in an edited book:

**Journal abbreviations source**
Journal names should be abbreviated according to the List of Title Word Abbreviations: http://www.issn.org/services/online-services/access-to-the-ltwa/.

**Video data**
Elsevier accepts video material and animation sequences to support and enhance your scientific research. Authors who have video or animation files that they wish to submit with their article are strongly encouraged to include links to these within the body of the article. This can be done in the same way as a figure or table by referring to the video or animation content and noting in the body text where it should be placed. All submitted files should be properly labeled so that they directly relate to the video file's content. In order to ensure that your video or animation material is directly usable, please provide the files in one of our recommended file formats with a preferred maximum size of 50 MB. Video and animation files supplied will be published online in the electronic version of your article in Elsevier Web products, including ScienceDirect: http://www.sciencedirect.com. Please supply 'stills' with your files; you can choose any frame from the video or animation or make a separate image. These will be used instead of standard icons and will personalize the link to your video data. For more
detailed instructions please visit our video instruction pages at http://www.elsevier.com/artworkinstructions. Note: since video and animation cannot be embedded in the print version of the journal, please provide text for both the electronic and the print version for the portions of the article that refer to this content.

AudioSlides

The journal encourages authors to create an AudioSlides presentation with their published article. AudioSlides are brief, webinar-style presentations that are shown next to the online article on ScienceDirect. This gives authors the opportunity to summarize their research in their own words and to help readers understand what the paper is about. More information and examples are available at http://www.elsevier.com/audioslides. Authors of this journal will automatically receive an invitation e-mail to create an AudioSlides presentation after acceptance of their paper.

Supplementary data

Elsevier accepts electronic supplementary material to support and enhance your scientific research. Supplementary files offer the author additional possibilities to publish supporting applications, high-resolution images, background datasets, sound clips and more. Supplementary files supplied will be published online alongside the electronic version of your article in Elsevier Web products, including ScienceDirect: http://www.sciencedirect.com. In order to ensure that your submitted material is directly usable, please provide the data in one of our recommended file formats. Authors should submit the material in electronic format together with the article and supply a concise and descriptive caption for each file. For more detailed instructions please visit our artwork instruction pages at http://www.elsevier.com/artworkinstructions.

Interactive plots

This journal encourages you to include data and quantitative results as interactive plots with your publication. To make use of this feature, please include your data as a CSV (comma-separated values) file when you submit your manuscript. Please refer to http://www.elsevier.com/interactiveplots for further details and formatting instructions.

Submission checklist

The following list will be useful during the final checking of an article prior to sending it to the journal for review. Please consult this Guide for Authors for further details of any item.

Ensure that the following items are present:
One author has been designated as the corresponding author with contact details:
• E-mail address
• Full postal address
All necessary files have been uploaded, and contain:
• Keywords
• All figure captions
• All tables (including title, description, footnotes)
Further considerations
• Manuscript has been 'spell-checked' and 'grammar-checked'
• All references mentioned in the Reference list are cited in the text, and vice versa
• Permission has been obtained for use of copyrighted material from other sources (including the Internet)
Printed version of figures (if applicable) in color or black-and-white
• Indicate clearly whether or not color or black-and-white in print is required.
• For reproduction in black-and-white, please supply black-and-white versions of the figures for printing purposes.
For any further information please visit our customer support site at http://support.elsevier.com.