The Development, Validity and Efficacy of different modes of Self Recall Training Diaries in assessing training load on Gaelic Footballers

Thesis submitted for the degree of Masters of Science

Siobhán O Connor (BSc)

School of Health and Human Performance

Dublin City University

Supervisor: Dr Noel McCaffrey

June 2012

Acknowledgements

To my supervisor Dr. Noel McCaffrey for his continued support, encouragement and words of advice throughout the thesis.

To all who assisted in developing the Training Diary including Dr Noel McCaffrey, Enda Whyte, Professor Mike Ferrara and Tony Farrell.

To all who volunteered to be my guinea pigs in the Pilot and Validation Study. Thanks for agreeing before I even had to ask twice.

To the managers, selectors and players from the Glenelly Under-14 girls, Clontarf Under-14 boys, Dublin Minor boys, Inch Minor girls, Clontarf Senior ladies and Padraig Pearse's Senior men's teams. I greatly appreciate the time and energy put into filling in and organising the Training Diaries and questionnaires.

To the staff and postgraduates in the School of Health and Human Performance. Thanks for your constant support and advice.

To my family for listening to me and putting up with me for the last two years. Special thanks to Mam for the cups of tea, Deirdre for the words of wisdom and Kathleen for teaching me grammar.

To my friends. Thanks for distracting me on a daily basis and pretending to care about Training Diaries ☺

Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of MSc is entirely my own work, that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

Signed: _____ (Candidate)

ID No.: 55482755____

Date: _____

Abstract

Analysing Gaelic Footballers' training load is important, as optimal levels of training will improve sporting performance and physical well-being. However, excessive or inappropriate training could increase the likelihood of injury or overtraining.

Aim: To develop an effective and valid method of assessing training load in Gaelic Footballers.

Methods: The primary aim was achieved through the completion of four related studies. *Study One:* The Training Diary was developed and a pilot study was completed. *Study Two:* The paper and online Training Diary's efficacy was compared over six Gaelic Football teams of both genders aged 14-30. *Study Three:* The Training Diary was validated against an accelerometer, SenseCam and interview. *Study Four:* The effect of an email and text reminder on the Training Diary was assessed.

Results: The Training Diary had a high face and convergent validity against the objective methods of measurement. Training Diaries provided a reasonable response rate. The average response rate for the paper and online Training Diary was 26.6% and 15.2% respectively. The use of email and text reminders with the online Training Diary increased the response rate to 21.9% and 31.9% respectively. No significant difference was found between paper and online Training Diaries. The text reminder produced a significantly higher response rate than no reminder ($p<0.05$). Gender caused no significant effect on response rates. Age caused no significant difference in response rates in the Online or Paper Training Diary. A significant difference was found between the Under-14 and Minor team, and the Under-14 and Adult team in response rates when using a reminder. The Under-14 team had a lower response rate than both of the older teams and the effect size was found to be large. There was no significant difference found between the Minor or Adult team. Participants reported no significant preference between the online and paper Training Diary, for which method they preferred, could access, fill out, return and use in the future the questionnaire. Reminders, especially the text reminder was found to be the most statistically beneficial. No significant preference for what time of the day to receive a reminder was noted by participants.

Conclusion: Training Diaries are an extremely valid and reasonably effective method of assessing training load in Gaelic Footballers. Reminders assist in increasing the response rate.

Table of Contents

ACKKNOWLEDGEMENTS....ii

DECLARATION....iii

ABSTRACT....iv

TABLE OF CONTENTS....v

TABLE OF FIGURES....xii

LIST OF TABLES....xii

Chapter 1.0 Introduction....1

1.1 Introduction....1

1.2 Aim of Study....2

1.3 Study Design....3

1.4 Hypothesis....3

1.5 Implications of the Study....3

1.6 Delimitations of the Study....4

1.7 Limitations of the Study....5

1.8 Definition of Terms....6

1.9 Summary of Introduction Chapter....7

Chapter 2.0 Literature Review....8

2.1 Physical Activity and methods to assess it....8

2.1.1 Criterion Methods....9

2.1.1.1 Direct Observation....10

2.1.1.2 Doubly Labelled Water....10

2.1.1.3 Indirect Calorimetry....11

2.1.2 Secondary (Objective) Measures....11

2.1.2.1 Heart Rate Monitor....11

2.1.2.2 Pedometer....12

2.1.2.3 Accelerometer....13
2.1.2.4 SenseCam....14
2.1.2.5 The Global Positioning System (GPS)....16
2.1.3 Subjective Measures....17
2.1.3.1 Questionnaire....17
2.1.3.2 Training Diary....18
2.2 Development of a Training Diary....19
2.2.1 Details Required by a Training Diary....19
2.2.1.1 Classification....19
2.2.1.2 The Team played with and Level of Activity....19
2.2.1.3 Relative Age....20
2.2.1.4 Perceived intensity in Training Diaries....20
2.2.1.5 Duration of Activity....21
2.2.1.6 Travel Time....21
2.2.1.7 Playing Surface....22
2.2.1.8 Footwear....23
2.2.1.9 Injury....23
2.2.1.10 Illness in Training Diaries....24
2.2.2 Using Codes in Training Diaries....25
2.3 Issues with Training Diaries....25
2.3.1 The Activity....26
2.3.1.1 Intensity of Activity....26
2.3.1.2 Environmental Conditions....27
2.3.2 The Participant....27
2.3.2.1 Age of Participant....27
2.3.2.2 Education of Participant....28

2.3.2.3 Employment Status....28
2.3.2.4 Gender....28
2.3.2.5 The Participant's level of Activity....29
2.3.2.6 Personality Traits....29
2.3.2.7 Race....30
2.4. Method of Filling in the Training Diary....30
2.4.1 Paper Training Diary....30
2.4.2 Online Training Diary....31
2.4.3 SMS Training Diary....32
2.4.4 Java Based Training Diary on a mobile phone....33
2.5. Timing of Filling in the Training Diary....33
2.6 Compliance and Return Rate of the Training Diary....35
2.6.1 Text Message....36
2.6.2 Phone Call....36
2.6.3 Email....36
2.6.4 Encourage a Routine....37
2.6.5 Identification with Researchers....37
2.6.6 Interest in the Study....38
2.6.7 Incentive....38
2.6.8 Support of Managers and Parents....38
2.7 Validation of the Training Diary....38
2.7.1 Representativeness of a validation study....39
2.7.2 Gender Distribution of a validation study....39
2.7.3 Sample Size of a validation study....40
2.7.4 Statistical Power....40
2.8 Summary of Literature Review Chapter....41

Chapter 3.0 Methodology....42
3.1 Research Design Overview....42
3.2 Purpose of Study....42
3.3 Research Team....43
3.4 Ethical and Legal Considerations....43
3.5 Participants....43
3.6 Data Collection/Procedure....44
3.7 Research Tools/Equipment....46
3.8 Data Analysis....49
3.9 Summary of Methodology Chapter....50
Chapter 4.0 Results....51
4.1 Pilot Study....51
4.2 Validation Study....52
4.2.1 Sport Played....52
4.2.2 Team Played with....52
4.2.3 Age Group....52
4.2.4 Activity Played....52
4.2.5 Intensity of Activity....52
4.2.6 Session Length....54
4.2.7 Travel Time....56
4.2.8 Training Surface....58
4.2.9 Footwear....58
4.2.10 Injury....58
4.3 Response Rates Study Two....58
4.3.1 Response Rate Adult Ladies Gaelic Football....59
4.3.2 Response Rate Adult Men's Gaelic Football....60

4.3.3 Response Rate Minor Ladies Gaelic Football.....60
4.3.4 Response Rate Minor Men's Gaelic Football.....61
4.3.5 Response Rate Under-14 Girl's Gaelic Football.....61
4.3.6 Response Rate Under-14 Boy's Gaelic Football.....62
4.4 Response Rates Study Four.....62
4.4.1 Response Rate Adult Ladies Gaelic Football.....63
4.4.2 Response Rate Adult Men's Gaelic Football.....64
4.4.3 Response Rate Minor Ladies Gaelic Football.....64
4.4.4 Response Rate Minor Men's Gaelic Football.....64
4.4.5 Response Rate Under-14 Girl's Gaelic Football.....64
4.4.6 Response Rate Under-14 Boy's Gaelic Football.....65
4.5 Questionnaire Results.....65
4.5.1 Method of Filling out the Training Diary.....65
4.5.1.1 Method of Filling out the Training Diary Adult Ladies.....65
4.5.1.2 Method of Filling out the Training Diary Adult Men.....66
4.5.1.3 Method of Filling out the Training Diary Minor Ladies.....66
4.5.1.4 Method of Filling out the Training Diary Minor Men.....67
4.5.1.5 Method of Filling out the Training Diary Under-14 Girls.....68
4.5.1.6 Method of Filling out the Training Diary Under-14 Boys.....68
4.5.2 Reminder Questionnaire.....69
4.5.2.1 Reminder Adult Ladies.....69
4.5.2.2 Reminder Adult Men.....70
4.5.2.3 Reminder Minor Ladies.....70
4.5.2.4 Reminder Minor Men.....71
4.5.2.5 Reminder Under-14 Girls.....71
4.5.2.6 Reminder Under-14 Boys.....71

4.6 Summary of Results Chapter....72
Chapter 5.0 Discussion....73
5.1 Introduction to Discussion....73
5.2 The Pilot Study....73
5.3 Validation of the Training Diary....74
5.3.1 Validation of Training Information....74
5.3.2 Validation of Intensity....74
5.3.3 Validation of Physical Activity Duration....78
5.3.4 Validation of Travel Time....79
5.3.5 Overall Validity and reasons for Variations....80
5.4 Response Rate....82
5.4.1 Reported Response Rate....82
5.4.2 Decrease of Response Rate over time....82
5.4.3 Effect of Age on Response Rate....83
5.4.4 Effect of Gender on Response Rate....83
5.4.5 Effect of Dropout on Response Rate....83
5.4.6 Response Rate Hypothesis....84
5.5 The Use of Reminders....84
5.5.1 The Effect of Reminders on Response Rate....84
5.5.2 Reminder Hypothesis....84
5.6 Questionnaire....85
5.6.1 The Qualitative viewpoint on Method of Filling in the Training Diary....85
5.6.2 The Qualitative viewpoint on Reminders....85
5.7 Practical Issues....85
5.7.1 Distribution and Returning of the Training Diary....86
5.7.2 Misinformation of Participant Details....87

5.7.3 Interest in Study.....87
5.8 Recommendations.....88
5.8.1 Involvement of Researchers.....88
5.8.2 Modification of Training Diary.....88
5.8.3 Addition of other Self Report Tools.....89
5.9 Future Research.....89
5.9.1 Utilise other methods of Filling in the Training Diary.....89
5.9.2 Longer Testing Period.....90
5.9.3 Assessing effect of Reminders on the paper Training Diary.....90
5.9.4 Use of an Incentive.....90
5.9.5 Utilise various Cut off Points in Validation Study.....90
5.9.6 Additional Equipment for Validation Study.....90
5.10 Conclusion.....91
Chapter 6.0 Conclusion.....92
Chapter 7.0 Bibliography.....93
Chapter 8.0 Appendices.....101

List of Figures

Figure 4.2.5: Agreement between Intensity of Training Diary and Accelerometer.....p.54

Figure 4.2.6: Agreement between Training Diary Duration of Activity and SenseCam.....p.56

Figure 4.2.7: Agreement between Training Diary Travel Time and SenseCam.....p.58

Figure 4.4.1.1: Method Players found Easiest to Access.....p.66

Figure 4.4.1.4: Why Players found a Method easier to Return.....p.68

Figure 4.4.2.1: What Time of the Day would Players Prefer to receive Reminder.....p.70

Figure 4.4.2.4: What Time of the Day would Players Prefer to receive Reminder.....p.71

List of Tables

Table 3.6.3: Testing Protocol for Study Two.....p.45

Table 3.6.4: Testing Protocol for Study Four.....p.46

Table 4.1: Pilot Study Results.....p.51

Table 4.2.5: Levels of Intensity in Training Diary and Accelerometer.....p.53

Table 4.3a: Effect of Gender on Response Rate.....p.59

Table 4.3b: Effect of Age on Response Rate.....p.59

Table 4.3.1a: Print Training Diary.....p.59

Table 4.3.1b: Online Training Diary.....p.60

Table 4.3.2a: Print Training Diary.....p.60

Table 4.3.2b: Online Training Diary.....p.60

Table 4.3.3a: Print Training Diary.....p.60

Table 4.3.3b: Online Training Diary.....p.61

Table 4.3.4a: Print Training Diary.....p.61

Table 4.3.4b: Online Training Diary.....p.61

Table 4.3.5a: Print Training Diary.....p.61

Table 4.3.5b: Online Training Diary.....p.62

Table 4.3.6a: Print Training Diary.....p.62

Table 4.3.6b: Online Training Diary.....p.62

Table 4.3.6c: Reminders.....p.58

Table 4.4a: Effect of Gender on Response Rate.....p.63

Table 4.4b: Effect of Age Group on Response Rate.....p.63

Table 4.4.1a: Reminders.....p.63

Table 4.4.2a: Reminders.....p.64

Table 4.4.3a: Reminders.....p.64

Table 4.4.4a: Reminders.....p.64

Table 4.4.5a: Reminders.....p.65

Table 4.4.6a: Reminders.....p.65

Table 5.3.2: Intensity Cut off Points.....p.76

Chapter 1.0 Introduction

1.1 Introduction

Gaelic Football is one of Ireland's national sports and is overseen by the Gaelic Athletic Association (GAA). Gaelic Football is played primarily in Ireland but also in the UK, Europe, North America, Australia and Asia (Blake, Sherry and Gissane 2009). Gaelic Football can last up to 70 minutes and consists of two opposing teams of 15 players. The ball used in this sport is similar to a soccer ball but is heavier (Wilson, et al. 2007). Approximately 2,000 GAA parish-based clubs exist throughout Ireland. Each club play within their own county divisions, and depending on the team's success, can compete at provincial and all-Ireland levels. There are also elite inter-county teams, which consist of players from clubs throughout the county, who play each other on a league and championship basis (Blake, Sherry and Gissane 2009). Players are divided into teams based on their chronological age. In the juvenile section, teams are divided into Under 10's, 12's, Under-14's, Under-16's and Under-18's (Minor). In the adult section, teams are divided into under 21's, Junior, Intermediate and Senior. The Junior, Intermediate and Senior teams are differentiated by standard and skill level. The highest standard is the Senior teams, followed by the Intermediate teams and the lowest level are the Junior teams.

Gaelic Football is considered an amateur sport. Nonetheless, some teams, especially those who perform well in the championship and inter-county teams can train and follow match schedules approaching professional standards (Blake, Sherry and Gissane 2009). Since the demands of Gaelic Football can reach these levels and it is common for Gaelic Footballers of all ages to compete in other sports in parallel, it is becoming essential to provide players with a quick and 'easy to use' method of quantifying this training. A suggested method of accomplishing this is a Self-recall Training Diary.

Training or exercise is defined as 'a regular and structured subset of physical activity, performed deliberately and with a specific purpose such as preparation for athletic competition or the improvement of some aspect of health' (Shepard 2003). Evaluating and quantifying this training or exercise is somewhat complex. It is commonly accepted in the literature that no distinct measurement technique accurately measures all aspects of training or exercise effectively (Machado-Rodrigues, et al. 2010).

The physical demands of different levels and genders in Gaelic Football have been assessed. It has been shown that inter county male Gaelic Footballers covered a mean distance of 8594±1056m in a game. Gaelic footballers have a mean work rate of 133m.min^{-1}. This has been shown to be higher than Australian Rules players (106m.min^{-1}) and Soccer players. (124.m.min^{-1}) It has been shown that elite female

Gaelic Footballers spend more time standing still and less time in high intensity running than their male counterparts.(Reilly and Doran 2001) In male Gaelic Footballers, the centre field players (9131±977m) covered greater distances than the backs (8523±1175m) and forwards (8490±673m) during matches. In female Gaelic Footballers the centre field players and half back and forward lines completed greater high intensity activities than the full back and full forward players. (Reilly and Doran 2001) This is to be expected as the nature of the game requires this. The heart rate of both inter county and club level Gaelic Footballers was found to be the heart rate required for "strenuous exercise". The heart rate in training sessions was moderate. (Reilly and Doran 2001) Gaelic Football requires largely aerobic fitness however anaerobic fitness is necessary throughout the game. Gaelic footballers, therefore, have been suggested to have a similar physical demand placed on them as soccer players. (Reilly and Doran 2001)

Self-recall Training Diaries are used to quantify the exact frequency, duration and intensity of exercise, the Gaelic Footballer is performing (Borresen and Lamber 2009). The Training Diaries can also be used to capture other relevant information such as training surface, travel time and injury occurrence. Analysing Gaelic Footballers' exercise patterns and training load is important, as optimal levels of training will improve sporting performance and physical well-being, benefitting both the individual and the team. However, excessive training could increase the likelihood of injury or lead to overtraining (Borresen and Lamber 2009). The Gaelic Footballers, managers and therapists associated with the team can benefit greatly from the information gleaned in a Training Diary. The therapist can use this information to identify the presence of unreported injuries in players, assess patterns of injury occurrence and injury prevalence within a team, aiming to reveal any predisposing factors to an injury, so that prevention strategies might be implemented. The Gaelic Footballers and managers can assess each player's training load and detect the presence of excessive fatigue and possible signs of overtraining. In addition, Training Diaries can reveal the level of commitment a player has to other sports or sporting activities, therefore, quantifying the overall training load and stress on an individual player.

To date there are no published research Training Diaries available that are developed specifically for Gaelic Football. Of those research Training Diaries that are available for general training or other sports, very few have been validated and analysed in the manner of this study.

1.2 Aim of Study

The aim of the study is to develop an effective and valid method of assessing training load in a large population of Gaelic Footballers.

1.2.1 Study's Objectives

This study has the following main objectives:

- To develop a daily Training Diary in order to accurately assess and monitor training load in Under-14, Under-18 and adult Gaelic Footballers.
- To compare and contrast the efficacy of two differing methods of completing the Training Diary (paper and online) in Under-14, Under-18 and adult Gaelic Footballers of both genders.
- To validate the developed Training Diary in the most effective form to accurately assess and monitor training load in Under-14, Under-18 and adult Gaelic Footballers of both genders.
- To compare and contrast a text reminder, email reminder or no reminder in the use of the daily Training Diary.

1.3 Study Design

A quantitative and qualitative research design was employed in this study. The quantitative research was conducted through assessing the use of the daily Training Diary by the participants and also comparing the accuracy of the dairy to an objective method of assessing training. Qualitative research was undertaken by utilising a questionnaire evaluating the participants' opinions of the Training Diary itself, the best method of completing the questionnaire and whether a reminder was necessary.

1.4 Hypotheses

This study has 4 hypotheses, namely:

1) The online method of the Training Diary is more effective and produces a larger response rate than the paper method of the Training Diary in Under-14, Under-18 and adult Gaelic Footballers of both genders.
2) The Training Diary is a valid method of assessing Training Load in Under-14, Under-18 and adult Gaelic Footballers of both genders.
3) Reminders are beneficial in increasing the effectiveness of the Training Diary in Under-14, Under-18 and adult Gaelic footballers of both genders.
4) Text reminders are the most beneficial method of reminding Under-14, Under-18 and adult Gaelic Footballers of both genders to fill in their Training Diary.

1.5 Implications of the Study

- There are no published Training Diaries developed specifically for Gaelic Football. This study will benefit Gaelic Footballers throughout Ireland and

beyond by enabling them to quantify their training load in a quick and easy manner.

- There is little information on which method of completing a Training Diary is the most effective in any age group. The study rectifies this by providing detailed information on which methods works best in all three age groups and both genders. It provides qualitative data on participants' views on each method.
- There is little information on whether reminders are beneficial in increasing the compliance of filling in Training Diaries. This study provides quantitative and qualitative information on the efficacy of reminders, which reminder works best and what timing and nature of reminders participants' prefer.
- The study ensures that the Training Diary developed is validated thoroughly. This in turn ensures that Gaelic Footballers utilising this diary will accurately monitor their training load.
- The study provides Gaelic Footballers with an easy to use self-recall method of assessing their training. The Training Diary will provide participants and managers with detailed information on all aspects of their training.
- The study assessed teams from all four provinces of Ireland including teams from counties Cork, Tyrone, Roscommon and Dublin. Thus, this study gives a broad look at Gaelic Footballers' opinion on Training Diaries and how well they can be applied practically in the future.

1.6 Delimitations of the Study

There were a number of delimitations to this Study:

- The participants in this study were aged between 12 and 30. It did not include any Gaelic Footballers younger or older than this age limit. The results of this study may not accurately transfer to Gaelic Footballers of a differing age than those included in the study.
- The Training Diary was self report in nature. Consequently, some participants in the study were unwilling to provide detailed personal information on their training. For this reason, researchers provided private username and passwords to each participant so their individual training levels remained confidential.
- Missing information on participants, including email addresses and phone numbers caused issues with the testing procedure. Researchers were unable to contact participants who did not provide these details, with their private usernames, passwords and instructions on how to fill in the Training Diary.
- Testing was completed between the months of March and August. However, since testing lasted 8 weeks for each team, the testing captures this time period between that March and August, depending on the team. This could have caused a discrepancy with the results, as results may change between months or

important times within the Gaelic Football calendar. For example, this testing protocol missed all of the pre-season testing which includes high volume training for the majority of Gaelic Football teams.

- The drop out level of participants from their teams could have affected the results of the study. Every attempt was made to prevent this from affecting results by enquiring whether dropout of participants occurred during the time period of our study. Researchers ensured our response rates were deciphered from the amount of players on the team during the final week of testing.
- A number of teams refused to take part in the study. This may have resulted in a biased sample as it will predominantly include teams where managers and selectors have a specific interest in training load and its effects.

1.7 Limitations of the Study.

There a number of limitations that exists within this study:

- Non randomisation of the study: Each team completed the paper Training Diary initially followed by the online Training Diary. This could have introduced a number of inherent issues within this study. The randomisation of the sequence of completing the different methods of using the Training Diary would have ensured that there was no bias in favour of one method of another due to the order they were implemented. The learning bias that non randomisation may suggest may be counteracted in this case as the participants used different methods of completing the Training Diary. The paper Training Diary utilised numerous codes and numbers whereas the Online Training Diary utilised a drop down menu of options. The online Training Diary also required participants to log in using an individual username and password which was not required in the paper Training Diary. However the sequence of testing may have negatively affected the response rate in the online Training Diary as by the end of the six weeks of testing they may have gotten bored of completing the Training Diary each day or lost interest in the Training Diary.

- The timing of the study: There were a significant number of drop outs in a single team in comparison to others. This was namely due to the fact that the testing corresponded to the time where a large number of participants on this team were completing their Leaving Certificate Examinations. Therefore they were unable to train and so fill in the Training Diary for a large portion of the testing. This may have skewed our results for this team.
- Study Four was completed using the Online Training Diary only: This may not be ideal as perhaps a reminder may have a differing effect on the paper version of the Training Diary.

1.8 Definition of Terms

- Physical Activity
  Any bodily movement produced by skeletal muscle that results in energy expenditure.
- Exercise Training
  A regular and structured subset of physical activity, performed deliberately and with a specific purpose such as preparation for athletic competition or the improvement of some aspect of health.
- Sport
  Physical activity that is governed by a set of rules or customs and often engaged in competitively.
- Training load
  The balance between training volume and training intensity.
- GAA
  The Gaelic Athletic Association (Cumann Luthclass Gael) is an amateur Irish and international cultural and sporting organisation which are focussed on promoting and developing the sports of Hurling, Camogie, Gaelic Football, Handball and Rounders.
- Minor Team
  This is another name for an Under-18 Gaelic Football team.
- Senior Team
  The Senior Team is an adult Gaelic Football team that belong to the highest standard competition.
- Intermediate Team
  The Intermediate Team is an adult Gaelic Football team that belong to the lower standard competition below the senior level.
- Junior Team
  The Junior Team is an adult Gaelic Football team that belong to the lowest standard completion below the senior and intermediate level.
- Response Rate
  The amount of participants who filled in the Training Diary during the time period in question.
- Overtraining
  The overtraining syndrome is a condition of fatigue and underperformance, often associated with frequent infections and depression which occurs following hard training and competition. The symptoms do not resolve despite two weeks of adequate rest, and there is no other identifiable medical cause.
- Fatigue
  Where we have exercised to the point that we feel that the task requires greater effort than it should.

1.9 Summary of Introduction Chapter

In summary, Gaelic Football is one of Ireland's national sports. It is considered an amateur sport however players can reach almost professional standards in training and match schedules. It is essential that an accurate and easy to use method of assessing training load is developed for Gaelic Football. Therefore this study aims to use both quantitative and qualitative methods to develop an accurate and effective Training Diary. It will compare and contrast the efficacy of two different methods of completing the Training Diary and will assess the effectiveness of reminders. The Training Diary will be validated in its most effective form. The following Chapter will provide an in depth assessment of the research in the literature at the moment on methods of assessing training load at the moment and the issues surrounding Training Diaries.

Chapter 2.0 Literature Review

2.1 Physical Activity and methods to assess it

The most comprehensive definition of Physical Activity is that of, 'any bodily movement produced by skeletal muscle that results in energy expenditure' (Caspersen, Powell and Christenson 1985). The amount of energy used to achieve an activity is measured in kilojoules (kJ) or kilocalories (kcal); 1 kcal is equal to 4.184 kJ (Caspersen, Powell and Christenson 1985). The total amount of energy expenditure used in Physical Activity depends on the amount of muscle mass recruited to produce the movement, and the intensity, duration and frequency of muscular contractions (Caspersen, Powell and Christenson 1985). Training or exercise, on the other hand, is a subcomponent of Physical Activity. It is defined as 'planned, structured, and repetitive bodily movement done to improve or maintain one or more components of physical fitness' (Rennie and Wareham 1998). There can be issues with this definition, as walking to work might be defined as transportation by some and as exercise by others, as that individual might want to lose weight and increase his/her fitness. Therefore, some authors suggest *exercise training* should be the term used as it refers to activities solely designed to enhance physical fitness (Haskell and Kiernan 2000). Another definition of exercise is that it is 'a regular and structured subset of physical activity, performed deliberately and with a specific purpose such as preparation for athletic competition or the improvement of some aspect of health' (Shepard 2003). Training load, on the other hand, is defined as the balance between training volume and training intensity (Fulton, et al. 2010).

Analysing Physical Activity and training load in sporting people is important as optimal levels of training will improve sporting performance and physical well-being, benefitting both the individual and the team. However, excessive training could increase the likelihood of injury or cause overtraining (Borresen and Lamber 2009). The training load is defined by the frequency, duration and intensity of exercise and all these aspects contribute to the nature and magnitude of the training effect. Therefore, in order to optimise the training effect, initial quantification of training load must be established (Borresen and Lamber 2009). Only when training load is analysed in conjunction with performance can athletes' positive or negative adaptation to the current level of training be assessed, and from this, coaches or athletes can adjust and tailor training to optimise the athlete's performance (Borresen and Lamber 2009). Conversely, a lack of Physical Activity and training in adolescents and adults can contribute to health problems. This sedentary lifestyle can increase the risk of cardiovascular disease, diabetes, obesity, osteoporosis and hypertension (Vanhees, et al. 2005, Sleap, et al. 2007). The Gaelic Footballers, managers and therapists associated with the team can benefit greatly from the information gleaned in a Training Diary. The therapist can identify, the presence of unreported injuries in players, any patterns of injuries within a team, and reveal

predisposing factors to an injury. The Gaelic Footballers and managers can assess each player's training load and detect the presence of possible signs of overtraining. The difference between training that results in a positive adaptation or excessive training that is causing a maladaptive response leading to underperformance can be very small (Guellich, Seiler and Emrich 2009). Training Diaries can allow stringent analysis of training load and response and help to prevent any maladaptive reactions occurring in athletes (Guellich, Seiler and Emrich 2009).

There are a large number of differing methods to assess Physical Activity and training within a population, and those that are used for research need to be valid, reliable and practical for the population studied and also nonreactive, (Sirard and Pate 2001). If the method is valid, it measures what it is intended to measure. If it is reliable, it consistently produces the same results under the same conditions. If it is practical for the population studied, the cost and timeframe to complete the assessmentare acceptable to both the investigators and subjects. If it is nonreactive, it doesn't change the behaviour of the population being assessed (Laporte, Montoye and Caspersen 1985). Sirard & Pate (2001) proposed three main different groups of measures of Physical Activity in their review assessing physical activity in children and adolescents. The criterion standards for assessing Physical Activity are direct observation, doubly labelled water and indirect calorimetry. Secondary measures (or objective measures) include heart rate monitors, pedometers and accelerometers, and subjective measures were self report, interviews, proxy-reports and Training Diaries, (Sirard and Pate 2001). Another review assessing physical activity in epidemiologic research identified more than 30 different techniques to assess Physical Activity and that no other health-related behaviour has been measured in so many different ways (Laporte, Montoye and Caspersen 1985). This is important because it makes it difficult to compare and contrast Physical Activity between populations and it highlights the fact that a practical and reliable method needs to be produced which can assess training load effectively.

2.1.1 Criterion methods

The criterion methods are the 'gold standard' methods used to assess physical activity. In the ideal study, all other objective and subjective methods should be validated against a gold standard method. However, since these criterion methods tend to be less practical, more time consuming and more expensive than other methods, there use is generally not feasible in the majority of large scale research studies (Vanhees, et al. 2005). For this reason, indirect calorimetry is used as the most common validation method of Physical Activity. If it is impractical to use a gold standard method within a study, it is advisable that the method chosen by the researchers should have a high correlation with a gold standard method (Rennie and Wareham 1998).

2.1.1.1 Direct Observation

Direct Observation involves experienced observers watching or videotaping subjects and noting their physical activity. There are different techniques utilised in various studies (Vanhees, et al. 2005). The sample size is small in these types of studies and the cost is generally high. The data entry is very simple and the technical error is low (Dollman, et al. 2009). This method is one of the gold standard methods to assess physical activity as it gives a large amount of contextual information (Vanhees, et al. 2005). It provides data on the type, duration, frequency and intensity of physical activity and is a very beneficial method to use in assessing physical activity in children. Nevertheless, the problem exists that subjects may change their behaviour in reaction to the fact that they are being observed. (Dollman, et al. 2009)

A study by Puhl et al. (1990) found that 16.6% of children aged 5 -6 changed their behaviour and reacted to observers being present. This is a time consuming method for researchers to use and there is disagreement as to the optimal duration to observe subjects in order to gain acceptable data (Sirard and Pate 2001). There is also the added problem that the data itself is subjective as it is based on the views of the observer (Veale, et al. 2008). Direct observation has been found to be valid and in Sirard and Pate's (2001) review, they found a correlation rating of r=0.61-0.91. (Sirard and Pate 2001) Each of the different observation techniques reviewed had satisfactory inter-observer agreement in observations of the same child (between 84%-99%) (Sirard and Pate 2001).

