‘A Comparative Study of Portable Body Sensing Technology and a Physical Activity Log, in a Physical Activity Adherence Programme’

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Submitted to the Higher Education and Training Awards Council, September 2012

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Abstract

A Comparative Study of Portable Body Sensing Technology and a Physical Activity Log, in a Physical Activity Adherence Programme

The purpose of this study is to compare the impact of portable body sensing technology (SW3 Armband) and a physical activity log. Participants' physical activity adherence levels were recorded over a six month period. The primary research involved a six month physical activity programme, entitled, 'Get Started and Stick with it', the programme commenced in October 2010 and finished in April 2011. Females (n=30) were recruited via a local newspaper and a radio advertisement. Participants were randomised to an Intervention Group (a), (n=15) or an Intervention Group (b), (n=15). The Intervention Group (a) (IGa) had the use of the SW3 Armband and a logbook, while the Intervention Group (b) (IGb) had the use of a logbook only for the duration of the study. To be eligible to participate in the study the following criteria applied: (1) age range: 30-50 years, (2) gender: female, (3) location: live in the Letterkenny or surrounding area, (4) physical activity levels: did not meet the World Health Organisations (WHO, 2011) minimum recommendations for physical activity, (5) have access to windows XP. Baseline characteristics for participants in the IGa showed that 53% were sedentary and 47% were irregularly active, while 33% of participants in the IGb were sedentary and 67% were irregularly active. Participants were assessed at Time 1 (T1), Time 2 (T2) and Time 3 (T3) regarding the amount of physical activity minutes accumulated and were also required to complete a stage of change (SOC) questionnaire, self-efficacy (SE) questionnaire, social support (SS) questionnaire and an enjoyment scale at each of the three time periods. The results of this study specify that the IGb performed a greater amount of moderate and vigorous intensity minutes of weekly physical activity compared to the IGa. At the end of T3, the IGb (Mean = 227.75) accumulated nearly three times more moderate and vigorous minutes of weekly physical activity than that of the IGa (Mean = 90.50). Therefore, a logbook has proved to be an effective method in promoting physical activity adherence in comparison to the SW3 Armband.

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Table of Contents

Appendices

List of Abbreviations

WHO	World Health Organisation
IGa	Intervention Group (a)
IGb	Intervention Group (b)
T1	Time 1
T2	Time 2
T3	Time 3
SOCM	Stage of Change Model
SPSS	Statistical Package for Social Science
ANOVA	One-way Analysis of Variance
TTM	Transtheoretical Model
SOC	Stage of Change
SE	Self-Efficacy
SSFam	Social Support from Family
SSFri	Social Support from Friends
TSS	Total Social Support
PARQ	Physical Activity Readiness Questionnaire
LYIT	Letterkenny Institute of Technology
MSE	Mean Self-Efficacy
SS	Social Support
MPA	Mean Physical Activity

List of Figures

List of Tables

Chapter 1 Introduction

1.1 Prologue

According to the World Health Organisation (WHO, 2011), 60% of adults world-wide fail to meet the minimum recommendations for health related physical activity and 46% of Irish adults do not meet the guidelines (Slan, 2007). The WHO (2011) has suggested that adults aged between eighteen and sixty – five should engage in the following physical activity levels for health related benefits:

Table 1.1 World Health Organisation (2011) minimum guidelines for physical activity for health related benefits

30 minutes of moderate-intensity physical activity 5 days per week;
OR
25 minutes of vigorous-intensity physical activity 3 days per week;
OR
an equivalent combination of moderate /vigorous-intensity physical activity;
AND
8-10 muscular strengthening exercises (8-12 repetitions) at least 2 days per week

The benefits of exercise are recognised at both a national and international level but a significant percentage of the population is unaware of, or tends to ignore the benefits, choosing to lead a sedentary lifestyle. Physical inactivity is associated more with females than males (WHO, 2011) and females find meeting the guidelines for physical activity a challenge (U.S Department of Health and Human Services, 2010). Research also shows that males are more likely than females to participate in competitive sports (Arbour and Ginis, 2009). Nies *et al* (1999) and Perry *et al* (2007) suggest that future research should promote physical activity behaviour interventions and consider the factors that motivate females to adhere to regular physical activity.

1.2 Benefits of regular physical activity

Research shows that females are the least active segment of the population (Bonheur and Young, 1991, Aaron *et al*, 1993, Aaron *et al*, 1995, Findorff *et al*, 2009) which suggests that females are at a greater risk of developing diseases associated with a sedentary lifestyle (Arbour and Ginis, 2009). The two studies mentioned above by Aaron et al, 1993 and 1995 were conducted on adolescents, these studies express concern that young females will remain sedentary as they reach adulthood. Participation in regular physical activity can enhance health and induce a greater lifespan (Paffenbarger *et al*, 1993, Bouchard *et al*, 2012). For females, physical activity can reduce and control various diseases such as cardiovascular disease (Whelton *et al*, 2002), osteoporosis (U.S Department of Health and Human Resources, 1996), obesity (Bonaiuti *et al*, 2002) and breast cancer (Schmitz *et al*, 2007). Participating in regular physical activity at a moderate intensity can also prevent individuals from developing numerous chronic diseases (Blair *et al*, 2004). Furthermore, regular physical activity can reduce rates of anxiety (Mutrie, 2000, Taylor, 2000), stress and depression (WHO, 2003).

Females report poorer health and well-being compared to men (Gijsbers Van Wijk *et al*, 1999, Denton *et al*, 2004, Zunzunegui *et al*, 2009) and are at a higher risk of physical inactivity in comparison to males (Pickering and Eakin, 2003, Macdonald and Palfai, 2008). For these reasons, this study will focus on the assessment of female's motivation in physical activity adherence.

1.3 Barriers to physical activity

There are many barriers to physical activity such as lack of time (Bauman *et al*, 2010), lack of energy (King *et al*, 2008), bad weather (Chan *et al*, 2006) and lack of facilities (Trost *et al*, 2002). Conversely, Salmon *et al* (2003) found that those who enjoy physical activity tend not to cite weather as a barrier. Grave *et al* (2010) carried out a review of strategies to increase adherence for individuals that are overweight. Participants perceived a number of barriers that prevented them from adhering to physical activity, including low motivation levels, low self-efficacy and social support, the financial cost of becoming a member of a gym, poor levels of access to facilities and lack of time.

Research on the barriers to physical activity participation consistently suggest that time is a major barrier (Coghill and Cooper, 2009). An eight week study on the promotion of physical activity through wearable hand held computer technology, found that the most common barrier to physical activity participation reported was time, accounting for thirty per cent (King *et al*, 2008). The majority of participants involved in King *et al's* study, perceived more limitations to participating in physical activity, than the benefits associated with exercise.

1.4 Females and barriers to physical activity

Females perceive barriers such as physical health problems, lack of time, weather, lack of a partner to exercise with and lack of motivation in performing regular physical activity (Conn *et al*, 1994). Within this research study, barriers such as physical health problems, lack of time, weather, lack of a partner to exercise with and lack of motivation to perform regular physical were noted by participants. To address these barriers a variety of approaches were included in the study. A PARQ was completed by each participant at Baseline to ensure all participants were capable of taking part in the programme. Lack of time was addressed through the generic physical activity programme that allowed participants to perform physical activity in their own environment and at their own convenience. During T1 a once per week optional walking session was organised that allowed participants to meet up with the research assistant and participants' as a means of social support. Lack of motivation was assisted through the use of a logbook for both groups and the IGa had additional support from the SW3 Armband in assisting physical activity adherence. Guinn and Vincent (2008) concur with King *et al* (2008), reporting that lack of time remains a consistent barrier to physical activity affecting participation levels. Mothers with young children are less likely to participate in physical activity because of family commitments and lack of time compared to females that do not have children (Verhoef *et al*, 1992, Brown *et al*, 2000). Brawley *et al* (2003) agree with the Canadian Fitness and Lifestyle Research Institute (1995) who state that lack of time and motivation are two major barriers to physical activity.

1.5 How much physical activity?

Supporting individuals to initiate and maintain physical activity in the long term is a challenge (Hasler *et al*, 2000, Crombie *et al*, 2004). As individuals age, their participation in physical activity drops off (Thurston and Green, 2004, Hughes *et al*, 2008). Thirty minutes of moderate intensity physical activity on most days of the week is considered a sufficient amount of exercise for health benefits (Pate *et al*, 1995, WHO, 2011, Health Service Executive, 2012 and Irish Heart Foundation, 2012). There is disagreement about the type, duration and intensity of physical activity required for health related benefits. Jakicic *et al* (1995;1999) report that short bouts of moderate cardiovascular physical activity (4 by 10 minutes daily) assist in promoting physical activity adherence, compared to one forty minute session of physical activity. The WHO (2011) has adopted the findings of the American College of Sports Medicine (2011) that recommend thirty minutes of physical activity per day for health related benefits.

1.6 Subjective and objective measurement tools

Traditionally, physical activity has been measured via subjective measurements such as questionnaires and record logbooks. Questionnaires have been a popular research tool (Philippaerts *et al*, 2001, Elosua *et al*, 2000). However, participants self-report their physical activity levels and can over estimate their physical activity minutes, which can often decrease accuracy of results (Aoyagi and Shepard, 2009). Research indicates that a combination of subjective and objective data collection enhances the accuracy of measuring physical activity (Harris *et al*, 2008, MacFarlene *et al*, 2006). King *et al* (2008) state that few research studies have been conducted on the effectiveness of technological devices for increasing physical activity levels. Consequently, this study evaluated the effectiveness of a physical activity logbook in comparison to the SW3 Armband in promoting physical activity adherence. Portable body sensing technology may help motivate individuals to adhere to exercise because of the real time physiological data that the user can access (Tudor-Locke, 2002, Mutrie *et al*, 2004b, Merom *et al*, 2007, Bravata *et al*, 2007, Baker *et al*, 2008).

1.6.1 Physical activity and technology

With advancements in technological innovation, physical activity is becoming easier to monitor and analyse. Marketable devices such as pedometers, accelerometers and more recently the SW3 Armband, provide individuals with real time physiological data and are accessible to the recreational enthusiast. According to King *et al* (2008, p. 138) 'efforts to achieve population wide increases in walking and similar moderate-intensity physical activities potentially can be enhanced through relevant applications of interactive communication technologies'. Research has shown that motion sensors are a valid and reliable means of gathering data (Bender *et al*, 2005, Duncan *et al*, 2005, Yamanouchi *et al*, 1995).

1.7 Research aim and questions

The aim of this research is to analyse the impact of portable body sensing technology compared to a physical activity logbook in promoting physical activity adherence.

The research questions are:

1. How effective is the SW3 Armband in promoting physical activity adherence?
2. What are the barriers and limitations posed by the use of the SW3 Armband and Physical Activity Logbook as part of a physical activity exercise adherence programme?
   a) What are the barriers and limitations posed by the use of the SW3 Armband for the Intervention Group?
   b) What are the barriers and limitations posed by the use of the Physical Activity Logbook for both the Intervention Group and Control Group?
3. How effective is self-reporting in a physical activity intervention over a six month period?
4. Do the mediators of Self-Efficacy, Total Social Support and Enjoyment impact on the participant's physical activity adherence levels?

1.8 Justification for undertaken this research

This research seeks to provide a better understanding of how a portable body sensing device can provide short term support in facilitating physical activity adherence. The real time feedback that participants in the IGa received from the SW3 Armband acted as a self-efficacy mediator, in promoting physical activity adherence. ‘Few systematic efforts to evaluate the efficacy of hand-held computers and similar devices for enhancing physical activity have occurred’ (King *et al*, 2008, p.138).

The research will be of significance for health care personnel in that it will make available data on the use of wearable sensors in encouraging physical activity and their impact on physical activity adherence. Recent research by Findorff *et al* (2009) suggests that studies on female adherence to physical activity should be undertaken in order to provide the health care industry with a greater insight into their specific adherence issues.

This research seeks to highlight and create awareness of the need for individuals to take personal responsibility for their health. According to the Irish Heart Foundation (2010), ten thousand people die each year from cardiovascular disease. Individuals should be encouraged to take responsibility for their own health by committing themselves to physical activity, to help them gain a better quality of life, which in turn may alleviate pressure on our health care systems.

This study attempts to bridge a gap in this research field by assessing the impact of the SW3 Armband in comparison to a physical activity logbook in promoting physical activity adherence. Few research studies have been conducted on the SW3 Armband with regards to promoting physical activity adherence. Previous research has been conducted on the reliability and validity of the SW3 Armband (Fruin and Rankin, 2004) and on individuals who are overweight (Erdogan *et al*, 2010) and those who are obese (Papazoglou *et al*, 2006). To the researcher's knowledge no studies have been conducted on the long term use of the SW3 Armband in promoting physical activity adherence over a six month period.

Table 1.2 The distribution and collection of questionnaires and logbooks by the research assistant at Baseline, T1, T2 and T3

Meeting One: Baseline 1. Introduction to the programme. 2. Participants will be randomly assigned to their respective group (intervention group and control group). 3. Fill out Questionnaires stated across. 4. Physical Activity Logbook Training. 5. Assign a generic exercise programme. 6. SW3 Armband Training.	**The following questionnaires will be filled in:** 1. Participant Information Form 2. Participant Consent Form 3. Physical Activity Readiness Questionnaire 4. Physical Activity History Questionnaire 5. Profile Questionnaire
Meeting Two: End of T1 1. Both groups will fill out questions with regards to the use of their logbook. The Intervention group will fill out questions on the use of the SW3 Armband. 2. Submit Logbook from T1. 3. Fill out Questionnaires at the end of T1. 4. Distribute new Logbooks and a new exercise programme to all participants.	**The following questionnaires will be filled in:** 1. Stages of Change Questionnaire 2. Self-Efficacy Questionnaire 3. Social Support Questionnaire 4. Enjoyment Questionnaire
Meeting Three: End of T2 1. Both groups will fill out questions with regards to the use of their Logbook. The Intervention group will fill out questions on the use of the SW3 Armband. 2. Submit Logbooks from T2. 3. Fill out Questionnaires at the end of T2. 4. Assign a new logbook and a new exercise programme to all participants.	**The following questionnaires will be filled in:** 1. Stages of Change Questionnaire 2. Self-Efficacy Questionnaire 3. Social Support Questionnaire 4. Enjoyment Questionnaire
Meeting Four: End of T3 1. Both groups will fill out questions with regards to their Logbook. The Intervention group will fill out questions on the use of the SW3 Armband. 2. Submit Logbooks from T3. 3. Fill out Questionnaires at the end of T3. 4. Programme completed.	**The following questionnaires will be filled in:** 1. Stages of Change Questionnaire 2. Self-Efficacy Questionnaire 3. Social Support Questionnaire 4. Enjoyment Questionnaire 5. ‘Teamer’ Questionnaire 6. Evaluation Questionnaire

1.9 Overview of study

1.9.1 Baseline

Before commencing the programme, participants were screened for medical conditions using a Physical Activity Readiness Questionnaire (Appendix 3). Participants also completed the following questionnaires; Participants Information Form (Appendix 4), Participant Consent Form (Appendix 5), Physical Activity History (Appendix 6) and Profile Questionnaire (Appendix 7).

1.9.2 T1 (week one – week eight)

The first eight weeks of the intervention are referred to as Time 1 (T1) throughout the study. The IGa completed a two hour information session on the use of the SW3 Armband, and all research participants were provided with a logbook at the start of T1, designed by the researcher. The logbook included questions on the use of the SW3 Armband for the IGa only and specific questions on the effectiveness of the logbook for both groups. At the end of T1, the research assistant brought both groups together to collect each participant's logbook from T1 and distributed a second logbook to each participant. Participants also filled out the research series of questionnaires that included the Stage of Change questionnaire (Appendix 11), Self-Efficacy questionnaire (Appendix 13), Social Support questionnaire (Appendix 14) and Physical Activity Enjoyment Scale (Appendix 15). The research assistant withdrew contact from week eight until week eighteen. During this second phase of the study it was anticipated that participants would take responsibility for their own physical activity adherence.

1.9.3 T2 (week nine – week eighteen)

The following ten weeks of the study are referred to as Time 2 (T2) throughout the study. At the end of T2, the research assistant brought both groups together and participants filled out the research series of questionnaires for a second time and a third logbook was distributed to all participants for Time 3 (T3), the final phase of the programme.

1.9.4 T3 (week nineteen – week twenty six)

The final eight weeks of the intervention are referred to T3 throughout the study. At the end of T3, the research assistant brought both groups together to collect each participant's logbook from T3. Participants filled out the research series of questionnaires for a third time.

A comparative analysis between both groups performance was completed along with a comparison between adherence levels and mediator scores for both groups. Participants in the IGa and IGb were monitored in accordance with the Stage of Change Model (SOCM) regarding their physical activity levels. The final analysis established the effectiveness of the SW3 Armband compared to the traditional method (logbook) in promoting physical activity adherence. Data was inputted to the Statistical Package for Social Science (SPSS), version 19, for windows software and excel.

1.10 Analysis of intervention

The findings are divided into four sections and each section corresponds to each of the research questions. SPSS, version 19 was used to statistically analyse data to answer research questions one and four. This analysis included tests such as independent sample t-tests, one-way repeated measures analysis of variance (ANOVA), ANOVA between groups with post hoc tests, Pearsons product-moment correlations and regression analysis. The researcher also used Excel to compute descriptive statistics to answer research questions two and three.

1.11 Outline of dissertation

Chapter two presents a detailed account of the literature on behavioural change, particular in relation to physical activity, through measures such as the Transtheoretical Model (TTM), the Stage of Change Model and the mediators associated with physical activity adherence. A review of the use of logbooks and portable body technology as part of a physical activity programme is also included. Chapter three addresses the research aim and questions, the research process, data collection methods and data analysis of the research series of questionnaires. Chapter four presents the findings and analysis of the research series of questionnaires. Chapter five discusses these findings in relation to each of the research questions. Chapter six provides a conclusion to the dissertation and proposes recommendations for further research.

Chapter 2 Literature Review

2.1 Introduction

This chapter presents a literature review to provide a context for the research. A detailed account of the literature, particularly in relation to physical activity through measures such as the TTM, the SOCM and subjective and objective measurements of physical activity is provided. A thorough overview of the TTM and associated physical activity mediators is reviewed. A logical summary of the SOCM and advantages and disadvantages that such a model presents is devised. The last section of the literature presents a synopsis of the SW3 Armband and traditional measurement tools such as questionnaires and a logbook.

2.2 The Transtheoretical Model

The framework for this study is the TTM. The TTM was designed to classify behaviour change and has been used in a diversity of areas. It has been used to measure increases and adoption of physical activity (Marcus *et al*, 1992a, Naylor *et al*, 1999, Parker *et al*, 2009) as well as a range of other behaviours such as smoking (Prochaska *et al*, 2001, Spencer *et al*, 2002), weight management and diet (Prochaska *et al*, 1992, Snelling and Adams, 2004), the use of sun cream (Herrick *et al*, 1997) and the management of diabetes (Kasila *et al*, 2003). Over the past twenty – five years the TTM has obtained 'empirical support' (Burkholder and Evers, 2002, Prochaska *et al*, 2002, Riebe *et al*, 2005). The framework has proved to be an effective measure when assessing physical activity (Prochaska and DiClemente, 1983 and Prochaska *et al*, 1992, Kirk *et al*, 2004).

2.3 Constructs of the Transtheoretical Model

Researchers have described the TTM as an 'integrative' model because a number of significant constructs are incorporated such as the SOCM, the process of change, decisional balance, self-efficacy and social support (Prochaska and DiClemente, 1983, Prochaska *et al*, 1992, Fallon *et al*, 2005). Some studies have neglected to include a range of variables in their research and tend to focus solely on the stage of change construct (Loughlan and Mutrie, 1997, Steptoe *et al*, 2001, Reger *et al*, 2002, Courneya *et al*, 2004, Kim *et al*, 2004, Ackermann *et al*, 2005). This study will include the following four elements of the TTM: **(i)** Stage of Change, **(ii)** Self-efficacy, **(iii)** Social Support and **(iv)** Enjoyment. The stage of change will assess what stage participants are at in relation to their physical activity levels. The mediators of self-efficacy, social support and enjoyment will be analysed by measuring the impact of these mediators in promoting physical activity adherence, over the duration of this study. The process of change and decisional balance mediators have been excluded from this study because the researcher does not intend to assess how an individual changes their behaviour (process of change) or determine the advantages and disadvantages of changing their behaviour (decisional balance), in terms of physical activity.

2.4 The Transtheoretical Model and Stage of Change Model

The TTM is an important theoretical framework for understanding why, how and when individuals change their behaviour. Within the TTM, the SOCM has been applied extensively and is a popular framework for identifying where an individual is in terms of physical activity (Prochaska and Velicer, 1997a). Researchers hold opposing views about the TTM. Samuelson (1997, p. 13) argues that the TTM is 'the most important theoretical health promotion development of the decade'. Prochaska and Velicer (1997a) concur with Samuelson stating that the TTM is a strong model for tracking behaviour change. Conversely, Bandura's (1997) uncertainty about the TTM focuses on the construct of the stage of change, suggesting that it is not a 'true' theoretical framework.

2.5 The effectiveness of the Transtheoretical Model

Recent research has contemplated the efficiency of the TTM to record adherence in long term exercise interventions (Bunton *et al*, 2000, Bridle *et al*, 2005, Adams and White, 2003). There is evidence to suggest that TTM interventions are 'inconsistent' (Hutchison *et al* 2009, p.829). A review of twenty – four studies by Hutchison *et al* (2009) reported that the reason researchers are indicating that the TTM is not as effective as it is portrayed, is due to inconsistencies in interventions. Fallon *et al* (2005, p. 630) suggest that the TTM is constructed by measuring the 'stages of change, self-efficacy, temptation, decisional balance and the processes of change'. Lenio (2006), Hutchison *et al* (2009), Gorely and Bruce (2000) argue that the TTM consists of four main constructs, the SOCM, the process of change, decisional balance and self-efficacy. Other studies have ignored such constructs, focusing primarily on the SOCM (Harland *et al*, 1999, Ackermann *et al*, 2005). Interventions that focus solely on the SOCM permit researchers to label the TTM as ineffective and 'inconsistent' (Hutchison *et al* 2009).

The constructs of the TTM are different in various studies (Fallon *et al*, 2005, Hutchison, 2009) because there is no set criteria as to which constructs to include (Courneya and Bobick, 2000). From a research point of view, assessing the TTM as a unit and including all of its constructs over a six month period (long term physical activity adherence) is unfeasible due to the depth of information that this model incorporates. Additionally, researchers have ignored some concepts of the TTM due to the unwieldiness of information that can be retrieved and have concentrated on sub-dividing the components of the TTM to produce a more effective account of the constructs (Ackermann *et al*, 2005, Hutchison, 2009).

Nevertheless, the TTM has been described as being effective (Prochaska *et al*, 1993), along with attaining 'positive effects' (Campbell *et al*, 1994), and 'favourable differences' (Steptoe *et al*, 1999). Few studies have addressed all of the components of the TTM making the outcome of results divergent (Bock *et al*, 2001, Pinto *et al*, 2001, Plotnikoff *et al*, 2001, Cox *et al*, 2003).

2.6 Studies on the Transtheoretical Model

A range of physical activity studies have been designed and measured against the TTM. The majority of studies on the TTM are cross sectional (Rogers *et al*, 2001), although longitudinal and intervention studies have materialised (Armstrong *et al*, 1993). Adams and White (2003) reviewed the effectiveness of twenty-six activity intervention programmes based on the TTM. These authors, along with Dishman (1991) concluded that the TTM activity interventions are effective in the short term but ineffective regarding long term adherence. Sixteen studies out of the twenty-six studies reviewed by Adams and White (2003) promoted short term adherence to exercise (Marcus *et al*, 1992a;1998a;1998b, Calfras *et al*, 1996;1997, Long *et al*, 1996, Pinto *et al*, 1998;2001, Goldstein *et al*, 1999, Harland *et al*, 1999, Hilton *et al*, 1999, Peterson and Aldana, 1999, Hassler *et al*, 2000, Norris *et al*, 2000, Bock *et al*, 2001, Kirk *et al*, 2001). Only two of the studies assessed by Adam and White (2003) promoted both short and long term adoption (Steptoe *et al*, 1999; 2001), while eight of these studies had neither a short or long term effect on physical activity (Cardinal and Sachs, 1994, Graham - Clarke and Oldenburg, 1994, Loughlan and Mutrie, 1997, Dunn *et al*, 1997; 1999, Kohl *et al*, 1998, Naylor *et al*, 1999, Sevick *et al*, 2000). Much debate exists around the timeframe for promoting short and long term adherence (Dunn *et al*, 1999, Bock *et al*, 2001). Researchers disagree on the timeframe required for short term and long term behaviour change to become embedded. Adams and White (2003) however, justify the timeframe required to achieve the maintenance stage of the TTM, signifying that individuals must be physically active for six months or longer. This study will assess physical activity adherence in accordance with the SOCM over a six month period.

2.7 The TTM and the timeframe for physical activity behaviour change

A debate exists around the TTM on the definition of the maintenance stage (Bock *et al*, 2001, Kaplan *et al*, 2001, Rhonda *et al*, 2001). Researchers generally accept that six months quantifies the time for behaviour change to become embedded into an individual's life (Dishman and Sallis 1994a, Dunn *et al* 1999, Bock *et al* 2001). Additionally, Pate *et al* (1995) and Dunn *et al* (1999) accept that behaviour change becomes embedded when an individual adheres to regular physical activity for six months after an intervention begins. Therefore if an intervention takes place over a six month period Pate *et al* (1995) and Dunn *et al* (1999) argue that six months later (one year) is the maintenance phase. This study will follow these guidelines in calculating physical activity adherence levels for both groups.

2.8 Stage of Change Model

The SOCM is a popular construct in the research area that has been applied extensively to physical activity adherence (Reed *et al*, 1997). The SOCM is the main construct of the TTM (Sarkin *et al*, 2001) and assesses an individual's 'readiness to engage in regular exercise' (Spencer *et al*, 2006, p. 428). The model identifies five stages that an individual moves through when attempting to change their behaviour (Findorff *et al*, 2007). The five stages are **(i)** Pre- contemplation, **(ii)** Contemplation, **(iii)** Preparation, **(iv)** Action, **(v)** Maintenance and **(vi)** Relapse.

2.8.1 Pre-contemplation stage

In the context of physical activity, individuals categorised in the pre – contemplation stage (stage one), do not participate in regular physical activity and have no intention to initiate participation within the next six months (Plotnikoff *et al*, 2001). This stage is also known as 'ignorance is bliss' (Brawer *et al*, 2009, p.526). These individuals are referred to as 'uninformed' because they do not recognise the need for the change in behaviour (Bulley *et al*, 2007). This stage, stage one is not relevant for this study as study candidates had already registered as potential participants for the associated physical activity programme, 'Get Started and Stick with it'. This assumes that participants were either contemplating (stage two) on making the change or engaging in some physical activity (stage three), at Baseline.

2.8.2 Contemplation stage

The contemplation stage, (stage two) refers to individuals who do not participate in regular physical activity but have the intention to start within the next six months (Parker *et al*, 2009). This stage is also known as 'sitting on the fence' (Brawer *et al*, 2009, p.526) and taking this first step to changing behaviour is difficult (Garber *et al*, 2008). .

2.8.3 Preparation stage

The preparation stage, (stage three) refers to individuals who do not participate in regular physical activity, but are determined to initiate regular participation in physical activity within the next month (Riebe *et al*, 2005). Brawer *et al* (2009, p.526) states that these individuals are 'testing the waters' because they are trying to change their physical activity behaviour.

2.8.4 Action stage

The action stage, (stage four) refers to individuals who are participating in regular physical activity but for less than six months (Adams and White, 2003). It is in this stage that an individual will notice physical changes, for example, weight loss (Seguin *et al*, 2002). Relapse is common within the action stage (Prochaska and Marcus 1994).

2.8.5 Maintenance stage

The maintenance stage, (stage five) classifies those individuals who have participated in regular physical activity for six months or longer (Plotnikoff *et al*, 2001). Within this stage, individuals are dedicated and focused to physical activity in order to 'stay on track' (Seguin *et al*, 2002, p.74).

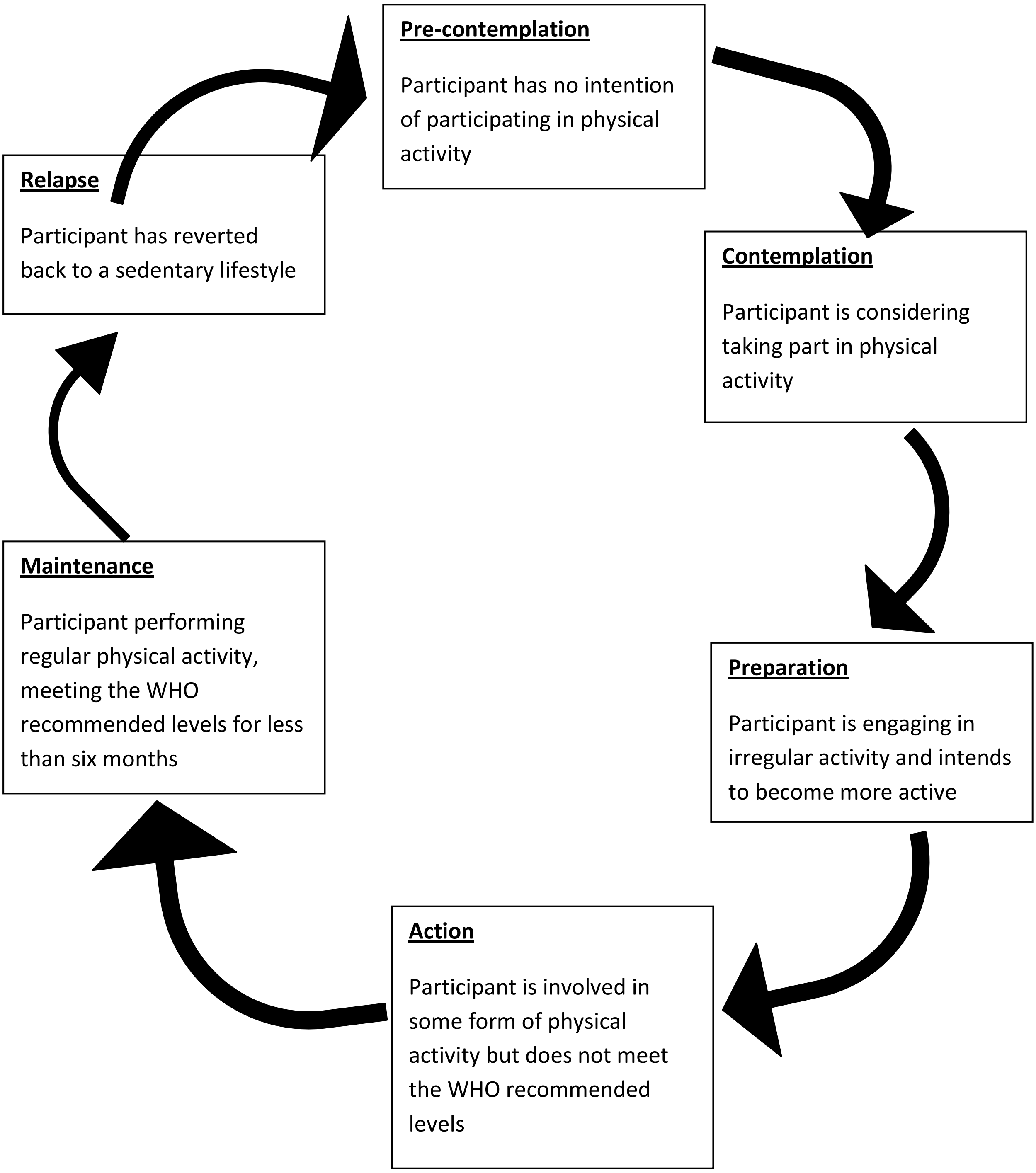
2.8.6 Relapse stage

This stage refers to those individuals who have reached the action or maintenance stage, but cannot sustain this behaviour. This results in the individual reverting back to their earlier behaviour, a sedentary lifestyle.

2.9 The stages of change as a 'cyclical' process

The SOCM is an essential concept of the TTM (Riebe *et al*, 2005). Individuals progress through the stages in a 'cyclical' manner (Fallon *et al,* 2005, Litell and Girvin, 2006). The term cyclical indicates movement back and forth through the five stages. When attempting to change physical activity habits, individuals may not succeed on their first attempt and it may take many cycles to achieve the WHO (2011) minimum recommendations for physical activity. An individual in the maintenance stage (stage five) could revert back to the pre-contemplation stage (stage one). Take for example an individual categorised in the maintenance stage who becomes ill and can no longer perform regular physical activity. The individual is re-categorised in the pre-contemplation stage (stage one), or the contemplation stage (stage two), due to the fact that regular physical activity cannot be performed. Each of these stages of change reveals a diverse statement, making each stage 'unique' (Clark *et al*, 2005).

Figure 2.1 below illustrates the stage of change process that participants will move through when attempting to change their irregular physical activity behaviour and to achieve the WHO (2011) recommendations for physical activity.



Adapted from Prochaska, J. O., and Di Clemente, C. C. (1982).

Figure 2.1 The stage of change process

2.10 Pre-requisites of this study and the Stage of Change

A requirement of this study is that participants commencing the programme are either in the contemplation stage (stage two) or preparation stage (stage three). Prochaska and Marcus (1994) suggest that those interventions that match individuals to a specific stage will be the most successful. More recent evidence by Findorff *et al* (2007), who completed a study on the TTM with females (n = 272), found that those females who commenced the study in the preparation stage, generally progressed into the maintenance stage after one year. This demonstrates that stage-matched interventions have a positive impact on increasing physical activity levels.

2.11 Advantages of the Stage of Change Model

Reed (1999) suggests that there are advantages of using the TTM as a tool for measuring physical activity behavior change. Firstly, the SOCM allows researchers to identify sedentary individuals and stage match interventions to meet the diverse needs of individuals in each of the stages. Individuals have different motivation levels when initiating and trying to maintain physical activity. For example, those individuals that are initiating physical activity tend to be less motivated than those individuals trying to maintain regular physical activity (Philips *et al*, 2004). Research studies confirm that tailored interventions assist in progressing and maintaining physical activity (Kreuter and Skinner, 2000, Parker *et al*, 2010). Kreuter and Skinner (2000, p.1) note that tailored interventions are ‘for a defined population subgroup that takes into account characteristics shared by the subgroup’s members’. According to Parker *et al* (2010) tailored interventions are more effective for increasing long term physical activity compared to interventions that are ‘stage-mismatched’. Physical activity interventions, tailored towards individuals needs can prevent dropouts and promote higher retention rates (Martinson *et al*, 2010).

Secondly, the researcher can divide a sample of participants across the first three stages of the SOCM (Reed, 1999). Studies that have implemented such stage-based interventions have had a positive effect on increasing physical activity behavior, because strategies for increasing physical activity at each of the stages of change can be applied (Johnson *et al*, 2008, Daley *et al*, 2009, Hildebrand and Neufeld, 2009, Huang *et al*, 2009).

Thirdly, an individual's willingness to modify change can forecast the possibility of that person successfully accepting and sustaining physical activity behavior (Reed, 1999). Finally, the TTM can be used extensively by experts in the health-care industry such as general practitioners, nurses and psychologists. For example, a doctor might advise an individual to engage in an exercise referral scheme to assist in overcoming health problems. The doctor can assess the individuals stage of change and provide techniques for increasing physical activity that may improve overall health and well-being (Bolognesi *et al*, 2006, Nigg *et al*, 2011).

Nevertheless, the validity of the stages within the model have been questioned by a number of authors (Adams and White, 2003, Riemsma *et al*, 2003, Sutton, 2001, West, 2005, Littell and Girvin, 2006, Armitage, 2009). Studies that focus solely on the SOCM alone 'can be considered as a single and consistent entity' (Whitelaw *et al*, 2000, p. 715). Farkas *et al* (1996) pinpoint that the SOCM was developed to help people refrain from smoking, which is a single variable, and physical activity is much more complex, involving a range of variables. Hutchison *et al* (2009, p. 830) categorise interventions that completely focus on one factor as 'incomplete representations of the model'. Brug *et al* (2005) highlight that there is a need to understand the SOCM and the additional dimension associated with the TTM, by incorporating all of the constructs of the model to establish its true effectiveness.

2.12 Criticisms of the Stage of Change Model

The first problem with the SOCM concerns the 'truthfulness' of the stages and their representative value (Bunton *et al*, 2000). Authors criticise the SOCM because the model classifies behaviour change into a sequence of diverse stages rather than a continuous process (Bandura, 1997, Weinstein *et al*, 1998, Brug *et al*, 2005, Armitage, 2009, Lippke *et al*, 2009). The SOCM classifies individuals into a stage with regards to their intention to change their physical activity behaviour (stage one and two), and as an individual's physical activity behaviour becomes steady, they progress towards stages three, four or five of the model. The stages have been criticised because of inconsistencies within the stages (Bandura, 1997, Adams & White, 2004, Bulley *et al* 2007). Stages one and two differ 'intentionally' while stages four and five differ in accordance with time (Bandura, 1997, Adams and White, 2004). The stages can also be avoided as an individual can move directly from stage one to three, bypassing stage two, and relapse into earlier stages is common. Whilst research signifies that there is evidence to support the distinction between the stages (Hall and Rossi, 2008, Lippke *et al*, 2009), the issue regarding time within each stage is problematic (Nigg *et al*, 2011). Bulley *et al* (2007) confirm that the maintenance stage is measured along a timescale, but argue that stages one and two of the SOCM are based on an individual's intention to change, and not time.

Another criticism of the SOCM is that individuals can self-report their stage inaccurately (Bulley *et al* 2007). Studies show that over fifty percent of individuals self-report physical activity inaccurately (Ronda *et al*, 2001, Lechner *et al*, 2006, Bolman *et al*, 2007). This confirms that the SOCM has associated limitations. Armitage (2009) states that even though the SOCM has weaknesses, the model is still a valued theoretical concept of the TTM.

2.13 The Stage of Change and relapse

Relapsing does not indicate that an individual has failed with their physical activity adherence. Researchers acknowledge that relapse is possible, indeed probable and change may take a number of Stage of Change cycles before the behaviour develops into a steady cycle (Dishman and Sallis 1994a, Dunn *et al* 1999, Bock *et al* 2001).

DiClemente *et al* (1991**)** note that individuals that relapse into an earlier Stage of Change, may successfully achieve physical activity adherence through 'learning from their mistakes' (McKenna and Riddoch, 2003, p.142).

Almost, fifty-percent of individuals who commence a physical activity programme will revert back to a sedentary lifestyle during the first six months (Dishman, 1988). More recent research by Dishman and Sallis (1994b), Robinson and Rogers (1994), Cox *et al* (2003), White *et al* (2005) and Findorff *et al* (2009) specify that approximately fifty percent of individuals who start a physical activity programme withdraw within the first six months. However, research by Stiggelbout *et al* (2006) indicates that eighty-five percent of their study participants were still adhering to physical activity after six months. Their programme attracted both males and females (aged 50 or older) and consisted of organised interventions such as gymnastics, table tennis and badminton.

The percentage of individuals ceasing their physical activity plans has been referred to as ‘problematic’ (Martin and Dubbert, 1985, Dishman 1991, Blair, 2007). Therefore, a unique challenge for practitioners and health care workers is to keep individuals involved in physical activity, despite adherence issues (Marcus *et al*, 1992a).

2.14 Mediators of behaviour change

The main three physical activity mediators examined in this study are Self-Efficacy (SE), Total Social Support (TSS), and Enjoyment. Within this study, the mediator of TSS is divided into SS Friends (SSFri) and SS Family (SSFam), therefore, findings of this study refer to five physical activity mediators in order to display visual findings in a relative and simple format. According to Masse *et al* (2011, p. 1) ‘a mediator is defined as a variable that is on the causal pathway between the intervention and the outcome of interest’. SE, SS and Enjoyment are also described as determinants of physical activity and have been used widely in research to determine their effects on physical activity (Brownson *et al*, 2000, Henderson and Ainsworth, 2002).

2.14.1 Self-Efficacy

In order for individuals to partake in physical activity and exercise one needs to be confident in one’s own ability to do so (Trost *et al*, 2002). SE can be defined ‘as an individual’s belief in their ability to successfully perform a specific behaviour’ (Schutzer and Graves, 2004, p.1059). SE refers to an individual’s confidence to perform physical activity and the consequences of partaking in physical activity through a set of individual, behavioural, psychosocial and ecological factors (Marcus *et al* 1994b, Bandura, 1997). These factors can impact on each other and the accomplishment of increasing physical activity is dependent on an individuals ability to regulate physical activity within these areas (Dunn *et al*, 1999). SE has been identified as an important determinant of physical activity throughout the literature. Several reports provide testimonial evidence of the correlation between SE and physical activity (Oman and King, 1998, Mc Auley and Blissmer, 2000, Morris *et al*, 2007). More specifically, Little *et al* (2003) found that physical activity programmes for females only are effective in increasing SE.

2.14.2 Self-Efficacy and the Transtheoretical Model

SE is a fundamental concept applied within the TTM when measuring physical activity behaviour (Prochaska and Marcus, 1994, Prochaska and Velicer, 1997a). Researchers believe that SE is a major predictor of exercise behaviour (Bandura, 1977, Courneya and Mc Auley, 1992, Mc Auley and Mihalko, 1998, Mc Auley *et al*, 2003, Callaghan, 2009) and particularly for females (Modra and Black, 1999, Conn *et al*, 2000, Little *et al*, 2003 and Chang *et al*, 2006). SE is the most widely studied mediator of the TTM (Bandura, 1986, Prochaska and Velicer, 1997b, Rogers *et al*, 2001). It is measured within the SE questionnaire revealing levels of consistency and strength when making physical activity a behaviour choice (Sallis *et al*, 1988).

2.14.3 Self-Efficacy and the Stages of Change Model

Several studies provide evidence that confirms SE levels increase as an individual increases their physical activity levels (Leenders *et al*, 2002, Schumann *et al*, 2003). SE is influential in the early stages of adoption and sustaining exercise adherence

(Sallis *et al*, 1990, Garcia and King, 1991, McAuley, 1992). An individual in the early stages of the SOCM tends to possess low levels of SE, but as their behaviour develops into a steady cycle, SE increases (Marcus *et al*, 1992a, Prochaska and Marcus, 1994, Leenders *et al*, 2002). Schumann *et al*, 2003 concur, asserting SE is a measure that is reflective of an individuals ability to perform physical activity. It follows that low levels of engagement in physical activity results in an individual possessing low SE, and high levels of participation in physical activity will produce high SE. In a study on adults aged between fifty and sixty – five years of age, Gorley and Gordan (1995) found that SE increased from pre-contemplation to maintenance stage over the duration of the study. As individuals move from a sedentary lifestyle through the change process, their confidence to perform physical activity increases, along with the amount of time spent participating in physical activity (Bock *et al*, 2001).

