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Testing innovative methods to improve the reach and effectiveness of web-based physical activity interventions

Doctor of Philosophy

2016
Testing innovative methods to improve the reach and effectiveness of web-based physical activity interventions

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Doctor of Philosophy

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February 2016
Abstract

Insufficient levels of physical activity increase the risk of developing cardiovascular disease, some cancers, diabetes, osteoporosis, depression, anxiety and obesity. However, less than half of the Australian population meet the minimum physical activity guidelines of accumulating 30 minutes of moderate intensity physical activity on most days of the week. This increases the burden of disease, lowers quality of life and costs the health care system over AUD $719 million per year. Therefore, there is an urgent need for effective population-based interventions to increase physical activity at low cost for large numbers of people. The Internet provides a good platform to deliver physical activity interventions as it can reach large numbers of people at low cost. Whilst the short-term effectiveness of web-based interventions has been established, effective promotion of web-based interventions, as well as long-term participant engagement and retention into web-based interventions, can be problematic and needs to be addressed in order to improve the long-term effectiveness of these kinds of interventions. Therefore, the first study examined the cost-effectiveness of web-based advertising methods compared to traditional print-based advertising methods, as they have the potential to attract large numbers of people into a web-based physical activity intervention at a lower cost. For the second study, a 3-group randomised controlled trial was conducted to determine the effectiveness (in terms of retention, adherence, website engagement, satisfaction, physical activity changes and quality of life changes) of using online video-coaching (using Skype) in addition to personally-tailored physical activity advice. For the third study the effectiveness of video-tailored advice to improve attention and recall of the physical activity message was compared to basic text-tailored advice using eye-tracking technology and a recall questionnaire. Findings from the recruitment evaluation (study 1) revealed that the cost-effectiveness of both the web-based and print-based methods
varied substantially. Newspaper articles and community calendars cost the least per sign-up, but resulted in a small number of sign-ups (17 and 6 respectively). The targeted Facebook advertisements were the next most cost-effective method (AUD $45 per sign up), and reached the most number of sign-ups (184). People reached through the targeted Facebook advertisements were on average older and had a higher BMI than people reached through the other methods. Google advertisements and newspaper advertisements were not cost-effective. Further research is needed to determine the effectiveness of Facebook advertising for attracting specific population groups and evaluate the use of mass-media to attract larger numbers to population level interventions. The intervention trial (study 2) revealed that the tailored advice + video-coaching group significantly improved their physical activity in comparison to a wait-list control group. However due to a low adherence to the coaching sessions, the tailored advice + video-coaching group did not improve their physical activity more than the tailoring only group. Participants who participated in the video-coaching sessions were nonetheless satisfied and had higher program and website engagement. Further research using online video-coaching should investigate ways to improve coaching adherence. The eye-tracking study (study 3) demonstrated that video-tailored advice leads to improved user-engagement compared to text-tailored advice (i.e., video participants paid more attention and interacted with the website for longer). However no group differences in recall of the physical activity message were found. More research is needed to determine how recall of computer-tailored advice can be improved and whether video-tailored advice can lead to greater health behaviour change than text-tailored advice. In summary, the findings from this PhD add valuable knowledge to the literature about improving the promotion, engagement and effectiveness of web-based physical activity interventions, and inform the development of the next generation of interventions.
Acknowledgements

Firstly, I would like to thank my supervisors for their time, guidance, patience and expertise. I was very fortunate to have such a strong supervisory team. Thank you Prof Corneel Vandelanotte for all the time you put into my thesis, planning, proof reading and advising. Thank you also for your advice and support as I began my research career. The knowledge you shared has been extremely valuable to me. Thank you Dr Cally Jennings for the Skype chats where you offered your guidance and advice in executing the thesis studies and making the most of my time as a PhD candidate. Thank you Prof Ronald Plotnikoff for sharing your expertise and experience in the field and your patience as you assisted me.

Thank you CQUuniversity, in particular the School of Human, Health and Social Sciences, and the Office of Research for the financial, practical and administrative support. A big thank you to Yvonne Holbeck for helping me to work out the university system, complete paperwork and for looking out for me. I would also like to acknowledge the Commonwealth supported Research Training Scheme and the National Health and Medical Research Council for the funding I received to undertake this PhD.

Thank you Mum and Dad for encouraging and supporting me with my education and for teaching me that success it not about being smart but hard work. Thank you for not only listening to me talk about my PhD, but getting out there and letterboxing hundreds of homes to help me to get enough participants. Thank you to my husband Steve for helping me to keep calm and move forward in the stressful times. Thank you for supporting me in working towards a career that I love. Lastly, I would like to thank the Rocky crew, and my Melbourne girls for all the good times, and for always being there to listen.
Declaration

The work contained in this thesis has not been previously submitted either in whole or in part for a degree at CQUniversity or any other tertiary institution. To the best of my knowledge and belief, the material presented in this thesis is original except where due reference is made in text.

Stephanie Jade Alley

11/07/2016

Date
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11/07/2016

Date
# Table of Contents

Abstract .................................................................................................................................... ii

Acknowledgements ................................................................................................................ iv

Declaration ...............................................................................................................................v

Copyright statement .............................................................................................................. vi

Table of Contents .................................................................................................................. vii

Table of Figures ................................................................................................................... xiii

Table of Tables ..................................................................................................................... xiv

Funding, publications and presentations by the candidate .................................................. xv

  Associated with thesis ........................................................................................................... xv
  Associated with chapter 3: Recruitment evaluation ........................................................... xv
  Associated with chapter 4: Intervention trial protocol ....................................................... xvi
  Associated with chapter 5: Intervention trial ................................................................. xvi
  Associated with chapter 6: Eye-tracking study ................................................................. xvii

Additional funding received by the candidate ................................................................. xviii

Additional publications by the candidate ............................................................................ xix

Additional papers by the candidate under review ............................................................. xx

Additional presentations by the candidate .......................................................................... xxi

Chapter 1.  

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

  1.1  Nature of the problem ................................................................................................. 1

  1.2  Aims and hypotheses .................................................................................................. 6
1.2.1 Recruitment evaluation aims and hypotheses ............................................ 7
1.2.2 Intervention trial aims and hypotheses...................................................... 7
1.2.3 Eye-tracking study aims and hypotheses ................................................... 8
1.3 Significance .................................................................................................. 8
1.4 Thesis outline ............................................................................................. 9
1.5 Definition of key terms .............................................................................. 9

Chapter 2. Literature Review ........................................................................... 13

2.1 Overview of the literature presented ........................................................ 13
2.2 Physical activity .......................................................................................... 13
  2.2.1 Introduction to physical activity ............................................................ 13
  2.2.2 The definition of physical activity ......................................................... 15
  2.2.3 Australian physical activity guidelines ................................................ 15
  2.2.4 Measurement of physical activity ......................................................... 16
  2.2.5 Correlates and determinants of physical activity .................................... 20
2.3 Physical activity and health ....................................................................... 22
  2.3.1 The preventive role of physical activity for non-communicable disease
       and falls ........................................................................................................... 22
  2.3.2 The preventive role of physical activity for mental health disorders ....... 27
  2.3.3 The health and economic impact of inactivity in Australia ................... 29
2.4 Physical activity interventions .................................................................... 33
  2.4.1 Introduction to physical activity interventions .......................................... 33
  2.4.2 Face-to-face interventions ...................................................................... 34
  2.4.3 Mass media interventions ...................................................................... 35
  2.4.4 Environmental interventions .................................................................. 35
  2.4.5 Policy interventions ................................................................................ 36
  2.4.6 Mediated interventions .......................................................................... 37
2.5 Theoretical frameworks ............................................................................ 42
  2.5.1 Behaviour change theories ..................................................................... 42
  2.5.2 Communication theories ....................................................................... 47
2.6 Web-based physical activity interventions ................................................. 49
  2.6.1 Challenges of web-based physical activity interventions ....................... 49
  2.6.2 Improving web-based physical activity interventions ............................ 51
  2.6.3 Prompts and reminders ......................................................................... 52
2.6.4 Social support components ...............................................................52
2.6.5 Counselling in physical activity interventions ..............................53
2.6.6 Tailoring in web-based physical activity interventions ..................55
2.6.7 Use of video to engage users ..........................................................57
2.6.8 Eye-tracking to evaluate users’ attention ........................................59
2.6.9 Promoting web-based physical activity interventions ...................61

2.7 Conclusion ........................................................................................64

Chapter 3. Recruitment evaluation ........................................................66

3.1 Abstract ............................................................................................67
3.2 Introduction .......................................................................................69
  3.2.1 Aims and hypotheses ....................................................................71
3.3 Methods ............................................................................................71
  3.3.1 Stage 1 Sign-up ............................................................................72
  3.3.2 Stage 2 Sign-up ............................................................................75
3.4 Measures ..........................................................................................78
  3.4.1 Participant numbers .....................................................................78
  3.4.2 Cost .............................................................................................79
  3.4.3 Efficiency ...................................................................................79
  3.4.4 Demographic characteristics ......................................................79
3.5 Data analysis ......................................................................................80
  3.5.1 Data screening .............................................................................80
  3.5.2 Participant numbers ....................................................................80
  3.5.3 Cost ............................................................................................80
3.6 Results ...............................................................................................80
  3.6.1 Participant numbers ....................................................................80
  3.6.2 Cost ............................................................................................81
  3.6.3 Demographic characteristics ......................................................83
  3.6.4 Targeted Facebook advertising .................................................85
3.7 Discussion ........................................................................................87
  3.7.1 Limitations ................................................................................92
  3.7.2 Conclusion .................................................................................93

Chapter 4. Intervention trial protocol ....................................................94
## 4.1 Abstract

**Abstract**

Introduction ................................................................................................................. 95

## 4.2 Introduction

**Introduction**

Methods ......................................................................................................................... 101

## 4.3 Methods

4.3.1 Participants ........................................................................................................... 101

4.3.2 Recruitment ........................................................................................................... 101

4.3.3 Procedure ............................................................................................................. 102

4.3.4 The ‘My Activity Coach’ intervention ................................................................. 105

## 4.4 Measures

4.4.1 Demographics ...................................................................................................... 115

4.4.2 Physical activity .................................................................................................... 116

4.4.3 Quality of life ....................................................................................................... 116

4.4.4 Theory of Planned Behaviour ............................................................................. 117

4.4.5 Participant satisfaction ........................................................................................ 118

4.4.6 Intervention adherence and study retention ....................................................... 119

4.4.7 Website engagement ........................................................................................... 119

## 4.5 Data analysis

4.5.1 Intervention effectiveness .................................................................................... 119

4.5.2 Secondary analyses ............................................................................................ 119

4.5.3 Sample size .......................................................................................................... 120

## 4.6 Discussion

**Discussion**

Chapter 5. **Intervention trial** ....................................................................................... 122

## 5.1 Abstract

**Abstract**

Introduction ..................................................................................................................... 123

## 5.2 Introduction

5.2.1 Aims and hypotheses .......................................................................................... 127

## 5.3 Methods

5.3.1 Recruitment .......................................................................................................... 128

5.3.2 Participants ........................................................................................................... 128

5.3.3 Protocol ................................................................................................................ 129

5.3.4 Intervention ........................................................................................................... 130

5.3.5 Measures .............................................................................................................. 132

5.3.6 Data analysis ........................................................................................................ 133

5.3.7 Sample size ......................................................................................................... 134
5.4 Results ...............................................................................................................134
  5.4.1 Flow of participants.....................................................................................134
  5.4.2 Sample characteristics ..............................................................................136
  5.4.3 Physical activity .......................................................................................138
  5.4.4 Quality of life ...........................................................................................139
  5.4.5 Coaching adherence and satisfaction ....................................................140
  5.4.6 Intervention adherence and retention ....................................................140
  5.4.7 Website engagement ..............................................................................141
  5.4.8 Satisfaction ..............................................................................................141

5.5 Discussion .....................................................................................................142
  5.5.1 Limitations ..............................................................................................146
  5.5.2 Conclusion ..............................................................................................148

Chapter 6. Eye-tracking study ..............................................................................149

  6.1 Abstract ........................................................................................................150
  6.2 Introduction ..................................................................................................151
    6.2.1 Aims and hypotheses ............................................................................154
  6.3 Methods .........................................................................................................154
    6.3.1 Procedure ..............................................................................................154
    6.3.2 Intervention ...........................................................................................156
  6.4 Measures .......................................................................................................158
    6.4.1 Demographics .......................................................................................158
    6.4.2 Attention ...............................................................................................158
    6.4.3 Recall .....................................................................................................160
  6.5 Data analysis ................................................................................................161
    6.5.1 Data screening .......................................................................................161
    6.5.2 Attention ...............................................................................................161
    6.5.3 Recall .....................................................................................................162
  6.6 Results ..........................................................................................................162
    6.6.1 Attention ...............................................................................................163
    6.6.2 Recall .....................................................................................................165
  6.7 Discussion .....................................................................................................166
    6.7.1 Limitations ............................................................................................170
Chapter 7. Summary and conclusions ........................................................................... 173

7.1 Main findings ........................................................................................................... 174
7.2 Strengths and limitations ....................................................................................... 177
7.3 Significance and implications for research and practice ........................................ 179
7.4 Future recommendations ........................................................................................ 182
7.5 Conclusions ............................................................................................................. 186

References .................................................................................................................. 188

Appendices .................................................................................................................. 223

Appendix A: Screening questionnaire for the intervention trial ............................... 223
Appendix B: Leaflet advertisement for the intervention trial ...................................... 227
Appendix C: Demographic questionnaire for the intervention trial ........................... 229
Appendix D: Active Australia Questionnaire (AAQ) ................................................... 232
Appendix E: Participant information form for the intervention trial ......................... 234
Appendix F: Participant consent form for the intervention trial ................................. 236
Appendix G: Participant email templates ................................................................... 237
Appendix H: Images of the intervention ..................................................................... 239
Appendix I: Video-coaching script ............................................................................. 243
Appendix J: Quality of life SF-12v2 .......................................................................... 248
Appendix K: Constructs of the Theory of Planned Behaviour .................................. 250
Appendix L: Satisfaction questionnaire for the intervention trial .............................. 253
Appendix M: Demographic questionnaire for the eye-tracking study ....................... 260
Appendix N: Eye-tracking study post intervention interview ...................................... 262
# Table of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>The Theory of Planned Behaviour flow diagram</td>
<td>47</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Leaflet and poster advertisement</td>
<td>73</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Newspaper advertisement</td>
<td>73</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Google AdWords</td>
<td>74</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Facebook advertisement</td>
<td>75</td>
</tr>
<tr>
<td>Figure 6</td>
<td>Feed advertisement targeted to males over 45 years with diabetes</td>
<td>77</td>
</tr>
<tr>
<td>Figure 7</td>
<td>Hours per sign-up, cost per sign-up and number of sign-ups for each advertising method</td>
<td>83</td>
</tr>
<tr>
<td>Figure 8</td>
<td>Average number of visits per AUD $100 spent on each Facebook advertisement target</td>
<td>87</td>
</tr>
<tr>
<td>Figure 9</td>
<td>Intervention recruitment page</td>
<td>102</td>
</tr>
<tr>
<td>Figure 10</td>
<td>Intervention process flow diagram</td>
<td>104</td>
</tr>
<tr>
<td>Figure 11</td>
<td>Intervention homepage</td>
<td>106</td>
</tr>
<tr>
<td>Figure 12</td>
<td>Tailored advice with physical activity graph</td>
<td>109</td>
</tr>
<tr>
<td>Figure 13</td>
<td>Action plan output</td>
<td>114</td>
</tr>
<tr>
<td>Figure 14</td>
<td>Participant flow through the intervention trial</td>
<td>136</td>
</tr>
<tr>
<td>Figure 15</td>
<td>Mean physical activity at baseline, week nine and six months</td>
<td>138</td>
</tr>
<tr>
<td>Figure 16</td>
<td>Video-based advice</td>
<td>157</td>
</tr>
<tr>
<td>Figure 17</td>
<td>Text-based advice</td>
<td>158</td>
</tr>
<tr>
<td>Figure 18</td>
<td>Saccades and fixations of a user</td>
<td>160</td>
</tr>
<tr>
<td>Figure 19</td>
<td>Gaze-, fixation-, and focusing-duration in the feedback area by group</td>
<td>164</td>
</tr>
</tbody>
</table>
Table of Tables

Table 1. Direct net cost of physical inactivity in Australia 2007/08 ($ million/annum) ..........32
Table 2. Timeline of strategies used to attract people to the intervention website ..............78
Table 3. Time investment, costs, impressions, first time visits and sign ups of each advertising method ..................................................................................................................................................82
Table 4. Descriptive summary of participant characteristics reached using targeted Facebook advertisements and all other methods ..................................................................................................................................................84
Table 5. Cost, impressions, website visits and sign-ups for each Facebook advertisement ordered by cost per visit ..................................................................................................................................................86
Table 6. Topics, tailoring items and Theory of Planned Behaviour constructs of the computer-tailored physical activity advice ........................................................................................................................................112
Table 7. Baseline characteristics, physical activity and quality of life by group assignment ..................................................................................................................................................136
Table 8. Physical activity, mental health and physical health changes by group ..................139
Table 9. Participant demographics for total group and for video- and text-groups ..............163
Table 10. Descriptive statistics for gaze-, fixation-, and focusing-duration in the feedback area and distraction by group (video and text) ........................................................................................................................................165
Table 11. Correct responses for each recall question by group and chi-square comparison of correct responses in video- and text-groups ........................................................................................................................................166
Funding, publications and presentations by the candidate

Associated with thesis

Please note that some publications are listed under the candidate’s maiden name, Bland, S.

Funding:


Associated with chapter 3: Recruitment evaluation.

Publication:


Presentation:


Role of the candidate:
The candidate SA designed the study, conducted the data collection, carried out the data analysis and drafted the manuscript. CJ, RCP and CV played a significant role in establishing the study design and drafting the manuscript.

**Associated with chapter 4: Intervention trial protocol**

**Publication:**


**Role of the candidate:**

The candidate SA conceived the study, developed the intervention and drafted the manuscript. CJ, RCP and CV played a significant role in establishing the study design, the intervention design and drafting the manuscript.

**Associated with chapter 5: Intervention trial**

**Publication (refer to the published article for the final version):**


**Symposium contribution:**

**Role of the candidate:**

The candidate SA managed the intervention trial, collected the data, conducted the data analysis and drafted the manuscript. CJ, RCP and CV played a significant role in advising procedures during the trial and in drafting the manuscript.

**Associated with chapter 6: Eye-tracking study**

**Publication:**


**Book chapter:**

(Eds.), *Current Trends in Eye Tracking Research* (pp. 245-265). Switzerland: Springer International Publishing.

**Presentation:**


**Role of the candidate:**

The candidate SA calculated the eye tracking data, conducted the data analysis and drafted the manuscript. CV conceived the study, NP and MH collected the data and CV, NP, MH, CD and RCP played a significant role in drafting the manuscript.

**Additional funding received by the candidate**


Additional publications by the candidate


**Additional papers by the candidate under review**


**Additional presentations by the candidate**


Chapter 1. Introduction

1.1 Nature of the problem

Physical activity improves physical and mental health and significantly lowers the risk of non-communicable disease including cardiovascular disease, diabetes mellitus and cancer (Lee et al., 2012). Individuals who are physically active have a reduced risk of cardiovascular disease by 30% - 50% and a reduced risk of mortality by 20% - 50% (Bassuk & Manson, 2005; Friedenreich & Orenstein, 2002a; Warburton, Nicol & Bredin, 2006). Physically active individuals diagnosed with a non-communicable disease have up to a 40% reduced risk of mortality compared to those who are inactive (Warburton et al., 2006). In addition to disease prevention physical activity leads to a reduced risk of anxiety and depression, a reduced risk of falls and osteoporosis in the elderly, general improvements in health and well-being (Warburton et al., 2006) and reduced non-communicable disease risk factors including obesity, high blood cholesterol and high blood pressure (Begg, Vos, Barker, Stanley & Lopez, 2008; Blair & Morris, 2009).

The World Health Organisation recommends 150 minutes of moderate-intensity physical activity, or 75 minutes of vigorous-intensity physical activity each week to receive the health benefits and reduce disease risk (World Health Organisation, 2008). Despite this, one out of three people worldwide fail to reach these guidelines. These high levels of insufficient activity significantly impact the high rates of non-communicable disease and premature mortality in both developed and developing countries. An estimated 3.2 million deaths each year are due to insufficient physical activity (World Health Organisation, 2008). In Australia, over half of the population is inactive (Australian Bureau of Statistics, 2013a) which is estimated to cost the Australian economy AUD $13.8 billion each year in: healthcare (AUD
$719 million), loss of productivity (AUD $9.3 billion) and mortality costs (AUD $3.8 billion) (Medibank Private, 2008). Hence there is an urgent need for physical activity interventions with a broad reach that are effective in improving participants’ physical activity levels.

A variety of physical activity interventions has been used to improve physical activity levels in the community. Interventions can target individuals, a community or the population (Artinian et al., 2010). Community and population interventions traditionally target inactivity by promoting health messages through mass media including banners, television, radio; by making environmental changes such as building new recreational facilities or by making policy changes such as mandatory physical activity classes in schools (Heath et al., 2012). Although mass media, environmental and policy interventions have the ability to impact a large number of individuals they only produce small changes in behaviour (Norman et al., 2007; Schmid, Pratt & Witmer, 2006; Wakefield, Loken & Hornik, 2010). Interventions aimed at individuals were traditionally delivered face-to-face through behaviour change programs in primary care, which has shown to be effective in improving participants’ physical activity levels. It is however difficult to impact a larger community or population through these programs, as they are limited to smaller numbers (Artinian et al., 2010; Hillsdon, Foster & Thorogood, 2005). Recently health promotion workers and researchers have utilised modern technology including computers, the Internet and smartphones to deliver behaviour change programs (Artinian et al., 2010; Davies, Spence, Vandelanotte, Caperchione & Mummery, 2012b; Foster, Richards, Thorogood & Hillsdon, 2013). These have time, geographical and financial advantages over face-to-face interventions enabling
behaviour change programs to be delivered at the community and population level (Micco et al., 2007; Wantland, Portillo, Holzemer, Slaughter & McGhee, 2004).

Web-based interventions have the ability to deliver many of the same components as traditional face-to-face behaviour change interventions through interactive technology including self-monitoring, tailored advice, coaching and peer support. Furthermore, web-based interventions can deliver these intervention components in a non-confrontational and convenient way (Christopherson, 2007; McConnon et al., 2007; Tate, Finkelstein, Khavjou & Gustafson, 2009). Web-based interventions have shown to be effective and produce similar behavioural outcomes to face-to-face interventions (Brouwer et al., 2011). Internet access in Australia is at an all-time high with 92% of Australians having access to the Internet in 2014 (Australian Communications and Media Authority, 2015). This gives web-based interventions the potential to reach large numbers at low cost. However, many health websites with varying focuses and credibility are available (Berry, Spence, Plotnikoff & Bauman, 2011) creating fierce competition to attract people to visit a website, join or subscribe and return on a regular basis. Therefore researchers and health promotion practitioners have struggled to attract large numbers to their evidence-based websites (Foster et al., 2011). Web-based interventions typically recruit participants through traditional media advertising methods including newspaper advertisements, posters and leaflets (Ferney, Marshall, Eakin & Owen, 2009; Foster et al., 2011). This is despite a growing range of available web-based marketing options that are successfully used for marketing in the commercial sector (Wakolbinger, Denk & Oberecker, 2009). To maximise the potential that web-based interventions hold, research is needed to test the effectiveness of web-based methods to attract large numbers of people to web-based physical activity interventions and
therefore increase the impact web-based interventions have on physical activity levels in the community.

Participant retention and engagement have also been identified as a challenge for web-based interventions with many reporting high drop-out rates or low use of the websites (Davies et al., 2012b; Dickinson et al., 2013; Vandelanotte, Spathonis, Eakin & Owen, 2007). As participant exposure to intervention content is associated with improved behavioural outcomes, these factors may be limiting the effectiveness of web-based interventions (Ferney et al., 2009). Optimising engagement and retention of web-based interventions is therefore important in order to take advantage of the Internet and deliver effective behavioural change programs to a large audience. To date research has provided some insights into intervention components that improve participant engagement and retention. Reviews have shown that successful web-based physical activity interventions have included personalised advice through coaching or computer tailoring, frequent participant contacts, social support and theoretically based behaviour change techniques (Greaves et al., 2011). Randomised controlled trials have found interventions with personalised advice (including computer-tailored advice or coaching sessions) to have improved engagement and behavioural outcomes compared to interventions with generic advice (Kroeze, Werkman & Brug, 2006; Noar, Benac & Harris, 2007). However little is known about how to optimally deliver personalised advice and this knowledge could help to further improve participant engagement, retention and physical activity outcomes.

Computer-tailored advice, which automatically generates personal advice based on participants’ responses to a questionnaire, is preferred by participants and is more effective in improving participant engagement and behaviour compared to generic advice (Lustria,
Cortese, Noar & Glueckauf, 2009). Computer tailoring is a popular method of delivering advice to intervention participants due to its effectiveness and relatively low cost for large scale interventions (Lustria et al., 2009). Coaching or counselling is another effective method of delivering personalised advice, which additionally provides participants with social support (Greaves et al., 2011; Tate, Jackvony & Wing, 2003). Online coaching or counselling can take place in a similar manner to the traditional face-to-face counselling programs through instant messaging and more recently video-calling. Coaching does however require a greater time and cost investment than automated computer-tailored advice (Tate, Jackvony & Wing, 2006). It is unknown whether combining online coaching and computer-tailored advice could utilise the benefits of both methods and improve intervention outcomes. Future research is required to explore the added benefit of online video-coaching to low cost computer-tailored advice to determine whether this leads to greater intervention effects than computer-tailored advice alone.

It is established that computer-tailored behaviour change advice improves participants’ outcomes, however few studies have explored optimal delivery methods for the tailored advice (Lustria et al., 2009). Computer-tailored advice is commonly delivered in text-based format on intervention websites despite users tending to skim and scan text when reading on the Internet and rarely engaging in concentrated reading (Sutherland-Smith, 2002). Recent research has found that people prefer information provided through graphically rich and interactive technologies such as video in an online environment, and many popular websites present information through video to engage users (Purcell, 2010; Vandelanotte & Mummery, 2011). New technology allows the delivery of tailored videos that are presented as a string of short videos selected for the user based on their responses to a short
questionnaire (Vandelanotte, Duncan, Plotnikoff & Mummery, 2012). Despite this, very few studies have been conducted to test participant engagement in computer-tailored advice delivered through an innovative video format in comparison to the traditional text format. Further research is required to test participant engagement in video- and text-tailored physical activity advice to determine whether video-tailoring could further improve participant engagement to tailored advice.

The Internet provides a potential platform to deliver effective physical activity interventions to a wide audience. Although the effectiveness of web-based interventions is well established, problems with participant attraction, engagement and retention are commonly cited. These problems restrict the long-term impact of web-based interventions in the community. Further research is therefore required to evaluate innovative methods to attract people to intervention websites; and to evaluate the effectiveness of innovative methods of delivering intervention content to improve participant engagement and retention. Such findings will enable the development of web-based physical activity interventions effective in producing long-term physical activity changes in large numbers and reducing the burden of disease in the community.

1.2 Aims and hypotheses

The challenges of attracting people to health behaviour change websites and adequately engaging them in the intervention content need to be addressed to deliver effective behaviour change techniques to a large number of people at low-cost. Therefore three studies were conducted for this thesis to a) investigate cost-effective ways to promote web-based physical activity interventions, b) investigate effective methods of delivering personalised advice that
will improve participants’ engagement and physical activity levels and c) explore participants’ engagement in video- and text-delivery of computer-tailored content.

1.2.1 Recruitment evaluation aims and hypotheses

This study aimed to determine the effectiveness (in terms of cost, efficiency and numbers reached) of print-based and web-based recruitment methods to attract Australian adults to a web-based physical activity intervention. Print-based recruitment methods included newspaper advertisements and leaflets and posters distributed in community health and sport centres. Web-based recruitment included Facebook and Google advertisements as well as posts on community websites. This study also aimed to explore the demographics of participants reached through web-based and print-based recruitment methods. It was hypothesised that the web-based advertising will reach a larger number of people at a lower cost and time investment than print advertising.

1.2.2 Intervention trial aims and hypotheses

A three group RCT was conducted to test the effectiveness of an eight week, four module computer-tailored physical activity intervention with or without online video-coaching sessions to briefly reiterate previously received computer-tailored physical activity advice. It was hypothesised that a tailoring + video-coaching group will have significantly higher study retention, intervention adherence, website engagement and program satisfaction compared to a tailoring only group. It was also hypothesised that a tailoring + video-coaching group will have greater improvements in physical activity and quality of life compared to a tailoring only group and a wait list control-group at the primary time point, nine weeks, and at six months post baseline.
1.2.3 **Eye-tracking study aims and hypotheses**

This study aimed to evaluate, with the use of an eye-tracking device and a recall questionnaire, the differences between video-tailored and text-tailored physical activity advice in terms of participant attention to and recall of the intervention content. It was hypothesised that participants receiving video-tailored advice will spend more time paying attention to the advice, be less distracted and have improved recall of their personal physical activity advice in comparison to those receiving text-tailored advice.

1.3 **Significance**

Findings from this PhD provides health promotion professionals with a greater understanding of innovative techniques that are effective in improving the ability of web-based physical activity interventions to attract larger numbers of participants and engage participants more effectively. The recruitment evaluation demonstrated that Facebook recruitment was the most effective at reaching large numbers of people at low-cost compared to other online recruitment strategies and traditional print promotion. The intervention trial demonstrated that brief online video-coaching sessions in addition to computer-tailored advice improved engagement and satisfaction, but did not produce improved behaviour change outcomes. The eye-tracking results improved our understanding of people’s attention to text- and video-delivered computer-tailored information in an online environment. These studies contribute to knowledge on strategies to improve the reach and effectiveness of the next generation of web-based physical activity interventions to aid in the reduction of disease in Australia.
1.4 Thesis outline

The next chapter of the thesis (chapter 2) outlines the current literature on the measurement, correlates, determinants and health outcomes of physical activity; the literature on the effectiveness of behaviour change interventions and the web-based delivery of intervention content. Chapter 3 presents the findings of a study evaluating the effectiveness of recruitment methods for a web-based physical activity program for inactive adults. The protocol for a web-based physical activity intervention trial is presented in chapter 4. Here a protocol for an intervention trial to test the effectiveness of online coaching with a behaviour change expert in addition to computer-tailored advice is presented. Chapter 5 presents the outcomes for the intervention trial. Outcome measures include the feasibility (retention, adherence, website engagement and satisfaction) and physical activity changes of a tailoring + video-coaching, tailoring only and a control group at post intervention (week nine) and six months. Findings from the final study, which used an eye-tracking device to measure participant attention to text-delivered and video-delivered computer-tailored advice in a web-based physical activity intervention, are presented in chapter 6. The final chapter (chapter 7) presents a discussion of the main findings and strengths and limitations of the studies. The significance and implications of the findings and future recommendations for research and practice are also discussed.

1.5 Definition of key terms

*Action planning:* Action planning is also referred to as intention implementation. It is a component of behaviour change interventions which involves the individual setting a specific plan to reach their behaviour change goals (Gollwitzer, 1999).
**Adherence**: The percentage of an intervention completed by each participant as intended.

**Attrition**: The percentage of participants who completed baseline data collection and who don’t complete the follow up data collection.

**Computer tailoring**: Computer tailoring delivers pre-written health behaviour messages relevant to the participant based on their characteristics or behaviour relevant to the message. ‘IF THEN’ algorithms are used to determine the messages that will be displayed to participants based on their responses to a questionnaire (e.g., IF participants are over 65 years of age, THEN display a pre written message about healthy aging) (Hawkins, Kreuter, Resnicow, Fishbein & Dijkstra, 2008).

**Counselling**: “The process of assisting and guiding clients esp. by a trained person on a professional basis to resolve esp. personal, social or psychological problems or difficulties” (Oxford, 2004a, p. 315).

**Feasibility**: Feasibility of an intervention is the level it is able to be done or put into effect.

**Fidelity**: A participant’s level of adherence to an intervention.

**Fixation duration**: A fixation recorded by an eye-tracking device is when the user focuses on a point in a computer screen, whilst fixation duration refers to the sum of the duration of all the fixations in the computer screen (Nielsen & Pernice, 2010).

**Gaze duration**: Gaze duration is recorded by an eye-tracking device, and specifically refers to the entire time users spend viewing the computer screen (Nielsen & Pernice, 2010).
**Goal setting:** A behavioural change strategy that encourages people to decide what pattern of behaviour they want to achieve and to create a plan to achieve it (Shilts, Horowitz & Townsend, 2004).

**Health coaching:** “Facilitating health behaviour change through interactions between a health professional (coach) and a client” (Olsen, 2013, p. 1).

**Impressions:** A measure of the number of times an advertisement is displayed (Facebook, 2012).

**Internet:** “An international information network linking computers, accessible to the public via modem links etc.” (Oxford, 2004b, p 732).

**Mediated interventions:** Interventions that use a medium (paper, phone, computer, email or the Internet) to deliver the intervention content indirectly instead of face-to-face (Marshall, Owen & Bauman, 2004).

**Physical Activity:** “Any bodily movement from skeletal muscles that results in energy expenditure” (Casperson, Powell & Christenson, 1985, p.127).

**Quality of life:** A person’s physical and mental health status. It can be measured through a questionnaire and has been identified as an important outcome measure of health interventions (Ware, Kosinski & Keller, 1996).

**Randomised controlled trial:** A study design where participants are assigned at random to either a treatment group or a control (comparison) group. It is the ‘gold standard’ research
design to test the effectiveness or efficacy of an intervention or treatment (Sibbald, Roland & 1998).

Relapse prevention: Relapse prevention is a component of behaviour change interventions, and specifically refers to identifying and preventing situations which put the individual at risk of reverting to their old behaviour pattern they are trying to change (Larimer, Palmer & Marlatt, 1999).

Retention: The percentage of participants who completed baseline data collection, who completed post intervention data collection and follow up data collection.

Saccades: A Saccade is recorded by an eye-tracking device when the user moves their gaze from fixating on one point to fixate on another point (Nielsen & Pernice, 2010).

Self-efficacy: Perceived ability and confidence in performing a target behaviour (Bandura, 1986).

Usability: How easy and pleasant a system is to use (Nielsen, 2012).

Web-based interventions: An intervention that is primarily delivered over the Internet. It is typically delivered on a website set up for the intervention and may include participant contact through other mediums including telephone and email.

Website Engagement: Participants’ use of web-based program components and website features. Website engagement is typically measured by time on the website and number of visits to the website.
Chapter 2. Literature Review

2.1 Overview of the literature presented

Chapter 2 presents an overview of the literature on physical activity and behaviour change programs. Firstly, a section on physical activity is presented which includes a definition of physical activity and a discussion of the Australian guidelines for physical activity, options for physical activity measurement, the correlates and determinants of physical activity and evidence for the health and economic impact of inactivity. Next, evidence for the effectiveness of physical activity interventions including face-to-face, mass media, environmental, policy and mediated is discussed. Common evidence based theoretical frameworks for effective communication and behaviour change used to inform intervention content are discussed. The final section includes an overview of the literature on web-based physical activity interventions. Here the benefits and challenges of web-based interventions and the strength of evidence for web-based interventions are discussed. The effectiveness of specific web-based intervention components including prompts and reminders, social support, counselling, computer tailoring and video are presented. The use of eye-tracking to evaluate website users’ attention to intervention components such as video is also discussed. Lastly evidence for low participation in web-based physical activity interventions and options to address this are presented.

2.2 Physical activity

2.2.1 Introduction to physical activity

Physical activity is strongly associated with improved mental and physical health outcomes. Physical activity reduces the risk of many non-communicable diseases including
cardiovascular disease, diabetes mellitus, cancer (colon and breast), bone and joint diseases (osteoporosis and osteoarthritis), and mental health illness (depression and anxiety) (Begg et al., 2008; Lee, 2003; Warburton et al., 2006). Furthermore physical activity indirectly affects disease risk by reducing obesity, high blood cholesterol and high blood pressure, which are risk factors for non-communicable disease (Begg et al., 2008; Blair & Morris, 2009).

Physical activity leads to general improvements in health and well-being, including back pain, period pain, stress, mood and tiredness (Egger, Donovan, Swinburn, Giles-Corti & Bull, 1999). Physical activity also leads to improved musculoskeletal fitness which can lead to a range of additional health benefits, particularly in the elderly. This includes improved functional independence, mobility, and a reduced risk of falls (Warburton et al., 2006).

Low levels of physical activity are prevalent, with 31% of the world’s population estimated to be insufficiently active for health benefits, in 2008 (World Health Organisation, 2008). There are many factors that are contributing to worldwide inactivity. One factor is the modern cultural emphasis on convenience which has led to new technologies that allow passive means of the majority of activities that make up our daily lifestyles, including transportation, communication and entertainment (Medibank Private, 2008). Environmental factors also discourage participation in physical activity including neighbourhood designs that encourage the use of inactive transport, a lack of walking paths and recreational facilities, pollution and violence. Furthermore increasingly busy lifestyles result in a lack of time to set aside for physical activity (Pratt et al., 2012). The rise of inactivity is having a significant impact on disease and disability in both developed and developing countries worldwide. (Pratt et al., 2012; World Health Organisation, 2008).
2.2.2 The definition of physical activity

Physical activity is defined as “any bodily movement from skeletal muscles that results in energy expenditure” (Casperson et al., 1985, p. 127). Exercise is a subset of physical activity, which is defined as “physical activity that is structured, repetitive and purposeful” (Casperson et al., 1985, p. 128). Physical activity is also separate to physical fitness which refers to health and athletic attributes that people have or achieve. Physical activity can be broken down into sub categories of occupational, transport, household and leisure time. Leisure time physical activity can be further broken down to sports, conditioning activities (i.e., exercises that improve strength and fitness with the goal of improving sports performance), and other activities (Casperson et al., 1985). Sedentary behaviour is a related but independent concept to physical activity and is also a risk factor for non-communicable disease. Sedentary behaviour is defined as prolonged participation in activities with a very low energy expenditure including sitting down and lying down (Edwardson et al., 2012). It is possible to have a high level of physical activity which improves health, but simultaneously have a high level of sedentary behaviour which has an independent negative impact on health (Dunstan et al., 2010). This thesis focuses on all types of physical activity including occupational, transport, household and leisure time.