2.1.1.2 Doubly Labelled Water

Doubly Labelled Water is another gold standard method. The subjects must ingest a standardised amount of two stable isotopes (^2H and ^{18}O). Over the next 5-14 days the Hydrogen atoms and the Oxygen atoms are removed as water (H_2O) and Carbon dioxide (CO_2). The differences in the removal rates from the body give the CO_2 production rates. This, in turn, can be used to calculate energy expenditure and physical activity rates (Vanhees, et al. 2005, Sirard and Pate 2001). The sample size is small in this method of assessment and it is very expensive to use. An additional disadvantage with this method is that data analysis is very complex and requires some expertise in the area (Vanhees, et al. 2005). A major advantage of this method of assessment is that it does not cause any change in physical activity behaviour in the subjects (Vanhees, et al. 2005). It is also a very reliable and valid method to assess physical activity and is accurate to within 3-4% of calorimeter values (Sirard and Pate 2001).There are a number of disadvantages with this method. It only provides total energy expenditure and does not give data on the duration, intensity, frequency or type of physical activity. Recordings need to be taken over a minimum of 3 days which can be difficult, and dietary records need to be kept throughout this recording period (Vanhees, et al. 2005, Sirard and Pate 2001). This method has been used to validate a number of Questionnaires assessing physical activity. One such

study validated the Physical Activity Scale for the Elderly (PASE) against doubly labelled water and found a correlation of 0.58 (Rennie and Wareham 1998).

2.1.1.3 Indirect Calorimetry

Indirect calorimetry is completed within a lab setting or in a ventilation chamber. The subject completes the activity and the oxygen consumption and carbon dioxide produced is analysed to estimate the energy expenditure (Vanhees, et al. 2005). Oxygen consumption VO_2 has a linear relationship to steady-state work rate once the intensity is below the lactate threshold. At intensities above the lactate threshold VO_2 no longer has the linear increase and is more complex, therefore, lactate levels must be analysed at this level (Borresen and Lamber 2009). While this method is reliable and valid it is not very practical as it uses non portable gas analysis equipment. It is especially impractical if the aim of the study is to gather information on usual or weekly physical activity (Sirard and Pate 2001). It is also an expensive method of assessing physical activity, (Vanhees, et al. 2005).

An alternative method of using indirect calorimetry would be to utilise a portable metabolic gas analysis system. There are a variety of portable systems available including the Aerosport "KB1-C", COSMED K4 and COSMED K4b^2. These systems solve a major issue with indirect calorimetry as they are lightweight and easy to move. This therefore means that they do not need to be utilised within a lab based setting and can allow more on field or sport specific testing to be completed. The quantity of data collected from the portable systems is comparable to the lab based systems. However the validity and reliability of these systems needs to be examined in more detail. (Macfarlane, et al. 2006) Validation studies have been completed on these systems. In a large amount of these studies there has been no significant difference shown between the portable systems and a criterion method. (Crandell et al., 1994, Lucia et al., 1993, Ienna et al., 2001) However the V02 max was found to be lower at some work rates in some validity studies (Lucia et al., 1993, Peel & Utsey, 1993, Lothian et al.,1993) (Macfarlane, et al. 2006)

2.1.2 Secondary (Objective) Measures

Objective measures available today utilise motion sensors and heart rate monitors. In the future, combined heart rate and movement sensors may improve the data recorded and give more precise results (Vanhees, et al. 2005).

2.1.2.1 Heart Rate Monitor

Heart Rate Monitoring is a popular method for measuring physical activity in both young people and adults and is based on the assumption that there is a linear relationship between heart rate and oxygen consumption (VO_2) or steady work rate (Borresen and Lamber 2009, Sirard and Pate 2001). Heart Rate Monitors have been suggested to be an objective method to validate questionnaire's assessing physical activity and training (Rennie and Wareham 1998). The Heart Rate Monitor is

usually secured around the chest and there is a display on a wristwatch. The sample size of studies utilising Heart Rate Monitors tends to be small to medium and the cost is quite high. The data entry and reduction is usually quite complex in comparison to other methods, however, the risk of technical error is quite low (Dollman, et al. 2009). The main advantages of the heart rate monitor are that the results are directly related to the physiological response to physical activity. The investigator can easily measure a specific activity with them, the data received is detailed and a subject can wear the Heart Rate Monitor and data can be collected for an unlimited time. The monitor itself is both lightweight and transportable (Vanhees, et al. 2005). Nevertheless, there are inherent problems with heart rate monitors. One of the most important issues is that heart rate can be affected by other factors besides physical activity, especially at the lower intensities. Factors like level of training, exercise duration, hydration, diurnal changes, level of altitude, medication taken, caffeine intake and environmental factors can all affect heart rate (Borresen and Lamber 2009, Sirard and Pate 2001). In fact, it has been shown that there is a day-to-day variation of 6.5% in heart rate (Borresen and Lamber 2009). Another source of error is that the subject's heart rate stays elevated after the activity, which could cause confusion as to the duration of physical activity and could mask physical activity patterns (Dollman, et al. 2009).

Heart Rate Monitors do not directly measure physical activity. Heart Rate Monitors assess energy expenditure and give no information on the type of physical activity completed (Vanhees, et al. 2005, Dollman, et al. 2009). Heart Rate Monitors cannot be worn in the water which could prevent recording activities such as swimming (Dollman, et al. 2009). It is necessary to individually calibrate the monitor for the baseline heart rate and oxygen consumption for each subject which is quite time consuming. The chest straps and monitor could also easily slip from position and so reduce the data gathered (Dollman, et al. 2009). Heart Rate Monitor's have a reported correlation of 0.94 with doubly labelled water and indirect calorimetry (Rennie and Wareham 1998).

2.1.2.2 Pedometer

Motion sensors like pedometers and accelerometers analyse body motion. When a person moves, the body is accelerated in relation to the forces caused by muscle contractions. This motion can then be related to energy expenditure (Vanhees, et al. 2005). The motion can be measured in one plane (vertical), two planes (vertical and anterior-posterior) and three planes (vertical, anterior-posterior and medio-lateral) (Vanhees, et al. 2005). Pedometers utilise a spring mechanism that records vertical plane motion only. It is worn on a belt over the right hip or else along the midline of the thigh (Vanhees, et al. 2005, Dollman, et al. 2009). Pedometers count the steps taken by the subject the entire time the device is being worn and the distance covered in km (Vanhees, et al. 2005). The sample size can range from small to large. The data entry is simple and technical error is low. The cost is moderate in

comparison to other methods (Dollman, et al. 2009). The benefits are that it is an objective and nonreactive method. Pedometers can also be reused and are lightweight and portable (Vanhees, et al. 2005, Sirard and Pate 2001). The major issue with this method is because it only measures physical activity in the vertical plane, activities like swimming, cycling and upper body movements cannot be measured (Vanhees, et al. 2005). The pedometers themselves have limited or no memory capacity, on the other hand, this can be solved by getting the subject to record the steps taken each day. However, compliance issues could affect the accuracy of this (Vanhees, et al. 2005). It is also very easy to lose data using this method. Pedometers must also be removed for contact sport and they give no data on the type, intensity or duration of physical activity (Vanhees, et al. 2005). Another practical issue is that the pedometer itself must be calibrated per subject for their stride length and weight. Not only is this time consuming but if the subject goes running, the distance can be under-estimated if the stride is set to walking pace (Dollman, et al. 2009).

The validity and reliability of pedometers have been inconclusive. Pedometers have been found to be valid and reliable in one review (Sirard and Pate 2001). However, in another, the validity of energy expenditure estimation has been questioned (Vanhees, et al. 2005). In fact, in one study there was a strong association between a direct observation technique and the pedometer (r=0.80-0.97) (Puhl, et al. 1990). In other studies, the correlation between the pedometer and VO_2 during treadmill running was found to be only moderate to strong (r=0.62-0.93) (Sirard and Pate 2001). Therefore, it would seem that pedometers correlate well to the more criterion methods for assessing physical activity and are an acceptable method to use in some research studies.

2.1.2.3 Accelerometer

Accelerometers differ from pedometers in that they analyse motion in more than one plane (Vanhees, et al. 2005). They use piezoelectric transducers and microprocessors to analyse the magnitude and direction of the acceleration. This digital signal is referred to as 'counts' (Vanhees, et al. 2005, Sirard and Pate 2001). The accelerometer is usually worn on a belt over the right hip (Dollman, et al. 2009). The sample size can range from small to large. The data entry is more complex but technical error is low. The cost is moderate in comparison to other methods (Dollman, et al. 2009). The benefits of this method include the fact that it is both objective and nonreactive. The accelerometers can also be reused (Sirard and Pate 2001). Accelerometers also provide some indication of the intensity of the activity completed (Vanhees, et al. 2005).

There are a number of issues with accelerometers. There is no standard protocol for data reduction which can be a source of error. Accelerometers are not able to measure some activities like cycling, climbing, and activities with little torso

movement. They must be removed when competing in contact sport, which prevents further physical activity data being collected. They also give no information on the type of physical activity completed and must be programmed per subject which is time consuming (Vanhees, et al. 2005, Dollman, et al. 2009). However the anatomical placement of the accelerometer and the development of specific algorithms could counteract the limitations of an accelerometer. Yngve et al., (2003) looked at the difference between placement of the accelerometer on the hip and the lower back. This study showed that there was a statistically significant effect of the placement setting however the difference between the two was small. (Yngve, et al. 2003) A statistical difference was not shown in the field test they completed. They are not waterproof and are thought to be more prone to mechanical failure compared to other secondary methods (Rennie and Wareham 1998). One study found a correlation ranging from r=0.25-0.91 between accelerometers and indirect calorimetry. This is a large variation and this is probably due to, the different monitors used, the placement of the monitors and the different activity protocols utilised (Westerterp 1999). Nevertheless, it has been suggested that accelerometers don't have as high a correlation as heart rate monitors (Rennie and Wareham 1998).

2.1.2.4 SenseCam

An objective method of assessing the activity completed throughout a day is the SenseCam. The SenseCam is a wearable camera that automatically takes photos of the participant's surroundings without the participant having to consciously record any activity or take a photo themselves (Hodges et al. 2006). It is reported that the SenseCam is the closest alternative to direct observation of the participant and has been suggested to have the potential to be a criterion method (Kelly, et al. 2011). The SenseCam is a small digital camera that has a wide angle lens that captures a wide view of the person's surroundings. If the subject was required to take photos throughout the course of the day it would be very disruptive to their routine and the participant might forget to take a photo regularly. Therefore, the SenseCam senses its surroundings and automatically triggers a photo to be taken if there is a change in light or audio level, if it detects body heat in front of the camera, or it can also take a photo after a certain period of time (usually every 30 seconds) (Hodges et al. 2006). It has a large storage capacity and can hold over a week's worth of images (approximately 32,000 images) (Kelly, et al. 2011), however, the participant must charge the battery regularly. It takes approximately three hours to recharge the camera when using a mains power adapter and approximately 12 hours when charging from a PC. The battery life is quite significant and it has been shown that if the SenseCam takes a photo every 30 seconds the battery can last for 24 hours (Hodges et al. 2006). There is also a privacy button that allows participants to stop collecting data for 4 minutes (Hodges et al. 2006). It allows the researcher to gain unprecedented contextual objective information on the activity of the participant without having to infer physical activity level from accelerometers or heart rate monitors (Kelly, et al. 2011).

The SenseCam equipment has been used in various studies especially related to memory and patients with memory defects (Murphy, et al. 2011, Doherty, Moulin and Smeaton 2011, Milton, et al. 2011b). It has been involved in studies using the SenseCam as a rehabilitation tool in those with amnesia, analysing everyday memory, assisting in memory, assessing effects on autobiographical memory for everyday events as well as gender differences; the effects the camera has in patients with limbic encephalitis; the effects the camera has on patients with transient epileptic amnesia and the effects the camera has on patients with aphasia therapy etc. (Murphy, et al. 2011, Doherty, Moulin and Smeaton 2011, Milton, et al. 2011b, Pauly-Takacs and Moulin 2011, Milton, et al. 2011a, St. Jacques, Conway and Cabeza 2011, Brindley, Bateman and Gracey , Finley, Brewer and Benjamin 2011, Berry, et al. 2009, Berry, et al. 2007, Muhlert, et al. 2010) (Burke, Franklin and Gowan 2011). One study utilised the SenseCam to investigate active and sedentary travel behaviour (Kelly, et al. 2011). This is relevant to our study as it required the participants to wear the SenseCam throughout the whole day in order to quantify a certain activity. Participants filled out a self recall daily travel diary on the same day as wearing the SenseCam (Kelly, et al. 2011). When researchers compared the self recall travel diary to the SenseCam they found that the SenseCam recorded 99 journeys over the course of the day whereas the diary noted 94. This consisted of the SenseCam capturing 94% of travel whereas the diary only noted 90% of travel. There was a strong correlation ($r=0.92$) between the diary and the SenseCam. However, the self reported diary overestimated the length of the journey by 16% (154 seconds) compared to the camera (Kelly, et al. 2011). The reasons participants missed out on capturing the travel journeys while using the SenseCam was that three participants forgot to put on the SenseCam itself, one participant's clothing blocked the SenseCam from taking photos and two participants had blurry photographs due to dim lighting. On the other hand, all journeys that were not reported by the diary were due to forgetting to fill in the diary (Kelly, et al. 2011). Researchers also completed an interview with participants to assess the practicality, benefits and drawbacks of the SenseCam. They found that all participants were content with wearing the SenseCam and that it wasn't a burden on them to use. Overall, 90% of participants preferred wearing the SenseCam than filling out the travel diary even though they were not willing to wear the camera at all times, preferring to remove it during specific activities including waiting outside schools for their children, at public swimming pools, at airports and waiting in line at a bank. Three advantageous aspects to the camera and protocol that participants reported, was the fact that there was a privacy button, the camera does not capture sound and that the protocol provided the participants with a pre-prepared answer if participants were questioned on what the camera was (Kelly, et al. 2011).

2.1.2.5 The Global Positioning System (GPS)

The Global Positioning System is a US developed navigational system that uses 27 satellites in orbit around earth to discover the position of a GPS receiver unit in relation to a minimum of 4 satellites. This can therefore provide the speed and the location of the GPS receiver unit. (Larsson 2003) There can be some error using normal GPS; therefore differential GPS (dGPS) can be used. The dGPS accounts for possible error by utilising a stationary receiver at a known location and a moving unit that is placed on the player and acts as the receiver unit in normal GPS. (Dobson and Keogh 2007)The GPS has an advantage as it can be utilised in field based tests therefore can allow for sport specific testing. The GPS is ideal to assess the distance covered, velocities completed, number and length of any sprints/runs completed by a participant during a training session or match. (Dobson and Keogh 2007) It is lightweight and easy to use. The GPS unit is usually placed on the player's upper back and secured using a strap. (Dobson and Keogh 2007) The data can be easily downloaded onto a personal computer and analysed. (Larsson 2003)

However there are a number of disadvantages to using GPS. Since 4 satellites are necessary to receive a signal, indoor games and in some heavily populated areas large buildings could disrupt the signal. Also players are required to wear the GPS usually on their upper back. This may be impossible to do in sports that are very physical in nature. For example if players were to land on the equipment or other players to hit against the player on that area. This could not only cause injury to the participant themselves and other players but could damage the equipment. Finally the accuracy of GPS has been questioned in sports that require a large amount of multi-directional movements e.g. Gaelic Football. GPS works the best when the unit is moving linearly with few changes in direction. This could therefore affect the validity of the GPS. (Dobson and Keogh 2007)The accuracy of the GPS has been assessed. It has been shown that the mean errors for distance are 0.04-0.7% and the mean position error has been found to be between 1.94 and 2.13 meters. It has also been reported that the coefficient of variation in walking was 1.38% and running was 0.82% using GPS. (Borresen and Lamber 2009) In fact it has been noted, that GPS that records at 1Hz may not be accurate in recording high intensity activities with multi-directional movements. These movements are essential in team sports like Gaelic Football. However this study was completed on a sample size of two male athletes. (Coutts and Duffield 2010) In a similar study which looked at twenty elite athletes it was discovered that as the velocity of motion increased in both straight line running and multi-directional running the accuracy of the GPS decreased. The difference between the criterion method of assessing distance and the GPS ranged from between 9% and 32.4%. (Jennings, et al. 2010)

GPS units have been utilised to assess training load in rugby, (Cunniffe, et al. 2009) (Lauchu and McGregor 2007)high school cross country runners, (Lauchu and McGregor 2007) Australian Rules Football, (Wisbey, et al. 2010) soccer (Hill-Haas,

et al. 2008) and field hockey. (Gabbett 2010) GPS is unable to capture the physiological response to training that other objective and subjective methods can infer. Therefore a combination of GPS and other methods of assessing training load could produce ideal results. For example, utilising the GPS with a heart rate monitor could provide the speed of the athlete and the physiological response to the training session and so allow easy and full comparison between training sessions and/or players.

2.1.3 Subjective Measures

2.1.3.1 Questionnaire

Questionnaires examine physical activity or exercise that has been completed over the previous week, month or years. Questionnaires are beneficial because they are easy to administer, they have relatively low cost and the use of questionnaires does not impede or interfere with training. These are especially helpful when analysing a large amount of subjects (Borresen and Lamber 2009), however they depend on the perception, encoding, storage, and retrieval(Hill-Haas, et al. 2008) of information about their previous physical activity and training (Shepard 2003).

Questionnaires have many issues that are similar to training diaries, namely, that exercise duration, frequency and intensity might be over or under reported. Additional problems are that questionnaires tend to be completed much less frequently than training diaries, therefore, there is greater time between the activities and recalling the data so the reliability of the information is further lessened (Borresen and Lamber 2009). The length of the questionnaire can cause some practical issues. A questionnaire should ideally minimise the questions needed to describe the participant's physical activity and training behaviour (Masse, et al. 1998). If the questionnaire is too long and requires a large amount of detail to fill in, the subject may become bored or confused and fail to fill in the correct or full amount of data (Borresen and Lamber 2009). However, if the questionnaire is too short it might omit important questions and researchers would fail to get a total view of the participant's physical activity and training behaviour (Masse, et al. 1998). The translation of a questionnaire into a different language or cultural factors could also affect the information given and the accuracy of the training data reported (Borresen and Lamber 2009). When applying cultural modifications to a questionnaire it is advised that instead of simply adding items to the questionnaire relevant to the new culture the investigators should find and remove activities that are not relevant to the culture as well (Masse, et al. 1998).

One form of questionnaire that assessed physical activity against direct observation found that the results were similar in 73.4% of subjects in one study and 86.3% in another study (Sirard and Pate 2001). Another questionnaire called the Previous Day Physical Activity Recall (PDPAR) had a high positive association with a pedometer and an accelerometer in young adults (Sirard and Pate 2001). Some questionnaires utilise an interviewer instead of self report. This can be beneficial because with

younger children, a trained interviewer could enhance the child's cognition and accuracy, thereby increasing the validity of the assessment method. In fact, one study found that 75% of the results found in a 7-day recall questionnaire were comparable to 1 week's direct observation (Sirard and Pate 2001). While interviewers might increase accuracy of reporting data in some aspects, the interviewer themselves might cause additional bias, for example, response bias. Interviewers may also increase the cost and man-power required for data collection (Sirard and Pate 2001). Another method is termed Global self-report. This method gives a self assessment of a participant's physical activity and then globalises this result to people of a similar age or gender. The main issue with this is the accuracy of the results (Haskell and Kiernan 2000).

Questionnaires can be global or descriptive. Global questionnaires generally define the participant as either active or inactive, compared to descriptive surveys which are considerably more detailed. Global questionnaires tend to be only one page and have fewer than 6 questions, while descriptive surveys are longer and inquire about the participant's frequency, intensity and duration of activity. An expert panel discussing issues in assessing physical activity in older and minority women suggested that researchers should not utilise both a global and descriptive survey as meaningful results would not be gained from this (Masse, et al. 1998).

A very effective and relevant online questionnaire to analyse training load, in basketball and volleyball players, as a risk factor for patellar tendinopathy was used by researchers in a previous study. The researchers examined the years spent playing their sport, the amount of hours they trained in the week previous to filling out the questionnaire, the number of games played in the previous month, the average hours they played other sports each week, the level of increase in their training compared to the previous year and the level at which the participant played. This questionnaire was highly relevant and in-depth in understanding the risk training load can have on developing a certain injury (van der Worp, et al. 2011).

2.1.3.2 Training Diaries

Training Diaries involve recording all training and exercise completed by the participant throughout a specific period of time. Training Diaries are commonly recorded every 24 hours, after a 3 day interval or after 7 days. They are beneficial because they usually gain information on the type, duration, intensity and frequency of training. However, they can also provide information on footwear, surfaces, environment, injury status, etc.

The majority of research in the literature that utilises self report training diaries assesses physical activity rather than training and exercise. For this reason, they require the participant to give detailed information on all activities completed throughout the day (Schuler, et al. 2001). Nonetheless, since this study is using Training Diaries to record only exercise or training completed (i.e. vigorous

physical activity) it is much less time consuming for participants. Also, planned and well-defined activities (e.g. a game of soccer versus cleaning the house) are a considerably less variable, and participants find it easier to accurately remember and record these activities (Schuler, et al. 2001). As mentioned previously, vigorous activity is recalled more accurately than other levels of physical activity. Since training and exercise is at this level of physical activity, it is expected that the information collected in the Training Diary will be more accurate than previous reports of diary usage in assessing physical activity (Schuler, et al. 2001).

An advantage of using a Training Diary compared to a questionnaire is that participants can fill in the activities that they have completed, whereas questionnaires provide a list of activities so if the activity is not present on the list, it cannot be recorded accurately. Training Diaries assess the previous days or weeks training rather than a 'usual' weeks training. As a result, it may require the participant to keep a longer diary to gain information on their usual training, compared to a questionnaire which may be more straightforward. A fault with Training Diaries is that since participants are not probed as much as in a questionnaire, they may omit a completed exercise, especially if they must recall the activity after a long period of time after completion.

Previous studies have utilised Training Diaries to quantify the training volume of their athletes in varying manners. Genin et al. (2011) utilised an online Training Diary that captured the presence of injury in their study and the difference in injury rate in novice or experienced runners.

2.2. Development of a Training Diary

2.2.1 Details Required by a Training Diary

2.2.1.1 Classification

Classification of the activity or type of exercise performed by the participant is very important. This provides the researcher with a sense of the demand that is placed on the body due to the type of activity completed. For example, if a participant noted in the diary that the participant cycled on Monday and completed upper body weights on Tuesday, researchers could decipher that the demands placed on the body would not be overloading one particular area. This suggests that this type of training is not leaving the participant open to overtraining. Morrissey et al. (2011) utilised a choice of activities to record in their training diary.

2.2.1.2 The Team played with and Level of Activity

It is important to decipher what team the player is playing with or whether they are training individually. This can give the researcher an insight into the level of

activity and the standard of training being completed. It has been suggested that as the level of sport increases the incidence of injury also increases. In rugby union, it has been found that professional level rugby has the highest injury rate of all levels of competitions (Bathgate, Best and Craig 2002). In fact, it has been shown in Rugby Union that the injury rate increases as the competition grade increases (Bird, et al. 1998). The possible reasons behind this enhanced rate of injury is because in more elite levels there is a higher level of skill, fitness, experience and intensity of games and so this results in an increased likelihood of injury (Takemura, et al. 2007). The Training Diary needs to record individual training sessions as these are usually unsupervised sessions that may not fit into the manager's training plan for that section of the season. It is also to ensure the players are not training excessively and increasing their likelihood of developing overtraining syndrome (Borresen and Lamber 2009).

2.2.1.3 Relative Age

The age group in which the player competes and trains is important to categorise, especially in younger participants. Gaelic Football divides players into teams and competitions based on their chronological age. The main reasoning behind this is that children develop relative to their age. This, therefore, in theory allows fair competition between players of the same age and allows a fair chance of success (Helsen, Winckel and Williams 2005). However, there are no restrictions placed on young Gaelic Footballers to prevent them from playing at higher age levels. For example, a talented young Under-16 Gaelic Footballer may be required to play minor, under 21 and even senior standard depending on the club and player. This is especially common in rural clubs that would not have a large number of players available to play. This can greatly affect the development of a player and could cause concern over the increased likelihood of injury (Helsen, Winckel and Williams 2005). Even the restriction of separating players from under 12 to Under-14 may be too general and cause a significant difference in body type between a child just turned 12 and one who is just under the age restriction for Under-14. An example given in relation to soccer was that a 10 year old could weigh 22 kilograms (kg) and be 1.26 metres (m) in height, however, an 11 year old born early in the year could be 49kg in mass and 1.54m tall. For this reason, the younger 10 year old could be 0.2m shorter and 27kg lighter than the older child. This represents a very large difference in body type between both children who are within the same age group. The difference is increased over two years and is even more significant if a player is playing in age groups older than their own age (Helsen, Winckel and Williams 2005).

2.2.1.4 Perceived intensity in Training Diaries

Perceived intensity is the player's ability to detect and rate the level of physiological effort that occurs in the body during exercise (Pfeiffer, et al.

2002). The Rate of Perceived Exertion (RPE) is a method of quantifying the physical strain placed on the body during exercise. There are various types of RPE scales available, including the Borg scale (6-20), Borg CR-10, Pittsburgh 9 and Fleishman Occupational Effort Scale. Each of these scales has been validated against criterion methods (Pfeiffer, et al. 2002).

A meta-analysis on the validity of the RPE scale in healthy individuals found that overall the RPE scale is a valid method to assess the intensity of exercise. However, when you take into account the quality of the study, the protocols used, the gender and fitness of participants studied, the validity may not be as high as previously reported in the literature (r=0.80-0.90). In fact, for each criterion method of assessing exercise intensity it was calculated that the validity coefficient in comparison, to heart rate was 0.62, blood lactate was 0.57, $\%VO_2$ max was 0.64, VO_2 was 0.63, ventilation was 0.61 and respiration rate was 0.72 (Chen, Fan and Moe 2002). Rate of perceived exertion has not been as vigorously studied in children and adolescents as it has been in adults (Pfeiffer, et al. 2002). Mahon and Marsh looked at the intraclass correlation coefficient of the Borg 6-20 RPE scale. They discovered in 8-12 year old children the intraclass correlation coefficient of the Borg RPE scale was 0.78, only 0.66 when compared to % HRmax and 0.70 when compared to $\%VO_2$ max (Pfeiffer, et al. 2002). RPE has been used in an online diary, similar to ours, to assess the intensity of training by paralympic swimmers (Fulton, et al. 2010). RPE is still important, even though it is not an objective measure of intensity. It defines "How hard" the participants found the session and reflecting the impact on the participant, not only physically but also psychologically.

2.2.1.5 Duration of Activity

The number of hours spent exercising in each activity needs to be identified. This can give an indication of the absolute volume of exercise completed and is very important in order to quantify the players training load. Morrissey et al. (2011) included this question in their weekly Training Diary. Buist et al. (2010) investigated the length of the session, in minutes, in their Training Diary which was very similar to this study. Quantifying exercise time is necessary in studies utilising training diaries in order to discover incidence, or risk factors, for injury in sport. This allows the researchers to calculate the exposure time to a sport and see the likelihood of injury in relation to the amount of training completed (Buist, et al. 2010).

2.2.1.6 Travel Time

Travelling to and from training can take up a significant amount of time in a player's day, especially with higher level athletes. Anecdotal reports suggest that players who have reached county level or even certain clubs require players to travel to training a number of times a week, regardless of the players own

schedule or where they live. In fact, it is common for players to travel up to three hours or more, to get home for training and return to where they go to college or work. This can put great stress on the player. In fact travel has been identified as a stressor that is linked with overtraining in athletes when coupled with a high training load (Foster 1998).

2.2.1.7 Playing Surface

Gaelic football is played on two different types of surface: Astroturf and natural grass. Grass, the traditional surface, is the most frequently used for Gaelic football matches. Nonetheless, since some Astroturf pitches can be used in any weather condition, they are increasingly being utilised. Astroturf has been proven to be harder than natural grass (Orchard 2002). In a review article on the relationship between artificial turf and lower limb injury risk, a 30-50% increase in risk of injury was found (Shovron, Levy and Agel 1990). However, another review concluded that there was an increase in less serious injuries on artificial turf, a possible enhanced risk of severe knee and ankle injuries, and no difference in severe injuries on artificial turf when compared with grass (Nigg and Segesser 1988). In a 5-year prospective study on 8 different high schools, there was a higher incidence rate of injury on field turf (15.2%) compared to on natural grass (13.9%). An important point to note was that there was a higher incidence of injuries which did not cause any time loss from sport. There was an increase in surface or epidermal injuries in field turf which is possibly related to Astroturf skin burns and lacerations (Meyers and Barnhill 2004). This was further supported in a study on elite soccer where wounds, burns and friction injuries were more common on artificial turf (Ekstrand, Timpka and Hagglund 2006). In two studies by Fuller et al. (2007a; 2007b) on training and match injuries over two seasons on male and female university football teams it was found that there were no major differences noted between the incidence, severity, nature or cause of training or match injuries received on artificial turf or grass by either gender. Ground condition and ground hardness has been suggested to be linked to injury. Ground hardness is a combination of soil structure, soil compaction and grass type and each of these factors can be moderated by weather conditions and usage of the pitch (Takemura, et al. 2007). Weather conditions, like rainfall, can decrease ground hardness whereas conditions like ‘evapotranspiration’ which is a combination of radiation, wind speed, temperature and humidity can cause enhanced ground hardness (Takemura, et al. 2007). Some studies, including a study on non-contact ACL injuries by Orchard (2001) have shown an increased risk of injury with ground hardness. In contrast, a study by Takemura et al. (2007) on Rugby Union injuries found no significant association between the two factors. However, they did report a seasonal bias in this study which they suggest may have disrupted the ability to compare the two factors. Hard ground produces faster running speeds, quicker movements and greater external force placed on the body if a

player falls, therefore, this has been suggested as the reasons why it causes an enhanced injury risk (Takemura, et al. 2007, Orchard 2002). This can also explain why Astroturf has an increased likelihood of injury compared to natural grass since Astroturf, as previously mentioned, has been shown to be harder than normal grass (Orchard 2002). In a study on Gaelic football the condition of the pitch was reported as being a contributing factor to injury in 29% of all cases. From this, the pitch condition contributed to the injury when it was dry/hard in 43% of cases, wet/soft in 39% and uneven in 18% of cases (Cromwell, Walsh and Gormley 2000).