Research findings have revealed that high SE levels provide benefits for adults with regards to their overall health. Those individuals that have high SE levels tend to display better health, both physically and psychologically (Netz *et al*, 2005). Therefore health issues such as depression, anxiety and stress appear to be reduced when high levels of SE are evident (Weber *et al*, 2003). High levels of SE have also been a factor in accelerating recovery from various health issues when compared to low SE levels (Grembowski *et al*, 1993). In a study by Plotnikoff *et al* (2001) on males and females' physical activity adherence (n = 683), over a one year period, results verified that SE is a key predictor of behaviour as individuals progress through the SOCM. As an individual moves through the stages and adheres to regular physical activity, their confidence in their ability to perform physical activity as well as the ability to complete daily tasks will be enhanced. Previous research has also shown that

SE is a key mediator of exercise behaviour change (Marcus *et al*, 1992a, King *et al*, 1996). Conversely, SE can also have a neutral effect on physical activity patterns (Castro *et al*, 1999, Steele *et al*, 2009). A study by Calfras *et al* (1997) on healthy, sedentary adult participants confirmed that SE did not impact on physical activity levels, but note that both cognitive and behavioural strategies improved within the intervention group (n= 98).

Individuals with high SE levels are more likely to have greater confidence in adhering to exercise plans, healthy eating and refraining from cigarette smoking, suggesting that lower SE levels result in less adherence (Dino *et al*, 2004). As stated earlier, regular physical activity is necessary to achieve a positive health-related lifestyle with a decreased chance of contracting diseases associated with physical inactivity (Schmitz *et al*, 2007). However, an inactive lifestyle is prevalent worldwide and a significant proportion of individuals are not meeting the minimum guidelines for physical activity (Steptoe *et al*, 2007, Haskell *et al*, 2007). It follows that interventions that anticipate a modification in physical activity behaviour should encourage the promotion of self-efficacy (Gleeson-Kreig, 2004).

2.15 Social Support

SS is delineated as 'a subjective feeling of belonging, being loved, esteemed, valued, and needed for oneself, not for what one can do for others' (Pender, 1996, p. 256). Cohen *et al* (2000) define SS as a process that supports and encourages the physical health and welfare of individuals. The three most important types of social support are emotional, informational and instrumental (Antonucci, 1985, House and Kahn, 1985, Carron *et al*, 1996). Emotional support refers to the encouragement and support a family member or friend offers, to help one adhere to physical activity (Sharma *et al*, 2005). Informational support is more educational, offering participants information on the benefits of physical activity. Instrumental support offers assistance with day to day activities such as providing individuals with a tangible support like a timer or a supportive technological device (Cohen, 2004). The intervention in this study explores the use of instrumental support, in that it involves the study of a tangible object, the SW3 Armband as a motivational instrument in exercise adherence over a six month intervention.

2.15.1 Social Support studies

Studies have established that SS and physical activity are strongly correlated (Kerr and Richey, 1990, Gillis, 1993, Dishman and Sallis, 1994b, Felton and Parsons, 1994, Adams *et al*, 2000, Resnicow *et al*, 2000, Boutelle *et al*, 2004, Fahrenwald *et al*, 2004). Litt and colleagues (2001) tracked the physical activity patterns of females (n = 189) in a longitudinal study (12 months), and verified that SS at twelve months was a significant variable in physical activity adherence. Conversely, Brassington *et al* (2002) completed a comparative study on older adults (n = 103: 67 females and 36 males , mean age = 70.17 years) on the effects of cognitive and social mediators on exercise adherence over a one year period. The authors established that SS had no affect on the physical activity programme, that included telephone contact. This finding could be deemed surprising, given the age profile of the sample, and the social support structures that would have been in place for the duration of the study.

2.15.2 The social environment

The social environment can enhance an individual's adherence to physical activity (Carron *et al*, 1996). Social support systems include family members and friends. Family members tend to be significant in the behaviour change process (Eyler *et al*, 1999). Studies have also shown that a spouse can be important for motivating a partner to continue with their physical activity programme (O' Reilly and Thomas, 1989, Wallace *et al*, 1995). Friends are also associated with motivating participation in physical activity (King *et al*, 1990, Courneya and McAuley, 1995). Females are motivated to exercise in groups, along with friends or family members because of the communal interactions (Gilette, 1988). Group exercising has been found to motivate females in initiating and adhering to physical activity plans (Clark, 1996, Eyler *et al*, 1998). An individual engaging in social interactions through participation in physical activity, can be an important means of broadening their social network, as support and encouragement is available when motivation levels are low (Coleman and Iso-Ahola, 1993, Lakey and Lutz, 1996).

2.15.3 Social Support and females

Eyler *et al* (1999) carried out a significant study on physical activity and SS (females = 2912, aged 40 and older), and found that those who had high levels of social support were more likely to accrue one hundred and fifty minutes of physical activity weekly, than those who had low levels of SS. Research indicates that females place greater importance on participating in physical activity to enhance their SS systems compared to males (Brown and Frankel, 1993, Dishman, 1994a, Modra and Black, 1999, Kaplan *et al*, 2001, Kilpatrick *et al*, 2005). There is evidence that when there is a deficiency in SS, physical activity levels will decrease (Stahl *et al*, 2001).

2.15.4 Social Support and Self-Efficacy

When SE is associated with physical activity there is a correlation with SS (Rovniak *et al*, 2002 and McAuley *et al*, 2003). SE and SS are strong predictors of the amount of time allocated to participating in physical activity (Sharma *et al*, 2005). A two year study by Sallis *et al* (1992) concluded that SE and the support of friends or family members were highly associated with vigorous physical activity in females. A SS network is important for changing physical activity behaviour (McAuley *et al*, 2003), especially support from family and friends (Eyler *et al*, 1999, Resnick *et al*, 2002). Cutrona and Troutman (1986) and Duncan and McAuley (1993) state that SS is influenced by SE. A strong SS network (Anderson *et al*, 2006), SE (McAuley and Blissmer, 2000) and enjoyment (Hurberty *et al*, 2008) of physical activity can increase adherence to physical activity.

2.16 Enjoyment

Enjoyment has been acknowledged as an important mediator for physical activity behaviour change (Wankel, 1993, Baranowski *et al*, 1998). Enjoyment is related to physical activity participation (Motl *et al*, 2001) and physical activity adherence (Johnson and Heller, 1998). Scanlon and Simons (1992, pp.202-203) define enjoyment in the context of physical activity as 'a positive affective response to the sport experience that reflects generalised feelings such as pleasure, liking and fun (Wankel, 1993). Enjoyment is associated with participation in physical activity, and high enjoyment levels during physical activity result in a greater number of individuals engaging in physical activity (Johnson and Heller, 1998, Salmon *et al*, 2003). A study by Sit *et al* (2008) who recruited three hundred and sixty middle-aged females to assess the motives and barriers associated with participation in physical activity found that the most important reason cited by participants for engagement in physical activity is enjoyment.

Individuals enjoy vibrant and motivating physical activity in comparison to physical activity that is tedious and cyclical (Franklin, 1986;1988). When individuals enjoy exercise through the inclusion of favoured activities, the likelihood of adherence and achievement of goals becomes apparent (Johnson and Heller, 1998). Enjoyment of the particular activity is important for sustained participation (Myers *et al*, 1999, White *et al*, 2005). The principle of physical activity and health appears to relate to a sense of enjoyment of an activity because of the way it makes an individual feel physically and psychologically (Henderson and Ainsworth, 2002). Individuals who think of physical activity as an unpleasant experience are less active than those who enjoy participation in exercise (Salmon *et al*, 2003). In a review of forty four articles on motivators and barriers to physical activity by Baert *et al* (2011), eight studies provided support for enjoyment as a motivator for physical activity adherence (Melillo *et al*, 1996, Conn, 1998, Kirkby *et al*, 1999, Goodman and Ballou, 2004, Kolt *et al*, 2004, Schuler *et al*, 2004, Hardy and Grogan, 2009, Whitehead and Lavelle, 2009). This review confirms that the physical activity mediator enjoyment is vital for sustained participation in physical activity. To facilitate physical activity adherence, strategies that promote engagement in a range of activities to prevent boredom are required for continued enjoyment of physical activity (Kim *et al*, 2006).

2.17 Subjective and objective measurement tools for assessing physical activity

2.17.1 Introduction

With advancements in technological innovation, exercise is becoming easier to monitor and analyse. Marketable devices such as pedometers, accelerometers and more recently, the SW3 Armband, provide individuals with real time physiological data and are accessible to the recreational enthusiast. According to King *et al* (2008, p. 138) 'efforts to achieve population-wide increases in walking and similar moderate intensity physical activities potentially can be enhanced through relevant applications of state-of-the-art interactive communication technologies'. Research has shown that motion sensors are a valid and reliable means of gathering data (Yamanouchi *et al*, 1995, Bender *et al*, 2005, Duncan *et al*, 2005). This study will evaluate the effectiveness of one such device, the SW3 Armband, in promoting physical activity adherence.

Wearable body sensor devices are being used increasingly in medical and clinical settings to monitor and analyse body functions (Bjorgaas *et al*, 2004, Stovitz *et al*, 2005, Corder *et al*, 2007, De Bruin *et al*, 2008). 'As technology rapidly decreases in size, wearable monitoring devices has become a viable and practical reality', (Liden *et al*, 2002, p. 1), allowing individuals to wear body sensors for extended periods (Jovanov *et al*, 2003).

Given the popularity of social networking in Ireland via Facebook, Twitter and Texting, the potential for a real time feedback device in terms of exercise and participation measurement makes sense. Research by Lombard and his colleagues (1995) found that regular contact with an exercise professional is essential for continuous participation in physical activity exercise. However, for many this is an unrealistic aspiration or desire. King *et al* (2002, p. 629) state that 'studies suggest that computer based advice and feedback may be perceived as less socially threatening compared to feedback delivered by a person'. This statement implies that the assessment of physical activity through a technological device is ideal and applicable to future research studies evaluating physical activity levels.

2.18 Subjective measurement of physical activity

Traditionally, physical activity has been measured via subjective measurements such as questionnaires and record logbooks. Questionnaires have been a popular research tool because they are practicable and are inexpensive (Elosua *et al*, 2000, Phillippaerts *et al*, 2001, Taber *et al*, 2009). A range of studies to date have used subjective measures to quantify participation levels in physical activity (Lawerence and Shank, 1995, Elosua *et al*, 2000, Sarkin *et al*, 2000, Schumann *et al*, 2003). Nevertheless, in studies where participants self-report their physical activity levels, over and under-estimations of their physical activity minutes can decrease the accuracy of results (Stevens *et al*, 2007, Aoyagi and Shepard, 2009). The literature indicates that a combination of subjective and objective data collection enhances the accuracy of measuring physical activity (MacFarlene *et al*, 2006, Harris *et al*, 2008). Walker *et al* (2004) note that getting participants to comply with the completion of a paper logbook to record physical activity levels when compared to an electronic record, is poor. Their study recruited forty-two participants with severe haemophilia. Participants were randomised to a hand-held computer group (n=22) and a paper diary group (n=19). Results showed a compliance rate of 86.2% with the electronic device, while adherence to paper diaries was 48.3%. The researchers concluded that an electronic diary can more easily analyse and summarise data retrieved, compared to a paper logbook. Milligan *et al* (2005) supports the use of formal instruments stating that they act as a record and opportunity for reflection of an individuals exercise regime and are therefore beneficial in promoting physical activity adherence. Earlier research by Raghoebar-Krieger *et al* (2001) provides support for Milligan's opinion, suggesting that a logbook provides individual and personal feedback in relation to a person's physical activity levels, and allows them to recognise any weaknesses that evolve.

2.19 Objective measurement of physical activity

More recently, objective measurement tools such as the SW3 Armband have been introduced to assess physical activity (Bassett, 2000, Sallis and Saelens, 2000, Andre *et al*, 2006, Taraldsen *et al*, 2011). Previous studies have validated the use of the SW3 Armband in a clinical setting (Taraldsen *et al*, 2011). Few efforts to assess technology devices in stimulating physical activity levels have befallen (King *et al*, 2008). Consequently, this study will evaluate the effectiveness of the SW3 Armband in promoting physical activity adherence, in comparison to the effectiveness of using a logbook only.

2.19.1 The SW3 Armband and physiological characteristics

The SW3 comprises an armband worn on the upper right arm with a wrist display. It encompasses an easy and efficient digital device for individuals to assess daily physiological features (Andre *et al*, 2006). A wireless device, it transmits physiological data, which is accessible on the wrist display. The SW3 processes the following information: (i) total energy expenditure and active energy expenditure, (ii) duration of physical activity, (iii) sleep duration, (iv) number of steps and (v) duration the SW3 Armband is worn. This information can be captured and calculated every minute of the day, as long as the user is wearing the armband (Fruin and Rankin, 2004). For the most accurate and comprehensive data, it is recommended that the SW3 is worn twenty four hours per day and is only removed when the individual is bathing or swimming. The data stored can be accessed more formally and in report format by connecting the armband to a computer system and using the online activity manager to download and access the information. Real time data such as how many steps an individual has taken, for example within a twenty four hour span, can be retrieved in real time from the wrist watch. The SW3 captures averages and variances on all features, but also can detect peak phases (i.e. a day of the week in which a user has recorded a personal best), (Andre *et al*, 2006). The SW3 has been clinically validated to be over ninety per cent accurate when determining calorie burn (Johannes, 2009).

Kasabach *et al* (2002, p. 2) noted that 'energy expenditure, level of physical activity, sleep quality, heart rate, stress, and contextual awareness were the most significant states worth obtaining continuously'. The SW3 Armband provides an easy and efficient digital device to individuals to assess daily physiological characteristics (Andre *et al*, 2006).

2.19.2 Studies on the SW3 Armband

The SW3 armband 'provides accurate, objective, and actionable data' (Andre *et al*, 2006, p. 4). Recent studies have assessed the validity of the SW3 in both adult females and males in detecting step count and intensity of physical activity, and provide support for the SW3 Armband as an accurate device for capturing physiological data

(Fruin and Rankin, 2004, Jakicic *et al*, 2004, King *et al*, 2004, Papazoglou *et al*, 2006). Langer *et al* (2009) state that the Armband does not accurately measure steps taken, but can determine moderate intensity physical activity accurately. Erdogan *et al* (2010) seem to concur, stating that the SW3 Armband provides an accurate estimation of energy expenditure during moderate physical activity, but accuracy for lower intensity physical activity was imprecise. Although there is a lack of consensus on the accuracy of the SW3 Armband at collecting lower intensity data, it appears that the instrument provides accurate and measurable data at moderate intensities (Kasabach *et al*, 2002, Fruin and Rankin, 2004, Andre *et al*, 2006).

Motion sensor devices have provided greater accuracy in detecting physical activity patterns in a wide variety of settings (Steele *et al*, 2003, Clemes *et al*, 2008, Gerdhem *et al*, 2008), yet authors state that objectively measured physical activity studies have provided inconsistent results (Yen *et al*, 2009, Frank *et al*, 2010). Nonetheless, technological devices have been found to have a positive effect on adherence levels, preventing drop-outs from programmes (Henderick *et al*, 2010).

Portable body sensing technology may assist in motivating individuals to adhere to physical activity because of the real time physiological data that the user can access (Tudor-Locke, 2002, Mutrie *et al*, 2004a, Merom *et al*, 2007, Bravata *et al*, 2007, Baker *et al*, 2008). Bassett *et al* (2000) state that measuring physical activity though the use of technological devices is more accurate than assessing physical activity via formal questionnaire. Tudor-Locke and Lutes (2009) disagree, suggesting that technical devices (pedometers) that are accompanied by a formal instrument such as a logbook, can assist in highlighting the significance of adherence issues in regular physical activity. Research supports the idea of a combination of tools for the assessment of physical activity, suggesting that the impact of a technological device can be improved, if it is accompanied with a formal instrument of recording daily activities to reinforce the activity behaviour (Tudor-Locke *et al*, 2000, Lauzon *et al*, 2008, Tudor-Locke and Lutes (2009), Petersen *et al*, 2012).

2.20 Objective and subjective measurement tools

Developing a combination of objective and subjective measures to assess physical activity patterns is critical, because questionnaires alone cannot calculate accurately every minute of physical activity (Allor and Pivarnik, 2001, Davis and Fox, 2007). Sugden *et al* (2008) completed a pilot study on the practicality of pedometers for increasing physical activity among sedentary females (n=54, average age 76). Participants were randomised into a pedometer and theory based intervention or a theory intervention group only. Both groups were also required to complete a logbook. The study demonstrated that pedometers are a practical device for increasing physical activity among sedentary older adults. The study also revealed that adherence to logbook keeping was high (98% in the pedometer group and 83% in the theory group). This study provides positive support for future research studies in terms of incorporating both subjective and objective measures to achieve more accurate results.

Research by Ainsworth *et al* (2000) further confirms the implementation of both subjective and objective measures. Their study evaluated three methods of assessing time spent in physical activity and confirms that an amalgamation of subjective and objective measurement tools are useful for evaluating physical activity. 83 adults (45 females and 38 males) were recruited to compare three methods of measuring time spent participating in physical activity, over a three week period. Methods included the use of an accelerometer, a logbook and a physical activity questionnaire. All three methods were seen as useful direct (accelerometer and logbook) and indirect (questionnaire) measurements of physical activity. This study uses both direct (SW3 Armband and a physical activity logbook) and indirect (questionnaire) methods to assess physical activity adherence levels in participants.

2.21 Summary

According to De Bruin *et al* (2008, p. 892) evaluating technological devices in 'real life settings' is difficult. The majority of studies have focused on energy expenditure and weight control (Buchowski *et al*, 2004). There is a depth of literature, in terms of the assessment of physical activity adherence, with regards to a range of technological devices, exclusive of the SW3 Armband. This leaves a gap in the current literature, that this study seeks to fill. The next chapter presents the research methodology, the research process, data collection methods and data analysis of the research series of questionnaires.

Chapter 3 Methodology

3.1 Introduction

The purpose of this chapter is to explain the methodological terms and the methods chosen for the study. The researcher begins by defining the methodological terms, and then moves on to outline the study, the participants involved in the research and the research tools used for data collection. This study followed a quantitative data collection method with some qualitative data collected. For the purposes of investigating the effectiveness of the SW3 Armband and a logbook in promoting physical activity adherence amongst a female sample, the primary research involved a six month physical activity programme. The physical activity programme will be described in **section 3.12.** The self-report measures (SOC, SE, SS, Enjoyment and the logbook) were collected at three assessment periods: **(i)** T1 (week one to eight), **(ii)** T2 (week nine to eighteen) and **(iii)** T3 (week nineteen to twenty-six).

3.2 Research aim and questions

The aim of this research is to analyse the impact of portable body sensing technology compared to a physical activity logbook in promoting physical activity adherence.

The research questions are:

1. How effective is the SW3 Armband in promoting physical activity adherence?
2. What are the barriers and limitations posed by the use of the SW3 Armband and Physical Activity Logbook as part of a physical activity exercise adherence programme?
    a) What are the barriers and limitations posed by the use of the SW3 Armband and Physical Activity Logbook for the Intervention Group?

b) What are the barriers and limitations posed by the use of the Physical Activity Logbook for the Control Group?

3. How effective is self-reporting in a physical activity intervention over a six month period?
4. Do the mediators of Self-Efficacy, Total Social Support and Enjoyment impact on the participant's physical activity adherence levels?

3.3 The research process

Research methodology is a process for collecting, analysing and interpreting information to answer the research questions (Bryman, 2008, Kumar, 2011). There are two types of methodologies that can be applied in research: **(i)** quantitative research which adheres to a positivist worldview and **(ii)** qualitative research that follows an interpretive worldview.

3.3.1 Positivism

Positivism refers to a structured approach to collecting data which is analysed and construed in both a factual and arithmetical manner, a key distinction being that the researcher remains independent of the survey sample chosen. This view is supported by Denscombe (2003) and Bryman (2008), who characterise the positivist researcher as one who adopts an approach that enables them to collect and analyse their data independently and objectively.

Jankowicz (1995) suggests that positivist research is based on the theory that there is only one truth and that there is no alternative to this truth. He continues by claiming that truth is verified by matching the research results with the initial assumptions. Gill and Johnson (1997) comment on how positivism is a deductive approach, which seeks to explain and test the relationships between data collected through quantitative methods.

3.3.2 Interpretivism

Interpretive research is also known as phenomenology and is a flexible approach to collecting data, focusing on the meanings and patterns behind the research, rather than focusing solely on facts and figures associated with the research. Interpretivism, in contrast to positivism, is based on the theory that there can be more than one truth on a particular subject matter (Saunders *et al*, 2003).

Interpretive research seeks to understand the subjective reality of those being studied, making sense of their motives, actions, and intentions, in a way that is meaningful to the research participants (Saunders *et al*, 2003). Interpretive research takes a qualitative approach when data is collected and analysed (Holloway and Wheeler, 2010).

3.3.3 Quantitative research

The quantitative approach is associated with numbers and quantifying the relationship between variables that can be illustrated by the use of charts, diagrams, tables and statistics. Robson (2011) states that a quantitative data method involving numeric calculations can be analysed statistically. The quantitative data collected through the measurement instruments forms a foundation for statistical data analysis and the testing of hypotheses (Creswell, 2009). Quantitative research should be objective, deductive, and generalisable and should produce numerical data. Quantitative questionnaires have been a popular measurement instrument (Bryman, 2008).

3.3.4 Qualitative research

In contrast to quantitative research, qualitative research is associated with collecting open-ended data that can be transformed into developing ideas, adding new theories to the existing research (Hair *et al*, 2007). The researcher is actively involved in the research and observes participants' patterns of behaviour over a period of time (Creswell, 2009). According to Robson (2011) qualitative data is non-numerical and the principles, values and commitment of the researchers and others involved are acknowledged. Qualitative data comprises narrative and provides rich accounts of detail, but can be time consuming. In contrast, quantitative data collection lacks the rich detail that is associated with qualitative research, but can be more efficient in large scale studies. Bryman (2008) presents differences between quantitative and qualitative which are displayed in table 3.1 overleaf.

Table 3.1 Differences between quantitative and qualitative data

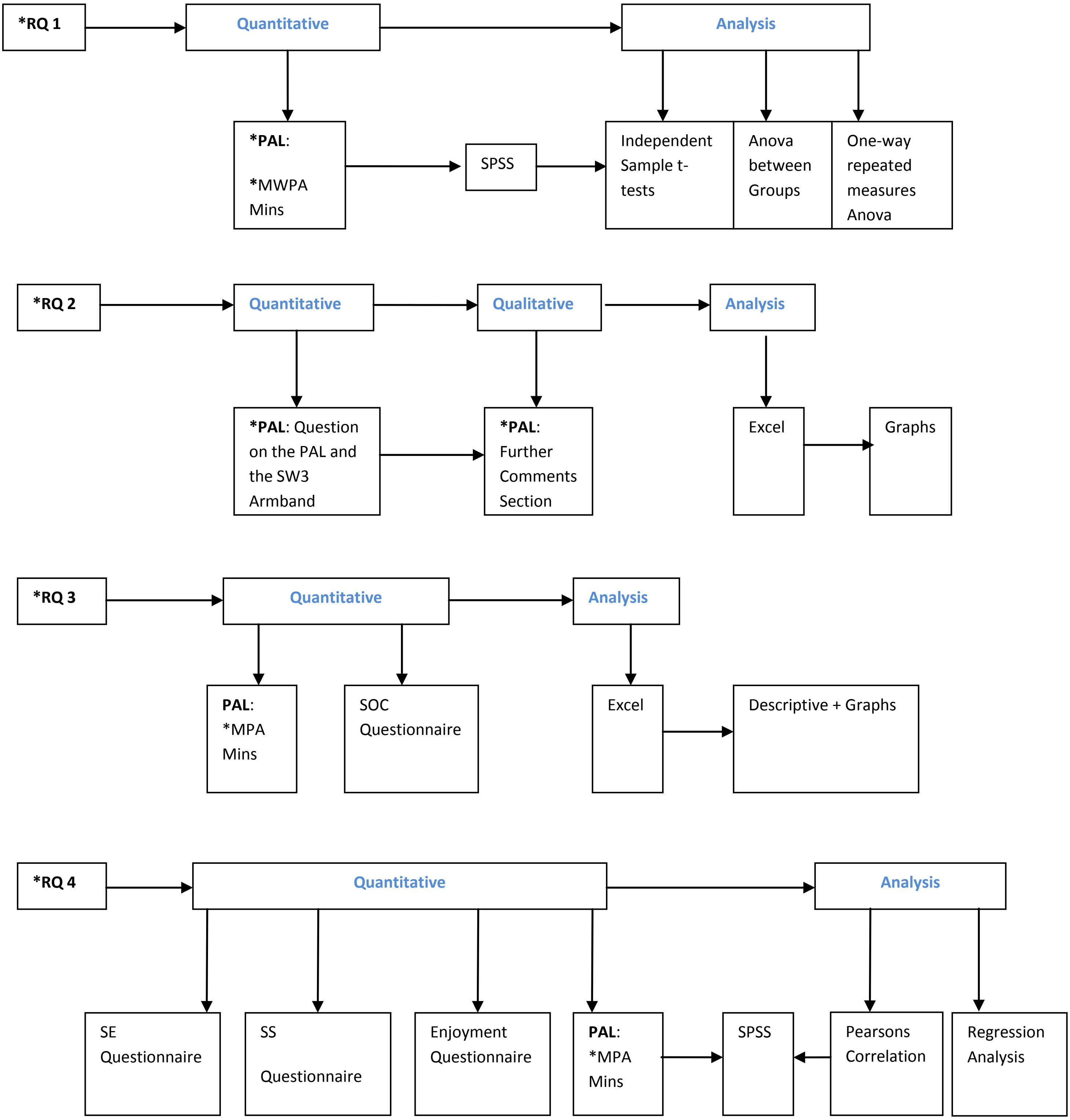
Quantitative	**Qualitative**
Numbers	Words
Point of view of the researcher	Points of view of participants
Researcher distant	Researcher close
Theory testing	Theory emergent
Static	Process
Structured	Unstructured
Generalisation	Contextual Understanding
Hard, reliable data	Rich, deep data
Macro	Micro
Behaviour	Meaning
Artificial settings	Natural setting

(Bryman, 2008, p.393)

3.3.5 Research approach adopted

Within this study the researcher used a quantitative approach to collect and analyse the data. The nature of such an approach was both appropriate and advantageous because as it allowed the researcher to directly answer the study's research questions (see figure 3.1). The methodology adopted involved the administration, analysis and statistical interpretation of four questionnaires: **(i)** Stage of Change questionnaire (Appendix 11), **(ii)** Self-Efficacy questionnaire (Appendix 13), **(iii)** Social Support scale (Appendix 14) and **(iv)** Physical Activity Enjoyment scale (Appendix 15). A logbook for the IGa (Appendix 1) and logbook for the IGb (Appendix 2) were also used for data collection and are described later in this chapter. The final section in participants' logbooks entitled 'comments' gave participants' the *option* to record additional comments in relation to the intervention and their experience of it. This last section in each participant's logbook is the qualitative research adapted in this study.

Not all these comments were displayed in the findings chapter, only those of relevance to the research questions. All comments are displayed in appendix 19. Each participants mean weekly minutes of physical activity, recorded in the logbook is a vital quantitative aspect to the study. Figure 3.1 below illustrates the research design and analysis for this study.



***RQ = Research Question, *PAL = Physical Activity Logbook and *MWPA Mins = Mean Weekly Physical Activity Minutes**

Figure 3.1 The research design and analysis undertaken for this study

3.3.6 Validity and reliability

Two key elements that underpin quality research are the reliability and validity of the measurement tools. Reliability means that the results can be repeated (Bryman, 2008). Reliability demands that other researchers ought to be able to replicate the study and come up with identical findings. For this reason, consistency and rigour is essential when calculating, analysing and interpreting results. Validity is the extent to which the constructs used are really measuring what they are supposed to. Validity refers to the strength of the conclusions, inferences and propositions that originate from the research. In other words, validity implies the extent to which results are accurate. The researcher gave considerable time to calculating the data accurately and care was taken while inputting the data to SPSS for statistical interpretation. The validity of quantitative data is accomplished by careful statistical and systematic analysis of the data (Cohen, 2002). The questionnaires used in this study have been accepted as a valid and reliable source of data retrieval within the existing literature and have been used comprehensively in physical activity research (Bock *et al* 2001, Callaghan *et al*, 2009, Findorff *et al*, 2007 Graham *et al*, 2011, Schneider and Cooper, 2011). Cronbach alpha coefficients were determined to check the internal consistency of the research series of questionnaires at the three timeframes, T1, T2 and T3 and are displayed in chapter four. The Cronbach alpha coefficient should exceed .7 to determine consistency (DeVellis, 2003).

3.3.7 Types of questions

Bryman (2008, p.697) refers to a questionnaire as a 'self-completion' method. Within this study each participant completed a set of questionnaires at three timeframes (T1, T2 and T3). Denscombe (2003) suggests that a question can be asked in one of two ways: **(i)** open questions and **(ii)** closed questions. An open question refers to a question that a respondent answers in their own words and is associated with qualitative data. A closed question is one that the researcher has pre-set on a pre-determined ranking scale or one which allows a respondent to answer 'yes' or 'no' and produces quantitative data. The research series of questionnaires (SOC, SE, SS and Enjoyment) used in this study comprised closed questions only. The researcher decided to use closed questions because the data was easily pre-coded and analysed, the questionnaires supplied standard answers for efficiency. Closed questions were also helpful in answering the research questions. The logbook used in this study measured participants' physical activity levels and included an open question where participants had the option to write about their feelings and perceptions of their experience of the intervention, lending a minor interpretive slant to the study.

According to Denscombe (2003), there are nine types of questions that can be developed within a questionnaire. These include a statement, a list, a 'yes'/'no' answer, agree/disagree with a statement, choose from a list of options, rank order, a likert type question, rate items and a semantic differential question. This research includes three types of these questions **(i)** a 'yes'/ 'no' question (SOC questionnaire), **(ii)** likert scale questions (SE and SS questionnaire) and **(iii)** semantic differential questions (Enjoyment scale). These questionnaires are explained in more detail at 3.4

below. Denscombe (2003) states that there are advantages and disadvantages of questionnaires which are presented in table 3.3.

Table 3.2 Advantages and disadvantages of questionnaires

Advantages	**Disadvantages**
Wide coverage	Poor response rate
Inexpensive	Incomplete answers/missing data
Pre-coded statistics	Limit and shape nature of answers
Allows the researcher to remain independent of the study	Cannot check or verify respondents answers

Adapted from Denscombe (2003, p. 161)

3.4 The research series of questionnaires

3.4.1 Mediators of change

The measurements used in the study included five self-report instruments. The questionnaires used were: **(i)** Stage of Change (Marcus *et al*, 1992a), **(ii)** Self-Efficacy (Marcus *et al*, 1992b), **(iii)** Social Support (Sallis *et al*, 1987), **(iv)** Enjoyment (Kendzierski and DeCarlo, 1991) and **(v)** a logbook. A mediator can be defined as an 'intervening psychosocial variable that is necessary to complete a cause-effect link between an intervention and physical activity' (Bauman *et al*, 2002, p.13). The mediators used within this study are discussed at section 3.4.3 to 3.3.5. Mediators measure changes in physical activity levels and assist researchers in identifying the variables that are significant for increasing physical activity levels (Baruth *et al*, 2010).

3.4.2 Stage of change questionnaire

Physical activity Stage of Change was assessed by providing participants with the Stage of Change questionnaire (Appendix 11). This questionnaire assesses where an individual is with regards to their physical activity levels. As defined in the previous chapter, the stages included in this model are pre-contemplation, contemplation, preparation, action and maintenance.

Inclusion criteria determined that participants were either at stage two (contemplation) or stage three (preparation) of the SOCM at Baseline. The Stage of Change questionnaire included four categorical questions (‘yes’/ ‘no’ questions) and each participant’s SOC was assessed using a flowchart (Appendix 12). The first question determines if the participant is engaging in any physical activity at the time of completing the questionnaire. The second question establishes the intention of the participant to increase their physical activity. The third question assesses if the participant is following the recommended levels of physical activity (WHO, 2011). The fourth question determines if physical activity has been consistent for a period of six months or longer. The flowchart for scoring the Stage of Change questionnaire reveals the following:

(i) If the participant answers ‘No’ to question one and two, the participant is categorised in the precontemplation stage, (stage one) of the SOCM. However, this stage of the SOCM was not represented within this study as selection criteria insisted that potential participants would be at least in the contemplation stage, (stage two).

(ii) If the participant answers ‘No’ to question one and ‘Yes’ to question two, the participant is placed is the contemplation stage, (stage two).

(iii) If the participant answers ‘Yes’ to question one and ‘No’ to question three, the participant is characterised as being in the preparation stage, (stage three).

(iv) If the participant answers 'Yes' to question one and three and 'No' to question four, the participant is believed to be in the action stage, (stage four).

(v) If the participant answers 'Yes' to question one, three and four, the participant is assumed to be in the maintenance stage, (stage five).

No feedback was given to participants at any time regarding their Stage of Change (SOC) result because of self-report issues. Participants were not informed about the SOCM or their SOC score because there was a possibility that they might answer the questions to 'suit' the research (Denscombe, 2003).

At T1, T2 and T3 participants answered the SOC questionnaire and the researcher used the SOC flowchart to categorise each participant into their appropriate SOC for each phase. For this study, three assumptions have been made in terms of participants movement through the stages of change: **(i)** by the end of T1 all participants would be at least in the preparation stage of the SOCM, **(ii)** by the end of T2 all participants would be in the action stage of the SOCM and **(iii)** by the end of T3 participants would be in the maintenance stage of the SOCM. Participants mean weekly minutes of physical activity was also used to assess if participants were meeting the WHO (2011) minimum guidelines for physical activity.

3.4.3 Self-Efficacy

SE is one of the most important mediators in the behavioural change process (Little *et al*, 2003). The SE questionnaire measures how confident an individual is in participating in physical activity in certain situations. The higher the score achieved, the greater the participant's self-efficacy in terms of physical activity. According to Callaghan *et al* (2009), the SE scale has good internal consistency, with a Cronbach alpha coefficient reported of .71. In the current study the Cronbach alpha coefficient ranged from .57 at T1 to .77 at T3 (see table 3.2).

SE is influential in the early stages of adoption and maintaining regular physical activity (McAuley, 1992). According to research by Prochaska and Marcus (1994), participants in the early stages of the SOCM tend to possess low levels of self-efficacy, but as their behaviour develops into a steady cycle, SE increases as individuals move from a sedentary lifestyle (stage one and stage two of the SOCM) to actually performing physical activity (stage three, stage four and stage five). Their confidence to perform physical activity increases along with the amount of time spent participating in physical activity (Bock *et al*, 2001). The assumption for this study with regards to participants mean self-efficacy (MSE) levels is that their confidence to perform physical activity will gradually increase over the duration of the physical activity programme.

The SE questionnaire includes five questions (Appendix 13). SE is measured through the use of a five point likert scale (from 1 = not at all confident to 5 = extremely confident). The maximum score a participant can score is 5 and the minimum is 1 per question. For both the IGa and IGb, MSE scores were calculated for each participant, by adding all five items together and dividing by five. The maximum score a group could have scored is 70 (12 × 5), the minimum group score is 12 (12 × 1). Participants' MSE scores were inputted to SPSS at T1, T2 and T3 and analysis was conducted on group scores for the IGa and IGb.

3.4.4 Social Support

The Social Support (SS) scale (Sallis *et al*, 1987) helps identify the level of support that friends, family and others offer the participant in their attempt to make physical activity a habit. According to the literature, females place greater emphasis on SS compared to men when attempting to adhere to physical activity (Kilpatrick *et al*, 2005). SS comprises of three types of support, represented by informational, emotional and instrumental feedback.

Similar to other studies (Cohen, 2004), this study seeks to explore instrumental support in that the IGa participants were provided with a tangible object, the SW3 Armband. The study also supported participants by providing information through the use of the social network programme, 'Teamer'. Furthermore, another SS element included in the study was an optional walking session once per week for the first eight weeks. However, both of these components ('Teamer' and the walking session option) were not used to answer the research questions; they were simply additional SS elements that participants could avail of in promoting physical activity adherence.

Sallis et al's SS scale comprises thirteen questions related to support from family members and thirteen questions related to support from friends (Appendix 14). The scale has good internal consistency, scoring 0.71 and 0.76 for SS Family and SS Friend respectively (Graham *et al*, 2011). This study also reported the SS scale as reliable (0.73)

The questionnaire is scored using a likert scale (0 = does not apply to 5 = very often) based on how often one's friends or family have engaged in physical activity with the participant or supported the participant in their physical activity efforts. To calculate a participant's total score for SS (family support), all thirteen items are added together. To calculate a participant's total score for SS (friend support), all thirteen items are also added together. The maximum score a participant can score per question is 5 and the minimum is 0. For the IGa and IGb, a TSS variable was computed. This involved adding the participants' scores together for both family and friend support and dividing by two to produce a mean TSS score, at the three time periods (T1, T2 and T3). SS Family, SS Friend and TSS scores were all inputted to SPSS to assess the impact of these three variables on mean weekly physical activity minutes.

The study assumes that participants' SS levels will progressively increase over the duration of the physical activity programme. SS levels will be greater during T1 due to additional support mechanisms offered to both groups, such as the optional walking session for the first eight weeks and the use of 'Teamer'. The IGa also had technological support regarding use of the SW3 Armband throughout the physical activity programme.

3.4.5 Enjoyment

The physical activity enjoyment scale (Kendzierski and DeCarlo, 1991) is a measure of how much an individual enjoys participating in physical activity. According to Schneider and Cooper (2011), the Enjoyment scale provides good internal consistency, with a Cronbach alpha coefficient reported of .91. The Cronbach alpha coefficient for this study ranged from .90 at T1 to .92 at T3 (see table 3.2). When an individual enjoys participating in physical activity they are more likely to stick with it (Bray *et al*, 2005, White *el al*, 2005, Sit *et al*, 2008). In this study, a generic physical activity programme was given to all participants at Baseline, T1 and T2. The programme was designed in such a way as to encourage participants to engage in their preferred physical activities. Participants who engage in their preferred activities are more likely to adhere to their physical activity plans (White *et al*, 2005). The current study makes the assumption that enjoyment levels will escalate over the duration of the physical activity programme as participants are engaging in their chosen physical activities.

Participants rate how they feel in relation to participation in physical activity, by scoring eighteen variables on a semantic differential scale from 1 to 7 (Appendix 15). The scoring of this questionnaire for each participant involved summing each of the eighteen items together to achieve one score. High enjoyment scores in this questionnaire reflect high enjoyment levels when participating in physical activity.
The maximum score a participant can score is 7 with a minimum score of 1 per question. For both the IGa and IGb, total enjoyment scores for all eighteen questions were computed and inputted into SPSS for each participant at T1, T2 and T3. Totals ranged from a maximum of 126 per participant (18×7) to a minimum of 18 (18×1).

3.5 Physical activity logbook

The physical activity logbook was designed by the researcher and included a space for the type of activity performed, the duration and the intensity. The logbook was not validated in terms of wider use, but was designed specifically for this study with the research cohort in mind. Its design was based on simple, easy to use, non-time consuming for the participants involved. Similar to other studies, participants were required to self-report their physical activity by completing a logbook (Arbour and Ginis, 2009). Each participant was provided with an example of how to complete the logbook at Baseline (Arbour and Ginis, 2009). During the study, the type and duration of physical activity engaged in by participants were documented, as well as the intensity of physical activity, using a pre-determined scale (Robertson, 2004). Physical activity adherence levels were determined by calculating the total accumulated amount of moderate and vigorous physical activity over T1, T2 and T3 for both the IGa and IGb separately. Mean physical activity minutes for each participant were then computed separately for the three time intervals. For both the IGa and IGb the following calculations were computed:

T1: Participants' total physical activity minutes (moderate and vigorous) were calculated for the first eight weeks. A mean weekly physical activity score was retrieved by dividing by eight.

T2: Participants' total physical activity minutes (moderate and vigorous) were calculated for the next ten weeks. A mean weekly physical activity score was produced by dividing by ten.

T3: T3 involved a further eight weeks. Participants' total physical activity minutes (moderate and vigorous) were calculated for eight weeks. A mean weekly physical activity score was produced by dividing by eight. Participants' mean weekly physical activity minutes were inputted into SPSS at T1, T2 and T3.

Participants also self-reported low intensity physical activity in their logbook. However, low intensity physical activity was not calculated within the results as it does not meet the WHO (2011) minimum recommendations for physical activity. Low level intensity was documented for the benefit of participants only.

3.5.1 Physical activity logbook questions

The logbook included quantitative style questions on the use of the SW3 Armband (Appendix 1) and the logbook itself (Appendix 2). These questions were designed by the researcher to determine the ease of use of completing the logbook and the effectiveness of the SW3 Armband as a motivator for change. The logbook also included an additional qualitative section that allowed participants' to further comment on their physical activity experience.

3.6 Pilot study: The SW3 Armband and the series of research questionnaires

A pilot study was conducted in July 2010, prior to the main study in October 2010. The pilot study consisted of five female volunteers aged between twenty-five to thirty years of age. Each volunteer wore the SW3 Armband for a period of two weeks.

The pilot study revealed advantages and disadvantages of wearing the SW3 Armband. The volunteers revealed that the SW3 Armband was significant in promoting their physical activity levels for the duration of the pilot study. The real time data on the wrist display (steps taken, minutes of physical activity performed and calories burned) was advantageous in terms of giving immediate feedback on daily step count and calorie burn. They reported that the SW3 Armband acted as a motivational tool in their adherence to physical activity over the two week period. Barriers relating to the use of the SW3 Armband included minor technical difficulties and slight discomfort when wearing the SW3 Armband for extended periods. Each volunteer filled out the research series of questionnaires (Stage of Change, SE, SS and Enjoyment) and a logbook without difficulty, and some formatting issues were uncovered and resolved.