2.2.3 Australian physical activity guidelines

The Australian Commonwealth Department for Health and Aged Care sets physical activity guidelines based on empirical evidence for the level of physical activity required for good health. These guidelines are promoted to encourage the public to become more active and therefore reduce the level of disease in Australia. The guidelines include the recommended amount of physical activity required to achieve good health and explain that health benefits
increase as physical activity levels increase (Department of Health and Aging, 2014). The recommended amount of physical activity was chosen to encourage the least active to engage in a level of physical activity that was both achievable and would significantly improve their health. The specific guidelines are as follows:

1. Doing any physical activity is better than doing none. If you currently do no physical activity, start by doing some and gradually build up to the recommended amount.
2. Be active on most, preferably all, days every week.
3. Accumulate 150 to 300 minutes (2 ½ to 5 hours) of moderate intensity physical activity or 75 to 150 minutes (1 ¼ to 2 ½ hours) of vigorous intensity physical activity, or an equivalent combination of both moderate and vigorous activities, each week.
4. Do muscle strengthening activities on at least two days each week.

2.2.4 Measurement of physical activity

There are a number of methods to measure physical activity, each with positives and negatives. Researchers must choose a method that is suited to their study design and available resources. Physical activity can be measured objectively or subjectively. Both objective and subjective methods of physical activity measurement are widely used in physical activity research.

Objective measurement includes pedometers, accelerometers, heart rate monitors and doubly labelled water. The pedometer is a device - typically worn on the belt - that records step count by detecting the impacts produced by steps during movement. Pedometers have the oldest technology, but are still used for research as they are simple and relatively low-cost.
Energy expenditure can be estimated from step count, however the estimations are inaccurate for moderate to vigorous activity (i.e., running, team sport and yard work) as pedometers do not reflect intensity of movement (Andre & Wolf, 2007; Yang & Hsu, 2010). A new range of high-tech monitors called accelerometers has recently become available for physical activity measurement. The monitors are usually worn on the wrist, hip or thigh. Accelerometers are able to measure intensity and frequency of ground ambulation (when an individual propels themselves along the ground). Accelerometers can therefore provide a more accurate measurement of energy expenditure over a wide range of activities including walking, running and team sports (Andre & Wolf, 2007; Yang & Hsu, 2010). Accelerometers, however, are not reliable at measuring upper body movement, weight training, cycling and swimming which do not incorporate ground ambulation. Accelerometers are frequently used in physical activity research but are expensive and require researchers to meet with participants to hand over devices and explain how to wear them correctly.

Heart rate monitors are used to measure a user’s heart rate during exercise for an accurate measure on intensity and energy expenditure during all types of exercise including running, swimming cycling, team sports (Andre & Wolf, 2007). Heart rate monitors are however infrequently used to measure energy expenditure in free living physical activity trials as they do not accurately measure low intensity activity and participants have shown poor compliance in wearing the monitors. The inaccuracy of low intensity activity is due to other factors such as ambient temperature, illness, caffeine and stress increasing heart rate to the level of low intensity activity (Andre & Wolf, 2007). Chest-strap heart rate monitors can constrict the chest leading to participant discomfort during long term wear and electrode based heart rate monitors require good skin contact which can lead to skin irritation. Doubly
labelled water is the gold standard for measuring free-living energy expenditure due to its high accuracy and ability to measure energy expenditure for all types of physical activity (Speakman, 1998). Participants are required to consume water with a concentration of hydrogen and oxygen. Participants give urine and saliva specimens before and after drinking the water and then return in one to two weeks to give a final urine specimen. As energy is expended in the body over the testing period, carbon dioxide and water are produced and the differences between the isotope elimination rates are used to calculate total energy expenditure (Speakman, 1998). This is an accurate measure of energy expenditure over one to two weeks of free living and the requirements on the participant are minimal. The process does however require specialised equipment and has a very high cost per person (Andre & Wolf, 2007). These objective measurements of physical activity have a greater validity and reliability of certain activities than subjective measurement, but the cost and location of participants can be a barrier for use of objective measurement in research studies.

Questionnaires are the most common form of subjective measurement in physical activity. There is a range of available questionnaires which vary in length, types of physical activity and target population groups. Three of the most common questionnaires used to measure physical activity in Australian adults include the Godin Leisure Time Exercise Questionnaire (GLTEQ) (Godin & Shephard, 1997), the Active Australia Questionnaire (AAQ) (Australian Institute of Health and Welfare, 2003) and the International Physical Activity Questionnaire (IPAQ) (Craig et al., 2003). The GLTEQ measures vigorous, moderate and mild physical activity in leisure time. The AAQ and the IPAQ also measure moderate and vigorous physical activity and in addition, incidental physical activity (including housework, gardening and walking for transport). Good validity and reliability has been confirmed for
the AAQ in an Australian sample and for the IPAQ across 12 countries. The IPAQ has a good test-retest reliability (Spearman’s $p$ clustered around 0.8) and a fair to moderate agreement with objectively measured physical activity (median Spearman’s $p$ of about 0.30). The IPAQ can over report physical activity but can detect behaviour change in intervention research (Craig et al., 2003). The AAQ also has a good test-retest reliability (Kappa = .52) (Brown, Trost, Bauman, Mummery & Owen, 2004b), has a high percentage agreement with other physical activity measures (67%-75%) (Brown, Bauman, Chey, Trost & Mummery, 2004a) and is sensitive enough to detect changes in physical activity (Ferney et al., 2009). The AAQ is used by the Australian Bureau of Statistics to estimate physical activity levels in the Australian population (Australian Bureau of Statistics, 2013a), allowing researchers using this measure to compare their sample to the Australian population.

Questionnaires have a lower validity and reliability than objective measurement, as they are reliant on self-reported data that may be subject to recall bias when respondents do not accurately recall their physical activity behaviour and social desirability bias when respondents answer the questions in a way that they perceive others will view most favourably (Patterson et al., 1993). However questionnaires are more feasible for large geographically diverse samples and allow the collection of contextual information such as the domain of physical activity performed (leisure time, occupational, transportation, or household chores) which cannot be collected using accelerometers. As the current thesis aimed to measure moderate, vigorous and incidental physical activity in a large sample throughout Australia, the Active Australia Questionnaire was used to measure participants’ physical activity.
2.2.5 Correlates and determinants of physical activity

There are many factors which influence physical activity levels. These factors are referred to as correlates and determinants of physical activity (Bauman, Sallis, Dzewaltowski & Owen, 2002). Correlates are factors that are associated with physical activity and determinants are factors which cause a change in physical activity or predict physical activity. Determinants are found in longitudinal or experimental research studies (Bauman et al., 2002). Researchers and health professionals can initiate change in physical activity behaviours by targeting correlates and determinants of physical activity. Some correlates and determinants can be modifiable and manipulated by health interventions whilst others cannot. For example the physical environment can be manipulated but gender and age cannot. However researchers and health promotion professionals can target individuals with non-modifiable characteristics associated with inactivity. For example some interventions target females who are typically less active (Cussler et al., 2008). Individual, social and environmental factors found to be correlates and determinants of physical activity are discussed below.

2.2.5.1 Individual

Health status (appearance or achievement) and personal history of physical activity are strong predictors of physical activity (Bauman et al., 2012; Craggs, Corder, van Sluijs & Griffin, 2011). Psychological predictors including perceived benefits of physical activity, self-efficacy or an individual’s confidence that they can lead an active lifestyle, and intentions to be active, are also strong predictors of physical activity in adults (Bauman et al., 2012; Craggs et al., 2011). Increased stress and perceived effort are associated with inactivity. Further, physical activity levels are lower in older people and people with higher BMIs. Male
gender, some ethnic origins and higher education are associated with higher physical activity levels (Bauman et al., 2012).

### 2.2.5.2 Social

Some occupational factors including work stress, working hours and overtime are associated with inactivity (Bauman et al., 2012). Social support has a strong association with physical activity. Social support from friends, family and a general practitioner have the strongest association with physical activity compared to social support from an instructor, coach or staff (Trost, Owen, Bauman, Sallis & Brown, 2002). The number of active close friends and family, the number of exercise partners and dog ownership are also positively associated with physical activity (Giles-Corti & Donovan, 2003), whilst social isolation is associated with inactivity (Trost et al., 2002).

### 2.2.5.3 Environmental

Research into environmental correlates of physical activity has only occurred in recent years and the majority of research in adults has been cross sectional (Bauman et al., 2012; Giles-Corti & Donovan, 2003). Walkability, street connectivity and presence of a local shop are associated with higher levels of transport physical activity; and short distances to a range of different businesses and public facilities (including theatre, bank, store, city hall, public transport stations and recreational facilities) are associated with higher levels of transport physical activity. The number of different businesses within 800 meters of the home is positively associated with transport physical activity (McCormack & Shiell, 2011). Transportation environment (pavement and safe road crossings), positive aesthetics, minor traffic, increased population density and higher quantities of parks and recreation facilities
are associated with higher leisure time physical activity (Bauman et al., 2012; Giles-Corti & Donovan, 2003; McCormack & Shiell, 2011). Lastly, neighbourhood safety including the absence of unrestrained dogs is associated with increased total physical activity (Sallis, King, Sirard & Albright, 2007).

### 2.3 Physical activity and health

#### 2.3.1 The preventive role of physical activity for non-communicable disease and falls

Physical activity plays a significant role in the prevention of non-communicable disease (Bassuk & Manson, 2005; Beaglehole et al., 2011; Blair, LaMonte & Nichaman, 2004; Blair & Morris, 2009; World Health Organisation, 2008). Non-communicable disease refers to disease which cannot be transmitted between individuals and includes cardiovascular disease, diabetes, cancer and osteoporosis. Physical inactivity is the fourth leading risk factor for both non-communicable disease and mortality worldwide (Lee et al., 2012) and is estimated to cause 6–10% of major non-communicable diseases and 9% of premature mortality (Lee et al., 2012). Physical activity also plays a significant role in the prevention of falls and osteoporosis in the elderly (Sherrington et al., 2008; Warburton et al., 2006).

The benefits of physical activity for cardiovascular health have been explored in many studies with diverse methodology since the 1950s. Early studies compared the cardiovascular health of workers in active and sedentary jobs, with findings revealing that men in more active jobs had lower levels of heart disease and fewer instances of clogged arteries (Morris & Crawford, 1958; Morris, Heady, Raffle, Roberts & Parks, 1953). Researchers have now found evidence for the protective role of both work and leisure time physical activity for cardiovascular health in men and women (Blair & Morris, 2009). Individuals who are
physically active have a reduced risk of cardiovascular disease by approximately 30% - 50% (Bassuk & Manson, 2005). For example, a longitudinal study conducted an extensive medical examination and health tests of around 80,000 participants over 30 years. The findings demonstrated that risk of mortality and morbidity from cardiovascular disease decreased as physical fitness increased (Sui et al., 2007). Furthermore improvements in cardiovascular health have been found to result from even small increases in the least active people (Shiroma & Lee, 2010). Shiroma and Lee (2010) found that for any increase in the amount of activity by an individual, the magnitude of benefit is inversely associated with the baseline activity. Therefore the greatest cardiovascular health benefits from increasing physical activity are seen in people who are the least active to begin with. Clinical trials have also provided evidence that physical activity reduces the severity of cardiovascular disease.

There is evidence to suggest that an energy expenditure of 9240 kJ per week is effective in reducing plaque build-up in patients with cardiovascular disease (Warburton et al., 2006).

A strong evidence base also exists for the benefit of physical activity in the prevention and management of diabetes. A large prospective study found each increase of 2100 kJ in energy expenditure (90 minutes of vigorous walking) per week was associated with a 6% decreased incidence of type two diabetes (Manson et al., 1999), a trend that has been supported by many other studies (Jeon, Lokken, Hu & van Dam, 2007). Individuals who are physically active have a reduced risk of diabetes by approximately 30% - 50% (Bassuk & Manson, 2005). In addition to activity as a preventative mechanism, physical activity is an effective treatment for diabetes patients. Type 2 diabetes is the most common form of diabetes, which makes up 87% of all people with diabetes. Both lifestyle changes, including diet and physical activity, and pharmacology treatments are prescribed to manage type 2 diabetes. More severe
cases may need insulin therapy. A small but clinically and statistically significant reduction in biological indicators of diabetes has been found in type 2 diabetes patients who increase their physical activity (Warburton et al., 2006). Furthermore the risk of mortality resulting from diabetes is estimated to be reduced by 42% in physical activity intervention participants, which is similar to a level of change associated with conventional pharmacology treatments (Warburton et al., 2006).

There is also a strong evidence base for the role of physical activity in the prevention of some cancers. These include colon and breast cancer that are among the most commonly diagnosed cancers in Australia. A systematic review on physical activity and cancer found the majority of cohort studies demonstrated a negative relationship between intensity of physical activity and risk of bowel cancer. The review also found the majority of cohort and case control studies demonstrated a negative relationship between intensity of physical activity and risk of breast cancer in women (World Cancer Research Fund, 2007). It is estimated that individuals who are physically active have a 40%- 50% lower risk of colon cancer and women who are physically active have a 30%- 40% lower risk of breast cancer (Friedenreich & Orenstein, 2002a). There is some evidence to suggest physical activity may reduce the risk of endometrium, lung and pancreas cancers, but further research is required to confirm and determine the extent of the relationship between physical activity in these cancers (World Cancer Research Fund, 2007). Physical activity has also been shown to reduce the risk of mortality in people diagnosed with colon or breast cancer. A longitudinal study involving breast cancer patients revealed that women who engaged in nine hours of physical activity a week had a 6% greater reduction in mortality risk than women who engaged in less than three hours per week of activity (Holmes, Chen, Feskanich, Kroenke & Colditz, 2005). A
A longitudinal study involving colon cancer patients revealed that those who engaged in regular exercise had a 23% lower risk of disease specific mortality than those who were inactive (Haydon, MacInnis, English & Giles, 2006).

Osteoporosis is characterised by low bone density and leads to an increased risk of fractures (Reginster & Burlet, 2006). Physical activity reduces the risk of osteoporosis by reducing bone decay (Warburton et al., 2006). A meta-analysis found that physical activity programs reduced bone decay by 1% per year in women. Weight-bearing exercise, especially resistance exercise, was most effective in slowing decline in bone mineral density (Wolff, van Croonenborg, Kemper, Kostense & Twisk, 1999). Furthermore, a randomised controlled trial has found that physical activity can improve bone density in women with osteoporosis. Liu-Ambrose et al. (2004) assigned 98 women 75-85 years, with osteoporosis, to receive either resistance training, agility training or stretching. The resistance-training group had a significant increase (1.4%) in their bone density, the agility training groups had a significant increase (0.5%) in their bone density and the stretching group had a non-significant reduction in their bone density.

A strong evidence base exists for inactivity as a risk factor for falls in older adults. Falls are due to a number of different factors including dementia, visual impairment, neurological and musculoskeletal disabilities, postural hypotension, medication, fear of falling and environmental hazards. However, the most significant risk factors for falling include muscle weakness, impaired gait and diminished balance which can be improved by physical activity (Daley & Spinks, 2000). Many recent studies have focused on the effectiveness of physical activity interventions on reducing falls. Sherrington et al. (2008) conducted a meta-analysis
of 44 physical activity trials with 9603 adults over 65 years of age. Findings revealed that individuals randomly assigned to a physical activity intervention had a 17% greater reduction in risk of falls compared to no intervention control participants. Interventions that include balance exercises and that promote a higher amount of exercise have a further reduction in falls risk (Sherrington et al., 2008). Programs focusing on balance had a 35% reduction in falls risk. To be effective in reducing falls, programs must include two sessions per week over 25 weeks (Sherrington et al., 2008). Tai Chi has become a popular physical activity intervention to reduce falls as it improves balance and it has the largest effect on falls reduction when compared to resistance, endurance and flexibility training (Wu, 2002). Interventions in both community dwelling older adults and older adults in a nursing home or facility, have been found to be effective in reducing falls (Bartnett, Smith, Lord, Williams & Baumand, 2003; Jensen, Lundin-Olsson, Nyberg & Gustafson, 2002).

In summary, there is a strong evidence base for the role of physical activity in the prevention of cardiovascular disease, diabetes, colon cancer, breast cancer, osteoporosis and falls. Meeting Australian physical activity guidelines is estimated to reduce the risk of these diseases and falls by up to 50%. Furthermore, physical activity can act as a secondary prevention method for cardiovascular disease, diabetes, cancer and osteoporosis as it has been found to reduce the instances of mortality and the severity of illness in people diagnosed with these diseases (Bassuk & Manson, 2005; Beaglehole et al., 2011; Blair et al., 2004; Blair & Morris, 2009; World Health Organisation, 2008). Therefore increasing physical activity levels in the population is needed to reduce the mortality and reduced quality of life resulting from non-communicable disease and falls.
2.3.2 The preventive role of physical activity for mental health disorders

Physical activity is associated with improved mental health. Physical activity reduces stress and improves mood in the general population, reduces risk of depression and anxiety and improves outcomes for individuals diagnosed with depression and anxiety disorders (Craft & Landers, 1998; Peluso & Andrade, 2005; Wipfli, Rethorst & Landers, 2008). The effect of physical activity on mood in the general population has been established through many large cross-sectional studies. For example Schnohr, Kristensen, Prescott and Scharling (2005) found mental stress and life dissatisfaction to have a negative association with physical activity in 12,028 randomly selected men and women aged 20–79 years in Denmark. Individuals who engaged in a moderate or large amount of physical activity were less worried and tense, and were more satisfied with their lives. The focus of the literature in recent years has been on the physical activity as a preventative mechanism and treatment for depression and anxiety (Bartley, Hay & Bloch, 2013; Chalder et al., 2012).

Many large-scale cross sectional studies have confirmed the inverse relationship of physical activity and depressive symptoms. For example Goodwin (2003) measured depressive symptoms and physical activity in 5,877 individuals aged 15–54 years and found that physically active individuals had lower levels of depression than non-active individuals. Furthermore a dose response between physical activity and depression was found, with depressive symptoms increasing as physical activity levels decreased. Conn (2010) conducted a meta-analysis on physical activity and anxiety with 3,289 non-clinical adults from 19 intervention studies. Findings revealed that participants randomly assigned to a physical activity intervention had significant reductions in anxiety compared to controls. The effect of physical activity on anxiety was strengthened when the physical activity was a
moderate or vigorous intensity, when it was conducted at an exercise facility, and when it was supervised by a professional. A recent meta-analysis of meta analyses (meta-meta-analysis) was conducted to measure the effect of physical activity interventions on both anxiety and depression in non-clinical populations (Rebar et al., 2015). A total of 92 studies with 4,310 participants was included to examine the effect of physical activity interventions on depression and a total of 306 studies with 10,755 participants was included to examine the effect of physical activity interventions on anxiety. A small effect was found for physical activity on anxiety and a medium effect was reported for physical activity on depression (Rebar et al., 2015).

Physical activity has also been found to reduce depressive symptoms in clinical samples of individuals diagnosed with depression. Meta-analyses have demonstrated effects for physical activity on depression that were similar to psychotherapeutic interventions (Craft & Landers, 1998). Craft and Landers (1998) found that physical activity had a greater effect on those who were severely depressed compared to those who were mildly or moderately depressed. Recent meta-analyses have confirmed that individuals from a clinical sample assigned to a physical activity condition had a reduction in anxiety compared to no treatment controls (Bartley et al., 2013; Wipfli et al., 2008). The literature on physical activity as a replacement to existing anxiety treatments has however been variable. A meta-analysis conducted by Wipfli et al. (2008) found that physical activity was more effective in reducing anxiety than meditation and stress management in a clinical sample whilst Bartley et al. (2013) found that physical activity was not as effective in reducing anxiety as pharmacology in a clinical sample. In summary, there is a strong evidence base for the role of physical activity in the prevention of anxiety and depression (Goodwin, 2003; Rebar et al., 2015), the treatment of
anxiety and depression (Craft & Landers, 1998) and improved mood and reduced stress in the general population (Peluso & Andrade, 2005; Schnohr et al., 2005). This further supports the importance of physical activity in the health and quality of life of individuals.

2.3.3 The health and economic impact of inactivity in Australia

Cardiovascular disease, diabetes and cancer significantly contribute to health loss in Australia, despite their preventable nature (Begg et al., 2008). This is due to the high prevalence of these diseases and the serious negative impact they cause on health and quality of life. As physical activity has a strong impact on the prevalence of these diseases, the high level of inactivity in Australia leads to significant health care costs each year. Despite the promotion of the Australian physical activity guidelines, 56% of Australians are failing to reach them. More specifically, 36% of Australians are performing less than the recommended amount of 150 minutes of physical activity each week and 20% are not engaging in any physical activity at all (Australian Bureau of Statistics, 2013a). The percentage of Australians not meeting the guidelines has remained relatively constant over the last five years. In 2007-08, 62% of Australians were not reaching the guidelines (Australian Bureau of Statistics, 2013a). Physical activity in Australia varies on location, income, disadvantage, gender, age and education. People living in rural Australia are less likely to meet the guidelines than those living in metropolitan regions. Income and education are positively associated with physical activity and level of disadvantage is inversely associated with physical activity. Physical activity decreases with age and is higher in males. The highest levels of physical activity are among the 18–24 year olds with 59% of males and 48% of females classed as sufficiently active (Australian Bureau of Statistics, 2013a).
The most recent disease prevalence rates from the Australian Bureau of Statistics reveals that 21% of Australians have a diagnosis of cardiovascular disease (Australian Bureau of Statistics, 2013b) and that it is the leading cause of death in Australia. Nearly a quarter (24%) of health loss from cardiovascular disease in Australia can be directly attributed to physical inactivity (Begg et al., 2008). Diabetes also leads to a significant health loss in Australia. The contribution of diabetes to overall health loss has risen from 5% in 2003 to 7% in 2013 and is estimated to rise to 9% in 2023 due to the rising prevalence of diabetes. The prevalence of diabetes in Australia during 2008 was 4%, which has risen from 1.5% in 1989 (Australian Bureau of Statistics, 2011b). It is estimated that in Australia 24% of health loss from diabetes can be directly attributed to physical inactivity (Begg et al., 2008).

It is estimated that cancer contributes 19% to total health loss in Australia, making it the largest cause of health loss (Begg et al., 2008). The prevalence of cancer in Australia is 1.5% (Australian Bureau of Statistics, 2013b). Bowel and breast cancer, which are affected by lifestyle factors including physical activity, are amongst the most common cancers in Australia. The three most commonly diagnosed cancers in Australia in 2012 were prostate (18,560), bowel (15,840) and breast (14,680) (Australian Institute of Health and Welfare, 2012). It is estimated that health loss from cancer attributed to physical inactivity is 6% in Australia (Begg et al., 2008).

Mental disorders contribute 13% to total health loss and 24% of all non-fatal health loss in Australia, making it the highest single contributor to non-fatal health loss (Begg et al., 2008). Anxiety and depression, which are affected by physical activity, make up 75% of all mental disorders (Australian Bureau of Statistics, 2008). Australian bureau of statistics data collected in 2007 found that almost half (47%) of adult Australians had a mental disorder
sometime in their lifetime and 20% of adult Australians had a mental disorder in the previous year (14% had an anxiety disorder and 6% had depression).

Non-fatal health loss attributable to musculoskeletal diseases is 7.3%, and total health loss attributable to musculoskeletal diseases is 4% (Begg et al., 2008). Osteoporosis is a significant health issue for older Australians with 16% of Australians over 65 years of age reporting to have osteoarthritis (Australian Bureau of Statistics, 2011a). Osteoporosis will therefore become more of a significant issue in the coming decade due to the aging population and needs to be addressed to minimise rising health costs for this age group. In 2008 13% of Australians were aged 65 years or over and it is estimated that by 2020 approximately 30% of the population will be aged 65 years and over (Australian Bureau of Statistics, 2014b; Daley & Spinks, 2000). Falls are also a significant issue for older Australians, with a third of Australians over 65 years falling each year. Many falls result in fractures or serious injury requiring hospitalisation and an average of three medical procedures result from a fall (Bradley & Harrison, 2007). A large percentage (11%) of time spent hospitalised for this population group is due to falls (Bradley & Harrison, 2007). Health care costs from falls attributable to physical inactivity are estimated to be AUD $503 million, which is higher than any other disease or condition including cardiovascular disease (Medibank Private, 2008). Similar to osteoporosis, these costs are likely to increase due to the aging population in Australia.

Physical inactivity is a key factor impacting the high prevalence of physical and mental illness in Australia and therefore costs Australia AUD $13.8 billion in healthcare costs, loss of productivity and mortality costs each year (Medibank Private, 2008). Healthcare due to inactivity is estimated to cost the government, public health care, insurance companies and
individuals AUD $719 million each year. The breakdown of these healthcare costs per
disease is listed in Table 1. Inactivity is estimated to lead to an average loss of 1.8 working
days a year which leads to loss of productivity costing the Australian economy AUD $9.3
billion. Mortality from physical activity is estimated to result in a loss of AUD $3.8 billion
per year from a decline in the workforce (Medibank Private, 2008). Inactivity affects the
health of a large percentage of Australians. It is estimated that inactivity led to premature
estimated that an achievable 10% increase in physical activity levels would result in 6000
fewer cases of disease and 2000 fewer deaths resulting from physical activity in Australia
each year. Hence there is a need for effective health promotion initiatives effective in
reducing the high levels of inactivity in Australia, to reduce disease rates and healthcare
costs.

Table 1. Direct net cost of physical inactivity in Australia 2007/08 ($ million/annum)

<table>
<thead>
<tr>
<th>Disease</th>
<th>Cost in million/annum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronary Heart Disease</td>
<td>399</td>
</tr>
<tr>
<td>Stroke</td>
<td>174</td>
</tr>
<tr>
<td>Type 2 Diabetes</td>
<td>226</td>
</tr>
<tr>
<td>Breast Cancer</td>
<td>45</td>
</tr>
<tr>
<td>Colon Cancer</td>
<td>66</td>
</tr>
<tr>
<td>Depression</td>
<td>190</td>
</tr>
<tr>
<td>Falls</td>
<td>503</td>
</tr>
<tr>
<td>Total</td>
<td><strong>1603</strong></td>
</tr>
</tbody>
</table>

*Offset by direct costs of being physically active*

| Total net cost of inactivity | 719 |

Adapted from (Medibank Private, 2008).

In summary physical inactivity has a high impact on cardiovascular disease and type 2
diabetes, which significantly contributes to health loss in Australia. Physical inactivity has a
smaller impact on cancer, but the contribution to health loss is still large as cancer is the largest cause of health loss in Australia. Although depression and anxiety have less of an impact on loss of life, these mental disorders significantly contribute to non-fatal health loss. The costs of this health loss attributed to inactivity are significant. Health care costs through falls make up the highest percentage of total health care costs due to inactivity in Australia. Osteoporosis currently has a lower impact on health loss, however this will dramatically increase in the coming years due to the aging population. The high levels of inactivity in Australia must be addressed to reduce the significant burden these diseases place on the health care system and economy.

2.4 Physical activity interventions

2.4.1 Introduction to physical activity interventions

A range of physical activity interventions has been implemented to address the low levels of physical activity and related health problems in many countries, including Australia. Interventions vary on many factors including the target group, the medium used for intervention delivery, the level of personalisation, number of contacts, length and theory base (Artinian et al., 2010; Greaves et al., 2011; Stephens, Cobiac & Veerman, 2014). Interventions are typically targeted at population groups such as inactive or overweight people, or those with a non-communicable disease diagnosis associated with physical inactivity. They can include individual assessment and targeted physical activity information and often include ongoing contact with participants over a few months (Artinian et al., 2010; Brouwer et al., 2011). Traditionally, interventions targeted at individuals were behaviour change programs delivered face-to-face through primary health care consultations or specialised physical activity counselling sessions (Artinian et al., 2010). Population and
community level interventions have also been implemented. These interventions typically target the environment and policy, or deliver short messages through mass media. Modern technology has recently allowed behaviour change programs to be delivered through different mediums other than face-to-face or group-based delivery. These include print, phone, computers, email or Internet and are also referred to as ‘mediated interventions’ (Napolitano & Marcus, 2002).

2.4.2 Face-to-face interventions

Traditional interventions that are targeted at individuals and that are delivered face-to-face have shown to be effective but costly (Artinian et al., 2010). These interventions, typically delivered in a primary care setting, were based on a cognitive-behavioural change theory to support participants in changing their physical activity behaviour. They included multiple components such as social support, goal setting, problem solving, behavioural reinforcement and relapse prevention (Greaves et al., 2011). Face-to-face interventions have the benefits of including social support and targeted cognitive-behavioural advice which improve physical activity intervention outcomes. Hardcastle, Taylor, Bailey and Castle (2008) evaluated the effectiveness of five primary care behaviour change counselling sessions in a randomised controlled trial. Participants who received the counselling sessions had greater increases in their physical activity and reductions in cardiovascular disease risk factors compared to the control group which received an information booklet. The effectiveness of behaviour change promotion in primary care has been demonstrated in many studies in different populations (Harland et al., 1999; Whitlock & Williams, 2003). However face-to-face delivery of cognitive-behavioural advice requires a large time investment from qualified professionals and therefore has high costs per participant. It also requires a large time and travel
commitment from participants. Lastly, the delivery of face-to-face interventions in remote locations is often not feasible due to even higher costs and unreasonable time and travel burdens on participants (Artinian et al., 2010).

2.4.3 **Mass media interventions**

Population level interventions delivered through mass media typically provide short educational and motivational physical activity messages through posters, television and radio for on average six-eight weeks (Marshall et al., 2004; Wakefield et al., 2010). Marshall et al. (2004) conducted a review of studies evaluating the effectiveness of mass media interventions and found that most mass media interventions produce awareness changes and some produced small behavioural changes. For example, Bauman, Bellew, Owen and Vita (2001) conducted a mass media physical activity campaign across New South Wales (NSW), Australia and found modest physical activity improvements in NSW compared to other control states in Australia. The intervention also included clinician mail-outs and community-level support programs and strategies. The mass media interventions that were effective in producing behavioural changes tended to be conducted in regional areas in conjunction with other strategies including print materials, community events and promotion via health professionals (Marshall et al., 2004). This makes it difficult to isolate the effects of the mass media messages.

2.4.4 **Environmental interventions**

Environmental interventions typically enhance or create new parks, paths and leisure/sporting facilities that promote physical activity. Others have reduced structural and environmental barriers to physical activity. Environmental interventions include pavement
continuity, street aesthetics and lighting, limiting density of development, improved public transport and increased driving costs. Cohen, Marsh, Williamson, Golinelli and McKenzie (2012) conducted an evaluation of ‘family fitness zones’ with publicly available outdoor exercise equipment in public parks in North America. Park users in parks with and without ‘family fitness zones’ were interviewed to measure their physical activity. Findings revealed that participants in the parks with ‘family fitness zones’ reported engaging in more exercise sessions per week. Heath et al. (2006) conducted a review of environmental physical activity interventions including urban design. Urban design changes addressed walkability of streets, development density and the location of stores, jobs and schools to be within walking distance of people’s homes. They found that improved urban design in small geographic areas produced on average 35% improvements in walking or cycling in these areas. Environmental interventions are applicable across diverse settings and population groups, with their effectiveness demonstrated in many countries and communities (Heath et al., 2012). Further, the relatively permanent environmental changes have the potential to lead to long-term behaviour changes of local residents. However environmental interventions can be costly and only result in small behavioural changes due to their low intensity (Heath et al., 2006).

2.4.5 Policy interventions

Policy changes commonly target town planning codes that promote physical activity (Heath et al., 2012). Heath et al. (2006) examined policy interventions in their systematic review and found strong evidence to support policies that enhance access to places for physical activity, such as public parks and sporting facilities. Their findings also support the use of street and community scale urban design and land use policies. These policies include improved street
lighting or infrastructure projects that increase the safety of street crossings, ensure walkway continuity, enhance traffic calming such as centre islands; or improve the aesthetics of the street area. Policy interventions have the ability to impact a large number of individuals, however only small behavioural changes result from them as they have few participant contacts and cannot deliver targeted behaviour change information (Marshall et al., 2004; Mummery & Brown, 2009). Policy interventions also require collaboration with council or state government to implement.

2.4.6 Mediated interventions

In recent years mediated interventions have taken advantage of available technology to cost-effectively deliver cognitive-behavioural change interventions at either the individual, community or population level. These include print, phone, computer, email and web-based interventions. Mediated interventions have been found to be as effective (in terms of behaviour change outcomes) as face-to-face interventions (Ashford, Edmunds & French, 2010; Greaves et al., 2011; Zur, 2012). Therefore mediated interventions are a popular choice for health professionals and researchers as they can effectively deliver cognitive-behavioural support to emulate face-to-face interventions at a lower time and cost investment (Tate et al., 2009). They also break down geographic barriers which is important for reaching rural and remote residents, and can be more flexible for participants. For example participants can make a telephone call or read a pamphlet in their lunch break but may not have the time to drive to a face-to-face meeting. Randomised controlled trials have demonstrated equivalent effectiveness of phone, print and web-based physical activity interventions with identical content (Marcus et al., 2007; Marshall, Leslie, Bauman, Marcus & Owen, 2003; Napolitano et al., 2008), and systematic reviews and meta-analyses have found no difference in
behavioural change effect sizes between the different delivery modes (Greaves et al., 2011; Neville, O'Hara & Milat, 2009). Positive results have also been found for mixed interventions that use a combination of delivery modes. Mediated interventions that include additional contacts through a different delivery mode such as telephone calls in a web-based intervention have improved outcomes compared to interventions which have only have one delivery mode (Greaves et al., 2011; Marshall et al., 2004). A review of the evidence including pros and cons for print, telephone and web-based interventions is explained in more detail below.

2.4.6.1 Print interventions

Print interventions can include booklets or letters detailing a physical activity program. Marshall et al. (2004) conducted a review of print physical activity interventions and found that print interventions were more effective in increasing participants’ physical activity levels compared to no intervention controls. Behavioural changes were improved in interventions which tailored the print materials to participant characteristics which included at least one face-to-face session at the beginning of the program and was delivered in conjunction with other strategies. Vallance, Courneya, Plotnikoff, Yasui and Mackey (2007) conducted an evaluation of print materials to promote physical activity in 377 breast cancer survivors. Findings revealed that participants receiving the print intervention had a significantly greater improvement in physical activity compared to a control group who received standard public health information (87 compared to 30 minutes per week). Physical activity interventions delivered through print materials have been found to be as cost-effective in improving participants’ physical activity levels as telephone and web-based interventions in small to moderate samples up to 450 participants (Golsteijn et al., 2014; Sevick et al., 2007).
However, print-based interventions are not as cost-effective or feasible in large population based interventions (Lewis, Williams, Neighbors, Jakicic & Marcus, 2010).

2.4.6.2 Telephone interventions

Telephone mediated physical activity interventions provide counselling over the phone. These interventions are effective in increasing physical activity levels in comparison to control groups, and are as effective as face-to-face interventions. Eakin, Lawler, Vandelanotte and Owen (2007) conducted a review of nutrition and physical activity interventions that delivered verbal telephone counselling. Twenty of 26 studies reported significant behavioural improvements. Interventions which lasted over six months and included 12 or more calls had improved effectiveness. Few of the included studies, however, reported the costs involved in delivery. The high requirement on counsellors’ time makes these interventions more costly than print and web-based interventions. In order to reduce time requirements on the counsellor and therefore reduce the cost, some researchers have trialled telephone mediated physical activity interventions with automated computer recordings. These studies did not find this delivery method to be effective in producing behaviour changes and feedback from participants revealed that they would have preferred a human counsellor to speak to (Marshall et al., 2004).

The development of mobile phones has led to a new range of telephone interventions referred to as mHealth interventions. mHealth interventions hold much potential as they seamlessly fit into people’s everyday lives and provide frequent reminders. Researchers have utilised the short message service (SMS) feature of mobile phones to deliver intervention content in a time efficient manner. Fjeldsoe, Neuhaus, Winkler and Eakin (2011) conducted a review of 14 mHealth behaviour change interventions using the SMS feature of mobile phones. The
majority of interventions were on diabetes management and smoking cessation. The clear majority (13 of 14) of the SMS interventions reported positive behaviour change outcomes. Further technological advances have led to a new generation of mobile phones called smartphones. Smartphones have the capabilities of a computer and enable software in the format of ‘applications’ to be downloaded. Smartphones allow researchers and health practitioners to deliver interactive physical activity information and support, enable easy self-monitoring through physical activity journaling and provide real time feedback. In 2015, 79% of Australian adults over 18 years of age owned a smartphone (Drumm & Swiegers, 2015). The percentage of Australians who own a smartphone is growing, but the low current ownership restricts the potential audience for smartphone interventions. A recent systematic review examined trials of 12 mHealth physical activity interventions of which nine reported significant physical activity changes (O'Reilly & Spruijt-Metz, 2013). The majority of the interventions used a mix of physical activity journaling and feedback via SMS. The studies reported high participant satisfaction for both the journaling and SMS feedback (O'Reilly & Spruijt-Metz, 2013). Another recent systematic review of 20 mHealth intervention trials found the most common intervention features were self-monitoring (n=7) and prompts to encourage physical activity behaviour (n=5). Two studies used an interactive smartphone application to deliver an exercise program (Blackman et al., 2013). In summary, traditional telephone interventions comprising telephone calls from a physical activity coach are effective in producing physical activity changes, however they require a high time investment per participant to implement. mHealth interventions reduce time requirements by utilising mobile phone or smartphone technology to deliver short messages or interactive content to participants. However, only half of Australian adults over the age of 18 own a smartphone, restricting the potential audience.
2.4.6.3 *Web-based interventions*

Web-based physical activity interventions are becoming a popular choice for health workers in developed countries due to their established effectiveness and ability to reach a large audience (Kohler, 2013). Internet access is increasing and in 2014 92% of Australians had access to the Internet (Australian Communications and Media Authority, 2015). In 2012-13 More than three quarters (77%) of Australians had broadband Internet access, which enables high-speed Internet usage in their homes (Australian Bureau of Statistics, 2014a). Furthermore household Internet access across metro, rural and remote subgroups is reasonably equal, with 79% of rural and remote Australians having Internet access in their homes (Australian Bureau of Statistics, 2014a). The effectiveness of web-based physical activity interventions in comparison to no intervention controls is well established (Anderson-Bill, Winett, Wojcik & Winett, 2011; Davies et al., 2012b; Foster et al., 2013; Marcus, Ciccolo & Sciamanna, 2009; Vandelanotte et al., 2007). A recent meta-analysis on 34 web-based physical activity interventions found that web-based interventions were effective in producing small effect sizes (mean $d = 0.14$) on physical activity. Interventions including educational components and those that targeted inactive participants had improved effect sizes (Davies et al., 2012b). Web-based interventions are also effective in improving both cognitive variables such as readiness to change, perceived social support and self-efficacy which lead to greater physical activity changes (Ashford et al., 2010; Poirier & Cobb, 2012). Biological measures also improve with web-based physical activity interventions, demonstrating that web-based interventions have the ability to lead to significant health improvements. These biological measures include blood pressure, lipids, waist circumference and cholesterol, which are all key risk factors of cardiovascular disease.
and diabetes (Carr et al., 2012; Conn, Hafdahl, Cooper, Brown & Lusk, 2009). Furthermore mental health outcomes have been found to improve with physical activity interventions. Conn (2010) found symptoms of depression to decrease in participants of a web-based physical activity intervention compared to a no intervention control group. In summary, a range of interventions with different delivery modes has been found to be effective. Web-based interventions have become popular, not only because of the low costs associated for each additional user, but because they can reach large numbers across Australia (Murray, 2012).