Playing Surface is commonly analysed in studies looking at training load. It was investigated in an online questionnaire as one of the possible risk factors for patellar tendinopathy in basketball and volleyball (van der Worp, et al. 2011). It was also queried in a Training Diary that triathletes completed for 8 weeks which analysed training and injury patterns (Korkia, Tunstall-Pedoe and Maffulli 1994).

2.2.1.8 Footwear

It is important to assess the types of footwear worn by players in a Training Diary. Footwear has been found to be related to incidence of injury in sport. The interaction between the shoe and the surface it is placed on is thought to cause this relationship. Higher injury rates are found as the friction between these two factors increases. Footwear can cause two different issues. If the frictional resistance between the shoe and the surface isn't high enough the person could slip and cause an injury. Nevertheless, too much friction would prevent the shoe to 'give' or twist and so cause the foot to be 'stuck' to the ground and cause a twisting injury to the knee, for example. In fact, the type of studs has been found to have an effect on injury level. A study on American high school football found that when the participants wore moulded studs there was a reduction in injuries that needed surgery (Milburn and Barry 1998).

2.2.1.9 Injury

The presence of an injury is an important aspect to capture in any Training Diary. Zwerver et al. (2010) inquired about the presence of pain and any symptoms of injury in their online Training Diary that is currently being tested on jumping athletes. Buist et al. (2010) asked in their training diary whether a participant was injured and invited them to provide specific details on the severity of the injury. This is required because players need to report when they are suffering from an injury. Players may be reluctant to report an injury as they may worry that they would lose their position on the team if they are injured and are not able to play for a period of time. This causes a reduction in reported injuries to managers, which may force players to play while injured, thereby increasing the likelihood of the injury becoming more severe and the player

being sidelined for a considerable time. The extent of the injury is important to note, enabling modification of training so that they do not aggravate the injured area while still maintaining fitness and skill level, without being unnecessarily banned from playing. For example, a Gaelic footballer with a sprained wrist could take part in any of the drills once modified to prevent use of the hands, or practice place kicking, agility drills, fitness etc.

Buist et al. (2010) classified levels of pain as "pain without running limitations, pain that caused a restriction in running, and running impossible because of a running related injury". A modification of this definition could be used for various sports. Some Training Diaries that have been developed can be even more specific about the nature of the injury and require the player to report the anatomical site of the pain they are experiencing (Buist, et al. 2010).

The main issue that can affect the validity of self reporting pain and injury in a Training Diary is that pain is very subjective. There is a large variation in the perception of pain between players. One player with a certain injury may be able to play with no pain or minimal pain, nevertheless, a teammate with the same injury may not be able to continue or return to play for a significant period of time (Buist, et al. 2010).

The participant's response to the question of whether or not a participant is feeling pain is important. In a study looking at injury risk in triathletes, researchers found that 60% of triathletes reported an overuse injury with a decrease in performance at least once within the 7 months they were followed. This shows that participants in other sports use Training Diaries to report the presence of pain so it can be an effective tool to analyse injury rate in certain sports (Vleck and Bessone Alves 2011).

Another study used text diaries to catch exposure to the sport and the incidence of injury with an elite female football team. Researchers compared the reporting of injury through the SMS Training Diary with reports made to the medical staff associated with the soccer team. They found that the SMS method of capturing injury information provided a more complete view of injury incidence within the team. Researchers noted that 62% of all injuries were reported by the SMS system, 10% were reported by the medical staff only and 28% by the two methods. Therefore, this supports the idea that Training Diaries can be an essential method of measuring incidence of injury in a team setting (Nilstad, Bahr and Andersen 2011).

2.2.1.10 Illness in Training Diaries

Information on the presence of illness in players and whether this prevents or modifies participation in a sport is essential to capture. A large volume and high

intensity of training can cause a suppression of the immune system in an athlete. This can cause an athlete to be more prone to illness and during important training periods, athletes can become sick and are therefore, prevented from training or competing to the best of their ability (Cunniffe, et al. 2011). Consequently, if a Training Diary captures the presence of an illness, the team doctor could compare this to the training load placed on the athlete and decipher whether the illness is related to the volume of activity. Players who are very driven may not believe illness is a valid reason to stop training or competing. In such cases, the Training Diary could capture that they are ill and inform the managers of the illness. This can be important because in team sports like Gaelic football, players are training and competing together on a regular basis. For this reason, transmission of a virus or illness between players can occur regularly. If this happens in the time period preparing for or during important matches, this can cause considerable impediment to preparations and can prevent a large number of key players from playing (Cunniffe, et al. 2011). One such study which utilised an online Training Diary found that it provided more information on banal infections that were not noted using alternative methods (Cunniffe, et al. 2011). Another study that captured the presence of illnesses that prevented or modified training was Korkia et al. (1994) who utilised a Training Diary in British triathletes.

2.2.2 Using Codes in Training Diary

Training Diaries are designed to be easy to fill in, to facilitate compliance. Many Training Diaries have utilised codes in order to do this. This requires the participant to fill in a number or a code word instead of writing out the activity itself. This also saves space in the Training Diary and ensures that it is not a very long form. Adam et al. (2007) required children aged 12 to 19 to fill in a time diary daily, organised their data using 365 codes. Each code corresponded to a certain activity. This study had such a large amount of codes due to the fact that it looked at information from every activity the child completed throughout the day, not just training or exercise Another study that validated the Bouchard Diary required the participants to put in a code that represented the predominant activity they completed every 15 minutes throughout their day (Wickel, Welk and Eisenmann 2006).

2.3 Issues with Training Diaries

Training Diaries tend to be retrospective in nature and these are thought to be methodologically weaker than prospective data. The reason for this is that the information is obtained post exposure, therefore, random and systematic errors and bias might influence the data recorded (Friedenreich 1994). It has been shown that the recall methods of evaluating physical activity does not account for 45% of the variance (Durante and Ainsworth 1996). There are a large number of different reasons behind this variance and without accurately collecting data on physical

activity, studies could find links and associations between physical activity and other factors that might not exist in reality (Durante and Ainsworth 1996). In fact, a study by Lee et al. (1992) found that the variance between subjects in recall was lowest for physical activity compared to data on smoking exposure and alcohol; even though, the recall error was greatest for physical activity compared to the other information. However, in this study the authors used no methods to enhance the recall ability of the subjects. The reliability of information reported tends to decrease as the time between the training and recall increases, probably because it is dependent on human memory (Borresen and Lamber 2009). A study that looked at the athlete's report of training and what they were actually doing in training found that 24% overestimated and 17% underestimated training duration; this is a large margin of error. The reasoning behind this overestimation could be that the subjects are influenced by what he/she thinks the examiners want to find (Borresen and Lamber 2009).

When research is analysed on the validity and reliability of Training Diaries and methods of assessing physical activity that utilise self recall, there are two main issues that influence it. These are the characteristics of the activity itself (i.e. intensity of activity and environmental conditions) and the characteristics of the participant (i.e. age, education level, employment status, gender, race, personal traits and their level of fitness or obesity) (Durante and Ainsworth 1996).

2.3.1 The Activity:

2.3.1.1 Intensity of Activity:

The intensity of a training session or exercise is commonly under or over reported and this has been proven in a range of studies. Sallins et al. looked at a large range of intensities of activities in the past seven days and found that most participants' recall of moderate activities was not as accurate as hard and very hard activities. The authors found this to be independent of gender, profession, and home, leisure and exercise activities (Durante and Ainsworth 1996). Another study which assessed leisure activities in the previous week, found that participants were more likely to under report or underestimate the amount of walking or light intensity activity that they had completed; participants were more likely to accurately recall the more vigorous activities (Durante and Ainsworth 1996). The reasoning behind this could be because it may be easier for participants to recall activities they put a lot of effort into as it would be more memorable. For exercise that involved very little effort or intensity it may be easier for them to forget about it and so not include it in their Training Diary. Moderate and vigorous intensity physical activity increase heart rate, breathing rate and can cause fatigue of the muscles which can all help improve the participants' memory and recall of the training event (Schuler, et al. 2001). Since training and exercise tends to be in the moderate to vigorous class of physical activity, it could be assumed that participants would

recall information more accurately than what is found in studies assessing all levels of physical activity (Schuler, et al. 2001). It is also common for participants to misreport the intensity of training and the same intensity of activity could be reported differently between participants. A possible explanation lies in individual, subjective perception of how hard the training was and can depend on the experience, fitness and tolerance of the subject. This is especially evident if you categorise intensity by light, moderate, hard or very hard (Borresen and Lamber 2009).

2.3.1.2 Environmental Conditions: Factors like the environmental conditions under which training was completed could affect the person in varying motivational, psychological and physical state and so affect the view they had on the training completed and the way they report it. For example, if a participant completed training in wet weather with high winds and heavy ground, they might report that the training session was at a much higher intensity and longer duration than if the exact same session was completed in nicer weather (Borresen and Lamber 2009).

2.3.2 The participant:

2.3.2.1 Age of Participant: The age of the participant can greatly affect the ability to recall information on their past physical activity. Children have lower cognitive functioning compared to adults, therefore, lowering their ability to accurately recall the frequency, intensity and duration of training (Borresen and Lamber 2009). Children also have less ability to think abstractly and find it harder to provide greater detail which can affect the accuracy of self recall data (Welk, Corbin and Dale 2000); In fact, even between younger and older children there can be differences in their ability to recall their training load. A study by Simons-Morton et al. (1994) found that older children in 5th grade had a greater correlation (r =0.72) between a 1-day physical activity interview questionnaire and an accelerometer than younger 3rd graders (r=0.50-0.57) (Simons-Morton, Taylor and Wei Huang 1994). A study that assessed seven-day recall and other methods of self report in children and adolescents found that the validity of the self report data improved as the age of the subjects increased, nevertheless, in all age groups the results were found to be sufficiently valid (Sallis, et al. 1993). It maybe necessary in very young children to ask their guardian to fill out the Training Diary if the child is too young to understand the questions and accurately fill in the Training Diary, however, this method has been reported to have reduced validity and reliability (Shepard 2003). A study that examined the difference in physical activity measures between accelerometer and self report found that adults had greater agreement between the two methods than adolescents with regard to reporting moderate physical activity (Slootmaker, et

al. 2009). Nevertheless, there was a larger disagreement in adults compared to adolescents with vigorous physical activity. Therefore, according to this study, there is inconclusive evidence on whether adolescents or adults are better at recording accurate data on physical activity and so training (Slootmaker, et al. 2009). Be that as it may, it is not only children who have issues with remembering information. A study assessing physical activity from the past 32 years found that younger males tended to underestimate the amount of physical activity they completed. On the other hand, they found that older males overestimated the amount of physical activity they had done (Durante and Ainsworth 1996). Another study that analysed this area looked at the amount of information remembered by female cardiac patients post cardiac event. They reported that older women were more at risk of remembering limited advice given to them (Rushford, et al. 2007). Therefore, this might indicate that older participants in the study may not be able to remember as much information on their training or physical activity compared to younger participants and possibly limiting the effectiveness of a Training Diary in collecting information. This could be due to the decreased cognitive functioning in older participants. In fact it may be necessary to give older participants a cognitive functioning test before completing the study to ensure that they understand the study and are able to recall the activities that they have completed (Masse, et al. 1998).

2.3.2.2 Education of Participant: The education level of the participant involved in the study has been reported to be associated with differences in data recording. One study found that participants with less education were more likely to over report their physical activity and those with more education were more inclined to under report their physical activity (Durante and Ainsworth 1996). Another study that investigated the difference between self report and data from accelerometers established that in adolescents with a high level of education there was a greater disagreement between the two methods compared to adolescents with a lower level of education. These results were contradictory to those found in adults where those with a lower level of education had a greater disagreement in data reporting (Slootmaker, et al. 2009).

2.3.2.3 Employment status: Falkner et al. (1994) found that younger males provided more precise information on physical activity on their nonworking days compared to their working days (Durante and Ainsworth 1996). There are many possible reasons for this, for example, on non-working days they have more time to fill out the Training Diary.

2.3.2.4 Gender: There have been differences reported in the amount of data recalled by participants depending on their sex. Kledges et al. (1990) examined 44 adults of both genders and analysed their self recall of the activity they completed in the previous hour. They established that males overestimated their

activities compared to females. However, a study on seven-day recall diaries and other various methods of self reporting physical activity found that males were more reliable at reporting physical activity than females (Sallis, et al. 1993). In a study on how high school graduates constructed the meaning of their primary school physical education, it was found that there was a significant difference between males and females. Females remembered more variety and greater detail about their physical education. This, however, was a study asking participants to recall details from 7 years before, therefore, there may not be gender differences of this type when participants are recalling activities soon after the event (Pissanos and Allison 1993). Another study which assessed both adolescents and adults found that in adults there were no differences in self recall reporting of physical activity data compared to results from an accelerometer between genders. Nonetheless, in adolescents it was found that when you examined the self recall reports, girls were more active (532 minutes) than boys (503 minutes) with regards to moderate physical activity. In the accelerometer reports, on the other hand, boys (112 minutes) were more active than girls (79 minutes) with regards to moderate physical activity (Slootmaker, et al. 2009). This study provides conflicting results on the effects of gender on data recall.

2.3.2.5 The Participant's level of Activity: The participant's level of fitness could affect their likelihood of recalling accurate information on physical activity. Kledges et al. (1990) found that obese participants underestimated their physical activity levels in the previous hour. On the other hand, Slootmaker et al. (2009) discovered that overweight adults reported more vigorous physical activity than normal weight adults using a self recall questionnaire on Physical Activity. However, this was not supported by data from the accelerometer they were wearing in conjunction with completing the questionnaire (Slootmaker, et al. 2009). Another study that highlights this issue looked at the ability of female cardiac patients to remember the information they received in hospital, post cardiac event. They found that women who were physically inactive or obese had limited recall of advice that doctors gave them about diet and physical activity (Rushford, et al. 2007). Accordingly, this might suggest that if participants in the study do little training and are overweight they might report less information and be less likely to remember what exactly they did. However, the population in this study are unlikely to be physically inactive or not training as they will all be playing Gaelic Football.

2.3.2.6 Personality traits

Some personality traits can affect self recall. A study on females discovered that the trait of 'social desirability' was strongly associated with over reporting physical activity. In fact it leads to an overestimation of physical activity energy expenditure by, 0.65 kcal/kg/day. It also overestimated the duration of activity

by 4.15-11.30 minutes per day. Social desirability is defined as 'the defensive tendency of individuals to portray themselves in keeping with perceived cultural norms' (Adams, et al. 2005). An interesting point that the authors noted was that when participants had a long recall period (i.e. when they recalled physical activity information from the last 7 days rather than from the previous day) they were more likely to over report activity (Adams, et al. 2005). It has also been noted that people who are higher on a scale of social desirability are increasingly likely to under report their fat and total energy intake, as well as over report their activity levels. This is especially the case with females (Adams, et al. 2005). Another trait that affected recall was social approval which was found to be weakly associated with under reporting physical activity by 0.15kcal/kg/day. Social approval is defined as 'the need to obtain a positive response in a testing situation' (Adams, et al. 2005).

2.3.2.7 Race

Race has been assessed to decipher if it has any effect on the ability to report accurate data about physical activity. In a study on assessing physical activity from 3 or 4 years previously, they found no significant differences between black or white participants in the study. Nonetheless, there was a methodological issue with this study. There was an uneven spread of race in the subject group which could affect the results, 29.6% of participants were black and 53.1% were white (Slattery and Jacobs 1995).

2.4 Method of Filling in the Training Diary

2.4.1 Paper Training Diary

The paper method of using a Training Diary is the most basic and most used mode of collecting training information. Players usually receive a Training Diary at the start of each week, fill it in daily for the week and return it to the manager/researcher at the following training session. They are also given a sheet which contains the codes to the Training Diary so all they fill in, in each section is a number. Bexelius et al. (2010) analysed paper training diaries and a mobile phone method of assessing training load in comparison to doubly labelled water and indirect calorimetry over two weeks. They found that the two different types of paper training diaries differed by only 0.004 and 0.007 in Physical Activity Level (PAL) in comparison to the criterion methods. Physical Activity Level was calculated by dividing the basal metabolic rate into the total energy expenditure of the participant. This is a promising result as this method does seem to accurately assess physical activity level. Various other studies have utilised paper diaries including Adam et al. (2007) which looked at a two day diary that was posted to each participant and returned through the post.

2.4.2 Online Training Diary

The online Training Diary usually contains all the same information as the written version however it requires the subjects to connect to a website. They log in using their own personal username and password. Once they have entered this they are asked a series of questions on their training during that day. There then is an option to fill in previous days or weeks training. The subjects could also view their training in the past few days or weeks. The main benefit is that the subjects can view their previous training, giving them a form of feedback on their training loads which can be very helpful. It also is not as time consuming as the paper method as a researcher does not have to collect the forms from the subjects and enter them into a computer. It helps prevent training diaries being lost or not returned to the researcher. The main issue with this method of collecting training data is that some subjects may not have access to the internet which prevents them from filling in their training diaries. The speed of internet connection can be another issue with online training diaries. If the speed of connection is quite slow, it may dissuade subjects from waiting to enter their data. This is especially the case if they need to open a number of pages within the diary. Another problem with this method is that unlike mobile phones, the internet is not ubiquitous in a lot of people's lives. In the younger generation or those who use the internet in work they would tend to connect to the internet every day. However, in those that do not, they must purposely turn on the computer and internet in order to fill in the Training Diary which may lower the compliance to an online Training Diary (Anhoj and Nielsen 2004). One study that analysed an online diary to record asthma values and symptoms surrounding asthma did not analyse response rates, however, 72% of the subjects reported they visited the site once a month (Anhoj and Nielsen 2004). Another study that looked at an internet-based migraine headache daily diary found that 68% of participants completed at least 50% of their daily diaries within the 24 hours and 75% of the participants completed them within 72 hours. When the participants were lacking internet access, due to factors like travelling, technical issues with their internet connection or computer and bad weather, at least 83% of them kept notes or printed pages so that they could fill in the data later. Another promising finding from this study was that 87% of the participants were willing to carry on completing the daily internet diary for at least another two months (Moloney, et al. 2009). This further suggests that an internet daily diary is a feasible method of assessing training and physical activity. There have been some studies that utilised online training diaries to quantify training volume and other aspects in participants. Guellich et al. (2009) investigated young world class rowers and followed the successful rowers from this group three years after completing the initial testing. They used an online Training Diary over the course of the entire season which reported their daily individual training. Both Buist et al. (2010) and Zwerver et al. (2010) utilised an online Training Diary similar to ours in their studies on the risk factors of injury in novice runners and the effect of an

intervention of extracorporeal shockwave therapy on jumping athletes with patellar tendinopathy, respectively. Another study used an online Training Diary which looked at the difference in injury rates in novice and experienced runners (Genin, Mann and Theisen 2011). A study that specifically looked at training volume as a risk factor for developing jumper's knee used a weekly online Training Diary (Visnes and Bahr 2011). These studies demonstrate the use Training Diaries can have in various fields for varying research questions.

2.4.3 SMS Training Diary

Another method of completing training diaries would be through Short Message Service (SMS). SMS is a service on all mobile phones where you can send messages of up to 160 characters to other mobile phones. The mobile phone does not need to be turned on or have reception for it to receive the message it will hold the message until the recipient phone turns on or is within range of reception (Anhoj and Moldrup 2004). The main issue with the online methods is as previously mentioned, the internet might not be integrated into the subject's everyday life. As a result, subjects may have to purposely log onto the internet to fill in the diary which can lessen compliance. The SMS method combats this as the majority of people own mobile phones. Market studies have shown that in 2001 60%-85% of people owned mobile phones in Western European countries (Vilella, et al. 2004). The majority of people who own mobile phones would tend to use them every day. This method would also be beneficial as it would not be a passive system that would wait for the subject to fill in the data, it would be more active and involve texting the subject with questions from the Training Diary and they would reply to the texts with the answers. A study that utilised this method looked at 12 asthma patients over two months. They sent 4 text messages to the subjects every day. Three of the questions required a text message to be sent back with a response and 1 question was a reminder to take medication. There was a delay of 1 minute between each text to allow the subject to reply. The response rate per subject (analysed by dividing the total number of SMS replies divided by SMS diary request per subject) was found to be 0.69 and ranged from 0.03 to 0.98, and half the subjects replied to more than two thirds of the requested diary information (Anhoj and Moldrup 2004). Out of the total of 727 study days, all users replied to all diary questions in 58% (438) of these days, 4% (31) of these days they replied to some diary questions and 38% (273) of days they replied to none of the questions. There was no major decline in responses during the study period and the only low response rate was in the days around Christmas and New Year's Eve. The major disadvantage of this method with respect to the internet method is that the subjects cannot look back at their past training data once they delete their message from their sent box on the mobile phone (Anhoj and Moldrup 2004). Subjects need to have 'credit' or money in their mobile phone in order to reply to the messages every day; some people may not have credit and would not be able to complete their

Training Diary. Also, the text messages in the asthma study were sent at the same time everyday even during weekends and holidays and this was viewed as negative by some subjects as they did not want to be awakened early during these periods. Overall, this method was deemed feasible and could easily be utilised to assess subjects training load in an easy to use and readily available method. Sports participation and the presence of injury was tracked using the SMS method in a study looking at whether being overweight was a risk factor in developing overuse injuries in children. The text messages were sent on a weekly basis and the information was reported by responding to the text message (Klakk, Jespersen and Wedderkopp 2011). Another study examining injury rates and exposure to sport in an elite female football team used a SMS diary, sending three messages weekly to each player and the players replied with the information (Nilstad, Bahr and Andersen 2011).

2.4.4 Java Based Training Diary on a Mobile Phone

Another method of utilising mobile phones in recording the participants Training Diary is by downloading the questionnaire from the internet via the participant's mobile phone using a Java (computer programming language) based application. One study investigated the efficacy of using this method to analyse physical activity in comparison to doubly labelled water and indirect calorimetry for 14 days. They found that the physical activity level described through the mobile phone Training Diary was similar to that found by the criterion methods. The disagreement between the two methods was found to be only 0.014. There was a high compliance level when using this method as only 2 out of the 22 participants missed a Training Diary report (Bexelius, et al. 2010). Another major benefit of this method is that not only do the majority of people have mobile phones but the cost of this method is much less than the text message version as the participants must only download the application, not pay for each text back to the researchers. However, some mobile phones (for example older models) do not have the ability to download the application and the questionnaire, therefore limiting the amount of participants that could utilise this method. However, Bexelius et al. (2010) found that out of the 22 participants 64% were able to download the application while the other 36% borrowed a phone supplied by the researchers for the duration of the study (Bexelius, et al. 2010).

2.5 Timing of filling in the Training Diary

Some training diaries or questionnaires can analyse training habits or load over a large number of years and others assess over very short periods of time. One study which analysed over a longer period interviewed 873 men and women in 1972 and discovered that their recalled physical activity levels equated to 1345kcal/day that year. They then interviewed the cohort again in 1983 and participants recalled their physical activity from 1972 and for that year. They established that the participants

recalled a much larger level of activity than they previously reported for 1972 (1899kcal v 1345kcal) and this recalled level was very similar to their level of activity of the current year (1822kcal) (Lee, Whittemore and Jung 1992). This emphasises the fact that as time between the activity and filling in the Training Diary or training questionnaire increases, the likelihood of error in the accuracy of reporting data increases as well. The authors however theorised that possible sources for these large differences could be because of the similarity between the activity levels of the participants in the study and because of the large random measurement error with the individual assessments (Lee, Whittemore and Jung 1992). Another study assessed physical activity in a much shorter time period. From 06.00 to 22.00 the participant had to fill in the activity they completed throughout the day in 15 minute intervals. From 22.00 to 06.00 in the morning they completed the diary for every hour. This method reduces the possibility of forgetting to report physical activity but it creates a large burden on the participant (Bringolf-Isler, et al. 2009). In a review of studies assessing physical activity and training load, Sirard & Pate (2001) proposed that studies that used 1-day or simpler measures of physical activity in comparison to 7-day or longer measures had greater correlations to criterion methods of assessment. A study that assessed seven day recall found that the test-retest reliability of this method was r=0.77 (Sallis, et al. 1993). Some methods of assessing training attempt to gather information from the previous month or year. A panel of experts agreed that this method should only be utilised if the routine activities and training activities of the participant didn't change much from day to day. However, in those whose training activities and routines changed frequently, they would be more successful using daily or past week training diaries (Masse, et al. 1998).

Another aspect which might affect the importance of how long to wait before filling in Training Diaries is that changes in seasons may affect the participants training and physical activity levels and patterns. If a diary is only filled out yearly it may not take into account the changes and variations in individuals' training. For example, in the summer, athletes may be peaking with their training and could be involved with an increased number and intensity of matches. This could be due to the fact that this is the time of the year where the championship is played. Another aspect is that due to the nicer weather participants might change their patterns, replacing gym sessions with outdoor sessions and may exercise more often (Masse, et al. 1998). Therefore, training diaries need to capture this change in training and behaviour and so should assess training at least every 3 months (Masse, et al. 1998).

Therefore, from published research available at the moment training diaries that are filled out daily or weekly seem to be the most widely advised method. An important point to make is that this study is assessing training, not all physical activity. For that reason, it does not need to capture every single motion that the participant does that day, nor does it need to be as detailed as other methods or studies that require

that much information. As a result, daily or weekly diaries would be more practical for the researcher and subjects alike. A study which utilised a weekly Training Diary in assessing the adherence to a rehabilitation programme on achilles tendon stiffness found that this would suffice (Morrissey, et al. 2011).

Buist (2010) analysed the predictors of running related injuries that used an online Training Diary that is very similar to our diary. Researchers asked the participants to fill in their diary information weekly. However, these participants had a set amount of training sessions that occurred only three days a week; because they would not be training daily, weekly logging of data would be more rational (Buist, et al. 2010). A study looking at the effects of oral bovine colostrums on the physical work capacity of a group of cyclists required all participants to fill in the Training Diary daily (Coombes, et al. 2002). Also, a study comparing male and female Ironman triathletes utilised a Training Diary that was completed daily consisting of information on the distance and duration of each activity, updated daily for three months (Knechtle, et al. 2010).

The duration that studies utilised a Training Diary varies depending on the goals of the study and the population being studied. A study that assessed training and injury patterns in triathletes asked participants to fill in their training for 8 weeks which is similar to this study (Korkia, Tunstall-Pedoe and Maffulli 1994). The majority of studies linked to a sport required their participants to fill in the Training Diary for the duration of their season. For example, a study on the menstrual cycle, oral contraceptives and its influence on the risk of lower back pain asked their subjects to fill in a Training Diary for the duration of their active soccer season which lasted over 5-8 months (Brynhildsen, Hammar and Hammer 1997).

2.6 Compliance and Return Rate of the Training Diary

The subject's compliance to the Training Diary is paramount in order to effectively assess the training load in participants. The higher the return rate of participants, the more information can be gleaned from the results. Therefore, it is imperative to maximise the amount of participants returning Training Diaries. Response rates are rarely reported in the available literature utilising Training Diaries. A study examining cross-training and injury risk in British Olympic-distance triathletes reported the exact response rate to their diary. Out of the 50 participants, 43, 38, 33, 26, 21, 14 and 11 returned their diary in each sequential month within the 7 months studied. This shows a high percentage of returns in the early stages of testing, nevertheless, as the study carried on the return rates reduced (Vleck and Bessone Alves 2011). The response rate of written Training Diaries in a study looking at the physical activity level of wealthy children aged 9 to 15 was discovered to be very low. The rate was only 33%, which was surprising as the study had the full support of the school and teachers (Sleap, et al. 2007). The response rate for a Training Diary study on British triathletes over 8 weeks was 29%. There was a significantly

larger response rate from participants that were recruited in clubs. These had a response rate of 48% whereas those recruited at competitions had a much lower response rate of 16% (Korkia, Tunstall-Pedoe and Maffulli 1994).

Therefore, due to low compliance it may be necessary to utilise a number of methods to increase compliance. There have been a number of different methods used in various studies however, not many of them have been accurately looked at in order to see if they do in fact increase compliance.

2.6.1 Text Message

Mobile phones could be utilised to increase the compliance in filling in the training dairy. Text messages could be sent to remind each participant to fill in their Training Diary, daily, weekly or monthly. The efficacy of mobile phones in improving the vaccination rates of people travelling to foreign countries has been studied. Vilella et al. (2004) found that 77.2% in the Control group in 2000 returned for the second hepatitis A + B, 80.7% in the Control group in 2001 and this increased to 88.4% in the Study Group when they received SMS messages to remind them to receive their vaccine. For the third hepatitis A + B vaccine the compliance rate was 23.6% in the Control group in 2000, 26.9% in the Control group in 2001 and there was an increase to 47.1% in the Study Group (Vilella, et al. 2004). Consequently, these results suggest that SMS messages can effectively increase compliance rates and would be a useful method to complete this task in this study.

2.6.2 Phone call

An alternative to sending a text message would be to contact the participants by telephone, requesting them to return or fill in their Training Diary. This was done by researchers in a study utilising Training Diaries in triathletes (Korkia, Tunstall-Pedoe and Maffulli 1994). However, the participants were required to return the Training Diary at the end of 8 weeks, and as a result, researchers only contacted them by telephone once. It would be a lot more invasive to personally ring each participant each day to remind them to fill in their Training Diary. Also, a text message may be more advantageous because if a participant was unable to answer their phone they would still receive the text message. Nevertheless, a phone call may encourage a better response as it is more personal and would provide the participants an opportunity to ask any questions related to the study (Korkia, Tunstall-Pedoe and Maffulli 1994).

2.6.3 Email

Another method that could be utilised in order to increase compliance is emails. Sending daily, weekly or monthly emails to subjects in order to remind them to fill in their Training Diary could be useful, especially in subjects who are filling in the Training Diary using the online system. One study that used this reminder looked at the compliance rates of females taking oral contraceptives. Self-recall studies have

shown that females miss at least one pill per cycle in 19-58% of cases and in 10-22% of cases miss two or more pills per cycle. This figure increases in studies that used an electronic device that detects when pills have been taken. 81% miss at least one pill per cycle and 51% miss three or more pills per cycle in this type of study. When a daily email was sent to remind the subject to take the pill the compliance rate was found to be higher; 50% missed no pills at all and only 20% missed one pill per cycle. 65% of subjects found the daily email somewhat helpful and 19% found it very helpful. In fact, 64% of subjects wanted to carry on receiving the daily email to remind them once the study finished (Fox, et al. 2003). The main limitation with this method compared to others is that it requires the participants to check their email daily. While those who work on computers or students may do this, those who do not have access to the internet will not receive the email and so will not receive their reminder.