3.7 Participants, population and sample

Similar to other research studies (King *et al*, 2008, Merom *et al*, 2007, Bonomi *et al*, 2009) female volunteers were recruited via local media (newspaper and radio advertisement), inviting applicants to join the research programme. Participants self-reported their physical activity levels through telephone and only those applicants not meeting the WHO (2011) recommended guidelines for physical activity were eligible to be part of the selection process. The study population consisted of middle aged females living in the North West Region, in and around Letterkenny, Co. Donegal, Ireland.

A total of eighty-nine volunteers applied for the physical activity programme. A sample of thirty females were randomly selected from the sampling frame of fifty-eight applicants that met the recruitment criteria (see figure 3.2 for the randomisation process). Random sampling can be defined as selecting a number of participants from a population with each participant having an equal chance of being selected (Bryman, 2008, Robson, 2011).

The researcher chose to use a set of random numbers as proposed by Spiegel *et al* (2009, p. 419) to select and assign participants at Baseline to one of the two treatment conditions (see figure 3.2). The research study recruited thirty females only, due to the financial limitation posed by the SW3 Armbands (unit price €800).

3.8 Randomisation of participants and distribution of questionnaires and logbooks

Thirty-one females in total were excluded from the recruitment process because they did not meet the recruitment criteria.

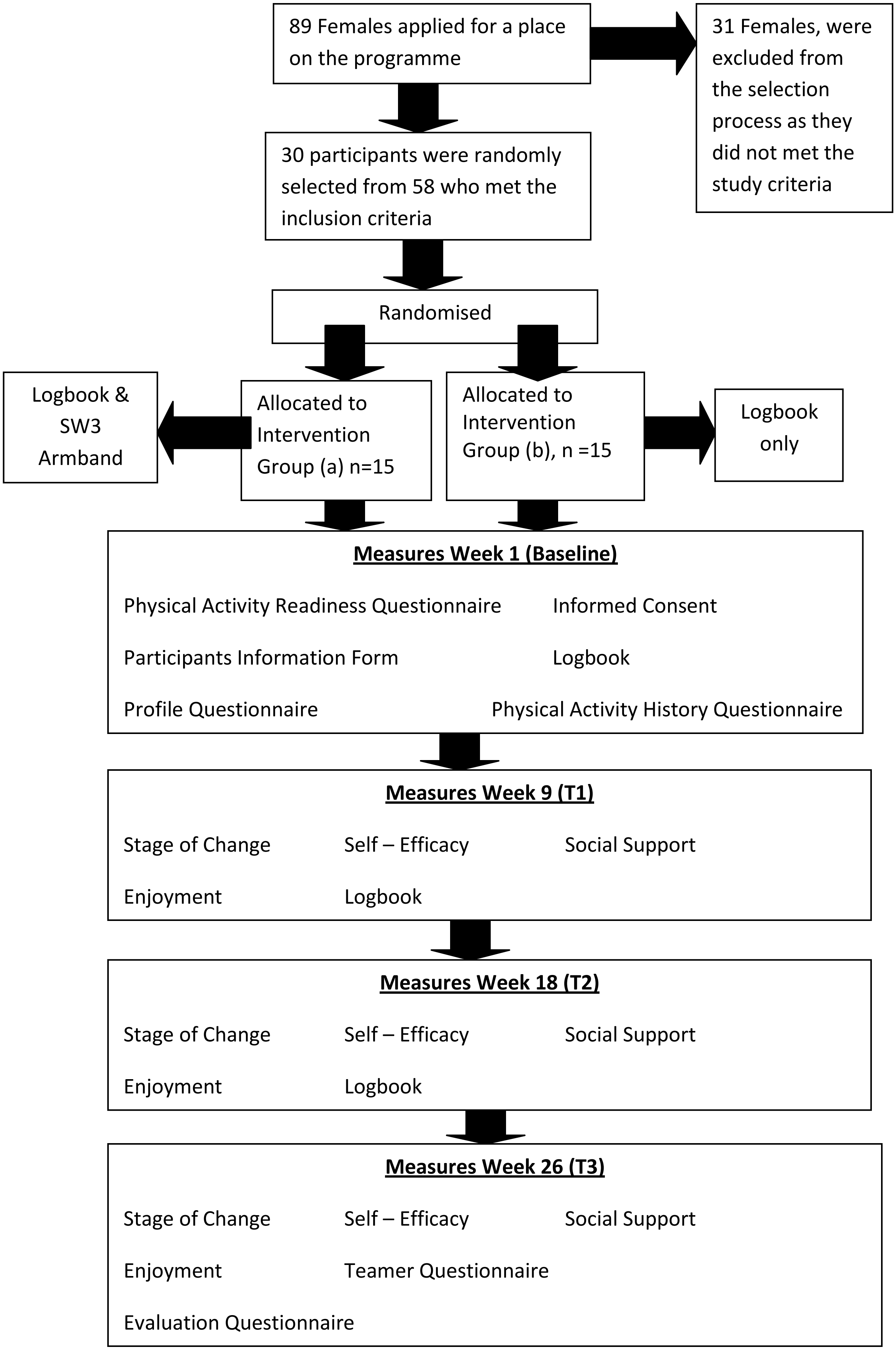
The remaining fifty-eight female volunteers were then randomised using a set of numbers by Spiegal *et al* (2009). Out of this fifty-eight, thirty females were selected, to take part in the physical activity programme (see figure 3.2 below).

The thirty participants that were selected for the physical activity programme were further randomised for a third time into the IGa (n=15) or IGb (n=15) using a set of numbers by Spiegal *et al* (2009). Participants in the IGa had the use of the SW3 Armband and a logbook while those in the IGb had the use of a logbook only. At Baseline, participants completed a participant's information form and informed consent (Appendix 4 and 5), physical activity readiness questionnaire (PARQ), (Appendix 3) and a physical activity history questionnaire (Appendix 6) and a profile questionnaire (Appendix 7). Each participant was provided with a logbook to record a brief account of their physical activity during the first eight weeks (T1).

At the end of T1 (week eight), participants completed the SOC, SE, SS and Enjoyment questionnaires. Both groups returned their completed logbooks for the first eight weeks and were provided with a second logbook for the next ten weeks (T2).

At the end of T2 (week nineteen), all participants completed the SOC, SE, SS and Enjoyment questionnaires for a second time. Both groups returned their completed logbooks for T2 and were provided with a third logbook for the next eight weeks (T3).

At the end of T3 (week twenty-six), participants completed the SOC, SE, SS and Enjoyment questionnaires for a third time. Both groups returned their completed logbooks for T3. Participants also filled out a questionnaire about ‘Teamer’, the social media network (Appendix 16) and an evaluation questionnaire about the physical activity programme (Appendix 17). This twenty-six week period, marked the end of the physical activity programme.



Adapted from Rose *et al*, (2007)

The Logbook was distributed at Baseline, T1 and T2 and was collected at T1, T2 and T3.

Figure 3.2 Flowchart of participant selection, allocation to IGa and IGb and measures taken over the study

3.9 Participant dropouts during the study

Eighty-nine females volunteered to participate in the physical activity programme entitled, 'Get Started and Stick with it'.

Thirty-one females in total were excluded from the recruitment process for two reasons:

(i) Twenty-two female volunteers did not meet the WHO (2011) recommendations for physical activity.

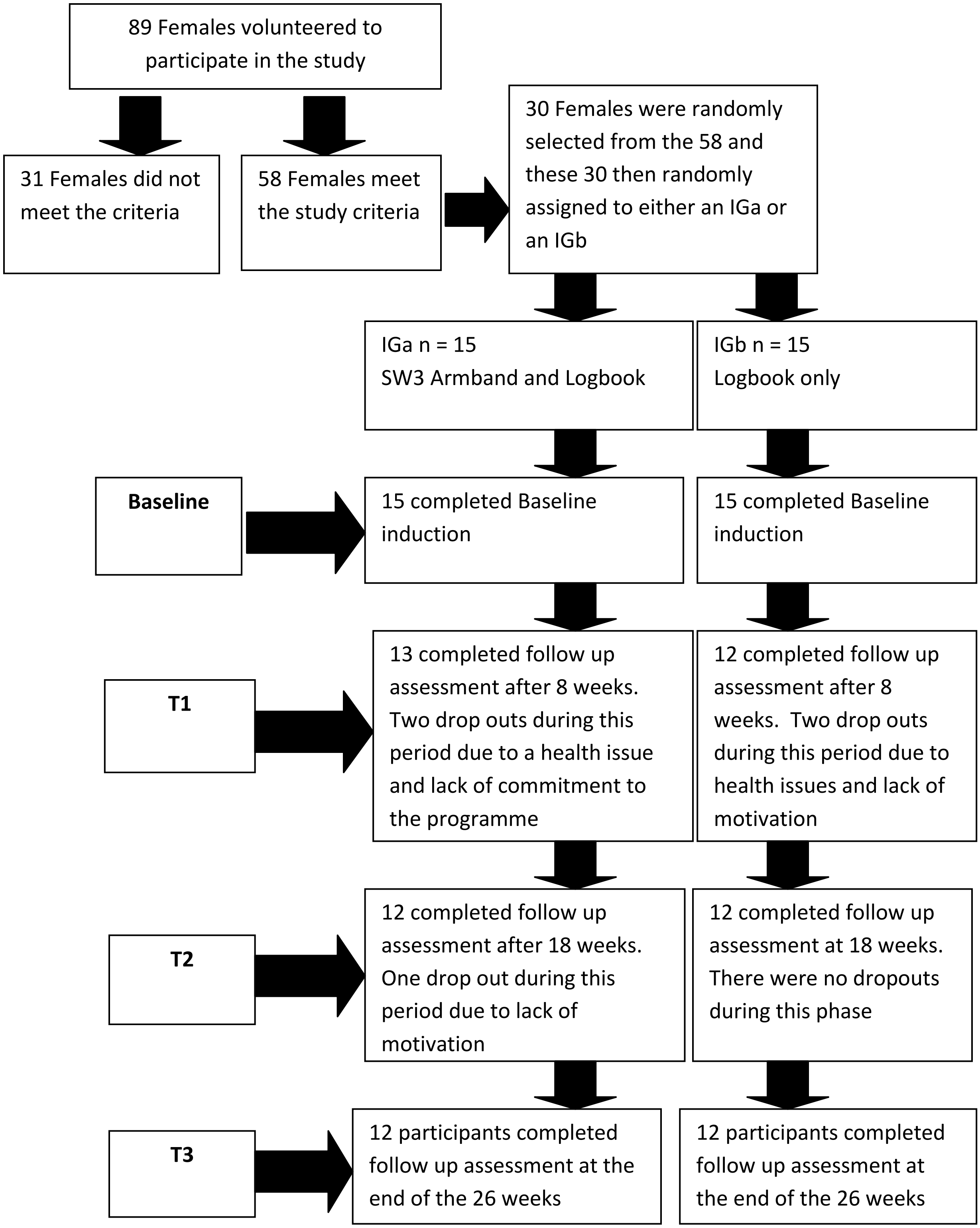
(ii) Nine female volunteers did not meet the age range criteria.

Thirty females from the remaining fifty-eight were randomly selected for the research programme.

At the end of T1, two participants in the IGa dropped out of the programme, one due to a health issue and a second due to lack of commitment to the programme. Three participants in the IGb dropped out of the programme, two due to health reasons and one due to lack of motivation to engage in physical activity. Thirteen participants in the IGa and twelve participants in the IGb completed the follow up assessment after week eight.

At the end of T2, one participant in the IGa dropped out because of lack of motivation to continue with the programme. There were no dropouts from the IGb during this period. Twelve participants in the IGa and twelve participants in the IGb completed the follow up assessment after week eighteen.

At the end of T3, there were no dropouts from the IGa or the IGb. Twelve participants in the IGa and twelve participants in the IGb completed the final follow up assessment at the end of the twenty-six weeks (see figure 3.3).



Adapted from Arbour, K. P., Ginis, K. A. (2009)

Figure 3.3 Flowchart of the study

3.10 Site of enquiry

The study was approved by Letterkenny Institute of Technology (LYIT) as part of a post-graduate opportunity. Participants in the study were required to meet the research assistant at LYIT at Baseline, T1, T2 and T3 to fill out questionnaires and to submit their logbooks. When participants were unable to attend a meeting or if they were absent without reason, the researcher posted the research series of questionnaires to those participants, with a return stamped envelope. Participants were then asked to return the questionnaires and logbook by post. The physical activity that participants engaged in was performed in various venues including home based, leisure centre based and environmental based locations (e.g walk around the town park, beach, hill walking).

3.11 Inclusion criteria

To be eligible to participate in the study, participants had to meet the following criteria: **(i)** age range: 30-50 years, **(ii)** gender: female, **(iii)** location: live in the Letterkenny or surrounding area, **(iv)** physical activity levels: do not meet the World Health Organisation's (WHO, 2011) recommendations for physical activity (see table 1.1), **(v)** have access to a personal computer with Windows XP.

3.12 Ethical approval

Ethics from a research perspective involves decisions about how to proceed with the investigation and how to analyse results in a righteous manner (Gerrish and Lacey, 2006). Diener and Crandall (1978) categorise the principals of ethics into four categories, based on whether there is **(i)** harm to participants, **(ii)** lack of informed consent, **(iii)** invasion of privacy and **(iv)** whether deception is involved. This study involved human participants.

To ensure confidentiality, anonymity and dignity, participants' personal information, logbook details and completed questionnaires were stored in a locked filing cabinet and user identifier codes were transcribed onto all files, ensuring participant names remained classified. Participants were fully informed of the research aims, objectives and methodology and were invited to participate. They were under no obligation to do so and had the right to withdraw at any time. The researcher engaged in adherence to protocols and honest reporting throughout the study.

A formal application was submitted to the Ethics Committee at Letterkenny Institute of Technology in October 2010. The application explained the purpose of the research, the design and the methodology chosen. The application was accompanied by the research proposal and related questionnaires. The study was awarded ethics approval on the 30th November, 2010.

3.13 Informed consent and confidentiality of data

An information sheet stating the purpose, design and procedures involved in the study was supplied to each participant prior to commencing the programme (Appendix 4). Participants also gave informed written consent (Appendix 5). The consent sheets were securely stored at Letterkenny Institute of Technology. Participants were also assured that information held regarding the analysis of data would be encrypted on the researcher's personal computer.

3.14 Research assistant

For the duration of the study a research assistant responded to technical problems regarding the SW3 Armbands used by the IGa and also recorded withdrawals from the study. The primary researcher remained distant from the study and took an observer effect to ensure there was no manipulation of data that could influence the results. Individuals are inclined to modify their behavior when they become aware that they are being observed (Denscombe, 2003). Therefore, the research assistant also oversaw the physical activity programme to ensure that the data collected was accurate and that there was no encouragement or direct guidance from the researcher. Similar to research by Merom *et al* (2007), the research assistant took responsibility for distributing and administering all questionnaires and logbooks throughout the research period. The research assistant co-ordinated and facilitated four structured sessions with both groups at Baseline, T1, T2 and T3 and these are explained in section 3.12. Some participants failed to show for these meetings for personal reasons. In such cases, the research assistant posted the research series of questionnaires to those participants with a postage paid envelope for ease of the return of the questionnaires and logbooks. The return rate of the total number of questionnaires distributed was 87% and logbooks (91%), for both groups from T1 to T3 (Appendix 18).

3.15 Definitions of regular, moderate and vigorous physical activity

3.15.1 Regular physical activity

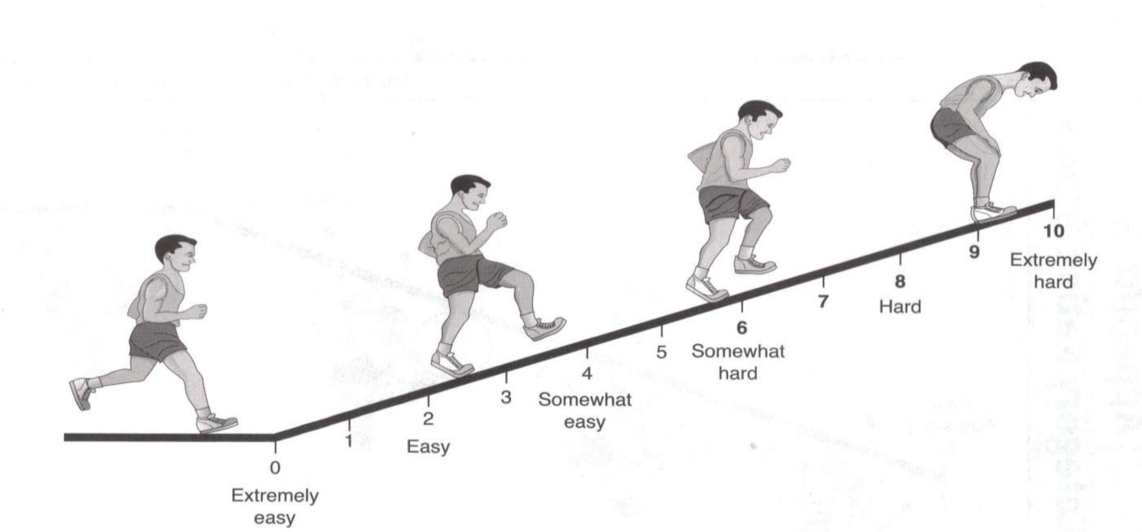
For this study regular physical activity is defined in accordance with the WHO (2011) recommended guidelines for physical activity of thirty minutes of moderate intensity physical activity five days per week *or* an equivalent combination of moderate and vigorous physical activity.

3.15.2 Moderate physical activity

For the purposes of this study moderate physical activity is defined as follows: Moderate physical activity exertion should result in being slightly out of breath and in line with the descriptions associated with numbers five to seven on Robertson’s (2004, p. 142) scale of perceived exertion (Figure 3.4).

3.15.3 Vigorous physical activity

Likewise, vigorous physical activity is defined as follows: Vigorous physical activity should result in deep rapid breathing and in line with the descriptions associated with numbers eight to ten on Robertson’s (2004, p. 142) scale of perceived exertion (Figure 3.4).



(Robertson, 2004)

Figure 3.4 Omnibus scale of percieved exertion (OMNI): adult, walking to running format

3.16 The study: Baseline, T1, T2 and T3

3.16.1 Overview

Participants' physical activity adherence levels were monitored in accordance with the SOCM over twenty-six weeks. The research assistant completed four structured assessments with the participants at Baseline and at the end of T1, T2 and T3.

This research study involved thirty females in total who were randomised into an IGa or an IGb, in order to take part in a physical activity programme lasting six months. A previous eleven week study on the effects of implementation intentions on female's walking behaviour, conducted by Arbour and Ginis (2009) randomised seventy-five females into an intervention group (n = 37) and a control group (n = 38), both groups were provided with a technological device to monitor their daily step count and self-reported this measure through a logbook which is similar to this current study. The difference between both these groups in Arbour and Ginis (2009) was that the intervention group were required to plan their intentions to exercise over the duration of the study. The title of the programme, 'Get Started and Stick with it' was designed by the researcher. The title is appropriate as it takes into consideration the initiation phase ('Get Started') of an exercise programme and describes the adherence phase of exercise to 'Stick with it'.

The purpose of this study was to assess the impact of the SW3 Armband in promoting physical activity adherence, in comparison to a logbook. Fifteen participants were equipped with both the SW3 Armband and logbook that tracked their participation in physical activity. The remaining fifteen were equipped with a logbook only. All participants followed a generic physical activity programme for the duration of the study (Appendix 8-10). The programme included activities such as walking, swimming, home workout, fitness classes and an open activity option classified as ‘other’. Both groups were provided with the support of a research assistant for the first eight weeks of the intervention who organised an optional group walking session once per week. Participants were not required to meet up with the research assistant but had the option to attend a group walking session once per week if they so desired. Participants also had support in the form of a social media website (Teamer), where they could interact with other participants if they so desired (see section 3.17). The research assistant withdrew support after the first eight weeks of the study to allow participants the opportunity to take control and responsibility for their own motivation to exercise.

The SW3 Armband users received real time feedback via digital display that counts day long calorie expenditure (from the moment they awakened to the moment they went to sleep) and the number of steps taken daily, amongst other measures (Kasabach *et al*, 2002). This study tracked and compared how well both groups adhered to their physical activity targets, based on the WHO (2011) minimum recommended guidelines for physical activity.

3.16.2 Baseline

Before commencing the programme participants were screened for any medical conditions using a Physical Activity Readiness Questionnaire (Appendix 3). A physical activity history questionnaire was also completed (Appendix 6). A summary of the purpose of the study and the benefits of physical activity was presented by the research assistant. An overview of the SOCM and the physical activity mediators (SE, SS and Enjoyment) were also presented. Participants were not required to complete the research series of questionnaires at this time but did so at the end of T1, T2 and T3. The research assistant inducted the relevant participants on the logbook use and the use of SW3 Armband. A generic eight week fitness programme was given to participants (Appendix 8). The research assistant supported participants by offering an optional physical activity session once per week during the first eight weeks (see table 3.3 below for attendance). This optional walking session was discontinued after T1 to allow participants to take control of their own physical activity participation. All the participants had the option to interact with the research assistant and other participants in the study through a social network site called 'Teamer' for the first eight weeks only. 'Teamer' was then used for reminding participants about when they would meet up again. For the purpose of this study, data in relation to 'Teamer' was not needed to answer the research questions set within, it was simply used as a means of additional social support for participants.

Table 3.3 Total number of participants who attended the optional walking session once per week

Date	Attendance	Weather
18th October (week 1)	13	Dry and windy
25th October (week 2)	5	Dry and windy
1st November (week 3)	2	Dry and humid
8th November (week 4)	2	Dry and drizzle
15th November (week 5)	1	Dry and drizzle
22nd November (week 6)	0	Hailstones
29th November (week 7)	0	Snow
6th December (week 8)	0	Snow

3.16.3 T1 (week one to eight)

At the end of T1 the research assistant collected the logbooks for the first eight weeks of the programme and the research series of questionnaires (Stage of Change, SE, SS and Enjoyment) were distributed, filled out and collected. A progressive ten week generic physical activity programme (Appendix 9) was distributed to participants and a profile questionnaire was completed by all participants (Appendix 7). Participants were also provided with a second logbook. The optional weekly physical activity session with the research assistant was discontinued after week eight to allow participants to take total responsibility for their own physical activity levels. Participants, who were having technical problems with the SW3 Armband or needed to contact the research assistant after T1, did so via email only, not by direct contact.

3.16.4 T2 (week nine to eighteen)

At the end of T2 the research assistant collected the logbooks and the research series of questionnaires were distributed for a second time. A progressive generic physical activity programme was distributed to participants for the final eight weeks of the programme (Appendix 10). Participants were also provided with a third logbook.

3.16.5 T3 (week nineteen to twenty-six)

At the end of T3 the research assistant collected the logbooks and the research series of questionnaires were distributed and collected for a third time. A ‘Teamer’ questionnaire (Appendix 16) and an evaluation questionnaire (Appendix 17) were also completed by participants. Participants from the IGa returned the SW3 Armbands and this marked the end of the twenty-six week research intervention. Participants were rewarded with a thank you card for their commitment to the programme.

3.16.6 Intervention Group (a)

The physical activity levels in terms of type, duration and intensity of participants in the IGa were assessed via the information recorded in the logbook. Participants followed a generic physical activity programme that included activities such as walking, swimming, home workout, fitness classes and an open activity option classified as 'other'. Participants recorded the type and duration of their physical activity and the intensity of their workouts in the logbook on a pre-determined scale (Robertson, 2004). Participants also had the use of the SW3 Armband and direct access to the data it stored. The data generated from the SW3 Armband was not required as a means of data collection for this study.

3.16.7 Intervention Group (b)

The physical activity levels in terms of type, duration and intensity of participants in the IGb were assessed via the logbook. Participants also followed the same physical activity programme as participants in the IGa. Participants recorded the type and duration of their physical activity and the intensity of their workouts in the logbook on a pre-determined scale (Robertson, 2004). The difference between the IGa and the IGb is that the IGa had the use of both a logbook and the SW3 Armband, whilst the IGb had the use of a logbook only, as a means of motivation. For both groups, the logbook was the instrument used to record participants' physical activity at low, moderate and vigorous intensities.

3.17 Teamer

'Teamer' is a sports team management network website. The 'Teamer' account was only accessible to participants on the programme via their log in details (username and password). The account allowed the research assistant to remind participants about meetings and requirements of the programme. The account also allowed participants to communicate with each other as an additional mechanism of social support, if they so desired, to share their experiences of participating in the programme.

3.18 Data storage

Data from the study was stored on a personal computer hard disk which was encrypted. Hard copies of participants' logbooks and PARQs were stored in a locked filing system in Letterkenny Institute of Technology. The final dissertation will include a digital copy and a hard copy and will be available in the library at Letterkenny Institute of Technology. The information stored on the computer will be confidential, with personal details coded to ensure this confidentiality. All data will be kept for five years and will then be destroyed.

3.19 Data analysis from the research series of questionnaires and logbooks

Excel was used to analyse the SOC questionnaire and the questions in the logbook. A range of descriptive statistics such as graphs, charts, means and standard deviations were computed, because according to Delaney (2009, p.283) descriptive statistics directly examine the data and 'tell a story'. The researcher also used SPSS version 19 for Windows software to analyse the questionnaires (SE, SS and Enjoyment) and logbook (physical activity minutes). A range of descriptive and inferential techniques were used to answer the research aim and questions. The 'exclude cases pairwise' option in SPSS was used to ensure that cases that were missing data were omitted from analysis. A 5% significance level was used in all statistical tests.

Parametric tests used to carry out analysis between both groups accumulated mean weekly physical activity minutes were as follows;

- **(i)** four independent samples t-tests between the IGa and IGb (T1, T2, T3 separately and T1-T3 collectively).
- **(ii)** One-way repeated measures ANOVA over the three time periods for both the IGa and IGb.
- **(iii)** One way analysis of variance between groups with post hoc tests for both the IGa and IGb.
- **(iv)** Correlation and regression analysis to assess the impact of the physical activity mediators of exercise adherence.

Parametric techniques such as independent samples t-tests were used to compare the means for the total accumulated mean weekly minutes of moderate and vigorous physical activity from T1-T3 inclusive. The effect size was also calculated to determine the magnitude of the difference between the IGa and IGb's mean weekly minutes of physical activity.

The researcher completed a one-way repeated measure ANOVA to compare scores between mean weekly physical activity minutes at T1 (week eight), T2 (week eighteen) and T3 (week twenty-six) for the IGa and the IGb.

A one-way ANOVA between groups with post-hoc comparisons was conducted to explore the impact of mean weekly physical activity minutes over the time intervals (T1, T2 and T3). Eta squared values were calculated to determine the effect size.

Regression analysis was undertaken between the physical activity mediators to ascertain the impact on mean weekly physical activity minutes. To assist in the regression analysis, several Pearson product-moment correlation coefficients were first computed to explore relationships between mean weekly minutes of moderate and vigorous physical activity and the physical activity mediators.

3.20 Limitations of the research

3.20.1 Sample size

The sample size of thirty females limits the study in terms of its findings. However, such a sample is comparable with previous studies in related research areas. Nies *et al* (1999) used a sample of sixteen females aged between 35-50 years to determine the factors that influence regular physical activity. Leenders *et al* (2001) evaluated methods to assess physical activity, such as the use of accelerometers and pedometers with thirteen females over seven days. Tudor-Locke *et al* (2004) monitored walking with the use of a pedometer over a one year period and recruited twenty three participants (sixteen females and seven men, mean age 38 years). King *et al* (2008) recruited thirty-seven healthy adults to evaluate the efficacy of handheld computer devices in promoting physical activity over an eight week period. Pal *et al* (2009) used pedometers to assess physical activity in a randomised sample size of twenty-six females. Previous research studies have recruited small sample sizes for short periods of time and these findings are study specific. The same logic applies to this study.

3.20.2 Financial cost, reliability and researcher's interaction

The limitations of the study can be categorised under the following headings: cost, self-reporting measurements and primary researcher involvement. The cost of the SW3 Armband (unit price €800) placed a restriction on the number of Armbands purchased by Letterkenny Institute of Technology research department, therefore limiting the number of participants recruited for the programme. A further limitation was that participants self-reported their SOC and physical activity workouts, through completion of the logbook. Self-reporting is dependent on participants' memory and accuracy (Carels *et al*, 2005). The primary researcher was minimally involved with participants but a researcher assistant was employed at Baseline, once per week throughout T1 and for the structured meetings at the end of T1, T2 and T3. Although the participants received a generic fitness programme from the research assistant at Baseline, they participated in physical activity in their own environment which limited the research assistant's interaction with the IGa and the IGb. Therefore, a strong attempt was made by the researcher to reduce interaction bias between herself and the research participants and between the research assistant and the participants.

3.21 Summary

This chapter outlined the research aims and questions. The research process was also described in detail. The quantitative research methodology employed by the researcher was fully justified as the best approach to answer the research questions. Issues pertaining to reliability, validity and ethics were addressed. The research series of questionnaires and the logbook were then outlined and described in detail. Finally, reference was made to the research limitations.

The remainder of this dissertation is dedicated to reporting, analysing and interpreting the data collected from the research fieldwork. The next chapter, chapter four presents the findings from the data collected.

Chapter 4 Findings

4.1 Introduction

This chapter presents the findings of the research series of questionnaires and the logbook from both the IGa and IGb at T1, T2 and T3. The chapter begins by presenting descriptive statistics of both groups' characteristics and are displayed in table 4.1. The findings are reported using descriptive statistics such as means, standard deviations, charts and graphs. The findings are divided into four sections and correspond to each of the research questions in turn.

4.2 Profile of participants

Table 4.1 below presents a synopsis of characteristics for all participants in the study. Participants' age, work, marital status and their physical activity levels before starting the programme are displayed. The table reports a 20% difference in sedentary physical activity at Baseline between the IGa and IGb. Furthermore, there was a 20% difference between both groups irregular physical activity at Baseline.

Table 4.1 Profile of participants: comparison between the IGa and the IGb

Variable	Measure	IGa (n = 15)	IGb (n = 15)
Age (years)	Average	40.26	40.46
Work Status (%)	Employed	60	53
	Self-Employed	0	7
	Unemployed	20	27
	Student	7	0
	Housewife	13	13
Smokers (%)	Yes	7	7
	No	93	93
Marital Status (%)	Single	33	27
	Married	67	60
	Other	0	13
Baseline Activity Level (%)	Sedentary	53	33
	Irregularly active	47	67

Adapted from Marcus *et al* (1998a)

4.3 Section 1: Findings relating to research question one

RQ1. How effective is the SW3 Armband in promoting physical activity adherence?

This section compares the MPA scores for the IGa and IGb. The assumption is that the greater the MPA scores, the greater the physical activity adherence in terms of the WHO (2011) minimum guidelines for moderate and vigorous physical activity (see table 1.1). It is also assumed that the participants in the IGa will accumulate a greater amount of mean weekly minutes of physical activity, because they have additional support from the SW3 Armband, in comparison to the IGb who have the use of a logbook only. Physical activity adherence levels were based on mean weekly physical activity minutes of exercise. Descriptive statistics such as means and standard deviations were computed for both groups at T1, T2 and T3 (see table 4.3) and T1-T3 inclusive (see table 4.5). Four independent samples t-tests were conducted between the IGa and IGb (T1, T2, T3 separately and T1-T3 inclusive) to compare MPA scores. On completion of a t-test, eta squared values were calculated using an SPSS formula (Appendix 20) to determine the size of the mean difference between both groups' means, and Cohen's (1988, p. 284) guidelines were used to assess the strength of the eta values.

A one-way repeated measures ANOVA was conducted to compare scores between the IGa and IGb's MPA scores and time intervals. Effect size was calculated using an SPSS formula (Appendix 21) and interpreted using the guidelines by Cohen (1988, p. 284).

This section ends with a display of the findings of the one-way ANOVA between groups with post-hoc test to compare both groups' MPA scores for T1-T3 inclusive.

4.3.1 Descriptive statistics for the IGa and IGb at T1, T2 and T3 for mean weekly minutes of physical activity

The MPA, standard deviation and standard error for the IGa and IGb over T1, T2 and T3 are displayed in table 4.2 below with supporting material in appendix 22 and 23.

Table 4.2 Descriptive statistics displaying the mean weekly minutes of exercise and standard deviation for the IGa and IGb at T1, T2 and T3

Group	N	Mean	Standard Deviation	Standard Error
IGa T1	12	56.92	43.87	12.66
T2	12	58.75	53.37	15.41
T3	12	90.50	61.13	17.65
Mean of T1-T3	36	68.72	54.03	9.00
CGb T1	12	95.92	66.68	19.25
T2	12	157.50	112.28	32.40
T3	12	227.75	130.71	37.73
Mean of T1-T3	36	160.39	103.22	29.80

4.3.2 Independent-samples t-test for T1, T2 and T3 separately for the IGa and IGb

Three independent-samples t-tests were conducted to compare mean weekly physical activity minutes between the IGa and IGb at T1 (Appendix 24), T2 (Appendix 25) and T3 (Appendix 26). The results for these tests are displayed in table 4.3 with associated discussion overleaf.

Table 4.3 Results from independent samples t-tests between mean weekly minutes of physical activity between the IGa and IGb at the end of T1, T2 and T3

	F	**Sig**	**T**	**Df**	**Sig. (2tailed)**
MPA T1					
Equal variance assumed	1.676	.209	-1.693	22	.105
Equal variance not assumed			-1.693	19.020	.107
MPA T2					
Equal variance assumed	4.606	.043	-2.752	22	.012*
Equal variance not assumed			-2.752	15.728	.014*
MPA T3					
Equal variance assumed	11.538	.003	-3.295	22	.003**
Equal variance not assumed			-3.295	15.592	.005**

***significant at .05 **significant at .01

There was no significant difference in MPA scores between the IGa and IGb at T1. However, there was a significant and revealing difference in scores at T2 and T3, with the IGb having the larger MPA scores (see table 4.3). Eta squared values were calculated using the eta squared formula (Appendix 20) for T2 (0.26) and T3 (0.33), these values suggest large effect sizes.

4.3.3 An independent-samples t-test for T1-T3 inclusive

An independent-samples t-test was conducted to compare MPA scores for the IGa and IGb (see appendix 27). Descriptive statistics such as the mean, standard deviation, standard error mean for mean weekly minutes of exercise for the IGa and IGa, for the time period T1-T3 inclusive are presented in table 4.4 below.

Table 4.4 Descriptive statistics displaying the mean, standard deviation and standard error for mean weekly minutes of physical activity for T1-T3 inclusive for the IGa and IGb

	Group	N	Mean	Std. Deviation	Std. Error Mean
Mean Physical Activity	Intervention Group a	36	68.72	54.025	9.004
	Intervention Group b	36	159.53	115.150	19.192

There was a significant difference in scores between the IGa (M = 68.72, SD = 54.025) and the IGb (M = 159.53, SD = 115.150, t (49) = - 4.284, p = .000 (two-tailed). The magnitude of the difference in the means (mean difference = -90.806, 95% CI: -133.391 to -48.220) was large (eta squared = 0.45). Further analysis was carried out through a one-way repeated measure ANOVA to compare MPA across the three time intervals.

4.3.4 One-way repeated measures ANOVA for the IGa and IGb

One-way repeated measures ANOVA were conducted to compare scores between MPA (dependant variable) scores at T1, T2 and T3 (independent variables) for the IGA and the IGb (Appendix 28). There was no significant effect for Time for the IGa, Wilks' Lamba = .678, F (2, 10) = 2.376, p > .0005.

For the IGb there was a significant effect for Time, Wilks' Lamba = .366, F (2, 10) = 8.646, p < .0005, multivariate partial eta squared = .634. The partial eta squared value suggests a large effect size. Further analysis involved computing a one way between groups ANOVA with Tukey post hoc tests for both groups to determine where the differences in MPA scores occurred.

4.3.5 One-way between groups analysis of variance with Tukey post hoc tests for the IGa and IGb

A one-way between groups ANOVA with Tukey post hoc test was conducted for the IGa (Appendix 29) and IGb separately (Appendix 30) to explore the difference between MPA scores over each of the three time intervals. The three time intervals, T1, T2 and T3 were of 8, 10 and 8 weeks duration respectively.

For the IGa, there was no statistically significant difference in MPA scores over the three time periods: $F (2, 33) = 1.508$, $p = .236$. Post-hoc comparisons using the Tukey HSD test indicated that the mean weekly physical activity minutes of exercise over T1 (Mean = 56.92, SD = 43.866), T2 (Mean = 58.75, SD = 53.365 and T3 (Mean = 90.50, SD = 61.130) were not significantly different from one another.

A similar one-way between groups ANOVA was carried out for the IGb. On this occasion there was a significant difference ($p < .05$) in MPA scores for the three time periods: $F (2, 33) = 4.589$, $p = .017$. The difference in MPA scores between the groups was large as the effect size, calculated using the eta squared formula (see appendix 21), was 0.22. Post-hoc comparisons using the Tukey HSD test indicated that MPA scores over T1 (Mean = 95.92, SD = 66.675) were significantly different from T3 (Mean = 227.75, SD = 130.713). T2 (Mean = 157.50, SD = 112.280) did not differ significantly from T1 or T3 (see table 4.5 overleaf for further details).

Table 4.5 Post Hoc test with multiple comparisons for the IGb across the three time periods

Time Interval		Mean Difference	Std. Error	Sig
T1	**T2**	- 61.583	43.550	.345
	T3	-131.833*	43.550	.013
T2	**T1**	61.583	43.550	.345
	T3	-70.250	43.550	.254
T3	**T2**	131.833*	43.550	.013
	T1	70.250	43.550	.254

*****significant at .05

4.3.6 Summary of section one

These findings reported in section one suggest that a logbook is an effective method in promoting physical activity adherence. Both groups were provided with a logbook to record their daily physical activity minutes and the IGa had additional, support from the SW3 Armband to aid exercise adherence. However, recording physical activity adherence levels via a logbook only proved to be a greater motivational mechanism for the promotion of physical activity, than the use of the SW3 Armband and a logbook together.

4.4 Section 2: Findings relating to research question two

RQ2. What are the barriers and limitations posed by the use of the SW3 Armband and Physical Activity Logbook as part of a physical activity exercise adherence programme?

This section presents the findings on the barriers and limitations of the SW3 Armband and logbook, using descriptive statistics (graphs and pie charts). At the end of T1, T2 and T3, participants in the IGa group only, completed questions on the use of the SW3 Armband. Participants in both the IGa and IGb completed questions on the use of the logbook as part of a physical activity programme. Additional qualitative comments with regards to the SW3 Armband and logbook were recorded by participants in the 'additional comments' section of the logbook (Appendix 19).

To assess the barriers posed in relation to the SW3 Armband for the IGa only, participants were invited to respond to questions relating to each of the following:

- **(i)** the ease of operating the SW3 Armband
- **(ii)** wear-ability of the SW3 Armband
- **(iii)** barriers to wearing the SW3 Armband

For both groups, the following three issues are addressed to establish the limitations of completing a traditional logbook daily:

- **(i)** the convenience or inconvenience of completing a logbook
- **(ii)** the completion of a logbook daily
- **(iii)** the logbook as a form of motivation for exercise adherence?

4.4.1 The ease of operating the SW3 Armband for the IGa

Throughout the physical activity programme (T1, T2 and T3) participants in the IGa found the SW3 Armband difficult to operate. 42%, 25% and 33% of participants stated that the SW3 Armband was 'somewhat hard' to operate at the end of T1, T2 and T3 respectively. At the end of T1, one participant noted that the SW3 Armband caused problems such as synchronising the watch and device but this was overcome and the SW3 Armband became part of their daily routine, *'Had some problems at first with sychronising the Armband. However now I do not even realise I am wearing the Armband, when I get up in the morning the Armband is like putting on my clothes'* (Participant 17).

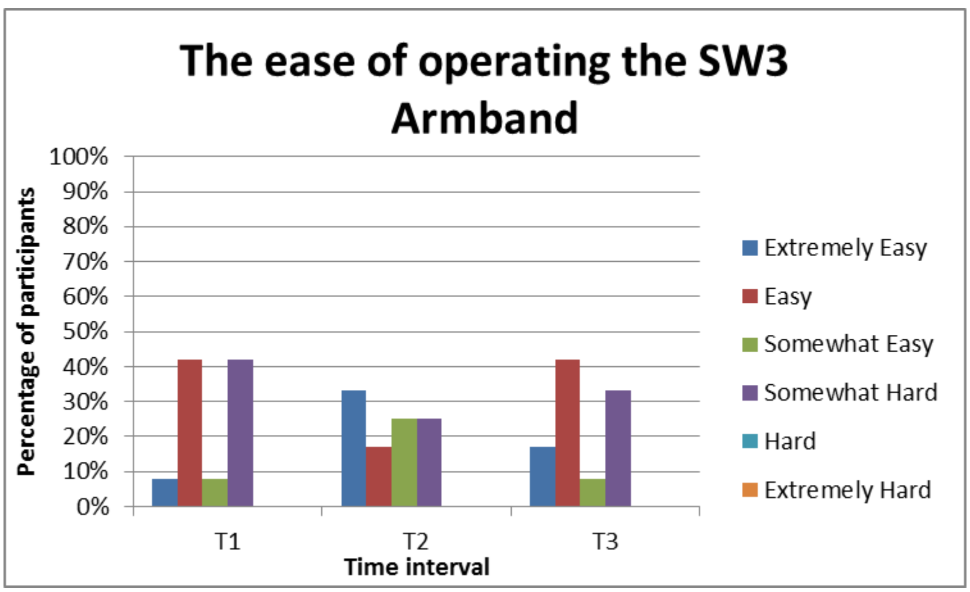


Figure 4.1 The percentage of participants in the IGa that found the SW3 Armband easy or difficult to use over the three time periods

4.4.2 The wearability of the SW3 Armband for the IGa

50%, 42% and 50% of participants stated that the SW3 Armband was comfortable to wear at the end of T1, T2 and T3 respectively. A significant number of participants (over half) found the SW3 Armband uncomfortable to wear at the end of T1 (50%), T2 (58%) and T3 (50%). One participant stated that '*the velcro on the SW3 Armband can be uncomfortable, if not adjusted properly*' (Participant 22).