2.5 Theoretical frameworks

2.5.1 Behaviour change theories

Physical activity interventions that are based on cognitive behavioural change theories have improved outcomes compared to those that are not (Lustria et al., 2009; Noar et al., 2007). All face-to-face and mediated interventions should follow a cognitive behavioural change theory to maximise intervention effects (Noar et al., 2007). According to Gourlan et al. (2015) the three most common theories used in web-based physical activity interventions are the Social Cognitive Theory (SCT) (Bandura, 1986), the Transtheoretical Model (TTM) (Prochaska, DiClemente & Norcross, 1992), and the Theory of Planned Behaviour (TPB) (Ajzen, 1988). Many of the concepts in the theories overlap, and many interventions use a mix of theories on which to base the intervention content (Brouwer et al., 2011; Lustria et al., 2009; Noar et al., 2007). Reviews have demonstrated the improved behavioural outcomes for interventions based on the SCT, TTM and TPB (Noar et al., 2007; Prestwich et al., 2013). Due to the established effectiveness and popularity of the TTM, SCT and TPB theories, all are outlined below.
2.5.1.1 The Transtheoretical Model

The TTM is an individual level, motivational theory that sees behaviour change as cyclic in nature (Prochaska et al., 1992). It proposes that individuals move through five stages to reach behavioural change. The stages, in order, include pre-contemplation, contemplation, preparation, action and maintenance. Individuals can progress and regress throughout the stages. The pre-contemplation stage is when the individual does not intend to start the target behaviour in the near future and may be unaware of the positives of changing their behaviour. The contemplation stage is where the individual intends to start the target behaviour. Individuals in the preparation stage are ready to begin changing their behaviour. They take small steps that they believe can help them to change their behaviour. Individuals in the action stage have begun to change their behaviour and need to work hard at continuing the process of behaviour change. Individuals in the maintenance stage have changed their behaviour and avoid situations that may tempt them to slip back into their old pattern of unhealthy behaviour. Self-efficacy, which refers to an individual’s belief that they have control over performing a behaviour successfully, improves through the stages. The decisional balance, where the individual weights the positives and negatives of performing the target behaviour, also improves through the stages. In the later stages individuals view the positives of performing the target behaviour as more significant than the negatives (Prochaska et al., 1992). Meta-analyses and systematic reviews have found interventions based on the TTM to be effective in improving participant physical activity levels (Lustria et al., 2009; Noar et al., 2007) and many cross sectional studies have found self-efficacy and decisional balance to explain a significant amount of variance in physical activity (Marshall & Biddle, 2001; Nigg et al., 2011; Plotnikoff, Hotz, Birkett & Courneya, 2001). However there is insufficient evidence for TTM as a predictor of physical activity due to a lack of
longitudinal studies examining TTM and PA levels over time (Marshall & Biddle, 2001; Nigg et al., 2011; Plotnikoff et al., 2001).

2.5.1.2 The Social Cognitive Theory

The SCT (Bandura, 1986) emphasises that learning occurs in a social context through observation of others. The SCT outlines that behaviour change is influenced by self-efficacy and outcome expectancies of the observer (Bandura, 1986). Outcome expectancies refers to an individual’s belief that the benefits of undertaking a behaviour outweigh the potential negative aspects that may be caused by performing the behaviour (Bandura, 1986). Outcome expectancies and self-efficacy are altered by viewing the ease and rewards of others performing the target behaviour and the existence of physically and socially supportive environments. The goal of physical activity interventions based on the SCT is for participants to see the health benefits they will receive from increasing their physical activity and to believe they have the ability to increase their physical activity (Noar et al., 2007). Napolitano et al. (2003) evaluated a physical activity intervention based on the SCT. Participants randomly assigned to receive the intervention improved their physical activity significantly more than a wait-list control group. Anderson-Bill, Winett and Wojcik (2011) explored the relationship between SCT constructs (self-efficacy, outcome expectancies and social support) and physical activity. They found that participants’ perceptions of their social support and self-efficacy were strong predictors of physical activity. The SCT model explained 22% of the variance in physical activity levels. A recent meta-analysis found the SCT model explained 31% of the variance in physical activity behaviour, however many of the included studies had poor methodological quality (Young, Plotnikoff, Collins, Callister & Morgan, 2014). There is much evidence to support the association between participants’ self-efficacy
and physical activity behaviour change in intervention trials, and the most effective interventions have placed a focus on self-efficacy (Anderson-Bill, Winett, Wojcik & Williams, 2010; Caudroit, Stephan & Le Scanff, 2011).

2.5.1.3 The Theory of Planned Behaviour

The TPB (Ajzen, 1988) proposes that intention is the strongest influence of behaviour, which is in turn influenced by the individual’s attitude, subjective norm and perceived behavioural control (see Figure 1). Attitude refers to the individual’s views on performing the target behaviour, which is formed from assessing the positives and negatives of performing the behaviour. Subjective norm refers to the individual’s perceptions of how they see their behaviour affecting their significant others. Perceived behavioural control refers to self-efficacy and controllability in performing the target behaviour. Interventions based on the TPB target participants’ attitudes, subjective norms, and perceived behavioural control in order to increase their intention to change their behaviour. There are many similarities to the SCT theory as self-efficacy and perceived behavioural control are very similar constructs (Ajzen, 1988). There is strong empirical support for attitude, subjective norms, perceived behavioural control (Armitage, 2005; Hobbs, Dixon, Johnston & Howie, 2013; Noar et al., 2007) and intention (Hagger, Chatzisarantis & Biddle, 2002; Rhodes & Dickau, 2012) as significant correlates of physical activity behaviour. Hagger et al. (2002) conducted a meta-analysis of 72 studies that examined TPB constructs in a physical activity context. A path analysis revealed that attitude explained the largest amount of variance in intentions followed by perceived behavioural control and then subjective norms. Intention explained the largest amount of variance in behaviour. Overall the model constructs explained 37.27% of the variance in intentions and 26.04% of the variance in physical activity behaviour (Hagger et
A more recent review looking at prospective prediction of health behaviours with TPB found that intention explained 23.9% of physical activity behaviour (McEachan, Conner, Taylor & Lawton, 2011).

Downs and Hausenblas (2005) conducted a systematic review of studies looking at people’s attitudes, subjective norms and control beliefs for physical activity. They found that the most salient attitudes towards physical activity benefits are; health improvements, weight control, improved daily functioning, increased energy, stress relief and relaxation. The most salient normative referents were; family members, friends and healthcare professionals. The most salient barriers towards physical activity (control beliefs) were health issues, inconvenience and lacking motivation, energy, time and social support. Interventions based on the TPB must therefore target these benefits, highlight the importance of these referents, and solve these barriers to alter participants’ intentions and physical activity behaviours. Web-based physical activity interventions based on the TPB have been found to be successful at increasing participants’ physical activity levels (Lustria et al., 2009; Noar et al., 2007).

Hardeman et al. (2002) conducted a review of 24 behaviour change interventions based on the TPB. They found that the most common behaviour change techniques were information and persuasion to target attitudes. Half of the interventions were effective in changing intentions and two-thirds were effective in changing behaviour. Intention is addressed in the TTM as part of the pre-action stages (Plotnikoff, Lippke, Johnson & Courneya, 2010) and is addressed in the SCT as a proxy for goal setting (Plotnikoff, Lippke, Courneya, Birkett & Sigal, 2008). However, TPB puts a focus on participants’ intentions and is therefore more appropriate for community and population level interventions where not all participants are already motivated to become more active (Hardeman et al., 2002).
In summary, physical activity interventions based on a theory have improved outcomes, however due to a high level of overlap, interventions based on the popular theories (TTM, SCT and TPB) appear to have equivalent effectiveness (Gourlan et al., 2015; Prestwich et al., 2013). The current thesis is based on the TPB due to the established effectiveness of interventions based on TPB, the evidence for TPB components as predictors of physical activity and TPB’s focus on intention.

**2.5.2 Communication theories**

Although behavioural change theories can explain variance in physical activity outcomes and provide an effective framework to construct interventions, they do not tell us how best to design messages so that they will be attended to, accepted and followed (Fishbein & Cappella, 2006). This is especially relevant for behaviour change interventions where there is no face-to-face interaction with participants and in environments such as the Internet, where there are a lot of competing messages. Communication theories are needed to advance our understanding of factors influencing attention and our understanding of what makes a message effective.
2.5.2.1 Elaboration Likelihood Model

The Elaboration Likelihood Model (ELM) is a popular communication theory used in marketing and health promotion as it offers detailed explanation of factors that influence the effectiveness of messages (Angst & Agarwal, 2009; Yang, Hung, Sung & Farn, 2006). The ELM describes the thinking processes that occur when attempts are made to change a person’s attitude, the effect of particular persuasion variables within these processes and the strength of the judgements that result (Cacioppo & Petty, 1984). The model assumes that individuals can differ in their elaboration of a message. Elaboration is characterised by cognitive processes of evaluation, recall, critical judgment, and inferential judgment. The model proposes two types of persuasion; central route which occurs when elaboration is high and peripheral which occurs when elaboration is low (Cacioppo & Petty, 1984). Central persuasion is when an individual takes consideration of ample information to form an attitude. It is more likely to result in stronger judgements which are more likely to last and lead to attitude consistent behaviour. Central participation can be encouraged by tailoring messages to individuals, providing adequate information, demonstrating credibility of the information and repeating key messages. Central persuasion is also more likely to occur when individuals have an initial positive attitude towards the message, when it is personally relevant and when they have the ability (e.g., absence of distractions) and relevant knowledge to examine the message (Petty & Cacioppo, 1986). Conversely peripheral persuasion is when an individual allows simplistic associations of negative and positive attributes to form their attitude. Individuals are more likely to rely on general impressions and early parts of the message. It is more likely to result in weak judgments which have a shorter duration and are less resistant to counter arguments. Peripheral persuasion is more likely to occur when an
individual has little interest in the subject or ability to process the message (Petty & Cacioppo, 1986). Rather than being mutually exclusive, these two types of persuasion represent positions on a continuous dimension ranging from low to high elaboration. Behavioural interventions that address the ELM encourage elaboration so that participants are influenced by central persuasion of the importance of meeting the target behaviour (Cacioppo & Petty, 1984; Rucker & Petty, 2006). Rucker and Petty (2006) explain that in order to facilitate elaboration of health promotion messages, interventions need to give listeners enough information about the health behaviour, demonstrate the credibility of the information, make the information relevant to the listener and repeat the key messages. The current thesis used the ELM to inform development of messages to improve the likelihood that these messages will be attended to, accepted and followed.

### 2.6 Web-based physical activity interventions

#### 2.6.1 Challenges of web-based physical activity interventions

Despite the established effectiveness of web-based physical activity interventions and their potential to reach large numbers at low cost, some challenges need to be addressed. These include the small and short-term nature of the behaviour change seen in mediated interventions (Fjeldsoe et al., 2011). Modest physical activity changes may be improved by increasing engagement and retention (Greaves et al., 2011; Vandelanotte et al., 2007), as interventions with higher levels of engagement and retention have been found to result in improved physical activity outcomes (Cussler et al., 2008; Hansen et al., 2012; Neve, Morgan & Collins, 2011).
Many different engagement measures have been included in web-based intervention trials including number of log-ins, frequency of log-ins, use of specific intervention components, time spent on the website and completion of modules. It is therefore difficult to calculate an average level of engagement, however many trials have concluded that engagement was low. Although it is not reported in all studies, the most common measure of engagement is number of log-ins to the intervention website. Recent meta-analyses have found the average number of log-ins to be around three times per participant, per week. (Brouwer et al., 2011; Davies et al., 2012b). Limited studies have explored the association between engagement and participant characteristics, but some have found Caucasian, older and educated participants to have higher levels of engagement (Davies et al., 2012a; Funk et al., 2010; Woodall et al., 2007). Some intervention components and website characteristics have also been found to be associated with engagement. Peer support through participant forums and discussion boards is associated with a longer stay on the website, email/telephone contact and updates of the intervention content are associated with increased log-ins, and a more interactive website is associated with a longer visit to the intervention (Brouwer et al., 2011).

Attrition (i.e., non-completion) rates for web-based physical activity interventions have been reported in meta-analyses to be just over one quarter of the sample (Vandelanotte et al., 2007). This high rate of attrition leads to low intervention exposure and therefore reduces the effectiveness of web-based interventions. Attrition has been found to be higher in some population groups. Schulz et al. (2012) found that women, older people and those with a healthy lifestyle were more likely to complete the program, whilst education, income and employment did not affect attrition. More research is needed to identify website characteristics and components to improve participants’ engagement, reduce attrition and
improve the effectiveness of web-based physical activity interventions at increasing participants’ long-term physical activity levels. This will inform the development of future web-based interventions that have the ability to increase community physical activity levels.

2.6.2 **Improving web-based physical activity interventions**

Web-based physical activity interventions are diverse as they can each include a plethora of different intervention components such as peer discussion boards, ask-an-expert features, goal setting and personalised advice. Due to this, effect sizes vary significantly across the interventions (Davies et al., 2012b). The mix of components used in the web-based interventions has also made it difficult to evaluate the individual components that are having the greatest contribution to the intervention effects (Brouwer et al., 2011; Davies et al., 2012b; Neve, Morgan, Jones & Collins, 2010). Systematic reviews have found improved intervention effectiveness to be associated with the inclusion of social support elements, a theory base, increased intervention contacts, behaviour change techniques such as goal setting, relapse prevention and self-monitoring, regularly updated intervention materials and the use of additional methods of communicating with participants such as text messages (Fjeldsoe et al., 2011; Greaves et al., 2011; Lustria et al., 2009; Webb, Joseph, Yardley & Michie, 2010). Due to the heterogeneity of components and outcome measures used in physical activity intervention trials, very few meta-analyses have been conducted to explore the effect individual components have on physical activity outcomes (Davies et al., 2012b). Of the few meta-analyses that have been conducted, educational components, feedback and self-monitoring were found to be associated with improved engagement and behavioural outcomes (Ashford et al., 2010; Brouwer et al., 2011; Davies et al., 2012b; Michie, Abraham, Whittington & McAteer, 2009). Some controlled trials have been conducted to isolate the
effects of single intervention components including prompts and reminders, social support and personalised advice through counselling and computer-tailored advice (Lombard, Lombard & Winett, 1995).

2.6.3 Prompts and reminders

A few controlled trials have supported the effectiveness of prompts and reminders showing that participants receiving prompts and reminders demonstrated a higher level of engagement and improved behavioural outcomes (Lombard et al., 1995). A systematic review specifically looking at 15 web-based physical activity interventions found interventions with more than five contacts to have improved behavioural outcomes (Vandelanotte et al., 2007). Fry and Neff (2009) conducted a systematic review of prompts and reminder use in 19 health behaviour interventions. Findings demonstrated that the effectiveness of prompts and reminders improves with higher frequency, with contacts by a counsellor and with contacts through a different medium (e.g., telephone reminders for participants in a web-based health behaviour intervention).

2.6.4 Social support components

High levels of perceived social support are significantly associated with improved physical activity outcomes for participants in web-based physical activity interventions (Scholz, Ochsner, Hornung & Knoll, 2013; Winett, Anderson, Wojcik, Winett & Bowden, 2007). Many controlled trials have evaluated social support elements, most commonly the advice from an expert or coach, ask-an-expert forum, peer forums and peer discussions. There have been mixed results, depending on the type and frequency of the social contacts. Participants assigned to a web-based intervention with personalised advice from a counsellor or expert
have been found to experience improved outcomes compared to those assigned to an intervention without a counsellor or expert (Tate et al., 2003; van den Berg et al., 2006). However very few studies have found peer discussion boards and ask-an-expert discussion boards to improve overall intervention effectiveness (Ferney et al., 2009; Liebreich, Plotnikoff, Courneya & Boule, 2009). This may be due to peer discussions and expert discussions having a low uptake, particularly by males. Many web-based interventions still include these features as they are valued by participants; and participants who use these components have demonstrated improved engagement, retention and behaviour changes (Hwang et al., 2010; McKay, King, Eakin, Seeley & Glasgow, 2001; Ravert, Hancock & Ingersoll, 2004; Webber, Tate & Michael Bowling, 2008).

2.6.5 **Counselling in physical activity interventions**

Many web-based health behaviour interventions provide personalised advice through a counsellor to provide similar support to traditional face-to-face counselling sessions in a way that reduces geographical, time and cost limitations (Lustria et al., 2009). Counselling can be defined as “the process of assisting and guiding clients esp. by a trained person on a professional basis to resolve esp. personal, social or psychological problems or difficulties” (Oxford, 2004a, p. 315). Coaching is a similar practice to counselling which is used in health behaviour change settings. Coaching is defined as “facilitating health behaviour change through interactions between a health professional (coach) and a client” (Olsen, 2013, p. 1). Web-based weight loss interventions providing online coaching sessions have been found to lead to weight loss outcomes similar to face-to-face weight loss counselling (Steele, Mummery & Dwyer, 2007b). Furthermore, web-based coaching is better received and more effective in engaging participants and producing behaviour change than generic information
in a web-based physical activity intervention (Brouwer et al., 2011; Foster et al., 2013; Lustria et al., 2009). Coaching provides social support to participants (Hogan, Linden & Najarian, 2002) and has a higher uptake than peer discussions and ask-an-expert forums (Ferney et al., 2009). Both coach initiated private messages and real time coaching sessions (Tate et al., 2006) have been found to result in greater weight loss compared to web-based interventions providing information on weight loss only. Tate et al. (2006) compared weight loss outcomes for adults participating in a web-based weight loss intervention randomly assigned to receive email counselling or no counselling. The results revealed that participants receiving the email counselling had improved outcomes compared to the no-counselling group. Web-based weight loss interventions providing online coaching sessions have also been found to lead to higher intervention engagement in obese adults (Micco et al., 2007).

Advances in Internet technology and broadband capacity allow coaching sessions to be delivered via free online video-calling programs (e.g., Skype, Google Hangout, FaceTime) which, unlike online instant messaging or forums, enables the participant to view the coach whilst engaging in a verbal discussion. Counselling over video facilitates higher engagement, feelings of accountability and social support, while reducing the risk of misunderstandings compared to emails and instant messaging (Abbott, Klein & Ciechomski, 2008; Fantus & Mishna, 2013). Murphy et al. (2009) tested patient functioning and satisfaction outcomes of online video counselling and face-to-face counselling. Patient functioning was assessed by the Global Assessment of Functioning Scale which is used to rate the social, occupational and physiological functioning of respondents. Patient satisfaction was measured by a ten item client satisfaction survey within a counselling setting. They found that client comfort, the establishing of a plan and the client’s perception of the counsellor’s skill and expertise was
equal between groups, while the overall counselling experience and perceived benefit was higher in the face-to-face group. Patient functioning improved in both groups and no between-group differences were found, supporting the effectiveness of online video counselling as an alternative to face-to-face counselling (Murphy et al., 2009). Psychological counselling over video-calling programs is becoming widely used and accepted and may further improve participants’ perceptions of social support, engagement, adherence and behavioural outcomes of a web-based physical activity intervention (Fantus & Mishna, 2013).

2.6.6 Tailoring in web-based physical activity interventions

Trials have also found personalised advice provided through computer-tailored feedback to be more effective in engaging participants and producing behaviour changes than interventions with generic advice (Lustria et al., 2009; Saperstein, Atkinson & Gold, 2007). The personalisation of public health messages can be classified into three categories (Hawkins et al., 2008). The first - ‘generic’ messages - includes no personalisation or targeting which is often used for mass communication. Next, ‘targeted’ messages provide relevant messages to audiences separated by demographic categories (e.g., gender or culture). Lastly, tailored messages produce messages matched to the needs and preferences of individuals. This level of personalisation is the most effective in producing behaviour changes (Hawkins et al., 2008). Tailored messages are most commonly delivered through computer tailoring which collects participant information through a questionnaire, then selects and delivers pre-written health behaviour messages relevant to the participant (Kreuter & Wray, 2003). IF-THEN algorithms are used to determine the messages from a large database that will be displayed to participants based on their interests, characteristics,
health behaviour, environment etc. (e.g. IF participants have a BMI > 25, THEN display the message ‘physical activity for weight loss’) (Hawkins et al., 2008). Tailored advice based on a behavior change theory, participants’ current behavior and participants’ demographics is the most effective in producing behaviour change (Lustria et al., 2009).

Computer-tailored interventions can be classified into three generations according to the technology used for delivery. The effectiveness has not been found to differ according to the technology used to deliver the tailored advice; however there are logistical benefits of some technologies over others. First generation interventions are delivered through printed reports. Second generation interventions are delivered through interactive technology including websites, email and CD-ROM programs which allow for the timely delivery of relevant messages to help motivate patients to change their behaviour (Lustria et al., 2009). Third generation interventions are delivered through the relatively new technology including remote devices such as mobile phones and handheld tablet computers, which may further enhance timely feedback and assessment. These interventions are not commonly implemented as the use of such technology is not as frequently used, particularly in older adults, and the devices have tighter programming restrictions.

Computer-tailored advice in web-based interventions improves access to expert-advice and enables more frequent messages and reminders to be given to participants. Computer-tailored advice delivers personalised advice to large numbers at low cost, however it cannot provide social support or accountability that a personal coach does. Behavioural outcomes have not been found to differ between web-based intervention participants receiving online counselling or computer automated advice (Tate et al., 2006), however each has their advantages and disadvantages. Advice in a web-based health behaviour intervention from
counsellors and experts is most similar to the traditional face-to face-method as it provides personal contact, but computer tailoring enables personalised advice to be given on demand with less time and cost limitations. To our knowledge no web-based studies have combined computer-tailored advice and counselling into one intervention, so it is unknown whether the optimal approach is utilising the benefits of both methods. The expert-advice may quickly add further explanation, personalisation and interpretation of theory-based computer-tailored advice, whilst the provision of computer-tailored advice can reduce the time required from the expert and reduce reliance on the knowledge and expertise of the counsellor (Vaes et al., 2013; van Wier et al., 2009). Research is needed to determine whether a short counselling session added to computer-tailored advice would improve the engagement, attrition and behaviour change outcomes compared to computer-tailored advice without counselling support.

In summary, some intervention components have been found to improve participant engagement and intervention outcomes including prompts and reminders, social support and personalised advice through computer tailoring and personal coaching. Advances in interactive web-technology have led to more options for delivery of personalised advice and social support such as video-calling programs. More research is needed to explore cost-effective methods of delivering social support and personalised advice in a web-based physical activity intervention.

2.6.7 Use of video to engage users

Website interactivity and visual appeal are important for engaging users in health website content (Hinchliffe & Mummery, 2008; Stout, Villegas & Kim, 2001). The development of
web-based health behaviour interventions has been predominately based on behaviour change theories and effective intervention components, with limited attention to the way the information is presented (Papadaki & Scott, 2006). Therefore the low level of engagement in web-based physical activity interventions is not surprising. Rich media content including graphics and videos has quickly become a common strategy to engage users on the Internet (Purcell, 2010). Viewing videos on the Internet is now common, with 71% of adults using video-sharing websites such as YouTube and 28% of adults accessing these sites daily (Moore, 2011). Therefore in order for health promotion websites to compete against countless websites and engage users they must provide content using equally visually attractive graphics and video instead of standard text. In support of this Liu (2005) found that people are less likely to engage in concentrated reading of text on a computer screen than in print format and only scan and browse text on the Internet. Text delivery of information may therefore contribute to the low engagement and retention rates of web-based physical activity interventions. Presenting information in video format is preferred by students, improves engagement and facilitates a stronger emotional response than text in educational settings. Koehler, Yadav, Phillips and Cavazos-Kottke (2005) tested students’ satisfaction, engagement, emotional response and recall of information (poetry, news stories and a lessons on theory) presented via text and video. The findings demonstrated that video improved satisfaction, engagement and emotional response more than text, however no difference was found for recall of the content. Despite the potential videos have to improve participant engagement in the intervention content, few web-based health interventions have included them. A study conducted by (Lee, 2012) evaluated the preference and self-reported attention of 60 high school students exposed to a web-based interactive video delivering sexual health education compared to a static website. The results revealed that attention and preference
were significantly higher when viewing the web video compared to the static site. Vandelanotte and Mummery (2011) developed a physical activity intervention that provides video-tailored advice and pilot-tested its efficacy. Results demonstrated that inactive participants who received video-tailored advice had greater improvements in physical activity levels than participants receiving traditional text-tailored advice with identical content; however a more conservative intention-to-treat analysis found no significant differences between the two groups. Although these results demonstrate that advice presented over video is preferred to text and that video-tailored advice has potential to improve behavioural outcomes over text-tailored advice, there has been no direct test to evaluate whether video-tailored advice leads to improved attention, recall and understanding in comparison to text-tailored advice. Comprehensive evaluations including usability tests and measurement of attention for video and text-tailored health information are needed to discover how individuals process video- and text-tailored health information. This will enable health promotion workers and researchers to improve the delivery of information on web-based behaviour change interventions to maximise participants’ engagement in the intervention content.

2.6.8 Eye-tracking to evaluate users’ attention

A potential tool to understand the difference in how participants process text-tailored advice and video-tailored advice is through eye-tracking technology. Eye-tracking technology has been used in marketing and educational research to record users’ eye gazes on information delivered on a web-page. This detailed eye-tracking data has been beneficial in understanding how people process information on a web-page and has guided improvements to the usability of many commercial websites (Djamasbi, Siegel & Tullis, 2010; Nielsen &
Pernice, 2010). Eye-tracking data tracks each user’s fixations, where the eye is relatively motionless and saccades, where the eye quickly moves from one fixation to a fixation on another element. The pattern of a user’s fixations and saccades is interpreted by researchers to identify confusion, reading or scanning behaviours, or simply what users are looking at. Fixation length on website elements is used to measure participants’ interest, as fixations have been linked to intense cognitive processing and is viewed as a reliable indicator of an individual’s attention (Vertegaal & Ding, 2002).

Information on pathways users go through to find out information from the website, sign up or purchase a product can be used to increase desired behaviours from consumers (Pernice & Nielsen, 2009). For example Bojko (2006) used eye-tracking technology to compare users’ search efficiency, time taken and accuracy of task completion on an original and updated website for an oncology organisation. Measured tasks included registering for a conference and signing up to become a member of the organisation. Some health promotion organisations have also used eye-tracking to quantify how users are interacting with health advertisements. For example O’Malley, Latimer and Berenbaum (2011) used an eye-tracking device to measure participants’ attention to a range of health promotion advertisements for osteoarthritis prevention in women. The eye-tracking data showed that gain-framed messages which focus on the benefits of physical activity were more effective in gaining prolonged participant attention than loss-framed messages that focus on the negative consequences of not participating in physical activity. Despite the detailed and objective information eye-tracking provides on users’ interaction and engagement on web-sties, no web-based health interventions have used eye-tracking technology to understand the way users interact with the websites or engage in different forms of intervention delivery. Eye-tracking technology
can provide detailed data on how users interact and attend to video and text delivered content to inform effective content delivery in future web-based health behaviour interventions.

2.6.9 Promoting web-based physical activity interventions

To take advantage of the Internet and deliver web-based physical activity interventions to a wide audience, effective promotion of the interventions is required. Much research has focused on improving the effectiveness of web-based interventions; however the vital component of disseminating the intervention is paid little attention despite its being crucial to its public health impact (Dickinson et al., 2013). To date, a range of strategies including newspaper advertisements, leaflets, web-based advertisements, radio and TV advertisements has been used to attract participants to web-based interventions, however limited research has evaluated these recruitment strategies (Foster et al., 2011). Many web-based physical activity interventions are continuing to use traditional methods of recruitment including newspaper articles, posters and leaflets (Bennett & Glasgow, 2009). However, this methodology is not in line with the underlying premise of specifically using the Internet to reach vast numbers at low-cost. The Internet not only provides a platform to deliver health interventions to a wide audience at low-cost, but it provides a powerful tool to promote the intervention and recruit a wide range of participants. The Internet is a key platform for commercial marketing in today’s society, with Internet banners, links on websites, social media and search engines being popular advertising strategies (Wakolbinger et al., 2009). The benefits of web-based marketing for the commercial sector include; ability to gather information about consumers, reach a bigger customer base, reduce paperwork surrounding transactions, reduce requirement for utilities and storage, customise advertisements to individuals and real time evaluation of advertisements (Kiang, Raghu & Huei-Min Shang, 2000). The companies that
receive the most success from online marketing tend to sell digital products that can be delivered online (Kalaignanam, Kushwaha & Varadarajan, 2008; Kiang et al., 2000). This suggests that web-based advertising may be effective for web-based physical activity interventions which deliver the product (i.e., program) online.

Advertising on social media (mainly Facebook) and Internet search engines (mainly Google), has been successful for attracting people to some web-based smoking, nutrition and depression interventions (Feil, Noell, Lichtenstein, Boles & Garth, 2003; Graham et al., 2012; Lohse, 2013; Morgan, Jorm & Mackinnon, 2013; Ramo, Rodriguez, Chavez, Sommer & Prochaska, 2014). This is not surprising as Facebook currently receives 18.60 billion visits each month and the Google search engine receives 14.90 billion visits a month (Similar Web, 2016). Of the few studies that have directly compared traditional advertising to Internet advertising, Gilligan, Kypri and Bourke (2014) found Facebook advertisements to be ten times more cost-effective than social networks and traditional media in recruiting mothers of adolescents to complete a survey. Facebook advertising has also been successfully used to attract people to online smoking and nutrition interventions conducted in the US. Costs per participant ranged from USD $9 to $40 across the studies. Facebook advertising allows clients to create an advertisement with text and a picture that can be shown to Facebook users when they are logged into Facebook. The advertisements can be targeted to Facebook users’ demographics and interests. Multiple advertisements can be created within a campaign, with each advertisement targeted to specific demographics such as age, gender and location and/or to people who have shown interest in certain Facebook pages. Feil et al. (2003) found advertising through Internet search engines to be the most effective strategy for recruiting people to an online smoking intervention in the United States. Radio advertisements and
Leaflets were the least effective. Multiple studies have found advertising through the Google search engine to be effective for recruiting participants to online depression and smoking interventions. The costs range from USD $5-$50. The depression interventions tended to have lower costs per participant than the smoking interventions (Heffner, Wyszynski, Comstock, Mercer & Bricker, 2013; Jones, Goldsmith, Williams & Kamel Boulos, 2012). The advertisements in the Internet search engine appear when people search for related concepts. Minimal targeting is available for Google AdWords, however the advertisements are shown to people searching for related information. Therefore these people may be more interested in the advertised intervention. A better understanding of how the Internet can be used to attract people to web-based health interventions will help researchers and public health workers attract large numbers to population wide web-based health interventions. Therefore comparing the cost-effectiveness of popular web-based methods to traditional print-based methods to promote web-based health interventions requires investigation.

More research is required to establish which recruitment strategies are most effective in reaching a diverse range of participants including those who will most benefit from a physical activity intervention. Individuals recruited for web-based interventions still tend to be Caucasian, female and educated (Foster et al., 2011). Internet advertising has the potential to reach minority groups such as those in rural areas, those with a low-income and those who are less educated. Internet advertising has been successful in attracting people from cultural minority groups and those with a low income to participate in smoking and nutrition interventions (Graham et al., 2012; Lohse, 2013). Graham et al. (2012) used Yahoo search engine advertisements with cultural targeting to recruit Latino smokers to an online smoking intervention but the cost was high at USD $73.76 per participant. Lohse (2013) used
Facebook to recruit low income women in the US to an online nutrition intervention for USD $15 per participant. The targeting feature of Facebook advertising which allows companies to target Facebook users with specific demographics can assist in reaching minority groups. For example companies can target ethnic minorities by targeting users’ language or users’ association with cultural pages and events. Furthermore, online recruitment may reach those more suited to an intervention delivered over the Internet. Thompson et al. (2008) found those recruited for a weight loss intervention through Internet mass media visited the website more than those recruited through traditional methods. Sadasivam et al. (2013) found smoking intervention participants recruited through Internet advertising to have a higher level of engagement compared to those recruited through medical referrals. Further evaluations are required to determine the characteristics of people reached (in terms of demographics and website usage) through Internet advertising and print advertising strategies for promoting web-based physical activity interventions in Australia.

2.7 Conclusion

Over half of Australians fail to reach the physical activity guidelines necessary to reduce the risk of cardiovascular disease, diabetes and cancer. Due to rising levels of chronic disease placing a significant burden on Australia’s health care system and economy, there is a need for effective population-based physical activity interventions. The Internet provides a convenient platform to deliver physical activity interventions as it can reach large numbers of people at low-cost. Whilst the short-term effectiveness of web-based physical activity interventions has been established, website promotion, participant engagement and retention have been identified as problems affecting population-level reach and long-term
effectiveness. Although some intervention components including personalised advice and website characteristics including video content have demonstrated promising outcomes, further research is required to rigorously test these website components and characteristics to understand what methods will optimise participant engagement and behavioural outcomes. Furthermore, little is known about how to cost-effectively attract people to web-based health interventions, in order to take advantage of the Internet’s wide reach and deliver interventions to large numbers. Further research is required to test the effectiveness of innovative web-based marketing strategies used in the commercial sector to recruit research participants.

The first study (recruitment evaluation) was conducted to discover effective methods of attracting participants to a web-based physical activity intervention. Next a randomised controlled trial (intervention trial) was conducted to determine whether brief online coaching sessions improve the effectiveness of computer-tailored advice, or whether comprehensive computer-tailored advice is sufficient to optimise behavioural outcomes of the intervention. The final study (eye-tracking study) compares participants’ processing and recall of commonly used text-tailored physical activity advice to interactive video-tailored physical activity advice. Overall, the combined study findings will help the next generation of web-based physical activity interventions to be effective in improving participants’ physical activity levels and reducing the prevalence of disease in Australia.
Chapter 3. Recruitment evaluation

An evaluation of web- and print-based methods to attract people to a physical activity intervention.
3.1 Abstract

Identifying effective and cost-effective methods to attract people to web-based health behaviour interventions is required. Traditional print methods including leaflets, posters and newspaper advertisements remain popular despite the expanding range of web-based advertising options that have the potential to reach larger numbers at lower cost. This study evaluated the effectiveness of multiple print-based and web-based methods to attract people to a web-based physical activity intervention and described the cost of each of these approaches. A range of print-based (newspaper advertisements, newspaper articles, letterboxing, leaflets and posters) and web-based (Facebook advertisements, Google AdWords and community calendars) methods was applied to attract participants to a web-based physical activity intervention in Australia. The time investment, cost, number of first time website visits, the number of completed sign-up questionnaires and the demographics of participants were recorded for each advertising method. A total of 278 people signed up to participate in the physical activity program. Of the print-based methods, newspaper advertisements totalled AUD $145, letterboxing AUD $135, leaflets AUD $66, posters AUD $52, and newspaper article AUD $3 per sign up. Of the web-based methods, Google AdWords totalled AUD $495, non-targeted Facebook advertisements AUD $68, targeted Facebook advertisements AUD $42, and community calendars AUD $12 per sign-up. Although the newspaper article and community calendars cost the least per sign-up, they resulted in only 17 and six sign-ups respectively. The targeted Facebook advertisements were the next most cost-effective method and reached a large number of sign-ups (n=184). The newspaper article and the targeted Facebook advertisements required the lowest time investment per sign up (five and seven minutes respectively). People reached through the targeted Facebook advertisements were on average older (60 years vs. 50 years, p <.001) and
had a higher BMI (32 vs. 30, \( p < .05 \)) than people reached through the other methods. Overall our results demonstrate that targeted Facebook advertising is the most cost-effective and efficient method at attracting moderate numbers to physical activity interventions in comparison to the other methods tested. Newspaper advertisements, letterboxing and Google AdWords were not effective. The community calendars and newspaper articles may be effective for small community interventions.
3.2 Introduction

Recent reviews and meta-analyses have confirmed the short-term effectiveness of web-based physical activity interventions (Davies et al., 2012b; Foster et al., 2013; Joseph, Durant, Benitez & Pekmezi, 2013). However the public health impact of these interventions is dependent on how many people they reach when being disseminated. It is more difficult and complex to successfully attract people to participate in web-based health programs than may commonly be perceived. The Internet is a very competitive environment with hundreds of thousands of websites all vying to attract attention of a potentially vast audience. To date, a range of methods has been used to attract participants to web-based health interventions including newspaper advertisements (Steele, Mummery & Dwyer, 2007a), leaflets (Ferney et al., 2009), email (Herman et al., 2006) and social media (Gilligan et al., 2014). However, limited research has measured the cost-effectiveness of these methods (Foster et al., 2011; Toerien et al., 2009).