2.6.4 Encourage a routine

A routine may increase compliance with training diaries in some participants. If, for example, subjects complete the diary at the same time every day and get into the habit of doing this they may be less likely to forget to complete it. In fact, women who take oral contraception are 3.3 times more likely to miss one or more pills per cycle if they do not take their pill at the same time every day and are 4.6 times more likely to miss more than two pills per cycle (Fox, et al. 2003). For this reason, participants should be strongly encouraged to get into a routine when filling out their training diaries.

2.6.5 Identification with researchers

If the participant cannot relate to the researcher it can be difficult for them to trust them and may reduce the response rate or amount of information the participant is willing to reveal. This idea is very evident with a lot of cultural minorities in the research setting. For example, studies on minority cultures often can be viewed as negative and so in order to gain these people's trust it may be necessary to have members in the research team of the same culture. This can be especially important when the study involves interviews. Other aspects like gender, (i.e. females interviewing females) and athletic background (i.e. a Gaelic Footballer interviewing another Gaelic Footballer) may affect compliance as the participant may feel that the researcher understands the nature of the sport and the demands placed on the participant. This may encourage the participant to contribute more to the study. Even in Training Diary research that does not involve interviews it may be important for researchers to demonstrate knowledge and familiarity with the sport and the training required (Masse, et al. 1998). Since the researcher will be attending a training session a week to collect the Training Diaries if the participants have a level of identification with the researcher they may be more likely to complete the Training Diary daily and return it in time.

2.6.6 Interest in the study:

Another method of encouraging response rates is ensuring the participants have an interest in the study. If they can understand and see the benefits of the study and the information they provide, there would be an increased likelihood of them completing the diary (Masse, et al. 1998). Therefore, in order to increase compliance researchers should fully explain the study to the participants and inform them how they would benefit (Masse, et al. 1998).

2.6.7 Incentive

Another method of encouraging participants to complete the Training Diary daily and faithfully is to award those who complete all their dairies with a small incentive (e.g. tickets to a G.A.A .game). An incentive is commonly used in studies, including a very similar study assessing the correlation between accelerometers and self report questionnaires in varying subgroups (Slootmaker, et al. 2009). Another study assessing training and injury patterns in British triathletes rewarded those who returned their training diary at the end of the 8 weeks with a t-shirt (Korkia, Tunstall-Pedoe and Maffulli 1994) Sleap, et al. 2007).

2.6.8 Support of Managers and Parents

The support of those involved with the team is thought to increase return rates and compliance with the study. In fact, researchers examining the physical activity level in a private school with children aged 9 to 15 noted that anecdotal reports, after the study was completed, suggested that some class teachers were more enthusiastic in encouraging the school children to fill in and hand up the Training Diaries. This could explain the fact that in some classes almost all students returned their written diaries however, in other classes a very small number returned their diary (Sleap, et al. 2007).

2.7 Validation of the Training Diary

The Training Diary must be validated in order to verify that the Training Diary itself fully reports the training completed by the participant. Therefore, in an ideal situation the Training Diary results could be compared to a method that objectively analyses the true amount, duration and frequency of training with no error (Rennie and Wareham 1998). Training Diaries have been validated against a number of other methods of reporting the physical activity level of a participant. In order to effectively validate Training Diaries, researchers should aim to compare the Training Diary information with a criterion method of assessing physical activity. However, this can be difficult as the cost of these methods can be large and impractical to use (Dollman, et al. 2009). Physical Activity Diaries have been found to have reasonable correlations between heart rate monitors and accelerometers (Sleap, et al. 2007). In fact, it has been declared that Training Diaries are superior to retrospective questionnaires and this is possibly due to the fact that it isn't necessary to remember events that occurred a long time ago (Sleap, et al. 2007)(Dollman, et al. 2009) Dollman, et al. 2009). Guellich et al. (2009) validated their online Training Diary against a survey that was posted directly to each

participant after the season's training was completed and the participant was finished filling in their Training Diary. This survey was anonymous and was completed by 29 out of the 36 participants in the study. Researchers found a correlation of r=0.88 in training frequency ($p<0.01$) between the Training Diary and the postal survey. They found a correlation of r=0.84 between training time of the two methods of analysis. They found the online diary resulted in a 4.0 ± 8.5% greater level of training frequency in comparison to the postal survey, and a 10.4 ± 12.3% reduced level of training time. They also discovered no significant relationship between the difference in results between the two forms of analysis and personal achievement of the participants. However, care must be taken when reviewing the results of this validation study as the postal survey itself was not validated against a criterion measure of physical activity. Therefore, it is not possible to state that the variation found between the two forms of analysis is due to a fault in the effectiveness of a Training Diary. Another one of the few validated diaries is the Bouchard Diary. This is a daily log that quantifies the activities undertaken throughout the whole day. It discovered a correlation of r=0.82 for its 3 day activity log. The validation study was completed over one day only (Wickel, Welk and Eisenmann 2006). There are a large amount of bias and error that can affect self recall of physical activity in Training Diaries and that need to be minimised as much as possible. In fact, self recall information can be one or a mix of four different factors: the actual truthful activity completed, a misrepresented memory of the activity completed, an estimate of their usual activity behaviour or level or their own view of what is ideal or what they wished they completed (Kelly, et al. 2011).

2.7.1 Representativeness of a validation study

The participants in a study to validate a Training Diary should replicate the population that the Training Diary is evaluating. A lot of validation studies utilise university staff and student volunteers as they are usually easy to recruit. However, this causes its own issues because if this is not the subgroup in which the Training Diary is aimed it is not as valid. For example, one study that aimed to look at Activity, Fitness and Exercise (SAFE) in a wide range of participants validates their questionnaire using 94% Caucasians with 71% of them holding graduate degrees. Therefore, they did not reflect the population the questionnaire was to be used with (Rennie and Wareham 1998). However, since validation studies are somewhat invasive and time consuming, it may be necessary to utilise any willing participants regardless of whether they represent the population to be studied (Rennie and Wareham 1998).

2.7.2 Gender distribution of validation study

In order to validate the Training Diary for both genders, the study participants must be of both sexes. It has been shown that you cannot generalise the validity of a study to another gender. In a study on physical activity and diabetes in women only, the researchers completed a validity study on their questionnaire

on both males and females. They found a correlation of r=0.46 between the self reported number of days with vigorous activity and VO_2max. However, if you looked at the correlation in women only, it lessened to r=0.26 which questions the validity of this questionnaire in assessing physical activity in women (Rennie and Wareham 1998).

2.7.3 Sample size of validation study

The sample size affects the strength of the results of a study and the size depends on the mode of measuring the training. For example, questionnaires can be given to large samples, whereas expensive methods like doubly labelled water tend to have smaller samples. Smaller sample sizes are also more inclined to produce non significants result or give large confidence intervals. Therefore, a validation study should aim to have as large a sample size as feasible. Sample sizes are varied and it was found in a review on the validation of physical activity that they varied from 17 to 986 (Rennie and Wareham 1998). There is an assumption in the literature that a necessary sample size for a criterion related validation study is between 30-50 subjects (Schmidt, Hunter and Urry 1976). In fact, an average sample size of 68 was found in a review of 406 published validation studies (Schmidt, Hunter and Urry 1976). Nevertheless, the question remains whether sample sizes of this proportion can effectively discover reliability and validity issues within a study. Schmidt et al. (1976) suggested a formula to discover the optimum sample size needed. These researchers discovered that if the sample size was 30, the power of the study to capture the validity of the study would only be 0.27. For this reason, a valid test (true validity or r=0.45) would be noted as invalid 73% of the time. This suggests that sample sizes need to be much larger than what is commonly reported in the literature..

2.7.4 Statistical Power

To effectively analyse the effects of Training Diaries it is beneficial to have adequate statistical power in the study. Statistical power is affected by four different issues, including: sample size, effect size, type of statistical test used, and the level of statistical significance (Haskell and Kiernan 2000). Therefore, in order to enhance the power of this study the sample size should be as large as possible, as previously mentioned. As the size of the sample population used in a study increases, the confidence interval (CI) or the difference between the upper and lower limit values found in the study decrease, and this helps increase the likelihood of significant differences being found and enhances the power of the study (Brooks and Fuller 2006). The Effect Size is the extent of the difference between the groups. To enhance the Effect Size the researcher must either increase the numerator or the difference between the mean change of the different groups of participants, or else decrease the denominator which would be the variability in the response rates within each of the groups. This can be

done by ensuring that all participants in the groups are alike in age, sex, etc. (Haskell and Kiernan 2000).

2.8 Summary of Literature Review Chapter

Results from this Review of Literature appear to suggest that it is essential that training load is accurately captured in Gaelic Football players of all ages. The literature review has shown a severe gap in research based methods of monitoring training load that is accurate, inexpensive and simple to use. The aim of this research project was to produce an easy to use, well analysed method of assessing training load in Gaelic Football players of all ages. The project aimed to develop an effective and valid Training Diary. The methodology of each of the four studies is presented in Chapter Three.

Chapter 3.0 Methodology

3.1 Research Design Overview

A quantitative research design was employed in this study. The quantitative research was conducted through assessing the use of the daily Training Diary by the participants. It also compared the accuracy of the Training Diary to an objective method of assessing training.

Qualitative research was undertaken by utilising a questionnaire evaluating the participants' opinions on the Training Diary itself, the best method of completing the questionnaire and whether a reminder was necessary.

3.2 Purpose

The purpose of this study was four-part:

1) To design a daily Training Diary to accurately assess and monitor training loads in Under-14, Under-18 and adult Gaelic Footballers of both genders.
2) To compare and contrast the efficacy of two differing methods of completing the Training Diary (paper and online) in Under-14, Under-18 and adult Gaelic Footballers of both genders.
3) To validate the designed Training Diary in the most effective form to accurately assess and monitor training loads in Under-14, Under-18 and adult Gaelic Footballers of both genders.
4) To compare and contrast a text reminder, email reminder or no reminder in the use of a daily Training Diary.

Dependant Variable for Study Two

The dependant variables consisted of:

1) The Response Rate of the Training Diary.

Independent Variables for Study Two

The independent variables consisted of:

1) The method of completing the Training Diary: paper and online.
2) The age group of the Gaelic Footballers participating in the study: Under-14, Under-18 and adult.
3) The gender of Gaelic Footballers participating in the study: male and female.

Dependent Variable for Study Three

The dependent variable was:

1) The Validity of the Training Diary

Independent Variables for Study Three

The independent variable was:

1) The Method of assessing Training Load: Training Diary, SenseCam, Accelerometer and Interview

Dependent Variable for Study Four

The dependent variable was:

1) The Response Rate of the Training Diary

Independent Variable for Study Four

The independent variables consisted of:

1) The use of a reminder to complete the Training Diary: Text reminder, Email reminder and no reminder.
2) The age group of the Gaelic Footballers participating in the study: Under-14, Under-18 and adult.
3) The gender of Gaelic Footballers participating in the study: male and female.

3.3 Research Team

The principle researchers were Dr. Noel McCaffrey and Ms. Siobhán O Connor who were part of an extensive research team involved in a large prospective cohort study that is examining the incidence of, and common risk factors for injury that occur in young elite and non-elite male and female Gaelic footballers.

3.4 Ethical and Legal Considerations

Ethical approval was granted for this study in November 2010 (see Appendix D). All subjects received a plain language statement. All participants attended a question and answer session whereby the objectives and procedures of the study were explained to them. Subjects were also given an opportunity to gain more information about the study at this session. All subjects signed a consent form prior to beginning the study (see Appendix F). Subjects recruited, who were under the age of consent, attended the question and answer session with their legal guardian. The legal guardian and subject both signed an informed consent form (see Appendix H). Subjects or their parents/guardians were free to discontinue participation in the study at any time.

3.5 Participants

Gaelic Footballers of all levels were recruited for this study. Participants were aged between 12 -30 years. They were both male and female. Subjects were both elite and non-elite. A total of 162 subjects took part in the study and 16 subjects took part in the validation study. In the study to assess different modes of Training Diaries and to assess the efficacy of reminders 146 subjects participated. Subjects were recruited from community GAA clubs throughout Munster, Leinster, Connaught and Ulster.

Inclusion Criteria:

1) Gaelic Footballers who play with a school, college or club team.
2) Gaelic Footballers of any level or gender.
3) Gaelic Footballers aged between 12 and 30.
4) Gaelic Footballers who did not meet any of the exclusion criteria

.

Exclusion Criteria:

1) Gaelic Footballers under the age of 12 and over the age of 30.
2) Former Gaelic Footballers who no longer play Gaelic football.

3.6 Data Collection/ Procedure

3.6.1 Study 1

The Training Diary was designed by six members of the cohort research team in three separate meetings (See Appendix A). Three separate drafts were drawn up at each meeting and further researched until the final Training Diary form was completed. The Training Diary aimed to accurately assess the individuals training from that day. The questions assess:

1) The number of sessions completed that day
2) The sport played during each session
3) The team the individual was playing with
4) The age group of the team the individual was playing with
5) The activity completed
6) How hard the session was (modification of the Borg CR-10 scale)
7) The duration of the session
8) The time taken to travel to the session
9) The training surface
10) The footwear worn at the session
11) Whether an injury was received

The Training Diary takes an average of 3.7 minutes to complete.

3.6.2 Pilot Study

The pilot study involved testing the Training Diary on a sample population. Ten Gaelic Footballers of both genders aged between 12 and 30 were recruited. Subjects were given the Training Diary in print form and asked to complete it for that day. Subjects were then asked a series of questions on the formatting of the diary including:

1) How long did the diary take to complete?
2) Were the questions easy to understand?
3) If not, what questions were difficult to understand and why?
4) Were there any questions missing in the Training Diary that you would like to be included?

3.6.3 Study 2

Study 2 aimed to compare and contrast the efficacy of two differing methods of completing the Training Diary. The Training Diary can be completed in two different forms, paper and online. Each form requests the same information. In order to assess which method is best in each age group and as a whole, the response rate of the Training

Diary was analysed. Table 3.6.3 demonstrates the protocol used over 6 weeks. Each separate team completed three weeks of filling in the Training Diary using each method.

Table 3.6.3: Testing Protocol for Study Two

Age Group	U 14 Girls	U 14 Boys	Minor Girls	Minor Boys	Adult Ladies	Adult Men
Week 1	Paper	Paper	Paper	Paper	Paper	Paper
Week 2	Paper	Paper	Paper	Paper	Paper	Paper
Week 3	Paper	Paper	Paper	Paper	Paper	Paper
Week 4	Online	Online	Online	Online	Online	Online
Week 5	Online	Online	Online	Online	Online	Online
Week 6	Online	Online	Online	Online	Online	Online

Each method was distributed to the participants in differing ways:

1) Paper Method: The paper forms and codes were distributed to each player at the start of each week at the team's training session. The participants were told to fill in the Training Diary each day and were instructed to return it to the researcher at the training session the following week. If some participants were not at training, the Training Diary and codes were given to the participant's friend to pass it on or else given to the manager to give to the player at the next training session.
2) Online Method: The participants were sent an email providing the login to the website; a user name and password individual to each player. The manager also received a copy of the usernames and passwords in order to provide login details if participants did not receive the email, forgot their details or deleted their details. If emails did not deliver, a text was sent to the participants' mobile phone with the login details. Subjects used these details in order to log into the site and fill in their Training Diary online. Participants were instructed to fill in the Training Diary daily.

The participants in this study also filled out a questionnaire after the 6 weeks were completed. This questionnaire assessed what participants thought of each method of completing the Training Diary and which method they found the most user-friendly (See Appendix J).

Study 3

Study 3 aimed to validate the Training Diary itself. In order to assess the accuracy of the Training Diary it was compared against an objective method of assessing physical activity. The objective method utilised was an Accelerometer and a SenseCam. Sixteen subjects, 8 male and 8 female from all three age groups, and levels of Gaelic Football wore an accelerometer and SenseCam from when they got up in the morning until they went to bed for a period of a single day. Simultaneously, the subjects completed the

Training Diary. All participants completed the online Training Diary. The accelerometer was used to objectively analyse the intensity of activity and the number of sessions completed. The SenseCam was used to objectively measure the sport played, the type of activity completed, session length, travel time, surface played on and footwear. The results were compared to the information received from the Training Diary, to evaluate the accuracy of the Training Diary. Three aspects of the Training Diary were not validated by the accelerometer or the SenseCam. These were whether an injury was received, what team they played with and the age group played with. Consequently, we conducted an interview the following day with participants as they returned their equipment to ensure the information provided in the Training Diary was correct.

3.6.4 Study 4

Study 4 assessed the effectiveness of a text reminder, email reminder and no reminder in the use of the daily Training Diary. The response rate was used to assess the effectiveness of each reminder. Table 3.6.4 demonstrates over 2 weeks how the effectiveness of each reminder was assessed.

Table 3.6.4: Testing Protocol for Study 4

Age Group	U14 Girls	U14 Boys	Minor Girls	Minor Boys	Adult Ladies	Adult Mens
Week 1	Email	Email	Email	Email	Email	Email
Week 2	Text	Text	Text	Text	Text	Text

The participants filled out a questionnaire at the end of the 2 weeks. It requested information on whether the participants thought a reminder was necessary, and if so, which reminder was most practical and helpful (See Appendix J).

3.7 Research Tools/Equipment

The equipment used in this study was: Accelerometers, SenseCams, online Training Diary Website and Forms, Paper Training Diary Forms and Pens.

3.7.1 Accelerometer

An accelerometer is used to measure a participant's motion in more than one plane. It measures physical activity by recording how often and how quickly movements are made by the participant on the day of testing. Accelerometers are small, non-invasive devices that are worn on a belt around the hip and do not interfere with the participant's usual daily activities or functions.

The intensity of the activity is analysed objectively using the accelerometer. The intensity is assessed by the "counts" produced by the accelerometer for the duration of the activity. Cut off points are used to differentiate whether the activity was sedentary,

light, moderate, vigorous and very vigorous. The cut off points used in this study will be as proposed by Freedson et al., (2000).

The placement of the accelerometer was on the right hip. This is the most usual placement in studies. (Dollman, et al. 2009)

3.7.1.1 Instructions on how to wear the Accelerometer

All subjects were given a full visual demonstration on how to wear the accelerometer and were also given a written set of instructions. A diagram of the accelerometer and the specific terms used for each aspect of this monitor was also given to each subject. The instructions were as follows:

- You will receive an accelerometer and electric strap. Attach the two of these together.
- Place the accelerometer around your hip and ensure the accelerometer is on your right hip.
- Ensure the GT3X marking and the flashing light on the accelerometer are facing outwards.
- Adjust the strap to ensure it fits snugly and comfortably against the hip.
- Wear the accelerometer from the minute you wake up in the morning until before you go to bed at night.

3.7.2. SenseCam

The SenseCam is a small wearable camera with a wide angle lens that automatically takes photos of the participant's surroundings without the participant having to consciously note any activity or take a photo themselves. The SenseCam senses its surroundings and automatically triggers a photo to be taken if there is a change in light level, change in audio level or if it detects body heat in front of the camera, and it can also take a photo after a certain period of time (usually every 30 seconds). It can hold over a weeks' worth of images (approximately 32,000 images).

3.7.2.1 Instructions on how to wear the SenseCam

All subjects were given a full visual demonstration on how to wear the SenseCam and were also given a written set of instructions. A diagram of the SenseCam and the specific terms used for each aspect of the monitor was also given to each subject. The instructions were as follows:

- You will receive a SenseCam and a strap that are attached together.
- Remove the lens protector covering the lens of the SenseCam.
- To turn on the SenseCam press the middle button on top of the SenseCam. The lights on top of the SenseCam will start flashing.
- The green light will shine continuously when the SenseCam is turned on.

- The orange light flashes each time a photo is taken by the SenseCam.
- Hang the SenseCam around your neck and shorten or lengthen the strap as appropriate.
- Do not wear the SenseCam when it is raining or in water e.g. a shower.
- Press the privacy button on the left of the SenseCam or remove the SenseCam when using the bathroom etc. The privacy button stops the SenseCam from triggering photos for a period of 4 minutes.
- Wear the SenseCam from the minute you get up in the morning until when you go to bed.
- The SenseCam can be secured around your chest when training with the additional Velcro strap provided.

3.7.3 Online Training Diary Website and Form

The online version of the Training Diary was set up by internal DCU computer researchers. Each participant was given a private username and password so that only the participant and the researchers could access the Training Diary. See Appendix C for a visual representation of the online version of the Training diary.

The intensity of the activity noted in the Online Training Diary will be noted by the use of a modified Borg CR-10 intensity scale. The 0.5 option from this scale was removed and so the participants noted the intensity from 0 (nothing at all) to 10 (very very hard/maximal). The Borg CR-10 scale is presented in *Appendix I*.

3.7.3.1 Instructions on how to use the Online Training Diary.

- Connect to the internet and type in the webpage http://healthsense.computing.dcu.ie/eDiary/
- Enter your own personal username (as given to you by the researchers) e.g. for the Dublin Gaelic Football team, they would type DGF001 into the "username" box
- Enter your own personal password (as given to you by the researchers) e.g. for the Dublin Gaelic Football Team, they would type d001 into the "password" box
- Fill in the appropriate response to each question
- Ensure you fill in the appropriate responses for EACH session completed each day
- Click "Save Training diary" at the bottom of the page
- Log out from the Training Diary

3.7.4 Paper Training Diary

The Paper Training diary required the participant to be present at every training session at the start of the week in order to receive the Training Diary and return the Training Diary from the following week.

The intensity of the activity noted in the Paper Training Diary will be noted by the use of a modified Borg CR-10 intensity scale. The 0.5 option from this scale was removed and so the participants noted the intensity from 0 (nothing at all) to 10 (very very hard/maximal). The Borg CR-10 scale is presented in *Appendix I*.

3.7.4.1 Instructions on how to use the Paper Training Diary

- You will receive the paper Training Diary at your training session at the start of the week
- You must fill out this Training Diary using the codes provided daily
- Ensure you fill in the appropriate responses for EACH session completed each day
- Return the Training Diary to the researchers at the next training session at the start of the following week

3.8 Data Analysis

1) All data collected was entered into Microsoft Excel and then SPSS Statistics 17.0.

2) The data were entered, cleaned, and outliers, mistakes and missing values were replaced.

3) For Study 2 and 4 the efficacy was tested by counting the responses by each team. The amount of Training Diaries returned was then compared to the size of the team by converting each value into a percentage of the total team's response.

Three separate statistical tests were utilised to assess the results in Study Two. A paired samples t-test was completed to analyse the response rate for the method used to complete the Training Diary. An independent samples t-test was completed to assess the response rate compared to gender. A one way between groups ANOVA was completed to examine the effect of age on response rate.

Three separate statistical tests were utilised to assess the results in Study Four. A one way within groups ANOVA was completed to examine whether a reminder and which reminder increases response rate. An independent samples t-test was completed to assess the effect of gender on response rates when receiving a reminder. A one way between groups was conducted to explore the impact of age on response rate when using a reminder.

4) For the Validation Study, a Spearman Rank Order Correlation was used to compare the intensity, duration of activity and travel time reported by the Training Diary with the SenseCam. A Bland Altman plot was also utilised to assess the agreement between the intensity, duration of activity and travel time reported by the Training Diary and the SenseCam. The percentage of cases where there was agreement between the SenseCam and the Training Diary was reported for sport played, type of activity, session length, travel time, training surface and footwear worn. The percentage of cases where there was agreement between the Training Diary and the interview was reported for what team the participants was playing with, age group and whether an injury was received.

5) For the questionnaires, the average percentage for each answer over all six teams was presented. The individual answers and reasons were presented for each team. Paired samples t-tests were completed between each answer to a question in the questionnaire on the most preferred method of filling in the Training Diary. A paired samples t-test, a one way repeated measures analysis of variance and the Friedman test were completed on the results of the reminder questionnaire.

3.9 Summary of Methodology Chapter

In summary, four separate studies were completed in order to assess the effectiveness and validity of the Training Diary. Study One was designed to develop an easy to use Training Diary to capture training information in Gaelic Footballers. This also incorporated a Pilot Study that tested the Training Diary on a sample population of Gaelic Footballers between the ages of 12 and 30. Study Two compared the response rates of two different methods of completing the Training Diary. It analysed the response rates produced in a Paper and Online Training Diary in six teams in three separate age groups. Study Three validated the Training Diary using an accelerometer, SenseCam and interview. Study Four assessed the effectiveness of an email and text reminder in six teams in three separate age groups. Chapter Four summarises the results found in each of the four studies completed.

Chapter 4.0 Results

4.1 Pilot Study

Gaelic Footballers aged between 12 and 30 completed the Training Diary in print form. There were ten participants consisting of five males and five females. Participants filled in the diary for that day and were asked a series of questions about the diary.

The Training Diary took a mean of 3.7 (±1.2) minutes to complete. The majority of participants (70%) found the Training Diary questions easy to understand. The majority of participants (90%) found that there were no further questions they would like included in the Training Diary.

Table 4.1: Pilot Study Results

Participant	How long did the diary take (in minutes)?	Questions easy to understand?	If no, what questions were difficult to understand?	Were there any questions missing that you would like to be included?
1	5	Yes	-	No
2	3	Yes	-	No
3	3	Yes	-	No
4	5	No	Layout was difficult to understand	No
5	2	Yes	-	A question on the time of activity – could help me remember the event and manage training.
6	3	Yes	-	No
7	3	Yes	-	No
8	5	No	Confused about the 5 options each day	No
9	3	No	Travel time question – Didn't know if the question meant return trip or one way.	No
10	5	Yes	-	No

4.2 Validation Study

The Validation Study consisted of 16 participants (8 male and 8 female) and was completed over 24 hours.

4.2.1 Sport Played

The participants recorded results of the sports played with 95% agreement between the Training Diary and the SenseCam and interview. A single result for one participant differed. The subject noted in the Training Diary that they had completed individual gym work, however, when observed on the SenseCam they had in fact been running. When interviewed the individual reported that they had completed a run.

4.2.2 Team Played With

The participants' reports had a 95% agreement between the Training Diary and both the SenseCam and interview with regard to the team they played with. Nevertheless, one participant in one of their Training Diary results reported that they played with their own age group. In reality however, they had completed an individual activity. This was confirmed in the interview.

4.2.3 Age Group

The subjects reported the same age group option in all cases which was confirmed by viewing the SenseCam and an interview.

4.2.4 Activity Played

The same activity was confirmed by the SenseCam in all cases. The activities recorded included outside and inside training.

4.2.5 Intensity of Activity

The level of intensity reported by participants was between 2 and 6, out of a maximum of 10. Intensity was defined as 0-3 as light intensity, 3-6 as moderate intensity and 6 or higher as vigorous intensity. The cut-off points were commonly used points derived by Freedson et al. (1998).

The level of intensity reported by participants was in accordance with the intensity reported on the accelerometer in 70% (n=14) of cases. There was no agreement with the accelerometer in 30% (n=6) of results but all were within one level of the intensity reported in the accelerometer. In 4 exercise sessions, participants over reported the intensity of the activity. On the other hand, in 2 exercise sessions, participants under reported the intensity of the activity. Table 4.2.5 demonstrates the Intensity reported by the Training Diary and accelerometer.

Table 4.2.5: Levels of Intensity in Training Diary and Accelerometer

Exercise Session	Intensity Diary	Intensity Accelerometer	Average Counts	Agreement
1	Moderate	Moderate	2634.3	Agree
2	Moderate	Moderate	2790.6	Agree
3	Hard	Moderate	4597.8	Disagree
4	Moderate	Light	1671.3	Disagree
5	Fairly Light	Sedentary/Light	102.1	Agree
6	Somewhat Hard	Vigorous	5739.7	Disagree
7	Fairly Light	Moderate	3080.6	Disagree
8	Moderate	Moderate	2679.6	Agree
9	Moderate	Moderate	2097.9	Agree
10	Moderate	Moderate	2238.9	Agree
11	Moderate	Moderate	5245.9	Agree
12	Very Light	Light	1752.8	Agree
13	Very Hard (8)	Vigorous	6302.9	Agree
14	Very Light	Light	1647.3	Agree
15	Fairly Light	Light	1135.5	Agree
16	Somewhat Hard	Moderate	2497.3	Agree
17	Hard	Moderate	4639.2	Disagree
18	Moderate	Moderate	5215.7	Agree
19	Moderate	Moderate	4158.1	Agree
20	Moderate	Light	1044	Disagree

The sample size was less than 30. Therefore, tests of normality were completed. Skewness was present in the Training Diary Intensity histogram and the Accelerometer Intensity histogram. No outliers were present in the data. The Accelerometer Intensity was significantly normal ($D(20) = 0.16$, $p > 0.05$). The Training Diary Intensity was significantly non-normal ($D(20) = 0.23$, $p < 0.05$)

Preliminary analysis showed a violation of assumptions of normality. Therefore, the Spearman Rank Order Correlation (rho) was completed. There was a strong positive correlation between the Training Diary Intensity and the Accelerometer Intensity ($r=0.918$, $p<0.001$).

Females demonstrated a stronger correlation ($r=0.974$, $p<0.0001$) compared to males ($r=0.894$, $p<0.0001$) when comparing the intensity reported in the Training Diary to the accelerometer.

The Bland Altman plot assessed the agreement between the intensity reported by the Accelerometer and the Training Diary. As demonstrated in Fig 4.2.5 there was no substantial fixed bias in over-reporting or under-reporting. The intensity bias demonstrated by the Bland Altman Plot indicates that in practical terms the Training

Diary is in sufficient agreement with the objective accelerometer (95% limits of agreement; -123 counts ± 480 (-1072-846 counts)). Of the 20 training sessions reported by the participants, one intensity (5%) was over-reported (above the y=0 line) and four reported intensities (20%) were under-reported (below the y=0 line).