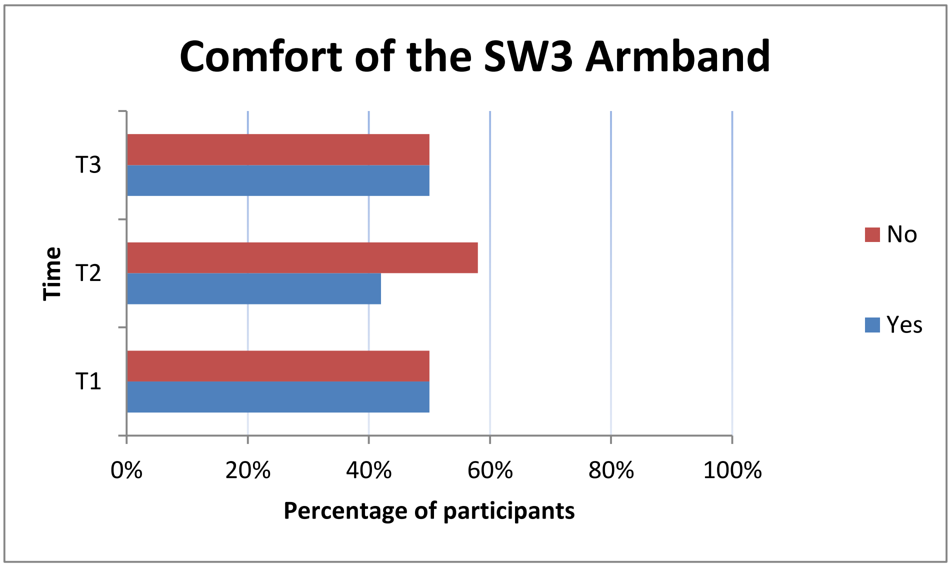


Figure 4.2 The percentage of participants in the IGa that found the SW3 Armband comfortable or not comfortable over the three time periods

4.4.3 The SW3 Armband and associated barriers for the IGa

A number of barriers regarding the use of the SW3 Armband were identified. The barriers noted were irritation, dress code, size and self-consciousness when wearing the device. The main barrier identified was irritation. At the end of T1, T2 and T3, the percentage of participants that cited irritation as a barrier was 33%, 42% and 42% respectively. One participant recorded at T3 that the device '*irritated my arm and left a* *rash, the rash went away when I did not wear the Armband for a few days*' (Participant 17), with another participant reporting '*the Armband really annoyed me, I found it irritating*' (Participant 26).

The bulkiness of the SW3 Armband was cited by 17% of participants as a barrier at T1, T2 and T3. One participant stated that '*I found the SW3 Armband annoying; getting it to fit under tight clothing was an issue*' (Participant 20). A further barrier perceived by participants was that the batteries in the device had to be changed often and became an annoyance because the device would have to be reset, '*keeping the Armband loaded up with batteries was a bit of a chore and I found I became lazy at doing it*' (Participant 22).

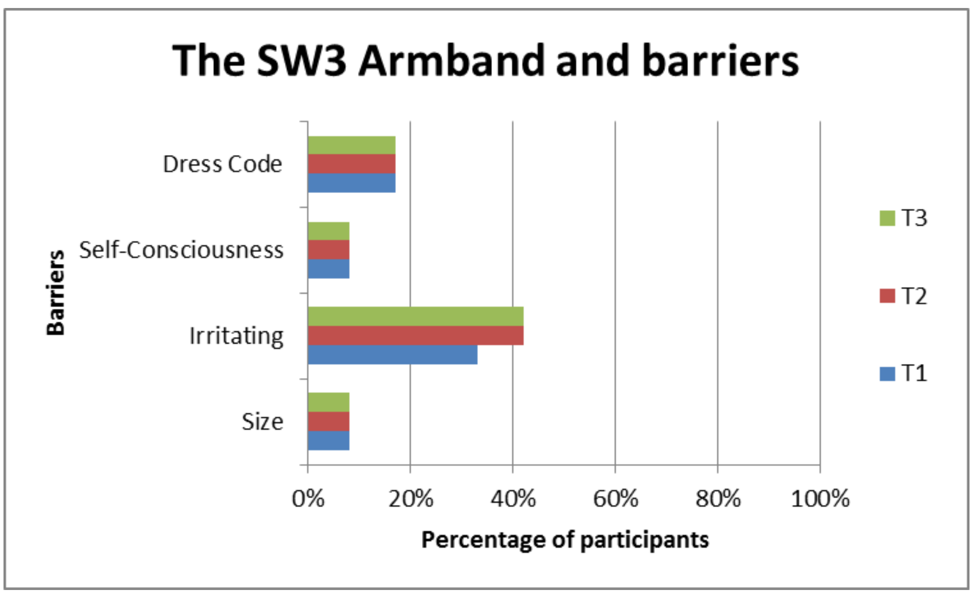


Figure 4.3 The percentage of participants in the IGa that found barriers to wearing the SW3 Armband over the three time periods

4.4.4 The SW3 Armband as a motivational tool for physical activity adherence for the IGa

The number of participants that suggested the SW3 Armband is a motivational tool for physical activity adherence remained consistent throughout the programme. At the end of T1 (67%), T2 (58%) and T3 (67%) noted the SW3 Armband stimulated exercise adherence. One participant stated that '*wearing the SW3 Armband has made me more aware of the number of steps taken daily, it made me more motivated to achieve my target daily step count. I try to set weekly targets now*'.

However there were a number of participants at the end of T1 (33%), T2 (42%) and T3 (33%) that stated that the SW3 Armband was not a motivational device to aid physical activity adherence. Furthermore, a comment by one participant suggests that the SW3 Armband did not have any influence on physical activity levels. '*I found the SW3 Armband a de-motivator as I would often reach my target activity and step count levels without doing any additional daily exercise*'(Participant 22).

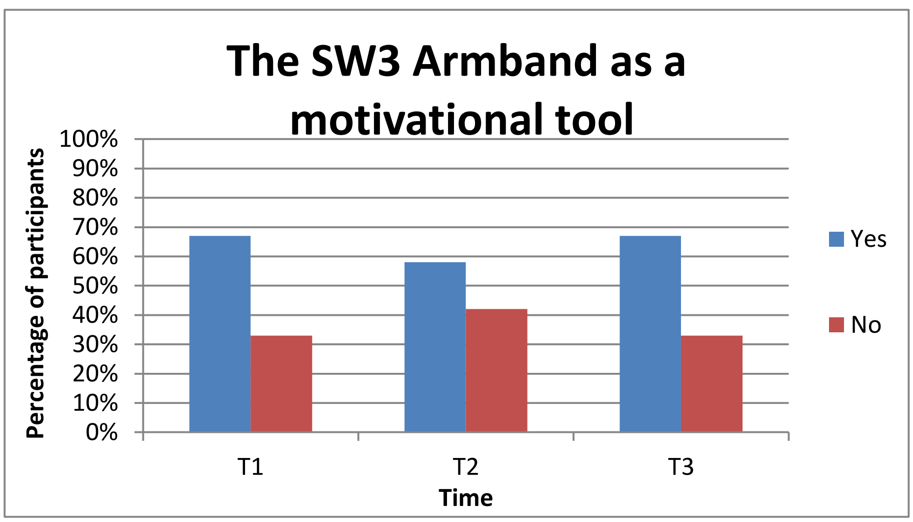


Figure 4.4 The percentage of participants in the IGa that specified that the SW3 Armband was or was not a motivational tool for physical activity adherence

4.4.5 The convenience or inconvenience of completing a daily logbook for the IGa and IGb

At the end of T1, 33% of participants in the IGa noted that the logbook was an inconvenient method of tracking physical activity levels (25% = somewhat inconvenient and 8% = inconvenient). 8% of participants in the IGb stated that the logbook was 'inconvenient'. Only 8% of participant in the IGa and 8% in the IGb found the logbook to be an 'inconvenient' method of recording their physical activity levels at the end of T2. At the end of the physical activity programme (T3), 8% of participants in the IGa (n = 12) and 8% of participants in the IGb (n = 12) stated that the logbook was an 'extremely inconvenient' and 'inconvenient' process of recording physical activity levels. This means that 92% of participants found that maintaining a logbook was at least somewhat convenient.

These findings suggest that the logbook was an efficient and convenient method of recording physical activity over the duration of the programme. Few participants noted that the logbook was an inconvenience yet, the majority of participants from both groups did not complete their logbook daily and these findings are displayed in figure 4.5 overleaf.

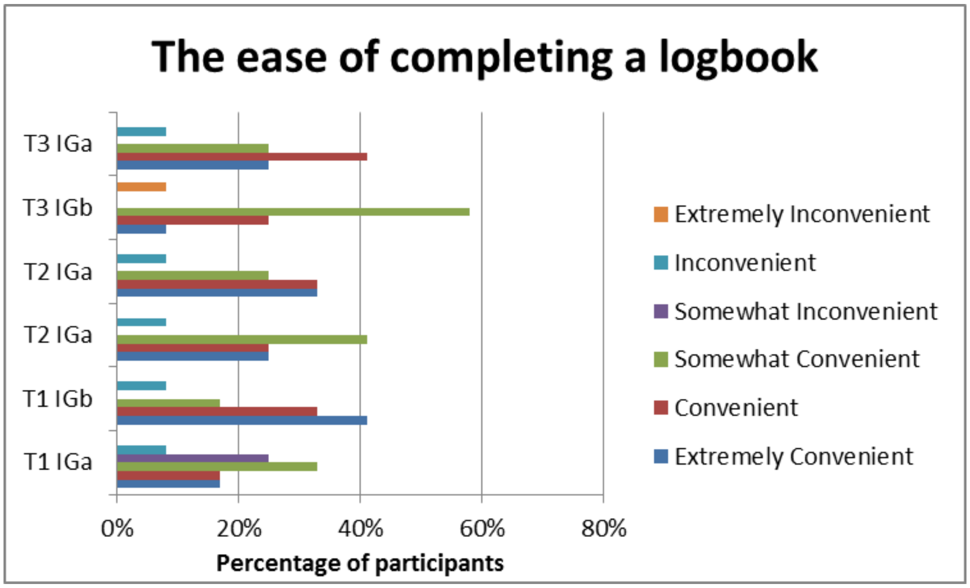


Figure 4.5 The percentage of participants in the IGa and IGb that found a logbook to be a convenient or inconvenient method to record daily physical activity levels over the three time periods

4.4.6 Completion of a daily logbook for the IGa and IGb

Over the duration of the physical activity programme, each participant was requested to complete a logbook daily (on the days that they performed physical activity).

The percentage of participants in the IGa that completed the logbook daily decreased from T1 (42%) to T3 (17%). This means there was a decrease of 25%, in the percentage of participants that completed their logbook from T1 to T3. At the end of the physical activity programme, 83% of participants stated that they did not complete their logbook daily. Participants can forget to keep an account of their daily physical activity, one participant noted, '*sometimes I forgot to complete my logbook*' (Participant 27), which is consistent with other research by Blondin *et al* (2010).

For the IGb, the percentage of participants that completed their logbook for T1 and T3 was the same, 33%. 67% of participants did not complete their logbook daily at T1 and T3. At the end of T2, more participants were completing their logbook than at any of the other time interval (58%). These findings suggest that the completion of a daily logbook was inconvenient for the majority of participants, due to the high percentages of participants who stated that they did not complete their daily logbook.

4.4.7 The logbook as a motivational tool for physical activity adherence for the IGa and IGb

At the end of each time period, the percentage of participants in the IGb that perceived a logbook to be a motivational tool was greater compared to the percentage of participants in the IGa. The percentage of participants in the IGa, at the end of T1, T2 and T3 that stated that the logbook was a motivational tool was 50%, 42% and 58% respectively. The percentage of participants in the IGb that stated the logbook was a motivational tool was greater at T1 (75%), T2 (75%) and T3 (67%). One participant in the IGb stated that '*the logbook is a good means of motivation, I have given my mother who is seventy-three years of age, a logbook that I made myself and it has encouraged her to become more physically active*' (Participant 4). This finding further provides evidence that the logbook was a valuable method in tracking physical activity adherence. Furthermore, these findings provide evidence that the logbook was a barrier for some participants. Findings show that the IGa, at the end of T1 (50%), T2 (58%) and T3 (42%) and the IGb, at T1 (25%), T2 (25%) and T3 (33%) found that a logbook was not a form of motivation for exercise adherence.

4.4.8 Summary of section two

This section can conclude that a logbook is an effective method for recording physical activity adherence. The majority of participants in both groups suggested that the logbook was a convenient technique. Participants from both groups noted that the logbook was difficult to complete on a daily basis, but was a motivational tool for exercise adherence. One limitation associated with the logbook was its daily completion. There are a number of barriers associated with the SW3 Armband. The SW3 Armband was found to be difficult to operate, in some cases uncomfortable to wear and at times irritated the skin when worn for long periods of time. However, at the end of T3, 67% of participants stated that the SW3 Armband acted as a motivational device in their physical activity adherence. Nonetheless, those participants in the IGa (mean = 68.72) participated in less mean weekly minutes of physical activity overall, compared to those of the IGb (mean = 159.53).

4.5 Section 3: Findings relating to research question three

RQ3. How effective is self-reporting in a physical activity intervention over a six month period?

The SOCM assumes that those individuals that are sedentary or perform some physical activity will be in the early stages of change. As physical activity becomes a habit, individuals can be categorised in the latter stages of change (see table 4.7). The SOC questionnaire (Appendix 11) was completed by participants at T1, T2 and T3. For ease of convenience, the findings are presented using clustered bar charts for the IGa and IGb separately at Baseline, T1, T2 and T3. These findings which are self-reported, were all checked for inaccuracies against all participants MPA scores (Appendix 22 and 23) and reconciled where necessary, all reconciliations are included in the cluster bar charts which follow.

This section further presents three research assumptions in relation to the SOCM :

(i) by the end of T1 all participants will be in the preparation stage at least of the SOCM

(ii) by the end of T2 all participants will be in the action stage of the SOCM

(iii) by the end of T3 all participants will be in the maintenance stage of the SOCM.

Table 4.6 provides a definition of the six stages in the stage of change model

STAGE	**DEFINITION**
Precontemplation **(stage 1)**	Sedentary individuals who have no intention of changing their behavior
Contemplation **(stage 2)**	Sendentary individuals with intention to become more physically active
Preparation **(stage 3)**	Irregularly active with intention to become more regularly active
Action **(stage 4)**	Engaging in regular physical activity but not meeting the WHO's minimum guidelines for physical activity
Maintenance **(stage 5)**	Engaging in regular physical activity for six months or more
Relapse **(stage 6)**	An individual cannot sustain physical activity levels and reverts back to a sedentary lifestyle

4.5.1 Stage of Change at Baseline for the IGa and IGb

Selection criteria determined that participants in the IGa (n = 15) and IGb (n = 15) were either in the contemplation stage (stage two) or preparation stage (stage three) of the SOCM at Baseline. 80% and 67% of participants in the IGa and IGb respectively were in the contemplation stage. A greater percentage of participants in the IGb (33%) were in the preparation stage at Baseline in comparison to the IGa (20%). Furthermore, there was a 20% difference in sedentary physical activity levels at Baseline between the IGa (53%) and IGb (33%). The IGb also reported a higher level of irregular physical activity (67%), compared to the IGa (47%). Figure 4.6 presents a summary of the self-reported SOC for both groups at Baseline.

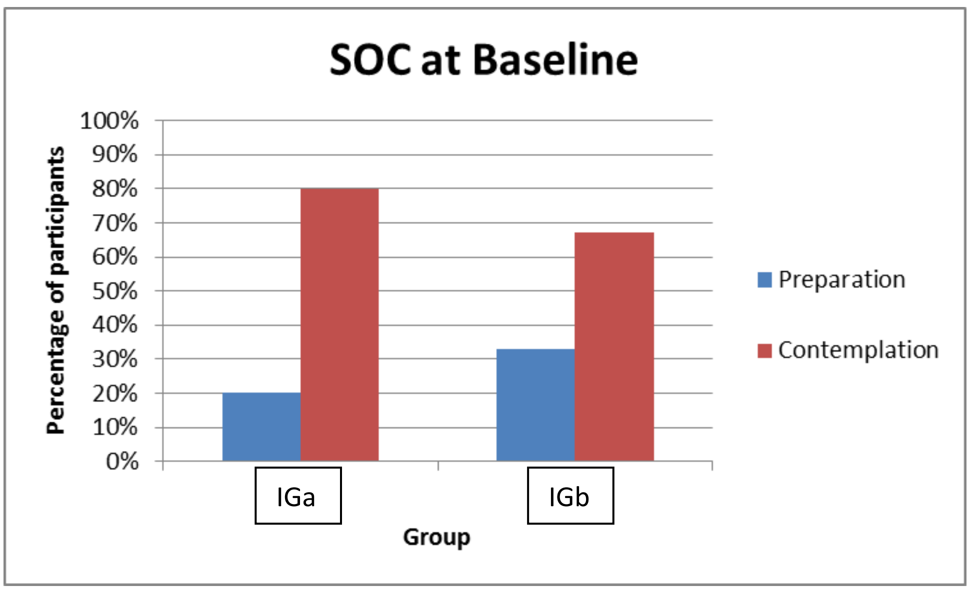


Figure 4.6 The percentage of participants in the IGa and IGb and their stage distribution in the SOCM at Baseline

4.5.2 Stage of change at the end of T1 for the IGa and IGb

The assumption is that participants in the IGa (n = 12) and IGb (n = 12) would be in the preparation stage at least of the SOCM at the end of T1. Participants in the IGa self-reported their stage of change at the end of T1 as contemplation (8%), preparation (42%) and action (50%). Participants in the IGb self-reported their stage of change at the same time interval as preparation (50%) and action (50% participants). There were inaccuracies in how participants reported their SOC and how they reported physical activity in their logbooks. Therefore, this self-reported method was contradicted when participants' logbook minutes were calculated over T1 (Appendix 22 and 23). The new reconciled percentages of participants, in terms of the SOCM for the IGa are as follows: 83% of participants were in the preparation stage, 8% in the action stage and 8% in the maintenance stage. The new reconciled percentages of participants in the IGb were as follows: 33% of participants were in the preparation stage, 33% in the action stage and 33% in the maintenance stage. Figure 4.7 presents a summary of the amended stages of change for both groups at the end of T1.

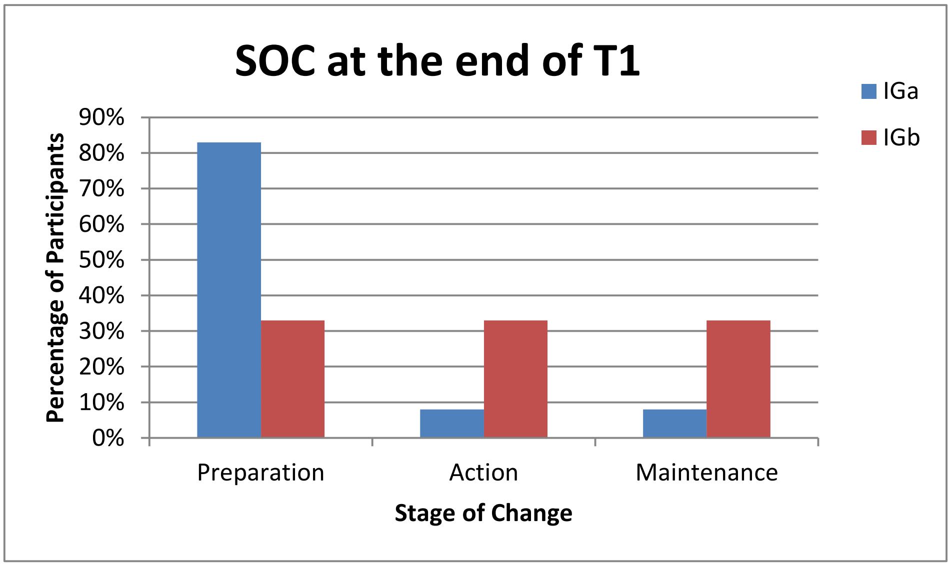


Figure 4.7 The percentage of participants in the IGa and IGb and their stage distribution in the SOCM at the end of T1

4.5.3 SOC at the end of T2 for the IGa and IGb

The assumption is that participants in the IGa (n = 12) and IGb (n = 12) would be in the action stage of the SOCM at the end of T2. Participants in the IGa self-reported their SOC at the end of T2 as contemplation (17%), preparation (33%) and action (50%). Participants in the IGb self-reported their SOC for the same time interval as preparation (33%), action (58%) and maintenance (8%). Evidence from the participants' logbooks with regards to their minutes of participation in physical activity (Appendix 22 and 23) contradicted this self-report measure and adjustments were made to reconcile participants SOC for both groups. The amended stages of change for both groups are similar to those displayed in figure 4.7 for T1. Figure 4.8 presents a summary of the amended stages of change for both groups at the end of T2.

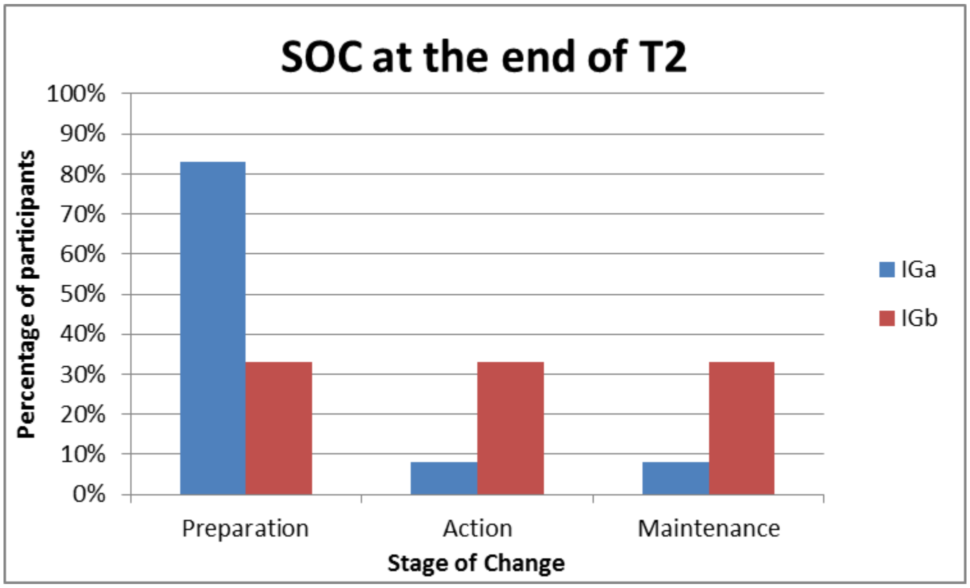


Figure 4.8 The percentage of participants in the IGa and IGb and their stage distribution in the SOCM at the end of T2

4.5.4 Stage of change at the end of T3 for the IGa and IGb

The assumption is that participants in the IGa (n = 12) and IGb (n = 12) would be in the maintenance stage of the SOCM at the end of T3. Participants in the IGa self-reported their SOC at the end of T3 as preparation (50%), action (17%) and maintenance (33%). Participants in the IGb self-reported their stage of change for the same time interval as preparation (8%), action (33%) and maintenance (58%). Evidence from participants' logbooks with regards to their minutes of physical activity (Appendix 22 and 23) provided contradictory evidence in relation to this self-report measure and adjustments were made to reconcile participants SOC. The new reconciled percentages of participants, in terms of the SOCM for the IGa were as follows: 33% of participants were in the preparation stage, 42% in the action stage and 25% in the maintenance stage. The new reconciled percentages of participants in the IGa were as follows: 42% were in the action stage and 58% were in the maintenance stage. Figure 4.9 presents a summary of the amended stages of change for both groups at the end of T3.

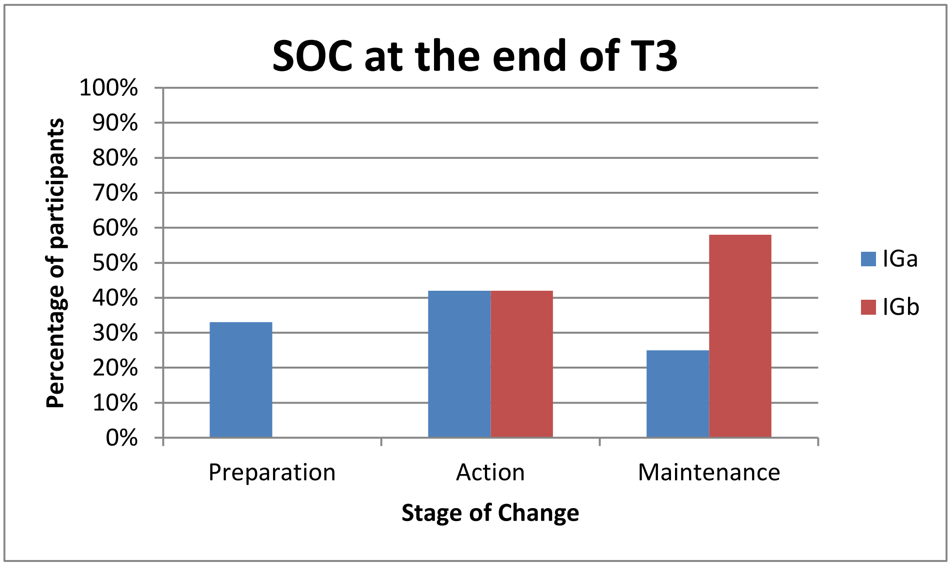


Figure 4.9 The percentage of participants in the IGa and IGb and their stage distribution in the SOCM at the end T3

4.5.5 The stage of change assumptions for this study

At the end of T1, 83% of participants in the IGa and 33% of participants in the IGb had met the assumption of being categorised in the preparation stage of the SOCM. The remaining participants from both groups had progressed into either the action or maintenance stage of the SOCM. 8% of participants in the IGa and 33% of participants in the IGb were in the action stage, while 8% (IGa) and 33% of participants (IGa) further progressed to the maintenance stage. Findings however indicate that at the end of T1, 58% of participants in the IGa and 33% of participants in the IGb self-reported their SOC inaccurately.

At the end of T2, 8% of participants in the IGa and 33% of participants in the IGb had met the assumption of being categorised in the action stage. The remaining participants from both groups had either lingered in the preparation stage or progressed into the maintenance stage of the SOCM and results are the similar to those noted for T2. The results specify that at the end of T2, 58% of participants in the IGa and 50% of participants in the IGb self-reported their SOC inaccurately.

By the end of T3, 25% of participants in the IGa and 58% of participants in the IGb had met the assumption of being categorised in the maintenance stage. These findings are consistent with participants minutes noted in their logbooks (Appendix 22 and 23). Some participants in the IGa remained in the preparation stage (33%). The remaining participants from the IGa (42%) and IGb (42%) were categorised as being in the action stage of the SOCM. At the end of T3, these findings show that 25% of participants in the IGa self-reported their current SOC inaccurately, but all participants in the IGb reported their current SOC accurately. Results from each participants logbook with regards to their accumulated minutes of physical activity over T1, T2 and T3 (Appendix 22 and 23) provides contradictory evidence regarding participants self-reporting. Therefore, the efficacy of the SOC as a means of assessing where an individual is at, in terms of physical activity over a six month intervention is limited due to participants self-reporting their SOC inaccurately. Figure 4.10 presents a summary of the percentage of participants in both groups that met the assumptions.

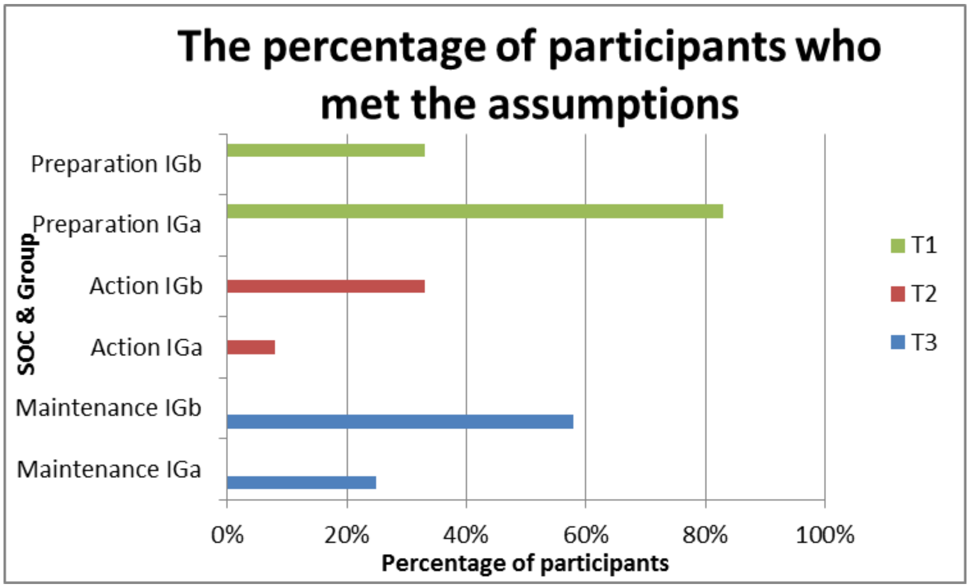


Figure 4.10 The percentage of participants in the IGa and IGb who met the assumptions of the stage of change at T1, T2 and T3

4.1 Section 4: Findings relating to research question four

4.2 Cronbach Alpha

Cronbach alpha coefficients were calculated for all the questionnaires used within this study and are displayed below in table 4.7 overleaf. These statistics provide an indication of the average correlation among all of the items that make up the scale, values range from 0-1 with higher values indication greater reliability (Pallant, 2007).

Table 4.7 Cronbach alpha coefficient scores for Social Support, Self-Efficacy and Enjoyment at Baseline, T1, T2 and T3

	T1	**T2**	**T3**	**Average (T1-T3)**
SE	.57	.71	.77	.68
SSFamily	.78	.82	.89	.83
SSFriends	.65	.89	.84	.79
Enjoyment	.90	.92	.92	.91

RQ4. Do the mediators of Self-Efficacy, Total Social Support (SSFam and SSFri) and Enjoyment impact on the participant's physical activity adherence levels?

This section presents the findings and analyses conducted to assess the impact of three physical activity mediators on mean weekly physical activity minutes of exercise (moderate and vigorous), computed for both the IGa and IGb. Values are taken together at the end of the three time intervals T1, T2 and T3. Mean weekly physical activity minutes of exercise (dependent variable) were used to gauge participants' physical activity adherence levels. The three physical activity mediators (independent variables) included Mean Self-Efficacy (MSE), Total Social Support (Social Support Family and Social Support Friend) and Enjoyment for both groups together at T1, T2 and T3. Normal P-P Plots and Scatterplots were produced via SPSS as part of the standard regression analysis, to ensure that there were no violations of the assumptions of linearity and homoscedasticity. The exclude cases pairwise function was used to ensure missing data were excluded from analyses. Two models were applied at the three time periods:

(i) mean weekly physical activity minutes and MSE, TSS and Enjoyment and (ii) mean weekly physical activity minutes and SSFam, SSFri and TSS.

A number of scatterplots were produced to visually identify relationships between mean weekly physical activity levels and the independent variables at the end of T1 (Appendix 31), T2 (Appendix 32) and T3 (Appendix 33). Descriptive statistics such as means and standard deviations were calculated for each mediator at the three time intervals (Appendix 40). Correlations were then calculated to determine the relationship between mean weekly physical activity and the mediators for both groups at T1 (Appendix 34), T2 (Appendix 35) and T3 (Appendix 36). The strength of these correlations (r values) was determined with reference to guidelines by Cohen (1988, pp.79-81) which are presented in table 4.8 below.

Table 4.8 Cohen's guidelines for interpreting r values below 1

Size	**Value**
Small	r = .10 to .29
Medium	r = .30 to .49
Large	r = .50 to 1.0

In devising suitable regression models, careful consideration was given to ensuring that the independent variables were not too highly correlated to each other. Very strong inter-item correlations would mean that the independent variables were all measuring the impact of a similar factor and this was not desirable. Secondly, it was important to ensure that the independent variables (mediators) had to have some degree of relationship to the dependent variable (MPA scores for the IGa and IGb), otherwise their analysis would be meaningless.

Taking cognisance of these considerations, two models were devised to answer research question four, for both groups together at T1, T2 and T3. The first model explored the impact of SE, TSS and Enjoyment on participants' mean weekly physical activity levels at T1 (Appendix 37), T2 and T3. The second model explored the impact of SSFam, SS Fri and TSS on participants' mean weekly physical activity levels at T1 (Appendix 38), T2 and T3 (Appendix 39). From the regression analysis at each time interval, the R Squared value, which explains how much variance in physical activity is explained by the model, were taken from the SPSS output. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity (a constant variance) occurred. This refers to the variance of the residuals around a dependent variable scores (Pallant, 2007).

4.3 Regression model for mean weekly physical activity minutes of exercise and the predictor variables Mean Self-Efficacy, Social Support Family, Social Support Friends Total Social Support and Enjoyment at the end of T1

Model 1: Impact of predictor variables MSE, TSS and Enjoyment on MPA scores for both the IGa and IGb.

The relationship between the predictor variables and MPA scores are presented in figure 4.11 overleaf. None of the correlations violate the multicollinearity of $r > 0.7$. It is noted that one of the predictor variables (TSS) has a weak correlation (0.23) with the dependent variable.

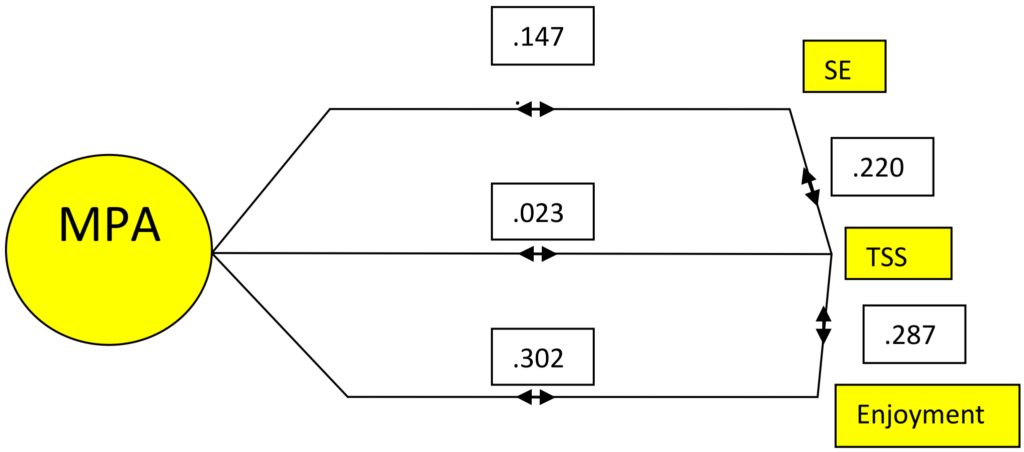


Figure 4.11 Pearson's product – moment correlations between mean physical activity and SE, TSS and Enjoyment at the end of T1

Standard multiple regression in SPSS (version 19) was used to enter the three predictor variables into the equation at once. This was carried out to ascertain how much variance in physical activity mean scores could be explained by all three predictor variables and also to find out how much unique variance each of the predictor variables contributed to MPA scores. The model summary is presented in table 4.9 below.

Table 4.9 Summary of regression model for mean physical activity scores and the predictor variables (MSE, TSS and Enjoyment) for the IGa and IGb together

R	**R square**	**F**	**Sig.**
.318	.101	.748	.536

R square value of .101 indicates that the three predictor variables explain 10.1% of the variance in MPA scores. Enjoyment (beta = .803) made the strongest contribution towards explaining MPA. However this is not a significant result (p=.536) at the 5% level of significance and no further analysis was pursued in terms of identifying the unique contribution of each predictor variable.

<u>Model 2</u>: Impact of predictor variables SSFri, SSFam and TSS on MPA scores for both the IGa and IGb.

The relationship between the predictor variables and MPA scores are presented in figure 4.12 overleaf. None of the correlations violate the multicollinearity of r > 0.7. One of the predictor variables (TSS) has a weak correlation (0.23) with MPA (independent variable).

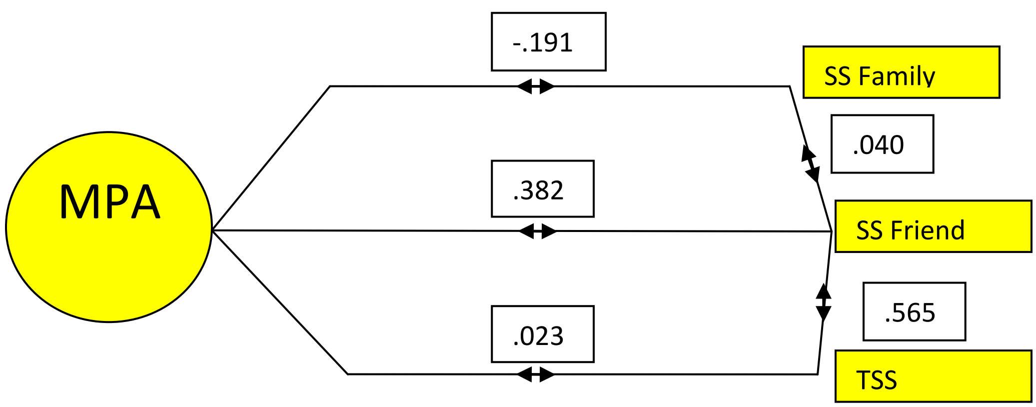


Figure 4.12 Pearson's product – moment correlations between mean physical activity and SSFam, SSFri and TSS at the end of T1

Standard multiple regression in SPSS (version 19) was used to enter the three predictor variables into the equation at once. This was carried out to ascertain how much variance in physical activity mean scores could be explained by all three predictor variables and also to find out how much unique variance each of the predictor variables contributed to MPA scores. The model summary is presented in table 4.10 below.

Table 4.10 Summary of regression model for mean physical activity scores and the predictor variables (SSFam, SSFri and TSS) for the IGa and IGb together

R	**R square**	**F**	**Sig.**
.586	.343	3.487	.035

R square value of .343 indicates that the three predictor variables explain 34.3% of the variance in MPA scores. This model was significant (p=.035) at the 5% level of significance. The three predictor variables were also significant at the 5% level of significance; SSFam (p = .050), SSFri (p = .027) and TSS (p = .042). TSS (beta = -6.976) made the strongest contribution towards explaining MPA when the other two predictor variables were controlled for.

4.3.1 Regression model for mean weekly physical activity minutes of exercise and the predictor variables Mean Self-Efficacy, Social Support Family, Social Support Friends Total Social Support and Enjoyment at the end of T2

Model 1: Impact of predictor variables MSE, TSS and Enjoyment on MPA scores for both the IGa and IGb.

The relationship between the predictor variables and MPA scores are presented in figure 4.13. None of the correlations violate the multicollinearity of r > 0.7. However, it is noted that the three predictor variables and the inter-item correlations are all very low; therefore, none of the variables were computed for regression analysis.

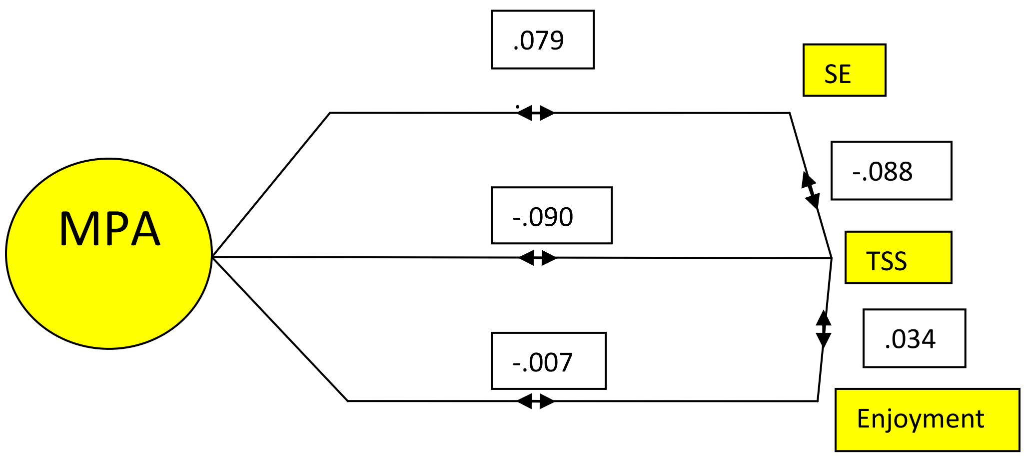


Figure 4.13 Pearson's product – moment correlations between mean physical activity and SE, TSS and Enjoyment at the end of T2

<u>Model 2</u>: Impact of predictor variables SSFri, SSFam and TSS on MPA scores for both the IGa and IGb.

The relationship between the predictor variables and MPA scores are presented in figure 4.14 overleaf. None of the correlations violate the multicollinearity of r > 0.7. None of the variables were computed for regression analysis because all correlations were too low. Therefore, no further analysis was required.

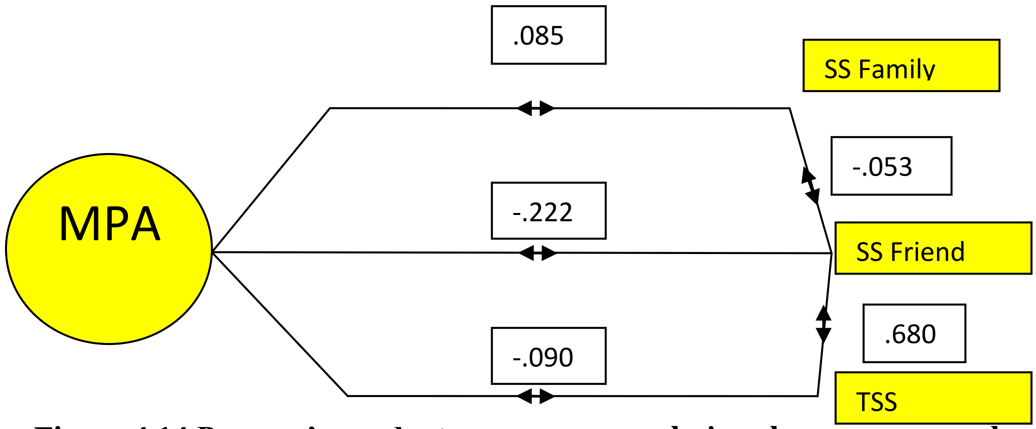


Figure 4.14 Pearson's product – moment correlations between mean physical activity and SSFam, SSFri and TSS at the end of T2

4.3.2 Regression model for mean weekly physical activity minutes of exercise and the predictor variables Mean Self-Efficacy, Social Support Family, Social Support Friends Total Social Support and Enjoyment at the end of T3

Model 1: Impact of predictor variables MSE, TSS and Enjoyment on MPA scores for both the IGa and IGb.

The relationship between the predictor variables and MPA scores are presented in figure 4.15. None of the correlations violate the multicollinearity of r > 0.7. However, it is noted that the three predictor variables and the inter-item correlations are too small to compute a regression analysis; thus, no additional analysis was necessary.