Traditional methods including leaflets, posters and newspaper advertisements are still commonly used by researchers and health professionals to attract people to web-based health interventions. This is despite the growing use of web-based methods which have the potential to reach larger numbers at lower cost (Foster et al., 2011). Email has been successfully used to attract specific groups such as workplace employees to web-based health interventions when email lists are available (Toerien et al., 2009). Email is nevertheless inappropriate for a population wide dissemination as it is becoming increasingly hard to engage people with emails that are not targeted and personally relevant, or not from a trusted source (Gopal, Walter & Tripathi, 2001). Internet banners, links on websites, social media and search
engines have been popular and effective web-based marketing methods in the commercial sector (Wakolbinger et al., 2009).

Recent studies have successfully used social media to attract adolescents and adults to nutrition, smoking and other health interventions (Lohse, 2013; Lohse & Wamboldt, 2013; Ramo et al., 2014). Gilligan et al. (2014) found Facebook advertisements to be ten times more cost-effective than traditional media, in recruiting mothers of adolescents to complete a survey. Furthermore, Morgan et al. (2013) found Google AdWords to be a cost-effective method for attracting adults to a depression intervention across six western countries. Their results also revealed that posts in forums and community notice boards were not effective. A better understanding of how the Internet can be used to attract people to web-based health interventions will help researchers and public health workers attract large numbers to web-based health interventions. Therefore evaluating the effectiveness and costs of web- and print- based methods to promote web-based health interventions requires investigation.

Participants of web-based physical activity interventions reached through traditional print-based methods have typically been Caucasian, female and educated (Lewis et al., 2008; McCoy, Couch, Duncan & Lynch, 2005). Internet use in Australia is currently widespread (83%), however Internet use decreases with lower education and income (Australian Bureau of Statistics, 2014a). It is unknown whether web-based advertising is more effective in reaching a representative sample than print-based advertising. Facebook advertising provides the advantage of targeted advertising to assist in reaching desired sample characteristics (Baltar & Brunet, 2012; Lohse, 2013). Therefore further research is required to determine the
characteristics of people reached through different web- and print-based methods for promoting web-based health interventions.

3.2.1 Aims and hypotheses

This study aims to determine the effectiveness (in terms of numbers reached) and cost effectiveness (in terms of cost and time investment per participant) of multiple web- and print- based methods to attract Australian adults to a web-based physical activity intervention. It was hypothesised that the Google AdWords and Facebook advertising would reach a larger number of people at a lower cost and time investment per sign-up than the community calendar and the traditional print-based methods.

3.3 Methods

The current study recorded and analysed methods to attract people to a web-based physical activity intervention in Australia. Data collection began in March 2014. The intervention itself was part of a randomised controlled trial (RCT) presented in chapter 4 and 5 of this thesis. The RCT compared the effectiveness (in terms of engagement, retention and physical activity changes) of computer-tailored advice only and computer-tailored advice with a brief coaching session in an eight week intervention. A detailed description of the intervention, measures and study protocol can be found in chapter 4. Participants were excluded from the RCT if they were: non- English speaking, pregnant, under 18 years of age, currently meeting the Australian physical activity guidelines (assessed by a single item, ‘do you currently participate in less than 30 minutes of physical activity on average each day?’), or at risk of injury or ill health from increasing their physical activity (as assessed by the Physical Activity Readiness Questionnaire) (Thomas, Reading & Shephard, 1992) (Appendix A).
These criteria are stricter than typical population or community based physical activity interventions, so all interested participants’ data were included in the current study, irrespective of their eligibility to participate in the following RCT. These numbers are more likely to reflect the effectiveness of strategies to attract people to real world web-based interventions that aim to sign-up as many people as possible. The research has been approved by the CQUniversity Human Research Ethics Committee (H13/04-044).

3.3.1 Stage 1 Sign-up

The advertising methods were implemented in the cities of Rockhampton and Mackay, Queensland Australia. All print-based advertisements including a newspaper advertisement, posters and leaflets displayed the intervention logo, the CQUniversity’s logo, the intervention URL and a quick response (QR) code (Figure 2). The QR code directs people to the intervention website where they scan it with a smartphone. Readers were asked ‘Do you want to get healthy and fit and go in the draw to win some fabulous prizes? You are invited to participate in an online research study where you will gain free access to the ‘My Activity Coach’ program developed by CQUniversity. It will provide you with personalised advice to help you become more active.’ The 10 by 3cm newspaper advertisements were printed in a local newspaper (The Morning Bulletin) which has a circulation of 20,000 in the Rockhampton region. The newspaper advertisements contained the same information as the posters and leaflets but in a more concise format, due to space restrictions (Figure 3).
The web-based methods included paid advertisements targeted at Mackay residents on the social media website Facebook and on the Google search engine (Google AdWords). Advertisements were also displayed on Mackay’s community websites, including the local
newspaper’s website (*The Daily Mercury*) and My Community Connect Mackay at no cost. These advertisements listed the program in the websites’ event calendars. Participants could click on the calendar entry to find out more information, including a link to the intervention website. The Google advertisements appeared when users searched for terms related to the intervention including fitness, healthy, physical activity, weight loss and exercise. The Google search engine displays the advertisements that generate the largest number of clicks for each keyword searched. Therefore each advertisement is competing against similar advertisements linked to the same keyword(s). The advertisement displayed one sentence about the program (Figure 4), and took people who clicked on the advertisement directly to the intervention website. Multiple advertisements were trialled with different wording. The frequency of the advertisements which generated the largest number of clicks was increased. A daily maximum spend of AUD $10 was applied.

![Google AdWords](image)

**Figure 4. Google AdWords**

Facebook advertising allows clients to create an advertisement with text and a picture that can be targeted to Facebook users’ demographics and interests. The advertisements can be displayed as part of the user’s newsfeed, or on the right side of their newsfeed. If the Facebook users click on the feed advertisement they will be taken to the organisation’s Facebook page, and if the users click on the side advertisement they will be taken directly to the organisation’s website. Multiple advertisements can be created within a campaign, with
the option to target each advertisement to specific demographics such as age, gender and location and/or to people who have shown interest in certain Facebook pages. Only side advertisements were used in the current study to promote direct traffic to the intervention website. Only Facebook users who were over 18 and reside in Mackay were targeted. No additional targeting was implemented to avoid biasing the sample of people reached. Multiple advertisements were trialled with different wording and pictures. Facebook increases the frequency of advertisements which generate the largest number of clicks from the target audience. A limit of AUD $20 per day was applied. The Facebook advertisements displayed a picture and a sentence inviting people to participate in the physical activity intervention (see Figure 5).

![Facebook advertisement](image)

**Figure 5. Facebook advertisement**

### 3.3.2 Stage 2 Sign-up

**Stage 2a:** At the end of May 2014 after two months of promoting the intervention, only 22 people had completed the sign-up survey. To increase the number of sign-ups the advertising
methods were extended to include several other Australian towns: Bundaberg, Townsville and Brisbane in Queensland, Melbourne (Victoria), Perth (Western Australia) and Sydney (New South Wales). The newspaper advertisements and Google AdWords which had a very high cost per sign-up were discontinued. A new method which involved delivering leaflets to people’s homes was also implemented (Appendix B).

Stage 2b: By August 15, 2014 after five months of promoting the intervention only 61 people had completed the sign-up survey. Delivering leaflets to people’s homes had a very high cost and time investment, so this was discontinued; and no additional posters and leaflets were distributed through health care centres. The event listings in the online calendars however were continued, as they were free and quick to implement. A news article about the program was printed in The Morning Bulletin on September 01, 2014; this was free of cost and took only 1.5 hours to arrange with the newspaper staff. The costly untargeted Facebook advertising was also discontinued. Instead, new, highly targeted Facebook advertising was implemented across Australia. From this point forward this was the main recruitment method. The advertisements were targeted to gender whereby the advertisements showed a photo of an active person of the same gender; and in order to reach individuals most likely to be interested and with most to gain from the intervention, individuals who had diabetes, depression, cancer and heart disease were targeted. To do this people who were members of Facebook pages and support groups on diabetes, depression, cancer, and heart disease were targeted. These advertisements included a statement relating to the condition the user was connected with. Finally some Facebook advertisements were shown only to individuals over 45 years of age. These advertisements displayed a picture of an active older person. Both feed advertisements which were displayed on the user’s newsfeed alongside
posts from their Facebook friends and groups, and side advertisements displayed on the right border of the Facebook webpage were used. Different combinations of gender, age, disease and advertisement location were created resulting in 24 different advertisements (e.g., feed advertisement targeted to males over 45 years with diabetes, see Figure 6). Initially, a daily maximum spend of AUD $5 for each advertisement was selected, but this was regularly updated by increasing the maximum daily spend for the advertisements that had the lowest cost-per click to the intervention website and decreasing the maximum daily spend for those that had the highest cost per click. See Table 2 for a timeline of the strategies implemented to attract people to the web-based physical activity intervention.

Figure 6. Feed advertisement targeted to males over 45 years with diabetes
Table 2. Timeline of strategies used to attract people to the intervention website

<table>
<thead>
<tr>
<th>Strategies</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mar</td>
<td>Apr</td>
</tr>
<tr>
<td><strong>Rockhampton and Mackay in QLD</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FB</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Google</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>NP ad</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Calendar</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Leaflet</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>Poster</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Letter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NP article</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Targeted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: FB = Facebook, NP = Newspaper, ad = advertisement, Letter = letterbox drop, Calendar = online community calendars

### 3.4 Measures

#### 3.4.1 Participant numbers

The number of times each advertisement was displayed (impressions) was recorded for the Facebook and Google AdWords advertisements. For the newspaper advertisements the circulation (estimated number of readers) was used as the measure of impressions. The number of first time website visits from each of the web-based methods was recorded through Google analytics. After visiting the homepage, individuals were encouraged to complete a screening survey which asked participants, ‘how did you hear about this program?’ Participants who did not select ‘Google search’, ‘Facebook’, ‘community calendar’ ‘newspaper article’, ‘newspaper advertisement’, ‘leaflet’, ‘letterbox drop’ or ‘poster’ were excluded from the current analysis. The number of website visits for each of the 24 targeted Facebook advertisements was recorded through Facebook.
3.4.2 **Cost**

The total cost of each of the methods used to attract people to the intervention was calculated. This included the cost of a research assistant to implement each method based on the CQUUniversity rate of AUD $35 per hour. The money spent on each of the 24 targeted Facebook advertisements was also recorded through Facebook.

3.4.3 **Efficiency**

The time spent implementing each method was calculated. This included the time spent planning, executing and monitoring each advertisement.

3.4.4 **Demographic characteristics**

Participant demographics were assessed only for those people who signed-up, were eligible, and who completed the baseline survey (50% of all those who signed up). The questionnaire collected participant demographics including; gender, marital status, language, income, education, employment, age, body mass index (BMI) and physical activity (Appendix C). Total minutes of physical activity during the previous week was assessed by the validated Active Australia Questionnaire (Australian Institute of Health and Welfare, 2003) (Appendix D).
3.5 Data analysis

3.5.1 Data screening

All analyses were conducted using SPSS version 20. Significance level was set at $p < 0.05$.

All continuous variables were screened for outliers and normality using Fisher’s skewness coefficient. Age, BMI and total physical activity per week were found to have a significant negative, positive and positive skewed distribution respectively. A reflect and square root, logarithm and square root transformation successfully transformed these variables into normal distributions respectively.

3.5.2 Participant numbers

The number of impressions, first time visits to the website and sign-ups for each advertising method were calculated.

3.5.3 Cost

Money spent on the recruitment method plus the hours spent implementing the recruitment method times the hourly cost of employing a research assistant (AUD $35) was calculated and divided firstly by the number of website visits and secondly by the number of sign-ups from each recruitment method.

3.6 Results

3.6.1 Participant numbers

The strategies implemented in stage 1 led to 59 sign-ups and the letterboxing implemented in stage 2a led to 18 sign-ups. During stage 2b the targeted Facebook recruitment led to 184
sign-ups and the newspaper article lead to 17 additional sign ups. The total cost, time investment, number of impressions, number of first time visits to the intervention website, and number of sign-ups through the print- and web-based methods are presented in Table 3.

3.6.2 Cost

Two newspaper advertisements were printed, which totalled AUD $446. A total of eight hours was spent organising the newspaper advertisements, costing AUD $280 in research assistant time. One thousand leaflets and 150 posters were displayed in 20 healthcare centres throughout Rockhampton and 21 healthcare centres in Brisbane. The leaflets and posters cost AUD $570.35 and AUD $154 for printing respectively. A total of 24 hours was spent distributing the leaflets and posters, costing AUD $840. Another 3500 posters and 1500 leaflets were delivered to homes in Rockhampton and Melbourne respectively. The printing for these leaflets cost AUD $990. A total of 41 hours was spent delivering the leaflets, costing AUD $1435.

The calendar entry in The Daily Mercury’s website and Mackay’s My Community Connect was free of costs, however the Research Assistant spent two hours organising this, costing AUD $70. A total of AUD $215 was spent on Google AdWords. The Research Assistant spent eight hours developing, implementing and evaluating the Google advertisements, costing AUD $280. Un-targeted side Facebook advertisements totalled AUD $1228. The Research Assistant spent six hours developing, implementing and monitoring these Facebook advertisements, costing AUD $210. The targeted Facebook advertisements totalled AUD $7021. The Research Assistant spent 20 hours developing, implementing and monitoring these Facebook advertisements, costing AUD $700. Figure 7 presents a visual representation
of the hours per sign-up, cost per sign-up and number of sign-ups for each advertising method.

Table 3. Time investment, costs, impressions, first time visits and sign ups of each advertising method

<table>
<thead>
<tr>
<th>Advertising Method</th>
<th>Time (hours)</th>
<th>Cost* ($)</th>
<th>Impressions (n)</th>
<th>Visits (n)</th>
<th>Sign-ups (n)</th>
<th>Time per sign-up (mins)</th>
<th>Cost* per Impression ($)</th>
<th>Cost* per Sign-up ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Web-based</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untargeted Facebook</td>
<td>6</td>
<td>1,438</td>
<td>119,806</td>
<td>877</td>
<td>21</td>
<td>17</td>
<td>0.01</td>
<td>68</td>
</tr>
<tr>
<td>Google AdWords</td>
<td>8</td>
<td>495</td>
<td>18,773</td>
<td>34</td>
<td>1</td>
<td>480</td>
<td>0.03</td>
<td>495</td>
</tr>
<tr>
<td>Community calendar</td>
<td>2</td>
<td>70</td>
<td>-</td>
<td>20</td>
<td>6</td>
<td>20</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td><strong>Targeted</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facebook</td>
<td>20</td>
<td>7,721</td>
<td>547,507</td>
<td>5372</td>
<td>184</td>
<td>7</td>
<td>0.01</td>
<td>42</td>
</tr>
<tr>
<td><strong>Print</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Newspaper ad</td>
<td>8</td>
<td>726</td>
<td>40,000</td>
<td>-</td>
<td>5</td>
<td>96</td>
<td>0.02</td>
<td>145</td>
</tr>
<tr>
<td>Health care leaflets</td>
<td>12</td>
<td>990</td>
<td>-</td>
<td>-</td>
<td>15</td>
<td>48</td>
<td>-</td>
<td>66</td>
</tr>
<tr>
<td>Posters</td>
<td>12</td>
<td>574</td>
<td>-</td>
<td>-</td>
<td>11</td>
<td>365</td>
<td>-</td>
<td>52</td>
</tr>
<tr>
<td>Letterbox drop</td>
<td>41</td>
<td>2,425</td>
<td>6000</td>
<td>-</td>
<td>18</td>
<td>137</td>
<td>0.4</td>
<td>135</td>
</tr>
<tr>
<td>Newspaper article</td>
<td>1.5</td>
<td>53</td>
<td>20,000</td>
<td>-</td>
<td>17</td>
<td>5</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>110.5</strong></td>
<td><strong>14492</strong></td>
<td><strong>752,086</strong></td>
<td><strong>6303</strong></td>
<td><strong>278</strong></td>
<td><strong>1175</strong></td>
<td><strong>0.08</strong></td>
<td><strong>113.11</strong></td>
</tr>
</tbody>
</table>

Note: Cost includes research assistant time. Ad = advertisement.
Figure 7. Hours per sign-up, cost per sign-up and number of sign-ups for each advertising method

Note: Number of sign-ups is represented by bubble size. Cost does not include research assistant time. FB = Facebook, NP = Newspaper, ad = advertisement, Letter = letterbox drop, Calendar = online community calendars

3.6.3 Demographic characteristics

A total of 140 participants (50% of sign-ups) completed the baseline questionnaire. The other 50% did not meet the inclusion criteria for the RCT (inactive Australian over 18 years with no health conditions that may affect their ability to safely become more active) or failed to complete the baseline questionnaire. Table 4 presents the characteristics for participants reached through targeted Facebook advertisements and all other methods. This comparison was conducted instead of comparing all print methods to web-based methods, as there was a large variance in effectiveness of the web-based methods and the targeted Facebook advertisement was the most effective method at reaching large numbers at low cost. People
reached through the targeted Facebook advertisements were on average older and had a higher BMI than people reached through the other methods. They were also more likely to be divorced or widowed and less likely to have never married which is likely to be due to the older age group.

Table 4. Descriptive summary of participant characteristics reached using targeted Facebook advertisements and all other methods

<table>
<thead>
<tr>
<th>Participant Characteristics</th>
<th>Targeted Facebook (n=74)</th>
<th>All other methods (n=66)</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td>$\chi^2=1.24$ p=.27</td>
</tr>
<tr>
<td>Males</td>
<td>19 (26)</td>
<td>12 (18)</td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>55 (74)</td>
<td>55 (82)</td>
<td></td>
</tr>
<tr>
<td>First language</td>
<td></td>
<td></td>
<td>$\chi^2=.26$ p=.61</td>
</tr>
<tr>
<td>English</td>
<td>71 (97)</td>
<td>66 (98)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2 (3)</td>
<td>1 (2)</td>
<td></td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
<td>$\chi^2=6.17$ p=.01</td>
</tr>
<tr>
<td>Never Married</td>
<td>0 (0)</td>
<td>5 (7)</td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>50 (69)</td>
<td>46 (69)</td>
<td></td>
</tr>
<tr>
<td>Divorced or Widowed</td>
<td>23 (31)</td>
<td>16 (24)</td>
<td></td>
</tr>
<tr>
<td>Employment</td>
<td></td>
<td></td>
<td>$\chi^2=3.23$ p=.19</td>
</tr>
<tr>
<td>Full Time</td>
<td>24 (33)</td>
<td>29 (43)</td>
<td></td>
</tr>
<tr>
<td>Part time/casual</td>
<td>13 (18)</td>
<td>15 (22)</td>
<td></td>
</tr>
<tr>
<td>Unemployed</td>
<td>36 (49)</td>
<td>23 (35)</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td>$\chi^2=1.55$ p=.46</td>
</tr>
<tr>
<td>Less than Secondary</td>
<td>1 (1)</td>
<td>1 (2)</td>
<td></td>
</tr>
<tr>
<td>Secondary</td>
<td>13 (18)</td>
<td>7 (10)</td>
<td></td>
</tr>
<tr>
<td>Further education</td>
<td>59 (81)</td>
<td>59 (88)</td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td>$\chi^2=1.4$, p=.50</td>
</tr>
<tr>
<td>Over $78,000</td>
<td>24 (49)</td>
<td>28 (50)</td>
<td></td>
</tr>
<tr>
<td>$31,200 - $77,999</td>
<td>13 (26)</td>
<td>19 (34)</td>
<td></td>
</tr>
<tr>
<td>Under $31,199</td>
<td>12 (25)</td>
<td>9 (16)</td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>59.72 (.57)</td>
<td>50.21 (1.24)</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>32.0 (.83)</td>
<td>30.36 (1.04)</td>
<td></td>
</tr>
<tr>
<td>Total Physical Activity (minutes/week)</td>
<td>161.67 (22.07)</td>
<td>162.84 (24.19)</td>
<td></td>
</tr>
</tbody>
</table>
3.6.4 Targeted Facebook advertising

The cost, number of impressions, website visits and sign-ups for each of the 24 targeted Facebook advertisements are presented in Table 5. The three most cost-effective Facebook advertisements at bringing people to the intervention website were; a) a feed advertisement targeting males over 45 years with diabetes, b) a side advertisement targeting females over 45 years, and c) a side advertisement targeting females over 18 years. The female targeted advertisements were more cost-effective per website visit than the male targeted advertisements except for the diabetes, depression and heart targeted advertisements. The advertisements targeted to adults over 45 years were more cost-effective per website visit than the advertisements shown to all ages. The advertisements targeted to general health were more cost-effective as a side advertisement, whilst the targeted health advertisements were more cost-effective as a feed advertisement. Overall, the side advertisements were more cost-effective per website visit than the feed advertisements, except for the diabetes targeted feed advertisement.

The average number of website visits per AUD $100 spent for each type of Facebook advertisement is presented in Figure 8. The advertisements targeting females were more cost-effective than the advertisements targeting males; the advertisements targeting general health were more cost-effective than the advertisements targeting specific diseases and the advertisements targeting adults over 45 years were more cost-effective than the advertisements targeting adults over 18 years.
Table 5. Cost, impressions, website visits and sign-ups for each Facebook advertisement ordered by cost per visit

<table>
<thead>
<tr>
<th>Facebook Advertisement</th>
<th>Real Cost</th>
<th>Impressions</th>
<th>Visits</th>
<th>Sign ups</th>
<th>Cost per Impression</th>
<th>Cost per Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed(a), diabetes, male</td>
<td>$85.49</td>
<td>3,805</td>
<td>127</td>
<td>2</td>
<td>$0.02</td>
<td>$0.67</td>
</tr>
<tr>
<td>Side, health(b), female</td>
<td>2500.92</td>
<td>259,992</td>
<td>3,237</td>
<td>53</td>
<td>$0.01</td>
<td>$0.77</td>
</tr>
<tr>
<td>Side, health, female, all ages</td>
<td>646.91</td>
<td>175,051</td>
<td>762</td>
<td>0</td>
<td>$0.00</td>
<td>$0.85</td>
</tr>
<tr>
<td>Side, health, male, all ages</td>
<td>123.72</td>
<td>65,069</td>
<td>144</td>
<td>0</td>
<td>$0.00</td>
<td>$0.86</td>
</tr>
<tr>
<td>Side, health, male</td>
<td>566.64</td>
<td>113,949</td>
<td>648</td>
<td>9</td>
<td>$0.00</td>
<td>$0.87</td>
</tr>
<tr>
<td>Side, cancer, female</td>
<td>$144.44</td>
<td>19,456</td>
<td>165</td>
<td>1</td>
<td>$0.01</td>
<td>$0.88</td>
</tr>
<tr>
<td>Feed, diabetes, female</td>
<td>$315.09</td>
<td>11,828</td>
<td>354</td>
<td>9</td>
<td>$0.03</td>
<td>$0.89</td>
</tr>
<tr>
<td>Side, diabetes, male</td>
<td>$241.46</td>
<td>3,111</td>
<td>268</td>
<td>2</td>
<td>$0.08</td>
<td>$0.90</td>
</tr>
<tr>
<td>Side, depression, male</td>
<td>$38.06</td>
<td>3,901</td>
<td>39</td>
<td>0</td>
<td>$0.01</td>
<td>$0.98</td>
</tr>
<tr>
<td>Side, diabetes, female</td>
<td>$564.05</td>
<td>8,051</td>
<td>547</td>
<td>2</td>
<td>$0.07</td>
<td>$1.03</td>
</tr>
<tr>
<td>Side, heart, male</td>
<td>215.47</td>
<td>6,141</td>
<td>210</td>
<td>1</td>
<td>$0.04</td>
<td>$1.03</td>
</tr>
<tr>
<td>Side, heart, female</td>
<td>590.06</td>
<td>13,148</td>
<td>569</td>
<td>7</td>
<td>$0.04</td>
<td>$1.04</td>
</tr>
<tr>
<td>Side, depression, female</td>
<td>$87.72</td>
<td>7,310</td>
<td>84</td>
<td>0</td>
<td>$0.01</td>
<td>$1.04</td>
</tr>
<tr>
<td>Side, cancer, male</td>
<td>$29.49</td>
<td>5,043</td>
<td>24</td>
<td>0</td>
<td>$0.01</td>
<td>$1.23</td>
</tr>
<tr>
<td>Feed, cancer, female</td>
<td>$103.17</td>
<td>5,123</td>
<td>72</td>
<td>0</td>
<td>$0.02</td>
<td>$1.43</td>
</tr>
<tr>
<td>Feed, heart, female</td>
<td>$111.42</td>
<td>4,663</td>
<td>65</td>
<td>0</td>
<td>$0.02</td>
<td>$1.71</td>
</tr>
<tr>
<td>Feed, depression, female</td>
<td>$116.73</td>
<td>5,054</td>
<td>67</td>
<td>0</td>
<td>$0.02</td>
<td>$1.74</td>
</tr>
<tr>
<td>Feed, health, female</td>
<td>$93.03</td>
<td>6,400</td>
<td>48</td>
<td>15</td>
<td>$0.01</td>
<td>$1.94</td>
</tr>
<tr>
<td>Feed, health, female, all ages</td>
<td>$80.34</td>
<td>9,584</td>
<td>41</td>
<td>0</td>
<td>$0.01</td>
<td>$1.96</td>
</tr>
<tr>
<td>Feed, health, male</td>
<td>$32.67</td>
<td>3,709</td>
<td>16</td>
<td>1</td>
<td>$0.01</td>
<td>$2.04</td>
</tr>
<tr>
<td>Feed, heart, male</td>
<td>$14.18</td>
<td>1,019</td>
<td>6</td>
<td>1</td>
<td>$0.01</td>
<td>$2.36</td>
</tr>
<tr>
<td>Feed, health, male, all ages</td>
<td>$45.36</td>
<td>6,037</td>
<td>19</td>
<td>0</td>
<td>$0.01</td>
<td>$2.39</td>
</tr>
<tr>
<td>Feed, cancer, male</td>
<td>$22.61</td>
<td>1,382</td>
<td>8</td>
<td>0</td>
<td>$0.02</td>
<td>$2.83</td>
</tr>
<tr>
<td>Feed, depression, male</td>
<td>$8.98</td>
<td>735</td>
<td>3</td>
<td>0</td>
<td>$0.01</td>
<td>$2.99</td>
</tr>
<tr>
<td>Can’t remember</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>37</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Note: Feed advertisements are displayed on the user’s newsfeed alongside posts from their Facebook friends and groups and side advertisements are displayed on the right border of the Facebook webpage. General health refers to advertisements that were not targeted to a physical activity related chronic disease.

<table>
<thead>
<tr>
<th>Total</th>
<th>$6,778.0</th>
<th>739,561</th>
<th>7523</th>
<th>140</th>
<th>$0.01</th>
<th>$0.90</th>
</tr>
</thead>
</table>

Figure 8. Average number of visits per AUD $100 spent on each Facebook advertisement target

3.7 Discussion

The effectiveness of the web-based strategies was highly varied. The results demonstrate the low cost-effectiveness of the Google AdWords (AUD $495), whilst the targeted Facebook advertisements were the most cost-effective (AUD $42 per sign up) method at reaching a large number of sign-ups (n = 184). This is in line with previous research demonstrating Facebook to be a cost-effective method for recruiting adolescent and young adults to nutrition and smoking interventions in Australia and North America (Lohse, 2013; Lohse &
Wamboldt, 2013; Ramo et al., 2014). The effectiveness of Facebook advertisements per sign-up may be due to the low cost per impression and the ability to tailor advertisements to individuals who are more likely to be interested in a web-based physical activity intervention (e.g., females over 45 years). The Facebook advertisements were not as effective when the targeting was not used, confirming that the effectiveness of the Facebook advertisements is partially due to tailoring. Health professionals implementing Facebook advertising in future interventions should target the advertisements to reduce costs, however they need to be aware that this can bias the sample reached. Researchers and public health professionals must balance cost-effectiveness with how representative the sample reached through Facebook advertising will be. On the other hand, targeted Facebook advertisements can be used to reach under represented demographics (e.g., people with a mental health condition) or those most in need of a physical activity intervention (e.g., males, people over 45 years) but this may result in a higher cost per click. Although the Facebook advertising was the most cost-effective method at reaching moderate numbers, AUD $42 per participant is still too costly for population wide dissemination of interventions. Facebook advertising may need to be used in conjunction with mass media and viral marketing strategies to be cost-effective for large-scale disseminations (Wakefield et al., 2010). Overall the findings from the current study provide evidence to support the use of targeted Facebook advertising to attract people to a web-based physical activity intervention.

Facebook advertisements displayed on the right side panel, that target females over 45 years and no health targeting were generally more cost-effective in attracting people to the physical activity intervention website. It is not surprising that the advertisements targeted to older females are the most cost-effective as this is the demographic that is typically more interested
in physical activity interventions (Lewis et al., 2008; McCoy et al., 2005). In many physical activity interventions women out-number men 60 to 40 (Davies et al., 2012b). Furthermore, it is not surprising that the smaller side advertisements were more cost-effective than the feed advertisements. The feed advertisements resulted in more clicks per dollar spent, however the feed advertisements take users to another Facebook page (about the physical activity intervention) and then users need to click again to go to the intervention website itself. It is therefore likely that many people were lost at this additional step. It is surprising, however, that the advertisements targeted to people who had liked Facebook pages about diabetes, heart disease, depression or cancer were not as effective as the advertisements targeted to general health. This could be due to the people who had liked these pages not having the disease themselves. Alternatively it could be due to a small number of users who had liked these pages, resulting in a high number of impressions made to the same people (i.e., repeated displays of the same advertisement to the same uninterested users).

Participants who found out about the program through Facebook were asked in the sign-up survey which Facebook advertisement they saw. Due to a high percentage ‘not remembering’ (31%), we did not include the analysis of cost per sign up for each Facebook advertisement. The result of this analysis suggests that the feed advertisements targeted to specific diseases were the most cost-effective in recruiting participants. This means that more people clicked on the side advertisements per dollar spent, but many decided they were not interested after visiting the intervention website and did not sign-up. On the other hand, less people clicked on the feed advertisements per dollar spent, but a higher percentage of these people signed up to the intervention making it the more cost-effective for achieving sign-ups. Although we cannot draw any conclusions from this data, it highlights the importance of future
interventions to monitor website visits as well as sign-ups to evaluate the performance of each Facebook advertisement. Facebook now allows customers to do this by choosing a ‘conversion’ behaviour (e.g., clicking on the sign-up button) to automatically track how many people from each advertisement begin the sign-up questionnaire on the website.

The high-cost and low-effectiveness of Google AdWords was not expected as Google AdWords is an effective marketing strategy in the commercial sector and the advertisements were shown to people who were searching for information related to the intervention. This means that the advertisements were viewed by people more likely to be interested in physical activity and health, compared to Facebook or print-based advertisements which are shown to people who are not searching for information on physical activity and health. Further, these findings are not consistent with Morgan et al. (2013) who found Google AdWords to be a cost-effective method for attracting adults to a depression intervention across six western countries (USD $12 per participant). The high cost of the Google AdWords for the current physical activity program could be due to a high level of competition for the AdWords used including exercise and weight loss. Google increases the frequency of the advertisements that generate the most clicks. Our Google advertisements were therefore competing against commercial weight loss and exercise related companies in the multi-billion dollar fitness industry which are more likely to gain clicks and therefore be shown more frequently.

The newspaper article and online calendar entries cost the least per sign up (AUD $3 and AUD $12 respectively), however they only reached a small number of sign-ups (n = 6 and 17 respectively). This is in line with the findings from Morgan et al. (2013), that community forums and notice boards resulted in few participants. Furthermore it may not be possible for
State or National wide interventions to use community forums and calendars as many only accept local events. The only forums that accepted the advertisement for the current project were in Mackay, as Mackay has a CQUniversity campus through which the program was run. The newspaper article was easy to arrange in Rockhampton where the main campus of the University is located, however newspapers in other towns were not interested. Although web-based community forums and newspaper articles did not reach many people, small community interventions may benefit from these methods as they can reach a few additional people for minimal time and monetary investment.

It is not surprising the newspaper article and the Facebook advertisements required the least amount of time investment per sign-up. The newspaper article was organised by the newspaper staff at their expense so the only time investment was contacting them about the program and answering some interview questions over the phone. The tailored Facebook advertisements can be set up online without any face-to-face meetings or need to manually distribute. Only a small time investment was required to choose appropriate figures and wording for the advertisements and to monitor and adjust them when they were running. The other advertisements needed to be distributed to health clinics (posters and leaflets), delivered to people’s homes (leaflets) and arranged with face-to-face meetings (newspaper advertisement). This further supports the use of targeted Facebook advertising to attract large numbers to web-based physical interventions with a wide reach.

There are currently 12 million Facebook users in Australia (Hopewell, 2014), and the demographics of Facebook users have broadened in recent years. Due to its wide reach, Facebook advertising has reached a representative sample of the target population in many
Australian studies (Fenner et al., 2012; Gilligan et al., 2014; Saul, 2014). It was therefore surprising that people reached through the targeted Facebook advertisements in our study were significantly older than those reached through the other methods. This may have been influenced by the Facebook advertisements that were targeted to people over 45 years. The high prevalence of chronic conditions related to physical inactivity in older adults (e.g., osteoarthritis, cardiovascular disease, diabetes and falls) and the aging population means there is a specific need for physical activity interventions that can reach older adults (Nelson et al., 2007). The finding that participants reached through targeted Facebook advertising had a significantly higher BMI than participants reached through the other methods may be due to the advertisements targeting individuals with cardiovascular disease and diabetes. It is encouraging that the findings of this study demonstrate the capability of web-based methods to reach older adults and people with high BMI’s who have a high need for a physical activity intervention. Facebook recruitment was not more effective at reaching typically hard to reach groups including males, people with a low education and non-Caucasians. Further research is needed to determine effective ways of attracting these hard to reach groups in order to reach those most at need of health interventions.

3.7.1 **Limitations**

This study presents data to help researchers and public health professionals understand the cost, effectiveness and issues surrounding different methods to attract people to a web-based health intervention. The findings however have limitations, including that the demographic data were only collected for participants eligible to participate in the randomised controlled trial and who completed the baseline assessment. Thus, it did not include people who signed-up but were not eligible. Further, to ensure enough people participated in the randomised
controlled trial, the amount of funds allocated to the advertisements was continuously evaluated and directed to the more successful advertisements over the recruitment period (hence the stages 1, 2a and 2b during the recruitment phase). Therefore, the most successful advertisement method (e.g., Facebook advertisements) was used for longer than the non-successful advertisements (e.g., Google AdWords and newspaper advertisements). The differences in time of year and total amount spent on different advertisement methods may have affected their success.

3.7.2 Conclusion

Our findings reveal that targeted Facebook advertising is the most cost-effective method to attract moderate numbers to a web-based health intervention whilst Google AdWords, despite being a popular marketing method in the commercial sector, was the least cost-effective method. The cost of Facebook advertisements is however unsustainable for large population-based interventions that seek widespread implementation. Such interventions may need to use mass media in addition to Facebook advertising to reach larger numbers at a lower cost. Community calendars and newspaper articles were the cheapest methods, however they achieved a limited number of sign-ups. These interventions may therefore be beneficial for local community-based interventions. In summary, our findings suggest that Facebook advertising is the most cost-effective method at attracting moderate numbers to physical activity interventions in comparison to the other methods tested. However, it is still too costly for population-based interventions. Further research is needed to determine alternative recruitment procedures more effective in reaching large numbers of participants at low cost.
Chapter 4. Intervention trial protocol

*My Activity Coach – Using video-coaching to assist a web-based computer-tailored physical activity intervention: A randomised controlled trial protocol*
4.1 Abstract

There is a need for effective population-based physical activity interventions. The Internet provides a good platform to deliver physical activity interventions and reach large numbers of people at low cost. Personalised advice in web-based physical activity interventions has shown to improve engagement and behavioural outcomes, though it is unclear if the effectiveness of such interventions may further be improved when providing brief video-based coaching sessions with participants. The purpose of this study is to determine the effectiveness, in terms of engagement, satisfaction and physical activity changes, of a web-based and computer-tailored physical activity intervention with and without the addition of a brief video-based coaching session in comparison to a control group. Participants will be randomly assigned to one of three groups (tailoring + video-coaching, tailoring-only and wait-list control). The tailoring + video-coaching participants will receive a computer-tailored web-based physical activity intervention (‘My Activity Coach’) with brief coaching sessions with a physical activity expert over an online video-calling program (e.g., Skype). The tailoring-only participants will receive the intervention but not the counselling sessions. The primary time point for outcome assessment will be immediately post intervention (week nine). The secondary time points will be at six and 12 months post-baseline. The primary outcome, physical activity change, will be assessed via the Active Australia Questionnaire (AAQ). Secondary outcome measures include correlates of physical activity (mediators and moderators), quality of life changes (measured via the SF-12v2), study retention, program adherence, engagement (using website user statistics) and participant satisfaction. Study findings will inform researchers and practitioners about the feasibility and effectiveness of brief online video-coaching sessions in combination with computer-tailored physical activity advice. This may increase intervention effectiveness at an acceptable cost and will inform the
development of future web-based physical activity interventions. The trial was registered in the Australian New Zealand Clinical Trials Registry (ACTRN12614000339651).
4.2 Introduction

Physical activity improves physical and mental health and significantly lowers the risk of non-communicable disease including cardiovascular disease, diabetes mellitus and cancer (Lee et al., 2012). It is estimated that individuals who are physically active have a 30% to 50% lower risk of non-communicable disease and have a 20% to 50% lower risk of mortality than inactive individuals (Bassuk & Manson, 2005; Friedenreich & Orenstein, 2002a; Warburton et al., 2006). The World Health Organisation recommends 30 minutes of moderate intensity activity on five days of the week to receive health benefits and reduce the risk of non-communicable disease (World Health Organisation, 2008). Despite this, more than 50% of Australians fail to meet these recommendations (Australian Bureau of Statistics, 2013a) which is estimated to cost the Australian economy AUD $13.8 billion each year in healthcare, loss of productivity and mortality costs (Medibank Private, 2008). Hence, there is an urgent need for effective physical activity interventions with a broad reach.