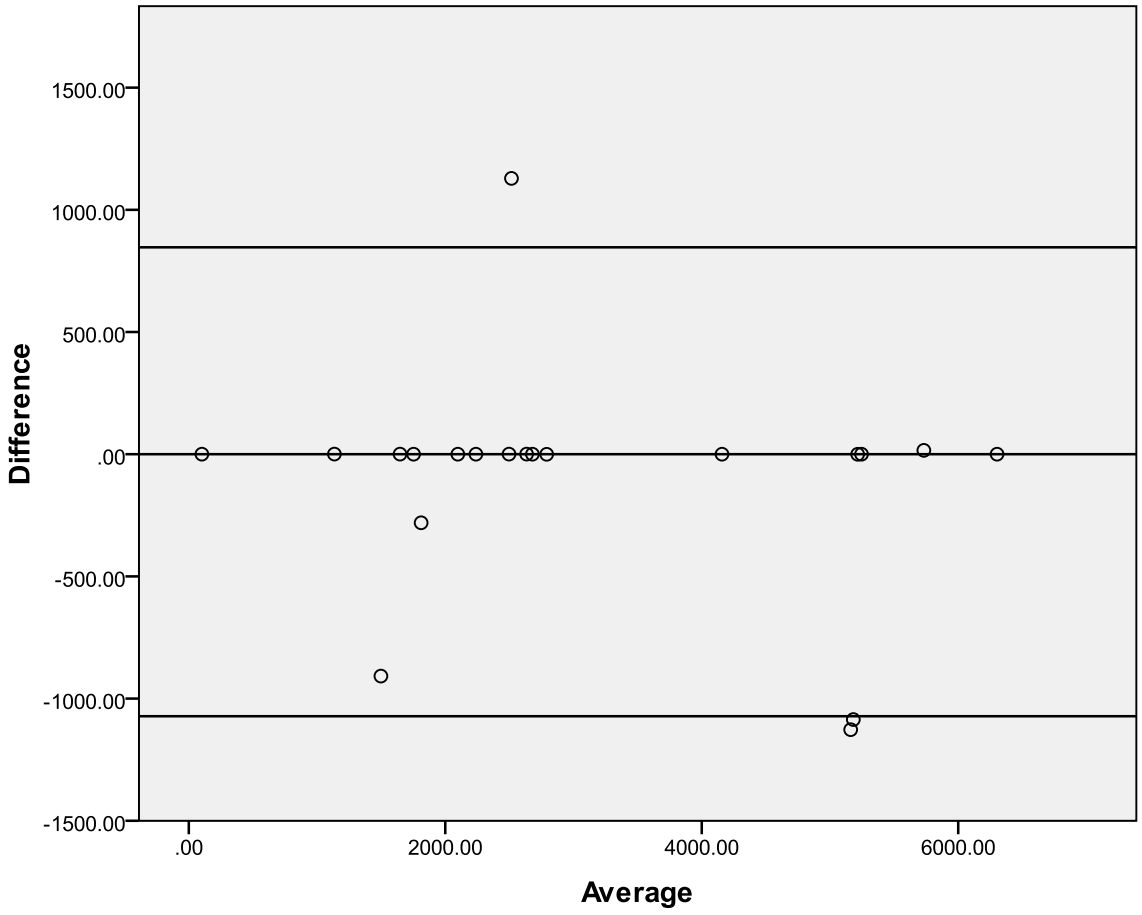


Figure 4.2.5: Agreement between Intensity of Training Diary and Accelerometer.

4.2.6 Session Length

There were 20 sessions reported by 16 participants within the testing time. 70% of participants within the validation study reported durations of Physical Activity that matched those viewed on the SenseCam. However, 30% of reported session lengths were over or underestimated.

The Training Diary reported a total amount of 813 minutes of activity. The SenseCam reported a net total of 781 minutes of activity. The maximum length of physical activity reported by the Training Diary was 83 minutes, whereas the maximum length of physical activity reported by the SenseCam was 70 minutes. The minimum session length noted in the Diary and SenseCam was 12 minutes. The mean minutes spent in activity as reported by the Training Diary was 40.7 ± 17.1 minutes. However, the

SenseCam noted a mean of 39.1 ± 14.5 minutes of activity. Therefore, there was a misrepresentation of 76 minutes as a whole by 16 participants. The Training Diary under-reported 2.7% (22 minutes) and over-reported 6.6 % (54 minutes). Thus, there was a total over reporting of 54 minutes of activity by the Training Diary as a whole.

In terms of gender, males reported a sum total of 339 minutes in the Training Diary which was similar to the total of 340 minutes observed in the SenseCam. Conversely, females noted a total of 474 minutes of activity which differed to the 441 minutes viewed by the SenseCam. Hence, females in this validation study over-reported the physical activity duration by a total of 33 minutes. The Training Diary reported a mean of 33.9 ± 16.3 minutes of physical activity for males while the SenseCam noted a similar mean of 34 ± 15.1 minutes. Females reported a mean of 47.4 ± 15.9 minutes in the Training Diary with a mean of 44.1 ± 12.6 minutes in the SenseCam.

The sample size was under 30; therefore, tests of normality were completed. Skewness was present in the Training Diary Duration histogram and the SenseCam Duration histogram. The Training Diary duration of activity was significantly non normal ($D(20) = 0.20$, $p<0.05$) Nevertheless, the SenseCam duration of activity was normal. A number of outliers were present in the data.

Preliminary analysis showed a violation of assumptions of normality therefore non-parametric tests were utilised. The Wilcoxon signed rank test revealed no significant difference between Training Diary and SenseCam duration of activity.

The Spearman Rank Order Correlation (rho) was completed. There was a strong positive correlation between the Training Diary and SenseCam duration of activity ($r= 0.851$, $p<0.001$).

Females ($r=0.709$, $p<0.05$) had a lower spearman rank order correlation than males ($r=0.909$, $p<0.0001$) when assessing the duration of activity reported by the Training Diary and SenseCam.

A Bland Altman plot was completed in order to analyse the agreement between the duration of activity of the SenseCam and the Training Diary. As demonstrated in Figure 4.2.6, there was no substantial fixed bias in over-reporting or under-reporting. The plot shows sufficient agreement between the duration of activity estimated by the Training Diary and SenseCam (95% limits of agreement, 1.6 min ± 7.5 (-13.4 – 16.6 min). Of the 20 training sessions reported by the participants, three durations of activity (15%) were over-reported (above the y=0 line) and two reported durations of activity (10%) were under-reported (below the y=0 line).

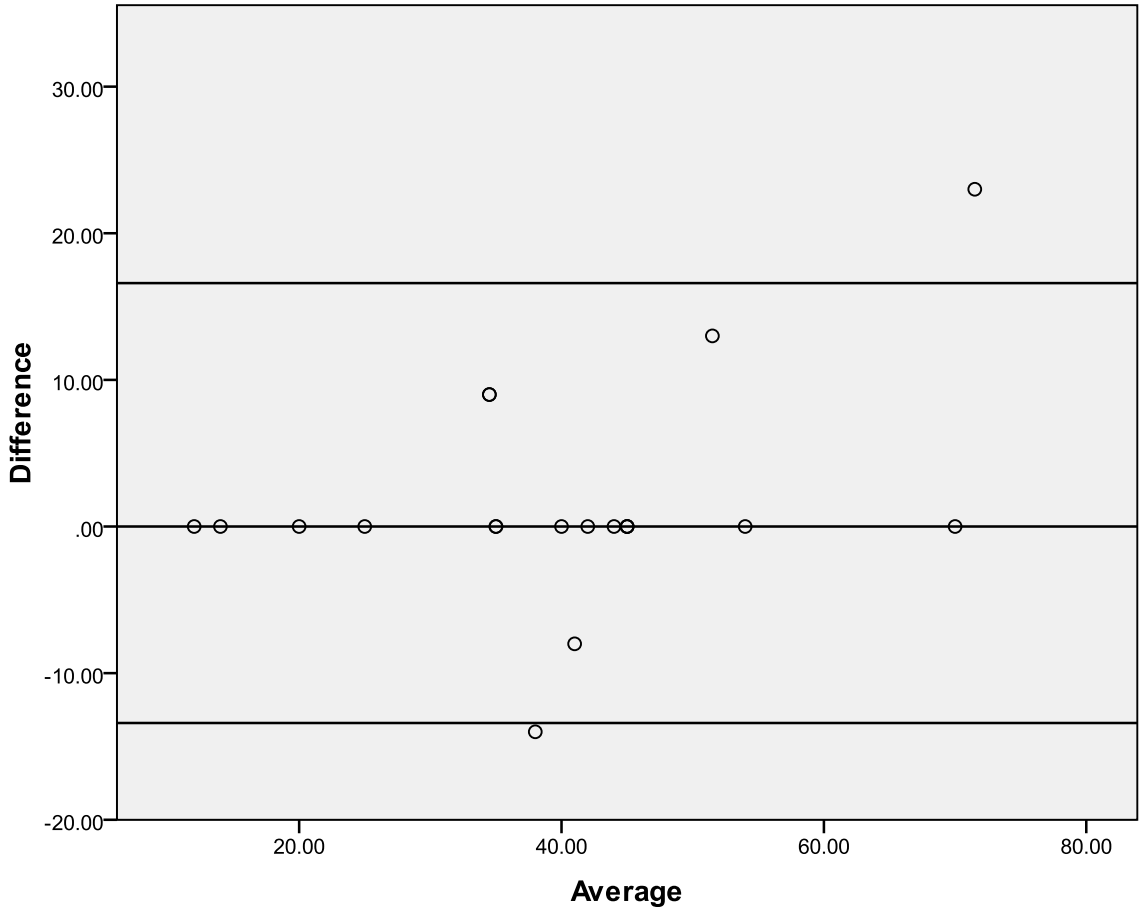


Fig 4.2.6: Agreement between Training Diary Duration of activity and SenseCam.

4.2.7 Travel Time

Sixteen participants travelled to and from training 20 times within the time period of the study. With regard to total travel time, 80% of total travel time in the Training Diary was in agreement with the SenseCam results. There was an over or under-reporting of 20% of total travel time in the Training Diary.

The SenseCam observed a travel time of 95 minutes in total. The Training Diary reported a travel time of 80 minutes. Both the SenseCam and Training Diary recorded a maximum travel time of 24 minutes and a minimum of 0 minutes. The average travel time of participants in the SenseCam was 4.75 ± 7.1 minutes. The average travel time of participants in the Training Diary was 4 ± 6.8 minutes. The Training Diary under-reported travel time by 15 minutes (15.8%).

Males reported a total of 35 minutes travel time in the Training Diary compared to 43 minutes on the SenseCam. This was an under-reporting of 8 minutes. Females reported a total of 45 minutes travel time in the Training Diary, however, in the SenseCam a total of 52 minutes were observed, an under-reporting of 7 minutes. The mean travel time for

male participants was 3.5 ± 6.2 minutes in the Training Diary compared to 4.3 ± 6.6 minutes in the SenseCam. Female participants noted a mean travel time of 4.5 ± 7.6 minutes in the Training Diary and 5.2 ± 7.8 minutes in the SenseCam.

The sample size was less than 30, therefore, tests of normality were completed. Skewness was present in the Training Diary Travel Time histogram and the SenseCam Travel Time histogram. Both the Training Diary Travel Time ($D(20) = 0.30$, $p<0.001$) and the SenseCam Travel time ($D(20) = 0.29$, $p<0.001$) was significantly non normal.

Preliminary analysis showed a violation of assumptions of normality therefore, non-parametric tests were completed. The Wilcoxon signed rank test revealed no significant difference between Training Diary Travel Time and SenseCam Travel Time.

The Spearman Rank Order Correlation (rho) was completed. There was a strong positive correlation between the travel time reported by the Training Diary and SenseCam ($r=0.994$, $p<0.001$).

The Spearman rho correlation was completed specific to gender. Males and females had the same strong correlation between travel time reported by the Training Diary and SenseCam.

A Bland Altman plot was completed to analyse the agreement between the duration of travel of the SenseCam and the Training Diary. As demonstrated in Figure 4.2.7, there was no substantial fixed bias in over-reporting or under-reporting. The Bland Altman plot demonstrated sufficient agreement between the travel time reported by the Training Diary and SenseCam (95% limits of agreement; 0.75 min ± 1.6 (-2.4 – 3.9 min). Of the 20 travel times reported by the participants, three instances (15%) were over-reported (above the y=0 line) and none were under-reported (below the y=0 line).

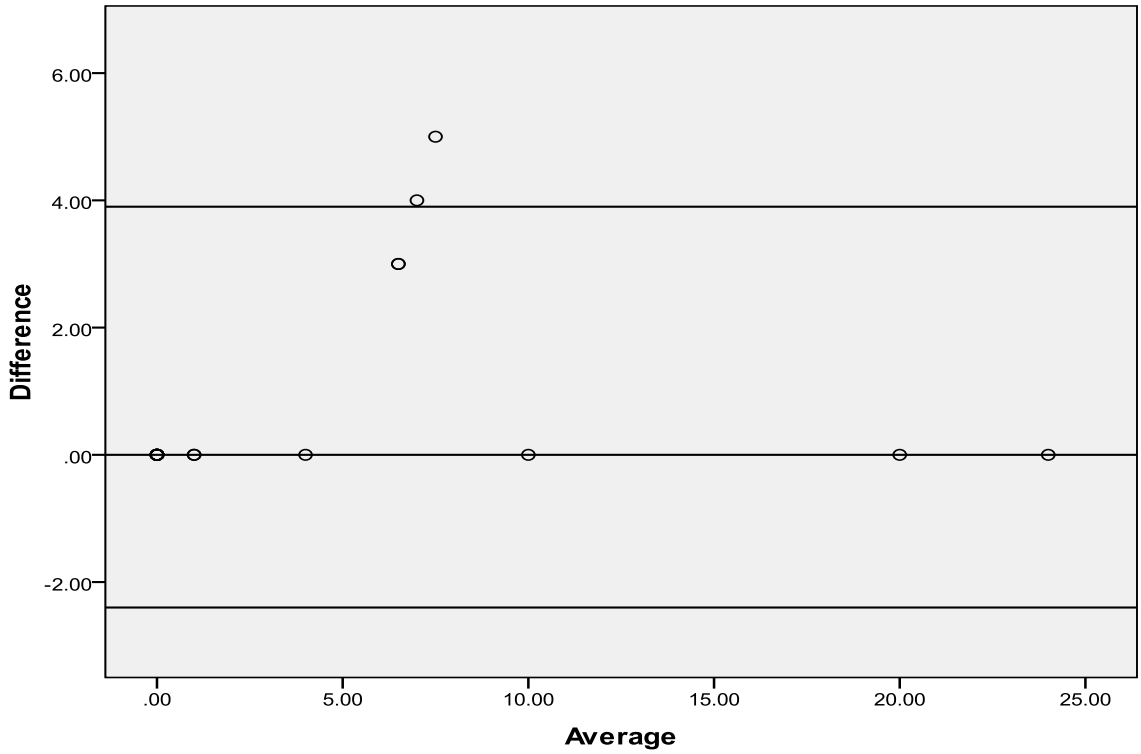


Fig 4.2.7: Agreement between Training Diary Travel Time and SenseCam.

4.2.8 Training Surface

100% of participants within the Validation study filled in the correct surface they trained on compared to the surface viewed on the SenseCam. There was a large variation in surfaces mentioned including grass, road, indoor etc.

4.2.9 Footwear

100% of participants within the Validation study filled in the correct footwear they wore when training compared to the footwear observed on the SenseCam. There was a large amount of footwear mentioned within this study including trainers, screw in football boots, cycling shoes etc.

4.2.10 Injury

100% of participants within the Validation Study filled in the correct injury status compared to the results obtained from the Interview. Two levels of injury status were reported. This included "No injury" and "I had pain but it did not stop my participation".

4.3 Response Rates for Study Two

Overall, the Print Training Diary had a mean response rate of 26.6 ± 21.3% over three weeks. The online Training Diary had a mean response rate of 15.2 ± 12.6% over three weeks. The maximum response rate established in the paper and online Training Diary was 70% and 50% respectively.

Tests of normality were completed. Slight skewness was present in the sample. No outliers were present. The data was found to be statistically normal according to the Kolmogorov-Smirnov statistic across all six teams ($p = 0.2$). Therefore parametric tests can be completed.

A paired samples t-test was completed to analyse the response rate for the method used to complete the Training Diary. There was no significant difference in response rate for the paper Training Diary and the online Training Diary.

An independent samples t-test was completed to assess the response rate compared to gender. There was no significant difference in response rate between males and females. The mean response for each method of filling in the Training Diary with regard to gender is demonstrated in Table 4.3a.

Table 4.3a: Effect of Gender on Response Rate

Method	Male		Female	
	Mean	SD	Mean	SD
Paper	9.1%	11.2%	44%	27.2%
Online	15.7%	14.1%	14.7%	17%

A one way between groups ANOVA was completed to examine the effect of age on response rate. There was no significant difference in response rate between the under 14 teams, minor and adult teams. The average response for filling in the Training Diary with regard to age group is demonstrated below in Table 4.3b.

Table 4.3b: Effect of Age Group on Response Rate

Method	Adult		Minor		Under-14	
	Mean	SD	Mean	SD	Mean	SD
Paper	29%	30.6%	27.5%	23.8%	23.3%	32.7%
Online	14.3%	5.2	29.6%	16.9	1.9%	3.1

4.3.1. Response Rate - Adult Ladies Gaelic Football

Twenty-three members of the Adult Ladies Gaelic Football team consented to take part in the study. The response rates for the different methods are presented in the tables below.

Table 4.3.1a: Print Training Diary

Week	Number Response	Percentage (%) Response
Week 1	16	69.6%
Week 2	15	65.2%
Week 3	5	21.7%
Average	12 (± 6.1)	52.2 (± 26.5) %

Table 4.3.1b: Online Training Diary

Week	Number Response	Percentage (%) Response
Week 1	5	21.7%
Week 2	4	17.4%
Week 3	2	8.7%
Average	3.6 (±1.5)	15.9 (±6.6) %

4.3.2 Response Rate - Adult Men's Gaelic Football

Twenty-nine members of the Adult Men's Gaelic Football team consented to take part in the study. The response rates for the different methods are presented in the tables below.

Table 4.3.2a: Print Training Diary

Week	Number Response	Percentage (%) Response
Week 1	3	10.3%
Week 2	2	6.9%
Week 3	0	0%
Average	1.6 (±1.5)	5.7 (± 0.1)%

Table 4.3.2b: Online Training Diary

Week	Number Response	Percentage (%) Response
Week 1	5	17.2%
Week 2	3	10.3%
Week 3	3	10.3%
Average	3.7 (±1.2)	12.6 (±0.01) %

4.3.3. Response Rate - Minor Ladies Gaelic Football

Ten members of the Minor (Under-18) Ladies Gaelic Football team consented to take part in the study. The response rates for the different methods are presented in the tables below.

Table 4.3.3a: Print Training Diary

Week	Number Response	Percentage (%) Response
Week 1	6	60%
Week 2	4	40%
Week 3	0	0%
Average	3.3 (± 3)	33.3 (± 0.3) %

Table 4.3.3b: Online Training Diary

Week	Number Response	Percentage (%) Response
Week 1	5	50%
Week 2	3	30%
Week 3	0	0%
Average	2.6 (± 2.5)	26.7 (± 0.3) %

4.3.4. Response Rate - **Minor Men's Gaelic Football**

Thirty-four members of the Minor (Under-18) Men's Gaelic Football team consented to take part in the study. The response rates for the different methods are presented in the tables below.

Table 4.3.4a: Print Training Diary

Week	Number Response	Percentage (%) Response
Week 1	13	38.2%
Week 2	9	26.5%
Week 3	0	0%
Average	7.3 (± 6.7)	21.6 (± 0.2) %

Table 4.3.4b: Online Training Diary

Week	Number Response	Percentage (%) Response
Week 1	14	41.2%
Week 2	10	29.4%
Week 3	9	26.5%
Average	11 (± 2.6)	32.4 (± 0.1) %

4.3.5. Response Rate - Under-**14 Girl's Gaelic Football**

Twenty members of the Under-14 Girl's Gaelic Football team consented to take part in the study. The response rates for the different methods are presented in the tables below.

Table 4.3.5a: Print Training Diary

Week	Number Response	Percentage (%) Response
Week 1	14	70%
Week 2	12	60%
Week 3	2	10%
Average	9.3 (± 6.4)	46.6 (± 32.2) %

Table 4.3.5b: Online Training Diary

Week	Number Response	Percentage (%) Response
Week 1	1	5%
Week 2	0	0%
Week 3	0	0%
Average	0.3 (± 0.6)	1.6 (± 2.9) %

4.3.6 Response Rate - Under-14 **Boy's Gaelic Football**

Thirty members of the Under-14 Boy's Gaelic Football team consented to take part in the study. The response rates for the different methods are presented in the tables below.

Table 4.3.6a: Print Training Diary

Week	Number Response	Percentage (%) Response
Week 1	0	0%
Week 2	0	0%
Week 3	0	0%
Average	0 (± 0)	0 (± 0) %

Table 4.3.6b: Online Training Diary

Week	Number Response	Percentage (%) Response
Week 1	2	6.7%
Week 2	0	0%
Week 3	0	0%
Average	0.6 (± 1.2)	2.2 (± 3.9) %

4.4 Response Rates for Study Four

The email reminder had a mean response rate of 21.9 ± 11.3% and the text reminder had a mean response rate of 31.9 ± 18.6% over a single week. No reminders had a mean response rate of 15.2 ± 12.6%. The maximum response rate established in this study was 32.4%, 60% and 50% for the email reminder, text reminder and no reminder respectively.

Tests of normality were completed. Slight skewness was present in the sample. No outliers were present. The data was found to be statistically normal according to the Kolmogorov-Smirnov statistic across all six teams ($p = 0.2$). Therefore parametric tests can be completed.

A one way within groups ANOVA was completed to examine whether a reminder and which reminder increases the response rate. There was a statistically significant difference in response rate with respect to a reminder (Wilk's Lambda = 0.16, $F(2, 4) = 10.47$, $p<0.05$). The effect size, calculated using partial eta squared, was large (0.84). Post-hoc comparisons using the Bonferonni test indicated that the mean score for the text reminder (M=31.9, SD=7.61) was significantly different from receiving no

reminder (M=15.23, SD=5.13, $p<0.05$). However there was no significant difference between the email reminder and receiving no reminder or between the text and email reminder.

An independent samples t-test was completed to assess the effect of gender on response rates when receiving a reminder. No significant difference was found between males or females in their response rates when receiving an email, text or no reminder. The average response for each reminder received with regard to gender is demonstrated in Table 4.3a.

Table 4.4a: Effect of Gender on Response Rate

Method	Male	Female
Email Reminder	18.8%	25.1%
Text Reminder	27.2%	35.3%
No Reminder	15.7%	14.7%

A one way between groups ANOVA was conducted to explore the impact of age on response rate. There was a statistically significant difference between age and response rate ($F(2, 15) = 14.8$, $p<0.001$). The effect size, calculated using eta squared, was large (0.66). Post-hoc comparisons using the Tukey HSD test indicated that the mean score for the Under 14 teams (M=7.83, SD=629) were significantly different from the minor (M=37.6, SD=12.45) and adult ((M=23.67, SD=8.68) teams ($p<0.05$). The average response for each reminder received with regard to age group is demonstrated below in Table 4.3b.

Table 4.4b: Effect of Age Group on Response Rate

Method	Adult	Minor	Under-14
Email Reminder	25.6%	31.2%	9.2%
Text Reminder	31.2%	52.1%	12.5%
No Reminder	14.3%	29.6%	1.9%

4.4.1. Response Rate - Adult Ladies Gaelic Football

Twenty-three members of the Adult Ladies Gaelic Football team consented to take part in the study. The response rates for the different reminders are presented in the table below.

Table 4.4.1a: Reminders

Type of Reminder	Number Response	Percentage (%) Response
Email	7	30.4%
Text	8	34.8%
None	3.6	15.9%

4.4.2 Response Rate - Adult Men's Gaelic Football

Twenty-nine members of the Adult Men's Gaelic Football team consented to take part in the study. The response rates for the different reminders are presented in the table below.

Table 4.4.2a: Reminders

Type of Reminder	Number Response	Percentage (%) Response
Email	6	20.7%
Text	8	27.6%
None	3.7	12.6%

4.4.3. Response Rate - Minor Ladies Gaelic Football

Ten members of the Minor (Under-18) Ladies Gaelic Football team consented to take part in the study. The response rates for the different reminders are presented in the table below.

Table 4.4.3a: Reminders

Type of Reminder	Number Response	Percentage (%) Response
Email	3	30%
Text	6	60%
None	2.6	30%

4.4.4. Response Rate - **Minor Men's Gaelic Football**

Thirty-four members of the Minor (Under-18) Men's Gaelic Football team consented to take part in the study. The response rates for the different reminders are presented in the table below.

Table 4.4.4a: Reminders

Type of Reminder	Number Response	Percentage (%) Response
Email	11	32.4%
Text	15	44.1%
None	11	32.4%

4.4.5. Response Rate - Under-**14 Girl's Gaelic Football**

Twenty members of the Under-14 Girl's Gaelic Football team consented to take part in the study. The response rates for the different reminders are presented in the table below.

Table 4.4.5a: Reminders

Type of Reminder	Number Response	Percentage (%) Response
Email	3	15%
Text	3	15%
None	0.3	1.6%

4.4.6 Response Rate - Under-14 **Boy's Gaelic Football**

Thirty members of the Under-14 Boy's Gaelic Football team consented to take part in the study. The response rates for the different reminders are presented in the table below.

Table 4.4.6a: Reminders

Type of Reminder	Number Response	Percentage (%) Response
Email	1	3.3%
Text	3	9.9%
None	0.6	2.2%

4.5 Questionnaire Results

4.5.1 Method of Filling out the Training Diary

Overall 50.3% of participants who filled in the questionnaire preferred the online Training Diary and 49.7% preferred the paper Training Diary. The majority of participants (57.3%) found the paper Training Diary easiest to access while 42.7% found the online Training Diary easier to access. The online Training Diary was reported as the easiest to fill out according to 59.1% of participants. With regard to returning the Training Diary, 69% of participants found the online Training Diary easiest to return. Fifty eight percent of all participants who completed the questionnaire would rather use the online Training Diary in the future.

Preliminary data demonstrated that the data in the questionnaire was statistically normal ($p>0.05$). Paired samples t-tests were completed. No significant difference was noted between the online and paper Training Diary for which method they preferred, could access, fill out, return and use in the future.

4.5.1.1 Method of Filling out the Training Diary Adult Ladies

Overall, 70.6% of participants preferred the paper version of the diary while 29.4% preferred the online version. Five participants favoured the paper version because it was easier to use, three because they had no internet access; two because the online version did not let the participants know what days they had previously filled in and one participant preferred how the diary had to be collected each week.

There were mixed views on which method was easiest to access. The majority of participants (58.8%) found the paper diary easiest to access, in comparison to 41.2%

who found the online diary easier to access. Two participants found the paper diary easier to access, two found the fact that you did not need a username and password more beneficial, and two had no consistent access to the internet to fill in the diary.

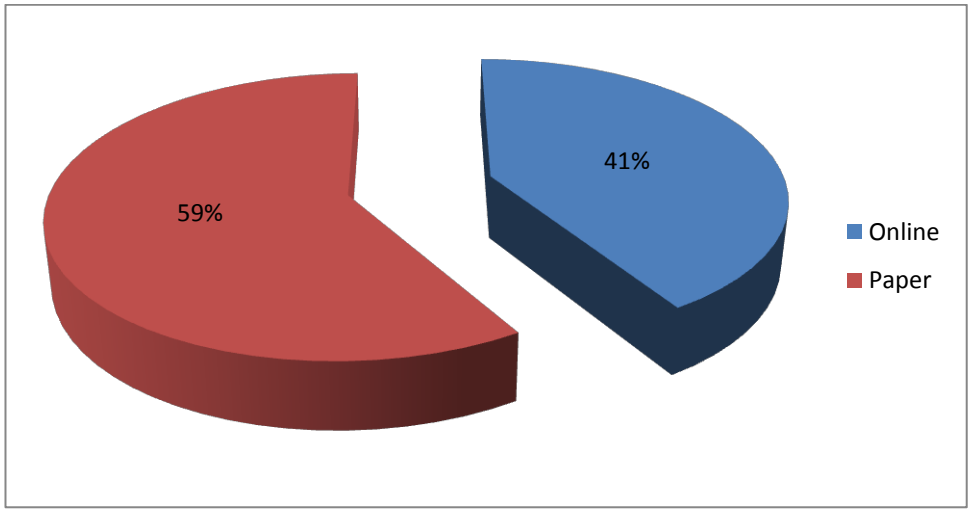


Figure 4.5.1.1 Method Players found Easiest to Access

Fifty two point nine percent of participants found the paper Training Diary easiest to fill in; however, 47.1% preferred the online Training Diary. 58.8% found the online Training Diary easier to return. One participant reported that this was because it was easier. However, 41.2% found the paper Training Diary easier. Two subjects noted that this was because there was a researcher at training to collect it. Fifty eight point eight percent would prefer to use the paper version if using the Training Diary in the future and 41.2% would rather the online version in the future.

4.5.1.2 Method of Filling out the Training Diary Adult Men

With regard to the online method of filling in the Training Diary 85.7% of adult male Gaelic Footballers preferred the online method of filling in the Training Diary and 71.4% found it easier to use. In the adult male team 71.4% of players found the online Training Diary easier to access whereas 28.6% favoured accessing the paper Training Diary. Two participants noted that they would be on their computer daily so accessing the online Training Diary was easier. One player did not have internet access therefore could not complete the online Training Diary.

Eighty five point seven percent found the online Training Diary easiest to fill out and 100% reported that the online Training Diary was easiest to return. In the future 85.7% of senior adult male Gaelic Footballers would have a preference to use the online Training Diary.

4.5.1.3 Method of Filling out the Training Diary Minor Ladies

Sixty percent of Under-18 female Gaelic Footballers preferred the online method of filling in the diary and 40% would rather utilise the paper method. One participant

preferred the online method because if she missed a training session she could still fill out the Training Diary without having to wait until the next session to get the Training Diary. Forty percent of players found the online method easier to access however, 60% found the paper method easier. Two participants found the username and password difficult to remember and one participant lost her username and password. Seventy percent found the online method easier to fill out whereas 30% found the paper method easier. Two participants noted that the online method was easier as they did not need to look through a sheet to find the Code corresponding to the activity.

The online method was deemed easier to return in 80% of cases. Two participants noted that this was because they did not need to remember to bring the Training Diary to training. Only 20% found the paper method easier to return. In the future, 60% of participants would prefer to use the online Training Diary and 40% would prefer to use the paper Training Diary.

4.5.1.4 Method of Filling out the Training Diary Minor Men

Overall, 75% (n=15) of male Gaelic Footballers in the minor category preferred the online method of filling in the Training Diary. Twenty five percent preferred the paper version of the Training Diary. The reasons behind preferring the online over the paper method was, that it was easier (55%); one participant liked how you did not have to retain a piece of paper. One participant found that the online version did not provide you with information detailing what days you had previously filled in, unlike the paper version.

The online Training Diary was found to be easier to access by 60% of participants. The reasons they provided for this was that it was easier (15%); one participant found it took less time, one stated that they would be on the computer regardless and two participants found it required less effort. Forty percent viewed the paper Training Diary as easier to access; one player found it easier, one player's computer was not working so could not access the diary, another found the fact that you did not need a username and password easier, and another thought that the online dairy required you to complete a lot more steps.