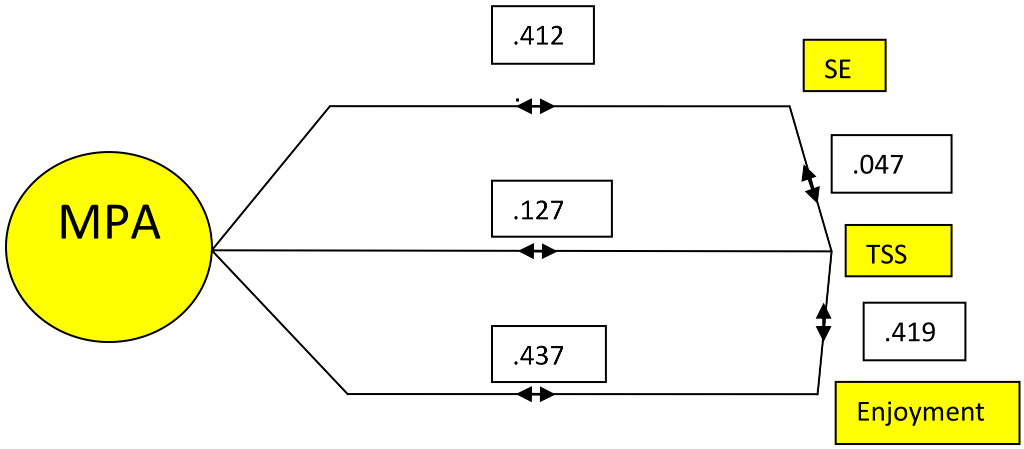


Figure 4.15 Pearson's product – moment correlations between mean physical activity and SE, TSS and Enjoyment at the end of T3

Model 2: Impact of predictor variables SSFri, SSFam and TSS on MPA scores for both the IGa and IGb.

The relationship between the predictor variables and MPA scores are presented in figure 4.16 ovearleaf. None of the correlations violate the multicollinearity of r > 0.7. One of the predictor variables (TSS) has a weak correlation with MPA (independent variable).

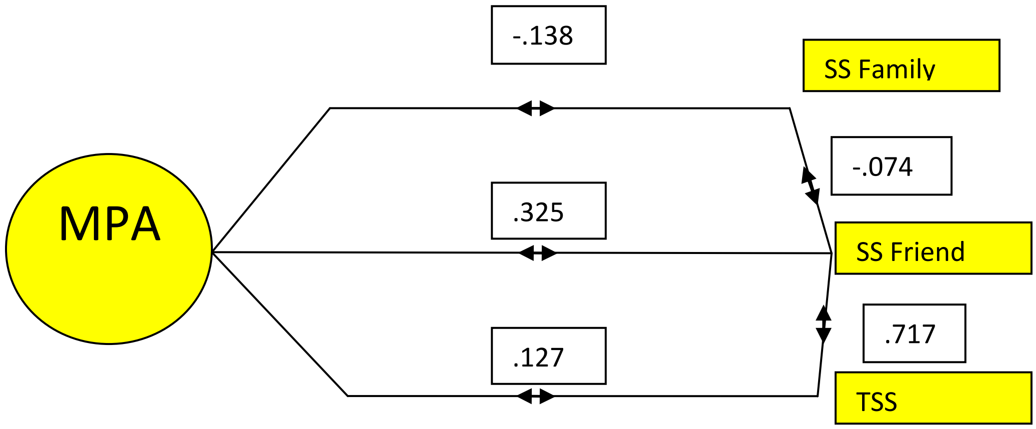


Figure 4.16 Pearson's product – moment correlations between mean physical activity and SSFam, SSFri and TSS at the end of T3

Standard multiple regression in SPSS (version 19) was used to enter the three predictor variables into the equation at once. This was carried out to ascertain how much variance in physical activity mean scores could be explained by all three predictor variables and also to find out how much unique variance each of the predictor variables contributed to MPA scores. The model summary is presented in table 4.11.

Table 4.11 Summary of regression model for mean physical activity scores and the predictor variables (SSFam, SSFri and TSS) for the IGa and IGb together

R	**R square**	**F**	**Sig.**
.410	.168	1.345	.288

R square value of .168 indicates that the three predictor variables explain 16.8% of the variance in MPA scores. TSS (beta = -1.812) made the strongest unique contribution towards explaining MPA. This is not a significant result (p=.288) at the 5% level of significance and no further analysis was pursued in terms of identifying the unique contribution of each predictor variable.

4.3 Summary of section four

The results from this section conclude that Enjoyment (beta = .803) was the best predictor of physical activity levels at the end of T1. Model two which included SSFam, SSFri and TSS were statistically significant predictors of MPA at T1. This model accounted for 34.3% of the variance in MPA. At the end of T2, no regression analysis was computed because correlations between variables were very low, thus concluding that the physical activity mediators had no impact on physical activity adherence levels. Model two, at the end of T3, which included SSFam, SSFri and TSS accounted for 16.8% of the variance in MPA, but was not statistically significant. TSS (beta = -1.812) was the best predictor of physical activity levels at the end of T3.

4.4 Summary

This chapter presented the quantitative findings for each of the four research questions. The results from the research series of questionnaires (SOC, SE, SS and Enjoyment) and mean weekly minutes of physical activity (logbook) were reported for both the IGa and IGb across three time periods. It would appear from the evidence relating to research question one, that technology (SW3 Armband) did not have an impact on physical activity adherence levels. The barriers and limitations of the SW3 Armband and a logbook as part of a physical activity programme were documented earlier (see section

4.4). Enjoyment, SSFam, SSFri and TSS were the best predictors of physical activity at the end of T1. The five physical activity mediators at the end of T2 showed no impact on physical activity adherence and TSS was the best predictor of exercise at the end of T3. The next chapter discusses these findings in relation to the literature review from chapter two.

Chapter 5 Discussion

5.1 Introduction

This chapter discusses the findings presented in the previous chapter for each of the four research questions. This study provides data on MPA levels accumulated, the barriers encountered by participants with regards to the use of the SW3 Armband and logbook as motivational tools, discusses the effectiveness of a self-reported instrument (SOC questionnaire) and the impact of five physical activity mediators (SE, SSFam, SSFri, TSS and Enjoyment) on participants physical activity levels.

5.2 Physical activity levels

The assumption was that the greater the MPA scores, the greater physical activity adherence would be in terms of the WHO (2011) minimum guidelines for moderate and vigorous physical activity. In this study, regular physical activity is defined in accordance with the WHO (2011) recommended guidelines for physical activity of thirty minutes of moderate intensity physical activity five days per week *or* an equivalent combination of moderate and vigorous physical activity. Other studies (Jakicic *et al*, 1995;1999) have promoted short bouts of physical activity (4 × 10 minutes daily) which arguably is more realistic for participants to achieve than the WHO (2011) physical activity guidelines. The results from this study revealed that by the end of the six month intervention, more participants in the IGb (58%) were meeting the WHO (2011) minimum recommended guidelines for physical activity compared to those in the IGa (25%). Hence, 75% of participants in the IGa and 42% of participants in the IGb were not meeting these guidelines at the end of the physical activity programme. This result is contrary to the author's assumption that the IGa would be more active than the IGb, indicating that the SW3 Armband hindered rather than promoted physical activity adherence.

It was assumed that the IGa would accumulate a greater amount of MPA because they had additional support from the SW3 Armband in comparison to the IGb who had the use of a logbook only. Contrary to the assumption, there was no support for the SW3 Armband as a relevant application in promoting long term exercise adherence among females. The majority of studies have found that an IGa perform better in comparison to a IGb (Napolitano *et al*, 2006, Marcus *et al*, 2007, King *et al*, 2008) but some studies have shown no statistical differences in physical activity levels between groups (Carroll *et al*, 2010). A targeted intervention study conducted by Carroll *et al* (2010) showed that both groups mean weekly physical activity scores increased from T1 to T3 but not all scores were statistically significant. The findings from this study have shown that the IGb accumulated more than the IGa with regards to MPA scores, but in a similar way to Carroll *et al's* findings, not all results were statistically significant. There was a large significant difference in MPA minutes between the IGa and IGb at T2 (eta = 0.26) and T3 (eta = 0.33) with the IGb having the larger MPA scores. There are several possible explanations for the lack of influence of the SW3 Armband on physical activity levels. It is possible that participants in the IGa under reported their physical activity minutes in their logbooks. Self-reporting has been found to be an issue in the study. The use of the SW3 Armband as a means of assisting physical activity motivation and adherence also presented barriers. In line with other studies, this study should have incorporated a cut-off point of 150 minutes of physical activity per week, which would be in line with the

WHO (2011) minimum recommendations for weekly physical activity (Carroll *et al*, 2010). Participants within the IGb engaged in a much greater amount of MPA compared to the IGa, hence the implementation of a cut-off point might have provided more statistically significant results in that both groups would have had to reach a maximum of 150 minutes of exercise per week. As there is no evidence within the corpus of studies that evaluated physical activity in conjunction with the effectiveness of the SW3 Armband and logbook, it is difficult to make comparisons with other studies in terms of MPA minutes. These findings do contradict work by King and colleagues (2008) who suggest that physical activity levels can be increased through the application of technological devices. King *et al* (2008) recruited a small sample size of thirty seven healthy, underactive adults aged fifty years of age and over. Participants were randomised into an Intervention Group (n=19) or a Control Group (n=18), with the intervention group having the use of a personal digital computer and the control group receiving health educational written material. The aim of their study was to assess the effectiveness of hand held computers in increasing minutes of moderate and vigorous physical activity over an eight week period, compared to the controlled arm. Results showed that the intervention group (mean= 302) accumulated more MPA minutes compared to the Control Group (mean=135), hence concluding that a technological device is effective for increasing physical activity.

This study concludes that the SW3 Armband is a less effective method in promoting physical activity adherence among a sample of females than a logbook only. The majority of participants in the IGa stated that the SW3 Armband acted as a motivational device for exercise adherence, but results provide inefficient evidence from participants

MPA scores, in terms of meeting the WHO (2011) guidelines for physical activity, to confirm that the SW3 armband is a motivational device in supporting long term exercise adherence. For example, only 25% of participants in the IGa reported meeting the WHO (2011) physical activity guidelines after six months. As a result, there is insufficient evidence to directly state that such a device can aid long term exercise adherence for females. Findings indicate that a logbook acted as a motivational tool. Nonetheless, the IGb performed a greater amount of MPA minutes in comparison to the IGa, suggesting that the logbook, when used on its own, excluding the technological device, has a greater impact on exercise adherence.

The barriers associated with the SW3 Armband (i.e difficult to operate and irritation when wearing it) could have impacted on participants physical activity levels in the IGa and perhaps other devices would have been more practical than the SW3 Armband. Further investigation of the different types of technological devices available (i.e pedometer, Ki-fit armband, sat-nav watches) in conjunction with a logbook should be investigated to help explain the differences in physical activity levels between both groups. Possibly, the assessment of a pedometer along with a logbook can provide some justification for the IGb outperforming the IGa within this study. The pedometer is the most widely used research tool, is inexpensive and easy to use (Arbour and Ginis, 2009). Furthermore, females give preference to walking as a type of physical activity and for this reason the implementation of a pedometer as part of a physical activity programme seems practical.

5.3 Barriers arising from the use of the SW3 Armband and logbook

Participants in the IGa provided evidence that the SW3 Armband was difficult to operate. At the end of T1, 42% of participants in the IGa stated that the SW3 Armband was difficult to operate. By the end of T2, the percentage of participants that found the device difficult to operate decreased to 25% with an increase at the end of the physical activity programme to 33%. The findings also reveal that the SW3 Armband could be uncomfortable to wear. At the end of the three time periods over half of all participants in the IGa stated that the device was uncomfortable to wear. This discomfort was manifested in a number of ways such as general irritation, dress code anomalies, self-consciousness and size. Irritation arising from the Velcro strap on the SW3 Armband when the device was worn for long periods of time was the most dominant barrier citied by participants at each time period.

Consequently, participants acknowledged that the device was a hindrance when it came to physical activity participation at T1 (42%), T2 (42%) and T3 (33%). Moreover, participants stated that they did not find the device motivational because it was uncomfortable to wear for extended periods of time and irritated the skin. At the three time intervals, 33%, 42% and 42% of participants respectively stated that the SW3 Armband irritated their skin when worn for long periods of time. This barrier is significant in that it promoted lack of usage by participants thus preventing access to their real-time physiological data that the device captures. The implementation of a device as a means of gathering data such as a pedometer, is more realistic because it is easy to use and is attached to an individual's foot or waist, with few reports of long term irritation.

The majority of participants in the IGa and IGb found the logbook to be a useful method of tracking physical activity. By the end of the physical activity programme, only 8% of participants in the IGa and 8% in the IGb stated that the logbook was an ‘inconvenient’ method of recording physical activity. These findings highlight that a logbook is an effective method of recording daily physical activity levels. Although most participants stated that the logbook was a convenient method, adherence to completing a daily logbook was challenging for both groups. Completing a logbook daily was difficult for most participants in the IGa and IGb. At the end of T3, 17% of participants in the IGa completed a logbook daily with 33% of participants in the IGb complying. Completing a logbook daily was difficult for the majority of participants who citied forgetfulness as a reason for not completing their logbooks after engaging in physical activity. Therefore, many reported that they would complete their logbooks on the next available occasion. Recording physical activity levels in a paper logbook can be viewed as challenging for these reasons but it is an effective method especially for those who are not computer literate. These findings contrast with work by Walker *et al* (2004) who also recruited a small sample size for their study (n = 41) and reported that adherence to completing a paper logbook (48.3%) was poor in comparison to those who completed an electronic logbook (86.2%).

This study provides evidence from some participants that the SW3 Armband and logbook were de-motivating techniques for assisting physical activity levels. Participants encountered a number of barriers associated with the SW3 Armband. As a result, the device did not provide instrumental support for participants to engage in the minimum recommended guidelines for physical activity. Additional evidence suggests that the logbook was an ineffective means of supporting physical activity. At the end of T3, 42% of participants in the IGa and 33% of participants in the IGb stated that the logbook was not a form of motivation to assist exercise adherence. Conversely, the results of this study, with regards to MPA scores suggest that a logbook is a firm motivational technique in promoting physical activity adherence. For example, the IGb within this study used a logbook only as a means of recording their physical activity and performed a substantial amount of physical activity over the six month period compared to the IGa. As a result, even though some participants did not perceive the logbook as a motivational method for exercise adherence, confirmation from the IGb's MPA scores over the duration of the physical activity programme provide support that a logbook is a motivational technique in promoting exercise.

5.4 The effectiveness of self-reporting as a measurement tool for physical activity

The Stage of Change questionnaire is a self-reported quantitative instrument that was completed by all participants at the three time intervals. This questionnaire has been used widely in a range of research studies (Adams and White, 2003, Armitage, 2009, Nigg *et al*, 2011). The Stage of Change questionnaire evaluated the efficacy of self-reporting among participants as part of their physical activity programme. At Baseline, selection criteria determined that participants were in stage two (contemplation) or three (preparation) of the SOCM, therefore ensuring the adoption of a stage-matched intervention approach. According to Prochaska and Marcus (2004), stage matched interventions are successful because of their positive impact on increasing physical activity levels. MPA scores from both groups in this study have demonstrated increases in physical activity levels over T1, T2 and T3, confirming that interventions matching individuals to a specific stage with the SOCM are successful at increasing physical activity. Research by Findorff *et al* (2007) presents recent evidence that supports the effectiveness of such stage matched interventions. In their study on the TTM (n=272 females), those participants who commenced the physical activity programme in the preparation stage progressed into the maintenance stage after one year. This indicates that physical activity programmes implementing stage matched interventions will be most successful at increasing physical activity. Within this study, at Baseline, a greater percentage of participants in the IGb (33%) compared to the IGa (20%) were categorised in the contemplation stage (stage two) of the SOCM. This indicates that a greater percentage of participants in the IGb were considering to exercise and progressed further than those participants in the IGa, in terms of adhering to regular physical activity. This finding is interesting considering that the IGa had the use of the SW3 Armband, but at the end of the physical activity programme only 25% of participants in the IGa were adhering to regular physical activity (maintainers) compared to 56% in the IGb.

At the three time intervals (T1, T2 and T3) findings from the Stage of Change questionnaire revealed that participants self-reported their Stage of Change inaccurately. There were inaccuracies in how participants reported their SOC and how they reported physical activity in their logbooks. These percentages were greater for the IGa at the three time periods in comparison to the IGb which have possibly impacted on participants' MPA scores, particularly among participants in the IGa. This study demonstrates that participants from both groups self-reported their stage of change wrongly. Findings show that participants from both groups reported their current Stage of Change inaccurately at the three time intervals. This finding is consistent with other research findings that suggest over 50% of participants will provide inaccurate self-reported measurements (Lechner *et al*, 2006, Bolman *et al*, 2007, Van Stralen *et al*, 2009, Ronda *et al*, 2011). Previous studies support the idea of introducing a combination of subjective and objective methods to assist in combatting self-reporting inaccuracies (MacFarlene *et al*, 2006, Harris *et al*, 2008). The objectiveness of research often relies upon self-reporting data which has been known to decrease accuracy of results (Stevens *et al*, 2007, Aoyagi and Shepard, 2009). As a result, it appears that an objective research instrument needs to be cross-examined with a subjective research tools to produce accurate and reliable results. Findings from this study reveal that self-reporting inaccurately is high at the start of a physical activity programme (T1), compared to the end of a physical activity programme (T3). The IGa confirmed that self-reporting inaccurately was lowest at the end of T3 (25%) compared to T1 (50%). The CG's self-reporting also proved to be more accurate by the end of T3, with all participants self-reported their Stage of Change accurately at the end of T3, compared to T1 (33%). This suggests that the accuracy in self-reporting can increase when participants become familiar with and accustomed to completing self-reported questionnaires (participants completed the stage of change questionnaire at T1, T2 and T3).

5.5 The mediators for physical activity

Regression analysis was conducted to assess the impact of five physical activity mediators on MPA scores (moderate and vigorous). These scores were computed for **both the IGa and IGb together**, at the three time intervals T1, T2 and T3 and two models were produced. Results from the regression analysis confirmed that Model 1 (SE, TSS and Enjoyment) at the end of T1 was insignificant. Findings revealed that Enjoyment (beta =.803) is the best predictor of physical activity but was not statistically significant (p =.536) at the end of T1. Research shows that Enjoyment is an important mediator for achieving physical activity goals and behavior change (Wankel, 1993, Baranowski *et al*, 1998, Johnson and Heller, 1998).

At the end of T1, Model 2 (SSFam, SSFri and TSS) proved to be a significant predictor for physical activity, accounting for 34.3% of the variance in MPA. The model (p = .035), along with each of the independent variables were significant at the 5% level. TSS (beta = 6.976) made the strongest contribution to explaining MPA. These findings support the view that SS is an important component in promoting physical activity adherence (Kaplan *et al*, 2001, Kilpatrick *et al*, 2005, Hanlon *et al*, 2010). This finding indicates that SS is critical when individuals are initiating exercise. Other studies hold opposing views. Litt *et al* (2001) found that SS was significant at twelve months and a study by Brassington *et al* (2002) established that SS had no effect on physical activity. The SS offered by friends and family is important for individuals in their efforts to adhere to physical activity (Sharma *et al*, 2005).

At the end of T2, correlations were too low to compute a regression analysis signifying that the physical activity mediators had no impact on MPA scores. At T3, model 1 (SE, TSS and Enjoyment) was insignificant due to low correlations between MPA minutes and the independent variables. Model 2 (SSFam, SSFri and TSS), at the end of T3, did share 16.8% of the variance in MPA, but was statistically insignificant. Therefore, TSS significantly influenced physical activity at the end of T1, but all other models at T2 and T3 were insignificant.

Although results show that Model 2 at the end of T1 was the only model that was statistically significant, MSE scores increased from T1 to T3. Mean TSS and Enjoyment scores decreased from T1 to T2, but were greater than any other time period by the end of T3 (Appendix 40). Studies have established that SE levels tend to be low when initiating physical activity (Prochaska and Marcus, 1994, Leenders *et al*, 2002). Results support this study, as participants MSE scores were low at the end of T1 (MSE = 2.88) compared to the other two time periods. SE levels increased from T1 to T3 and both groups also increased their physical activity levels throughout the programme. This finding is consistent with other research studies that confirm as SE levels increase, physical activity levels increase correspondingly (Gorely and Gordan, 1995, Plotnikoff *et al*, 2001).

The mean scores for the physical activity mediator TSS displayed a slight decrease from T1 (mean = 33.00) to T2 (mean = 31.17), with a further increase at the end of T3 (mean = 33.75). The mean scores for the physical activity mediator Enjoyment also showed a decrease from T1 (mean = 95.38) to T2 (mean = 92.58), with a further increase at the end of T3 (mean = 99.46). One possible explanation for this slight decrease in TSS and Enjoyment is the incidence of the heavy snowfall that occurred in December 2010 and January 2011 and the restrictions it placed on participants exercise regimens (Chan *et al*, 2006). Furthermore, such inclement weather might also have limited participants from engaging in their preferred activities, hence the decrease in Enjoyment levels at the end of T2. The weather did improve during T3 and results indicate an increase in TSS and Enjoyment levels at the end of T3, which may suggest that inclement weather was a barrier during T2.

5.6 Summary

The SW3 Armband is a less effective method in promoting physical activity adherence among a sample of females, because of the number of barriers perceived by participants. A logbook appears to be an efficient and effective technique in promoting physical activity adherence among females. Similar to other studies, inaccurate self-reporting remains an issue that needs to be addressed to provide more accurate results.

Physical activity levels increased for both groups from T1 to T3 (see table 4.3). MSE was the only physical activity mediator to increase progressively in conjunction with MPA minutes. Mean TSS and Enjoyment scores decreased during T2 but MPA minutes increased during this period. Regression analysis confirmed that Model 2, at T1 was the only significant model for predicting physical activity. Research suggests that a robust

SS network can promote physical activity and increase adherence levels, particularly when individuals are initiating physical activity (Anderson *et al*, 2006).

Chapter 6 Conclusion and Recommendations

6.1 Conclusion

The primary aim of the present study was to analyse the impact of portable body sensing technology (SW3 Armband) compared to a physical activity logbook in promoting fitness programme adherence over a six month time period, with a sample of females (n=30) aged between thirty and fifty years of age. The results of this study with regards to MPA scores confirm that a logbook is a less effective method for promoting long term physical activity adherence, compared to the use of the SW3 Armband. However, it is possible that the direct feedback on the SW3 Armband led to more realistic log-booking for IGa.

Barriers associated with the use and wearablilty of the SW3 Armband restricted participants from wearing and using the device in accessing real time physiological data. These barriers evidently impacted on participants MPA scores because of the lack of instrumental support offered from the device. The main barrier to wearing the SW3 Armband is ‘irritation’ of the upper arm caused when the device is worn for long periods of time. However, the SW3 Armband did act as a motivational instrument, but did not provide adequate support to assist participants in meeting the WHO (2011) physical activity guidelines.

Females are the least active segment of the population and find meeting the WHO (2011) physical activity guidelines a challenge. Only 42% of females in total were meeting the WHO (2011) guidelines for physical activity by the end of the programme. This statistic is worrying considering females are at greater risk of developing diseases associated with inactivity (Whelton *et al*, 2002, Schmitz *et al*, 2007). Walking is a popular choice of physical activity for women (Tudor-Locke and Myers, 2001). Therefore, walking programmes and interventions should be administered in various physical activity settings to promote walking among the female population. This type of intervention offers great potential in promoting physical activity and increasing female participation (Nies *et al*, 1999, Perry *et al*, 2007). Another objective of this study was to assess the accuracy of self-reporting through the Stage of Change questionnaire and participants Stage of Change answers were cross examined with their logbook reports to check for accuracy. Participants completed the Stage of Change questionnaire at T1, T2 and T3. Inaccurate self-reporting of the Stage of Change questionnaire is evident at the three time periods. Findings show that as participants became familiar and accustomed to completing the questionnaire, results show that inaccuracies reported decreased. For example, at T1, 33% of participants in the IGb inaccurately reported their Stage of Change but by the end of T3 reported their SOC accurately.

The physical activity mediator MSE increased along with MPA minutes from T1-T3, suggesting that SE should be an essential component of physical activity interventions. Model 2 at the end of T1 which included SSFam, SSFri and TSS, significantly predicted physical activity adherence. Interestingly, MPA scores increased from T1-T3, TSS whilst Enjoyment levels decreased by the end of T2. Considering both groups MPA minutes increased, one would have thought that both independent variables would increase correspondingly.

6.2 Recommendations for future research

Future research should encourage the use of a logbook as a motivational tool and in tracking physical activity levels, especially for this age category (thirty-fifty years of age). However, thirty to fifty year old females may be apprehensive towards using technological devices because of operating issues arising.

Future research studies on physical activity adherence should also consider incorporating a combination of both subjective and objective methods in order to further increase our understanding of the effectiveness or ineffectiveness of such technological devices and formal instruments. Further investigation on the use of other less bulky body sensors in conjunction with a logbook should be investigated to help explain the differences in physical activity levels between both groups in this study. A replication of this study comparing a less bulky body sensor device and a logbook may provide some justification for the IGb outperforming the IGa.

Future studies promoting long-term exercise adherence could implement focus groups throughout the intervention to provide a better qualitative understanding of physical activity behavior change. Within this study, a focus group at the end of T1, T2 and T3 may have assisted in providing additional evidence to explain why the IGb performed a greater amount of MPA minutes compared to the IGa.

Future studies could target those in different stages of change separately. For example, individuals in stage three of the SOCM should be targeted differently from those in stage five.

Future studies should anchor their work on relevant theory such as the SOCM but that it is very important to let the study unfold in its own right, independently of the theory.

Impending research should consider targeting social support in studies related to physical activity interventions, because of the particular significance of this mediator in relation to positive adherence outcomes (Murphy et al, 2006).

Finally, there is a case to be made to implement cross-examinational instruments into physical activity interventions that incorporates self-report measures aswell as objective data collection.

6.3 Publication

A paper in relation to this research was published in the Irish Business Journal (Appendix 41).

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Appendices

Appendix 1
Physical activity logbook for the IGa

Your physical activity logbook must be kept on a daily basis. The best time to fill the logbook in is straight after your workout otherwise you can forget to do so. Please read the following guidelines to help you fill out your logbook.

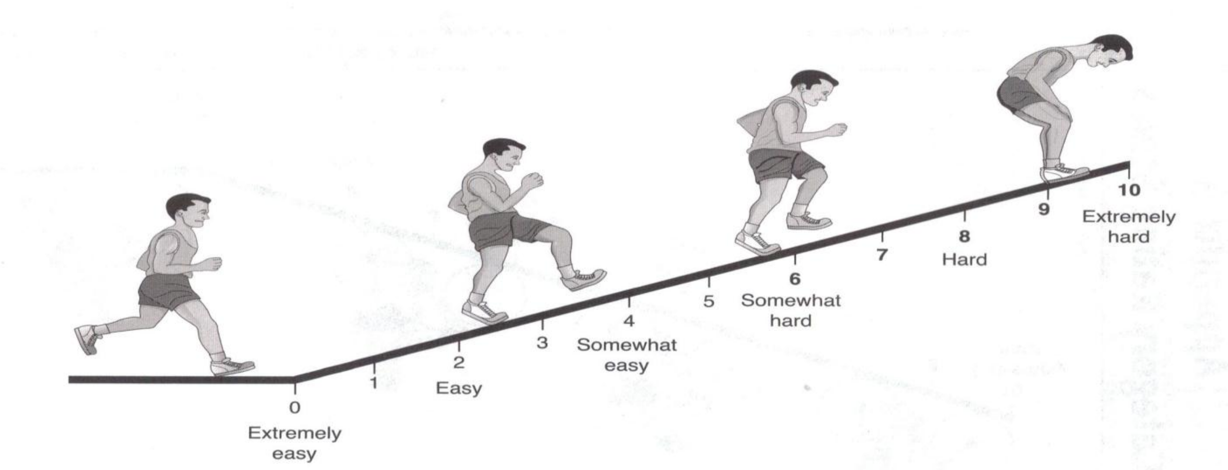
1. The physical activities included in your logbook will be as follows:
   (i) Walking/Jogging **(ii)** Fitness Class **(iii)** Swimming
   (ii) **(iv)** Home Workout **(v)** Other

2. Please insert these activities as you perform them in the space in your logbook beside the word 'Activity' on pages 2 and 3.

3. 'Duration' in your logbook means the amount of time you have performed any of the physical activities listed above. Please insert, beside the word 'Duration', on pages 2 and 3 the amount of time you have spent daily doing physical activity.

4. 'Intensity' in your logbook refers to how hard you are working. Please insert the number on pages 2 and 3 that best describes how hard you have performed your physical activity. Refer to the diagram below:

Intensity:



OMNI Scale of Percieved Exertion: Adult, Walking to Running Format
From Percieved Exertion for Practioners: Rating Effort With the OMNI Picture System by R. J. Robertson. Champaign, IL: Human Kinetics, 2004

Physical activity logbook for the IGa

	Mon	Tues	Wed	Thur	Fri	Sat	Sun
Week One	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:
Week Two	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:
Week Three	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:
Week Four	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:

Physical activity logbook for the IGa

	Mon	Tues	Wed	Thur	Fri	Sat	Sun
Week Five	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**
Week Six	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**
Week Seven	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**
Week Eight	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**

Physical activity logbook for the IGa

Please answer the following questions when you have completed your logbook for the first eight weeks in relation to your Physical Activity Logbook and the SW3 Armband:

LOGBOOK

1. Please circle how convenient or inconvenient filling out your logbook was daily?
   - Extremely convenient
   - Convenient
   - Somewhat convenient
   - Somewhat inconvenient
   - Inconvenient
   - Extremely inconvenient

2. Did you fill your logbook out everyday?

   (Please Circle) Yes No

3. Does completing a logbook motivate you to stick with physical activity?

   (Please Circle) Yes No

SW3 ARMBAND DEVICE

1. Please rate how easy or difficult it has been for YOU to work the SW3 Armband?

Extremely Easy Easy Somewhat Easy Somewhat Hard Hard Extremely Hard

2. Did you find the SW3 Armband comfortable to wear all day? **(Please Circle)**

Yes No

Physical activity logbook for the IGa

3. If the answer is ‘No’ to the above question, why was the armband uncomfortable, or not worn all day? **(Please Circle)**

Size (Big on arm) Irritating Self-Consciousness Dress Code

4. Did the SW3 Armband motivate you to stick with physical activity? **(Please Circle)**

Yes No

COMMENTS

Please insert any other comments you wish to express:

____
____
____
____
____
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____
____
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____
____
____

Participant Signature: ________________________ Date: ____________

Appendix 2
Physical activity logbook for the CGb

Your physical activity logbook must be kept on a daily basis. The best time to fill the logbook in is straight after your workout otherwise you can forget to do so. Please read the following guidelines to help you fill out your logbook.

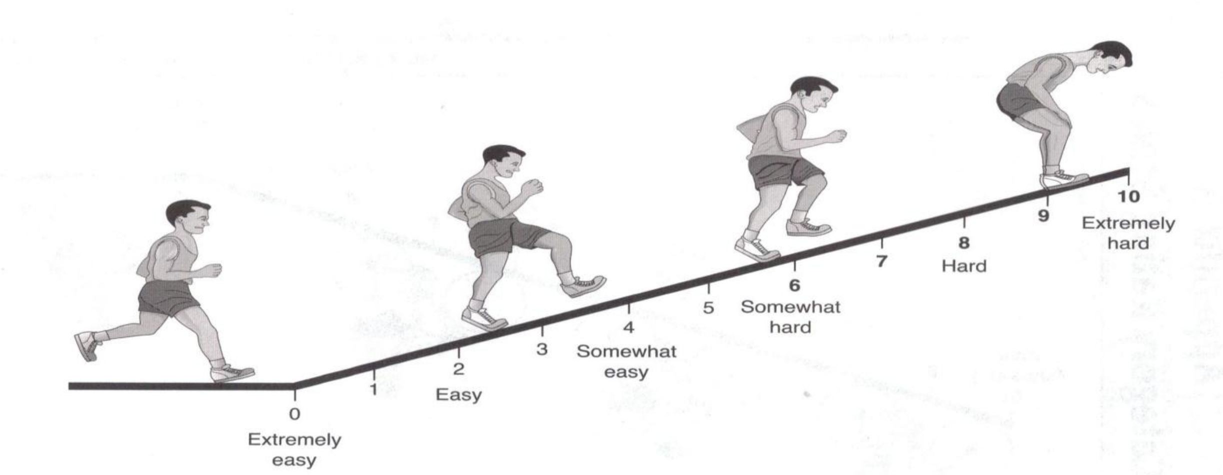
1. The physical activities included in your logbook will be as follows:
   (i) Walking/Jogging **(ii)** Fitness Class **(iii)** Swimming,
   (iv) Home Workout **(v)** Other

2. Please insert these activities as you perform them in the space in your logbook beside the word 'Activity' on pages 2 and 3.

3. 'Duration' in your logbook means the amount of time you have performed any of the physical activities listed above. Please insert, beside the word 'Duration', on pages 2 and 3 the amount of time you have spent daily doing physical activity.

4. 'Intensity' in your logbook refers to how hard you are working. Please insert the number on pages 2 and 3 that best describes how hard you have performed your physical activity. Refer to the diagram below.

Intensity:



OMNI Scale of Percieved Exertion: Adult, Walking to Running Format
From Percieved Exertion for Practioners: Rating Effort With the OMNI Picture System by R. J. Robertson. Champaign, IL: Human Kinetics, 2004.

Physical activity logbook for the CGb

	Mon	Tues	Wed	Thur	Fri	Sat	Sun
Week One	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:
Week Two	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:
Week Three	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:
Week Four	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:	Activity: Duration: Intensity:

Physical activity logbook for the CGb

	Mon	Tues	Wed	Thur	Fri	Sat	Sun
Week Five	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**
Week Six	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**
Week Seven	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**
Week Eight	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**	**Activity:** **Duration:** **Intensity:**

Physical activity logbook for the CGb

Please answer the following questions when you have completed your logbook for the first eight weeks in relation to your Physical Activity Logbook:

LOGBOOK

1. Please rate how convenient or inconvenient filling out your logbook was daily? **(Please Circle)**
    - Extremely convenient
    - Convenient
    - Somewhat convenient
    - Somewhat inconvenient
    - Inconvenient
    - Extremely Inconvenient

2. Did you fill your logbook out everyday? **(Please Circle)**

    Yes No

3. Does completing a logbook motivate you to stick with physical activity?

    (Please Circle) Yes No

COMMENTS

Please insert any other comments you wish to express:

____

____

____

____

____

Participant Signature: __________________________ Date: ____________

Appendix 3

Physical activity readiness questionnaire (PARQ)

Date: ____________ D.O.B: ___________ Age: __________

Home No: ___________________ Mobile No: ______________________

Please answer the following questions honestly and truthfully:

Has a practitioner ever told you that you have a heart condition and can only participate in physical activity prescribed by a doctor?	**YES**	**NO**
Do you suffer from high cholesterol?	**YES**	**NO**
During physical activity have you ever experienced chest pains?	**YES**	**NO**
In the past two months have you experienced chest pains while not participating in physical activity?	**YES**	**NO**
Is there a family history of Coronary Heart Disease?	**YES**	**NO**
Do you have high blood pressure?	**YES**	**NO**
Do you have low blood pressure?	**YES**	**NO**
Have you ever felt weak, dizzy or lost consciousness while at rest or during physical activity?	**YES**	**NO**
Is your doctor prescribing drugs or medication for you?	**YES**	**NO**
Do you have a bone or joint problem such as arthritis that may become agitated by participating in physical activity?	**YES**	**NO**
Do you have a metabolic disorder such as diabetes mellitus?	**YES**	**NO**
At present, do you smoke?	**YES**	**NO**
Are you pregnant or is there a possibility that you may be pregnant?	**YES**	**NO**
Is there any other reason why you should not participate in this physical activity programme?	**YES**	**NO**

Declaration

I hereby declare that I have agreed to participate in this six month programme. I fully understand that I will be participating in activities such as walking, fitness classes, swimming and home exercises. I realise that participating voluntarily in the above programmes may involve the risk of injury.

Client's Name:	**Instructor's Name:**
Client's Signature:	**Instructor's Signature:**
Date:	**Date:**

Appendix 4

Participant information form

Title: A Comparative Study of Portable Body Sensing Technology and a Physical Activity Logbook, in a Physical Activity Adherence Programme.

Introduction

The aim of this research is to analyse the impact of body sensing technology (using the SW3 Armband) compared to a physical activity log, in a physical activity adherence programme. Participants' physical activity levels will be tracked in accordance with the Transtheoretical Model. The study will consist of thirty female volunteers who will be studied over a six month period. The volunteers will be split into an intervention group (15 × Females) who will have the use of the SW3 Armband and a Physical Activity Logbook and a control group (15 × Females) who will have the use of a Physical Activity Logbook only. Participants are required to meet the research assistant four times over the duration of the six months. At the end of the study the researcher will answer the following questions:

1. How effective is the SW3 Armband in promoting physical activity adherence?
2. What are the barriers and limitations posed by the use of the SW3 Armband and Physical Activity Logbook as part of a physical activity exercise adherence programme?
   a) What are the barriers and limitations posed by the use of the SW3 Armband for the Intervention Group?
   b) What are the barriers and limitations posed by the use of the Physical Activity Logbook for both the Intervention Group and Control Group?
3. How effective is self-reporting in a physical activity intervention over a six month period?

4. Do the mediators of Self-Efficacy, Total Social Support and Enjoyment impact on the participant’s physical activity adherence levels?

Procedures

The programme is designed for participants who engage in moderate exercise twice per week or less. The following criteria apply for selection to the programme:

1. Volunteers must live in Letterkenny or surrounding areas.
2. Volunteers must be between 30-50 years of age.
3. Volunteers must have an interest in becoming more physically active.
4. Volunteers must have access to a computer with windows XP.

This study seeks to investigate the effectiveness of a body sensor and a Physical Activity Logbook in promoting physical activity adherence. The Intervention Group will wear the SW3 Armband and record their physical activity in a Physical Activity Logbook. It is recommended that the SW3 Armband is worn twenty-four hours daily but for the purposes of this study, although recommended, this is not necessary. The physiological data collected by the armband is for the participants use only. The Control Group will fill out a simple Physical Activity Logbook over the duration of the study only. All participants will be asked to record their physical activity from day to day. Both groups will be given a generic exercise programme to follow.

Participant information form

The World Health Organisation recommends that adults aged between eighteen and sixty – five should engage in:

1. 30 minutes of moderate-intensity physical activity 5 days per week;

   OR

2. 25 minutes of vigorous-intensity physical activity 3 days per week;

   OR

3. an equivalent combination of moderate- / vigorous-intensity physical activity;

   AND

4. 8-10 muscular strengthening exercises or equivalent (8-12 repetitions) at least 2 days per week

The research assistant will meet the participants once per week for a thirty minute walk, for the first eight weeks of the study. This walk is optional for each participant. Communication between the research assistant and participants will be carried out via a sports management team website site called ‘Teamer’.

Participant information form

Participants are required to meet the research assistant four times over the six month period. Below is a brief description of each meeting:

<table>
<tr><td>Meeting One: Baseline
Introduction to the programme.
Participants will be randomly assigned to their respective group (intervention group and control group).
Fill out Questionnaires stated across.
Physical Activity Logbook Training.
Assign a generic exercise programme.
SW3 Armband Training.</td><td>The following questionnaires will be filled in:
Participant Information Form
Participant Consent Form
Physical Activity Readiness Questionnaire
Physical Activity History Questionnaire
Profile Questionnaire</td></tr>
<tr><td>Meeting Two: End of T1
Both groups will fill out questions with regards to the use of their logbook. The Intervention group will fill out questions on the use of the SW3 Armband.
Submit Logbook from T1.
Fill out Questionnaires at the end of T1.
Distribute new Logbooks and a new exercise programme to all participants.</td><td>The following questionnaires will be filled in:
Stages of Change Questionnaire
Self-Efficacy Questionnaire
Social Support Questionnaire
Enjoyment Questionnaire</td></tr>
<tr><td>Meeting Three: End of T2
Both groups will fill out questions with regards to the use of their Logbook. The Intervention group will fill out questions on the use of the SW3 Armband.
Submit Logbooks from T2.
Fill out Questionnaires at the end of T2.
Assign a new logbook and a new exercise programme to all participants.</td><td>The following questionnaires will be filled in:
Stages of Change Questionnaire
Self-Efficacy Questionnaire
Social Support Questionnaire
Enjoyment Questionnaire</td></tr>
<tr><td>Meeting Four: End of T3
Both groups will fill out questions with regards to their Logbook. The Intervention group will fill out questions on the use of the SW3 Armband.
Submit Logbooks from T3.
Fill out Questionnaires at the end of T3.
Programme completed.</td><td>The following questionnaires will be filled in:
Stages of Change Questionnaire
Self-Efficacy Questionnaire
Social Support Questionnaire
Enjoyment Questionnaire
‘Teamer’ Questionnaire
Evaluation Questionnaire</td></tr>
</table>

Participant information form

Benefits

According to the Irish Heart Foundation, 10,000 people die each year from cardiovascular disease. Exercise helps keep weight under control, strengthen bones and muscles, improves mental health and mood, improves ability to do daily activities and increases the chances of living longer. This programme also seeks to help participants take responsibility for their own health and well-being. Participants who adhere to the programme should increase their overall health and well-being.

Exclusion from the programme

The researcher has the right to remove a participant from the programme if any of the following are true:

1. A participant has a serious health issue.
2. A participant encounters a long term injury.

Confidentiality

Participants identities will remain confidential. Your name and other personal information will be classified. Your information will be stored on a database with the researcher having sole access to your information.

Voluntary Participation

You have volunteered to participate in this six month programme. If you wish to drop out of the programme at any time, you may do so. There will be no penalty encountered if you do withdraw from the programme

Discontinuation of the study

The researcher reserves the right to withdraw your participation in the programme at any time without your permission.

Participant information form

Permission

This programme has research ethics approval from the ethics committee at Letterkenny Institute of Technology.

Appendix 5
Participant informed consent

Project Title:
A Comparative Study of Portable Body Sensing Technology and Physical Activity Logbooks in Fitness Programme Adherence.

Principal Investigator: B. Cunningham **Research Assistant**: M. Farrelly

Background
Participants will take part in a six month physical activity programme as part of a research project at Letterkenny Institute of Technology. This study seeks to examine the participant's adherence levels to physical activity. All participants physical activity adherence will be monitored through the completion of a Physical Activity Logbook and the intervention group will additionally have use of the SW3 Armband. Participant's personal information will be kept confidential.