High levels of Internet access (e.g., 83% in Australians) make the development and dissemination of web-based physical activity interventions worthwhile (Australian Bureau of Statistics, 2014a). Health behaviour change interventions delivered via the Internet have the potential to reach a large audience at low-cost, are convenient for participants and enable the content to be delivered in a non-confrontational way (Christopherson, 2007; McConnon et al., 2007; Tate et al., 2009). Although the short-term effectiveness of web-based physical activity interventions is well-established, participant retention and engagement have been identified as a challenge with many web-based interventions reporting high drop-out rates or low use of the websites after a period of time (Davies et al., 2012b; Vandelanotte et al., 2007). As the amount of exposure to the intervention content is strongly linked to
behavioural outcomes, low participant retention and engagement may limit the effectiveness of web-based interventions (Ferney et al., 2009; Hansen et al., 2012).

Reviews have shown that successful web-based physical activity interventions have included personalised advice through coaching or computer tailoring, numerous participant contacts, social support elements and theoretically-based behaviour change techniques (George et al., 2012; Greaves et al., 2011; Vandelanotte et al., 2007). Randomised controlled trials have found that web-based interventions that provide some form of personalised advice result in improved engagement and behavioural outcomes compared to interventions providing generic advice (Kroeze et al., 2006; Lustria et al., 2009). Online coaching and computer-tailored advice are effective ways of providing personalised advice in web-based interventions that mimic the advice and support provided in traditional face-to-face counselling sessions, in a way that reduces geographical, time and cost limitations (Lustria et al., 2009; Noar et al., 2007).

Coaching is defined as “facilitating health behaviour change and improving health outcomes through interaction or partnership between a health professional (coach) and an individual client” (Olsen, 2013, p. 1). Online coaching sessions provide personal contact similar to traditional face-to-face counselling. Online coaching sessions are typically delivered through private messages (email, SMS), real time instant messaging (chat) and group forums. Online coaching in web-based behaviour change settings has been found to improve perceptions of social support which is positively associated with behaviour change (Barrera, Toobert, Angell, Glasgow & Mackinnon, 2006; Winett et al., 2007). Counsellor initiated private messages and real time coaching sessions have been found to result in greater weight loss compared to web-based interventions providing information on weight loss only (Tate et al.,
Other methods of delivering social support in web-based interventions with lower time and cost restraints include online peer discussions and provision of an available online coach (“Ask the expert” button). Neither method has been found to be successful at improving behavioural outcomes of the intervention, as few participants were shown to use these features (Barrera, Glasgow, McKay, Boles & Feil, 2002). Although the effectiveness of online coaching is well established, the high time and cost investment in comparison to computer-tailored advice means that they are rarely included in web-based health behaviour interventions aiming to reach a wide audience (Joseph et al., 2013; Kelders, Kok, Ossebaard & Van Gemert-Pijnen, 2012).

Computer-tailored advice is more common in web-based physical activity interventions as it can be delivered at a lower cost. Computer-tailored advice is automatically produced using a computer-based expert system that delivers feedback based on participants’ responses to a questionnaire (Lustria et al., 2009). Computer-tailored physical activity advice is read, printed, discussed and remembered more than generic advice (Spittaels, De Bourdeaudhuij, Brug & Vandelanotte, 2007). Furthermore, it is also more appreciated by participants, processed more intently and leads to greater attention compared to generic advice (Brug, Oenema & Campbell, 2003). As such, it is unsurprising that it leads to improved health behaviour changes compared to generic health advice (Brouwer et al., 2011). Despite the well-established effects of computer tailoring, it is unknown if computer-tailored interventions would be more effective with an element of human support.

It appears no web-based physical activity interventions have provided both computer-tailored advice and online coaching simultaneously. It is therefore unknown whether this combined
approach improves intervention outcomes. When computer-tailored advice is delivered prior to the online coaching session it can largely reduce the time required from a coach to provide feedback. This allows the time and financial costs to conduct the intervention to be viable to reach large numbers. In addition the computer-tailored advice may reduce reliance on the knowledge and expertise of the coach. The addition of a brief online coaching session may add further explanation, personalisation and interpretation of the theory-based computer-tailored advice as well as provide a social support element (Olsen, 2013; Vaes et al., 2013; van Wier et al., 2009). Furthermore, advances in Internet technology and broadband capacity allow the coaching sessions to be delivered via free online video-calling programs (e.g., Skype) which, unlike online instant messaging or forums, enables the participant to view the coach whilst engaging in a verbal discussion. Psychological counselling over video-calling programs is becoming widely used and accepted (Fantus & Mishna, 2013). Video-coaching facilitates higher engagement, feelings of accountability and social support and reduces the risk of misunderstandings compared to emails and instant messaging (Abbott et al., 2008; Fantus & Mishna, 2013).

The current study will examine the feasibility in terms of retention, adherence, engagement and participant satisfaction of a computer-tailored web-based physical activity intervention, with and without brief online video-coaching sessions. The findings will guide health promotion professionals in delivering future large-scale web-based physical activity interventions that are effective in engaging participants and producing long-term behaviour changes. More specifically this study will assess the between-group differences in physical activity and quality of life outcomes as a result of receiving computer-tailored advice inclusive of video-coaching sessions, compared to computer-tailored advice alone and a wait-
list control group. Between-group differences in retention, adherence, engagement (website user statistics) and participant satisfaction will be assessed. TPB constructs will be assessed as mediators and moderators of physical activity. The adherence and satisfaction with the video-coaching sessions will be measured to help assess the feasibility of this intervention approach.

4.3 Methods

4.3.1 Participants

Participants will be eligible to participate if they are English speaking adults (over 18 years) who reside in Australia. Participants will be excluded if they are: non-English speaking, pregnant, under 18 years of age, currently meeting the Australian physical activity guidelines (assessed by a single item, ‘do you currently participate in less than 30 minutes of physical activity on average each day?’), or at risk of injury or ill health from increasing their physical activity (assessed by the Physical Activity Readiness Questionnaire) (Thomas et al., 1992) (Appendix A).

4.3.2 Recruitment

Print and Internet advertising will be used to recruit participants. Print advertising will include newspaper advertising in newspapers and posters and leaflets promoting the intervention will be displayed in sporting clubs, schools, the University and medical centres. The Internet advertising will include free posts on community websites and Google and Facebook advertisements. All advertisements will direct interested individuals to a specific recruitment page that is part of the intervention website (Figure 9) where they can find out more information about the study and download the participant information sheet (Appendix
E). A screening questionnaire will be delivered through the intervention website to assess an individual’s eligibility. Eligible participants will give their consent via an online consent form before commencing the intervention (Appendix F). Eligible participants will be randomly assigned to one of the three groups and notified via email of their log-in details and intervention starting date (Appendix G). Participants will be allocated at random using a computer generated sequence. Group assignment will only be disclosed after participants have completed the baseline assessment. 

Figure 9. Intervention recruitment page

4.3.3 Procedure

Participants will be randomly assigned to one of three groups: tailoring + video-coaching, tailoring-only or wait-list control. All tailoring groups will receive a web-based physical
activity intervention named ‘My Activity Coach’ that consists of four modules of computer-tailored advice. Additionally the tailoring + video-coaching participants will also receive four brief coaching sessions with a physical activity expert to discuss the personalised advice they received in the previous module. To control for exposure to additional intervention contacts in the tailoring + video-coaching groups the tailoring-only participants will receive a total of four tailored emails to remind them of the tailored advice they received in the previous module (Appendix G), but they will not receive any coaching. Questionnaire data will be collected at baseline, immediately post-intervention at week nine, and six and 12 months post baseline (see Figure 10). All questionnaires will be completed through the intervention website, including the wait-list control group (though no tailored content will be available for these participants). Satisfaction with the intervention and video-coaching will only be measured at nine weeks in intervention group participants. Participant retention, adherence and website engagement will be measured for the intervention participants throughout the intervention. Participants in the wait-list control group will be given the opportunity to participate in the intervention after they have completed the 12-month follow-up questionnaire (see Figure 10).
Figure 10. Intervention process flow diagram
4.3.4 The ‘My Activity Coach’ intervention

The ‘My Activity Coach’ intervention will provide four modules with personalised physical activity feedback over an eight week period. A new module will become available to participants every second week. In each module participants will log on to the intervention website (Appendix H), complete a brief survey and immediately receive computer-tailored advice based on their answers. Given that all content will be personally–tailored, there will be differences in the information that participants receive. For example, participants who are overweight or obese will receive additional information not provided to participants who are of normal weight, as this information would be irrelevant for them. Photographs of people tailored to participants’ activity levels, age and gender will be included in the feedback. The intervention will also provide participants with an action planning tool to support them in setting detailed physical activity plans during the program (Rhodes, Bruijn & Matheson, 2010a; Sniehotta, Scholz & Schwarzer, 2005). The content of the tailored advice and the action planning tool is described in more detail below. Every second week a new intervention module will become available to participants. The module will appear on the intervention homepage (Figure 11), and participants will receive an email to alert them that it is available (Appendix G). Participants will also receive up to two reminder emails to complete each module if they haven’t already done so (Appendix G). Participants who haven’t completed the module one week after it first becomes available will receive a reminder telephone call. Participants can access and re-complete previous modules up to 12 months post-baseline.
Constructing computer-tailored advice on an empirically supported theoretical framework has been found to improve intervention outcomes (Lustria et al., 2009). Research has demonstrated that tailoring to a combination of theoretical constructs, behavioural outcomes and demographics is ideal (Lustria et al., 2009; Morrison, Yardley, Powell & Michie, 2012; Noar et al., 2007). Therefore the tailoring scripts in the current intervention will be predominantly based on one behaviour change theory, Theory of Planned Behaviour (TPB) and one communication theory, Elaboration Likelihood Model (ELM). The tailoring scripts will thus tailor to TPB constructs, demographics and physical activity levels (Ajzen, 1988). The TPB was chosen as the behaviour change theory to guide the tailored advice as it
identifies pathways to behaviour change, has been found to explain a significant amount of variance in physical activity behaviour (Armitage & Conner, 2002; Hagger et al., 2002) and has been used to successfully guide a number of physical activity interventions over a range of population groups (Lustria et al., 2009; Noar et al., 2007; Vallance et al., 2007; Webb et al., 2010). The TPB (Ajzen, 1988) proposes that intention is the strongest influence of behaviour, which is in turn influenced by the individual’s attitude, subjective norm and perceived behavioural control. Attitude refers to the individual’s views on performing the target behaviour, which is formed from assessing the positives and negatives of performing the behaviour. Subjective norm refers to the individual’s perceptions of how they see their behaviour affecting their significant others. Perceived behavioural control refers to self-efficacy, which is an individual’s belief that they will be able to execute a target behaviour (Rodgers, Hall, Blanchard, McAuley & Munroe, 2002), and controllability in performing the target behaviour. Interventions based on TPB target individuals attitudes, subjective norms and perceived behavioural control to strengthen participants’ intentions to change the target behaviour. Interventions based on TPB also provide tools (e.g., action planning) to facilitate behaviour change arising from intentions (Ajzen, 1988). The intervention topics in the ‘My Activity Coach’ program and the corresponding TPB constructs they are designed to target can be found in Table 6.

The Elaboration Likelihood Model was also chosen to guide the intervention content in order to address the formation of participants’ attitudes (Cacioppo & Petty, 1984). The ELM identifies two types of persuasions that influence attitude; central and peripheral. Central persuasion is when an individual takes consideration of ample information to form an attitude. Peripheral persuasion is when an individual allows simplistic associations of
negative and positive attributes to form their attitude. Stronger and longer-term attitudes are likely to result from central persuasion. The central persuasive route is likely to occur with high elaboration (including evaluation, recall and judgment) (Cacioppo & Petty, 1984). Rucker and Petty (2006) explain that in order to facilitate elaboration of health promotion messages, interventions need to give listeners enough information about the health behaviour, demonstrate the credibility of the information, make the information relevant to the listener and repeat the key messages. Therefore ‘My Activity Coach’ participants are provided with information on the specific benefits of physical activity supported by research findings and trusted organisations (e.g., World Health Organisation). The participants are encouraged to see how physical activity is relevant to them and the key benefits of physical activity with the recommended amount of physical are presented in different forms (e.g., text, graph) (Rucker & Petty, 2006).

*Physical activity progress feedback:* Participants’ physical activity will be assessed via the validated Active Australia Questionnaire (AAQ) in every module (Appendix D). The tailored advice in Module 1 will begin with a graph of participants’ current level of physical activity compared to the minimum and optimal recommendations. The tailored advice in Modules 2, 3 and 4 will begin with a graph of participants’ current physical activity, their physical activity in the previous modules and the minimum and optimal recommendations (see Figure 12). This is included because increased awareness of participants’ own activity levels and progress over time have been found to improve participants’ self-efficacy (Ashford et al., 2010). In modules 3 and 4 participants will also receive a tailored statement about their success in completing the action plan they set in the previous module which will include appropriate feedback in creating their next action plan.
Module 1, titled ‘Are you active enough?’, will cover the importance of physical activity and the physical activity recommendations. Module 1 will introduce participants to the intervention, explain the physical activity recommendations in relation to participants’ current level of physical activity, and explain the health benefits of physical activity tailored to their BMI, age and level of physical activity. Participants will also receive personalised feedback about the benefits of becoming more active. Beliefs in the benefits of physical activity have been found to explain a significant amount of the variation in attitude to becoming more active (Downs & Hausenblas, 2005). Participants will receive a tailored statement addressing their task self-efficacy which is essential for starting exercise (Rodgers et al., 2002). Task self-efficacy refers to a participant’s belief that they can meet the physical activity recommendations. The module ends with a suggested goal (based on their current
activity level) to work towards until they receive the next module 14 days later. Goals set by researchers have been found to produce higher self-efficacy (Ashford et al., 2010).

**Module 2**, titled ‘Let’s set some goals’, will provide participants with information on goal setting and action planning. Information on creating SMART (Specific, Measurable, Achievable, Realistic and Timely) goals will be provided to participants. Goal setting is acknowledged as a successful strategy in improving physical activity levels and targets participants’ perceived behavioural control (Shilts et al., 2004). Azjen recommends that interventions based on the Theory of Planned Behaviour should also include implementations intentions (or action planning) to facilitate behaviour changes resulting from participants’ intentions to change the behaviour (Gollwitzer, 1999). Action planning requires participants to determine the specifics of how they will reach their goals (e.g., what, where, when, etc.). Action plans have been successful in improving participants’ health behaviours including physical activity (Gollwitzer, 1999; Sniehotta et al., 2005). Participants will also receive a tailored statement addressing their coping self-efficacy for common barriers including business, tiredness and lack of an activity partner. Coping self-efficacy is essential for exercise adherence (Rodgers et al., 2002).

**Module 3**, titled ‘Physical activity and your environment’, delivers tailored information on utilising participants’ social and physical environments to increase their physical activity. Participants will receive tailored information regarding their physical environment including whether they have a garden, how far they live from places regularly visited, whether they work full time, how long their work lunch breaks are and if they have showering facilities at work. Participants will also receive tailored information about their social environment including whether they are active with others and whether their family and friends are active
and/or support them in becoming more active. Participants will also receive a tailored statement addressing their scheduling self-efficacy which is important for exercise adherence (Rodgers et al., 2002). For example, participants who indicate that it will be hard to schedule 30 minutes of physical activity every day will be given tips to help them find times to get active (just do three 10 minute walks, or walk to the shops and back, or walk with a friend instead of meeting at the café), to illustrate that it is achievable.

Module 4, titled ‘Staying active’, addresses participants’ barriers to leading an active lifestyle and covers relapse prevention. Participants will be given tailored information about their most significant barrier to support them in overcoming that barrier. Participants’ beliefs about significant barriers to becoming more active have been found to explain a significant amount of the variation in perceived behavioural control (Downs & Hausenblas, 2005). Module 4 will also provide participants with information on relapse-prevention. Relapse prevention helps participants identify specific high-risk situations for relapse, enhances coping skills within those situations, helps participants manage lapses so it doesn’t lead to a relapse, and restructures participants’ perceptions of the relapse process. Research findings support the effectiveness of relapse prevention at reducing participants’ relapses (Larimer et al., 1999). Lastly, participants will receive a tailored statement addressing their maintenance self-efficacy. Here participants who indicate that it will be difficult to maintain an active lifestyle will be encouraged that it is achievable once habits are formed. Table 6 explains the sections in each module of the personalised activity advice, how the advice is tailored and the Theory of Planned Behaviour constructs that the section aims to address in order to improve physical activity behaviour.
Table 6. Topics, tailoring items and Theory of Planned Behaviour constructs of the computer-tailored physical activity advice

<table>
<thead>
<tr>
<th>Module</th>
<th>Topic</th>
<th>Tailoring variables</th>
<th>TPB Construct</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module 1: Are you active enough?</strong></td>
<td>Physical activity guidelines</td>
<td>None</td>
<td>Attitude</td>
</tr>
<tr>
<td></td>
<td>Normative feedback (also in graph format), compares participants’ physical activity to recommendations</td>
<td>Current physical activity levels</td>
<td>Subjective norms</td>
</tr>
<tr>
<td></td>
<td>Physical activity sessions</td>
<td>Current physical activity levels and number of activity sessions each week</td>
<td>Subjective norms</td>
</tr>
<tr>
<td></td>
<td>Importance of physical activity, tailored to current activity levels, BMI and age. Task self-efficacy</td>
<td>Current physical activity levels, BMI and age</td>
<td>Attitude</td>
</tr>
<tr>
<td></td>
<td>Benefits</td>
<td>Top two most important benefits of becoming more active</td>
<td>Attitude</td>
</tr>
<tr>
<td></td>
<td>Suggested goal increase in physical activity</td>
<td>Current physical activity levels</td>
<td>Intention</td>
</tr>
<tr>
<td><strong>Module 2: Let’s set some goals!</strong></td>
<td>Feedback on physical activity changes</td>
<td>Physical activity levels at modules 1 and 2</td>
<td>PBC</td>
</tr>
<tr>
<td></td>
<td>Coping self-efficacy</td>
<td>Current physical activity levels, and perceived difficulty with meeting the guidelines when not feeling great, busy and/or do not have an activity buddy</td>
<td>PBC</td>
</tr>
<tr>
<td></td>
<td>Goal setting</td>
<td>Current physical activity levels, and experience and knowledge of goal setting</td>
<td>Intention</td>
</tr>
<tr>
<td></td>
<td>Action plans</td>
<td>Current physical activity levels</td>
<td>Intention</td>
</tr>
<tr>
<td><strong>Module 3: Physical activity and your environment</strong></td>
<td>Feedback on physical activity changes</td>
<td>Physical activity levels at modules 2 and 3</td>
<td>PBC</td>
</tr>
<tr>
<td></td>
<td>Feedback on progress to meeting action plan</td>
<td>Success at meeting action plan set after module 2</td>
<td>PBC</td>
</tr>
<tr>
<td></td>
<td>Scheduling self-efficacy</td>
<td>Current physical activity levels and perceived difficulty with scheduling times to get active</td>
<td>PBC</td>
</tr>
<tr>
<td></td>
<td>Utilising physical environment to become more active</td>
<td>Possession of a garden, distance to places regularly visited, working status, length of lunch break and facilities at work.</td>
<td>PBC</td>
</tr>
<tr>
<td></td>
<td>Utilising social environment to become more active</td>
<td>Activity levels of friends and family, support from friends and family and presence of an activity buddy or sporting team</td>
<td>Subjective norms</td>
</tr>
<tr>
<td><strong>Module 4: Staying active</strong></td>
<td>Feedback on physical activity changes</td>
<td>Physical activity levels and number of activity sessions at modules 1 and 4</td>
<td>PBC</td>
</tr>
</tbody>
</table>
Feedback on progress to meeting action plan

Success at meeting the action plan set after module 3

PBC

Barriers

Top two most significant barriers to becoming more active

PBC

Maintenance self-efficacy

Current physical activity levels and perceived difficulty with continuing to meet the guidelines

PBC

Relapse prevention

Physical activity levels at modules 1, 2, 3 and 4

Intentions

PBC: Perceived Behavioural Control

**Action planning tool:** An action planning tool will be provided to guide participants in setting an effective action plan. The action planning tool is made up of a structured form where participants can enter up to four different activities they plan to do in the upcoming fortnight. For each activity they will be asked where they will do it, when they will do it, for how long they will do it (session duration), and with whom they will do it (activity partner). Participants will be provided with information and tips to guide them in choosing their activities, locations, time and support person. After participants have completed their action plan they will be provided with an overview in the format of a weekly calendar with the times they selected to participate in each of the activities, including their support person and the location (Figure 13). Participants are encouraged to print their action plan and carry it out over the following two weeks. Participants will be encouraged to create an action plan after module 2 (where the concept of goal setting and action planning is explained), module 3 and module 4.
Figure 13. Action plan output

**Video-coaching sessions:** The video-coaching sessions will take place on alternate weeks to the modules (e.g., week 1 = module 1, week 2 = video-coaching, week 3 = module 2, etc.) through an online video-calling program of participants’ choice. The coaching sessions will only be available for participants in the tailoring + video-coaching group. These participants will have a ‘video-coaching’ tab on the website which will include a link to free online video-calling programs including Skype, Google Hangout, Yahoo Messenger and Face Time; and information on how to set up an account (Appendix H). The website will also provide a link to a calendar where participants can book their time slot with the Activity Coach (Appendix H). They will need to book a time for each of the four sessions, and will be asked to do this immediately following the completion of a module (thus one week in advance of
the coaching session). During the session the Activity Coach will comment on the tailored advice participants received in the module from the previous week. The Coach will ask participants if they have been able to act on the advice and if they encountered any problems adhering to the advice (Appendix I). The coach will also ask participants if they have any questions. The coach will ensure that the video call will be a maximum of 15 minutes in length. The sessions are purposefully designed to be short to assess whether this method can be viable for future large scale interventions, and to keep the time requirements of participants to a minimum.

4.4 Measures

Participants will receive a total of four questionnaires to assess their physical activity, the correlates of physical activity related to the Theory of Planned Behaviour and quality of life across four time points (baseline, immediately after the end of the intervention (week nine), at six months and at 12 months post-baseline). Participants’ demographics and satisfaction with the intervention will only be assessed in the baseline and post intervention (week nine) questionnaires respectively. The satisfaction questions will only be given to the intervention groups, as the wait-list control participants will not have completed the intervention at this time point (week nine). The individual measures included in the questionnaires are explained below. Participant adherence, retention and engagement will be measured throughout the intervention. These measures are explained in detail below.

4.4.1 Demographics

Participants’ demographics including gender, age, BMI, marital status, income, education, employment and location will be assessed in the baseline survey (Appendix C).
4.4.2 Physical activity

The validated Active Australia Questionnaire will be used to measure total physical activity and whether participants meet the physical activity guidelines (Australian Institute of Health and Welfare, 2003). This tool assesses the number of sessions and total time spent walking, participating in moderate physical activities, vigorous physical activities and gardening during the previous week (Appendix D). Total physical activity time is calculated by summing the time spent walking, performing moderate-intensity physical activity, and performing vigorous-intensity physical activity multiplied by two. Physical activity sessions need to be ten minutes or longer to be included. Participants are categorized as being sufficiently physically active for health benefits if they participate in a minimum of 150 minutes of physical activity per week. The Active Australia Questionnaire has been found to have a good test-retest reliability (Kappa = .52) (Brown et al., 2004b), a high percentage agreement with other physical activity measures (67%-75%) (Brown et al., 2004a) and is sensitive enough to detect changes in physical activity (Ferney et al., 2009).

4.4.3 Quality of life

The SF-12v2 will be used to measure participants’ quality of life by assessing participants’ physical and mental health status (Appendix J). The SF-12v2 measures eight health domains: physical functioning, role participation with physical health problems (role-physical), bodily pain, general health, vitality, social functioning, role participation with emotional health problems (role-emotional), and mental health (Ware et al., 1996). Physical health component and a mental health component scores are calculated using norm based standardised scores. The SF-12v2 was developed as a short version of the SF-36 and has been proven to be a valid and reliable measure of quality of life. It has good construct validity compared to other
measures of quality of life including the SF-36 (PHC r=.95, MCH r=.96) (Burdine, Felix, Abel, Wiltraut & Musselman, 2000), and good test-retest reliability (PHC r=.89, MCH r=.76) (Ware et al., 1996).

4.4.4 Theory of Planned Behaviour

Constructs of the Theory of Planned Behaviour including attitude, subjective norm, perceived behavioural control and intention towards physical activity will be measured using a 16 item questionnaire developed by Rhodes, Hunt Matheson and Mark (2010b) (Appendix K). The measures for all constructs have shown good reliability (α=.80-.95) and attitude, perceived behavioural control and subjective norm have a good predictive validity of intention (r=.85) (Rhodes et al., 2010b). To measure attitude participants will be asked to respond to “For me, regular physical activity over the next two weeks would be. . . .” by selecting a response on six 7-point bipolar adjective scales that measure both instrumental (beneficial/harmful, useful/useless, wise/foolish) and affective (enjoyable/unenjoyable, interesting/boring, relaxing/stressful) aspects of attitude. Subjective norm will be measured by four items on a 7-point Likert scale, for example “Most people who are important to me would encourage me to engage in regular physical activity over the next two weeks.”

Perceived behavioural control will be measured by three items on a 7-point Likert scale, for example “In the next two weeks, doing physical activity, if I really wanted to, is under my control.” Intentions will be measured by three items on a 7-point Likert scale, for example “I am committed to engage in physical activity over the next two weeks.” A four item planning scale will also be used to assess the plans participants have to increase their physical activity. The planning scale was developed by Trinh, Plotnikoff, Rhodes, North and Courneya (2012) and includes four items, i.e., ‘I have made plans concerning ‘when’, ‘where’, ‘what’ and
‘how’ I am going to engage in regular physical activity in the coming month.’ The items will be assessed on a 7-point Likert scale with options ranging from ‘no plans’ to ‘detailed plans.’ Trinh et al. (2012) developed this scale based on the guidelines by Ajzen (2006), and found it to explain a significant percentage of the variance in physical activity behaviour ($r = .50; p<.001$).

4.4.5 Participant satisfaction

Intervention satisfaction will be assessed for intervention group participants only. Participants’ satisfaction with different parts of the intervention will be assessed by a questionnaire (68 items) that was specifically developed for this study though based on previous research (Yip, Chang, Chan & MacKenzie, 2003), and will include items on the questions needed to generate the personalised feedback, the tailored advice, website usability, the coaching sessions (for tailoring + video-coaching participants only) and the overall satisfaction with the program (Appendix L). The majority of items are on a 5-point Likert scale where participants are asked to rate their agreement (strongly agree to strongly disagree) to statements about the intervention, for example, ‘the questions were easy to understand.’ Four open ended items will also be included in the sections on the tailored advice, website usability, the coaching session and the overall program to provide participants with the opportunity to describe 1) what they liked, 2) what they didn’t like, 3) any recommendations they may have to improve the program and 4) if they have any further comments.
4.4.6 Intervention adherence and study retention

To determine whether the intervention was delivered as planned, participants’ completion of the intervention sessions will be recorded. The coaching participant’s completion of the coaching sessions and the length of the coaching sessions will also be recorded to measure coaching adherence and fidelity. Participants’ completion of the research surveys was recorded as a measure of retention.

4.4.7 Website engagement

Google Analytics will be set up to record the number of times participants visit the intervention website and the total time participants spend on the website.

4.5 Data analysis

4.5.1 Intervention effectiveness

Data will be analysed using intention-to-treat principles. Physical activity will be modelled using linear mixed models with random intercepts, the fixed effects of group (control, tailoring only, tailoring + video-coaching) and time (baseline, post-intervention, 6-months, 12-months), and a group by time interaction.

4.5.2 Secondary analyses

The secondary analyses will be conducted using linear mixed models to determine the effect of group and time on quality of life. Chi-square tests and analyses of variance will also be used to compare retention, adherence, engagement and satisfaction between groups. Multiple regression analyses will be conducted to assess Theory of Planned Behaviour concepts including intention, attitude, subjective norm, perceived behavioural control and planning as
mediators for physical activity changes. Multiple regression analyses will also be used to assess these Theory of Planned Behaviour concepts as well as demographic variables (age, gender, income, marital status, education and BMI) as moderators for physical activity changes. Descriptive statistics will be used to assess participant satisfaction and adherence to the video-coaching sessions.

4.5.3 Sample size

The sample size needed to detect between-group differences in physical activity levels across the primary time points (baseline and post-intervention) through linear mixed models was calculated from the sample size analysis developed by Lu, Luo and Chen (2008). The alpha level was set to ≤0.05 (80% power). The effect size was estimated to be small (.43) based on the findings from a recent meta-analysis looking at the effectiveness of physical activity interventions with a minimal control group (Davies et al., 2012b). Reviews and meta-analyses have found average attrition levels of web-based physical activity levels to be around 25% (Davies et al., 2012b; Vandelanotte et al., 2007). Therefore an estimated attrition of 25% was factored into the calculations. The analysis revealed that a sample size of 300, or 100 in each study arm, is required for the current study to detect small effects between group differences in physical activity across the two time points.

4.6 Discussion

Further research is needed to determine effective combinations of web-based intervention components to improve intervention effectiveness in terms of participant engagement and long-term behaviour changes (Davies et al., 2012b). An understanding of effective low cost methods of delivering personalised physical activity advice (online coaching and tailored
advice) is important as, although there is some evidence for the effectiveness of both components (Lustria et al., 2009; Noar et al., 2007; Winett et al., 2007), each form of personalised advice has different benefits and costs. Web-based interventions commonly use computer-tailored advice as it can deliver similar content at a lower cost than coaching sessions (Lustria et al., 2009; Noar et al., 2007). However coaching adds a social support element that is found to improve intervention outcomes (Barrera et al., 2006; Winett et al., 2007). The current study will measure the effectiveness of a novel approach, combining both computer-tailored advice and an online coaching session using a video-calling program (e.g., Skype) in order to provide participants with advice and social support at a low-cost. This approach minimises the content the coach is required to deliver and utilises the availability of free online video-calling programs. The physical activity, retention, adherence, engagement and satisfaction outcomes of brief online coaching sessions in addition to a web-based physical activity intervention that provides computer-tailored advice will be assessed. The findings will shed light on whether this new approach to delivering tailored advice is feasible and more effective than stand-alone computer-tailored advice. Knowledge of the effectiveness of brief online coaching sessions will be beneficial for the development of future web-based physical activity interventions that can be delivered on a large scale and are effective in engaging participants and producing long-term behaviour changes.
Chapter 5. Intervention trial

Web-based video-coaching to assist an automated computer-tailored physical activity intervention for inactive adults: A randomised controlled trial.
5.1 Abstract

Web-based physical activity interventions that apply computer tailoring have shown to improve engagement and behavioural outcomes, but provide limited accountability and social support for participants. It is unknown how online video-calls with a behavioural expert in a web-based intervention will be received and whether they improve the effectiveness of computer-tailored advice. The purpose of this study was to determine the effectiveness and feasibility of brief video-based coaching in addition to computer-tailored advice in a web-based physical activity intervention. Participants were assigned to one of three groups: 1) tailoring + video-coaching where participants received an eight week computer-tailored web-based physical activity intervention (‘My Activity Coach’) including four ten minute coaching sessions with a behavioural expert using a web-based video-calling program (e.g., Skype) (n=52); 2) tailoring-only where participants received the same intervention without the coaching sessions (n=54); and 3) a wait-list control group (n=45). Demographics were measured at baseline, intervention satisfaction at week nine and physical activity at baseline, week nine and six months by self-report surveys. Effectiveness was assessed using linear mixed models to compare physical activity changes between groups. Feasibility was analysed by comparing intervention groups on retention, adherence, engagement and satisfaction using t-tests and chi²-tests. At nine weeks physical activity increased from baseline to post-intervention in all groups (tailoring + video-coaching: +150 minutes/week; tailoring-only: +123 minutes/week; wait-list control: +34 minutes/week). The increase was significantly higher in the tailoring + video-coaching group compared to the control group (P=.01). No significant difference was found between intervention groups and no significant between-group differences were found for physical activity change at six months. A low percentage of tailoring + video-coaching completers participated in the
coaching calls (48%). However the majority of those who participated in the video-calls were satisfied with them (71%), and had improved intervention adherence (82% completed three or four modules vs. 43%, \( P=.01 \)) and engagement (110 minutes spent on the website vs. 78 minutes, \( P=.02 \)) compared to other participants. There were no overall retention, adherence, engagement and satisfaction differences between tailoring + video-coaching and tailoring only participants. The findings support the effectiveness of providing online video-coaching and computer-tailored advice in a web-based physical activity intervention. More research is needed to determine whether online coaching is more effective than stand-alone computer-tailored advice.
5.2 Introduction

Physical activity improves physical and mental health and significantly lowers the risk of non-communicable disease, including cardiovascular disease, diabetes and cancer (Lee et al., 2012). Australian guidelines recommend 150-300 minutes of low to moderate intensity activity each week, over five days, to receive health benefits and reduce the risk of non-communicable disease (Department of Health and Aging, 2014). Despite this, less than 50% of Australians meet these recommendations (Australian Bureau of Statistics, 2013a). As such, there is a need for effective and affordable physical activity interventions with a broad reach.

Health behaviour change interventions delivered via the Internet have the potential to reach a large audience at low-cost, due to the majority of Australians (92%) having Internet access (Australian Communications and Media Authority, 2015). Furthermore, they are convenient for participants and enable the content to be delivered in a non-confrontational manner (Christopherson, 2007; McConnon et al., 2007; Tate et al., 2009). The effectiveness of web-based physical activity interventions is well established, however problems with low engagement and high drop-out rates limit their effectiveness to achieve long-term behaviour changes (Davies et al., 2012b; Vandelanotte et al., 2007). Personalised health advice through online coaching sessions or computer-tailored feedback engages participants and improves the effectiveness of web-based health behaviour interventions (Broekhuizen, Kroeze, van Poppel, Oenema & Brug, 2012; Brouwer et al., 2011; Lustria et al., 2009). Both online coaching sessions and computer-tailored advice provide support similar to traditional face-to-face coaching sessions, at a lower cost with fewer geographical restrictions (Lustria et al., 2009; Noar et al., 2007).
Coaching is defined as “facilitating health behaviour change through interactions between a health professional (coach) and a client” (Olsen, 2013, p. 1). Online coaching sessions are most similar to traditional face-to-face coaching as they provide personal interaction. Online coaching in web-based physical activity interventions improves participants’ perceptions of their social support which is associated with greater levels of behaviour change (Barrera et al., 2006; Winett et al., 2007). Advances in Internet technology and broadband capacity now allow the option of delivering coaching sessions via free online video-calling programs (e.g., Skype), which allow participants to view the coach and engage in a verbal discussion. Video-coaching facilitates higher engagement, feelings of accountability and social support, and reduces the risk of misunderstandings compared to emails and instant messaging (Abbott et al., 2008; Fantus & Mishna, 2013). However, web-based video-coaching remains a relatively high cost method of delivering personalised advice.

Computer tailoring can deliver personalised advice at a low cost by using a computer-based expert system to automatically deliver feedback to participants’ responses to an online questionnaire (Lustria et al., 2009). Computer-tailored physical activity advice is preferred by participants and leads to greater attention (Brug et al., 2003) and improved health behaviour outcomes compared to generic health advice (Brouwer et al., 2011). Although the effectiveness of computer tailoring is well established and it has the benefit of providing personalised advice to large numbers at low-cost, it is unknown whether it could be more effective with an element of human support.

To our knowledge no health behaviour interventions have combined computer-tailored advice with online video-coaching. This approach may improve intervention outcomes by utilising the benefits of both methods. Providing computer-tailored advice can limit the time
required from a video-coach, therefore limiting costs as well as reducing reliance on the knowledge and expertise of the coach. A brief coaching session can add an element of social support as well as further explanation, personalisation and interpretation of theory-based computer-tailored advice received by participants at an earlier time. It is unknown whether brief video-coaching sessions lead to improved physical activity and quality of life compared with stand-alone computer-tailored advice. It is also unknown whether they are feasible in terms of retention, adherence, engagement and satisfaction. Therefore this study explores the effectiveness and feasibility of brief online coaching sessions in addition to computer-tailored advice.

5.2.1 Aims and hypotheses

The first aim of the study is to test the effectiveness of brief video-coaching, when used to discuss previously received computer-tailored physical activity advice, in a stand-alone web-based intervention for inactive adults in terms of physical activity and quality of life outcomes. The second aim is to determine the feasibility of the video coaching sessions. Feasibility will be determined by adherence and satisfaction of the coaching sessions and comparing intervention retention, adherence, website engagement and satisfaction of the tailoring + video-coaching and tailoring only groups. The primary outcome was between group differences in physical activity changes. The secondary outcomes were between group differences in quality of life changes and feasibility. It was hypothesised that computer tailoring in combination with video-coaching would result in greater improvements in quality of life and physical activity compared to a computer-tailored only group and a wait-list control group. It was also hypothesised that computer tailoring and video-coaching would
result in greater retention, adherence, engagement and satisfaction with the intervention, compared to a computer-tailored only group and a wait-list control group.

5.3 Methods

A detailed account of the methods can be found in chapter 4. The 12 month follow up and theory of planned behaviour mediation analysis planned in the protocol was not included in the current chapter as it was beyond the scope and time frame of the thesis. The recruitment methods, participant eligibility, protocol, intervention description, measures and data analysis are summarised below.

5.3.1 Recruitment

Print and Internet advertising were used to recruit participants from a number of Australian metropolitan and regional cities (Sydney, Melbourne, Perth, Brisbane, Rockhampton, Bundaberg, Mackay and Townsville). Print advertising included newspaper advertisements and articles, posters and leaflets displayed in health clinics and leaflets distributed to peoples’ homes (Appendix B). The Internet advertising included links displayed on community websites and paid advertisements on Google and Facebook. Ethics approval was received from the CQUniversity Human Research Ethics Committee (H13/04-044), before recruitment took place from March 2014 to January 2015.

5.3.2 Participants

People were eligible to participate if they were English speaking Australian adults (over 18 years). Participants were excluded if they were pregnant, at risk of injury or ill health from increasing their physical activity (as assessed by the Physical Activity Readiness Questionnaire), or if they were already meeting the physical activity recommendations (as
assessed via a single item asking if participants participated in 30 minutes of physical activity on most days; Appendix A).