The online method was found to be easiest to fill out in 75% of players. Of these 75% of players, 25% found it was easier, 5% found the fact you did not need a pen was helpful and another 5% stated that they would be on a computer regardless. The paper method on the other hand was noted by 25% of players to be the easiest to fill out. This was because 5% (n=1) found that it was easier and 5% (n=1) preferred the fact that in the paper method if no activity was completed for that day it was easily recorded.

With respect to returning the Training Diary 85% of players preferred the online method. This was because it was viewed as easier by 15%; one player noted that people could easily forget to bring the paper version to training. Fifteen percent of players

preferred the paper version and this was due to the fact that they perceived the paper diary to be better organisation while 5% found it was easier.

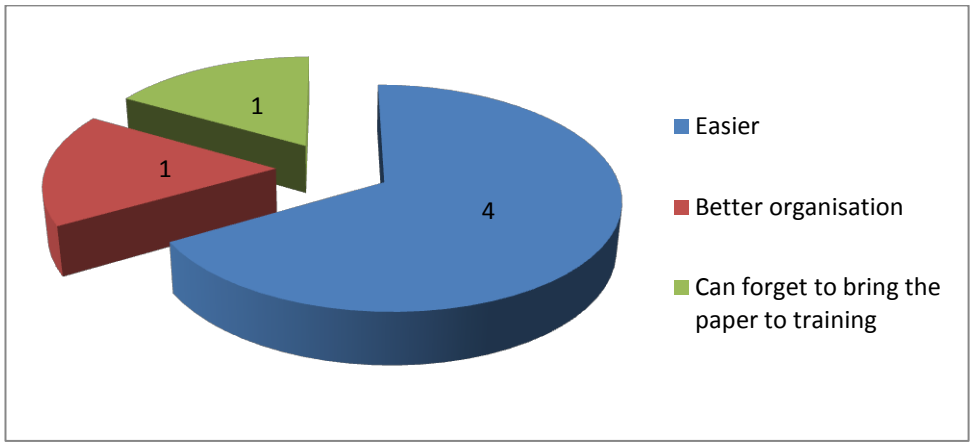


Figure 4.5.1.4: Why Players found a Method easier to Return

Seventy five percent reported that they would prefer to use the online diary if they were to use the Training Diary in the future. This was because 35% found the online Training Diary easier. Twenty five percent would like to use the paper diary in the future and 10% stated that this was because it was easier.

4.5.1.5 Method of Filling out the Training Diary Under-14 Girls

The paper Training Diary was preferred by 67.7% of Under-14 girls and 33.3% would rather use the online Training Diary. Results indicated that 75% found the paper Training Diary easier to access whereas 25% could access the online Training Diary easier. Half of the participants noted that the online Training Diary was easier to fill out and the other half favoured the paper Training Diary. Fifty eight point three percent considered the online Training Diary easier to return with 41.7% preferring the paper Training Diary.

In general, 66.7% would rather use the paper Training Diary whereas only 33.3% of participants had a preference for the online Training Diary.

4.5.1.6 Method of Filling out the Training Diary Under-14 Boys

The paper Training Diary was preferred by 81.3% of Under-14 boys and 81.3% also found the paper Training Diary easiest to access. The easiest method to fill out the Training Diary was deemed the online method by 26.7% of players. However, the majority of members of this team favoured the paper Training Diary (73.3%).

With regard to the returning of the Training Diary 62.5% reported that the paper Training Diary was easiest to return while 37.5% found the online Training Diary easier to return. Overall, the majority (81.3%) of Under-14 participants would prefer to use the paper Training Diary in the future with only 18.7% favouring the online Training Diary.

4.5.2 Reminder Questionnaire

In total, 94.2% of participants found reminders beneficial. The text reminder was reported by 74.1% of participants as the most helpful, 19.2% found the email and 5.7% reported no reminder, as the most helpful.

The majority of participants (36.3%) would prefer to receive their reminder in the evening, 27.2%, 19.6% and 15.8% of participants would favour receiving their reminder in the morning, night and afternoon respectively.

In the future, 74.9% of participants would rather receive a text reminder 15.3% would prefer an email reminder, and 2.6% would not like to receive a reminder in the future. 7.2% noted that they would prefer both a text and email reminder which was not an option in the questionnaire.

Tests of normality were completed. There was slight skewness present in the sample for the question, 'are reminders beneficial'. Both the "yes" ($D(6) = 0.279$, $p>0.05$) and "no" ($D(6) = 0.279$, $p>0.05$) data was found to be statistically normal. The paired samples t-test demonstrated that participants found reminders significantly more helpful than no reminder ($t(5) = 14.51$, $p<0.0001$).

With respect to the question deciphering which reminder was most beneficial, data was found to be statistically normal for the text reminder ($D(6) =0.169$, $p>0.05$), email reminder ($D(6) = 0.194$, $p>0.05$) and no reminder ($D(6) = 0.207$, $p>0.05$). A one-way repeated measures analysis of variance was completed. The Wilks' Lambda statistic demonstrated a significant difference between which type of reminder participants preferred ($p<0.0001$). When analysed individually, participants' preferred text reminders significantly more than email ($p<0.05$) or no reminder ($p<0.0001$).

The data assessing what time of the day participants would rather receive a reminder was found to be statistically non-normal for the morning ($D(6) = 0.336$, $p<0.05$), the afternoon ($D(6) = 0.187$, $p>0.05$), evening ($D(6) = 0.188$, $p>0.05$) and night ($D(6) = 0.187$, $p>0.05$). Hence, the Friedman Test was completed. No significant difference was found in the time participants' preferred to receive a reminder.

The data examining which reminder participants would prefer to receive in the future found that a text reminder ($D(6) = 0.280$, $p>0.05$) and email reminder ($D(6) = 0.262$, $p>0.05$) was statistically normal. However the data for no reminder was non-normal ($D(6) = 0.404$, $p<0.05$) According to the Friedman Test there was a significant difference found between the reminders [χ^2 (2, n= 6) =9.36, $p<0.05$)].

4.5.2.1. Reminder Adult Ladies

A reminder was found to be helpful by 81.3% of adult Ladies Gaelic footballers. Seventy five point five percent of participants preferred the text reminder, 12.5% (2) preferred the email version of the reminder and 12.5% found no reminder helpful. The majority of senior ladies (31.3%) preferred to receive their reminder in the morning,

25% preferred to receive it at night, 18.8% would rather their reminder to be sent in the afternoon and evening. Eighty seven point five percent would prefer a text reminder if they were to receive one in the future, whereas 12.5% would prefer an email reminder.

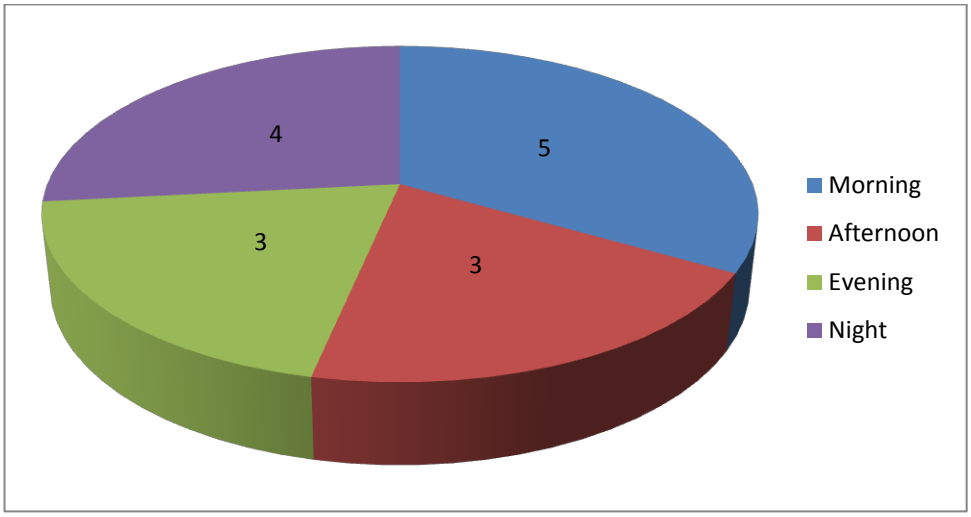


Fig 4.5.2.1: What time of the Day would Players Prefer to receive their Reminder

4.5.2.2. Reminder Adult Men

Overall 100% of adult male Gaelic Footballers found a reminder beneficial. Fifty seven point one percent found the text reminder more beneficial, whereas 42.9% found the email reminder more practical and helpful. The evening was the most commonly preferred time for players to receive a reminder. 57.1% of players favoured this time. Twenty eight point six percent, 14.3%, and 0% of players preferred the morning, night and afternoon respectively.

Twenty eight point six percent preferred a daily text reminder, 28.6% of players favoured a daily email reminder and 42.9% of players preferred both a text and email reminder together.

4.5.2.3. Reminder Minor Ladies

All female Under-18 Gaelic Footballers in this study found a reminder beneficial. Seventy percent of players found the text reminder helpful and practical, whereas 30% preferred the email reminder. The time players preferred to receive the reminder was: 40% (n=4) in the morning, 30% (n=3) in the evening, 20% (n=2) the night and 10% (n=1) in the afternoon.

In the future, 70% of players would prefer to receive a text reminder, whereas 30% would rather an email reminder.

4.5.2.4. Reminder Minor Men

All male minor Gaelic Footballers in this study found a reminder beneficial to remember to fill in their Training Diary. The majority (82.4%) of players found the text reminder the most helpful and practical, whereas 11.8% preferred the email reminder. One player (5.9%) found that no reminder benefited them. Participants preferred varying times of day to receive the Training Diary reminder. Twenty nine point four percent of players would prefer to receive their reminder in the morning, whereas the same amount of players (29.4%) would like to receive it at night, 23.5% would prefer the afternoon and 17.6% would rather the evening.

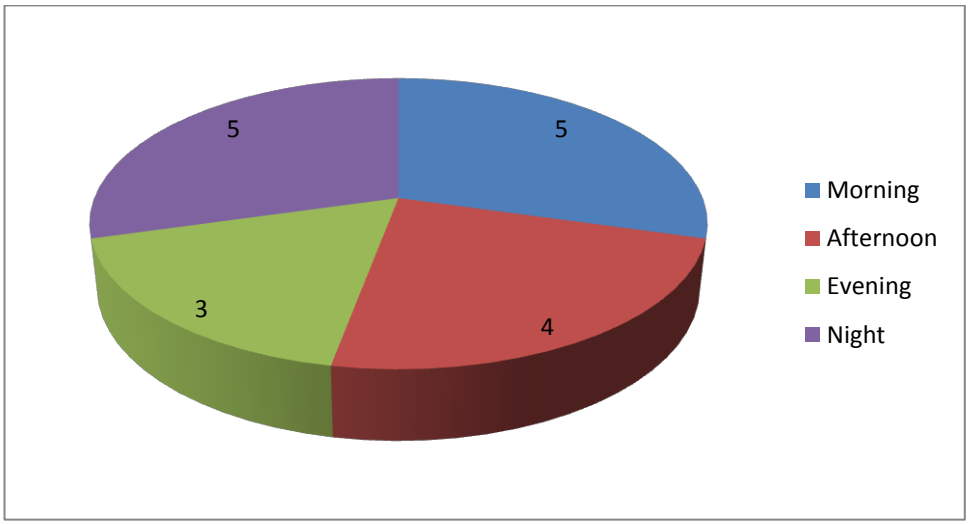


Fig 4.5.2.4: What Time of the Day would Players Prefer to Receive their Reminder

In the future, 88.2% of players would prefer to receive a text reminder to fill in their Training Diary 11.8% would rather an email reminder.

4.5.2.5. Reminder Under-14 Girls

Ninety point nine percent of Under-14 girls found a reminder helpful. Seventy two point seven percent preferred receiving a text reminder, 18.2% would rather an email reminder and 9.1% found neither reminder benefitted them. Participants reported that 54.5% would favour receiving a reminder in the evening, 27.3%, 9.1% and 9.1% preferred the morning, afternoon and night respectively. Eighty one point eight percent of Under-14 girls would favour a daily text reminder whereas, 9.1% would prefer an email reminder; 9.1% found reminders not helpful and so would prefer not to receive a reminder.

4.5.2.6. Reminder Under-14 Boys

The majority of the Under-14 boys found a reminder beneficial with 93.3%reporting the text reminder the most beneficial, 0% preferred the email reminder and 6.7% believed that reminders did not help. 40%, 33%, 20% and 6.7% found that reminders sent to the participant were most helpful in the evening, afternoon, night and morning respectively.

A daily text reminder was predominantly preferred by 93.3% of participants while 6.7% would prefer no reminder.

4.6 Summary of Results

In summary this Chapter demonstrates that the Training Diary developed is a valid method of assessing training load in Gaelic Footballers. Training Diaries provided a reasonable response rate. The average response rate for the paper and online Training Diary was 26.6% and 15.2% respectively. The use of email and text reminders with the online Training Diary increased the response rate to 21.9% and 31.9% respectively. No significant difference was found between Paper and Online Training Diaries. The text reminder produced a significantly higher response rate than no reminder ($p<0.05$). Gender caused no significant effect on response rates. Age caused no significant difference in response rates in the Online or Paper Training Diary. A significant difference was found between the Under-14 and Minor team, and the Under-14 and Adult team in response rates when using a reminder. There was no significant difference found between the Minor or Adult team. Participants reported no significant preference between the Online and Paper Training Diary, for which method they preferred, could access, fill out, return and use in the future the questionnaire. Reminders, especially the text reminder was found to be the most statistically beneficial. No significant preference for what time of the day to receive a reminder was noted by participants. Chapter Five will discuss the results presented here in Chapter Four and provide some recommendations for future studies.

Chapter 5.0 Discussion

5.1 Introduction

The current study developed and examined the validity and effectiveness of a self-recall Training Diary to use with Gaelic Footballers of all ages and genders. Analysing a Gaelic Footballer's exercise and training load is important, as optimal levels of training will improve sporting performance and physical well-being. This, consequently, benefits both the individual and the team. Nevertheless, excessive training could increase the likelihood of injury or cause overtraining (Borresen and Lamber 2009). The results of this study indicate that the Training Diary developed was valid and reasonably effective at assessing training load in Gaelic Footballers.

5.2 The Pilot Study

The Training Diary took a mean of 3.7 minutes to complete. This indicates the Training Diary is a very quick and short method of analysing daily activity. Long, time consuming Training Diaries are not advised, as the subject may become bored or confused and fill in the incorrect or incomplete amount of data (Borresen and Lamber 2009). It may also dissuade participants from filling in the Training Diary because if they are busy they may not believe they have the time to complete it.

The effectiveness of a Training Diary is partially based on how easy it is to understand and complete. Seventy percent of participants in the pilot study found the questions in the Training Diary easy to understand. However, the question on "Travel Time" caused confusion. The original question did not specify that this answer included the time it took to travel to and from the session. Once noted in the pilot study it was rectified. It was important to specify this question, as take for example, a participant who plays for a club in one county but works in a different county may take over an hour to travel to training from work but only ten minutes to travel home after training. For this reason, the total amount of time spent travelling would be far more beneficial to examine.

The layout of the paper Training Diary confused one participant in the pilot study. Another participant did not understand the reason for five separate options of training sessions in this method. Both aspects were rectified in the following studies by an explanation session, where researchers went through the Training Diary in detail with all participants.

Ninety percent of participants in the pilot study reported no further questions that should be included in the Training Diary. One participant concluded that a separate question enquiring on the time the activity was completed would help him remember the training event and manage his training more effectively. This idea was considered by researchers, however, following discussions with other pilot study participants, researchers decided against the addition of this question. Researchers felt that it would make the Training Diary more time consuming and none of the other participants felt that it would benefit their memory of physical activity.

5.3 Validation of Training Diary

The face and convergent validity of the Training Diary was analysed in detail. The Training Diary information was compared against objective measures including an interview, a SenseCam and an accelerometer.

5.3.1 Validation of Training Information

The Training Diary showed excellent face validity of the training details compared to the SenseCam and interview. All participants reported the correct age group, activity played, training surface, footwear and injury status in the Training Diary as confirmed by the SenseCam and interview. Ninety five percent of participants reported the correct sport played and team the participant played with, again confirmed by the SenseCam and interview. This indicates that the Training Diary this study developed, accurately reports the details related to the training event.

5.3.2 Validation of Intensity

The validity of the intensity of physical activity can be difficult to decipher since the Training Diary is a subjective means of analysing intensity. Seventy percent of participants' reported level of intensity was in accordance with the intensity reported on the accelerometer. This is a relatively high percentage of correct intensities. Any of the intensities misreported were all within one level of the intensity reported by the accelerometer. The results did not display a significant trend towards over or under-reporting intensity of activity by the Training Diary.

Each player's perception of training event intensity is very subjective and can depend on the experience, fitness and tolerance of the subject. This is especially evident if you categorise intensity by light, moderate, hard or very hard (Borresen and Lamber 2009). Since the Training Diary in this study categorised the level of intensity this way, it may explain the 30% disagreement with the accelerometer. The accelerometer in this current study was placed around the right hip in each participant; the recommended position for measuring physical activity in a population (Aadahl and Jorgensen 2003). One of the main issues with accelerometers when placed around the hip is the fact that it does not capture movement if there is no movement occurring at that joint. For this reason, activities like cycling and resistance work that are quite static in nature may not be captured effectively by the accelerometer. Contact activities and underwater activities like swimming, during which the device cannot be worn, would also not be captured effectively (Mathews 2005). It is important to note that four participants' Training Diaries disagreed with the accelerometer; three completed resistance training in the gym as their activity that day and another and one completed a cycle. This indicates that perhaps weaknesses with accelerometer use with certain equipment used may have lessened the validity of the Training Diary.

Another issue that may have affected the validity of the Training Diary in comparison to the accelerometer is the cut-off points used. Cut-off points are values used to classify the "counts" produced by accelerometers into different levels of intensity (Ham, et al. 2007). There is a vast number of cut-off points in the current literature, the most commonly used of which are shown in Table 5.3.2 cut-off. In fact, it has been noted that cut-off points for the Actigraph accelerometer for intensity at the moderate level can differ tenfold between studies (Mathews 2005). There are inherent issues with the classification of cut-off points. The majority of studies use the mean value of the activity to decipher the cut-off point. Colley & Tremblay (2011) pointed out the obvious issue with this method of deciding cut-off points; it causes a misclassification of 50% of the participants. Half of the participants count ratings would be above the mean and half below the mean. The cut-off points chosen in a study could greatly affect the validity of the Training Diary. If they do not accurately predict the intensity of the activities completed, the Training Diary could be erroneously reported as invalid (Anderson, Hagstromer and Yngve 2005). Each cut-off point value has individual advantages and disadvantages.

The cut-off points utilised by this study were in accordance with the study of Freedson et al. (2008) who tested 50 participants at three speeds, measuring oxygen consumption on a treadmill in order to determine cut-off points. The velocities were 4.8km per hour (km/h) for slow walking, 6.4 km/h for fast walking and 9.7km/h for jogging. The main benefits of these cut-off points were that they were exercise, not daily activity, based which are more relevant to our study. It also provided an option of including "sedentary" and "very vigorous" classifications. The Training Diary developed for this study provided options to fill in "nothing at all" and "very very light" which would be comparable to sedentary. The Training Diary also provided an option for "Very Very Hard" which would be comparable the "very vigorous" cut-off point. These cut-off points are commonly used in the literature, allowing researchers to compare correlations computed in this study to other studies (Freedson, Melanson and Sirard 1998).

Nichols et al. (2000) determined cut-off point values based on a field test, and were therefore very practical. Nonetheless, since it was not laboratory based, the validity of these cut-off points are questionable (Anderson, Hagstromer and Yngve 2005). Aadahl & Jorgensen (2003) utilised the Nichols's cut-off points in their validation study of a newly developed method of analysing physical activity. The correlations reported by researchers in this study were extremely low, possible because Nichols's cut-off points were valid for walking and jogging activities but other types of activities were not shown to be valid (Aadahl and Jorgensen 2003). As a result, this current study chose Freedson et al. (2008) cut-off points instead (Anderson, Hagstromer and Yngve 2005). A comparison of cut-off points is shown in Table 5.3.1 below.

Table 5.3.2: Intensity Cut-off Points

Study	Light	Moderate	Vigorous
Freedson et al 1998	≤ 1952	1953 – 5724	5725 – 9498
Nichols et al 2000	≤ 1576	3285	5677
Swartz et al 2000	573	574 – 4944	≥ 4945
Hendelman et al 2000 (walking only)	≤ 2190	2191-6892	≥ 6893
Hendelman et al 2000 (All activitites)	≤ 190.6	190.7-7525.7	≥ 7525.8

The validity of the Training Diary may also have been affected by the intensity scale used. The Training Diary originally used the Borg CR-10 scale shown in *Appendix I*. However, preliminary data with the Under-14 players noted that they considered the 0.5 option difficult to understand. Consequently, researchers modified the scale in order to use whole numbers only. The same wording was used. This was more practical and allowed participants to understand the scale more fully, nevertheless, it prevents direct comparison to other studies utilising the Borg CR-10 scale (Borg 1998).

The Spearman Rank Order Correlation test showed a significant strong positive correlation between the intensity reported in the Training Diary and accelerometer ($r=0.918$, $p<0.001$). This demonstrates that the Training Diary reports the intensity of training completed accurately in comparison to the accelerometer. This correlation was much stronger than reported by other diaries in the literature to date. The Spearman correlation between the Previous Day Physical Activity Recall (PDPAR) with the accelerometer was found to be 0.42 using the Freedson et al., (2008) cut-off points. Even though the correlation in the current study was much higher than this, the PDPDAR study was completed on adolescents only (Anderson, Hagstromer and Yngve 2005). Validation studies completed on the RPE scale against criterion measures of assessing physical activity have shown correlations of between 0.80 and 0.90 which is similar to the correlation reported by the current study (Chen, Fan and Moe 2002). On the other hand, Ainsworth et al., (2000) utilised the Freedson et al. cut-off points and analysed separate intensity relationships with an accelerometer. Anderson et al., (2005) found a Spearman rank order correlation of 0.24 with moderate intensity and 0.36 with hard/very hard intensity.

The difference in reporting intensity between genders was assessed in the current study. Both genders exhibited a strong correlation between both methods of assessment, yet, females ($r=0.974$, $p<0.001$) had a slightly stronger correlation compared to males ($r=0.894$, $p<0.0001$). This differs from other studies assessing the intensity of activity. Richardson et al., (2001) analysed the Stanford 7-Day Recall and established a correlation of 0.54 in comparison with a Caltrac accelerometer in men and a correlation

of 0.20 in women. Anderson et al., (2005) also discovered males had a higher correlation between the PDPDAR as compared to an accelerometer.

The Bland Altman plot demonstrated reasonable agreement between the accelerometer and the Training Diary. No trend suggesting over or under-reporting was observed and there was no increased likelihood of misreporting at different intensity levels of activity. Other studies have reported trends in misreporting the intensity of activity demonstrated by Bland Altman plots. Aadahl & Jorgensen (2003) noted that a self-recall log that researchers developed caused a systematic above average intensity compared to a Training Diary. Anderson et al., (2005) discovered a reasonable agreement between the PDPAR diary and an accelerometer during moderate and vigorous activity. However, their study differed from this current study, in that, as activity duration increased, the PDPAR diary showed a trend of overestimating the intensity. They reported a mean difference of -38.9 with limits of agreement between -187.9 and 110.

Calculating how well two methods of assessment measure a certain variable is a topical issue in the literature. In previous studies researchers compared two methods by assessing how well they are related using a correlation test. Recently a new statistical method, the Bland Altman Plot, has been suggested. This plot analyses the agreement between the two methods of assessment and has been suggested to be superior to correlation analysis. There are various reasons as to why agreement between two methods is superior. In order to complete a correlation, it is necessary to have a wide sample range. Researchers tend to include a wide sample in studies assessing two methods, therefore the wider the sample range, the higher the correlation. This is not related to how well the method assesses the variable. If a measurement scale is changed, the correlation does not change, however the agreement between the two measurements changes. Another aspect is that in a correlation, you are checking how well they are related. An obvious point to make is that if two methods are assessing the same variable, it would be highly unusual for them not to be related, (Brazdzionyte and Macas 2007, Bland and Altman 1986). Studies have shown that data sets which have produced high correlations show poor agreement when the Bland Altman Plot is completed (Bland and Altman 1986). In order to compare our results with other studies and to get a true reflection of the validity of the Training Diary it is necessary to complete both a correlation and Bland Altman plot.

Regardless of the issues that cause uncertainty in the validity of a subjective method of assessing intensity, they may need to be overlooked as it may be more important to assess them. Training Diaries aim to discover how difficult each player is finding their training sessions. The scale used in this Training Diary allows managers and therapists to gain information on the impact the training session has on the participant, not only physically but also psychologically.

5.3.3 Validation of Physical Activity Duration

In the current study 2.7% of activity duration (22 minutes) was under-reported by the Training Diary and 6.6 % (54 minutes) was over-reported by the Training Diary. Boon et al., (2010) analysed two self report measures of physical activity and compared the results against an accelerometer. Researchers noted an overestimation of approximately 165% which is a significantly higher overestimation than our current study. This indicates that the Training Diary developed in this current study was a more accurate method of assessing training duration. In fact, it has been reported that studies have shown an overestimation of as much as 200-300% in physical activity duration (Boon, et al. 2010). A larger margin of error was discovered in a study analysing athletes' report of training compared to this current study. They found an overestimation of 24% and underestimation of 17% in duration of training (Borresen and Lamber 2009).
The Training Diary in the present study reported a total of 813 minutes activity. The SenseCam reported a net total of 781 minutes activity. Macfarlane et al., (2006) analysed six different methods of assessing physical activity. The total duration of physical activity was found to be 1,020 minutes according to the physical activity log. However, the MTI accelerometer only recorded a total duration of 360 minutes. This was a much larger variance than reported in the present study (Macfarlane, et al. 2006).

The Wilcoxon signed rank test revealed no significant difference between the duration of activity noted by the Training Diary and SenseCam. Yet, this is not the case in other studies comparing a self report physical activity log with an accelerometer. Macfarlane et al., (2006) found a significant difference ($p<0.001$) between the two measures of physical activity. The result of Marfarlane's study indicates that the self-recall log used in their study was not accurate in analysing the duration of activity compared to the Training Diary developed in the present study.

The Spearman Rank Order Correlation (rho) was completed. There was a strong positive correlation between the duration of activity reported by the Training Diary and SenseCam ($r= 0.851$, $p<0.001$). Aadahl & Jorgensen (2003) developed a self-report instrument to analyse physical activity. These researchers validated their instrument against an accelerometer and discovered a significantly lower Spearman rho correlation of 0.34. They also analysed a previously used physical activity diary with the developed self-recall scale and an accelerometer and found only a slightly higher correlation between the diary and the accelerometer. Boon et al., (2010) noted a much lower Spearman correlation coefficient than our current study (0.30-0.32) compared to an accelerometer. A low correlation of 0.32 was also noted in a study comparing a physical activity log and a Titrac accelerometer. An even lower correlation of 0.18 was discovered with the same self report measurement compared to the MTI accelerometer (Macfarlane, et al. 2006). Schmidt et al., (2003) also demonstrated a low correlation of 0.24 while utilising Freedson et al., cut-off points between a physical activity log and an accelerometer (Schmidt, Freedson and Chasen-Taber 2003).

Males (r=0.909, p<0.0001) demonstrated a higher Spearman rank order correlation in comparison to females (r=709, p<0.05) in the present study. Aadahl & Jorgensen (2003) reported that neither men (r=0.05) nor women (r=0.31) had a significant correlation using the self report log with the accelerometer. Boon et al., (2010) discovered that men had a low correlation between self-report measures and an accelerometer (0.29-0.37) and that females had a similar low correlation of 0.30-0.31. This differs from our study in that our present study reported a much higher correlation between the two measures. Differences have been shown in the amount of data recalled by subjects depending on their gender. In fact, Kledges et al., (1990) demonstrated that males overestimated physical activity completed in the previous hour more than females. Schmidt et al., (2003) discovered higher correlations (0.23-0.38) with women with normal BMI compared to males. The results of Kledges et al., (1990) and Schmidt et al., (2003) were not supported by the present study. On the other hand, a study on seven-day recall diaries agreed with the present study's results, which noted that males were more reliable than females at reporting physical activity (Sallis, et al. 1993).

A Bland Altman plot was completed to analyse the agreement between the duration of activity reported by the SenseCam and the Training Diary. There was no substantial fixed bias in over-reporting or under-reporting. The plot also showed that there was sufficient agreement between the SenseCam and the Training Diary in assessing duration of activity. In Boon et al., (2010) they discovered good agreement between the two measures at lower levels of intensity. As the level of intensity increased, the agreement between physical activities duration decreased. Schmidt et al., (2003) discovered a similar phenomenon between a physical activity log and an accelerometer. The study observed a good agreement at activity levels below 50 min/day. However, above this value the physical activity log overestimated the activity level. The results observed by these two studies were not evident in our study, as level of intensity did not cause an increased misrepresentation of duration of activity.

5.3.4 Validation of Travel Time

Eighty percent of participants' reported total travel time in the Training Diary which corresponded to the SenseCam results reporting the same maximum travel duration (24 minutes) and minimum duration (0 minutes). This indicates a high face validity of the Training Diary with regard to travel duration. Kelly et al., (2011) found an average over-reporting of 154 seconds in their travel diary in comparison to the SenseCam. This translated to 36% of the moderate intensity activity that is recommended in national and international guidelines. Conversely, our study found a trend to under-report travel time duration. The current study found an under- reporting of 15 minutes (15.8%) of travel duration. Kelly et al., (2011) noted that the likelihood of participants rounding up their travel duration to the nearest 5 or 10 seconds accounted for the over-reporting. This was not the case in our current study as participants had an option to pick the duration between set values. However, the fact that exact travel times were not required may explain the under-reporting found by the Training Diary. Males' under-reported 8

minutes and females 7 minutes in the Training Diary compared to the SenseCam. Thus, indicating that there was no significant difference in misreporting of travel duration between genders.

The Spearman rho showed a high positive correlation of 0.994 ($p<0.001$) between the Training Diary and accelerometer with regard to travel duration. This was similar to the correlation of 0.92 reported by Kelly et al., (2011).

Males and females had the same strong correlation between travel time reported by the SenseCam and Training Diary ($r=0.997$, $p<0.0001$), thus, indicating that there was no significant difference in misreporting of travel duration between genders.