Participant Declaration (Please circle the correct answers below)		
I have read the information sheet and I fully understand the contents within it.	**Yes**	**No**
I have been given the opportunity to ask questions and I am content with the answers.	**Yes**	**No**
I agree to take part in this research programme.	**Yes**	**No**
I am aware that my participation in the programme is voluntary and that I can withdraw from the programme at any time.	**Yes**	**No**
I am aware that withdrawal from the programme will not affect my right to use services or legal rights.	**Yes**	**No**
I give consent to the publication of results.	**Yes**	**No**
I give consent for the data from this study to be used in future studies without the need for the researcher to contact me again for consent.	**Yes**	**No**
Researcher Declaration (Please circle the correct answers below)		
I have explained the research study to the participant	**Yes**	**No**
I have answered the participant's questions about the research programme.	**Yes**	**No**
I accept as true that the participant understands the purpose of this study; its contents and she gives consent to participate.	**Yes**	**No**

Participants proclamation
I have read the consent form. I had my questions about the programme answered and I am satisfied. I give consent to participate voluntarily in this research programme for six months. I am aware that I may withdraw from this programme at any time. I have been given a copy of the above consent form.

Participants Name: ___________________________________
Participants Signature: ___________________________________

Researchers proclamation
I have stated the purpose, procedures and risks of this research study to the participant. I have answered questions in relation to the study that the participant had and I am satisfied. I believe the participant has understood my explanation and purpose of this study and has given me informed consent.

Researchers Signature: ___________________________________
Date: ___________________________________

Appendix 6
Physical activity history questionnaire

If you *do not currently* participate in physical activity, answer these questions:
1. How long has it been since you did regular physical activity or exercise? **(Please Circle)**

a. less than 6 months
b. more than 6 months but less than a year
c. more than 1 but less than 2 years
d. more than 2 but less than 5 years
e. more than 5 years but less than 10 years
f. more than 10 years
g. I have never been regularly physically active

If you *are currently physically active*, answer the following questions:

1. How many days per week are you physically active? ____________.
2. Approximately how many minutes are you active each time? ____________.
3. How long have you been physically active at this level? ____________.
4. What activities do you do? ____.

Answer the following questions whether or not you are currently physically active.

1. As an adult, were there ever times when you were physically active regularly for at least 3 months and then stopped being physically active for at least 3 months?**(Please Circle)** a. Yes b. No
2. If 'Yes', how many times? ___________.
3. Regarding the most recent time, why did you stop your activity? **(Please Tick *All* Relevant Categories)**

Lack of time because of

Work or school	_____	Lack of physical activity partner	_____
Household duties	_____	Lack of interest in physical activity	_____
Children	_____	Health problems	_____
Social activities	_____	Injury	_____
Spouse	_____	Season or weather change	_____
Lack of money	_____	Personal stress	_____
Lack of facilities	_____	Other	_____

Adapted from Marcus & Forsyth (2003)

Appendix 7

Profile questionnaire

Name: ____________________________

1. Please tick your current status:

   Single ☐ Married ☐ Other ☐

2. At present are you:

   Employed ☐ Self- Employed ☐ Unemployed ☐ Student ☐

   Housewife ☐ Other ☐

3. If you ticked employed above or other, please state your job title?

   ____

4. Do you have any children? **(Please Tick)**

   Yes ☐ No ☐

5. If Yes to the above question please state how many children and what are their ages?

   ____

   ____

PHYSICAL ACTIVITY

6. How have you found the past eight weeks in terms of adhering to exercise? **(Please Tick)**

   Extremely Easy ☐ Easy ☐ Difficult ☐ Very Difficult ☐

7. Over the past eight weeks what prevented you from participating in physical activity? **(Please Tick)**

   No Time ☐ Work ☐ Weather ☐ No Motivation ☐

   No-one to Exercise with ☐ Children ☐ Other

Appendix 8

Physical activity programme: Level one

WEEK	DURATION	INTENSITY	TYPE OF ACTIVITY
Week 1	2 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 2	2 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 3	2 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 4	2 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 5	3 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 6	3 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 7	3 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 8	3 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.

Exercise Tips:

1. Drink plenty of water before, during and after your workout.
2. Wear comfortable footwear and clothing that is suitable for the weather and the activity.
3. While you are exercising consider listening to some music.
4. Do not overexert yourself starting of; over time try building up your physical activity by exercising most days off the week for 30 minutes.

Physical activity programme: Level two

WEEK	DURATION	INTENSITY	TYPE OF ACTIVITY
Week 1	3 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 2	3 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 3	3 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 4	3 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 5	4 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 6	4 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 7	3 Days × 30 mins 1 Day × 20 mins	3 Days × 30 mins Moderate Intensity & 1 Day × 20 mins Vigorous Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 8	4 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.

Exercise Tips:

1. Drink plenty of water before, during and after your workout.
2. Wear comfortable footwear and clothing that is suitable for the weather and the activity.
3. While you are exercising, consider listening to some music.
4. Do not overexert yourself starting of; over time try building up your physical activity by exercising most days off the week for 30 minutes.

Appendix 9

Physical activity programme: Level three

WEEK	DURATION	INTENSITY	TYPE OF ACTIVITY
Week 9	3 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 10	3 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 11	3 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 12	3 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 13	4 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 14	4 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 15	4 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 16	4 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 17	3 Days × 30 mins 1 Day × 20 mins	3 Days × 30 mins Moderate Intensity AND 1 Day × 20 mins Vigorous Intensity	Walking/Jogging, Swimming, Home Workout, Fitness Class, Other.
Week 18	4 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.

Physical activity programme: Level four

WEEK	DURATION	INTENSITY	TYPE OF ACTIVITY
Week 9	4 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 10	4 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 11	4 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 12	4 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 13	3 Days × 30 mins 1 Day × 20 mins	3 Days × 30 mins Moderate Intensity AND 1 Day × 20 mins Vigorous Intensity	Walking/Jogging, Swimming, Home Workout, Fitness Class, Other.
Week 14	4 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 15	3 Days × 30 mins 1 Day × 20 mins	3 Days × 30 mins Moderate Intensity AND 1 Day × 20 mins Vigorous Intensity	Walking /Jogging, Swimming, Home Workout, Fitness Class, Other.
Week 16	4 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 17	4 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 18	5 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.

Appendix 10

Physical activity programme: Level five

WEEK	DURATION	INTENSITY	TYPE OF ACTIVITY
Week 19	5 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 20	4 Days × 30 mins 1 Day × 20 mins	4 Days × 30 mins Moderate Intensity AND 1 Day × 20 mins Vigorous Intensity	Walking /Jogging, Swimming, Home Workout, Fitness Class, Other.
Week 21	3Days × 30 mins 2 Days × 20 mins	3 Days × 30 mins Moderate Intensity AND 2 Days × 20 mins Vigorous Intensity	Walking /Jogging, Swimming, Home Workout, Fitness Class, Other.
Week 22	5 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 23	4 Days × 30 mins 1 Day × 20 mins	4 Days × 30 mins Moderate Intensity AND 1 Day × 20 mins Vigorous Intensity	Walking /Jogging, Swimming, Home Workout, Fitness Class, Other.
Week 24	3 Days × 30 mins 2 Days × 20 mins	3 Days × 30 mins Moderate Intensity AND 2 Days × 20 mins Vigorous Intensity	Walking /Jogging, Swimming, Home Workout, Fitness Class, Other.
Week 25	5 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 26	4 Days × 30 mins 1 Day × 20 mins	4 Days × 30 mins Moderate Intensity AND 1 Day × 20 mins Vigorous Intensity	Walking /Jogging, Swimming, Home Workout, Fitness Class, Other.

Exercise Tips:

1. Drink plenty of water before, during and after your workout.
2. Wear comfortable footwear and clothing that is suitable for the weather and the activity.

Physical activity programme: Level six

WEEK	DURATION	INTENSITY	TYPE OF ACTIVITY
Week 19	5 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 20	4 Days × 30 mins 1 Day × 20 mins	4 Days × 30 mins Moderate Intensity AND 1 Day × 20 mins Vigorous Intensity	Walking /Jogging, Swimming, Home Workout, Fitness Class, Other.
Week 21	3 Days × 30 mins 2 Days × 20 mins	3 Days × 30 mins Moderate Intensity AND 2 Days × 20 mins Vigorous Intensity	Walking /Jogging, Swimming, Home Workout, Fitness Class, Other.
Week 22	5 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 23	4 Days × 30 mins 1 Day × 20 mins	4 Days × 30 mins Moderate Intensity AND 1 Day × 20 mins Vigorous Intensity	Walking /Jogging, Swimming, Home Workout, Fitness Class, Other.
Week 24	3 Days × 30 mins 2 Days × 20 mins	3 Days × 30 mins Moderate Intensity AND 2 Days × 20 mins Vigorous Intensity	Walking /Jogging, Swimming, Home Workout, Fitness Class, Other.
Week 25	5 Days × 30 mins	Moderate Intensity	Walking, Swimming, Home Workout, Fitness Class, Other.
Week 26	2 Days × 30 mins 3 Days × 20 mins	3 Days × 30 mins Moderate Intensity AND 2 Days × 20 mins Vigorous Intensity	Walking /Jogging, Swimming, Home Workout, Fitness Class, Other.

Exercise Tips:

1. Drink plenty of water before, during and after your workout.
2. Wear comfortable footwear and clothing that is suitable for the weather and the activity.

Appendix 11
Stage of change questionnaire

For each of the following questions, please circle Yes or No. Please be sure to read the questions carefully. Physical activity or exercise includes activities such as walking briskly, jogging, bicycling, swimming, or any other activity in which the exertion is at least as intense as these activities.

	No	**Yes**
1. I am currently physically active.	0	1
2. I intend to become more physically active in the next 6 months.	0	1

For activity to be regular, it must add up to a total of 30 minutes or more per day and be done at least 5 days per week. For example, you could take one 30 – minute walk or take three 10 - minute walks for a daily total of 30 minutes.

	No	**Yes**
3. I currently engage in regular physical activity.	0	1
4. I have been regularly physically active for the past six months.	0	1

(Marcus, Rossi, *et al*, 1992)

Scoring Algorithm

If (question 1 = 0 and question 2 = 0), then you are at stage 1.

If (question 1 = 0 and question 2 = 1), then you are at stage 2.

If (question 1 = 1 and question 3 = 0), then you are at stage 3.

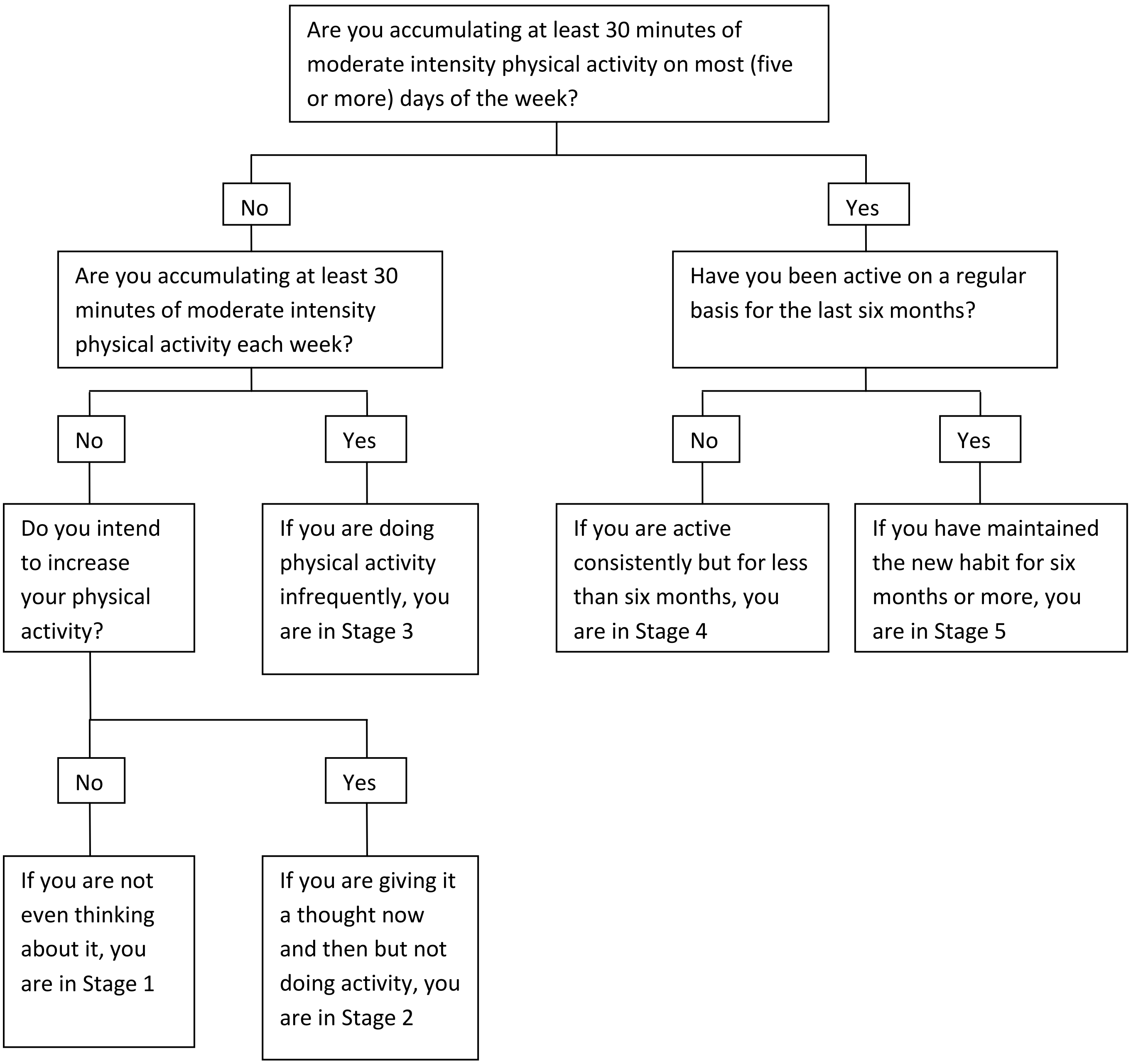
If (question 1 = 1 and question 3 = 1, and question 4 = 0), then you are at stage 4.

If (question 1 = 1 and question 3 = 1, and question 4 = 1), then you are at stage 5.

From *Motivating People to Be Physically Active*, by Bess H. Marcus and LeighAnn H. Forsyth, 2003, Human Kinetics, Champaign, IL

Appendix 12
Stage of change flowchart

Flowchart for determining Stage of Change (SOC)



(Marcus & Forsyth, 2003)

Appendix 13
Self-efficacy questionnaire

Please circle the number that indicates how confident you are that you could be physically active in each of the following situations:

Scale

1 = not at all confident

2 = slightly confident

3 = moderately confident

4 = very confident

5 = extremely confident

When I am tired	1	2	3	4	5
When I am in a bad mood	1	2	3	4	5
When I feel I do not have time	1	2	3	4	5
When I am on vacation	1	2	3	4	5
When it is raining or snowing	1	2	3	4	5

Marcus *et al* (1992c)

Appendix 14

Social support for physical activity scale

Please rate each question two times. Under 'Family' rate how often anyone in your household has said or done what is described during the past three months. Under 'Friends' rate how often your friends, acquaintances, or co – workers have said or done what is described during the past three months.

Please write one number from the following rating scale in each space:

1 = none   2 = rarely   3 = a few times   4 = often   5 = very often

0 = does not apply

	Family	Friends
1. Did physical activity with me.	______	______
2. Offered to do physical activity with me.	______	______
3. Gave me helpful reminders to be physically active. (i.e, 'Are you going to do your activity tonight?')	______	______
4. Gave me encouragement to stick with my activity programme.	______	______
5. Changed their schedule so we could do physical activities together.	______	______
6. Discussed physical activity with me.	______`	______
7. Complained about the time I spend doing physical activity.	______	______
8. Criticised me or made fun of me for doing physical activities.	______	______
9. Gave me rewards for being physically active. (i.e, gave me something I liked)	______	______
10. Planned for physical activities on recreational outings.	______	______
11. Helped plan events around my physical activities.	______	______
12. Asked me for ideas on how they can be more physically active.	______	______
13. Talked about how much they like to do physical activity.	______	______

Sallis *et al*, (1987)

Appendix 15
Physical activity enjoyment scale

Please rate how you feel at the moment about physical activity. Below is a list of feelings with respect to physical activity. For each feeling, please tick the box under the number that best describes you.

		1	2	3	4	5	6	7	
1.	I enjoy it.								I hate it.
2.	I feel bored.								I feel interested.
3.	I dislike it.								I like it.
4.	I find it pleasurable.								I find it un-pleasurable.
5.	I am very absorbed in physical activity.								I am not at all absorbed in physical activity.
6.	It is no fun at all.								It is a lot of fun.
7.	I find it energising.								I find it tiring.
8.	It makes me depressed.								It makes me happy.
9.	It is very pleasant.								It is very unpleasant.
10.	I feel good physically while doing it.								I feel bad physically while doing it.
11.	It is very invigorating.								It is not at all invigorating.
12.	I am very frustrated by it.								I am not at all frustrated by it.
13.	It is very gratifying.								It is not at all gratifying.
14.	It is very exhilarating.								It is not at all exhilarating.
15.	It is very stimulating.								It is not at all stimulating.
16.	It gives me a strong sense of accomplishment.								It does not give me any sense of accomplishment.
17.	It is very refreshing.								It is not at all refreshing.
18.	I feel as though I would rather be doing something else.								I feel as though there is nothing else I would rather be doing.

Kendzierski & DeCarlo, (1991)

Appendix 16

Social networking questionnaire

Name: ____________________ Date: _________

1. Are you a member of any social network services? **(Please tick)**

Yes ☐ No ☐

2. Are you a member of any of the following social network service? **(You can choose more than one)**

Facebook ☐

Twitter ☐

YouTube ☐

MySpace ☐

Teamer ☐

Bebo ☐

Other: ________________ **(Please specify**).

3. Which social network site is your favourite? **(Please specify**)

____

4. Why do you use social network sites? **(Please tick)**

To interact with:

Family ☐

Friends' ☐

Co-workers ☐

People that live far away ☐

Strangers: People you do not know ☐

5. How long have you been using social network sites? **(Please tick)**

Less than a month □

1 - 6 months □

6 months to a year □

1 - 2 years □

2 - 3years □

3 years + □

6. Are you a member of the social network site called 'Teamer'?

Yes □ No □

7. How long have you been a member off 'Teamer'? **(Please tick)**

I am not a member □

Less than a month □

2 – 4 months □

4 – 6 months □

6 months + □

8. How often have you used 'Teamer' over the past six months? **(Please tick)**

Everyday □

Once a week □

Once a fortnight □

Once a month □

Never □

9. Did you interact with other participants in your group through 'Teamer'? **(Please tick)**

Yes □ No □

10. Why did you not use ‘Teamer’ regularly? **(Please tick)**

I do not know how to use social networking sites □

No interest in social networking sites □

Fear of technology □

Lack of self-confidence to interact with other participant’s □

Not computer literate □

Other: **(Please specify**)

Appendix 17

Evaluation questionnaire

Name: ____________________ **Date**: _________

1. Has taking part in the physical activity programme, 'Get Started and Stick with it' changed your lifestyle in terms of physical activity? **(Please tick)**

Yes □ No □

2. If you answered 'Yes' to question one above please state how physical activity has changed your lifestyle?

____

____

____

____

3. If you answered 'No' to question one above please state why physical activity has not changed your lifestyle?

____

____

____

____

4. Will you continue to take part in regular physical activity?

Yes □ No □

Appendix 18

Number of questionnaires and logbooks distributed and returned by the IGa and CGb at Baseline, T1, T2 and T3

Total Distributed	**1**	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**3**	**3**	**1**	**1**
Participant	***PI**	***PIC**	**PARQ**	***PAH**	***P**	**SOC**	**SS**	**SE**	**Enjoy**	***PAL**	***T**	***E**
P1	1	1	1	1	1	3	3	3	3	3	1	1
P2	1	1	1	1	1	3	3	3	3	3	1	1
P3	1	1	1	1	1	3	3	3	3	3	1	1
P4	1	1	1	1	1	3	3	3	3	3	1	1
P5	1	1	1	1	1	3	3	3	3	3	1	1
P6	1	1	1	1	1	3	3	3	3	3	1	1
P7	1	1	1	1	1	3	3	3	3	3	1	1
P8	1	1	1	1	1	3	3	3	3	3	1	1
P9	1	1	1	1	1	3	3	3	3	3	1	1
P10	1	1	1	1	1	3	3	3	3	3	1	1
P11	1	1	1	1	1	3	3	3	3	3	1	1
P12	1	1	1	1	1	3	3	3	3	3	1	1
P13	1	1	1	1	1	1	1	1	1	2	0	0
P14	1	1	1	1	1	1	1	1	1	1	0	0
P15	1	1	1	1	1	1	1	1	1	1	0	0
TD **TR**	**15** **15**	**15** **15**	**15** **15**	**15** **15**	**15** **15**	**15** **36**	**39** **36**	**39** **36**	**39** **36**	**40** **36**	**12** **12**	**12** **12**
P16	1	1	1	1	1	3	3	3	3	3	1	1
P17	1	1	1	1	1	3	3	3	3	3	1	1
P18	1	1	1	1	1	3	3	3	3	3	1	1
P19	1	1	1	1	1	3	3	3	3	3	1	1
P20	1	1	1	1	1	3	3	3	3	3	1	1
P21	1	1	1	1	1	3	3	3	3	3	1	1
P22	1	1	1	1	1	3	3	3	3	3	1	1
P23	1	1	1	1	1	3	3	3	3	3	1	1
P24	1	1	1	1	1	3	3	3	3	3	1	1
P25	1	1	1	1	1	3	3	3	3	3	1	1
P26	1	1	1	1	1	3	3	3	3	3	1	1
P27	1	1	1	1	1	3	3	3	3	3	1	1
P28	1	1	1	1	1	1	1	1	1	1	0	0
P29	1	1	1	1	1	1	1	1	1	1	0	0
P30	1	1	1	1	1	1	1	1	1	1	0	0
TD **TR**	**15** **15**	**15** **15**	**15** **15**	**15** **15**	**15** **15**	**39** **36**	**39** **36**	**39** **36**	**39** **36**	**39** **36**	**12** **12**	**12** **12**

PI = Participant Information sheet, **PIC** = Participant Informed Consent, **PAH** = Physical Activity History, **P** = Profile Questionnaire, **PAL** = Physical Activity Logbook, **T** = Teamer Questionnaire, **E** = Evaluation, **TD** = Total Distributed, **TR** = Total Returned.

Appendix 19

Qualitative data in logbooks for all participants at the three time intervals

Participant 1

T1: I really enjoyed walking the week of the snow as it was so beautiful and it felt more like a workout as your feet would sink down in the snow which meant it was more effort put in.

Participant 2

T2: Just looking through my logbook, I have not done very well in the past two months. It is not that I don't want to do it but rather I wasn't able to do it. I mainly walk and I wasn't able to get out with the weather in December and when I started again in January I felt unfit. I was doing lots of exercise before Christmas. I am still motivated to do more exercise for my health.

T3: At the end of the programme, I am more aware of the importance of doing exercise. I feel much better in myself and I make time to do it during the day. Sometimes it was not possible to go out and walk so the next day I was more eager to get out. I am aware that at times I don't do enough exercise. I am going to try increase my physical activity time and get out for three days a week at 60-90 minutes. This is what I am going to aim for over the summer months. I have enjoyed being part of this programme.

Participant 3

T1: This programme has set me on a path to setting and achieving realistic goals. I have joined a gym. I bring my gym bag with me in the morning. I am exercising at least three times weekly and I hope to increase this amount of exercise in the coming months. I am feeling positive about exercising now and it obviously is having a positive impact on all aspects of my life.

T2: Really enjoying exercise. I have the confidence and determination to consistently exercise.

T3: I am now almost a stone lighter. I am training for the North West 10km on the 1st May. I feel so much healthier. I think starting this programme was the boost I needed.

Participant 4

T2: I found over the Christmas period hard to exercise as I could not get out with the snow and ice. I was extremely busy until the end of December. I got myself a bit mixed up with the logbook and tried to keep a note of things on the computer which wasn't as effective as the logbook. I intend to keep a better logbook for the months ahead. It is great to have the logbook as it really does make me aware of what and how much exercise I am doing and not doing.

T3: Was delighted to be part of this programme. I am now focused again on exercise as to how important my health is. The logbook is a good sense of motivation, I have given my mother, who is seventy-three years of age, a logbook that I made myself and it has also encouraged her to become more physically activity.

Participant 6

T3: The six months flew by. I enjoyed participating in the programme. I found it motivating filling in the logbook. I intend to continue with exercise and healthy eating.

Participant 7

T2: Started off well in January, but seemed to lack motivation all of a sudden. Rather than exercise being enjoyable, recently it has felt like a chore.

Participant 12

T2: I have linked up with a friend to walk together, she is now a sense of motivation for me to do my exercise.

Physical Activity Logbook and SW3 ARMBAND (IGa)

Participant 16

T2: I did not do as much exercise because of Christmas. The weeks of snow and ice made it difficult to get out as I did not feel safe due to slipping. Although the SW3 Armband is not uncomfortable to wear, I am getting a bit fed up wearing it.

Participant 17

T1: Had some problems at first with synchronising the Armband. The SW3 Armband irritated my arm and left a rash. However, now I don’t even realise I am wearing the Armband during the day. When I get up in the morning, the Armband is like putting my clothes on. Sometimes my job is a barrier and prevents me from walking because I do a lot of travelling.

T2: I had a problem with the Armband, it caused a rash on my arm. The rash disappeared when I didn't wear the Armband for a few days. The watch face keeps falling off the strap.

Participant 19

T1: Wearing the Armband made me more aware of the number of steps taken everyday. It made me more motivated to reach a target of 10,000 steps each day. I try to set weekly targets now. Although family life doesn't always allow things to happen (three sick babies all at the one time didn't help). I was more focused by the end of the first eight weeks.

T3: I would like to take this opportunity to thank the researcher and research assistant for giving me a chance to take part in the programme. It ends the same weekend my baby turns three. I have gotten well passed the level of fitness I expected which is great. I have also built the fitness programme into my lifestyle.

It was great to get to wear the SW3 Armband. It has made me more aware of my physical activity levels, especially on days that I am not exercising. The logbook was fab as it is great to see the progress on a weekly basis I believe seeing this helps.

It has been a great six months, I have got physically fitter, toned my body and I am all the better for it. Thanks again for this great opportunity.

Participant 20

T1: Found the Armband bulky when wearing with winter clothing i.e long sleeve tops and coats.

T2: I think the wearing of the Armband was made more difficult by the wearing of winter clothing with long sleeves and tight fitting sleeves. I also found the device very sore on batteries, they seemed to last no time.

T3: I have lost weight taking part in this programme but I did find the Armband annoying. Getting it to fit under clothing was another issue. If all the technology could have been stored on the watch, it would have been a great motivator.

Participant 22

T1: The watch and Armband is quite bulky. The velcro on Armband can be very uncomfortable, if not adjusted properly.

T3: I lost motivation to keep with the programme when I became frustrated with the lack of time I had to exercise. At the beginning of the programme I was highly motivated and exercised 2-3 times per week. When I tried to fit in 4 sessions per week, it became too much for me and I lost motivation. I found the Armband a de-motivator as I would often reach the target activity and step count levels without doing any additional daily exercise. I still want to get fit but now need to get back into it with a new goal. Keeping the Armband loaded up with batteries was a bit of a chore and I found I became lazy at doing it.

Participant 24

T1: Found wearing the Armband motivated me, otherwise I would have been lazy.

T3: I enjoyed taking part in the programme. I have gone from being sedentary to trying to do exercise at least 3 times a week. Improved overall well-being. Hope to maintain my new healthy lifestyle.

Participant 25

T1: Had problems with Armband. When the battery ran low, if I didn't change it right away, I would have to reset the Armband.

Participant 26

T1: The Armband is a great motivator but I found it very hard to do any exercise once the weather changed and we got snow. I think I will buy one of these Armbands to motivate me.

T2: The weather at Christmas was a big factor that played the part in me not doing exercise. I fell badly so that triggered my back again. The Armband is okay to wear but once it is on for a while, it can get annoying.

T3: The Armband really annoyed me, I found it irritating. I think if we meet up more as a group for training, it would have motivated me more.

Participant 27

T1: Sometimes I forgot to complete my logbook.

T2: Batteries in Armband kept running out. The Armband is a good motivator because I can check and see how much physical activity I have done.

Participant 28

T1: I find my lack of physical activity is mostly due to my inconsistent work days and hours. Hopefully when the snow clears I will get out to do exercise again.

Appendix 20

Formula for calculating effect size: Independent samples t-test

$$\text{Eta squared} = \frac{t^2}{t^2 + (N12 + N2 - 2)}$$

Appendix 21

Formal for calculating effect size: One-way analysis of variance

$$\text{Eta squared} = \frac{\text{Sum of squares between groups}}{\text{Total sum of squares}}$$

Appendix 22

Physical activity mean weekly minutes over T1, T2 and T3 for each participant in the IGa

Participant	Time	Moderate Intensity Minute	Vigorous Intensity Minutes	*Mean Minutes of Physical Activity	Total Accumulated Moderate & Vigorous Physical Activity (T1+T2+T3)	Meeting WHO Guidelines	% of participants meeting WHO Guidelines
Participant 1	**T1**	310	95	51	1295	No	0%
	T2	140	165	31		No	0%
	T3	400	185	73		No	0%
Participant 2	**T1**	250	0	31	350	No	0%
	T2	0	50	5		No	0%
	T3	50	0	6		No	0%
Participant 3	**T1**	950	505	182	4165	Yes	8%
	T2	1110	690	180		Yes	8%
	T3	400	510	114		Yes	8%
Participant 4	**T1**	125	60	23	1730	No	0%
	T2	180	270	45		No	0%
	T3	725	370	137		No	0%
Participant 5	**T1**	50	0	6	330	No	0%
	T2	120	0	12		No	0%
	T3	160	0	20		No	0%
Participant 6	**T1**	380	0	48	1265	No	0%
	T2	200	0	20		No	0%
	T3	685	0	86		No	0%
Participant 7	**T1**	588	60	81	1588	No	0%
	T2	640	30	67		No	0%
	T3	270	0	34		No	0%
Participant 8	**T1**	333	0	42	663	No	0%
	T2	70	0	7		No	0%
	T3	200	60	33		No	0%
Participant 9	**T1**	390	20	51	1980	No	0%
	T2	630	40	67		No	0%
	T3	870	30	112		No	0%
Participant 10	**T1**	450	80	66	3240	No	0%
	T2	910	120	103		No	0%
	T3	1140	540	210		Yes	8%
Participant 11	**T1**	400	0	50	2890	No	0%
	T2	1230	0	123		No	0%
	T3	1260	0	158		Yes	8%
Participant 12	**T1**	415	0	52	1685	No	0%
	T2	450	0	45		No	0%
	T3	820	0	103		No	0%
Participant 13	**T1**	620	50	84	670	No	0%
Totals		**17921**	**3930**	**2474**	**21851**	**3 participants**	**25%**

***Mean Minutes of Physical Activity = moderate + vigorous / 8 = T1, = moderate + vigorous / 10 = T2, = moderate + vigorous / 8 = T3**

Appendix 23

Physical activity mean weekly minutes over T1, T2 and T3 for each participant in the CGb

Participant	Time	Moderate Intensity Minute	Vigorous Intensity Minutes	*Mean Minutes of Physical Activity	Total Accumulated Moderate & Vigorous Physical Activity (T1+T2+T3)	Meeting WHO Guidelines	% of participants meeting WHO Guidelines
Participant 1	**T1**	490	0	61	2990	No	0%
	T2	1350	0	135		No	0%
	T3	1150	0	143		No	0%
Participant 2	**T1**	445	100	68	1995	No	0%
	T2	530	35	57		No	0%
	T3	885	0	111		No	0%
Participant 3	**T1**	495	30	66	2190	No	0%
	T2	645	190	84		No	0%
	T3	750	80	104		No	0%
Participant 4	**T1**	510	30	68	5550	Yes	0%
	T2	1590	30	162		Yes	8%
	T3	3330	60	424		Yes	8%
Participant 5	**T1**	400	0	50	2275	No	0%
	T2	945	0	95		No	0%
	T3	900	30	116		No	0%
Participant 6	**T1**	1200	30	154	8750	Yes	8%
	T2	4050	0	405		Yes	8%
	T3	3210	260	434		Yes	8%
Participant 7	**T1**	1650	585	279	8295	Yes	8%
	T2	2770	515	329		Yes	8%
	T3	2355	420	347		Yes	8%
Participant 8	**T1**	1055	0	132	6660	Yes	8%
	T2	2500	35	254		Yes	8%
	T3	3070	0	384		Yes	8%
Participant 9	**T1**	260	230	59	3130	No	0%
	T2	860	320	118		No	0%
	T3	1310	150	183		Yes	8%
Participant 10	**T1**	548	0	69	2579	No	0%
	T2	820	0	82		No	0%
	T3	1158	53	151		Yes	8%
Participant 11	**T1**	375	0	47	1975	No	0%
	T2	640	0	64		No	0%
	T3	960	0	120		No	0%
Participant 12	**T1**	820	0	103	3595	No	0%
	T2	1045	0	105		No	0%
	T3	1730	0	216		Yes	8%
Totals		**46801**	**3183**	**5779**	**49984**	**7 participants**	**58%**

***Mean Minutes of Physical Activity = moderate + vigorous / 8 = T1, = moderate + vigorous / 10 = T2, = moderate + vigorous / 8 = T3**

Appendix 24

Independent samples t-test between the IGa and CGb mean weekly minutes of physical activity at the end of T1

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Mean Weekly Physical Activity T1	Intervention Group	12	56.92	43.866	12.663
	Control Group	12	95.92	66.675	19.247

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mean Weekly Physical Activity T1	Equal variances assumed	1.676	.209	-1.693	22	.105	-39.000	23.039	-86.781	8.781
	Equal variances not assumed			-1.693	19.020	.107	-39.000	23.039	-87.219	9.219

Appendix 25

Independent samples t-test between the IGa and CGb mean weekly minutes of physical activity at the end of T2

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Mean Weekly Physical Activity T2	Intervention Group	12	58.75	53.365	15.405
	Control Group	12	157.50	112.280	32.412

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mean Weekly Physical Activity T2	Equal variances assumed	4.606	.043	-2.752	22	.012	-98.750	35.887	-173.175	-24.325
				-2.752	15.728	.014	-98.750	35.887	-174.934	-22.566

Appendix 26

Independent samples t-test between the IGa and CGb mean weekly minutes of physical activity at the end of T3

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Mean Weekly Physical Activity T3	Intervention Group	12	90.50	61.130	17.647
	Control Group	12	227.75	130.713	37.734

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mean Weekly Physical Activity T3	Equal variances assumed	11.538	.003	-3.295	22	.003	-137.250	41.656	-223.639	-50.861
	Equal variances not assumed			-3.295	15.592	.005	-137.250	41.656	-225.745	-48.755

Appendix 27

Independent samples t-test between the IGa and CGb mean weekly minutes of physical activity from T1-T3 inclusive

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Mean Physical Activity	Intervention Group	36	68.72	54.025	9.004
	Control Group	36	159.53	115.150	19.192

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mean Physical Activity	Equal variances assumed	13.833	.000	-4.284	70	.000	-90.806	21.199	-133.085	-48.526
	Equal variances not assumed			-4.284	49.697	.000	-90.806	21.199	-133.391	-48.220

Appendix 28

One-way repeated measures ANOVA for the IGa and CGb

Descriptive Statistics

Group		Mean	Std. Deviation	N
Intervention Group	Mean Weekly Physical Activity T1	56.92	43.866	12
	Mean Weekly Physical Activity T2	58.75	53.365	12
	Mean Weekly Physical Activity T3	90.50	61.130	12
Control Group	Mean Weekly Physical Activity T1	96.33	66.404	12
	Mean Weekly Physical Activity T2	157.50	112.280	12
	Mean Weekly Physical Activity T3	227.75	130.713	12

Multivariate Tests[b]

Group	Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intervention Group	Time	Pillai's Trace	.322	2.376[a]	2.000	10.000	.143	.322
		Wilks' Lambda	.678	2.376[a]	2.000	10.000	.143	.322
		Hotelling's Trace	.475	2.376[a]	2.000	10.000	.143	.322
		Roy's Largest Root	.475	2.376[a]	2.000	10.000	.143	.322
Control Group	Time	Pillai's Trace	.634	8.646[a]	2.000	10.000	.007	.634
		Wilks' Lambda	.366	8.646[a]	2.000	10.000	.007	.634
		Hotelling's Trace	1.729	8.646[a]	2.000	10.000	.007	.634
		Roy's Largest Root	1.729	8.646[a]	2.000	10.000	.007	.634

Multivariate Tests[b]

Group	Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intervention Group	Time	Pillai's Trace	.322	2.376[a]	2.000	10.000	.143	.322
		Wilks' Lambda	.678	2.376[a]	2.000	10.000	.143	.322
		Hotelling's Trace	.475	2.376[a]	2.000	10.000	.143	.322
		Roy's Largest Root	.475	2.376[a]	2.000	10.000	.143	.322
Control Group	Time	Pillai's Trace	.634	8.646[a]	2.000	10.000	.007	.634
		Wilks' Lambda	.366	8.646[a]	2.000	10.000	.007	.634
		Hotelling's Trace	1.729	8.646[a]	2.000	10.000	.007	.634
		Roy's Largest Root	1.729	8.646[a]	2.000	10.000	.007	.634

a. Exact statistic

b. Design: Intercept

Within Subjects Design: Time

Appendix 29

One-way between groups ANOVA with Tukey post hoc tests for the IGa

Descriptives

Mean Physical Activity

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
T1	12	56.92	43.866	12.663	29.05	84.79	6	182
T2	12	58.75	53.365	15.405	24.84	92.66	5	180
T3	12	90.50	61.130	17.647	51.66	129.34	6	210
Total	36	68.72	54.025	9.004	50.44	87.00	5	210

ANOVA

Mean Physical Activity

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	8557.056	2	4278.528	1.508	.236
Within Groups	93598.167	33	2836.308		
Total	102155.222	35			

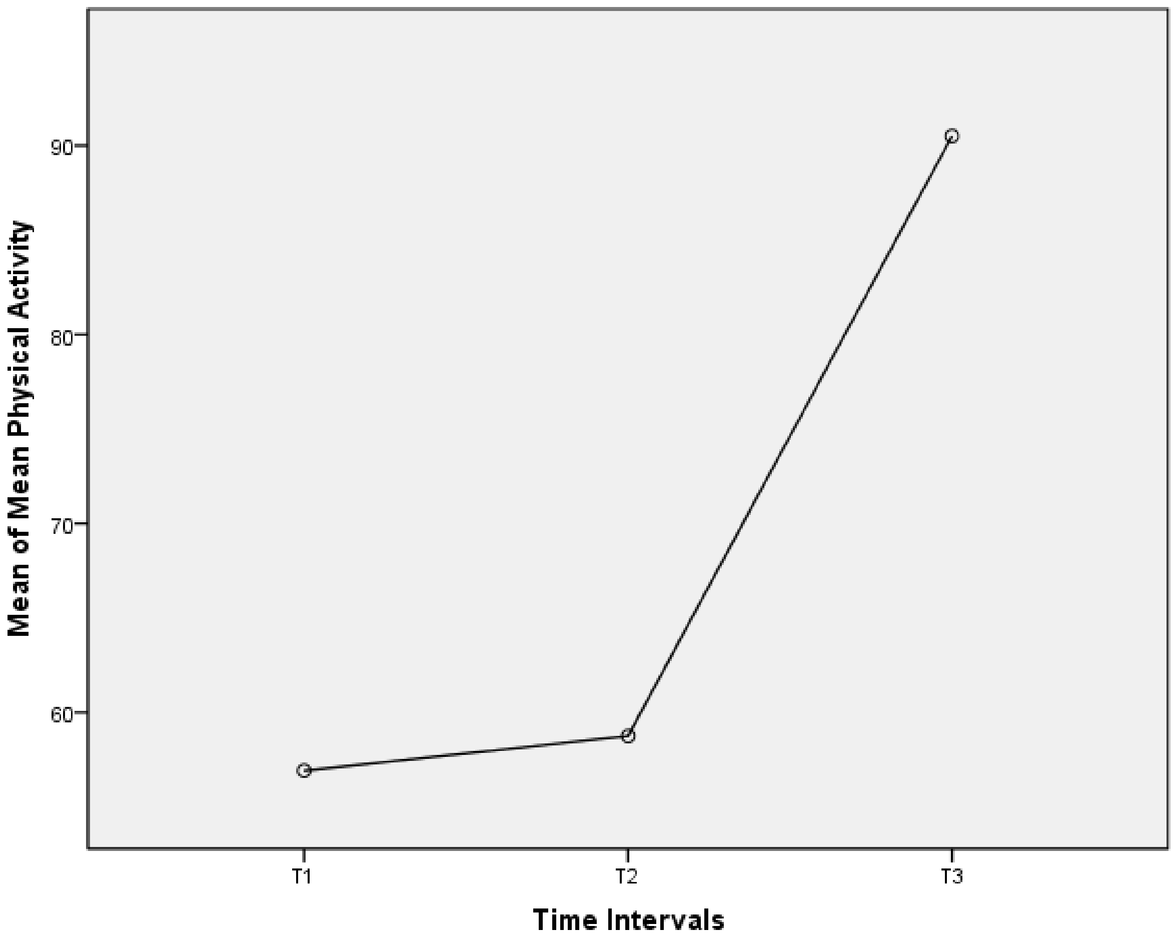
Multiple Comparisons

Mean Physical Activity

Tukey HSD

(I) Time Intervals	(J) Time Intervals	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
T1	T2	-1.833	21.742	.996	-55.18	51.52
	T3	-33.583	21.742	.284	-86.93	19.77
T2	T1	1.833	21.742	.996	-51.52	55.18
	T3	-31.750	21.742	.323	-85.10	21.60
T3	T1	33.583	21.742	.284	-19.77	86.93
	T2	31.750	21.742	.323	-21.60	85.10

Means Plots


90
80
70
60
Mean of Mean Physical Activity
T1
T2
T3
Time Intervals

Appendix 30

One-way between groups ANOVA with Tukey post hoc tests for the CGb

Descriptives

Mean Physical Activity

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
T1	12	95.92	66.675	19.247	53.55	138.28	47	279
T2	12	157.50	112.280	32.412	86.16	228.84	57	405
T3	12	227.75	130.713	37.734	144.70	310.80	104	434
Total	36	160.39	117.102	19.517	120.77	200.01	47	434

ANOVA

Mean Physical Activity

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	104430.389	2	52215.194	4.589	.017
Within Groups	375520.167	33	11379.399		
Total	479950.556	35			

Multiple Comparisons

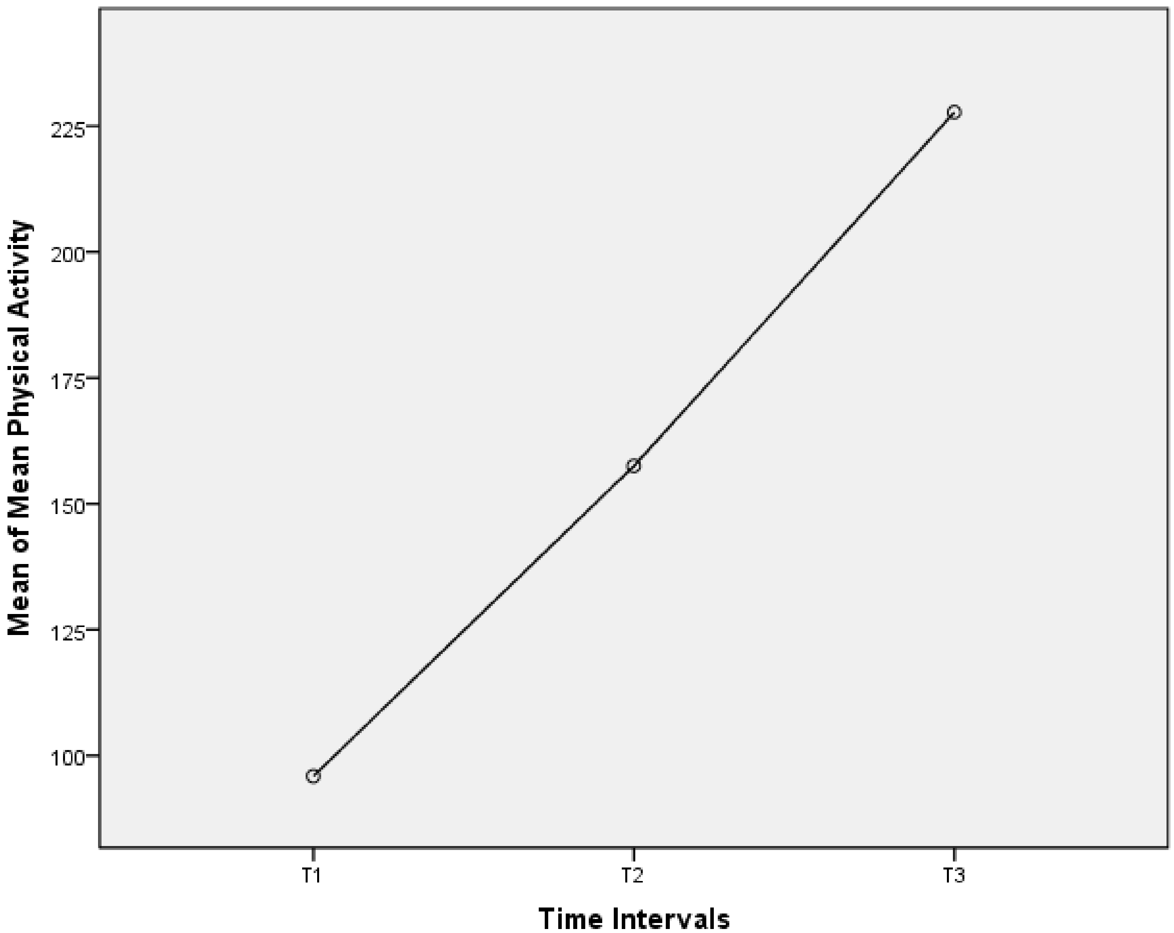
Mean Physical Activity

Tukey HSD

(I) Time Intervals	(J) Time Intervals	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
T1	T2	-61.583	43.550	.345	-168.45	45.28
	T3	-131.833*	43.550	.013	-238.70	-24.97
T2	T1	61.583	43.550	.345	-45.28	168.45
	T3	-70.250	43.550	.254	-177.11	36.61
T3	T1	131.833*	43.550	.013	24.97	238.70
	T2	70.250	43.550	.254	-36.61	177.11

*. The mean difference is significant at the 0.05 level.