5.3.3 Protocol

Information about the study was available on the landing page of the intervention website. To assess an individual’s eligibility, how they heard about the program and collect contact details, a screening questionnaire was delivered through the intervention website. Eligible participants were randomly assigned based on a sequence (not concealed) of random numbers between 1 and 3 to one of three study arms: tailoring + video-coaching, tailoring-only or wait-list control. This was done in blocks of 15 participants. SA generated the random allocation sequence and assigned participants to groups. Participants remained blind to their condition until after completing all baseline measures. It was not possible to blind researchers to participants’ group assignment after they had completed the baseline questionnaire as the researchers conducted the coaching sessions. The consent sheet explained the two interventions and therefore it is possible that participants worked out whether they were in the intervention of interest or comparator. Participants began the intervention on the Monday following their recruitment. The consent form (Appendix F) and then baseline questionnaire were administered through the intervention website for all groups. Upon completing the baseline questionnaire the intervention groups received module 1 of their personalised advice, whereas the control group received nothing. The intervention, ‘My Activity Coach’ delivered one module of computer-tailored advice every two weeks over eight weeks (four modules in total). During the weeks where no new modules were received participants in the tailoring + video-coaching group received a brief coaching session through an online video-calling program (e.g., Skype) to reiterate the advice received
in their previous module (Appendix I). Participants in the tailoring-only group received an email reminding them of the tailored advice they received in the previous module to ensure both intervention groups received the same number of contacts (Appendix G). Participants in the wait-list control group were given the opportunity to participate in the intervention without coaching, after they completed the final questionnaire. Questionnaires were administered through the intervention website immediately after the end of the intervention (week nine) and six months after the end of the intervention. Participants who completed all surveys went in the draw to win one of 30 pedometers, 6 fit bits and 3 heart rate monitors. The intervention was run from March 2014 to March 2015. Due to many individuals beginning and failing to complete the screening questionnaire, conducting the screening questionnaire by telephone was trialled (after receiving an ethics amendment from the CQUniversity Human Research Ethics Committee). This was done for 15 prospective participants and discontinued due to failure to increase screening completions. No other changes to the protocol were carried out during the trial.

5.3.4 Intervention

The eight-week ‘My Activity Coach’ intervention delivered a new module of tailored advice to participants every two weeks. Each module required participants to complete a brief online questionnaire about their physical activity and psychosocial correlates of physical activity. Feedback was then provided based on their responses to the questionnaire. Participants received up to four reminder emails (Appendix G) and a reminder telephone call when they didn’t complete the survey required for each module. The tailored advice was based on behaviour change theory (Theory of Planned Behaviour) (Ajzen, 1988) and communication theory (Elaboration Likelihood Model) (Cacioppo & Petty, 1984). Each module began with a
graph including bars to represent participants’ current physical activity and their physical activity during the previous modules, as well as the minimum and optimal physical activity recommendations. Module 1, titled ‘Are you active enough?’, explained the physical activity recommendations and health benefits of physical activity tailored to their BMI, age and level of physical activity. The module ended with a suggested goal (based on their current activity level) to work towards until the next module. Module 2, titled ‘Let’s set some goals’, provided participants with information on goal setting and action planning. Module 3, titled ‘Physical activity and your environment’, delivered tailored information on using participants’ social and physical environments to increase their physical activity. Module 4, titled ‘Staying active’, addressed relapse prevention. Participants also received tailored advice on their perceived benefits and barriers to being active and self-efficacy to become more active throughout the modules. The modules and intervention website were adapted from an earlier 2-module web-based intervention with computer-tailored advice for inactive adults (Vandelanotte et al., 2012). Focus groups were conducted to inform development of this prior intervention (Vandelanotte & Mummery, 2011).

An action planning tool became available to participants after Module 2. The tool allowed participants to create an action plan for up to four activities (specifying where, when, for how long, and with whom they would be active over the following two weeks). Participants could print a calendar-based overview of their action plan. The coaching group’s 10 to 15 minute bi-weekly video-coaching sessions were conducted through an online video-calling program of participants’ choice (e.g., Skype, Google Hangout, Yahoo Messenger and Face Time). During the session the Activity Coach commented on the tailored advice participants
received in the module from the previous week, answered any questions participants had and provided encouragement, support and accountability.

5.3.5 Measures

Participants’ demographics including gender, age, BMI, income, education, employment and location were assessed in the baseline survey (Appendix C). Participants were also asked if they used a video-calling program (Skype, Google hangout, Facetime, Other, None). The primary outcome, weekly physical activity, was assessed at all time-points by the Active Australia Questionnaire (AAQ) which is valid (Brown et al., 2004a) and reliable (Brown et al., 2004b) (Appendix D). Quality of life was measured at all three time points by the SF-12v2 which is valid (Burdine et al., 2000) and reliable (Ware et al., 1996) (Appendix J). A physical health and a mental health component score was calculated from the SF-12v2 following manual instructions (Saris-Baglama et al., 2011). Completion of the coaching sessions, the length of the coaching sessions and reasons for missed coaching sessions were recorded by the coach. Intervention retention and adherence were assessed by recording participants’ completion of the research surveys and intervention modules respectively and website engagement was measured through Google Analytics. Google Analytics recorded the number of website visits and time spent on the website for each participant. Intervention participants’ satisfaction with the intervention was assessed at the end of the intervention (week nine). Satisfaction with module questions (four items), computer-tailored advice (14 items), website usability (13 items), overall program (five items) and coaching (14 items) were all assessed (Appendix L). The items were specifically developed for this study, though based on previous research (Yip et al., 2003). The items were on a 5-point Likert scale where participants were asked to rate their agreement (1=strongly agree to 5= strongly disagree) to
statements about the intervention. All positively framed questions were reverse scored. For each category, participants with a mean rating of 3.6 or higher (maximum = 5) were categorised as ‘satisfied.’ Coaching participants were also asked if they completed a coaching session and if not why not. All intervention participants were asked four open-ended questions about three topics; the advice, website and overall program. Coaching participants who completed a coaching session were asked an additional four open-ended questions specifically relating to the coaching sessions. The four questions for each category (advice, website, program and coaching) were; 1) What did you like about the advice/website/program/coaching? 2) What did you not like? 3) Any recommendations for improvement? and 4) Any other thoughts? Responses for all questions were thematically analysed.

5.3.6 Data analysis

Baseline demographics for participants in each trial arm (tailoring + video-coaching, tailoring-only and control) were presented. The demographics of completers vs. drop-outs, as well as coaching participants who did vs. did not complete a coaching session were compared using chi-square and t-tests. To test effectiveness longitudinal data were analysed using intention-to-treat principles. Physical activity, mental health score and physical health score were each modelled using linear mixed models with time (baseline, week nine and six months) as a repeated factor, fixed effects of time and group (control, tailoring-only, tailoring + video-coaching) and a time by group interaction.

To test feasibility of the coaching sessions, completion of the coaching sessions, the length of the coaching sessions and reasons for missed coaching sessions were presented. Next, the two intervention groups, as well as coaching participants who did vs. did not complete a
coaching session, were compared on retention (drop-outs vs. completers) and adherence (completed 1-2 modules vs. 3-4 modules) using a chi-square test, number of website visits and time spent on the website using t-tests and satisfaction scores (satisfied, vs. neutral or not satisfied) using a chi-square test. Significance level was set to $p<.05$.

5.3.7 Sample size

Sample size calculations revealed that a sample size of 300, or 100 in each study arm, is required to detect between-group differences in physical activity from baseline to post intervention using linear mixed models (Lu et al., 2008). This calculation was based on the alpha level of $\leq 0.05$ (80% power) and a small effect size (.43) and 25% attrition which are common in similar interventions (Davies et al., 2012b).

5.4 Results

5.4.1 Flow of participants

Of the 239 randomly assigned participants, 154 completed the baseline questionnaire and at least one of the intervention modules. Of these, 84 participants completed the post intervention survey at week nine (55% retention). A total of 59 participants completed the six month follow up questionnaire (38% retention). There were no demographic differences between those who completed the nine week survey and those who did not. The majority of participants were recruited through Facebook (63%), and small percentages were recruited through Google (8%), a newspaper article (6%), letterbox drops (5%), family or friend (5%), leaflets (5%), posters (4%), community websites (3%) and newspaper advertisements (1%). Figure 14 presents the flow of participants through the trial.
Figure 14. Participant flow through the intervention trial

*Participants excluded because they were identified as having a health issue preventing them from safely increasing their physical activity according to the Physical Activity Readiness Questionnaire.

5.4.2 Sample characteristics

The majority of participants were female (76%) and were on average 54 years of age. Just under half (43%) were not employed and 83% had completed a higher education course. Less than half (40%) of participants were physically active and on average participated in 168 minutes of physical activity. The average BMI was 31, which is in the obese range. The majority (70%) used a video-calling program (Table 7).

Table 7. Baseline characteristics, physical activity and quality of life by group assignment

<table>
<thead>
<tr>
<th></th>
<th>Tailoring + video coaching n(%)</th>
<th>Tailoring only n(%)</th>
<th>Control n(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender n = 154</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>16(30)</td>
<td>14(25)</td>
<td>7(16)</td>
</tr>
<tr>
<td>Females</td>
<td>37(67)</td>
<td>42(75)</td>
<td>38(84)</td>
</tr>
<tr>
<td><strong>Employment n = 151</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full time</td>
<td>19(37)</td>
<td>21(38)</td>
<td>18(40)</td>
</tr>
<tr>
<td>Part time/casual</td>
<td>10(19)</td>
<td>10(19)</td>
<td>9(20)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>23(44)</td>
<td>23(43)</td>
<td>18(40)</td>
</tr>
<tr>
<td><strong>Education n = 151</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than secondary</td>
<td>2(4)</td>
<td>0(0)</td>
<td>0(0)</td>
</tr>
<tr>
<td>Secondary</td>
<td>8(15)</td>
<td>10(19)</td>
<td>6(13)</td>
</tr>
<tr>
<td>Further education</td>
<td>42(81)</td>
<td>44(81)</td>
<td>39(87)</td>
</tr>
<tr>
<td><strong>Income n = 112</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over $78,000</td>
<td>21(55)</td>
<td>14(36)</td>
<td>21(60)</td>
</tr>
<tr>
<td>$31,200 - $77,999</td>
<td>11(29)</td>
<td>17(44)</td>
<td>6(17)</td>
</tr>
</tbody>
</table>
39 respondents chose not to disclose their income. Note: Baseline data was lost for three participants and data for one participant’s BMI was removed as it was outside the possible range.

<table>
<thead>
<tr>
<th>Under $31,199</th>
<th>6(16)</th>
<th>8(20)</th>
<th>8(23)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Uses online video-calling</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>51(63)</td>
<td>53(68)</td>
<td>63(79)</td>
</tr>
<tr>
<td>No</td>
<td>30(37)</td>
<td>25(32)</td>
<td>17(21)</td>
</tr>
<tr>
<td>M(SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Age (years) n = 154</strong></td>
<td>55.26(10.93)</td>
<td>52.18(11.53)</td>
<td>55.18(13.45)</td>
</tr>
<tr>
<td><strong>BMI (kg/m²) n = 150</strong></td>
<td>32.08(7.43)</td>
<td>31.58(7.43)</td>
<td>29.97(6.75)</td>
</tr>
<tr>
<td><strong>Baseline Total Physical Activity (minutes/week) n = 151</strong></td>
<td>189.52(214.30)</td>
<td>152.87(174.33)</td>
<td>160.44(191.23)</td>
</tr>
<tr>
<td><strong>Week 9 Total Physical Activity (minutes/week) n = 83</strong></td>
<td>387.83(264.89)</td>
<td>315.17(264.39)</td>
<td>211.00(164.16)</td>
</tr>
<tr>
<td><strong>6 month Total Physical Activity (minutes/week) n = 59</strong></td>
<td>419.52(77.109)</td>
<td>319.71(164.77)</td>
<td>305.00(315.86)</td>
</tr>
<tr>
<td><strong>Baseline Mental Health Score n= 148</strong></td>
<td>46.10(1.30)</td>
<td>41.36(12.27)</td>
<td>42.74(1.78)</td>
</tr>
<tr>
<td><strong>Week 9 Mental Health Score n= 82</strong></td>
<td>48.97(10.27)</td>
<td>30.03(6.12)</td>
<td>45.19(10.50)</td>
</tr>
<tr>
<td><strong>6 month Mental Health Score n= 59</strong></td>
<td>48.16(12.11)</td>
<td>43.90(10.34)</td>
<td>44.94(11.84)</td>
</tr>
<tr>
<td><strong>Baseline Physical Health Score n= 146</strong></td>
<td>46.90(10.17)</td>
<td>51.92(8.28)</td>
<td>48.62(8.98)</td>
</tr>
<tr>
<td><strong>Week 9 Physical Health Score n= 78</strong></td>
<td>46.88(12.05)</td>
<td>51.48(6.95)</td>
<td>47.32(9.37)</td>
</tr>
<tr>
<td><strong>6 month Physical Health Score n= 59</strong></td>
<td>46.60(10.22)</td>
<td>52.38(5.47)</td>
<td>48.18(10.46)</td>
</tr>
</tbody>
</table>
5.4.3 Physical activity

The primary outcome, physical activity (minutes/week) improved from baseline to post-intervention (week nine) and from baseline to follow-up (six months) in all groups (Table 8, Figure 15). The physical activity increase from baseline to post-intervention in the tailoring + video-coaching group in comparison to the control group was significant (Table 8). No significant difference was found between the intervention groups (Table 8). No significant differences were found between groups on physical activity changes from baseline to follow-up at six months.

Figure 15. Mean physical activity at baseline, week nine and six months

Note: 95% confidence intervals presented for the coaching and control groups only.
5.4.4 Quality of life

Physical health scores remained relatively constant across each time point (Table 8). Mental health scores remained relatively constant in the control and tailoring + video-coaching group, however mental health scores dropped in the tailoring-only participants at post-intervention (Table 8). Therefore there was a significant difference in mental health between both intervention groups from baseline to post-intervention (Table 8).

Table 8. Physical activity, mental health and physical health changes by group

<table>
<thead>
<tr>
<th></th>
<th>Baseline to Post-intervention(^b)</th>
<th>Baseline to Follow-up(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate (P) value</td>
<td>Estimate (P) value</td>
</tr>
<tr>
<td><strong>Physical Activity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tailoring + video-coaching vs. control</td>
<td>140.94 (-254.01, -27.87)</td>
<td>66.16 (-244.55, 112.24)</td>
</tr>
<tr>
<td>Tailoring + video-coaching vs. tailoring-only</td>
<td>35.39 (-148.50, 77.71)</td>
<td>-25.16 (-211.74, 161.43)</td>
</tr>
<tr>
<td><strong>Mental Health</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tailoring + video-coaching vs. control</td>
<td>.04 (-5.87, 5.94)</td>
<td>.36 (-5.65, 6.38)</td>
</tr>
<tr>
<td>Tailoring + video-coaching vs. tailoring-only</td>
<td>-13.18 (-19.10, -7.26)</td>
<td>1.43 (-4.91, 7.77)</td>
</tr>
<tr>
<td><strong>Physical Health</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tailoring + video-coaching vs. control</td>
<td>-2.97 (-7.16, 1.22)</td>
<td>-2.07 (-6.34, 2.20)</td>
</tr>
<tr>
<td>Tailoring + video-coaching vs. tailoring-only</td>
<td>-2.58 (-7.00, 1.83)</td>
<td>.16 (-4.32, 4.65)</td>
</tr>
</tbody>
</table>

Reference: tailoring + video-coaching group, \(^a\)Physical activity in minutes per week, \(^b\)Intention to treat. Note: Higher scores represent improved scores to comparison group.
5.4.5 Coaching adherence and satisfaction

Coaching participants had low adherence to the coaching sessions. Just under half of coaching group completers (48%) and under a quarter of all coaching participants (21%) completed one coaching session. There were no demographic differences between those who participated in a coaching session and those who did not. Of the coaching participants who did not do a coaching session, eight wanted a second chance to do a session but did not book or show up the second time, seven refused to do one, four were too busy, seven had technical difficulties, two had injuries and contact was lost with 13. Of those who participated in at least one coaching session an average of 2.4 sessions were completed, the average coaching session length was 10.4 minutes and 15% of the coaching calls were interrupted with technical difficulties. Eight coaching participants (15%) completed the coaching satisfaction questions. The majority were satisfied with the coaching sessions (71.4%). In response to open ended coaching questions participants said the sessions held them accountable (n=3), appreciated the support (n= 1), appreciated the information (n= 1), liked the structure (n= 1), and liked talking about exercise that suits them (n= 1). However some had technical problems (n= 2), and would have preferred to use a telephone (n= 1).

5.4.6 Intervention adherence and retention

Retention did not differ between intervention groups ($\chi^2= 4.66$, $P= 0.11$). Participants who completed at least one coaching session had a higher percentage of week nine survey completers (73%) compared to other intervention participants (59%), but this difference was not significant ($\chi^2= .75$, $P= 0.38$). Just under half (47%) of participants completed at least three of the intervention modules. Intervention adherence was similar for the tailoring +
video-coaching group and the tailoring-only group ($\chi^2= 2.13, P= 0.15$), however significantly more participants who participated in the coaching sessions completed at least three of the intervention modules (82%) compared to other intervention participants (43%; $\chi^2= 6.03, P= .01$).

5.4.7 Website engagement

Website visits and minutes spent on the website for the intervention groups averaged 7.53 (SD=7.14) and 87.07 (SD=77.33), respectively. Average website visits was similar for the tailoring + video-coaching group and the tailoring-only group ($t= (1,103) .05, P= .96$). Average minutes spent on the website was higher for the tailoring + video-coaching group ($M=99.58, SD= 95.71$), than for the tailoring-only group ($M=75.25, SD= 52.90$), but this was not significantly different ($t (1,103)= 1.60, P= .11$). Participants who completed the coaching sessions spent significantly longer ($t (1,103) = 2.73, P=.02$) on the intervention website ($M=174.64, SD= 110.11$) compared to other intervention participants ($M=77.84, SD= 67.48$). Participants who completed the coaching sessions also visited the website more frequently ($M=10.20, SD= 3.85$) compared to other intervention participants ($M=7.25, SD= 7.36$), but this difference was not significant ($t (1,103) = 1.24, P= .22$).

5.4.8 Satisfaction

A quarter of participants were satisfied with the overall program (24.5%), whilst the majority of participants were satisfied with the website usability (76.9%), the computer-tailored advice (76.0%) and the module questions (90.6%). There was no difference between intervention groups on program satisfaction scores ($\chi^2=.14, P=.71$). A higher percentage of
those who participated in the coaching sessions (87.5%) were satisfied with the program compared to other participants (64.4%), however, this difference was not statistically significant ($\chi^2= 1.66, P=.20$).

In response to open ended questions on the overall program, participants mentioned that they liked the convenience (n= 4), ease of use (n= 4), the information (n= 5), emails (n= 2), found it motivating (n= 5) and liked the accountability (n= 2). Participants also mentioned that they would like more contact with a real person (n= 7), and thought there were too many questions (n= 2). In response to the questions on the advice, participants mentioned that it was easy to understand (n=12), was concise (n=4), laid out well (n= 4), was non-judgemental (n= 2) and that they liked the personalisation (n= 2). However some participants thought it was not personalised enough (n=11), did not like the online format (n=4) and learnt nothing new (n= 2). In response to open ended questions on the website, participants mentioned that the website was easy to use (n= 14) whilst others thought it was hard to use (n= 5). Lastly, some participants thought the website could use more visuals and interesting links (n =6).

### 5.5 Discussion

The first aim of this study was to assess the effectiveness of the coaching sessions, by comparing physical activity and quality of life changes of the tailoring + video-coaching group to the tailoring only and control groups. After the eight week intervention period there was a significant treatment effect of the tailoring + video-coaching physical activity intervention on the main outcome, physical activity compared to no intervention. The improvement in physical activity compared to the control group (116 minutes per week) resulted in a moderate effect size and is considered clinically significant due to the large
health effects seen from doing even small amounts of physical activity (Warburton et al., 2006). This finding is in line with findings that activity counselling over the telephone (Hekler et al., 2013), via email (Tate et al., 2006) and computer-tailored advice (Lustria et al., 2009), improves participants’ physical activity in comparison to a control group. Few studies have specifically tested the effectiveness of counselling through video-calls in physical activity interventions. Pilutti, Dlugonski, Sandroff, Klaren and Motl (2014) found that video-coaching to promote physical activity in multiple sclerosis patients was effective. However, the coaching groups’ significant improvement in physical activity compared to the control group in the current study, could be due to the computer-tailored advice.

The tailoring + video-coaching group improved their physical activity 27 minutes per week more in comparison to the tailoring-only group, however no significant between-group differences were found. The availability of human support may have improved the overall physical activity of the tailoring + video-coaching group. Participants who needed to discuss their computer-tailored advice were able to do so. Limited studies have compared the effectiveness of coaching in addition to computer-tailored advice. Van Hoye, Boen and Lefevre (2015) compared physical activity self-monitoring with and without additional face-to-face coaching sessions. They found that the coaching group had significantly greater physical activity improvements than the self-monitoring only group. An earlier study tested the effectiveness of email coaching in addition to a basic web-based weight loss intervention (Tate et al., 2003). The email coaching group had significantly greater weight loss outcomes than the web-based intervention only group. However, the effectiveness of coaching found in these studies may be due to the minimal nature of the comparison interventions (generic physical activity information + self-monitoring). The physical activity advice given in the
The current study was highly tailored to participants’ physical activity behaviour, demographics and psychosocial correlates of physical activity. This feedback might be enough to optimise physical activity outcomes (as demonstrated by a 172 min/week increase in physical activity in this group). The lack of significant differences between the intervention groups could also be due to the analysis being underpowered or the low adherence to the coaching sessions, which may have reduced the effectiveness of the intervention in the tailoring + video-coaching group. The detailed computer-tailored advice may have discouraged participants to adhere to their coaching sessions as they were satisfied with the computer-tailored advice. Core intervention content may need to be delivered in the coaching sessions to promote higher adherence. Therefore, more research is needed to determine whether online coaching is more effective than stand-alone computer-tailored advice.

The physical activity levels in the tailoring + video-coaching and tailoring only groups were maintained at six months. There were, however, no significant between-group differences in physical activity changes from baseline to six months. This was due to the control group’s increasing their activity from nine weeks to six months post intervention. The absence of between-group physical activity changes at six months post intervention is not uncommon in physical activity interventions, however it is usually due to the intervention group’s decline in physical activity rather than a physical activity increase in the control group (Fjeldsoe et al., 2011).

There were no differences in the physical health component of quality of life over time for any of the groups. This may be due to the sample not being large enough to detect subtle improvements, or the overall high level of physical activity and physical health in the sample.
at baseline. Although previous studies have established a positive association between physical activity and quality of life (Bize, Johnson & Plotnikoff, 2007), the effect of increased physical activity on quality of life is mainly seen in clinical samples which have a lower quality of life at baseline (Fong et al., 2012). The significant reduction in quality of life in relation to mental health in the tailoring-only group from baseline to post intervention in comparison was unexpected. It is possible that the reduction was caused by the participants realising through the intervention that they were not active or healthy enough and did not have any human support available. However the group did increase their physical activity at a clinically significant level. Based on the established positive relationship between physical activity and quality of life, this is a surprising result (Bize et al., 2007).

The second aim of this study was to determine the feasibility of online video-coaching sessions. The low participation and high satisfaction with the coaching sessions suggests that the majority of people participating in web-based physical activity interventions are reluctant to talk to a coach using a video-calling program, but those who do find it worthwhile. The low participation in the coaching sessions could be explained by the high percentage of coaching participants (37%) that do not use video-calling software. This may be due to the older age of the sample who are less comfortable with technology (Australian Communications and Media Authority, 2015). Although the time commitment for the coaching sessions was minimal, some participants may have found it difficult to set aside time where they had private and uninterrupted access to a computer with fast internet speed. The high satisfaction of the video-coaching sessions adds to past research findings of high satisfaction of coaching sessions conducted over the telephone (Nes et al., 2012). An
important reason for the high satisfaction could be the accountability provided through the coaching sessions, as this was the most frequently given positive feedback for the sessions.

The two most common negative comments about the overall program were the lack of personal contact and that it was not personalised enough. Therefore, it is not surprising those participants who participated in coaching sessions reported higher levels of program satisfaction. Participant satisfaction leads to improved engagement, which is important for intervention effectiveness (Mair & Whitten, 2000). In support of this, the participants who completed the coaching sessions were not only more satisfied with the program, but had significantly higher retention, adherence and spent significantly longer on the website. This is in line with past research, demonstrating that personal contact in a web-based intervention improves engagement (Meyer et al., 2012; Spittaels & De Bourdeaudhuij, 2006). However, it is possible that the coaching sessions are only effective in some people, and that the coaching session in the current study may have attracted a sub-sample that was more motivated to participate to begin with. Due to the low participation in the coaching sessions, there were no significant differences in overall retention, adherence, engagement and satisfaction between the two intervention groups. Web-based interventions with computer-tailored advice and coaching sessions may increase retention, adherence, engagement and satisfaction, but only if they can convince participants to participate in the coaching sessions.

### 5.5.1 Limitations

Limitations of the research include self-reported physical activity, which may be subject to social desirability bias. Participants and researchers were not blinded to group assignment which may have biased results. The sample was predominantly female, white and educated.
Therefore the results may not be generalisable to males, other cultures and low socioeconomic groups. Further, 40% of the sample was physically active at baseline despite the target group being inactive adults. This is not uncommon in physical activity studies (Vandelanotte et al., 2015), though results may not generalise to physically inactive Australians who are most at need of increasing their activity. The additional telephone calls the coaching participants received encouraging them to complete the coaching calls may have affected their physical activity levels. However, this is expected to be minimal due to the telephone discussion being focused on scheduling the coaching call rather than their physical activity. Objective measurement of physical activity (e.g., accelerometry) is needed to confirm the findings of this study. Although we were able to detect a difference in physical activity changes between the tailoring + video-coaching and tailoring only groups, the analysis was underpowered to detect other between-group differences as the required sample size of 100 per group was not met. The low number of participants could be due to the advertising and intervention website not being appealing to the public, and the lack of face-to-face contact at the recruitment stage. The low retention is also a significant limitation to the reliability of the physical activity and quality of life changes reported, particularly at 6 months follow up. Low retention is common in web-based programs, potentially due to the minimal face-to-face contact through either recruitment or the intervention. Similar retention rates have been observed in other web-based health behaviour interventions (Carr et al., 2012; Skar, Sniehotta, Molloy, Prestwich & Araujo-Soares, 2011). Further, the intervention website had a simple design and minimal interactive features which may have limited participant engagement in the intervention. Retention is likely to be even lower outside of an RCT setting which includes reminder calls from researchers. However, missing data were imputed through maximum likelihood as part of linear mixed modules to deal with the high
percentage of missing data at post intervention and follow up. Maximum likelihood is an established and widely used method of imputing missing data as part of linear mixed modules. Imputing missing values reduces bias of the results towards participants who completed the post intervention and follow up surveys, therefore avoiding inflation of positive behaviour changes resulting from the intervention (Verbeke & Molenberghs, 2000).

5.5.2 Conclusion

Combined online video-coaching and computer-tailored advice was effective in comparison to a control group immediately post intervention. Only small non-significant improvements were seen immediately post intervention when online video-coaching was included in addition to computer-tailored advice. A small percentage of participants adhered to online video-coaching sessions, but those who participated were highly satisfied and more engaged in the intervention. Further research should investigate how adherence to online coaching sessions can be improved.
Chapter 6.  Eye-tracking study

Do personally-tailored videos in a web-based physical activity intervention lead to higher attention and recall? – An eye-tracking study.
6.1 Abstract

Over half of the Australian population does not meet physical activity guidelines and has an increased risk of chronic disease. Web-based physical activity interventions have the potential to reach large numbers of the population at low cost, however issues have been identified with usage and participant retention. Although personalised (computer-tailored) physical activity advice delivered through video has the potential to address low engagement, it is unclear whether it is more effective in engaging participants when compared to text-delivered personalised advice. This study compared the attention (primary outcome) and recall (secondary outcome) of tailored physical activity advice in video- versus text-format. Participants (n=41) were randomly assigned to receive either video- or text-tailored feedback with identical content. Outcome measures included attention to the feedback, measured through advanced eye-tracking technology (Tobii 120) and recall of the advice, measured through a post intervention interview. Between-group ANOVA’s, Mann-Whitney U tests and chi-square tests were applied. Participants in the video-group displayed greater attention to the physical activity feedback in terms of gaze-duration on the feedback (7.7 min vs. 3.6 min, p<001), total fixation-duration on the feedback (6.0 min vs. 3.3 min, p<001), and focusing on feedback (6.8 vs. 3.5 min, p<001). Despite both groups having the same ability to navigate through the feedback, the video-group completed a significantly (p<.001) higher percentage of feedback sections (95%) compared to the text-group (66%). The main messages were recalled in both groups, but many details were forgotten. No significant between-group differences were found for message recall. These results suggest that video-tailored feedback leads to greater attention compared to text-tailored feedback. More research is needed to determine how message recall can be improved and whether video-tailored advice can lead to greater health behaviour change.
6.2 Introduction

Physical activity improves physical and mental health and significantly lowers the risk of non-communicable disease including cardiovascular disease, diabetes mellitus and cancer (Lee et al., 2012). It is estimated that individuals who are physically active have a 30% to 50% lower risk of non-communicable disease and a 20% to 50% lower risk of mortality than inactive individuals (Bassuk & Manson, 2005; Friedenreich & Orenstein, 2002b; Warburton et al., 2006). The World Health Organisation recommends 30 minutes of moderate intensity activity on five days of the week to receive health benefits and reduce the risk of non-communicable disease (World Health Organisation, 2008). Despite this, more than 50% of Australians fail to meet these recommendations (Australian Bureau of Statistics, 2013a) which is estimated to cost the Australian economy AUD $13.8 billion each year in healthcare, loss of productivity, and mortality costs (Medibank Private, 2008). Hence, there is an urgent need for effective physical activity interventions with a broad reach.

Innovative web-based physical activity interventions have been developed to take advantage of the high percentage of Australians (79%) with access to the Internet in their homes (Australian Bureau of Statistics, 2011c). Not only do health interventions delivered via the Internet have the potential to reach a large audience at low-cost, they are convenient for the participants and enable the content to be delivered in a non-confrontational way (Christopherson, 2007; McConnon et al., 2007; Tate et al., 2009). Although the short-term effectiveness of web-based physical activity interventions is well established, participant retention and engagement have been identified as challenges with many web-based interventions reporting high drop-out rates or low use of the websites (Davies et al., 2012b;
Vandelanotte et al., 2007). As exposure to the intervention content is strongly linked to behavioural outcomes, low participant retention and engagement may be limiting the effectiveness of the web-based interventions (Ferney et al., 2009; Hansen et al., 2012).

Web-based health interventions that provide personalised advice improve engagement and behavioural outcomes compared to interventions that provide generic advice (Kroeze et al., 2006; Lustria et al., 2009). Computer-tailored advice is personalised feedback that is automatically produced using a computer-based expert system that delivers feedback based on participants’ responses to a questionnaire (Lustria et al., 2009). Computer-tailored feedback is commonly delivered in text-based format on intervention websites, despite users tending to skim and scan text on the Internet rather than engage in concentrated reading (Liu, 2005). The use of rich media content, including graphics and videos, has become very common on the Internet and users have become accustomed to this (Purcell, 2010). Furthermore information presented in video format has been found to result in improved recall of website content (Balslev, de Grave, Muijtjens & Scherpbier, 2005), improved engagement, and to facilitate a stronger emotional response than text in educational settings (Koehler et al., 2005; Yadav et al., 2011). Information presented through videos in web-based health interventions may therefore be an effective way of engaging users and be more effective in producing behaviour changes.

To date, only a small number of web-based health interventions have used videos to deliver program content, and only one provided videos with personalised content to participants (Frenn et al., 2005; Vandelanotte et al., 2012). Vandelanotte et al. (2012) developed and conducted pilot testing of a physical activity intervention with two modules of either text- or video-tailored feedback. Video-group participants received their activity feedback in video
format with a presenter and animated graphical images, whilst text-group participants received their feedback in text-format, which included static graphics. Results demonstrated that inactive participants who received computer-tailored physical activity feedback in video format had greater improvements in physical activity levels than participants receiving traditional computer-tailored feedback in text-based format with identical content; however a more conservative intention-to-treat analysis found no significant differences between the two groups (Soetens, Vandelanotte, de Vries & Mummery, 2014). A study conducted by Lee (2012) found that participants in a web-based health intervention which delivered content through videos had greater levels of self-reported attention, interactivity, overall website evaluation and preference than participants assigned to a static intervention site. These results suggest that videos may be more effective in engaging participants in web-based tailored health information and have the potential to improve the behavioural outcomes of text-tailored feedback. Further research is required to understand how participants process video- and text-delivered information and to determine whether video-tailored physical activity feedback leads to greater observed engagement, understanding and recall than traditional text-tailored physical activity feedback.

Eye-tracking technology can be used to objectively measure participants’ attention and engagement in web-based health interventions. Eye-tracking technology has been used in marketing and educational research to record users eye-gazes on web-delivered information (Nielsen & Pernice, 2010; Wilson & Ehmke, 2007). The eye-tracking data provides a physiological measure that is directly linked to cognitive processing (Fox, Krugman, Fletcher & Fischer, 1998), and has been beneficial in understanding how people attend to and process information on a web-page (Wilson & Ehmke, 2007). Past health studies have used eye-
tracking data to determine what types of health promotion advertisements attract attention. These studies also found that eye-gaze predicted correct recall of the advertisements, demonstrating the importance of attention for learning (Fox et al., 1998; Krugman, Fox, Fletcher, Fischer & Rojas, 1994). To our knowledge no web-based physical activity interventions have used eye-tracking technology to understand the way users interact with and attend to personal activity information. Eye-tracking technology can therefore improve our understanding of how users process health advice delivered through text and video on the Internet. Such findings will enable health promotion workers and researchers to make adjustments to the delivery of information on web-based behaviour change interventions and improve participants’ engagement in the intervention content.

6.2.1 Aims and hypotheses

The aim of this study was to examine, with the use of an eye-tracking device and a recall questionnaire, the differences between video-tailored and text-tailored physical activity feedback in terms of participant attention to (primary outcome) and recall of the intervention content (secondary outcome). It was hypothesised that participants receiving video-tailored feedback would spend more time paying attention to the feedback, be less distracted and have improved recall of their personal physical activity feedback in comparison to those receiving text-tailored feedback.

6.3 Methods

6.3.1 Procedure

A two group randomised trial was conducted to compare participants’ processing of text- and video-tailored physical activity feedback. Participants were recruited via email from staff and
students of CQUniversity’s Noosa campus. To be eligible participants had to be English speaking, be over 18 years of age and be familiar with using the Internet for general purposes. Data were collected from each participant in one 20 to 25-minute session from March to June 2012. Participants were given an information sheet to explain the aims of the study and what was required of them in the experimental session. They were then asked to complete a consent form before data collection commenced. To begin the session participants were seated at a computer in a quiet research room where they were un-interrupted. Participants’ eyes were calibrated with an eye-tracking device connected to the computer. Participants were then invited to complete a demographic questionnaire on the computer. Next, participants were provided with access to the ‘My Physical Activity Advice’ website where they completed two modules of tailored feedback in either video- or text- format. The intervention website automatically assigned participants at random to receive either text- or video-tailored physical activity feedback as they signed into the website. The researcher supervising the session was unaware of the randomisation sequence. It is possible that participants worked out which intervention group they were assigned to as the aim of the study (to compare attention to video- and text- tailored advice) was explained to them in the information sheet. While participants were completing the intervention, the eye-tracking device video recorded and produced data of their eye movements which was used to measure the primary outcome, attention. Once they had completed the intervention the researcher asked participants nine brief questions to test the secondary outcome, recall of the intervention content. Participants did not receive any incentives to participate in the project. Ethical clearance was obtained from the CQUniversity Human Research Ethics Committee (project number H13/04-044).
6.3.2 Intervention

The two module web-based physical activity intervention with video- and text-tailored advice was previously developed by Vandelanotte and colleagues (Vandelanotte et al., 2012). The intervention has been found to be effective in increasing participants’ physical activity levels (Soetens et al., 2014). The content and structure of the video-based (Figure 16) and text-based (Figure 17) feedback was identical, only the method of delivery was different. The computer-tailored content was tailored to participants’ physical activity levels, as assessed by the Active Australia Questionnaire (AAQ); Australian Institute of Health and Welfare, 2003), participant demographics (age, body mass index (BMI), work environment, and the distance to often-visited places) and psychosocial correlates of physical activity that were based on the theory of planned behaviour (attitudes, subjective norm, perceived behavioural control and intention; Ajzen, 1988). The intervention provided normative feedback by comparing participants’ physical activity to the minimum and optimal physical activity guidelines in a bar graph. Participants’ perceived benefits and barriers to becoming more active were also discussed. The intervention consisted of two modules. Participants can receive up to seven sections of feedback in the first module, which focuses on the benefits of physical activity and up to ten sections of feedback in the second module, which focuses on creating an active lifestyle. A more detailed description of the intervention can be found elsewhere (Soetens et al., 2014).
Figure 16. Video-based advice
Figure 17. Text-based advice

6.4 Measures

6.4.1 Demographics

The pre-test demographic survey collected information on: gender, age, height and weight (to calculate body mass index), highest level of education, current employment status, household income level, and motivation to increase physical activity through the question ‘do you want to increase your physical activity?’ with two response options, yes and no (Appendix M).