No substantial fixed bias was noted by the Bland Altman plot. The present study discovered an average of 0.75 ± 1.6 minutes with 95% limits of agreement between -2.4 and 3.9 minutes. Kelly et al., (2011) noted a substantial fixed bias of over-reporting of the Travel Diary compared to the SenseCam. Our present study noted only a 15% over-reporting of travel time whereas Kelly et al., (2011) discovered 70% of journeys were over-reported. In addition, the current study noted no under-reporting. Conversely, Kelly et al., (2011) established 30% of journeys in their study were underreported.

5.3.5 Overall Validity and reasons for Variations

The validation study supports the hypothesis of the researchers that the Training Diary is a valid method of measuring training load in Gaelic Footballers. Numerous rationales exist outlining how the self report Training Diary differs from the objective accelerometer and SenseCam data. The validation study did not uncover large variances between the Training Diary and an objective method of assessment. This is important as Training Diaries need to be accurate. If teams and studies utilised an inaccurate Training Diary, erroneous links and associations between physical activity and other factors could be found (Durante and Ainsworth 1996). Various possible factors could account for the small variance noted between the Training Diary and the interview, SenseCam and accelerometer. Retrospective data collection, trait of social desirability, age, definitions and protocols used, can all contribute to some variation noted by the Validation Study. Training Diaries collect training data after the training event. This is a retrospective method of collecting information and is thought to be methodologically weaker than prospective data collection methods. The reason for this is that the information is obtained post exposure, so random and systematic errors and bias might influence the data recorded (Friedenreich 1994). The delay in the training event occurring and filling in the Training Diary may account for some of the misreporting of training information. In fact, Sirard and Pate (2001) proposed that studies that used 1-day or simpler measures of physical activity in comparison to seven-day or longer measures had greater correlations to criterion methods of assessment. Nonetheless, since participants would need to fill in the Training Diary over the entire Gaelic Football season, a method that requires participants to fill in training information more than once

a day would create a large burden on the participant and possibly decrease response rates. Hence, a daily Training Diary similar to ours seems appropriate.
The trait of "Social desirability" has been suggested as a reason for variance in reporting physical activity in research studies. Social desirability is, as previously mentioned, the tendency of participants to portray their physical activity levels on par with everyone else. Often participants overestimate their physical activity level as they consider this socially desirable (Boon, et al. 2010). In fact, Adams et al. (2005) noted that females overestimated the duration of activity by 4.15-11.30 minutes per day due to social desirability.

The age of the participant can greatly affect the ability to recall information on their past physical activity. This can in turn affect the validity of the self-recall method e.g. a Training Diary. Children have lower cognitive functioning compared to adults, therefore lowering their ability to accurately recall the frequency, intensity and duration of training (Borresen and Lamber 2009). Children also have less ability to think abstractly and find it harder to provide greater detail which can affect the accuracy of self-recall data (Welk, Corbin and Dale 2000). A study that assessed seven-day recall and other methods of self report in children and adolescents found that the validity of the self report data improved as the age of the subjects increased, nevertheless, in all age groups the results were found to be sufficiently valid (Sallis, et al. 1993). A study that examined the difference in physical activity measures between accelerometer and self report found that adults had greater agreement between the two methods of measuring physical activity than adolescents, with regard to reporting moderate physical activity. Nevertheless, there was a larger disagreement in adults compared to adolescents with vigorous physical activity. Therefore, there is inconclusive evidence on whether adolescents or adults are better at recording accurate data on physical activity and so training (Slootmaker, et al. 2009). On the other hand, no differences in correlations were found by Schmidt et al., (2003) between the physical activity log and accelerometer between different age groups. These previous studies suggest that age may have an effect on the validity of a Training Diary; however, the extent to which it affects the validity is not conclusive.

The definitions and protocols used in a study could also cause a variation between the Training Diary and an objective method of assessing training load. A good example of this is the previously mentioned cut-off points. The cut-off points used can significantly alter the results of a study and can contribute to the variance determined between the Training Diary and an accelerometer (Schmidt, Freedson and Chasen-Taber 2003) In fact, Schmidt et al., (2003) looked at three different cut-off points including the cut-off points Freedson et al. (1998) which were utilised in the present study. The study reported that at best, the cut-off points indicated a "poor to fair" ability to predict activity level (Schmidt, Freedson and Chasen-Taber 2003). Moy et al., made the point that the classification of intensity can also contribute to misreporting of physical activity. Standard definitions of light, moderate and vigorous intensity should be

developed in order to prevent any over or underestimations occurring due to this fact (Boon, et al. 2010).

5.4 Response Rate

5.4.1 Reported Response Rate

The mean response rate for each of the methods of testing the Training Diary was 26.6 ± 21.3% for the paper Training Diary and 15.2 ± 12.6%. An email reminder produced a response rate of 21.9 ± 11.3% and the text reminder was 31.9 ± 18.6. These results, while disappointing, were not unexpected. The response rate of written Training Diaries in a study by (Sleap, et al. 2007) looking at the physical activity level of wealthy children aged 9 to 15 was discovered to be very low. The rate was only 33%, which was surprising as the study had the full support of the school and teachers. The response rate for a Training Diary study on British triathletes over 8 weeks was 29%. There was a significantly larger response rate from participants that were recruited in clubs. These had a response rate of 48% whereas those who researchers recruited at competitions had a much lower response rate of 16% (Korkia, Tunstall-Pedoe and Maffulli 1994). Therefore, our study produced similar response rates to studies available in the literature.

Overall, there was no significant difference between the paper and online Training Diary. There was however a significant difference found between the response rate when using a reminder ($p<0.05$). Post hoc tests indicated that when using the online Training Diary a text reminder can significantly increase the response rate compared to no reminder ($p<0.05$). The effect size was found to be large which further exemplifies this point (0.84). When you analyse the results visually between all teams there is a clear indicator that even as the response rate decreases over time reminders help increase the response rate when utilised.

5.4.2 Decrease of Response Rate over time

The duration of testing in this study was over 6 weeks per team in Study Two. Each method of completing the Training Diary was analysed for a three week period. For Study Four each reminder was analysed for one week. There was a gradual decrease in the response rate as the weeks of testing progressed. This decline is expected, as initially participants' interest and motivation to fill in the diary is high. As time passes however, this motivation decreases. This is especially evident during the final week of testing in the paper Training Diary, where the response rate was zero in four out of six teams tested. With the online Training Diary, during the final week of testing, the response rate was zero in three out of six teams tested. Vleck & Bessone Alves (2011) utilised a similar Training Diary with a similar decline in response rate. They reported, that out of the 50 participants, 43, 38, 33, 26, 21, 14 and 11 returned their diary in each sequential month within the 7 months studied. This corresponds to a response rate of 86% at the beginning of the study and 22% after 7 months of testing.

This decrease in response rate as the testing continued could explain why the online Training Diary did not perform as well as the paper Training Diary. The testing protocol followed the same format for each team. For the first three weeks, participants completed the paper Training Diary and for the second three weeks participants completed the online Training Diary. Therefore, participants began the online Training Diary at a stage when their motivation and focus on the study was decreasing. This is a severe limitation of the study and future studies should rectify this.

5.4.3 Effect of Age on Response Rate

There was no statistically significant difference found between age groups when using the paper or online Training Diary. There was however a significant difference found when assessing the Training Diary with respect to reminders. There was no significant difference found between the adult and minor teams when receiving a reminder. However, the Under-14 team's response rate significantly differed from the minor and adult team ($p<0.05$). Thus, when using the online Training Diary with reminders the Under-14 team had a significantly lower response rate than the older teams in this study.

This demonstrates that age can affect the response rate of a Training Diary when using reminders. In fact, when you view the average response rates overall for each method of filling in the Training Diary and Reminders, the Under-14 age group had the lowest average response rate. There are various practical reasons why the online Training Diary with reminders caused a significant difference between age groups. The online Training Diary, while efficient does not allow the researcher to be present and verbally remind players to fill in the Training Diary. Participants under the age of 18 were not contacted directly, but their parents or legal guardians were. Hence, directions, usernames, passwords and reminders were not received directly and if their legal guardians forgot to remind their son/daughter, the information might have been delivered. This was not the case with the older age groups as they received the information directly. This could account for the lower response rate in the Under-14 team when using reminders.

5.4.4 Effect of Gender on Response Rate

The response rate was analysed with respect to gender for both the paper and online methods of filling in the Training Diary and for email and text reminders. No significant difference was noted when using the online Training Diary or with email and text reminders.

5.4.5 Effect of Drop out on Response Rate

In order to combat the effect drop-out has on the response rate, the amount of people on the team during the final week of testing was considered the total team. Any participants who dropped out during the course of testing were excluded from the study. This factor could have greatly affected our results. The minor girls' team demonstrates this fact. As testing progressed, we experienced a large drop-out rate due to extenuating

circumstances. The majority of players on that team were completing their final Leaving Certificate exams in June. As testing drew closer to that date the dropout rate increased, leaving only 10 players training and playing for that age group in the final week of testing. Consequently, the percentage response rate may not be the true response rate if the full team was training and playing. Future research should combat this by ensuring testing avoids time periods which forces players to drop out for an extended period of time.

5.4.6 Response Rate Hypothesis

These results do not present support for the hypothesis that the online Training Diary is more effective than the paper format. Various methodological reasons could be attributed to the lack of statistical data supporting the superiority of the online Training Diary.

5.5 The Use of Reminders

5.5.1 The Effect of Reminders on Response Rate

Reminders have been shown to increase the response rate in previous studies. As mentioned previously, studies have shown reminders to increase the likelihood of women taking the contraceptive pill and increasing vaccination rates (Vilella, et al. 2004, Fox, et al. 2003). The current study demonstrated that text reminders produce a significantly higher response rate than no reminder. As already mentioned, the testing protocol meant that reminders were completed by every team at the end stages of testing. Thus, during the last two weeks, participants received reminders. As demonstrated, as testing progresses the participants' motivation and response rates decrease. Therefore, even though there was no significant difference found between the email reminder and no reminder, when you look visually at the average response rates, both the email and text reminder increased the response rate back up to the levels of those at the beginning of the study. In fact, the text reminder was the highest average reminder (31.9%). However the email reminder was not shown to cause a statistically significant increase in response rate.

The protocol in this study analysed the response rate of email and text reminders with participants using the online Training Diary only. This is a limitation to the results of the study. It would have been interesting to note the response rate with a reminder using the paper Training Diary also. On the other hand, both methods decipher the same training information therefore the effects may not have been significantly different.

5.5.2 Reminder Hypothesis

This aspect of the study supports the researchers' hypothesis that reminders increase the response rate of Training Diaries. It also supports the hypothesis that text reminders are the most beneficial reminder. Nevertheless, statistically, only the text reminder was found to have a significantly increased response rate compared to no reminder using the

online Training Diary. Changes in testing protocol however could demonstrate an increased effect of reminders on response rate.

5.6 Questionnaire

5.6.1 The Qualitative viewpoint on Method of Filling in the Training Diary

The questionnaire analysed the participants' viewpoint on the paper and online Training Diary. It provides qualitative feedback on which method participants preferred to use. No significant preference was noted between the online and paper Training Diary for which method they preferred, could access, fill out return and use in the future. The majority of participants found the online Training Diary the method they most preferred (50.3%), easiest to fill out (59.1%), return (69%) and would rather use in the future (58%). This is surprising given the low response rate in Study Two. This result might support the idea that a decrease in motivation of participants as the testing period continues and perhaps the testing protocol may have caused a reduced response rate. The majority of participants (57.3%) however, found the paper Training Diary easiest to access. This important factor may have also caused the reduced response rate of the online Training Diary. If participants found the link, username and password difficult to use the likelihood of filling in the Training Diary on a daily basis would be decreased. Consequently this may suggest that future researchers could simplify the means used to access the Training Diary.

5.6.2 The Qualitative viewpoint on Reminders

The questionnaire analysed the participants' viewpoint on reminders. It provides qualitative feedback on the effect reminders have on prompting participants to fill in their Training Diaries. Overall reminders were found to be statistically beneficial ($t(5) = 14.51$, $p<0.0001$) with 94% of participants finding them helpful. This result was expected and perhaps suggests that if reminders were completed using a different protocol it could have produced a much higher response rate.

Participants' preferred text reminders significantly more than email ($p<0.05$) or no reminder ($p<0.0001$). With 74.1% of participants preferring to receive a text reminder and 74.9% favouring receiving a text reminder in the future, it would seem that in the future researchers and manager should utilise this method.

There was no significant difference found in the time participants' preferred to receive a reminder. The majority of participants (36.3%) preferred to receive their reminder in the evening. While statistically it was not proven that participants favoured this time, practically it might be more advantageous. If the reminder was received in the evening it would be after work/school for most participants and so make more sense.

5.7 Practical Issues

A number of practical issues were noted in the questionnaire and observed by researchers which affected the response rate of the Training Diary. Simple issues

affected the distribution, accessing, filling out and returning of the online and paper Training Diary.

5.7.1 Distribution and Returning of the Training Diary

Distribution and returning of the paper Training Diary was affected when players missed training sessions. The player would not receive the Training Diary that day and either waited until the next training session or when a player passed the Training Diary on to them. Even if the Training Diary was received that week, it still caused a delay in the time between exercise and filling in the Training Diary. Delays in filling in Training Diaries can cause a misreporting of training information due to human error (Borresen and Lamber 2009). Players that missed a training session often forgot to return the paper Training Diary for that week throughout the length of the testing period. Another difficulty with the paper Training Diary was that participants routinely lost the sheet that contained the codes to fill in the Training Diary. A number of participants reported that this was a significant problem when filling in the paper Training Diary in the questionnaire. The codes, themselves, caused some confusion to a number of the younger participants at the beginning of testing. Nonetheless, the explanation session at the beginning of the testing resolved this. Returning the paper Training Diary to the researcher requires a substantial amount of man power if there are a large number of subjects and teams within the study. It is beneficial to collect the Training Diary on the same training session each week because developing a routine has been shown to increase the memory of participants to complete an event. This has been shown in studies analysing the compliance in taking the contraceptive pill (Fox, et al. 2003). Logistically, a problem may arise if there are a number of teams training on the same night. This was encountered in the present study. Researchers managed this issue by collecting Training Diaries at the beginning of the session for one team and the end of the session for another team. The perceived involvement and knowledge of the sport of a researcher has been shown to increase response rate (Masse, et al. 1998). It was noted in the questionnaire that the paper Training Diary was more effective because the researcher was attending training sessions and so players were more likely to remember the Training Diary. While this has been shown to increase the response rate as players can identify with the researcher and so aim to complete the study to the best of their ability, this may not be possible in a large scale study. If there is a significant distance between the researcher's home and the area where the team is located, attending each session may not be possible. This problem was encountered as we investigated teams from all provinces in Ireland. With one team it was only possible to attend the explanation session and the first training session. Within this team there was a low compliance rate and low subject size which may have been caused by this.

An issue that was not perceived to be a possible problem before testing commenced was the practicality of returning the paper Training Diaries in a legible form. In one case it was raining so heavily that even though the manager placed all paper Training Diaries in a folder, each diary was illegible. No report on training load could be given to players

from that team that week. A manager of another team reported that two paper Training Diaries were blown away by the wind when collecting them from players after training.

5.7.2 Misinformation of Participant Details

Failure of participants to provide their correct email addresses caused a number of subjects not to receive their private username, password and the link to access the online Training Diary. Researchers combated this by texting each participant the details. Nevertheless, the instructions to use the Training Diary were not reiterated to each participant. Participants who accidentally deleted their emails, whose email accounts were full or who forgot their username and password all contributed to a reduced response rate. In fact, in the questionnaire, some participants reported that the username and passwords were one of the barriers they had to filling in the Training Diary. Access to the internet can also affect response rate. One participant on the adult ladies team noted in the questionnaire that she failed to fill in any of the online Training Diaries as she had no access to the internet at home or at work. Incorrect email addresses, email accounts being full and participants not checking their email daily all contributed to the email reminder not working to its full potential. Incorrect phone numbers and failure of participants to provide a contact phone number contributed to the text reminder not working to its full potential. No contact is allowed to be directly made to any underage Gaelic Footballer within the G.A.A. This meant that for both the Under-14 and Under-18 girls and boys teams, researchers' contacted parents. This required parents to remind their son or daughter to fill in the Training Diary. This caused a large problem. For example, some parents provided the email contact for the mother and phone number contact for the father. In a number of cases this caused issues as the parent who did not sign the informed consent or attend the explanation session and did not understand the details of the study was receiving reminders. Ethically it is not possible to contact an underage Gaelic Footballer directly however in future use of the Training Diary it should be advised that a single parent sign the consent form, attend the explanation session and receive both the email and text reminder. This would prevent a large amount of confusion that was present within this study.

5.7.3 Interest in Study

The interest and knowledge of managers and players in the study was shown to increase the response rate of participants. Masse et al., (1998) noted that if participants understand and see the benefits of the study and the information they provide, there would be an increased likelihood of them completing the diary. It was clear while working with certain teams, whose managers and players had a particular interest in the study, had an increased response rate. The Minor boys and Adult ladies are a clear example of this. The effect the support of a manager or official in charge of the group of subjects has been shown in other studies on Training Diaries. For example, a study on the physical activity of 9 to 15 year olds noted that anecdotal reports after the study was completed suggested that some class teachers were more enthusiastic in encouraging the school children to fill in and hand up the Training Diaries. This could explain the fact

that in some classes almost all students returned their written diaries however, in other classes a very small number returned their diary (Sleap, et al. 2007). This supports the idea that in order to effectively utilise Training Diaries both the managers and players are required to have an interest in the use of the diary. It also suggests players respond well to the encouragement of their management in filing out the Training Diary.

5.8 Recommendations

There are a number of important recommendations that can be made for the use of Training Diaries by teams in the future. Training Diaries have been shown by this study to be both valid and effective, however, this can be maximised by a number of simple measures.

5.8.1 Involvement of Researchers

As previously mentioned, the more involved and "hands-on" managers and therapists are, distributing and collecting the Training Diaries with the team, the more inclined players are to consistently fill in the Training Diary. It would be beneficial for a single manager, selector or therapist to be the sole person dealing with the Training Diaries. Consequently, the Training Diaries can be more easily tracked and this would prevent any confusion. This is especially the case when dealing with younger age groups. The Training Diary seemed to work better with the younger teams when the researcher was more active and present at training sessions. However, with the older age groups the researchers could be more distant and remind participants through email and text. The fact that parents must be contacted, not the participant themselves could have contributed to this fact. Nevertheless, since this is an ethics violation, future use of the Training Diary would need to combat this by the person responsible for the diary attending as many training sessions as possible.

5.8.2 Modification of Training Diary

The Training Diary itself could be improved by being modified in a number of ways. The codes provided in the online and paper Training Diary should be expanded. At least three activities were commonly reported which were not available in the Training Diary. Jogging and walking were commonly reported in the older age group and rollerblading was in the Under-14 age group. The visual layout of the paper Training Diary could be made clearer. It was observed throughout the study that a number of participants lost the codes of the paper Training Diary regularly. Thus, double siding the Training Diary with the codes on the back would solve this issue. The online Training Diary was visually a lot clearer. However, unlike the paper Training Diary, you could not look back over the past weeks training. Inserting an option where the participant could view their last week/months training as a graph would be exceptionally beneficial to players. A number of players raised the point that if a participant forgot to fill in a number of days, it was not possible for them to recheck what days they had filled in already. A calendar at the side of the Training Diary could be included. The days that they have

previously filled in could be darkened or alternatively crossed out. The calendar would provide an easy to view, simple method of providing participants with this information.

5.8.3 Addition of other Self Report Tools

The inclusion of other self report tools in Gaelic Football may help increase the response rate of a Training Diary within a team. Utilising other tools like a Food Diary or a Sleep Diary may promote the importance of self monitoring within a sport and enhance each player's habit of filling in information about training, eating habits and sleeping habits. All of these methods can help track the player's training, health and well being and so improve the athlete's performance and feeling of wellness.

5.9 Future Research

The research conducted in this study gives a detailed view of the possible use and benefits of Training Diaries in Gaelic Football. Nonetheless, there is a broad scope of areas that need to be examined in order to provide the most comprehensive and efficient Training Diary.

5.9.1 Utilise other methods of Filling in the Training Diary

The methods of filling in the Training Diary used in this study were paper and online. The paper and online methods are the most common methods used by studies in the available literature. Future research should focus on the benefits of using more modern types of Training Diaries. The effectiveness of SMS diaries and Java based diaries is necessary to analyse. One of the main issues with online Training Diaries is that they are not as effective if the internet is not integrated into the participants' daily life. Mobile phones, on the other hand, are very much integrated into the population's daily lives and so could increase the compliance rate. As previously mentioned, market studies have shown that in 2001 60%-85% of people owned mobile phones in Western European countries (Vilella, et al. 2004). This percentage has more than likely increased in Ireland in the time since then, especially in the age group being tested in this study. The SMS system does not rely on the participants own initiative to access the Training Diary as it directly texts participants the Training Diary questions. This method has a significantly different protocol than the protocol applied in the current study and so requires analysis. Previous studies have utilised this method in medication studies and have found that in 58% of the study days they received a 100% response rate (Anhoj and Moldrup 2004). This provides a further incentive for future research on this method of filling in the Training Diary. Nonetheless, it must be noted that it has not been utilised in a physical activity study, and so, may not have the resultant high compliance rate that occur in medication studies. The Java-based study, on the other hand, is similar to the online Training Diary method. A high compliance rate was discovered for this method in a study on physical activity. The study reported only 2 out of the 22 participants missed a Training Diary report which is a much larger response rate than our current study (Bexelius, et al. 2010). Future research could apply the same method of testing but utilise the SMS and Java-based Training Diary instead.

5.9.2 Longer Testing Period

Future studies should increase the time period of testing and allow analysis of response rate over a full season. As mentioned previously, the response rate of participants decreased over the period of testing for both methods of filling in the Training Diary. Future studies should assess if this trend continues over a longer period of time. The effectiveness of each method of reminder was assessed over one week. It would be beneficial for future research studies to assess if each reminder increases and maintains the response rate shown by the current study over a longer period of time.

5.9.3 Assessing effect of Reminders on the paper Training Diary

The current study assessed reminders using the online Training Diary system only. Future research should analyse the effect of reminders on the paper Training Diary in order to decipher if it causes the same increase in the response rate as shown by the present study.

5.9.4 Use of an Incentive

Incentives were not utilised in this study on Training Diaries. Incentives are commonly used in studies including a very similar study assessing the correlation between accelerometers and self-report questionnaires in varying subgroups (Slootmaker, et al. 2009). Another study assessing training and injury patterns in British triathletes rewarded those who returned their training diary at the end of the 8 weeks with a t-shirt (Korkia, Tunstall-Pedoe and Maffulli 1994). It would be beneficial to analyse the effectiveness of incentives on the response rate of Training Diaries. An example of a possible incentive would be a ticket to a G.A.A. game if all Training Diaries were completed daily for the season. Incentives and reminders used in conjunction could be proven to increase the Training Diary response rate dramatically. Future research could focus on this issue and aim to prove this hypothesis.

5.9.5 Utilise various Cut-off Points in Validation Study

Future studies should analyse the effect of different cut-off points and its effect on the intensity validity of the Training Diary. As previously discussed, cut-off points greatly affect the variance of results. Development of cut-off points that are weighted averages of the most common sports played by participants would greatly affect the results. Cut-off points should ideally be developed for Gaelic Football, gym work, hurling etc. (Schmidt, Freedson and Chasen-Taber 2003). While this could contribute to a reduced variance produced by the accelerometer, issues will still exist. Different body type and stride length would persist in causing variation between participants and affect results (Schmidt, Freedson and Chasen-Taber 2003).

5.9.6 Additional Equipment for Validation Study

Future studies could analyse the intensity generated by the participant while training using both an accelerometer and a heart rate monitor. This could help increase the

ability of the study to accurately measure a more "gold standard" intensity level. Researchers could then compare the intensity results noted in the Training Diary and achieve a more valid result (Schmidt, Freedson and Chasen-Taber 2003). The use of multiple accelerometers in various anatomical sites could also increase the likelihood of reporting an accurate intensity level. Placement of an accelerometer on the wrist and hip could ensure that both upper and lower body movements are captured effectively.

5.10 Conclusion

In conclusion, the present study supports the developed Training Diary. The Training Diary was found to be an extremely valid method of assessing training load in Gaelic Footballers of all ages and both genders. The effectiveness of Training Diaries was adequate, however, this study proposed a number of recommendations to increase the response rate. Reminders were found to increase response rate and a text reminder produced the greatest response rate. The results supported the original hypothesises proposed by the researchers.

Chapter 6.0 Conclusion

The Training Diary developed was found to have a high face and convergent validity against the objective SenseCam, accelerometer and interview methods. Training Diaries provided a reasonable response rate. The average response rate for the paper and online Training Diary was 26.6% and 15.2% respectively. The use of email and text reminders with the online Training Diary increased the response rate to 21.9% and 31.9% respectively. No significant difference was found between paper and online Training Diaries. The text reminder produced a significantly higher response rate than no reminder ($p<0.05$). Gender caused no significant effect on response rates. Age caused no significant difference in response rates in the Online or Paper Training Diary. A significant difference was found between the Under-14 and Minor team, and the Under-14 and Adult team in response rates when using a reminder. The Under-14 team had a lower response rate than both of the older teams and the effect size was found to be large. There was no significant difference found between the Minor or Adult team. Participants reported no significant preference between the online and paper Training Diary, for which method they preferred, could access, fill out, return and use in the future the questionnaire. Reminders, especially the text reminder was found to be the most statistically beneficial. No significant preference for what time of the day to receive a reminder was noted by participants.

Future research should focus on utilising more novel methods of Training Diaries including mobile phone and Java Based Training Diaries. Incentives, different objective equipment, longer testing period and further research on reminders could also be investigated. Recommendations on how to maximise the response rate and enhance the Training Diary have been provided in this study.

Thus, in conclusion, Training Diaries are an extremely valid and reasonably effective method of assessing and self monitoring training load in Gaelic Footballers. The present study has discovered that text reminders assist in increasing the response rate of Gaelic Footballers.

Chapter 7.0 Bibliography

Aadahl, M. and Jorgensen, T. 2003. Validation of a New Self-Report Instrument for Measuring Physical Activity. *Medicine and Science in Sports and Exercise,* 35(7), pp.1196-1202.

Adams, S.A., Matthews, C.E., Ebbeling, C.B., Moore, C.G., Cunningham, J.E., Fulton, J. and Herbert, J.R. 2005. The Effect of Social Desirability and Social Approval on Self-Reports of Physical Activity. *American Journal of Epidemiology,* 161(4), pp.389-398.

Anderson, C.B., Hagstromer, M. and Yngve, A. 2005. Validation of the PDPAR as an Adolescent Diary: Effect of Accelerometer Cut Points. *Medicine and Science in Sports and Exercise,* 37(7), pp.1224-1230.

Anhoj, J. and Moldrup, C. 2004. Feasibility of Collecting Diary Data From Asthma Patients Through Mobile Phones and SMS (Short Message Service): Response Rate Analysis and Focus Group Evaluation From a Pilot Study. *Journal of Medical Internet Research,* 6(4), pp.42-51.

Anhoj, J. and Nielsen, L. 2004. Quantitative and Qualitative Usage Data of an Internet-Based Asthma Monitoring Tool. *Journal of Medical Internet Research,* 6(3), pp.23-38.

Bathgate, A., Best, J.P. and Craig, G.'., M. 2002. A prospective study of injuries to elite Australian rugby union players. *British Journal of Sports Medicine,* 36(4), pp.265-269.

Berry, E., Hampshire, A., Rowe, J., Hodges, S., Kapur, N., Watson, P., Browne, G., Smyth, G., Wood, K. and Owen, A.M. 2009. The neural basis of effective memory therapy in a patient with limbic encephalitis. *Journal of Neurology, Neurosurgery and Psychiatry,* 80(11), pp.1202-1205.

Berry, E., Kapur, N., Williams, L., Hodges, S., Watson, P., Smyth, G., Srinivasan, J., Smith, R., Wilson, B. and Wood, K. 2007. The use of a wearable camera, SenseCam, as a pictorial diary to improve autobiographical memory in a patient with limbic encephalitis: A preliminary report. *Memory,* 17(4), pp.582-601.

Bexelius, C., Lof, M., Sandin, S., Lagerros, Y.T., Forsum, E. and Litton, J.E. 2010. Measures of Physical Activity Using Cell Phones: Validation Using Criterion Methods. *Journal of Medical Internet Research,* 12(1), pp.e2.

Bird, Y.N., Waller, A.E., Marshall, S.W., Alsop, J.C., Chalmers, D.J. and Gerrard, D.F. 1998. The New Zealand Rugby Injury and Performance Project: V. Epidemiology of a season of rugby injury. *British Journal of Sports Medicine,* 32(4), pp.319-325.

Blake, C., Sherry, J. and Gissane, C. 2009. A survey of referee participation, training and injury in elite gaelic games referees. *BMC Musculoskeletal Disorders,* 10pp.74-82.

Bland, M.J. and Altman, D.G. 1986. Statistical Methods for Assessing Agreement between two Methods of Clinical Measurement. *The Lancet,* 327(8476), pp.307-310.

Boon, R.M., Hamlin, M.J., Steel, G.D. and Ross, J.J. 2010. Validation of the New Zealand Physical Activity Questionnaire (NZPAQ-LF) and the International Physical Activity Questionnaire (IPAQ-LF) with accelerometry. *British Journal of Sports Medicine,* 44(10), pp.741-746.

Borg, G. 1998. *Borg's Rating of Perceived Exertion and Pain Scales.* Illinois: Champaign: Human Kinetics.

Borresen, J. and Lamber, M.I. 2009. The Quantification of Training Load, the Training Response and the Effect on Performance. *Sports Medicine (Auckland),* 39(9), pp.779-795.

Brazdzionyte, J. and Macas, A. 2007. **Bland-Altman analysis as an alternative approach for statistical evaluation of agreement between two methods for measuring hemodynamics during acute myocardial infarction.**. *Medicina (Kaunas),* 43(3), pp.208-214.

Brindley, R., Bateman, A. and Gracey, F. Exploration of use of SenseCam to support autobiographical memory retrieval within a cognitive-behavioural therapeutic intervention following acquired brain injury. *Memory,* Janpp.1-13.

Bringolf-Isler, B., Grize, L., Mader, U., Ruch, N., Sennhauser, F.H. and Braun-Fahrlander, C. 2009. Assessment of intensity, prevalance and duration of everyday activities in Swiss school children: a cross-sectional analysis of accelerometer and diary data. *International Journal of Behavioural Nutrition and Physical Activity,* 5(6), pp.50-60.