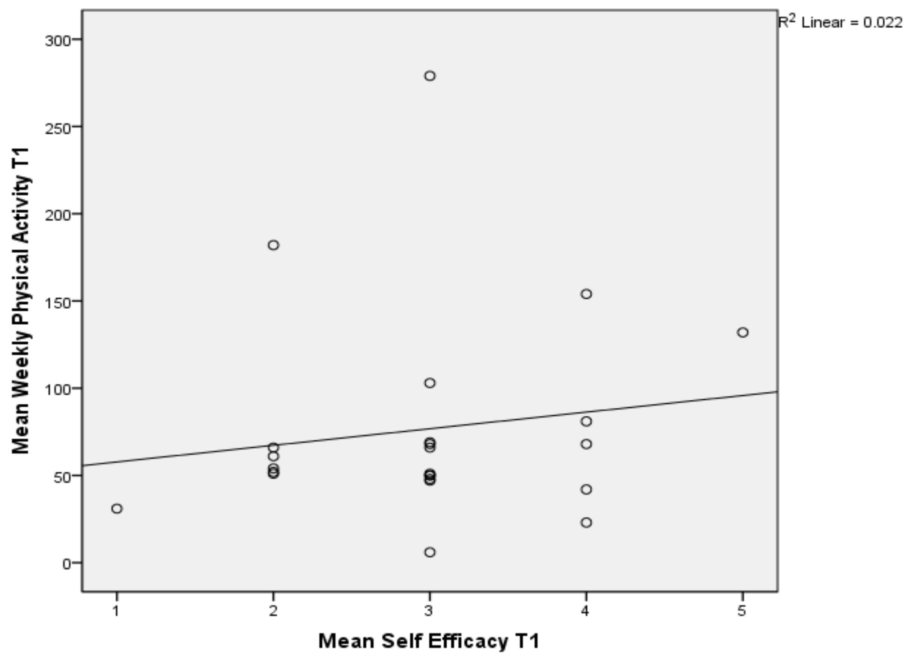
Means Plots



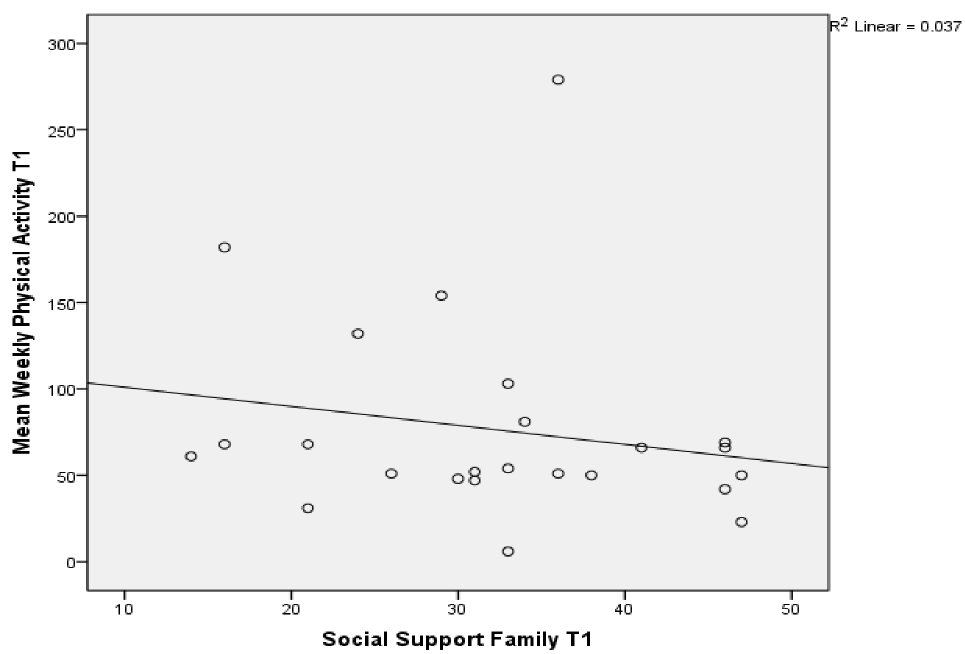
225
200
175
150
125
100
Mean of Mean Physical Activity
T1
T2
T3
Time Intervals

Appendix 31

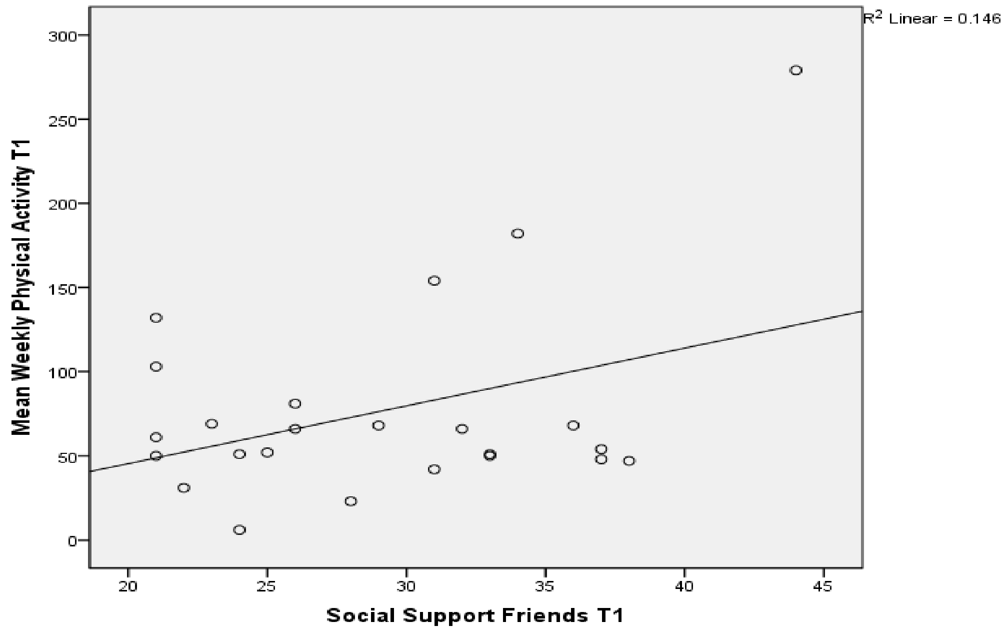
Scatterplot: the relationship between mean weekly physical activity and SE at T1



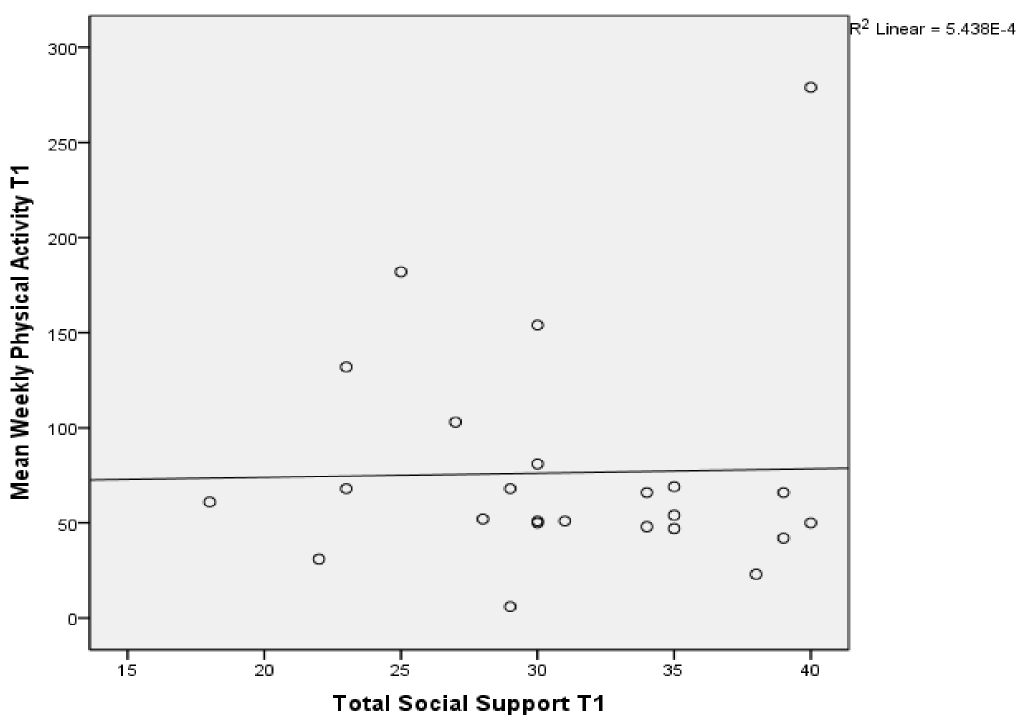
Scatterplot: the relationship between mean weekly physical activity and SSFam at T1



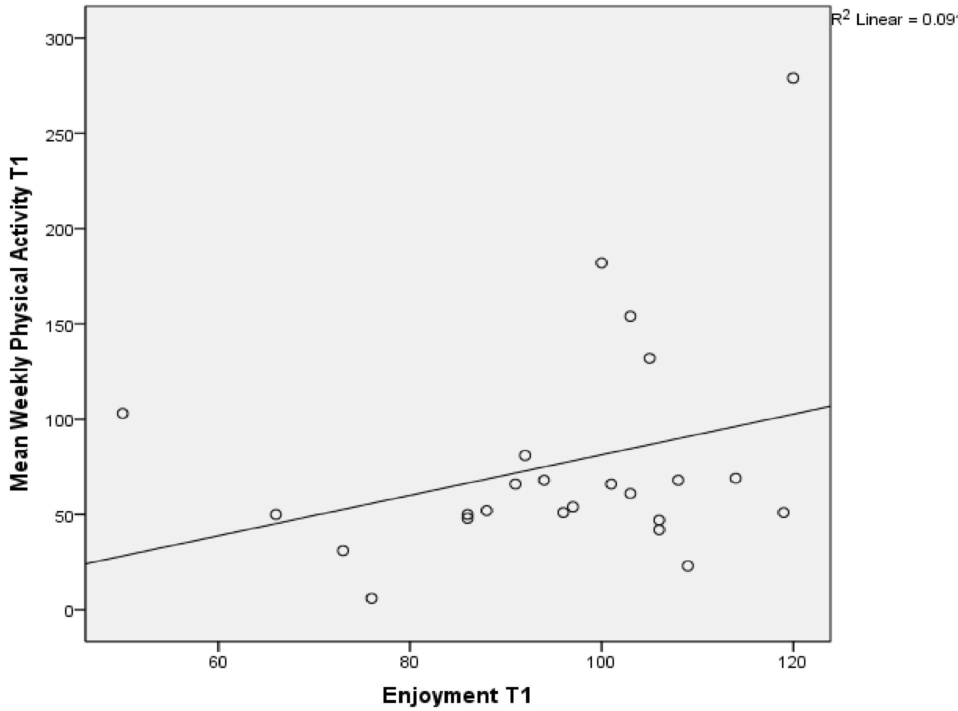
Scatterplot: the relationship between mean weekly physical activity and SSFri at T1



Scatterplot: the relationship between mean weekly physical activity and TSS at T1

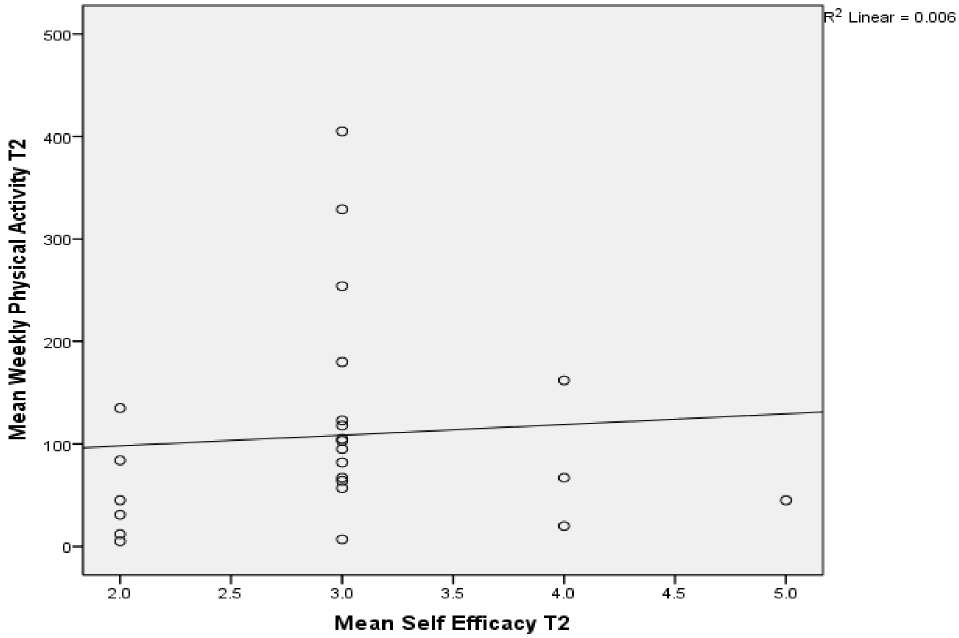


Scatterplot: the relationship between mean weekly physical activity and Enjoyment at T1

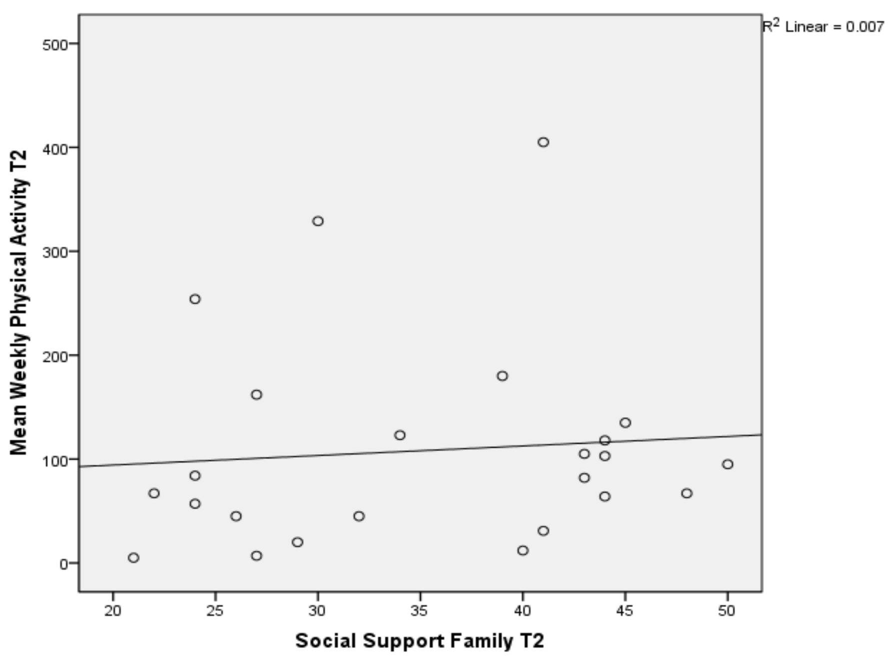


Appendix 32

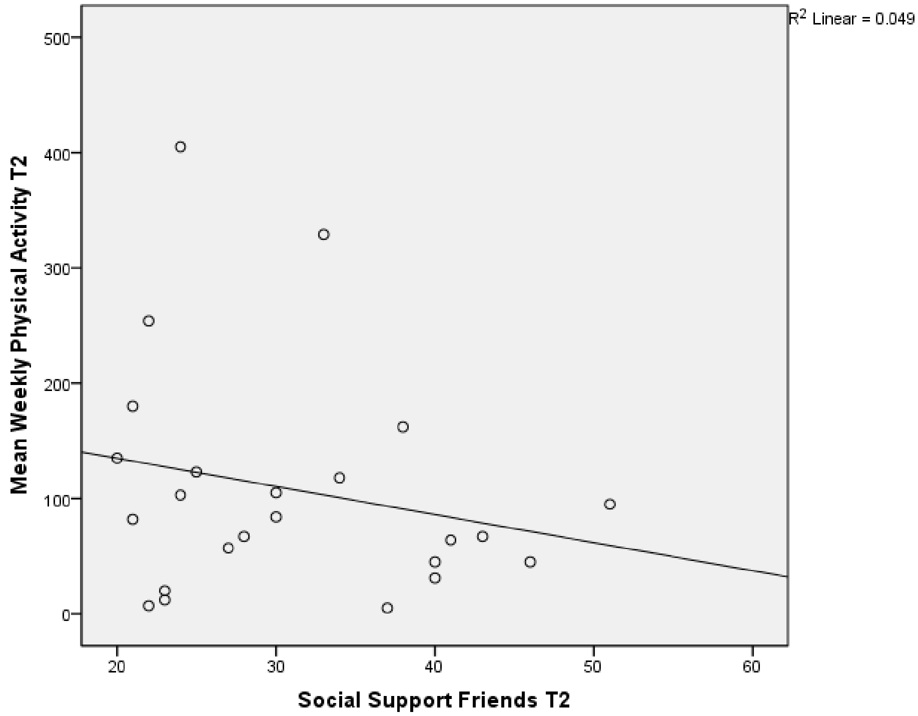
Scatterplot: the relationship between mean weekly physical activity and SE at T2



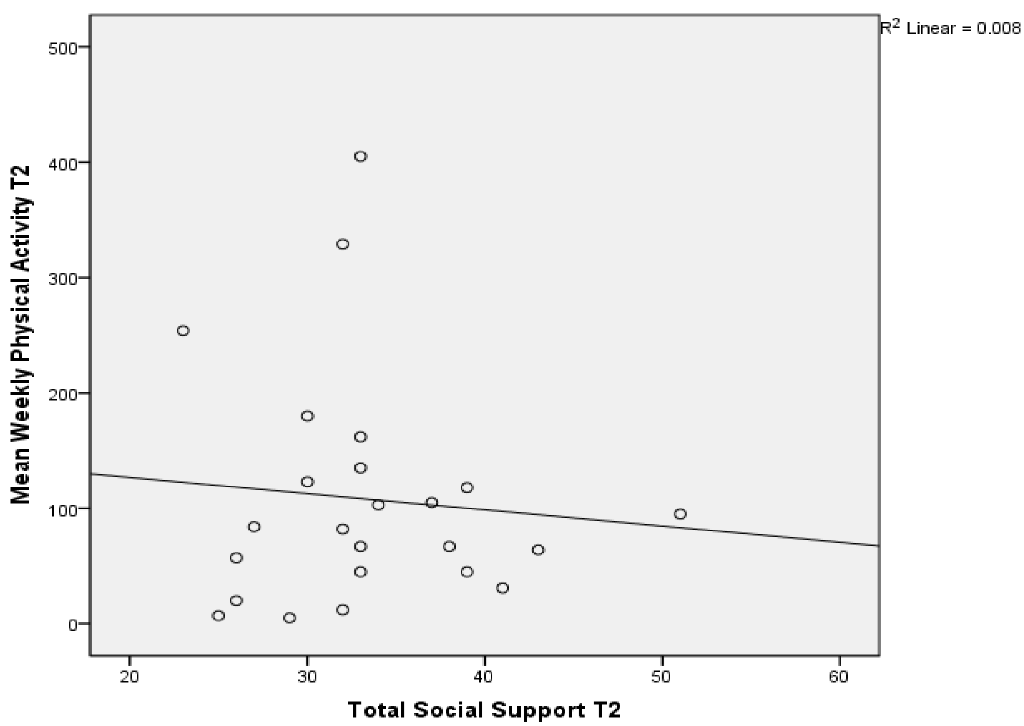
Scatterplot: the relationship between mean weekly physical activity and SSFam at T2



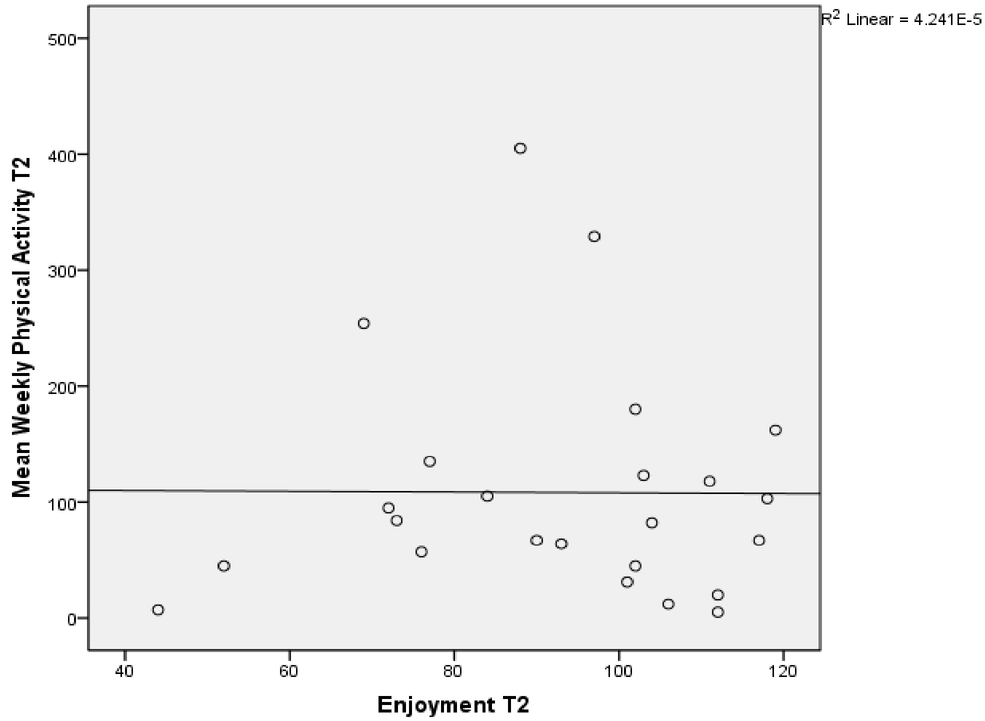
Scatterplot: the relationship between mean weekly physical activity and SSFri at T2



Scatterplot: the relationship between mean weekly physical activity and TSS at T2

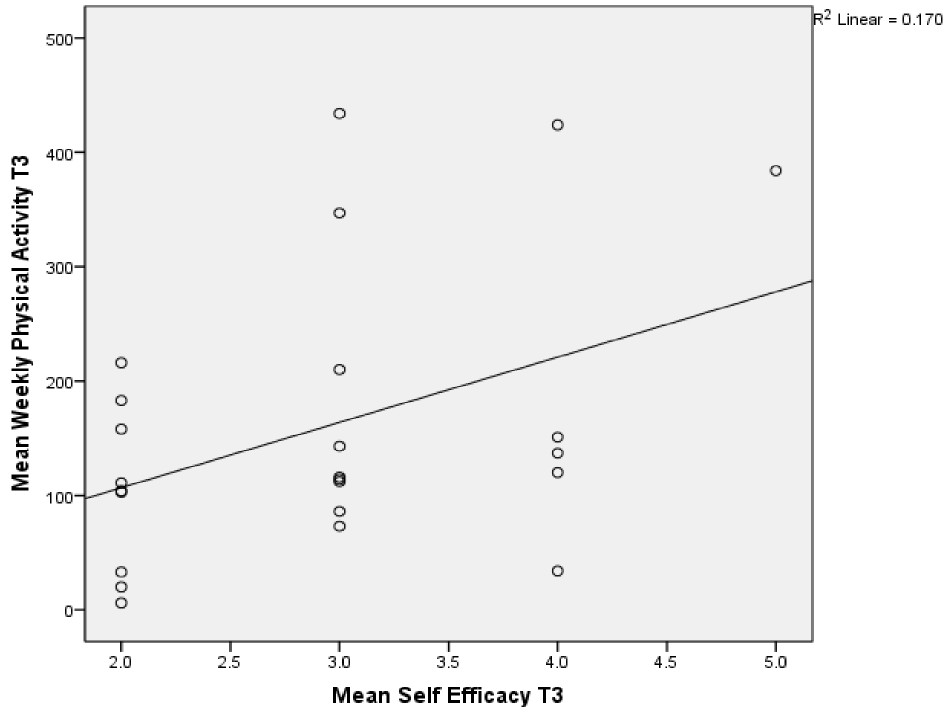


Scatterplot: the relationship between mean weekly physical activity and Enjoyment at T2

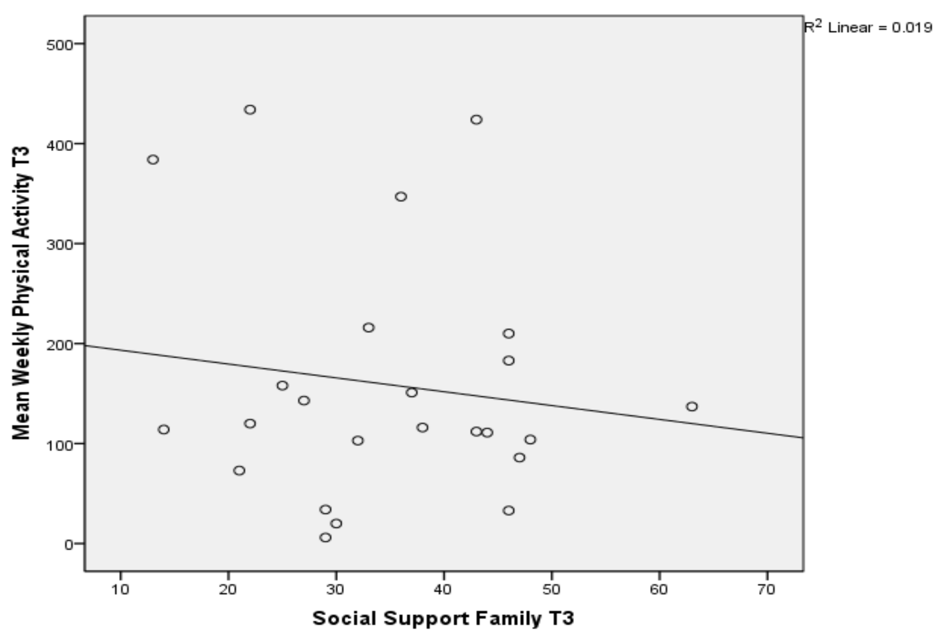


Appendix 33

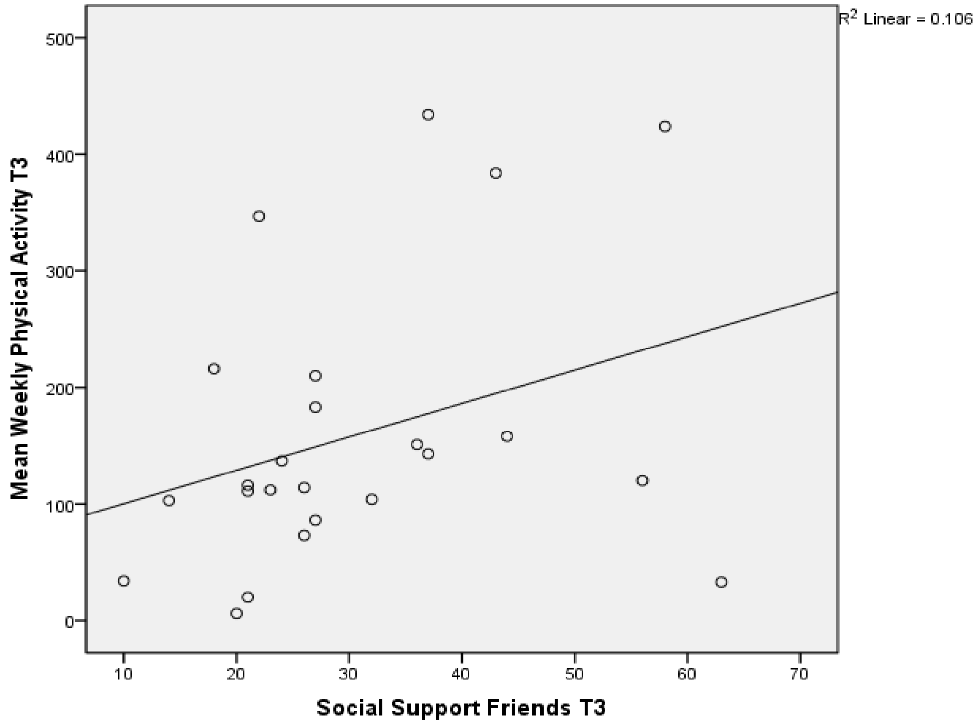
Scatterplot: the relationship between mean weekly physical activity and SE at T3



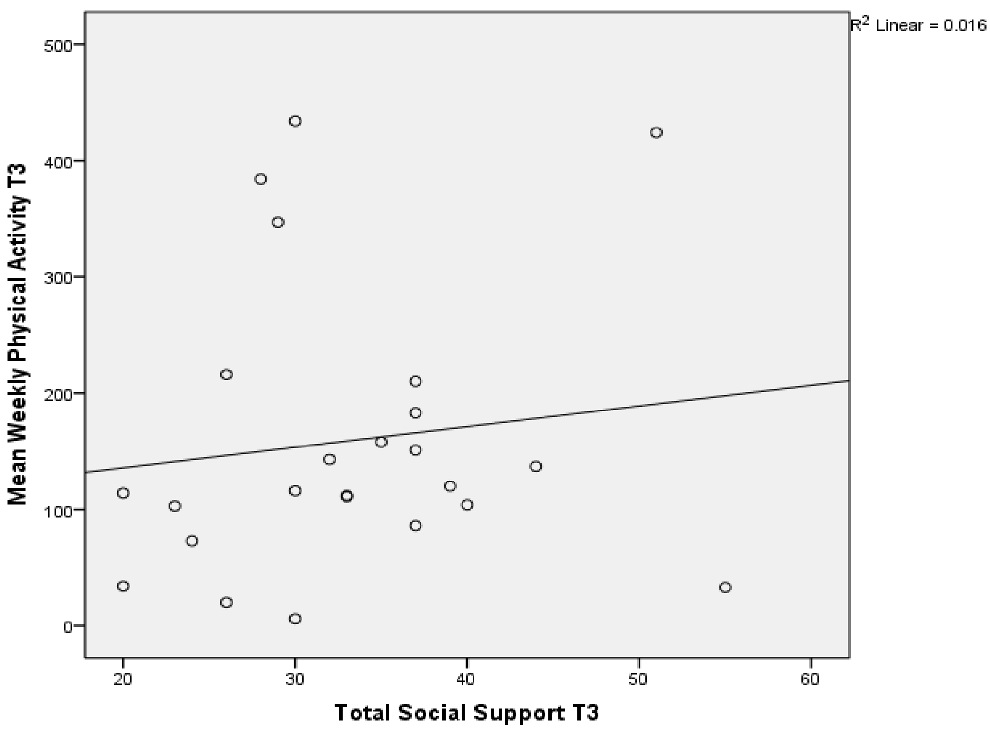
Scatterplot: the relationship between mean weekly physical activity and SSFam at T3



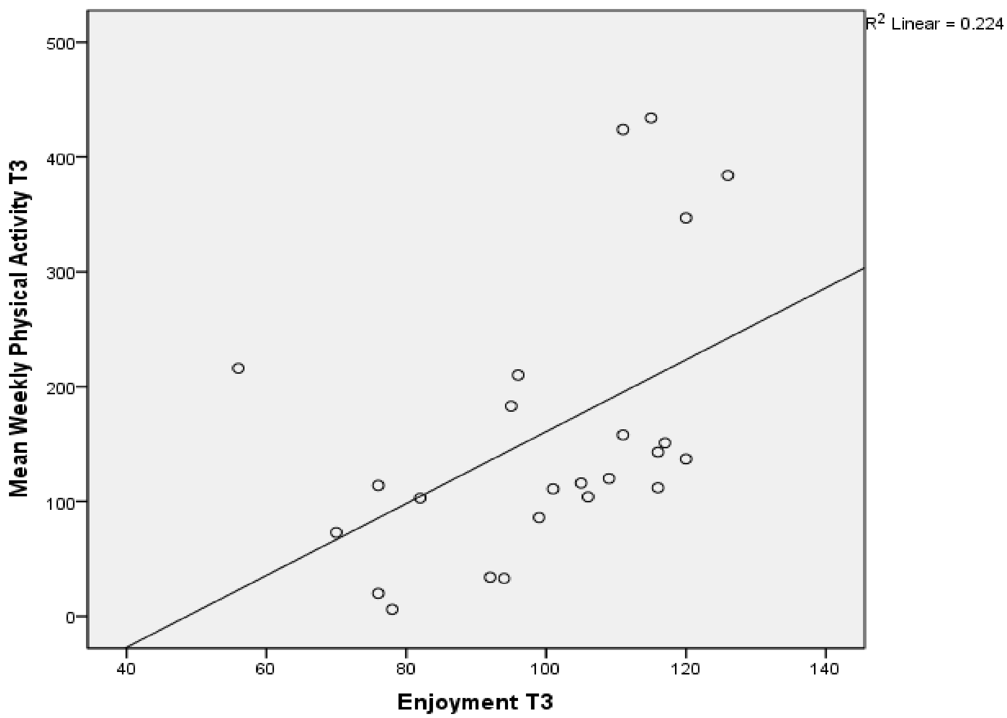
Scatterplot: the relationship between mean weekly physical activity and SSFri at T3



Scatterplot: the relationship between mean weekly physical activity and TSS at T3



Scatterplot: the relationship between mean weekly physical activity and Enjoyment at T3



Appendix 34

Pearsons product-moment correlations between mean weekly physical activity Mean Self-Efficacy, Total Social Support and Enjoyment at the end of T1

Correlations

		Mean Weekly Physical Activity T1	Mean Self Efficacy T1	Total Social Support T1	Enjoyment T1
Pearson Correlation	Mean Weekly Physical Activity T1	1.000	.147	.023	.302
	Mean Self Efficacy T1	.147	1.000	.220	.294
	Total Social Support T1	.023	.220	1.000	.287
	Enjoyment T1	.302	.294	.287	1.000
Sig. (1-tailed)	Mean Weekly Physical Activity T1	.	.246	.457	.076
	Mean Self Efficacy T1	.246	.	.151	.082
	Total Social Support T1	.457	.151	.	.087
	Enjoyment T1	.076	.082	.087	.
N	Mean Weekly Physical Activity T1	24	24	24	24
	Mean Self Efficacy T1	24	24	24	24
	Total Social Support T1	24	24	24	24
	Enjoyment T1	24	24	24	24

Pearsons product-moment correlations between mean weekly physical activity Social Support Family, Social Support Friends and Total Social Support at the end of T1

Correlations

		Mean Weekly Physical Activity T1	Social Support Family T1	Social Support Friends T1	Total Social Support T1
Pearson Correlation	Mean Weekly Physical Activity T1	1.000	-.191	.382	.023
	Social Support Family T1	-.191	1.000	.040	.845
	Social Support Friends T1	.382	.040	1.000	.565
	Total Social Support T1	.023	.845	.565	1.000
Sig. (1-tailed)	Mean Weekly Physical Activity T1	.	.185	.033	.457
	Social Support Family T1	.185	.	.426	.000
	Social Support Friends T1	.033	.426	.	.002
	Total Social Support T1	.457	.000	.002	.
N	Mean Weekly Physical Activity T1	24	24	24	24
	Social Support Family T1	24	24	24	24
	Social Support Friends T1	24	24	24	24
	Total Social Support T1	24	24	24	24

Appendix 35

Pearsons product-moment correlations between mean weekly physical activity Mean Self-Efficacy, Total Social Support and Enjoyment at the end of T2

Correlations

		Mean Weekly Physical Activity T2	Mean Self Efficacy T2	Total Social Support T2	Enjoyment T2
Pearson Correlation	Mean Weekly Physical Activity T2	1.000	.079	-.090	-.007
	Mean Self Efficacy T2	.079	1.000	-.088	.348
	Total Social Support T2	-.090	-.088	1.000	.034
	Enjoyment T2	-.007	.348	.034	1.000
Sig. (1-tailed)	Mean Weekly Physical Activity T2	.	.358	.338	.488
	Mean Self Efficacy T2	.358	.	.341	.048
	Total Social Support T2	.338	.341	.	.438
	Enjoyment T2	.488	.048	.438	.
N	Mean Weekly Physical Activity T2	24	24	24	24
	Mean Self Efficacy T2	24	24	24	24
	Total Social Support T2	24	24	24	24
	Enjoyment T2	24	24	24	24

Pearsons product-moment correlations between mean weekly physical activity Social Support Family, Social Support Friends and Total Social Support at the end of T2

Correlations

		Mean Weekly Physical Activity T2	Social Support Family T2	Social Support Friends T2	Total Social Support T2
Pearson Correlation	Mean Weekly Physical Activity T2	1.000	.085	-.222	-.090
	Social Support Family T2	.085	1.000	-.053	.695
	Social Support Friends T2	-.222	-.053	1.000	.680
	Total Social Support T2	-.090	.695	.680	1.000
Sig. (1-tailed)	Mean Weekly Physical Activity T2	.	.346	.148	.338
	Social Support Family T2	.346	.	.403	.000
	Social Support Friends T2	.148	.403	.	.000
	Total Social Support T2	.338	.000	.000	.
N	Mean Weekly Physical Activity T2	24	24	24	24
	Social Support Family T2	24	24	24	24
	Social Support Friends T2	24	24	24	24
	Total Social Support T2	24	24	24	24

Appendix 36

Pearsons product-moment correlations between mean weekly physical activity Mean Self-Efficacy, Total Social Support and Enjoyment at the end of T3

Correlations

		Mean Weekly Physical Activity T3	Mean Self Efficacy T3	Total Social Support T3	Enjoyment T3
Pearson Correlation	Mean Weekly Physical Activity T3	1.000	.412	.127	.473
	Mean Self Efficacy T3	.412	1.000	.047	.538
	Total Social Support T3	.127	.047	1.000	.419
	Enjoyment T3	.473	.538	.419	1.000
Sig. (1-tailed)	Mean Weekly Physical Activity T3	.	.023	.277	.010
	Mean Self Efficacy T3	.023	.	.414	.003
	Total Social Support T3	.277	.414	.	.021
	Enjoyment T3	.010	.003	.021	.
N	Mean Weekly Physical Activity T3	24	24	24	24
	Mean Self Efficacy T3	24	24	24	24
	Total Social Support T3	24	24	24	24
	Enjoyment T3	24	24	24	24