6.4.2 Attention

Participants’ visual attention to the personalised video- and text-tailored feedback was measured with a TobiiX 120 eye-tracking device. The TobiiX 120 tracks eye movements at a
resolution of 1280 pixels and at a controller refresh rate of 60-75 Hz. It allows 15 degrees of head movement 60 centimetres from the screen (Tobii Technology, 2008). Eye-gazes on the screen including fixation, when participants’ eye-gaze focuses on one point and saccades, when participants’ eye-gaze moves from one fixation to fixate on another point (Figure 18), were recorded at 15 milliseconds. The eye-tracking software, Tobii studio, can be set to record fixations and saccades in a selected area of interest. The area on the computer screen in which the feedback was displayed (the video or text) was chosen as an area of interest. Tobii studio software calculated data on gaze-duration (the total time of both fixations and saccades), and fixation-duration (the total time of all fixations) for the area of interest as well as the total computer screen (Tobii Technology, 2008). Gaze-duration in areas on the screen outside the area of interest was calculated as a measure of distraction. The video recording of participants’ eye movements was used to measure the focusing-duration, by measuring the duration of actually reading by text-group participants or watching key parts of the video (e.g., presenter, graph) by video-group participants. Due to the potential measurement error when recording focusing-duration, a second researcher re-timed the focusing-duration of ten (24%) randomly selected participants to test the inter-researcher reliability. The video was also used to record the number of feedback sections participants skipped before they finished reading or watching the advice in full. Gaze-duration outside the feedback area of interest was recorded as a measure of distraction. The proportion of gaze-duration in the feedback area compared to gaze-duration in the entire screen and the proportion of fixations compared to gaze-duration in the feedback area were also calculated as measures of distraction.
Recall

The post intervention recall interview was conducted immediately after each participant received their physical activity feedback. The interview consisted of nine open-ended questions. The questions assessed participants’ understanding of the goal of the feedback they received, their memory of the feedback they received (including the recommendations for physical activity, their own physical activity levels and the benefits of physical activity) and their understanding of the graph comparing their physical activity levels to the recommendations (Appendix N). The interview duration was approximately five minutes. Participant responses were recorded using an audio digital recorder (LiveScribe Pen) and transcribed in Microsoft Word. Each question was coded as correct or incorrect. A total recall score was also calculated for each participant by summing the total number of correct recall responses the participant gave on all questions. Possible scores ranged from 0-9.
6.5 Data analysis

6.5.1 Data screening

All analyses were conducted using SPSS version 19. Significance level was set at $p < 0.05$. Descriptive statistics were calculated for participant demographic information. A chi-square test was conducted to compare group baseline participant characteristics. All continuous variables were screened for outliers and normality using Fisher’s skewness coefficient. The proportion of time participants spent viewing the feedback compared to the entire screen and the number of feedback sections skipped, were found to have a significantly skewed distribution. Square root, logarithm and inverse transformations were unsuccessful to transform these variables. Therefore Mann-Whitney U tests were used to analyse the data from these variables.

6.5.2 Attention

A series of four one-way between-groups Analyses of Variance (ANOVA’s) were conducted to compare video- and text-participants on attention which included gaze-duration, fixation-duration, and focusing-duration in the feedback area, and number of sections skipped. Bonferroni correction was applied to control for the risk of a false positive arising from the four comparisons of attention and group. A $p$ value score of $p < 0.01$ was therefore required for any of the attention and group analyses to be deemed significant. Three Analyses of Variance were also conducted to compare video- and text-participants on distraction (gaze-duration in the areas outside the feedback), the proportion of gaze-duration spent in the feedback area compared to other areas on the screen, and the proportion of fixation-duration compared to gaze-duration. Bonferroni correction was applied to control for the risk of a false positive arising from the three comparisons of distraction and group. A $p$ value score of
\( p < 0.017 \) was therefore required for any of the distraction and group analyses to be deemed significant. The number of feedback sections participants read or watched was entered as a co-variante in all attention analyses. Based on past eye tracking research (Pernice & Nielsen, 2009) the aim was to recruit 40 participants. Sample sizes as low as \( n=20 \) are appropriate for quantitative research using eye tracking due to the highly detailed and objective data collected continuously from each participant resulting in a high number of data points (Pernice & Nielsen, 2009).

6.5.3 Recall

A chi-square test was conducted to determine whether there was a between-group (video and text) difference in the mean number of correct responses to each question. An Analysis of Variance was conducted to compare the total recall scores in video- and text-participants. Next, the total recall score was dichotomised using a median split in order to examine the relationship between group, recall and attention. An Analysis of Variance was conducted to compare gaze-duration in the feedback area and recall (high total recall score vs. low total recall score) with the co-variates group (video vs. text), and number of feedback sections.

6.6 Results

The demographic details of the participants are documented in Table 9 below. Data were collected from 41 participants. Participants were randomly assigned to the video- (\( n = 21 \)) or text-group (\( n = 20 \)). There were no baseline differences between the two intervention groups for participant characteristics.
Table 9. Participant demographics for total group and for video- and text-groups

<table>
<thead>
<tr>
<th></th>
<th>Total n (%)</th>
<th>Video n (%)</th>
<th>Text n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n= 41)</td>
<td>(n= 21)</td>
<td>(n= 20)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>14 (34)</td>
<td>7 (33)</td>
<td>7 (35)</td>
</tr>
<tr>
<td>Females</td>
<td>27 (66)</td>
<td>14 (67)</td>
<td>13 (65)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-30</td>
<td>12 (29)</td>
<td>8 (38)</td>
<td>4 (20)</td>
</tr>
<tr>
<td>31-50</td>
<td>15 (37)</td>
<td>5 (24)</td>
<td>10 (50)</td>
</tr>
<tr>
<td>&gt;50</td>
<td>14 (33)</td>
<td>8 (38)</td>
<td>6 (30)</td>
</tr>
<tr>
<td>BMI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal (&lt;25)</td>
<td>23 (57)</td>
<td>11 (55)</td>
<td>12 (60)</td>
</tr>
<tr>
<td>Overweight (≥ 25)</td>
<td>17 (43)</td>
<td>9 (45)</td>
<td>8 (40)</td>
</tr>
<tr>
<td>Motivation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motivated</td>
<td>31 (76)</td>
<td>16 (76)</td>
<td>15 (75)</td>
</tr>
<tr>
<td>Not motivated</td>
<td>10 (24)</td>
<td>5 (24)</td>
<td>5 (25)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary School</td>
<td>9 (22)</td>
<td>5 (24)</td>
<td>4 (20)</td>
</tr>
<tr>
<td>Technical college</td>
<td>7 (17)</td>
<td>3 (14)</td>
<td>4 (20)</td>
</tr>
<tr>
<td>University</td>
<td>25 (61)</td>
<td>13 (62)</td>
<td>12 (60)</td>
</tr>
<tr>
<td>Employment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full Time</td>
<td>13 (32)</td>
<td>7 (33)</td>
<td>6 (30)</td>
</tr>
<tr>
<td>Part time</td>
<td>17 (42)</td>
<td>8 (38)</td>
<td>9 (45)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>3 (7)</td>
<td>1 (5)</td>
<td>2 (10)</td>
</tr>
<tr>
<td>Student</td>
<td>8 (20)</td>
<td>5 (24)</td>
<td>3 (15)</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 30,000</td>
<td>16 (39)</td>
<td>9 (43)</td>
<td>7 (35)</td>
</tr>
<tr>
<td>30,001 – 70,000</td>
<td>11 (26)</td>
<td>5 (24)</td>
<td>6 (30)</td>
</tr>
<tr>
<td>&gt; 70,001</td>
<td>14 (35)</td>
<td>7 (33)</td>
<td>7 (35)</td>
</tr>
</tbody>
</table>

6.6.1 Attention

As shown in Figure 19 and Table 10, gaze-duration within the feedback area was significantly higher in the video-group than the text-group, $F(1,36)= 30.39, p<0.001$.

Furthermore video-group participants had a significantly greater fixation-duration and focusing-duration, $F(1,36)= 13.09, p<0.001$; $F(1,36)= 20.85, p<0.001$ respectively. The inter-researcher reliability of the focusing-duration variable was very high, as indicated by a Krippendorff’s alpha of .99. Researcher one timed the ten participants who were measured by both researchers to have a mean of 4.8 (SD = 2.9) minutes focusing on the feedback and researcher two timed these participants to have a mean of 4.9 (SD = 3.0) minutes focusing on the feedback. Video-group participants finished 95% of their feedback sections ($M=.75, SD= ...
2.2) compared to the text-group participants who finished only 66% of their feedback sections (M = 4.6, SD = 3.9); this difference was significant at p < .001.

As seen in Table 10 distraction, measured by the length of gaze-duration within areas on the screen other than the feedback area, was significantly higher in video- compared to text-group participants F(1,36) = 29.33, p < .001. The proportion of gaze-duration within the feedback area compared to gaze-duration within the total screen was significantly lower in video-group participants (M = 82%, SD = 8.83%) than text-group participants (M = 87%, SD = 16.15%; p < .01). The proportion of time participants spent fixating on the feedback from the total time they spent viewing the feedback was 76.28% (SD = 11.07) in the video-group and 83.27% (SD = 9.02) in the text-group. This difference was not significant F(1,36) = 4.01, p = .053.

**Figure 19. Gaze-, fixation-, and focusing-duration in the feedback area by group**

NOTE: Adjusted for number of feedback sections. (video, n = 20; text n = 17). *** p < .001.
Table 10. Descriptive statistics for gaze-, fixation-, and focusing-duration in the feedback area and distraction by group (video and text)

<table>
<thead>
<tr>
<th>Group</th>
<th>n*</th>
<th>Gaze duration feedback area (min)</th>
<th>Fixation duration feedback area (min)</th>
<th>Focusing duration on feedback (min)</th>
<th>Gaze duration other areas on screen (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>Video</td>
<td>20</td>
<td>7.72±</td>
<td>30.39</td>
<td>5.96±</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.00</td>
<td>*</td>
<td>1.93</td>
<td>9*</td>
</tr>
<tr>
<td>Text</td>
<td>17</td>
<td>3.63±</td>
<td>2.43</td>
<td>3.30±</td>
<td>2.19</td>
</tr>
</tbody>
</table>

*p<.001 NOTE: Adjusted for number of feedback sections. * Eye-tracking data was missing from one video and three text participants

6.6.2 Recall

The percentage of correct responses for each of the recall interview questions for total group and the video- and text-groups is presented in Table 11. A chi-square test revealed that there were no between-group recall differences for any of the questions.

The mean total recall response was 5.86 (SD = 2.26) in the video-group and 6.15 (SD= 1.63) in the text-group. No significant relationship between total recall and group (video vs. text) was found $F(1,36)= .22, p=.639$. Based on the total recall scores 17 participants were assigned to the low recall category and 21 to the high recall category using a median split.

The mean gaze-duration in the feedback area for participants with high recall was 5.51(SD=2.83) minutes, and 6.28 (SD= 3.20) minutes for participants with a low recall score. No significant relationship was found between attention and recall.
Table 11. Correct responses for each recall question by group and chi-square comparison of correct responses in video- and text-groups

<table>
<thead>
<tr>
<th>Question</th>
<th>Correct response total group</th>
<th>Correct response video group</th>
<th>Correct response text group</th>
<th>Chi-square $\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1. What is the goal of the advice?</td>
<td>33 (80)</td>
<td>15 (71)</td>
<td>18 (90)</td>
<td>2.25 ns.</td>
</tr>
<tr>
<td>Q2. What is the recommended amount of physical activity?</td>
<td>25 (61)</td>
<td>12 (57)</td>
<td>13 (65)</td>
<td>.27 ns.</td>
</tr>
<tr>
<td>Q3. What is the optimal amount of physical activity per day?</td>
<td>21 (51)</td>
<td>11 (52)</td>
<td>10 (50)</td>
<td>.02 ns.</td>
</tr>
<tr>
<td>Q4. Are you meeting the physical activity guidelines?</td>
<td>36 (88)</td>
<td>18 (86)</td>
<td>18 (90)</td>
<td>.18 ns.</td>
</tr>
<tr>
<td>Q5. Exactly how many minutes of physical activity do you do on a weekly basis?</td>
<td>35 (85)</td>
<td>17 (81)</td>
<td>18 (90)</td>
<td>.67 ns.</td>
</tr>
<tr>
<td>Q6. What was presented in the graph?</td>
<td>14 (34)</td>
<td>7 (35)</td>
<td>7 (33)</td>
<td>.01 ns.</td>
</tr>
<tr>
<td>Q7. What was each of the bars in the graph showing?</td>
<td>15 (37)</td>
<td>8 (38)</td>
<td>7 (35)</td>
<td>.04 ns.</td>
</tr>
<tr>
<td>Q8. How will meeting the physical activity recommendations benefit you?</td>
<td>34 (83)</td>
<td>17 (81)</td>
<td>17 (85)</td>
<td>.12 ns.</td>
</tr>
<tr>
<td>Q9. What chronic diseases can be prevented?</td>
<td>33 (80)</td>
<td>18 (86)</td>
<td>15 (75)</td>
<td>.75 ns.</td>
</tr>
</tbody>
</table>

ns. = not significant

### 6.7 Discussion

The findings demonstrate that video-tailored advice is more effective in gaining participants’ visual attention than text-tailored advice in a web-based physical activity intervention.

Video-group participants spent significantly longer viewing their feedback, had a higher sum of fixations on the feedback, and spent longer focused on the key parts of the feedback than text-group participants. Furthermore video-group participants finished a significantly greater amount of feedback sections than the text-group participants despite both groups having the ability to navigate through their feedback and finish sections prematurely. The objective eye-
tracking data confirms the findings from Lee (2012) of improved self-reported attention to video-presented health information compared to identical text-presented information. The findings also demonstrate that the improved engagement towards video-messages compared to text-messages observed in marketing and educational settings applies in a web-based health behaviour intervention setting (Koehler et al., 2005; Yadav et al., 2011). The finding of improved attention in video-group participants is important for the development of web-based health interventions as high exposure to the intervention content is associated with improved behaviour change (Ferney et al., 2009; Hansen et al., 2012). Presenting health advice through video may be an effective strategy to improve the low levels of participant engagement and therefore exposure to web-based health interventions.

There might be several reasons to explain the improved attention to the message in the video-group participants. Firstly, the improved attention in the video-group participants could in part be a result of participants’ expectations. Website users have come to expect interactive websites with rich media content due to the current Internet environment where popular websites are employing rich media content to engage users (Purcell, 2010). Secondly, the higher attention in video-group participants could be due to participants’ social and emotional connection to the feedback. The presenter delivering the feedback and the images of active people in the video may produce a greater emotional and social connection to the feedback. This is in line with previous research that found students to have a greater emotional response to information delivered in video compared to text (Yadav et al., 2011). Thirdly, the improved attention in video-group participants could be due to the lower level of mental effort required from the video-group participants. Text requires users to actively read in order to comprehend the text, whilst watching a video
requires a lower mental effort (Cennamo, 1993). This might also be the reason text-group participants skipped more feedback sections than video-group participants. Lastly, the higher level of attention seen in the video-group participants may be due to the perceived control video- and text-group participants have to move through their feedback. Although both video- and text-group participants were able to click over to the next section of the feedback at any time, text-group participants more frequently clicked over to the next section before they had finished their current section. Internet-users typically have less control over the pace of information they receive through video compared to text (Ramos & Balakrishnan, 2003) and could therefore be in the habit of watching videos to the end, without navigating through them. Furthermore, text-group participants were forced to click to read the next section, whereas transitions through the video sections were automatic. As such video-group participants may have been less aware of their ability to fast-forward through the video-feedback.

Although video-group participants spend longer viewing their feedback than the text-group participants, they demonstrated greater levels of distraction than text-group participants. Video-group participants spend significantly longer viewing other areas on the screen whilst the feedback was being presented; and viewed the feedback area on the computer screen for a significantly lower percentage of time than text-group participants. This may also have resulted from the difference between groups in perceived control to move through the feedback faster (Ramos & Balakrishnan, 2003). It is likely that text-group participants clicked through to the next section immediately when they chose not to read any more of the section they were on, whereas video-group participants tended to continue watching each section until it finished. It is likely that video-group participants were looking outside of the
feedback area when they had brief moments of distraction or when they perceived some sections of the feedback as less interesting. Alternatively, they could have been listening to the audio of the video without paying close attention to what was on the computer screen. The measure of attention produced by the eye-tracking device is based upon visual attention only and does not account for the audio of the video. Whilst it is important to note the increased distraction in the video-group participants, it is more important that video-group participants spent longer viewing the feedback, as they were less likely to skip to the next section when momentarily distracted.

Although video led to a higher level of attention, no group differences were found for the number of correct responses on each of the recall questions, or the total number of correct responses for all of the recall questions. This is incongruent with past research findings of video leading to a greater recall in marketing and education settings (Balslev et al., 2005). Furthermore, the lack of relationship between attention and recall was not expected as past research demonstrated a significant positive relationship between attention and recall (Fox et al., 1998; Krugman et al., 1994). It is possible the questionnaire used did not adequately measure recall, as many participants might have had prior knowledge of some answers such as their level of physical activity, the benefits of physical activity and the diseases associated with inactivity. Furthermore, participants in both groups had a very high number of correct responses, which may have been due to the interview being conducted immediately after the intervention. This might have created a ceiling effect where the low variability in participants’ responses made it difficult for any group differences to be detected. If there was a greater time gap between the intervention and the recall questionnaire group, differences resulting from participants’ attention to the feedback may have been detected. Further
research is needed to determine whether increased attention to video leads to greater recall and behaviour changes, with the use of a pre-post test design and a comprehensive recall questionnaire conducted with a longer time gap after the intervention, to adequately assess recall.

Finally, the recall questionnaire outcomes revealed that participants remembered the main messages of the advice very well, but the details were much less well retained. The majority (at least 80%) of participants knew what the goal of the advice was, could remember if they were meeting the guidelines or not, knew how many minutes of physical activity they did on a weekly basis, could list how physical activity could benefit them and could recall the diseases physical activity helps to prevent. However less than half of participants could recall that the recommendations and their own activity levels were presented in the physical activity graph, and just over half of participants could correctly recall the minimum and optimal physical activity recommendations.

6.7.1 Limitations

Although eye-tracking technology has improved our understanding of how to engage participants in online health interventions, the nature of the eye-tracking data poses some limitations. The eye-tracking technology only measures visual attention, not auditory attention. Furthermore, it is possible that the longer gaze- and fixation-duration in the video-group was because it took longer to watch the videos than it would take to read the same information in text-format. Another limitation with the eye-tracking technology is the use of eye-gaze as an attention measure. It is possible that participants were looking within the feedback area but were not actually processing the feedback, however given the outcomes on
focusing-duration (which was much higher in the video-group) this is doubtful. Finally there may have been error in the measurement of BMI due to the use of self-reported data.

6.7.2 Conclusion

The findings support the hypothesis that video-delivered content is an effective way of improving participants’ attention to tailored health information in a web-based physical activity intervention. This is important for the development of future web-based physical activity interventions as attention and engagement are strongly linked with behavioural outcomes. Future research is required to evaluate the effectiveness of video-tailored advice in producing long-term behaviour changes in comparison to standard text-tailored advice. Furthermore, future research with a larger sample size is needed to conduct analyses on the two-way interactions between participant demographics (gender, BMI, motivation to become more active and age) and group (video, text) on attention. It is, for example, important to determine whether personalised video content is effective in increasing activity levels in older or overweight participants, as they are at higher risk of developing chronic diseases. Further, it is possible that video-tailored advice could engage people with a low health literacy who have a high need for health behavior change interventions but are hard to engage. Currently online videos are highly accessed by many population groups including low socioeconomic groups and those with a low education who are more likely to have a low health literacy (Paasche-Orlow, Parker, Gazmararian, Nielsen-Bohlman & Rudd, 2005; Purcell, 2010). Future research is therefore required to evaluate whether video-tailored advice is effective at improving attention and content recall of participants with a low health literacy. The findings did not support the hypothesis that video-group participants would have a higher recall of the intervention content. Due to the high percentage of participants in
both groups with correct responses to many of the questions, further research with more sensitive measures is needed to confirm this finding. However, the low levels of recall, especially for the physical activity recommendations highlight a need for future research to evaluate ways of improving recall of the key parts of physical activity advice. Overall this research using eye-tracking data demonstrates that video-tailored advice leads to a higher level of attention compared to text-tailored advice in a web-based physical activity intervention.
Chapter 7. Summary and conclusions

The primary aim of this thesis was to investigate methods to improve the participation, engagement and behavioural outcomes of web-based physical activity interventions. Physical activity levels in Australia are low (Australian Bureau of Statistics, 2013a) which is contributing to the high and increasing prevalence of chronic disease (Begg et al., 2008). The Internet holds much potential to deliver behaviour change programs to large numbers at low cost (Australian Bureau of Statistics, 2014a; Davies et al., 2012b; Lewis et al., 2010) as web-based physical activity interventions have shown to be effective in improving participants’ physical activity levels (Davies et al., 2012b). However the challenges of low participation and engagement may limit their long term effectiveness (Joseph et al., 2013). Therefore the specific aims of this thesis were to a) investigate cost-effective ways to promote web-based physical activity interventions, b) investigate effective methods of delivering personalised advice that will improve participants’ engagement and physical activity levels and c) explore participants’ engagement in video- and text-delivery of computer-tailored content.

A review of the literature was presented in chapter 2, ‘literature review.’ The literature on physical activity, the significance and prevalence of inactivity, physical activity promotion and web-based physical activity interventions were discussed. Chapter 3, ‘recruitment evaluation’, presented a descriptive study on methods to attract participants to web-based physical activity interventions. Chapter 4, ‘intervention trial protocol’, provided a protocol for a randomised controlled trial comparing the effectiveness of computer-tailored advice in a web-based physical activity intervention with and without video-coaching. Chapter 5, ‘intervention trial’, reported the outcomes of the randomised controlled trial and as such reported on the feasibility and effectiveness of video-coaching in a web-based physical
activity intervention. Finally chapter 6, ‘eye-tracking study’, presented a cross-sectional study measuring participants’ engagement to text- and video- delivered computer-tailored physical activity advice. The following section provides a summary of the main findings, strengths and limitations of the studies, significance of the findings and future recommendations and conclusions of the research in this thesis.

### 7.1 Main findings

Chapter 3 evaluated the effectiveness of multiple web- and print- based methods to recruit participants to a web-based physical activity intervention. Web-based methods (community calendars, Facebook advertisements and Google AdWords) and print-based methods (posters and leaflets, newspaper advertisements and articles and brochures delivered to people’s homes) were implemented. The cost, time investment and numbers of potential participants reached were recorded for each method. The recruitment methods with the lowest cost per intervention sign up were the online calendars and the newspaper articles as they were free to implement. Only a minimal time investment was required of project staff to submit the intervention to the online calendars and to be interviewed by the newspaper staff. However, the downside to these methods was that they only resulted in a small number of sign ups (6 and 17 respectively). The methods that resulted in the next lowest cost per participant were posters (AUD $14) and leaflets (AUD $38) delivered in community centres, sporting centres and medical clinics. Although the cost per participant was not high, the time investment required of project staff to obtain permission to display posters and leaflets and distribute them was very high (365 and 48 minutes respectively). The next most cost-effective strategy per participant recruited was targeted Facebook advertising. These advertisements were targeted to different ages, genders and people with chronic diseases, and resulted in a large
number of sign-ups (184) as well as a low time investment (7 minutes per sign up) and acceptable cost (AUD $38 per sign-up). Non-targeted Facebook advertisements were also used, however these were not as cost-effective as the targeted Facebook advertisements (AUD $58 per sign-up). The Google AdWords, newspaper advertisements and brochures delivered to people’s homes were not effective. People reached through the targeted Facebook advertisements were on average older and had a higher BMI than those reached through the other methods. This is likely to be due to the Facebook advertisements that were targeted at people over 45 years and the advertisements targeting individuals with cardiovascular disease and diabetes.

Chapter 4 presented the protocol for a randomised controlled trial of an eight week web-based physical activity intervention. The trial included one arm where participants received four modules of computer-tailored physical activity advice; one arm where participants received the same computer-tailored advice as well as four online video-coaching sessions; and the third arm consisted of a wait-list control group. Physical activity and quality of life were measured through a self-report survey at baseline, post intervention and six months. Participants’ intervention adherence, satisfaction and website use were also recorded. Chapter 5 presented the outcomes of the randomised controlled trial including the feasibility and effectiveness of online video-coaching to discuss computer-tailored advice in a web-based physical activity intervention. The results revealed that only a low percentage of people were willing to participate in the video-coaching sessions to discuss their computer-tailored advice, but those who did participate had higher levels of adherence, website use and satisfaction. Open-ended questions revealed participants felt that technology was a barrier to participating in the coaching sessions but those who participated appreciated the
accountability they received from the sessions. The technology barrier may be higher due to the older age of the sample who are typically slower to engage in new technology (Australian Communications and Media Authority, 2015). Some participants may also have found it difficult to set aside time where they had private and uninterrupted access to a computer with fast internet speed to participate in the coaching sessions. This is different to computer tailored advice which participants can privately access at any time, for example during their lunch break at work or on public transport. Participants in the tailoring + video-coaching group and the tailoring only group improved their physical activity from baseline to post-intervention, but only the tailoring + video-coaching group improved their physical activity significantly more than the control group. Only small improvements were seen for the tailoring + video-coaching group compared to the tailoring only group and the difference was not significant. Quality of life did not improve in the intervention groups as a result of their improved physical activity levels. This could be due to the high levels of both physical and mental health in the intervention groups at baseline, as well as the short intervention duration.

Chapter 6 presented an eye-tracking study comparing participants’ attention (measured by time spent in engaged viewing) to text- and video-delivered computer-tailored advice. The findings revealed that participants assigned to a web-based physical activity intervention with video-tailored advice had a higher level of attention to the advice compared to the text-delivered group. Participants in the video-group were also significantly more exposed to the computer-tailored advice than the text-group, despite both groups having the ability to click through to the next section of the tailored advice before they had finished the current one. The video-group spent a longer time distracted from the advice, as measured by proportion of
time spent viewing areas of the screen other than where the advice was presented. However, video participants may have been listening to the audio of the video whilst viewing other areas on the screen. The video-group participants did not have a higher recall of the intervention content after spending longer time engaged in the intervention content. Lastly, participants’ recall in both groups was low for some sections of the advice including the physical activity recommendations.

7.2 Strengths and limitations

The strengths of the recruitment evaluation include the objective measurement of the time and monetary costs to evaluate common recruitment methods. However, there are some notable limitations to the study design. First, to ensure a sufficient number of people participated in the randomised controlled trial, money spent on advertisements was evaluated weekly and adjusted in favour of the most effective advertisements. Therefore, the most successful recruitment method (i.e., Facebook advertisements) was used for longer than the non-successful advertisements (e.g., Google AdWords and newspaper advertisements). The differences in time of year and total amount spent on different recruitment methods may have affected their success. More funds were allocated to Facebook towards the end of recruitment during summer. Fewer barriers to being active (such as cold weather and short daylight hours) may have contributed to the success of Facebook compared to the other methods. Further, the effectiveness of the discontinued methods may have improved if they were implemented for longer. For example, the cost per participant recruited from the newspaper advertisements may have improved if five to ten consecutive advertisements were printed instead of two. Second, the demographic data were only collected for participants eligible to participate in the randomised controlled trial and who had completed the baseline.
assessment. Thus, the analysis on demographics excluded people who signed-up, but were not eligible or dropped out before the baseline questionnaire.

Strengths of the intervention trial include the randomised and controlled design and the use of intention to treat analysis. The novel approach used to deliver personalised health advice in an online environment was also a significant strength of the study. Limitations include self-reported physical activity which may be subject to social desirability bias, a high drop-out rate and a small sample size resulting in an underpowered analysis. High drop-out rates are not uncommon in web-based physical activity interventions due to the lack of fact-to-face contact (Skar et al., 2011) and need to be addressed in future trials. The low participation and high dropout rates may have been particularly high in the trial due to the advertising and simple intervention website failing to engage the public. The low participation and high dropout rates means that the primary outcome analysis comparing groups on physical activity changes was underpowered. Further, the sample was predominantly female, white and educated. Therefore the results may not be generalisable to males, other cultures and low socioeconomic groups. Finally, the additional telephone calls the tailoring coaching participants received, to encourage them to complete the coaching sessions, may have affected their physical activity levels.

A major strength of the eye-tracking study is the use of eye-tracking technology, which creates detailed objective data of participants’ eye movements on the physical activity advice. However the eye-tracking data also comes with limitations. Firstly, the eye-tracking technology only measures visual attention, not auditory attention. It is possible that people in the video-group were engaged in the audio when they were not viewing the video. This may have inflated the measure of distraction and led to an underestimation of attention in the
video-group. Second, it is possible that the longer time spent viewing the advice by the video-group was due to its taking longer to watch the videos compared to reading the same information in text-format. However the video-group not only spent longer viewing the video-tailored advice, but watched significantly more information than the text-group read. Third, a limitation of the use of eye-gaze as an attention measure is that it does not measure whether participants are actually processing the feedback. Finally we do not know whether increased attention to the video-tailored advice leads to a higher motivation to become more active or change behaviour.

### 7.3 Significance and implications for research and practice

Given that over half of the Australian population is inactive (Australian Bureau of Statistics, 2013a), which is costing the economy AUD $13.8 billion each year in healthcare, loss of productivity and mortality costs (Medibank Private, 2008), there is an urgent need for effective physical activity interventions with a broad reach. Popular technology including computers, the Internet, and smartphones provide an opportunity to deliver behaviour change programs (Artinian et al., 2010; Davies et al., 2012b; Foster et al., 2013) with no need for face-to-face contact. These e- and m- health interventions have similar effectiveness to face-to-face interventions and have time, geographical and financial advantages (Brouwer et al., 2011; Micco et al., 2007; Wantland et al., 2004). Currently 92% of Australians have access to the Internet (Australian Communications and Media Authority, 2015) which gives web-based interventions the potential to reach many Australians at low cost. However, researchers and health promotion practitioners have found that the lack of face-to-face contact in web-based interventions can lead to low participation and challenges with participant engagement (Davies et al., 2012b; Foster et al., 2011).
Results from the recruitment evaluation advance knowledge by demonstrating effective methods of improving the low participation seen in web-based physical activity interventions. Improving participation level is vital for the interventions to have an impact on community physical activity and chronic disease levels. Web-based interventions typically recruit participants through traditional media advertising methods including newspaper advertisements, posters and leaflets (Ferney et al., 2009; Foster et al., 2011) despite the availability of web-based marketing options (Wakolbinger et al., 2009). Results from this study suggest that public health professionals and researchers should consider using targeted Facebook advertising to recruit participants, over print based methods or other web-based methods, to optimise participation in web-based physical activity interventions and their impact on community physical activity levels.

The intervention trial contributes to the field by exploring ways to optimise the engagement and behavioural outcomes of personalised advice in a web-based physical activity intervention. Personalised advice through coaching or computer tailoring has been found to improve engagement and behaviour changes, however it is unknown how to optimally deliver personalised advice (Greaves et al., 2011). Computer tailoring which provides participants with automated feedback is cost-effective in engaging participants and producing behavioural change in large scale interventions (Lustria et al., 2009). Coaching or counselling has also been shown to be effective in engaging participants and producing behaviour changes and additionally provides participants with accountability and social support (Greaves et al., 2011; Tate et al., 2003). Computer tailoring is more frequently implemented due to its low cost, however further information is needed to determine whether online coaching in addition to computer tailoring may further improve engagement and
behavioural outcomes. Outcomes from the intervention trial indicate that computer-tailored advice and coaching are effective in comparison to a control group but not a tailoring only group; these findings provide important information for researchers and public health professionals. The lack of additional effectiveness of the video-coaching sessions could be due to the low adherence to the sessions, the analysis comparing the video-coaching + tailoring and the tailoring only groups being underpowered or that the sessions were not effective at improving behaviour in addition to computer tailored advice. Despite the methodological limitations of the study, the results do not support the effectiveness of video coaching in addition to computer tailored-advice. However due to the high satisfaction of the video-coaching sessions and the increased engagement in those who completed the video-coaching sessions, it is possible that coaching is liked and effective for a sub-group of participants, therefore it may still be offered as an additional option with the aim to only offer it to those who are willing and interested in video-coaching, but not for all participants.

Lastly, the eye-tracking study contributes to our understanding of participant engagement in computer-tailored physical activity advice. It is established that computer-tailored behaviour change advice improves participant outcomes and is low cost for large scale interventions, however engagement can still be improved (Lustria et al., 2009). Computer-tailored advice is commonly delivered in text-based format on intervention websites despite users tending to only skim and scan text when reading on the Internet (Liu, 2005). Today people have come to expect information to be provided through graphically rich and interactive technologies such as video in an online environment (Purcell, 2010; Vandelanotte & Mummery, 2011). New technology allows the delivery of tailored videos that present a string of short videos selected for the user based on their responses to a short questionnaire (Vandelanotte et al.,
2012). The finding that video-tailored advice is more engaging than text-tailored advice is important for future interventions as attention and engagement are strongly linked with behavioural outcomes. To engage participants, web-based health interventions must evolve with the online environment, and findings suggest that video-tailoring is the next step forward.

7.4 Future recommendations

Although findings from the recruitment evaluation demonstrated that targeting Facebook advertising was the most cost-effective method to attract participants to a web-based health intervention, at AUD $42 per sign up (AUD $38 without staff costs) it is not viable for population-based interventions that seek widespread implementation. Such interventions may need to use additional methods including mass media and viral marketing to promote general awareness of the intervention in addition to Facebook advertising. As such, research is required to evaluate the effectiveness of mass media in addition to Facebook advertising to promote awareness and uptake of web-based health interventions. More research is also needed to test the effectiveness of Facebook advertising for targeting specific population groups. Facebook has the ability to target specific demographics, however we do not know if the cost per participant would rise for interventions targeting hard to reach demographics. Promoting interventions through a dedicated Facebook page should also be explored. The current study had minimal activity on its own Facebook page due to the moderate size of the intervention. Large scale interventions may benefit from promoting activity on a Facebook page to further promote awareness of the intervention throughout the Facebook community at low cost. Managing a Facebook page requires time, but provides the ability to reach people through posts without the use of paid advertisements. These posts also have the potential to
‘go viral’ through many people sharing with their friends (Valdez et al., 2014). Finally, Facebook advertising and mass media should be compared to promoting web-based interventions through the health care system. Recruiting participants through clinics and hospitals has been effective in reaching people at risk of diabetes or cardiovascular disease and clinical samples (Dickinson et al., 2013; McTigue et al., 2011), however the cost and time investment for reaching participants through this method compared to general advertising and whether it differs by population groups, is unknown.

Although the findings from the intervention trial revealed a low adherence to the coaching sessions and only minor non-significant physical activity improvements in the tailoring + video-coaching participants compared to the tailoring only participants, further research is needed to investigate the effectiveness of coaching in comparison to computer-tailored advice. A higher participation in the coaching sessions could be promoted by incorporating delivery of new intervention content into the coaching sessions rather than discussing previously received computer-tailored advice. However, this would raise the requirements of the activity coach and therefore the cost of the intervention. Delivering the intervention content through the coaching sessions may be particularly effective in clinical groups who may require further social support and accountability (Pilutti et al., 2014; Suh et al., 2014). The Elaboration Likelihood Model of Persuasion (ELM) and the Theory of Planned Behaviour (TPB) were used to ensure intervention content was persuasive and addressed important components of behaviour change. Effective behaviour change techniques such as goal setting and action planning which address TPB constructs were also included to optimise behaviour changes. This use of theory may have contributed to the large physical activity changes seen in the tailoring + video-coaching in comparison to the control group.
However the lack of engagement in the intervention seen by the low participation numbers and high dropout rates demonstrates a need for a greater focus on website appeal. Although highly engaging website designs, layouts and features do not directly produce behaviour changes, they are important intervention components necessary for behaviour change. Intervention websites need to be visually appealing and engaging for participants to adhere to the intervention modules, engage in the content and continue their participation in the intervention. This will increase participants’ exposure to the evidence based behaviour change techniques and therefore improve behaviour changes resulting from the intervention (Ferney et al., 2009). Despite this, website appeal and engagement is often overlooked in the development of web-based physical activity interventions. Further research is needed to examine methods to improve participant engagement in the websites. The evaluation of popular features included in existing high traffic websites such as interactive and content sharing web 2.0 intervention features may be the first step forward.

The eye-tracking study demonstrated low levels of recall of the computer-tailored advice, especially for the physical activity recommendations. This highlights a need for future research to evaluate ways of improving recall of key parts of physical activity advice. This may include repetition of the advice in different forms. For example the physical activity recommendations could be presented in the video-tailored advice through text, audio, pictures and graphs throughout the video to enforce learning (Rucker & Petty, 2006). It would also be beneficial to conduct the research with a larger sample size to test two-way interactions between participant demographics (gender, BMI, motivation to become more active, and age) and advice delivery (video, text) on attention. It is, for example, important to determine whether video-tailored advice is effective in engaging older participants or males,
who are typically less active and at higher risk for developing chronic diseases (George et al., 2012; Nelson et al., 2007). Lastly, the next step for evaluating video-tailored advice is to examine the effectiveness of video-tailored advice in producing long-term behaviour changes in comparison to standard text-tailored advice in a randomised controlled trial.

Collectively the three studies in this thesis provide information on the effectiveness of web- and print-based recruitment methods, video-coaching and video-tailoring in web-based interventions. However for the field to continue forward, further research is needed to test the effectiveness of other web-based intervention components such as individual behaviour change techniques, action planning tools, self-monitoring tools, social media applications, videos and interactive features. In particular more RCTs are required to determine the effectiveness of these components in isolation. This will enable the identification of components that have a positive effect on behaviour without being masked by simultaneously delivered components.

Further, recent research has confirmed the effectiveness of interventions delivered through tablets and smartphone applications (Carter, Burley, Nykjaer & Cade, 2013; Kirwan, Duncan, Vandelanotte & Mummery, 2012). These interventions have the benefit of fitting into the users’ lifestyle and enabling them to access the intervention when they are out and about, even when they are moving around. Tablet and smartphone delivered interventions can be stand-alone interventions or can be used in conjunction with an intervention website. Although the use of tablets and smartphones is still not as common as desktop computers, use in Australia is rising dramatically, particularly in younger age groups (Australian Communications and Media Authority, 2014). Smartphones also now have inbuilt sensors including accelerometers, compasses and global positioning systems which allow users to
monitor their movement. These provide opportunity for seamless self-monitoring within interventions. Researchers and public health professionals examining web-based interventions should at least consider making the website accessible through tablets and smartphones (i.e., apply responsive designs) to promote intervention use and adherence. Future research is required to compare the engagement, adherence and effectiveness of interventions delivered through desktop computers, to those delivered through tablets and smartphones and to determine whether this differs by age and demographic groups.