Pearsons product-moment correlations between mean weekly physical activity Social Support Family, Social Support Friends and Total Social Support at the end of T3

Correlations

		Mean Weekly Physical Activity T3	Social Support Family T3	Social Support Friends T3	Total Social Support T3
Pearson Correlation	Mean Weekly Physical Activity T3	1.000	-.138	.325	.127
	Social Support Family T3	-.138	1.000	-.074	.631
	Social Support Friends T3	.325	-.074	1.000	.717
	Total Social Support T3	.127	.631	.717	1.000
Sig. (1-tailed)	Mean Weekly Physical Activity T3	.	.260	.061	.277
	Social Support Family T3	.260	.	.365	.000
	Social Support Friends T3	.061	.365	.	.000
	Total Social Support T3	.277	.000	.000	.
N	Mean Weekly Physical Activity T3	24	24	24	24
	Social Support Family T3	24	24	24	24
	Social Support Friends T3	24	24	24	24
	Total Social Support T3	24	24	24	24

Appendix 37

Regression analysis for mean weekly physical activity minutes of exercise and the predictor variables Mean Self-Efficacy, Total Social Support and Enjoyment at the end of T1

Descriptive Statistics

	Mean	Std. Deviation	N
Mean Weekly Physical Activity T1	76.42	58.679	24
Mean Self Efficacy T1	2.96	.908	24
Total Social Support T1	31.00	6.101	24
Enjoyment T1	95.38	16.691	24

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.318[a]	.101	-.034	59.666

a. Predictors: (Constant), Enjoyment T1, Total Social Support T1, Mean Self Efficacy T1

b. Dependent Variable: Mean Weekly Physical Activity T1

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7992.788	3	2664.263	.748	.536[a]
	Residual	71201.045	20	3560.052		
	Total	79193.833	23			

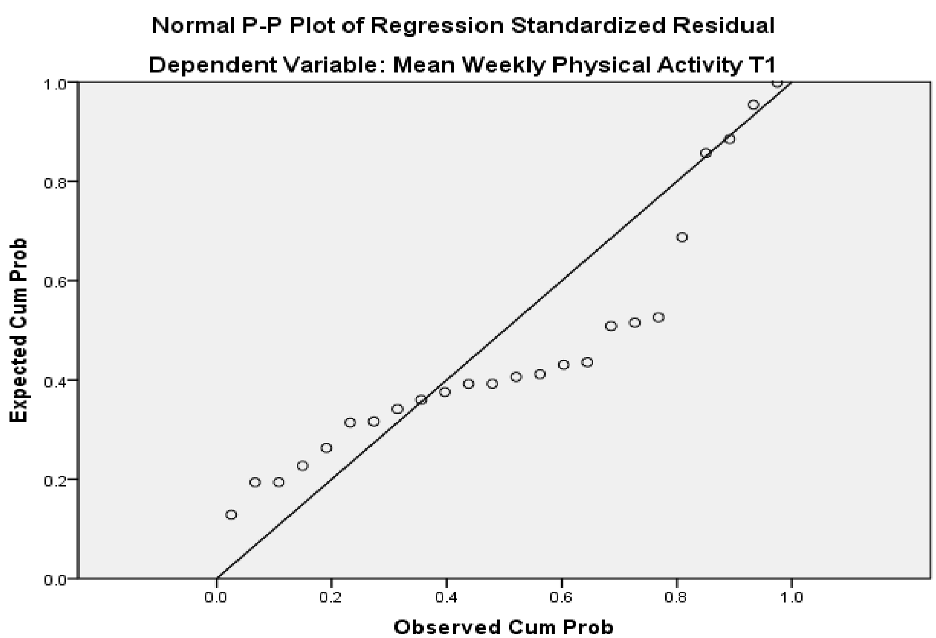
a. Predictors: (Constant), Enjoyment T1, Total Social Support T1, Mean Self Efficacy T1

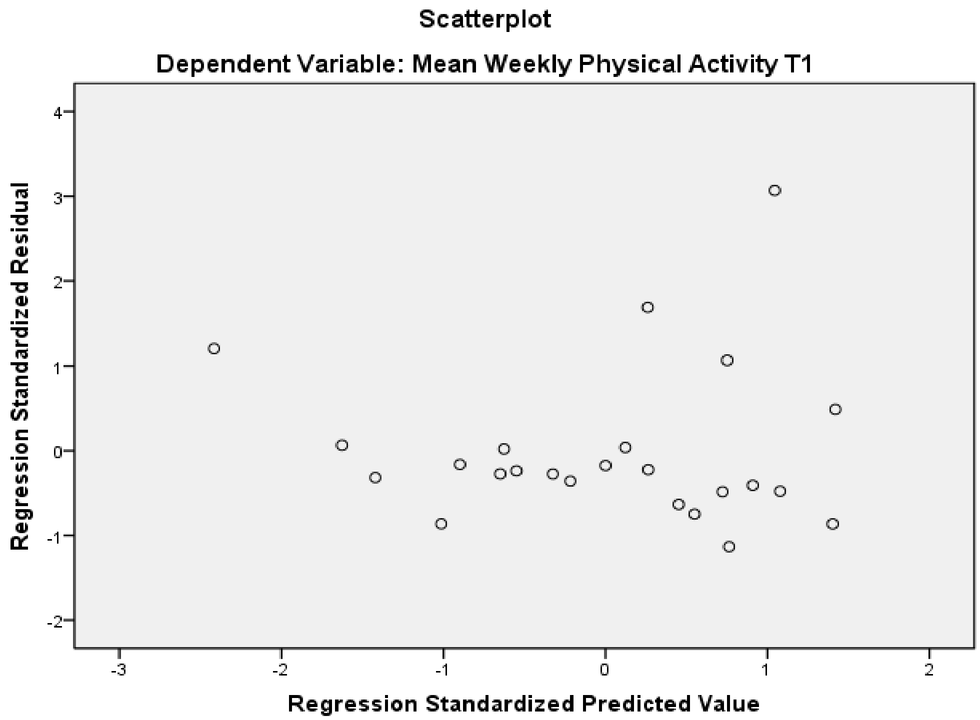
b. Dependent Variable: Mean Weekly Physical Activity T1

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	-15.763	86.020		-.183	.856	-195.197	163.670					
	Mean Self Efficacy T1	4.904	14.495	.076	.338	.739	-25.333	35.141	.147	.075	.072	.894	1.119
	Total Social Support T1	-.773	2.153	-.080	-.359	.723	-5.263	3.718	.023	-.080	-.076	.898	1.114
	Enjoyment T1	1.066	.803	.303	1.327	.199	-.609	2.740	.302	.284	.281	.862	1.160

a. Dependent Variable: Mean Weekly Physical Activity T1




Scatterplot
Dependent Variable: Mean Weekly Physical Activity T1
Regression Standardized Residual
Regression Standardized Predicted Value
4
3
2
1
0
-1
-2
-3
-2
-1
0
1
2

Appendix 38

Regression analysis for mean weekly physical activity minutes of exercise and the predictor variables Social Support Family, Social Support Friends and Total Social Support at the end of T1

Descriptive Statistics

	Mean	Std. Deviation	N
Mean Weekly Physical Activity T1	76.42	58.679	24
Social Support Family T1	32.29	10.183	24
Social Support Friends T1	29.04	6.537	24
Total Social Support T1	31.00	6.101	24

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.586[a]	.343	.245	50.990

a. Predictors: (Constant), Total Social Support T1, Social Support Friends T1, Social Support Family T1

b. Dependent Variable: Mean Weekly Physical Activity T1

ANOVA[b]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	27194.649	3	9064.883	3.487	.035[a]
	Residual	51999.185	20	2599.959		
	Total	79193.833	23			

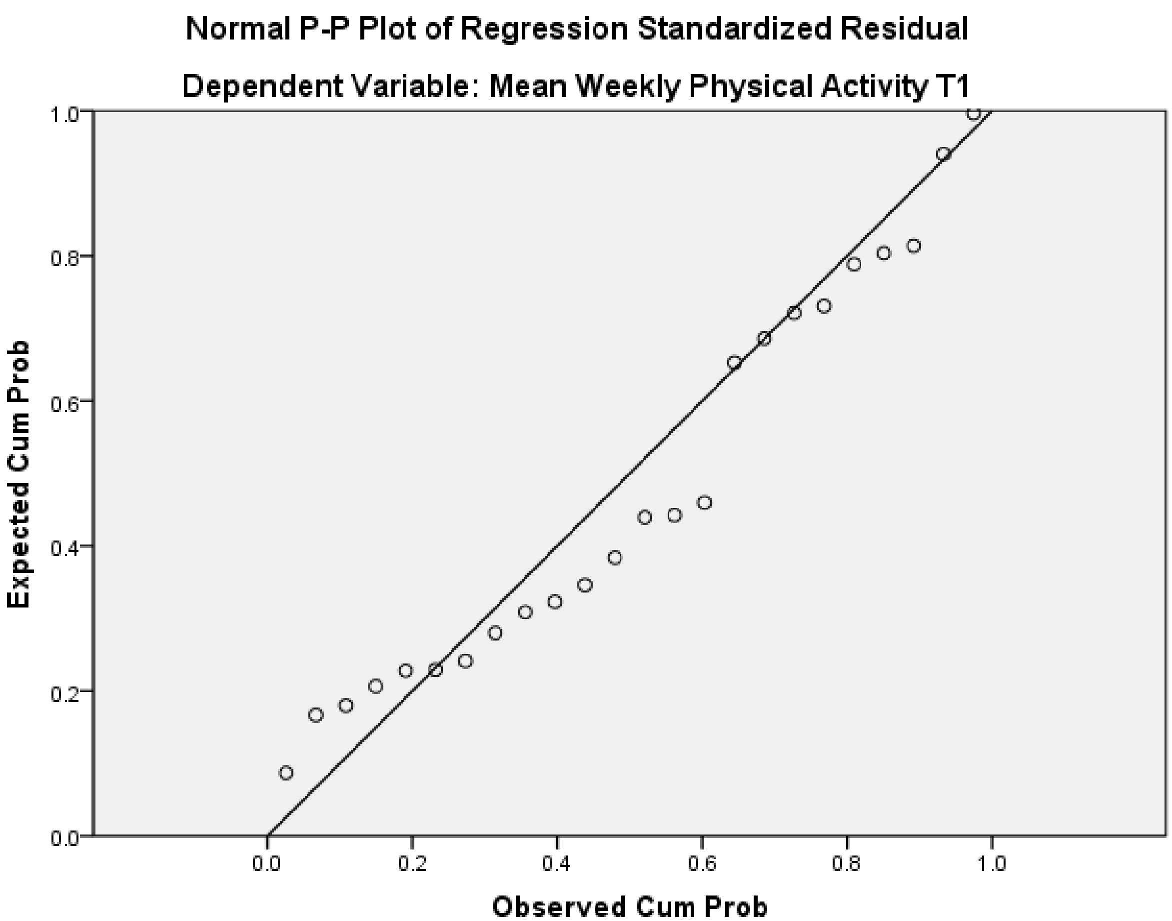
a. Predictors: (Constant), Total Social Support T1, Social Support Friends T1, Social Support Family T1

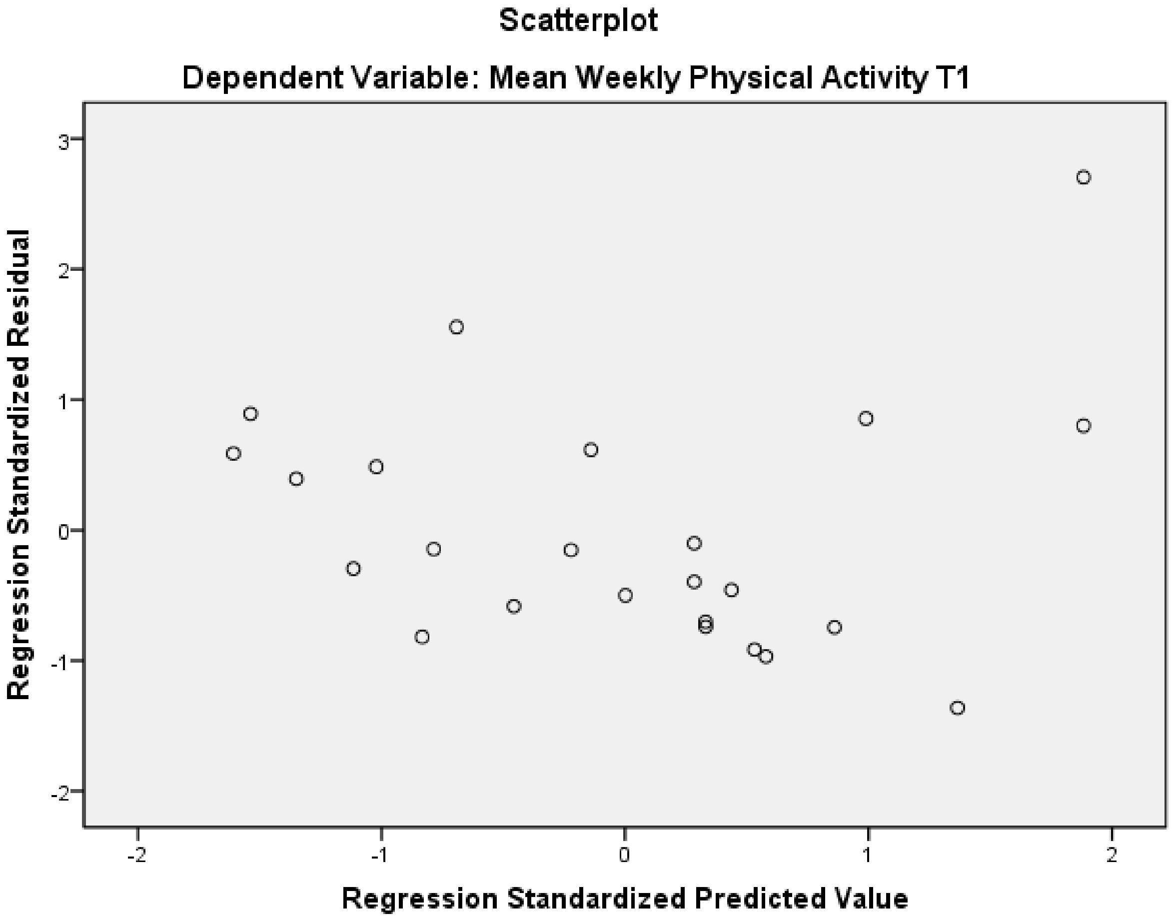
b. Dependent Variable: Mean Weekly Physical Activity T1

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	57.039	61.335		.930	.363	-70.903	184.981					
	Social Support Family T1	31.932	15.302	5.541	2.087	.050	.013	63.850	-.191	.423	.378	.005	214.778
	Social Support Friends T1	36.785	15.424	4.098	2.385	.027	4.612	68.958	.382	.471	.432	.011	89.937
	Total Social Support T1	-67.098	30.923	-6.976	-2.170	.042	-131.603	-2.594	.023	-.437	-.393	.003	314.826

a. Dependent Variable: Mean Weekly Physical Activity T1




Scatterplot
Dependent Variable: Mean Weekly Physical Activity T1
Regression Standardized Residual
Regression Standardized Predicted Value
3
2
1
0
-1
-2
-2
-1
0
1
2

Appendix 39

Regression analysis for mean weekly physical activity minutes of exercise and the predictor variables Social Support Family, Social Support Friends and Total Social Support at the end of T3

Descriptive Statistics

	Mean	Std. Deviation	N
Mean Weekly Physical Activity T3	159.13	121.954	24
Social Support Family T3	34.75	12.184	24
Social Support Friends T3	30.54	13.825	24
Total Social Support T3	33.17	8.766	24

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.410[a]	.168	.043	119.302

a. Predictors: (Constant), Total Social Support T3, Social Support Family T3, Social Support Friends T3

b. Dependent Variable: Mean Weekly Physical Activity T3

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	57416.787	3	19138.929	1.345	.288[a]
	Residual	284657.838	20	14232.892		
	Total	342074.625	23			

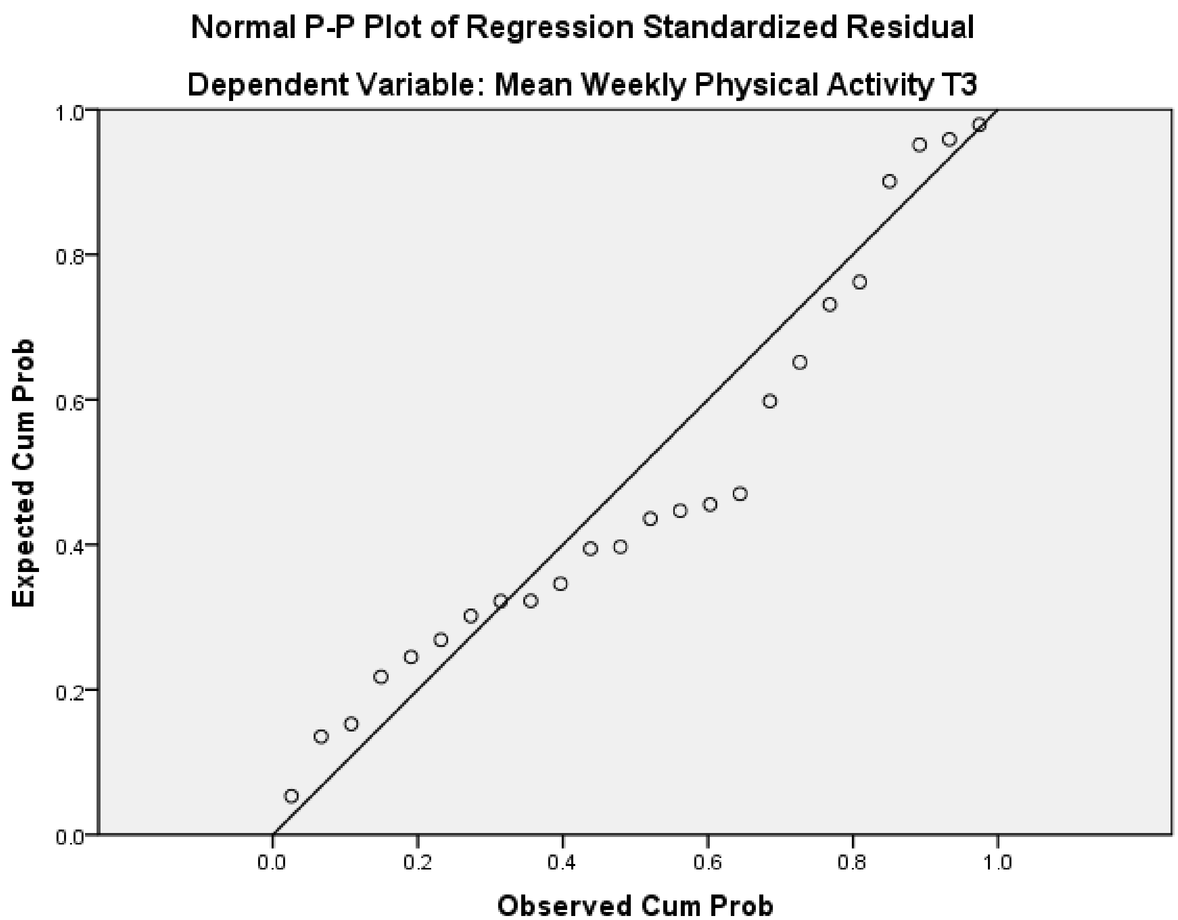
a. Predictors: (Constant), Total Social Support T3, Social Support Family T3, Social Support Friends T3

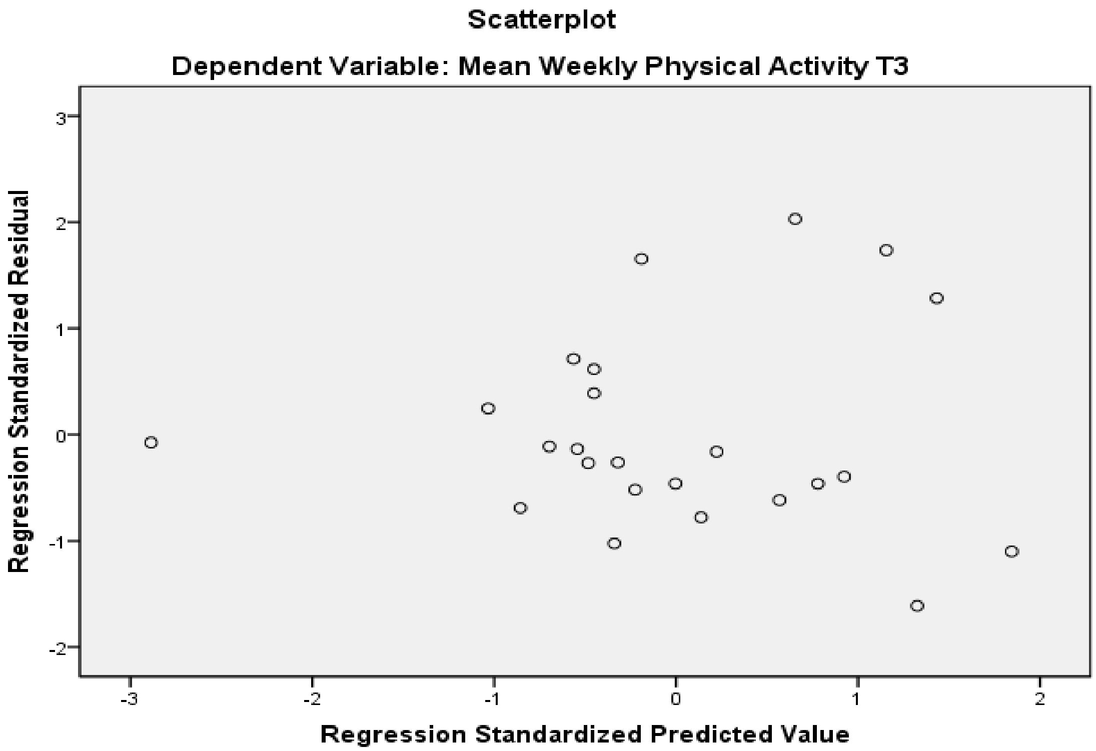
b. Dependent Variable: Mean Weekly Physical Activity T3

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta	T	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	141.265	99.556		1.419	.171	-66.405	348.935					
	Social Support Family T3	11.332	11.661	1.132	.972	.343	-12.993	35.658	-.138	.212	.198	.031	32.624
	Social Support Friends T3	15.073	11.440	1.709	1.318	.203	-8.791	38.937	.325	.283	.269	.025	40.424
	Total Social Support T3	-25.215	23.193	-1.812	-1.087	.290	-73.594	23.165	.127	-.236	-.222	.015	66.794

a. Dependent Variable: Mean Weekly Physical Activity T3




Scatterplot
Dependent Variable: Mean Weekly Physical Activity T3
Regression Standardized Residual
3
2
1
0
-1
-2
-3
-2
-1
0
1
2
Regression Standardized Predicted Value

Appendix 40

Descriptive statistics for the five physical activity mediators (Self-Efficacy, Social Support Family, Social Support Friend, Total Social Support and Enjoyment) at T1, T2 and T3

	N	Mean	Std. Deviation
Mean Self-Efficacy T1	24	2.88	.741
Mean Self-Efficacy T2	24	2.92	.830
Mean Self-Efficacy T3	24	3.04	.955
Social Support Family T1	24	33.42	9.546
Social Support Family T2	24	33.96	10.140
Social Support Family T3	24	33.21	12.532
Social Support Friend T1	24	28.71	7.469
Social Support Friend T2	24	27.67	12.527
Social Support Friend T3	24	32.29	11.461
Total Social Support T1	24	33.00	6.782
Total Social Support T2	24	31.17	9.490
Total Social Support T3	24	33.75	9.506
Enjoyment T1	24	95.38	16.691
Enjoyment T2	24	92.58	20.547
Enjoyment T3	24	99.46	18.437
Valid N (listwise)	24		

Appendix 41

Article published in the Irish Business Journal

Introduction

According to the World Health Organisation (WHO, 2011) approximately 31% of adult's world-wide fail to meet the minimum recommendations for health related physical activity and 46% of Irish adults do not meet the guidelines (SLAN, 2007). The WHO (2011) minimum physical activity recommendations designed for health benefits for adults aged between eighteen and sixty – five are as follows:

Table 1 World Health Organisations (WHO, 2011) Guidelines for Minimum Physical Activity

MINUTES	INTENSITY	DAYS PER WEEK
30	Moderate	5
OR		
25	Vigorous	3
AND Muscular endurance training at least two days or more per week		

How Much Physical Activity?

Trying to support individuals to initiate and maintain physical activity in the long term is a challenge (Brawley *et al*, 2003, Marcus *et al*, 1998 and Hasler *et al*, 2000). As individuals age their participation in physical activity drops off (Hughes *et al*, 2008 and Thurston & Green, 2004). Thirty minutes of moderate intensity physical activity on most days of the week is considered as a sufficient amount of physical activity for health benefits (Pate *et al*, 1995). Authors vary in their opinions about the type, duration and intensity of physical activity. Jakicic *et al* (1999 and 1995) report that short bouts of moderate cardiovascular physical activity (i.e. 4 by 10 minutes daily) assist in promoting physical activity adherence, compared to one forty minute session of physical activity. The WHO (2011) have adopted the findings of the ACSM (2008) who recommend that thirty minutes of physical activity per day will provide health related benefits. Research studies accept these guidelines from the WHO (Frank *et al*, 2005, Schumann *et al*, 2003 and Dunn *et al*, 1999) but also acknowledge that short bouts are sufficient to achieve physiological and psychological benefits of physical activity (Jackicic *et al*, 1999 and 1995).

Research signifies that females are the least active segment of the population and consequently are at a greater risk of developing diseases that are associated with a sedentary lifestyle (Findorff *et al*, 2009, Arbour & Ginis, 2009, Aaron *et al*, 1995 and Bonheur & Young, 1991). In Ireland, ten thousand people die each year from cardiovascular disease (Irish Heart Foundation, 2010). Participation in regular physical activity can enhance health and induce a greater lifespan (Paffenbarger *et al*, 1993).

Subjective and Objective Measurement Tools

Traditionally, physical activity has been measured via subjective measurements such as questionnaires and record logbooks. Questionnaires have been a popular research tool (Philippaerts *et al*, 2001 and Elosua *et al*, 2000). However, participants self-report their physical activity levels and can over estimate their physical activity minutes which can often decrease accuracy of results (Aoyagi & Shepard, 2009). Research indicates that a combination of subjective and objective data collection enhances the accuracy of measuring physical activity (Harris *et al*, 2008 and MacFarlene *et al*, 2006).

More recently, objective measurements such as accelerometers and the SW3 Armband have been introduced to assess physical activity (Taraldsen *et al*, 2011, Andre *et al*, 2006, Bassett 2000 and Sallis & Saelens, 2000). Wearable body sensor devices are been used increasingly in medical and clinical settings to monitor and analyse body functions (De Bruin *et al*, 2008, Corder *et al*, 2007, Stovitz *et al*, 2005 and Bjorgaas *et al*, 2004). 'As technology rapidly decreases in size, wearable monitoring devices has become a viable and practical reality', allowing individuals to wear body sensor devices for extended periods (Liden *et al*, 2002, p. 1). Motion sensor devices have provided greater accuracy in detecting physical activity patterns in a wide variety of settings (Clemes *et al*, 2008, Gerdhem *et al*, 2008 and Steele *et al*, 2003). Additionally, technological devices have a positive affect on adherence levels, preventing drop-outs from programmes (Henderick *et al*, 2010). King et al (2008, p.138) state that 'few systematic efforts to evaluate the efficacy of hand-held computers and similar devices for enhancing physical activity levels have occurred'. Consequently, this study evaluated the effectiveness of the SW3 Armband in promoting physical activity adherence in comparison to a PAL.

A range of studies to date have used subjective measures to quantify participation levels in physical activity (Schumann *et al*, 2003, Elosua *et al*, 2000 and Sarkin *et al*, 2000). The measurement of physical activity objectively through the use of a technical device is more accurate than assessing physical activity through a formal questionnaire (Bassett *et al*, 2000). Technological devices that are accompanied by a formal instrument such as a PAL can help highlight the significance of physical activity adherence issues (Tudor-Locke & Lutes, 2009, Lauzon *et al*, 2008 and Tudor-Locke *et al,* 2000).

Portable body sensing technology may assist in motivating individuals to adhere to physical activity because of the real time physiological data that the user can access (Baker *et al*, 2008, Bravata *et al*, 2007, Merom *et al*, 2007, Mutrie *et al*, 2004 and Tudor-Locke, 2002). A range of studies to date have used subjective measures to quantify participation levels in physical activity (Lawerence & Shank, 1995). Future research studies on physical activity adherence should consider incorporating a combination of both subjective and objective methods in order to increase our understanding of the effectiveness of such technological devices and formal instruments.

The SW3 Armband and Physiological Characteristics

With advancements in technological innovation, physical activity is becoming easier to monitor and analyse. Marketable devices such as pedometers, accelerometers and more recently the SW3 Armband provide individuals with real time physiological data and are accessible to the recreational enthusiast. According to King et al (2008, p. 138) 'efforts to achieve population wide increases in physical activities potentially can be enhanced through relevant applications of interactive communication technologies'. Research has shown that motion sensors are a valid and reliable means of gathering data (Bender *et al*, 2005, Duncan *et al*, 2005 and Yamanouchi *et al*, 1995).

The SW3 comprises an armband worn on the upper right arm and a wrist watch display. The SW3 is a wireless device comprising a transmitter worn on the upper arm that captures real time, collective and significant data. It is recommended that the SW3 is worn twenty four hours per day and is only removed when the individual is bathing or swimming. The data stored can be acquired by connecting the armband to a computer system and using the online activity manager to download and access the information. Real time data such as how many steps an individual has taken within twenty four hours, can be retrieved in real time from the wrist watch display. The SW3 has been clinically validated to be over ninety per cent accurate when determining calorie burn (Johannes, 2009).

Kasabach et al (2002, p. 2) noted that ‘energy expenditure, level of physical activity, sleep quality, heart rate, stress, and contextual awareness were the most significant states worth obtaining continuously’. The SW3 processes the following information: 1. Total Energy Expenditure and Active Energy Expenditure, 2. Duration of Physical Activity, 3. Sleep Duration, 4. Number of Steps, 5. Duration the SW3 Armband is worn. The SW3 Armband provides an easy and efficient digital device to individuals to assess daily physiological characteristics (Andre *et al*, 2006) and can offer assistance to health and fitness instructors in supporting clients to make healthier lifestyle choices. This information can be captured and calculated every minute of the day as long as the user is wearing the armband (Fruin & Rankin, 2004). The SW3 captures averages and variances on all features, but also can detect peak phases (i.e. a day of the week in which a user has walked the most number of steps (Andre *et al*, 2006).

Research Methodology

The research study was completed by means of a quantitative approach. Participants were required to self-report their activity, duration and intensity of physical activity in their PAL’s. The quantitative method involved analysing the accumulated minutes of moderate and vigorous physical activity within the PALs. These were collected at the end of T1 (week eight), T2 (week eighteen) and T3 (week twenty-six). All participants filled out a questionnaire regarding the ease of use of the PAL. The IG also completed a questionnaire on the ease of use of the SW3 Armband. Intensity of physical activity was measured using the Omnibus Scale of Perceived Exertion (OMNI), adult: walking to running format (Robertson, 2004). OMNI is short for 'omnibus' which means that the perceived exertion picture scale used to measure intensity is appropriate for a wide diversity of individuals and physical activity settings.

Participants

Female volunteers were recruited through local media inviting applicants to join the research programme. A total of eighty-nine volunteers applied for the programme, entitled *'Get Started and Stick with it'*. Thirty females were selected from a total of the fifty-eight applicants that met the recruitment criteria. The researcher chose to use a set of random numbers proposed by Spiegel *et al* (2008, p. 419) to select and assign participants at Baseline to one of two treatment conditions. Participants in the IG had the use of a digital body monitoring device known as the SW3 Armband, in conjunction with a PAL that tracked their physical activity participation. The remaining fifteen participants in the CG did not have access to the SW3 Armband, but kept a PAL only. For the duration of the study a trained research assistant responded to queries from participants and withdrawals from the study. In addition, the research assistant completed four structured assessments with the participants at Baseline, at the end of T1, T2 and T3 and was responsible for distributing and administering the PALs and questionnaires.

Definition of Regular, Moderate and Vigorous Physical Activity

For the purposes of this study regular, moderate and vigorous physical activity was defined as follows:

1. Regular physical activity was defined in accordance with the WHO (2011) recommended guidelines for physical activity of thirty minutes of moderate

intensity physical activity five days per week OR an equivalent combination of moderate and vigorous physical activity.

2. Moderate physical activity exertion should result in being slightly out of breath and categorised from 'number five to number seven' on the Omnibus Scale of Perceived Exertion (Robertson, 2004).
3. Vigorous physical activity should result in deep rapid breathing and categorised from 'number eight to ten' on the Omnibus Scale of Perceived Exertion (Robertson, 2004).

Intervention Group and Control Group

The physical activity levels of participants (n = 30) in the IG and CG was assessed via a PAL. Participants followed a generic physical activity programme that included activities such as walking, swimming, home workout, fitness classes and an open activity option classified as 'other'. Participants recorded the type and duration of their physical activity and the intensity of their workouts in the PAL on a pre-determined scale (Robertson, 2004). Participants in the IG also had the use of the SW3 Armband and direct access to the data it stored, as a potential motivational tool to aid physical activity adherence. The difference between the IG and the CG was that the IG had the use of both a PAL and the SW3 Armband, whilst the CG had use of a PAL only as a means of potential motivation.

The Study: Baseline, T1 (week 1-week 8), T2 (week 9-week 18) and T3 (week 19-week 26)

Before commencing the programme participants were screened for any medical conditions using a Physical Activity Readiness Questionnaire. A summary of the purpose of the study and the benefits of physical activity was presented by the research assistant. The research assistant inducted the relevant participants to the use of the PAL and the SW3 Armband. A generic fitness programme was given to participants. The research assistant supported the participants, offering an optional accompanied physical activity session once per week during the first eight weeks.

At the end of T1 (week eight), the research assistant collected the PALs for the first eight weeks of the programme and the quantitative questionnaires on the use of the SW3 Armband and PAL were distributed and collected. An updated generic physical activity programme was distributed to participants. Participants were also provided with a second PAL. The optional accompanied weekly physical activity session with the research assistant was discontinued after week eight. Support from the research assistant was also withdrawn after week eight. Participants who were having technical problems with the SW3 Armband or needed to contact the research assistant after T1, did so via email only, thus no direct contact.

At the end of T2 (week eighteen), the research assistant collected the PALs and the quantitative questionnaires on the SW3 Armband were distributed and collected for a second time. An updated generic physical activity programme was distributed to participants. Participants were also provided with a third PAL.

At the end of T3 (week twenty-six), the research assistant collected the PALs and the quantitative questionnaires on the SW3 Armband were distributed and collected for a third time. Participants returned the SW3 Armbands and this marked the end of the twenty-six week research intervention. Participants were rewarded with a thank you card for their commitment to the programme.

Table 2 Profile of Participants: Comparison between the Intervention Group (IG) and the Control Group (CG)

Variable	**Measure**	**IG**	**CG**
Age (years)	Average	40.26	40.46
Work Status (%)	Employed	60	53
	Self-Employed	0	7
	Unemployed	20	27
	Student	7	0
	Housewife	13	13
Smokers (%)	Yes	7	7
	No	93	93
Marital Status (%)	Single	33	27
	Married	67	60
	Other	0	13
Baseline Activity Level (%)	Sedentary	53	33
	Irregularly active	47	67

Table 2 above presents a demographic synopsis of all participants in the study. Participants' age, work, marital status and their physical activity levels before commencing the programme are displayed. As it is evident, similar findings can be found regarding the profile of the IG and CG in terms of age, work status, physical activity behavioural habit and marital status. The average age of participants in both groups was forty years of age. However, the table reports a difference between both groups baseline physical activity levels. The control group exhibited a significantly higher baseline activity level when compared to the intervention group. A significance difference was also notable at baseline regarding irregular activity, with the intervention group more likely to engage in irregular activity than the control group.

Findings

As stated previously, the aim of this quantitative study was to compare the impact of SW3 Armband to a PAL in promoting physical activity adherence. The findings are presented by comparing both groups' total accumulated minutes of moderate and vigorous physical activity. The effectiveness of using a PAL as part of a physical activity programme is examined and the efficacy of the SW3 Armband is also assessed.

Table 3: The total accumulated minutes of moderate and vigorous physical activity performed over T1, T2 and T3 for both the IG and CG

Time	Moderate (IG)	Moderate (CG)	Vigorous (IG)	Vigorous (CG)
T1	5261	8248	870	1005
T2	5680	17745	1365	1125
T3	6980	20808	1695	1053
Total	**17921**	**46801**	**3930**	**3183**

Table 3 above provides evidence that the CG performed more moderate minutes of physical activity over T1, T2 and T3 compared to the IG. The most preferred activity was walking, followed by attending a fitness class (pilates, aerobics and circuit training classes). Unseasonally heavy snowfall in the North West of Ireland in November and December, 2010 affected both groups physical activity patterns for a four week period. Both the IG and CG accumulated fewer minutes of vigorous physical activity over T1, T2 and T3. The IG accumulated more minutes of vigorous physical activity over T2 and T3 compared to the CG. At the end of T3, the CG had accumulated three times more moderate physical activity levels than the IG. Therefore, these results outline that given the conditions of this study, a PAL is a motivational tool in aiding physical activity adherence because the CG accumulated more minutes of moderate physical activity over the six month period of the study, compared to the IG. In addition, the CG met the WHO (2011) minimum recommendations for physical activity at the end of T3.

Table 4: The percentage of participants in the IG and CG who found use of Physical Activity Logbook (PAL) to be convenient or inconvenient

	Extremely Convenient		Convenient		Somewhat Convenient		Somewhat Inconvenient		Inconvenient		Extremely Inconvenient	
Group	**IG**	**CG**	**IG**	**CG**	**IG**	**CG**	**IG**	**CG**	**IG**	**CG**	**IG**	**CG**
T1 (%)	17	38	17	38	33	15	25	8	8	0	0	0
T2 (%)	25	33	25	33	42	25	0	0	8	8	0	0
T3 (%)	8	25	25	42	58	25	0	0	0	8	8	0

The majority of participants within both groups found that a PAL is a convenient method to track participation in physical activity. Few participants acknowledged the PAL as an inconvenience.

Table 5: The percentage of participants in the IG and CG who completed their PAL daily

Group Time	IG T1	CG T1	IG T2	CG T2	IG T3	CG T3
Yes (%)	42	38	25	58	17	33
No (%)	58	62	75	42	83	67

Completing a daily PAL proved to be a challenge for participants in both groups. At the end of T3, 83% of participants in the IG and 67% of participants in the CG revealed that they did not complete a daily PAL. The PAL relies on a twenty-four hour recall; thus participants can overestimate or underestimate their physical activity levels by not completing their PAL daily (MacFarlane *et al*, 2006).

Table 6: The percentage of participants in the IG and CG who found a PAL was a motivational tool for physical activity adherence

Group Time	IG T1	CG T1	IG T2	CG T2	IG T3	CG T3
Yes (%)	50	69	42	75	58	67
No (%)	50	31	58	25	42	33

The PAL is a consistent motivational tool and technique to record physical activity. At the end of T3, 58% of participants in the IG and 67% of participants in the CG found a PAL to be a form of motivation for physical activity adherence.

Table 7: The percentage of participants in the IG that found the SW3 Armband easy or difficult to operate

Time	Extremely Easy	Easy	Somewhat Easy	Somewhat Hard	Hard	Extremely Hard
T1 (%)	8	50	8	33	0	0
T2 (%)	33	17	25	25	0	0
T3 (%)	17	42	8	33	0	0

Table 7 shows that the majority of participants confirmed that the SW3 Armband is easy to operate. A small percentage of participants stated that the SW3 Armband was 'somewhat hard' to operate during T1, T2 and T3. Participants encountered some technical difficulties with the SW3 Armband during the programme and these issues were logged and resolved with the research assistant.

Table 8: The percentage of participants in the IG and their perception of the SW3 Armband as part of a physical activity programme

Did you find the SW3 Armband comfortable to wear?				
Time	**T1**		**T2**	**T3**
Yes (%)	50		42	50
No (%)	50		58	50
Barriers associated with wearing the SW3 Armband				
Time	**Size**	**Irritating**	**Self-Consciousness**	**Dress Code**
T1 (%)	8	33	8	17
T2 (%)	8	42	8	17
T3 (%)	8	42	8	17
Was the SW3 Armband a form of motivation for physical activity adherence?				
Time	**T1**		**T2**	**T3**
Yes (%)	62		58	67
No (%)	38		42	33

Table 8 above displays results relating to the comfort of wearing the device, the barriers relating to the SW3 Armband and the device as a supportive mechanism for promoting physical activity adherence. At the end of T3, 50% of participants acknowledged that the SW3 Armband was not comfortable to wear; these figures were consistent for T1 and T2. As a result, participants perceived barriers to wearing the device. The main barrier to using the SW3 Armband was irritation of the strap on the upper arm when worn for long periods of time. Although the SW3 Armband presents some barriers, 67% of participants found that the SW3 Armband was a motivational tool in aiding physical activity adherence. Conversely, 58% of participants in the IG found a PAL to be a motivational method of promoting physical activity adherence.

Conclusion

It can be concluded from the research that in the conditions imposed by the study, a traditional method of recording physical activity levels through the use of a PAL is more effective when compared to the SW3 Armband. The main barrier to wearing the SW3 Armband is 'irritation' of the upper arm caused when the device is worn for long periods of time. However, the SW3 Armband also acted as a motivational instrument but did not provide adequate support to assist participants in meeting the WHO (2011) physical activity guidelines.

Walking is a popular choice of physical activity for females in the age categories stated. Women are at a greater risk of developing cardiovascular disease and sustaining an inactive lifestyle (Findorff *et al*, 2009, Arbour & Ginis, 2009). Therefore, walking programmes and interventions should be administered in various physical activity settings to promote walking amongst female participants within this age range. This type of intervention offers greater potential in promoting physical activity and increasing female participation.

Future research studies could encourage the use of a PAL, especially for this age category (thirty to fifty years of age). Attitudes towards apprehensiveness in using technological devices to track physical activity adherence is also recommended. To tackle the burden of cardiovascular disease and associated mortality rates in Ireland amongst females, government agencies could focus on interventions that focus on walking, and physical activity tracking via a formal PAL, as a means of motivational support to increase physical activity levels.