Finally, to keep interventions appealing to users websites must continually be updated in order to provide the same level of interactivity, visual appeal and connectivity seen in successful commercial websites, and research is needed to evaluate users’ engagement with or without ongoing upgrades. Usability testing should also be carried out to ensure there are no features or functionalities in the intervention websites that are difficult for the users to navigate through (Hinchliffe & Mummery, 2008). In summary, research into ongoing improvements to the components, delivery mode, appeal and usability of web-based physical activity interventions is required in order for future interventions to have high levels of engagement, adherence and behaviour changes.

### 7.5 Conclusions

In conclusion this thesis presents information on effective methods for improving the promotion, engagement, satisfaction and effectiveness of web-based physical activity interventions. This is important as physical activity levels are low in Australia and around the globe despite inactivity leading to poor mental and physical health. The Internet provides a means of promoting physical activity to large numbers at low cost, however recruitment
and engagement problems limit their effectiveness. Findings from this thesis suggest that Facebook advertising is more cost-effective in recruiting intervention participants compared to other online methods and traditional print advertising. Next, findings revealed that online video-coaching in addition to computer-tailored advice is not effective in increasing engagement or behaviour outcomes. As such, low-cost computer-tailored advice is sufficient in large population based physical activity interventions. Finally, findings demonstrate that video-tailored advice leads to improved engagement compared to text-tailored advice. Together the findings from the thesis provide researchers and public health professionals with information to guide the development of future web-based physical activity interventions effective in reaching and engaging large numbers of the population. This will allow them to more effectively take advantage of the Internet and deliver behaviour change programs that have an impact on the physical activity levels in the community.
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193


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Appendices

Appendix A: Screening questionnaire for the intervention trial

Q1. What is your first name?

Q2. What is your second name?

Q3. What is your phone number?

Q4. What is your postal address?

Q5. a) Do you use a video-calling program? e.g., Skype?
   a. Yes
   b. No

b) If yes which one?
   a. Skype
   b. Google Hangout
   c. Yahoo Messenger
   d. Face Time
   e. Other
   f. None

Q6. When did you find out about this program?
   a. Today
   b. Yesterday
   c. Earlier this week
   d. Last week
   e. A fortnight ago
   f. A month ago
   g. Longer than a month ago
Q7. How did you find out about the program?

a. Newspaper advertisement
   a. The Morning Bulletin
   b. Central Queensland News
   c. Capricorn Local News
   d. Capricorn Coast Mirror
   e. Other

b. Newspaper article
   a. The Morning Bulletin
   b. Central Queensland news
   c. Capricorn Local News
   d. Capricorn Coast Mirror
   e. Other

c. Poster
   a. Health clinic
   b. Pharmacy
   c. Sports club
   d. Community centre
   e. Other

d. Leaflet
   a. Health clinic
   b. Pharmacy
   c. Sports club
   d. Community centre
   e. Letter box
   f. other

e. Facebook advertisement
   a. Newsfeed
   b. Right side
   c. I can’t remember

f. Google advertisement
   a. Community website
b. My Community Connect
c. Daily Mercury
d. Other
e. Family or friend
f. Other

Q8. IF yes to Facebook: Which Facebook advertisement did you see?
   a. Improve your health
   b. Improve your heart health
c. Feeling down?
d. Suffer from diabetes?
e. Cancer diagnosis?
f. I can’t remember

Q9. Are you:
   a. Male
   b. Female

Q10. IF FEMALE, Are you Pregnant?
   a. Yes
   b. No

Q11. Are you over 18 years of age?
   a. Yes
   b. No

Q12. IF OVER 18 YEARS, What is your age?

Q13. The ‘My Activity Coach’ Program is aimed at helping people who are not active become more active. Therefore only people who are currently participating in less than 30 minutes of physical activity on average each day are eligible to participate.

Do you currently participate in LESS THAN 30 mins of physical activity on average each day of the week?

If you are not sure, please select yes. People are more likely to overestimate than underestimate their physical activity.
   a. Yes
   b. No
Q14. The following questions are to detect any problems with your health that may affect your ability to become more active. Only those whose health allows them to safely become more active are eligible to participate in the program.

Do you have any conditions that may prevent you from increasing your activity levels?
   a. Yes
   b. No

Has your doctor ever said that you have a heart condition and that you should only perform physical activity recommended by a doctor?
   a. Yes
   b. No

Do you feel pain in your chest when you perform physical activity?
   a. Yes
   b. No

In the past month, have you had chest pain when you were not performing any physical activity?
   a. Yes
   b. No

Do you lose your balance because of dizziness or do you ever lose consciousness?
   a. Yes
   b. No

Do you have a bone or joint problem that could be made worse by a change in your physical activity?
   a. Yes
   b. No

Is your doctor currently prescribing any medication for your blood pressure or for a heart condition?
   a. Yes
   b. No

Do you know of any other reason why you should not engage in physical activity?
   a. Yes
   b. No

Q15. Do you wish to have a plain English statement of the overall research results emailed to you at completion of the project?
   a. Yes
   b. No
Appendix B: Leaflet advertisement for the intervention trial

Front and back pages:

You are invited to participate in the free ‘My Activity Coach’ program to help you become more active!

Centre for Physical Activity Studies, Central Queensland University

Do you want to become healthier, fitter, and happier?

www.myactivitycoach.org.au

Principal researcher: Stephanie Alley
Ph: 49232263
Email: coach@myactivitycoach.org.au

MY ACTIVITY Coach

CQ University AUSTRALIA
Complete the online surveys to go in the draw to win one of the following prizes:

- 30 Pedometers (to record your steps)
- 6 Fit bits (physical activity trackers)
- 3 Polar heart rate monitors

My Activity Coach

The program, My Activity Coach, is a state-of-the-art online physical activity program developed by CQUniversity. The program includes four 30-minute sessions (spread over 8 weeks) that provides personalised information to help you become more active and live a healthier and happier life. The sessions cover the physical activity recommendations, goal setting, action planning, confidence, benefits and barriers to becoming more active, creating an active lifestyle, and preventing relapse. Participation is free and in return participants are required to complete four 20-minute online surveys. Please visit the website, www.myactivitycoach.org.au, or contact the principal researcher, Stephanie Alley at coach@myactivitycoach.org.au to sign up or find out more.
Appendix C: Demographic questionnaire for the intervention trial

Are you:  Male ☐  Female ☐
Age – What is your current age?  (Enter years) _________
Height – What is your height in centimetres (cm)? _________
Weight – What is your weight in kilograms (kg)? _________
Location – What is your postcode? _________
Ethnicity – What is your ethnicity?
   White ☐
   Indigenous Australian ☐
   African ☐
   Asian ☐
   Islander ☐
   Other ☐ Please Specify __________________

Internet literacy - How many days per week do you usually use the Internet (total per week)?
   AT HOME: _____ days per week
   AT WORK: _____ days per week
On average, for how long do you use the Internet each day you use it (total per day)?
   AT HOME: _____ hours _____ minutes
   AT WORK: _____ hours _____ minutes.
On a scale of 1-5 where 1 is VERY CONFIDENT and 5 is NOT CONFIDENT, how confident are you with using the Internet for general purposes?
   RATING 1-5 _______

Employment status – What is your current employment status?
   Employed part-time ☐
   Employed casual ☐
   Self employed ☐
   Unemployed ☐
   Retired ☐
   Student ☐
   Home Duties ☐
Pensioner □
Employed full-time □

Level of position – Please indicate the level at which you work
Manager & administrator □
Professional □
Associate/para professional □
Tradesperson □
Clerk □
Salespersons & personal service worker □
Plant & machine operators, & driver □
Advanced clerical & service worker □
Intermediate clerical & service worker □
Intermediate production & transport worker □
Elementary clerical, sales & service worker □
Labourer & related worker □
Other □ Please Specify

Household income – What is your approximate annual combined household income (before tax)?
$2,500 or more per week ($130,000 or more per year) □
$2,000 - $2,499 per week ($100,000 - $129,999 per year) □
$1,500 - $1,999 per week ($78,000 - $99,999 per year) □
$1,000 - $1,499 per week ($52,000 - $77,999 per year) □
$800 - $999 per week ($41,600 - $51,999 per year) □
$700 - $799 per week ($36,400 - $41,599 per year) □
$600 - $699 per week ($31,200 - $36,399 per year) □
$500 - $599 per week ($26,000 - $31,199 per year) □
$400 - $499 per week ($20,800 - $25,999 per year) □
$300 - $399 per week ($15,600 - $19,799 per year) □
$200 - $299 per week ($10,400 - $15,599 per year) □
<table>
<thead>
<tr>
<th>Weekly Income Range</th>
<th>Annual Income Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>$160 - $199</td>
<td>$8,320 - $10,399</td>
</tr>
<tr>
<td>$120 - $159</td>
<td>$6,240 - $8,319</td>
</tr>
<tr>
<td>$80 - $119</td>
<td>$4,160 - $6,239</td>
</tr>
<tr>
<td>$40 - $79</td>
<td>$2,080 - $4,159</td>
</tr>
<tr>
<td>$1 - $39</td>
<td>$1 - $2,079</td>
</tr>
<tr>
<td>Nil or negative</td>
<td></td>
</tr>
<tr>
<td>No response</td>
<td></td>
</tr>
</tbody>
</table>

Level of education – What is your highest level of education? This includes complete or incomplete.

- Pre-school
- Infants/Primary school
- Secondary school
- Technical or further educational institution (inc TAFE)
- University or other higher educational institution
- No schooling
Appendix D: Active Australia Questionnaire (AAQ)

The next questions are about any physical activities that you may have done in the last week:

In the last week, how many times have you walked continuously, for at least 10 minutes, for recreation, exercise or to get to or from places?

__________ times

What do you estimate was the total time that you spent walking in this way in the last week?
In hours and/or minutes

__________ minutes

__________ hours

In the last week, how many times did you do any vigorous gardening or heavy work around the yard, which made you breathe harder or puff and pant?

__________ times

What do you estimate was the total time that you spent doing vigorous gardening or heavy work around the yard in the last week?
In hours and/or minutes

__________ minutes

__________ hours

The next questions exclude household chores, gardening or yard work:

In the last week, how many times did you do any vigorous physical activity which made you breathe harder or puff and pant? (e.g., jogging, cycling, aerobics, competitive tennis)

__________ times

What do you estimate was the total time that you spent doing this vigorous physical activity in the last week?
In hours and/or minutes

__________ minutes

__________ hours
In the last week, how many times did you do any other more moderate physical activities that you have not already mentioned? (e.g., gentle swimming, social tennis, golf)

__________ times

What do you estimate was the total time that you spent doing these activities in the last week?

In hours and/or minutes

__________ minutes

__________ hours
Appendix E: Participant information form for the intervention trial

Participant Information Form

Thank you for your interest in participating in this research. This research is being conducted in Central Queensland through the Centre for Physical Activity Studies, CQUniversity.

The program

The program, ‘My Activity Coach’ is a state-of-the-art online physical activity program made up of four 30-minute sessions (spread over eight weeks) that provides personalised information to help you become more active and live a healthier and happier life. Your participation in the study is entirely free.

Is this program for you?

To participate in the program you must meet all of the below criteria:

Speak English

Have basic computer skills, and have access to a computer with broadband Internet fast enough to watch videos directly from the internet

18 years or above

Not currently meeting the national physical activity guidelines (30 minutes of physical activity on five or more days of the week)

Have no physical impairments that will prevent you from becoming more active.

Not pregnant

Participant Commitments

Over time ALL participants will receive the physical activity program for free. In return participants are required to complete 4 online surveys (immediately prior to program commencement, and 9 weeks, 6 months and 1 year after program commencement). Each questionnaire will take approximately 20 minutes to complete.

Participants will be randomly assigned to one of 3 groups so we can establish how effective each intervention is at improving physical activity:

*Video-coaching + personalised-advice:* In addition to the program explained above people in this group will be asked to participate in four 10-minute coaching sessions using an internet video-calling program (e.g., Skype). These coaching sessions will allow discussing the advice participants received in the program.

*Personalised-advice only:* People in this group will only receive the ‘My Activity Coach’ program as explained above.
**Wait-list:** People in this group will be given access to the program explained above at the end of the study after completing all surveys.

**Prizes**
Participants will go in the draw to win **prizes** after completing each follow-up questionnaire (9 weeks, 6 months, 1 year). The prizes to be drawn after EACH questionnaire are: 10 pedometers, 2 Fit Bit Accelerometers, 1 Polar Heart Rate monitor.

**Your rights as a participant**
There are **no anticipated risks or dangers** associated with participating in this study; however the program is not appropriate for you if you have a physical impairment preventing you from becoming more active.

You are able to withdraw or decline to participate in the program at any stage with no consequences.

Any information that is obtained from participants during the program will be stored for 5 years. The **information will remain confidential** and will be stored securely. No personal information that could identify you will be disclosed in any reports on the project, or to any other party.

At the end of the study a plain English **statement summarising study findings** will be available to all participants.

Please note that there is no obligation to be involved in this program and your participation is entirely voluntary.

If you have any questions, please ask the Physical Activity Coach, Stephanie Alley.
Email: s.alley@cqu.edu.au Phone: (07) 4932 2263

Alternatively, please contact the CQUniversity’s Office of Research should there be any concerns about the nature and/or conduct of this research project.
Email: ethics@cqu.edu.au Phone: (07) 4923 2603
Appendix F: Participant consent form for the intervention trial

Participant consent form

‘My Activity Coach’

I agree to take part in the CQU’s research project ‘My Activity Coach’. I have read the Information Sheet (if not click here <link> opens a new window), and understand that agreeing to take part means that I am willing to:

Be contacted by the researcher by email and phone

Complete 4 questionnaires (immediately before the program, 1 week after the program, 6 months after program commencement and 1 year after program commencement)

If assigned to ‘tailoring’ or ‘coaching’ groups: To participate in 4 online sessions, which will provide me with personalised physical activity information, over an 8 week time-period. Each session will take about 30 minutes in total.

If assigned to the ‘coaching group’: To additionally participate in 4 brief online coaching sessions with the Physical Activity Coach using an online video-calling program over the same 8 week period. Each session will take 5 to 10 minutes.

If assigned to the ‘wait-list’ group: To complete all study surveys, before gaining access to the intervention program.

I understand that my participation is voluntary, that I can choose not to participate in part or all of the project. I understand that I can withdraw my participation and/or information at any stage of the project without being penalised or disadvantaged in any way.

I understand that any information I provide is confidential, and that no information that could lead to the identification of any individual will be disclosed in any reports on the project, or to any other party. I understand that the data collected from this project will be stored in a secure manner and will accessible to the researchers only.

I understand that the results to the project, including group program results will be published in a PhD thesis, research journals, and will be presented at conferences.

I agree that I have had any questions I had about the project answered to my satisfaction by the Information sheet and any further verbal explanation provided.

I agree that I am providing informed consent to participate in this project.

I agree ☐ I disagree ☐

I wish to have a plain English statement of the research results emailed to me

Yes ☐ No ☐
Appendix G: Participant email templates

Automatic email alert/reminder for surveys

Hi Hamish,

It's the Activity Coach! This is another reminder that the survey, 12 Month Questionnaire is ready for you to complete. Log on to 'My Activity Coach' to complete it before the end of this week.

Please email me (contact details below) if you have trouble logging in or have any questions. If you do not complete the survey by Sunday, I will give you a call to ensure there are no problems and to see if you need any assistance.

Have fun being active!

Kind regards, The activity coach
Email: coach@myactivitycoach.org.au

Welcome email template

Hi ___________,

Thank you for signing up to participate in ‘My Activity Coach.’
Please use your email and first name to log into the ‘My Activity Coach’ website, www.myactivitycoach.org.au:
Email: ___________
Password: ___________

The first session is ready for you to complete. You have one week to complete each of the four sessions that are delivered fortnightly. You will be emailed a reminder when a new one becomes available. If you have any questions please do not hesitate to contact me at coach@myactivitycoach.org.au.

I trust that you will gain some information and support to help you get more active!

Kind Regards,
Your Activity Coach,
Stephanie
Example of email template for non-coaching participants (week 2).

Hi __________,

I just wanted to check in to see how you are going with your physical activity! I hope you have had a successful week. I want to encourage you to do an additional __________ week to kick off your healthier lifestyle. Keep in mind that increasing your activity will help you ____________ (which you listed as your main reason for getting more active). Your next session is on goal setting and will be available for you to complete on Monday. Until then, have fun being active!

Please let me know if you have any questions,

Kind Regards,
Your Activity Coach,
Stephanie
Appendix H: Images of the intervention

Log in page
Contact us with a problem or feedback

Contact us to resolve any problems:

- **Your Name**: Hamish Bland
- **Your Email Address**: Hamish.bland@gmail.com

Details:

[Submit button]
Coaching tab

Book a Coaching Session

The coaching session will be a 10-15 minute video call with the Activity Coach to provide you with the opportunity to discuss the tailored feedback you received in the previous session, and your overall progress with becoming more active. It will take place on alternate weeks to the tailored feedback sessions, so will be on weeks 2, 4, 6 and 8. You will be reminded at the end of each feedback session to book a time slot for the following weeks coaching session. Get in early to get the time slot you prefer! If you wish, you may book all four sessions up front, just make sure you book only one session during each of the available weeks. Make sure you have set up the video program on your computer and created yourself an account before you book a session (see the section below for more information).

To book a session you will need to click on the link below, which will take you through four steps as follows:

1. Select the Service: Click on ‘Book now’ under coaching session.
2. ‘Choose a Person and Time Slot’: Click on the appropriate week using the monthly calendar, and then choose an available time slot.
3. ‘Contact Information’: Enter in your name, email, the video calling program you want to use and the name to find you in the program.
4. ‘Review’: Make sure the details for your coaching session are correct.

[Book appointment now]

The activity coach will call you when it is your scheduled time. Make sure you have set up a video calling program on your computer that the video calling program is ON, that your status is ‘online’ and that you have added the activity coach as a friend.

Video Calling Setup

You can choose whether you would like to use Skype, Google Hangout, Yahoo Messenger or Face time for the activity coach to call you. If you would like more information about installing and using these programs, here is a FAQ with information on these video calling programs. Please which program you would like to use, and then set up the program ready for week 2 of My Activity Coach. The contact details of the activity coach for each program are provided below.

<table>
<thead>
<tr>
<th>Program</th>
<th>Contact details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skype</td>
<td>Name: Activity Coach</td>
</tr>
<tr>
<td></td>
<td>Email: <a href="mailto:activity.coach2014@gmail.com">activity.coach2014@gmail.com</a></td>
</tr>
<tr>
<td>Google Hangout</td>
<td><a href="mailto:activity.coach2014@gmail.com">activity.coach2014@gmail.com</a></td>
</tr>
<tr>
<td>Yahoo Messenger</td>
<td>activity.coach2014</td>
</tr>
<tr>
<td>Face Time</td>
<td>First Name: My Activity Coach</td>
</tr>
<tr>
<td></td>
<td>Email: <a href="mailto:activity.coach2014@gmail.com">activity.coach2014@gmail.com</a></td>
</tr>
</tbody>
</table>

NOTE: You will be able to see a video of the activity coach during your coaching call, however you can choose to turn off your video that would be presented to the activity coach. If you do wish to turn your video on, you will need an inbuilt camera or have an internal one installed.

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Calendar booking system
Appendix I: Video-coaching script

Session 1:

Hi ___________, Thank you for chatting with me today. My name is Steph. I will be your activity coach for the program.

These 10 minute coaching sessions are to provide you with an opportunity to discuss your progress with physical activity to ask any questions you may have about the advice you received. The main purpose is to offer some support and accountability to help you become more active.

‘It’s great you have made exercise a priority’ Why did you sign up to the program?

Discuss their main reasons for becoming active________________________

Weight- more about eating! Don’t eat more when you start exercising! Need to be active for at least 1h, but increasing activity will still improve long term health regard less of weight.

Focus on short term as well as long term

• Have you tried to get active before?
• What’s different this time?
• How determined are you to get more active?

You are currently doing____________ minutes of physical activity each day

You are meeting the, Minimal? Optimal?

You are/are not doing enough vigorous? – if not give ideas. hills, backpack etc smartphone applications? – Run keeper

At least 5 days each week?

*Ask about sedentary behavior.

Mention if relevant: Physical activity reduces your risk of disease by 20-50%. For every 1.5 hours of walking each week your risk of diabetes is reduced by 6%. Burning 2200 calories (5x1 hour mod activity) is associated with reduced plaque in arteries. Strength training reduces risk of arthritis in people over 50. Physical activity recommendations for people with diabetes also includes strength training (major muscle groups, 8 exercises, 10 reps) a few times a week and 1.5 hours of vigorous activity each week. Physical activity improves breast cancer outcomes by 39-54%

Are you attempting to follow the advice to increase your activity by _____________

Why did you mention that becoming more active will be________________________ (difficult/sometimes difficult). What will it take for you to be more confident that you can become more active?

• Many people find it difficult, but it is possible.
• Short bursts
• Doesn’t have to be vigorous
Will cover tips to create an active lifestyle in later sessions
Is there anything else about the program that you are not sure about or wanted to discuss?
Thank you for chatting with me today. All the best for the following week of becoming more active. I will speak to you in two weeks. Make sure you book a time slot early so you can get a time that suits you.

**Session 2:**

Hi ____________, Thank you for chatting with me today.

How is your activity going?
Discuss participants PA changes since last session ________________

*if increased, ‘how were you able to do that?’ ‘Impressive’
*if not increased, ‘What do you think stopped you?’ ‘Most people need a few tries so see what works for them and their environment’. ‘Can you think how you can change your approach this week to help you increase your chances of increasing your activity?’

Discuss their coping self-efficacy
Too busy? This is why we do action plans. Make exercise a priority. Many busy people are active
Tired? You may feel worse at first, but your body will adapt and you will have more energy in the long run.

No partner? Find one! Join a gym? Or get emotional support?
Remind them that people who set goals & action plans are more likely to change their behaviour than those that don’t.

Have you set goals?
Did you follow the SMART goal criteria?

**REVIEW THEIR GOALS OR HELP TO CREATE**

• Choose something that means something to you.
• Set Increments?
• Also set food goals?

Have you done the action plan?

**REVIEW THEIR ACTION PLAN OR HELP TO CREATE**

• Morning sessions are good
• Mix it up to keep it interesting
• Find an activity buddy or someone to support who is positive about you getting more active.
How have gone with your action plan in the last week?
Did you print it off or put it in your diary?
Thanks again for chatting with me today, all the best with following you activity goals until next time!

**Session 3:**
Hi ____________, Thank you for chatting with me today.
How is your activity going?
Discuss participants PA changes since last session ________________
*if increased, ‘how were you able to do that?’ ‘Impressive’
*if not increased, ‘What do you think stopped you?’ ‘Most people need a few tries so see what works for them and their environment’. ‘Can you think how you can change your approach this week to help you increase your chances of increasing your activity?
Met action plan? ______________
Set harder or easier next time?
If scheduling self-efficacy is low:
  - put activity in diary
  - make activity a priority
  - Your routine of physical activity will only take a few weeks to establish
Were there any tips about creating an active lifestyle that would suit your environment?
  - Garden/housework
  - Active travel
  - Breaking up working day- exercise at lunch?
  - Exercise with family and friend? Or join club?
Social support
Thanks again for taking the time to discuss your progress with me today, all the best with creating an active lifestyle!

**Session 4:**
Hi ____________, Thank you for chatting with me today.
How is your activity going?
Discuss participants PA changes since last session ________________
*if increased, ‘how were you able to do that?’ ‘Impressive’
*if not increased, ‘What do you think stopped you?’ ‘Most people need a few tries so see what works for them and their environment’. ‘Can you think how you can change your approach this week to help you increase your chances of increasing your activity?

Met action plan? ____________

Set harder or easier next time?

If maintenance self-efficacy is low:

- Motivation to get you going. Habit to keep you going.
- Succeeding is about making a habit of exercising. Only takes a few weeks to establish a new habit!
- Don’t have to always feel motivated. Just do it! Instead of over thinking it make it a routine in your life.

Recap on relapse prevention

- It’s common to relapse. Learn from your mistakes.
- What’s different about quitting this time?
- Many circumstances we can control. It’s about getting back into your routine and not giving up.
- Have you identified any triggers that may cause you to relapse into being in-active?
- How can you prevent this trigger from causing a relapse?
- Your main barrier _______________ could be a trigger. Could any other common barriers be a trigger?
  - Time
  - Interest
  - Fun
  - Social support
  - Activity buddy
  - Health
  - Tired

Injury – seek professional diagnosis and work around it in the meantime. – swimming, upper body work, bike riding etc..

Sick – Cold- keep going. Fever no, you need to rest!

The more you exercise will power the easier it gets. Also, the more you establish a routine of physical activity including planning your week around it you can avoid situations when your will power might slip.

So overall, how do you think you have you gone in the program?

All the best with your physical activity. This is the end of the program. Keep setting action plans and goals so you don’t let you activity slip! Next week you will be given a
questionnaire to complete which will help us to evaluate the program. After completing it you will go in the draw to win some cool prizes including physical activity trackers and heart rate monitors. Thank you for your participation in this project.
Appendix J: Quality of life SF- 12v2

Your Health and Well-Being

This questionnaire asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. Thank you for completing this survey!

For each of the following questions, please select the response option that best describes your answer.

In general, would you say your health is:

<table>
<thead>
<tr>
<th>Excellent</th>
<th>Very good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ 1</td>
<td>☐ 2</td>
<td>☐ 3</td>
<td>☐ 4</td>
<td>☐ 5</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Yes, limited a lot</th>
<th>Yes, limited a little</th>
<th>No, not limited at all</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a) Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf

b) Climbing several flights of stairs

During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

<table>
<thead>
<tr>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a) Accomplished less than you would like

b) Were limited in the kind of work or other activities
During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

<table>
<thead>
<tr>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Accomplished less than you would like</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Did work or other activities less carefully than usual</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>A little bit</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks…

<table>
<thead>
<tr>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Have you felt calm and peaceful?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Did you have a lot of energy?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Have you felt downhearted and depressed?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>A little bit</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Appendix K: Constructs of the Theory of Planned Behaviour

For the next questions we refer to ‘regular physical activity.’ Regular physical activity equals doing the physical activity recommendations of 30 minutes of physical activity on five or more days of the week. This includes at least moderate intensity activity such as brisk walking or cycling. The 30 minutes of physical activity can be reached through multiple sessions, but each session should be at least 10 minutes in duration.

Please answer each of the following questions by circling the number that best describes your opinion. Some of the questions may appear to be similar, but they do address somewhat different issues. Please read each question carefully.

For me to get regular physical activity in the coming month would be:

*Beneficial* 1 2 3 4 5 6 7  *Harmful*

*Useful* 1 2 3 4 5 6 7  *Useless*

*Wise* 1 2 3 4 5 6 7  *Foolish*

*Interesting* 1 2 3 4 5 6 7  *Boring*

*Enjoyable* 1 2 3 4 5 6 7  *Un-enjoyable*

*Relaxing* 1 2 3 4 5 6 7  *Stressful*

Most people who are important to me would encourage me to engage in regular physical activity over the coming month

*Strongly disagree* 1 2 3 4 5 6 7  *Strongly agree*

Most people whose opinions I value would approve of me engaging in regular physical activity over the coming month

*Strongly disagree* 1 2 3 4 5 6 7  *Strongly agree*

I think that over the coming month, most people who are important to me will be..
**Active** 1 2 3 4 5 6 7  **Inactive**

I think that over the coming month, the activity levels of most people who are important to me will be

*High* 1 2 3 4 5 6 7  *Low*

In the coming month, doing physical activity, if I really wanted to, is under my control

*Strongly disagree* 1 2 3 4 5 6 7  *Strongly agree*

I am confident I could engage in regular physical activity in the coming month if I wanted to

*Strongly disagree* 1 2 3 4 5 6 7  *Strongly agree*

Engaging in regular physical activity over the coming month *if I wanted to do so* would be easy. . . .

*Strongly disagree* 1 2 3 4 5 6 7  *Strongly agree*

I am committed to engage in regular physical activity over the coming month

*Strongly disagree* 1 2 3 4 5 6 7  *Strongly agree*

I am motivated to engage in regular physical activity over the coming month

*Strongly disagree* 1 2 3 4 5 6 7  *Strongly agree*

I am determined to engage in regular physical activity over the coming month

*Strongly disagree* 1 2 3 4 5 6 7  *Strongly agree*

I have made plans concerning ‘when’ I am going to engage in regular physical activity in the coming month
I have made plans concerning ‘where’ I am going to engage in regular physical activity in the coming month.

I have made plans concerning ‘what’ kind of regular physical activity I am going to engage in over the coming month.

I have made plans concerning ‘how’ I am going to get to a place to engage in regular physical activity over the coming month.
Appendix L: Satisfaction questionnaire for the intervention trial

Questions

The next questions are about the questions you needed to complete in order to receive the personalised physical activity advice in the 4 online sessions.

Q1. The questions were easy to understand

\[\text{Strongly disagree} \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad \text{Strongly agree}\]

Q2. It was easy to answer the questions

\[\text{Strongly disagree} \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad \text{Strongly agree}\]

Q3. There were too many questions to answer before I got the advice

\[\text{Strongly disagree} \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad \text{Strongly agree}\]

Q4. It’s easy to go from one question to another

\[\text{Strongly disagree} \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad \text{Strongly agree}\]

Advice

The next questions are about the content of the physical activity advice you received in the 4 online sessions.

Q1. The physical activity advice is interesting

\[\text{Strongly disagree} \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad \text{Strongly agree}\]

Q2. The physical activity advice is credible

\[\text{Strongly disagree} \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad \text{Strongly agree}\]

Q3. The physical activity advice is logical and well-organised

\[\text{Strongly disagree} \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad \text{Strongly agree}\]

Q4. The physical activity advice is easy to understand

\[\text{Strongly disagree} \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad \text{Strongly agree}\]
Q5. Through the physical activity advice I learned something new about my own physical activity

Strongly disagree 1 2 3 4 5 Strongly agree

Q6. The physical activity advice is personally relevant

Strongly disagree 1 2 3 4 5 Strongly agree

Q7. Too much physical activity advice was provided

Strongly disagree 1 2 3 4 5 Strongly agree

Q8. The physical activity advice is confusing

Strongly disagree 1 2 3 4 5 Strongly agree

Q9. I will use the physical activity advice

Strongly disagree 1 2 3 4 5 Strongly agree

Q10. The physical activity advice was persuading to become more active

Strongly disagree 1 2 3 4 5 Strongly agree

Q11. I have already started to become more physically active because of this program

Strongly disagree 1 2 3 4 5 Strongly agree

Q12. I would recommend this program to others

Strongly disagree 1 2 3 4 5 Strongly agree

Q13. I have changed my opinion about physical activity because of this program

Strongly disagree 1 2 3 4 5 Strongly agree

Q14. I would prefer to get my physical activity information from a different source

Strongly disagree 1 2 3 4 5 Strongly agree

Q15. What did you like about the format or content of the advice?

____________________________________________________________________
Q16. What did you not like about the format or content of the advice?

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

Q17. Do you have any recommendations for the format or content of the advice?

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

Q18. Do you have any other comments or suggestions about the format or content of the advice?

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

Brief Coaching Acceptability

The next questions are about the coaching session you participated in as part of 'My Activity Coach'.

Q1.a. Did you participate in the video-coaching sessions?
   a) Yes
   b) No
   c) Some

Q1.b. (If No to Q1a) Can you briefly explain why you did not complete the video-coaching sessions?

Q2. The coaching session helped me to understand the computer-tailored advice I received in the previous week’s module

   Strongly disagree 1 2 3 4 5  Strongly agree

Q3. The coaching session helped me become more active

   Strongly disagree 1 2 3 4 5  Strongly agree

Q4. The coaching session was enjoyable

   Strongly disagree 1 2 3 4 5  Strongly agree

Q5. The coaching session was too short

   Strongly disagree 1 2 3 4 5  Strongly agree

Q6. The discussions in the coaching session were relevant to me
Q7. The coaching session helped me to feel supported in becoming more active

Q8. I received additional information in the coaching session that helped/will help me become more active

Q9. I have acted on the advice I received in the coaching session

Q10. The video-calling program was easy to set up on my computer

Q11. The video-calling program was easy to use

Q12. The program would have been as helpful to me without the coaching session.

Q13. The coaching session was a waste of time

Q14. What did you like about the coaching sessions?

Q15. What did you not like about the coaching sessions?

Q16. Do you have any recommendations for the coaching sessions?

Q17. Do you have any other comments or suggestions about the coaching sessions?

Website Usability
The following questions are about the 'My Activity Coach' website

Q1. I think that I would like to continue to use this website
   *Strongly disagree* 1 2 3 4 5 *Strongly agree*

Q2. I found the website unnecessarily complex
   *Strongly disagree* 1 2 3 4 5 *Strongly agree*

Q3. I thought the website was easy to use.
   *Strongly disagree* 1 2 3 4 5 *Strongly agree*

Q4. I was able to easily find my way around the website
   *Strongly disagree* 1 2 3 4 5 *Strongly agree*

Q5. I found it easy to complete specific tasks on the website
   *Strongly disagree* 1 2 3 4 5 *Strongly agree*

Q6. I liked the overall presentation of the website – colours, texts, shapes
   *Strongly disagree* 1 2 3 4 5 *Strongly agree*

Q7. I liked the overall layout of the website – the links, tabs, how things sit on the page
   *Strongly disagree* 1 2 3 4 5 *Strongly agree*

Q8. Navigation labels, page titles, headings and other terms were easy to understand and accurate
   *Strongly disagree* 1 2 3 4 5 *Strongly agree*

Q9. Icons and other images were helpful and easy to understand
   *Strongly disagree* 1 2 3 4 5 *Strongly agree*

Q10. It was easy to obtain my personal physical activity advice
    *Strongly disagree* 1 2 3 4 5 *Strongly agree*

Q11. I found it difficult to find the information I was looking for on the website
    *Strongly disagree* 1 2 3 4 5 *Strongly agree*

Q12. It was easy to log in and out of the website
    *Strongly disagree* 1 2 3 4 5 *Strongly agree*

Q13. The website was very slow
    *Strongly disagree* 1 2 3 4 5 *Strongly agree*

Q14. What did you like about using the website?

____________________________________________________________________
____________________________________________________________________
Q15. What did you not like about using the website?
____________________________________________________________________
____________________________________________________________________

Q16. Were there any problems that stopped or hindered your use of the website?
____________________________________________________________________
____________________________________________________________________

Q17. Do you have any recommendations for the website?
____________________________________________________________________
____________________________________________________________________

Q18. Do you have any other comments or suggestions about the website?
____________________________________________________________________
____________________________________________________________________

My Activity Coach Program
The following questions are about the 'My Activity Coach' program
Q1. The program gave me enough information to increase my physical activity
   Strongly disagree 1 2 3 4 5                       Strongly agree
Q2. The program was enough to help me become more active
   Strongly disagree 1 2 3 4 5                       Strongly agree
Q3. The program gave me enough support to increase my physical activity
   Strongly disagree 1 2 3 4 5                       Strongly agree
Q4. I would have liked additional components in the program
   Strongly disagree 1 2 3 4 5                       Strongly agree
Q5. The program met my expectations
   Strongly disagree 1 2 3 4 5                       Strongly agree
Q6. I wanted more from the program
   Strongly disagree 1 2 3 4 5                       Strongly agree
Q7. What did you like about the program?
Q8. What did you not like about the program?

____________________________________________________________________

____________________________________________________________________

Q9. Do you have any recommendations for the program?

____________________________________________________________________

____________________________________________________________________

Q10. Do you have any other comments or suggestions?

____________________________________________________________________

____________________________________________________________________
Appendix M: Demographic questionnaire for the eye-tracking study.

Gender: Male ☐ Female ☐

Age – What is your current age? (Enter years) _________

Height – What is your height in centimetres (cm)? _________

Weight – What is your weight in kilograms (kg)? _________

Internet literacy - How many days per week do you usually use the Internet (total per week)?

- AT HOME: _____ days per week
- AT WORK: _____ days per week

On average, for how long do you use the Internet each day you use it (total per day)?

- AT HOME: _____ hours _____ minutes
- AT WORK: _____ hours _____ minutes.

On a scale of 1-5 where 1 is VERY CONFIDENT and 5 is NOT CONFIDENT, how confident are you with using the Internet for general purposes?

RATING 1-5 _______

How many days per week do you engage in at least 30 minutes of activity of a moderate intensity or higher physical activity? For example, brisk walking, swimming, tennis, etc.

_____ days per week

Would you like to increase your level of physical activity? Yes ☐ No ☐

Level of education – What is your highest level of education? This includes complete or incomplete.

- Pre-school ☐
- Primary school ☐
- Jnr Secondary school ☐
- Snr Secondary school ☐
- Technical or further educational institution (inc TAFE) ☐
- University or other higher educational institution ☐
- No schooling ☐

Employment status – What is your current employment status?

- Employed full-time ☐
<table>
<thead>
<tr>
<th>Employment Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employed part-time/casual</td>
</tr>
<tr>
<td>Unemployed</td>
</tr>
<tr>
<td>Retired</td>
</tr>
<tr>
<td>Student</td>
</tr>
<tr>
<td>Home Duties</td>
</tr>
<tr>
<td>Pensioner</td>
</tr>
</tbody>
</table>

**Household income – What is your approximate annual combined household income (before tax)?**

<table>
<thead>
<tr>
<th>Income Range</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $30,000</td>
<td></td>
</tr>
<tr>
<td>$30,001-$50,000</td>
<td></td>
</tr>
<tr>
<td>$50,001-$70,000</td>
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<tr>
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<td></td>
</tr>
<tr>
<td>$100,001-$150,000</td>
<td></td>
</tr>
<tr>
<td>Greater than $150,000</td>
<td></td>
</tr>
</tbody>
</table>
Appendix N: Eye-tracking study post intervention interview

(Questions asked by researcher immediately after interacting with the website – video recorded, not allowed to look at the website whilst answering them).

According to the physical activity advice that you received:

1. What is the goal of the advice?

2. What is the recommended amount of physical activity?

3. What is the optimal amount of physical activity per day? (skip if answered already)

4. Are you meeting the physical activity guidelines?

5. Exactly how many minutes of physical activity do you do on a weekly basis? (skip if answered already)

6. What was presented in the graph?

7. What was each of the three bars in the graph showing? (skip if answered already)

8. How will meeting the physical activity recommendation benefit you?

9. What chronic diseases can be prevented? (skip if answered already)