Brooks, J.H.M. and Fuller, C.W. 2006. The Influence of Methodological Issues on the Results and Conclusions from Epidemiological Studies of Sports Injuries. Illustrative Examples. *Sports Medicine (Auckland),* 36(6), pp.459-472.

Brynhildsen, J.O., Hammar, J. and Hammer, M.L. 1997. **Does the menstrual cycle and use of oral contraceptives influence the risk of low back pain? A prospective study among female soccer players**. *Scandinavian Journal of Medicine and Science in Sports,* 7(6), pp.348-353.

Buist, I., Bredeweg, S.W., Lemmink, K.A.P.M., van Mechelen, W. and Diercks, R.L. 2010. Predictors of Running-Related Injuries in Novice Runners Enrolled in a Systematic Training Program: A Prospective Cohort Study. *The American Journal of Sports Medicine,* 38(2), pp.273-280.

Burke, K., Franklin, S. and Gowan, O. 2011. Passive imagine technology in aphasia therapy. *Memory,* Janpp.1-7.

Caspersen, C.J., Powell, K.E. and Christenson, G.M. 1985. Physical Activity, Exercise, and Physical Fitness:Definitions and Distinctions fro Health-Related Research. *Public Health Reports,* March-April 100(2), pp.126-131.

Chen, M.J., Fan, X. and Moe, S.T. 2002. Criterion-related validity of Borg ratings of perceived exertion scale in healthy individuals: a meta-analysis. *Journal of Sports Sciences,* 20(11), pp.873-899.

Coombes, J.S., Conacher, M., Austen, S.K. and Marshall, P.A. 2002. Dose effects of oral bovine colostrum on physical work capacity in cyclists. *Medicine and Science in Sports and Exercise,* 34(7), pp.1184-1188.

Coutts, A.J. and Duffield, R. 2010. Validity and reliability of GPS devices for measuring movement demands of team sports. *Journal of Science and Medicine in Sport,* 13(1), pp.133-135.

Cromwell, F., Walsh, J. and Gormley, J. 2000. A pilot study examining injuries in elite gaelic footballers. *British Journal of Sports Medicine,* 34(2), pp.104-108.

Cunniffe, B., Griffiths, H., Proctor, W., Davies, B., Baker, J.S. and Jones, K.P. 2011. Mucosal Immunity and Illness Incidence in Elite Rugby Union Players across a Season. *Medicine and Science in Sports and Exercise,* 43(3), pp.388-397.

Cunniffe, B., Proctor, W., Baker, J.S. and Davies, B. 2009. An evaluation of the physiological demands of elite rugby union using global positioning system tracking software. *The Journal of Strength & Conditioning Research,* 23(4), pp.1195.

Dobson, B.P. and Keogh, J.W.L. 2007. Methodological issues for the application of time-motion analysis research. *Strength & Conditioning Journal,* 29(2), pp.48.

Doherty, A.R., Moulin, C.J.A. and Smeaton, A.F. 2011. Automatically assisting human memory: A SenseCam browser. *Memory,* Janpp.1-11.

Dollman, J., Okel, A.D., Hardy, L., Timperio, A., Salmon, J. and Hills, A.P. 2009. A hitchhiker's guide to assessing young people's physical activity: Deciding what method to use. *Journal of Science and Medicine in Sport,* 12(5), pp.518-525.

Durante, R. and Ainsworth, B.E. 1996. The recall of physical activity:using a cognitive model of the question-answering process. *Medicine and Science in Sports and Exercise,* 28(10), pp.1282-1291.

Ekstrand, , Timpka, T. and Hagglund, M. 2006. Risk of injury in elite football played on artificial turf versus natural grass: a prospective two-cohort study. *British Journal of Sports Medicine,* 40(12), pp.975-980.

Finley, J.R., Brewer, W.F. and Benjamin, A.S. 2011. The effects of end-of-day picture review and a sensor-based picture capture procedure on autobiographical memory using SenseCam. *Memory,* Janpp.1-12.

Foster, C. 1998. Monitoring training in athletes with reference to overtraining syndrome. *Medicine and Science in Sports and Exercise,* 30(7), pp.1164-1168.

Fox, M.C., Creinin, M.D., Murthy, A.S., Harwood, B. and Reid, L.M. 2003. Feasibility study of the use of a daily electronic mail reminder to improve oral contraceptive compliance. *Contraception,* 68(5), pp.365-371.

Freedson, P.S., Melanson, E. and Sirard, J. 1998. Calibration of the Computer Science and Applications, Inc. accelerometer. *Medicine and Science in Sports and Exercise,* 30(5), pp.777-781.

Friedenreich, C.M. 1994. Improving Long-Term Recall in Epidemiologic Studies. *Epidemiology,* 5(1), pp.1-4.

Fulton, S.K., Pyne, D.B., Hopkins, W.G. and Burkett, B. 2010. Training Characteristics of Paralympic Swimmers. *Journal of Strength and Conditioning Research,* 24(2), pp.471-478.

Gabbett, T.J. 2010. GPS analysis of elite women's field hockey training and competition. *The Journal of Strength & Conditioning Research,* 24(5), pp.1321.

Genin, J., Mann, R. and Theisen, D. 2011. Determining the running-related injury risk factors in long distance runners. *British Journal of Sports Medicine,* 45(4), pp.349.

Guellich, A., Seiler, S. and Emrich, E. 2009. Training Methods and Intensity Distribution of Young World-Class Rowers. *International Journal of Sports Physiology and Performance,* 4(4), pp.448-460.

Ham, S.A., Reis, J.P., Strath, S.J., Dubose, K.D. and Ainsworth, B.E. 2007. Discrepancies between Methods of Identifying Objectively Determined Physical Activity. *Medicine and Science in Sports and Exercise,* 39(1), pp.52-58.

Haskell, W.L. and Kiernan, M. 2000. Methodologic issues in measuring physical activity and physical fitness when evaluating the role of dietary supplements for physically active people. *The American Journal of Clinical Nutrition,* 72(2 Suppl), pp.541-550.

Helsen, W.F., Winckel, J.V. and Williams, A.M. 2005. The relative age effect in youth soccer across Europe. *Journal of Sports Sciences,* 23(6), pp.629-636.

Hill-Haas, S., Coutts, A., Rowsell, G. and Dawson, B. 2008. Variability of acute physiological responses and performance profiles of youth soccer players in small-sided games. *Journal of Science and Medicine in Sport,* 11(5), pp.487-490.

Hodges, S., Williams, L., Berry, E., Izadi, S., Srinivasan, J., Butler, A., Smyth, G., Kapur, N. and Wood, K. 2006. SenseCam: A Retrospective Memory Aid *IN:* AnonymousUbicomp, pp.177-193.

Jennings, D., Cormack, S., Coutts, A.J., Boyd, L. and Aughey, R.J. 2010. The validity and reliability of GPS units for measuring distance in team sport specific running patterns. *International Journal of Sports Physiology and Performance,* 5(3), pp.328-341.

Kelly, P., Doherty, A., Berry, E., Hodges, S., Batterham, A.M. and Foster, C. 2011. Can we use digital life-log images to investigate active and sedentary travel behaviour? Results from a pilot study. *International Journal of Behavioral Nutrition and Physical Activity,* 8(1), pp.44-73.

Klakk, H., Jespersen, E. and Wedderkopp, N. 2011. Overweight - a risk factor of overuse injuries in children? the childhood health, activity, and motor performance school study - a 3-year controlled intervention study. *British Journal of Sports Medicine,* 45(4), pp.357.

Knechtle, B., Wirth, A., Baumann, B., Knechtle, P., Rosemann, T. and Oliver, S. 2010. Differential Correlations Between Anthropometry, Training Volume, and Performance in Male and Female Ironman Triathletes. *Journal of Strength and Conditioning Research,* 24(10), pp.2785.

Korkia, P.K., Tunstall-Pedoe, D.S. and Maffulli, N. 1994. An epidemiological investigation of training and injury patterns in British triathletes. *British Journal of Sports Medicine,* 28(3), pp.191-196.

Laporte, R.E., Montoye, H.J. and Caspersen, C.J. 1985. Assessment of Physical Activity in Epidemiolgic Research: Problems and Prospects. *Epidemiology,* 100(2), pp.131-146.

Larsson, P. 2003. Global positioning system and sport-specific testing. *Sports Medicine,* 33(15), pp.1093-1101.

Lauchu, J. and McGregor, S.J. 2007. The Use of Global Positioning System (GPS) to Monitor Training and Model Performance in High School Cross Country Runners: 2225: Board# 138 June 1 9: 00 AM-10: 30 AM. *Medicine & Science in Sports & Exercise,* 39(5), pp.S402.

Lee, M.M., Whittemore, A.S. and Jung, D.J. 1992. Reliability of recalled physical activity, cigarette smoking, and alcohol consumption. *Annals of Epidemiology,* 2(5), pp.705-714.

Macfarlane, D.J., Lee, C.C.Y., Ho, E.Y.K., Chan, K.L. and Chan, D. 2006. Convergent validity of six methods to assess physical activity in daily life. *Journal of Applied Physiology,* 101(5), pp.1328-1334.

Machado-Rodrigues, A.M., Figueiredo, A.J., Mota, J., Cumming, S.P., Eisenmann, J.C. and Matlina, R.M. 2010. Concurrent validation of estimated activity energy expenditure using a 3-day diary and accelerometry in adolescents. *Scandinavian Journal of Medicine and Science in Sports,* June(16),

Masse, L.C., Ainsworth, B.E., Tortolero, A., Levin, S., Fulton, J.E., Henderson, K.A. and Mayo, K. 1998. Measuring Physical Activity in Midlife, Older, and Minority Women: Issues from an Expert Panel. *Journal of Women's Health,* 7(1), pp.57-67.

Mathews, C.E. 2005. Calibration of Accelerometer Output for Adults. *Medicine and Science in Sports and Exercise,* 37(11), pp.512-522.

Meyers, M.C. and Barnhill, B.S. 2004. Incidence, Causes, and Severity of High School Football Injuries on FieldTurf Versus Natural Grass. A 5-Year Prospective Study. *The American Journal of Sports Medicine,* 32(7), pp.1625-1638.

Milburn, P.D. and Barry, E.B. 1998. Shoe-Surface Interaction and the Reduction of Injury in Rugby Union. *Sports Medicine (Auckland),* 25(5), pp.319-327.

Milton, F., Muhlert, N., Butler, C.R., Benattayallah, A. and Zeman, A.Z. 2011a. The neural correlates of everyday recognition memory. *Brain and Cognition,* 76(3), pp.369-381.

Milton, F., Muhlert, N., Butler, C.R., Smith, A., Benattayallah, A. and Zeman, A.Z. 2011b. An fMRI study of long-term everyday memory using SenseCam. *Memory,* Janpp.1-12.

Moloney, M.F., Aycock, D.M., Cotsonis, G.A., Myerburg, S., Farino, C. and Lentz, M. 2009. An INternet-Based Migraine Headache Diary: Issues in Internet-Based Research. *Headache,* 49(5), pp.673-686.

Morrissey, D., Roskilly, A., Twycross-Lewis, R., Isinkaye, T. and Screen, H. 2011. The effect of eccentric and concentric calf muscle training on Achilles tendon stiffness. *Clinical Rehabilitation,* 25(3), pp.238-247.

Muhlert, N., Milton, F., Butler, C.R., Napur, N. and Zeman, A.Z. 2010. Accelerated forgetting of real-life events in Transient Epileptic Amnesia. *Neuropsychologia,* 48(11), pp.3235-3244.

Murphy, F.C., Barnard, P.J., Terry, K.A.M., Carthery-Goulart, M.T. and Holmes, E.A. 2011. SenseCam, imagery and bias in memory for wellbeing. *Memory,* Janpp.1-10.

Nigg, B.M. and Segesser, B. 1988. The influence of playing surfaces on the load on the locomotor system and on football and tennis injuries. *Sports Medicine (Auckland),* 5(6), pp.375-385.

Nilstad, A., Bahr, R. and Andersen, T.E. 2011. Text messaging as a new method for injury registration in sports - a methodological study in elite female football. *British Journal of Sports Medicine,* 45(4), pp.330.

Orchard, J. 2002. Is There a Relationship Between Ground and Climatic Conditions and Injuries in Football? *Sports Medicine (Auckland),* 32(7), pp.419-432.

Pauly-Takacs, K. and Moulin, C.J.A. 2011. SenseCam as a rehabilitation tool in a child with anterograde amnesia. *Memory,* Janpp.1-8.

Pfeiffer, K.A., Pivarnik, J.M., Womack, C.J., Reeves, M.J. and Malina, R.M. 2002. Reliability and validity of the Borg and OMNI rating of perceived exertion scales in adolescent girls. *Medicine and Science in Sports and Exercise,* 34(12), pp.2057-2061.

Pissanos, B.W. and Allison, P.C. 1993. Students' constructs of elementary school physical education. *Research Quarterly for Exercise and Sport,* Dec 64(4), pp.425-435.

Puhl, J., Greaves, K.A., Hoyt, M. and Baranowski, T. 1990. Children's activity rating scale (CARS):description and evaluation. *Research Quarterly for Exercise and Sport,* 61(1), pp.26-36.

Reilly, T. and Doran, D. 2001. Science and Gaelic football: A review. *Journal of Sports Sciences,* 19(3), pp.181-193.

Rennie, K.L. and Wareham, N.J. 1998. The validation of physical activity instruments for measuring energy expenditure:problems and pitfalls. *Public Health Nutrition,* 1(4), pp.265-271.

Rushford, N., Murphy, B.M., Worcester, M.U.C., Goble, A.J., Higgins, R.O., Le Grande, M.R., Rada, J. and Elliott, P.C. 2007. Recall of information received in hospital by female cardiac patients. *European Journal of Cardiovascular Prevention and Rehabilitation,* 14(3), pp.463-469.

Sallis, J.F., Buono, M.J., Roby, J.J., Micale, F.G. and Nelson, J.A. 1993. Seven-day recall and other physical activity self-reports in children and adolescents. *Medicine and Science in Sports and Exercise,* 25(1), pp.99-108.

Schmidt, F.L., Hunter, J.E. and Urry, V.W. 1976. Statistical Power in Criterion-Related Validation Studies. *Journal of Applied Psychology,* 61(4), pp.473-485.

Schmidt, M.D., Freedson, P.S. and Chasen-Taber, L. 2003. Estimating Physical Activity Using the CSA Accelerometer and a Physical Activity Log. *Medicine and Science in Sports and Exercise,* 35(9), pp.1605-1611.

Schuler, P.B., Richardson, M.T., Ochoa, P. and Wang, M.Q. 2001. Accuracy and Repeatability of the Yale Physical Activity Survey in Assessing Physical Activity of Older Adults. *Perceptual and Motor Skills,* 93(1), pp.163-177.

Shepard, R.J. 2003. Limits to the measurement of habitual physical activity by questionnaires. *British Journal of Sports Medicine,* 37(3), pp.197-206.

Shovron, M., Levy, I. and Agel, J. 1990. Living with artificial grass: a knowledge update. Part 2: epidemiology. *American Journal of Sports Medicine,* 18(5), pp.510-513.

Simons-Morton, B.G., Taylor, W.C. and Wei Huang, I. 1994. Validity of the physical activity interview and Caltrac with preadolescent children. *Research Quarterly for Exercise and Sport,* 65(1), pp.84-88.

Sirard, J.R. and Pate, R.R. 2001. Physical Activity Assessment in Children and Adolescents. *Sports Medicine (Auckland),* 31(6), pp.439-454.

Slattery, M.L. and Jacobs, D.R. 1995. Assessment of Ability to Recall Physical Activity of Several Years Ago. *Annals of Epidemiology,* 5(4), pp.292-296.

Sleap, M., Elliot, B., Paisi, M. and Reed, H. 2007. The Lifestyles of Affluent Young People Ages 9 to 15 Years: A Case Study. *Journal of Physical Activity and Health,* 4(4), pp.459-468.

Slootmaker, S.M., Schuit, A.J., Chinapaw, M.J.M., Seidell, J.C. and van Mechelen, W. 2009. Disagreement in physical activity assessed by accelerometer and self-report in subgroups of age, gender, education and weight status. *Internatinal Journal of Behavioral Nutrition and Physical Activity,* 25(6), pp.17-27.

St. Jacques, P.L., Conway, M.A. and Cabeza, R. 2011. Gender differences in autobiographical memory for everyday events: Retrieval elicited by SenseCam images versus verbal cues. *Memory,* Janpp.1-10.

Takemura, M., Schneiders, A.G., Bell, M.L. and Milburn, P.D. 2007. Association of ground hardness with injuries in rugby union. *British Journal of Sports Medicine,* Sep 41(9), pp.582-587.

van der Worp, H., van Ark, M., Zwerver, J. and van der Akker-Scheek, I. 2011. Risk factors for patellar tendinopathy in basketball and volleyball players: a cross-sectional study. *British Journal of Sports Medicine,* 45(4), pp.380.

Vanhees, L., Lefevre, J., Philippaerts, R., Martens, M., Huygens, W., Troosters, T. and Beunen, G. 2005. How to assess physical activity? How to assess physical fitness? *European Journal of Cardiovascular Prevention and Rehabilitation,* 12(2), pp.102-114.

Veale, J.P., Pearce, A.J., Koehn, S. and Carlson, J.S. 2008. Performance and anthrpometric characteristics of prospective elite junior Australian footballers: A case study in one junior team. *Journal of Science and Medicine in Sport,* 11(2), pp.227-230.

Vilella, A., Bayas, J.M., Diaz, M.T., Guinovart, C., Diez, C., Simó, D., Munoz, A. and Cerezo, J. 2004. The role of mobile phones in improving vaccination rates in travelers. *Preventive Medicine,* 38(4), pp.503-509.

Visnes, H. and Bahr, R. 2011. Training volume as a risk factor for the development of jumper's knee? data from the patellar tendinopathy cohort 2006-2010. *British Journal of Sports Medicine,* 45(4), pp.324-325.

Vleck, V. and Bessone Alves, F. 2011. Cross-training and injury risk in british olympic distance triathletes. *British Journal of Sports Medicine,* 45(4), pp.382.

Welk, G.J., Corbin, C.B. and Dale, D. 2000. Measurement issues in the assessment of physical activity in children. *Research Quarterly for Exercise and Sport,* 71(2 Suppl), pp.59-73.

Westerterp, K.R. 1999. Physical activity assessment with accelerometers. *International Journal of Obesity and Related Metabolic Disorders,* 23(3), pp.45-49.

Wickel, E.E., Welk, G.J. and Eisenmann, J.C. 2006. Concurrent Validation of the Bouchard Diary with an Accelerometry-Based Monitor. *Medicine and Science in Sports and Exercise,* 38(2), pp.373-379.

Wilson, F., Caffrey, S., King, E., Casey, K. and Gissane, C. 2007. A 6-month prospective study of injury in Gaelic football. *British Journal of Sports Medicine,* 41(5), pp.317-321.

Wisbey, B., Montgomery, P.G., Pyne, D.B. and Rattray, B. 2010. Quantifying movement demands of AFL football using GPS tracking. *Journal of Science and Medicine in Sport,* 13(5), pp.531-536.

Yngve, A., Nilsson, A., Sjostrom, M. and Ekelund, U. 2003. Effect of monitor placement and of activity setting on the MTI accelerometer output. *Medicine & Science in Sports & Exercise,* 35(2), pp.320.

Chapter 8.0 Appendices

Appendix A: Training Diary Paper

Appendix B: Training Diary Codes

Appendix C: Training Diary snapshot online

Appendix D: Ethical Approval

Appendix E: Plain Language Statement

Appendix F: Informed Consent Adult

Appendix G: Informed Consent Underage

Appendix H: Pilot Study Questionnaire

Appendix I: Borg CR scale

Appendix J: Methods of filling in Diary questionnaire

Appendix K: Reminder Questionnaire

Appendix A

Name:_____ Training Diary Date:_____

Day	Sess No.	Sport	Playing With	Team Age	Activity	How Hard ?	Sess Length	Travel Time (mins)	Training Surface	Foot-wear
Mon	1									
	2									
	3									
	4									
	5									
Tue	1									
	2									
	3									
	4									
	5									
Wed	1									
	2									
	3									
	4									
	5									
Thu	1									
	2									
	3									
	4									
	5									
Fri	1									
	2									
	3									
	4									
	5									
Sat	1									
	2									
	3									
	4									
	5									
Sun	1									
	2									
	3									
	4									
	5									

Appendix B

Sport	
1	gaelic football
2	Hurling
3	Camogie
4	Soccer
5	Rugby
6	Basketball
7	Tennis
8	Hockey
9	Cycling
10	Athletics
11	individual gym work
12	Squash
13	Other

Playing / Training With	
1	own GAA club
2	other sports club
3	school
4	college / uni
5	work team
6	county GAA team
7	representative team (other sport)
8	individual session

Age Group	
1	own age
2	older age
3	NA

Activity	
1	Indoor training
2	outside training
3	competitive game
4	friendly game
5	specific dead ball kicking
6	specific skills session
7	PE class
8	NA

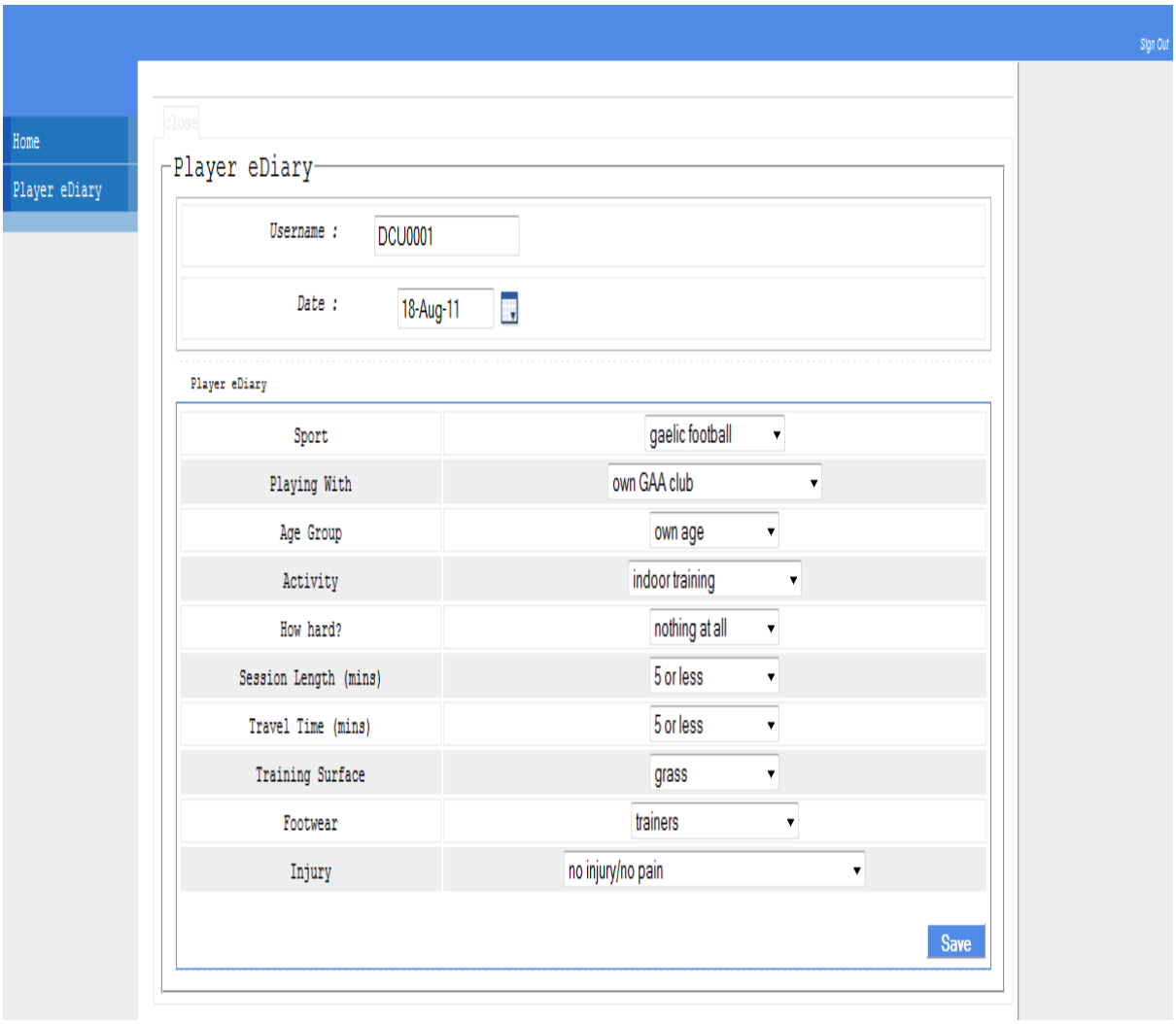
How Hard	
0	nothing at all
1	very light
2	fairly light
3	light
4	moderate
5	Somewhat hard
6	Hard
7	very hard (level 7)
8	very hard (level 8)
9	very very hard (level 9)
10	Very very hard

Training surface	
1	grass
2	synthetic
3	indoor
4	track
5	road
6	beach
7	other

Footwear	
1	Trainers
2	football boots (blades)
3	football boots (moulded)
4	football boots (screw in)
5	cycling shoes
6	Barefoot
7	Other

Injury	
1	no injury/no pain
2	injury that stopped or modified my participation
3	illness that stopped or modified my participation
4	I had pain but it did NOT stop my participation

Appendix C


Sign Out
Home
Player eDiary
close
Player eDiary
Username :
DCU0001
Date :
18-Aug-11
Player eDiary
Sport
gaelic football
Playing With
own GAA club
Age Group
own age
Activity
indoor training
How hard?
nothing at all
Session Length (mins)
5 or less
Travel Time (mins)
5 or less
Training Surface
grass
Footwear
trainers
Injury
no injury/no pain
Save

Dublin City University

RESEARCH ETHICS COMMITTEE

APPLICATION FOR APPROVAL OF A PROJECT INVOLVING **HUMAN PARTICIPANTS**

Application No. *(office use only)* DCUREC/2009/ ☐☐☐

Period of Approval *(office use only)* ...../...../..... to ...../...../....

This application form is to be used by researchers seeking ethics approval for individual projects and studies.

The **signed original and an electronic copy** of your completed application must be submitted to the DCU Research Ethics Committee. *Applications must be completed on the form; answers in the form of attachments will not be accepted, except where indicated. No handwritten applications will be accepted.* **Research must not commence until written approval has been received from the Research Ethics Committee.**

PROJECT TITLE **The Development, Validity and Efficacy of different modes of Self Recall Training Diaries in assessing training load on Gaelic Footballers.**

PRINCIPAL INVESTIGATOR(S) **Dr. Noel Mc Caffrey**

1. ADMINISTRATIVE DETAILS

THIS PROJECT IS: *(tick as many as apply)*

- ☐ Research Project
- ☐ Practical Class
- ✓ Student Research Project *(please give details)*
  - ✓ Masters
  - ☐ PhD
- ☐ Funded Consultancy
- ☐ Clinical Trial
- ☐ Other - *Please Describe:*

Project Start Date: *January, 2010*

Project End date: *January 2012*

1.1 INVESTIGATOR CONTACT DETAILS

PRINCIPAL INVESTIGATOR(S):

TITLE	*SURNAME*	*FIRST NAME*	*PHONE*	*FAX*	*EMAIL*
Dr.	Mc Caffery	Noel	017008187	-	noel.mccaffrey@dcu.ie

OTHER INVESTIGATORS:

TITLE	*SURNAME*	*FIRST NAME*	*PHONE*	*EMAIL*
Ms	O Connor	Siobhan	0861639016	Siobhan.oconnor27@mail.dcu.ie

FACULTY/DEPARTMENT/SCHOOL/ CENTRE: School of Health and Human Performance

1.2 WILL THE RESEARCH BE UNDERTAKEN ON-SITE AT DUBLIN CITY UNIVERSITY?

✓ YES ☐ NO All of the data will be collected in DCU, Glasnevin, Dublin 9

1.3 IS THIS PROTOCOL BEING SUBMITTED TO ANOTHER ETHICS COMMITTEE, OR HAS IT BEEN PREVIOUSLY SUBMITTED TO AN ETHICS COMMITTEE?*)*

☐ YES ✓ NO

DECLARATION BY INVESTIGATORS

The information contained herein is, to the best of my knowledge and belief, accurate. I have read the University's current research ethics guidelines, and accept responsibility for the conduct of the procedures set out in the attached application in accordance with the guidelines, the University's policy on Conflict of Interest and any other condition laid down by the Dublin City University Research Ethics Committee or its Sub-Committees. I have attempted to identify all risks related to the research that may arise in conducting this research and acknowledge my obligations and the rights of the participants.

If there any affiliation or financial interest for researcher(s) in this research or its outcomes or any other circumstances which might represent a perceived, potential or actual conflict of interest this should be declared in accordance with Dublin City University policy on Conflicts of Interest.

I and my co-investigators or supporting staff have the appropriate qualifications, experience and facilities to conduct the research set out in the attached application and to deal with any emergencies and contingencies related to the research that may arise.

Signature(s):

Principal investigator(s): _____

_____

Print name(s) in block letters: _____

_____

__

Date: _____

_____

2. PROJECT OUTLINE

2.1 LAY DESCRIPTION

The project to be undertaken will be part of a larger study (a prospective cohort study that will examine the incidence of and risk factors for the injuries that occur commonly in young non-elite male and female gaelic footballers). The larger study has already been approved by the DCU Research Ethics Committee. Our study will focus on developing the training diary that will then be used in the larger study.

There will be three parts to this study.

- The first part will be a validation study in which participants will wear a heart rate monitor (in order to identify periods of training) for one week and concurrently fill in the training diary.
- The second part will compare three different methods of completing the diary (paper, online and texting).
- The third part will compare three different completion protocols based on three different recall times (daily, once every three days and once every week)

2.2 AIMS OF AND JUSTIFICATION FOR THE RESEARCH

Gaelic football is the most popular field sport in Ireland. It is played in all parts of the country by people from all socio-economic backgrounds and at standards that range from recreational to elite (intercounty). Training loads differ massively between levels, teams and age groups and this affects the nature and magnitude of the training effect. Therefore you need to quantify the training load in order to distinguish whether the athlete is adapting positively to the training load and so is optimizing their performance, or conversely is negatively adapting to the training load and so increasing their risk of injury. (Borresen and Lamber 2009) Injury is an inevitable consequence of participation in sport. However the risk of injury should be minimized in every way possible. This study aims to determine an effective measure of assessing training load in gaelic footballers for future use within the cohort to assess the effects of training load on injury rates.

At present the focus with regard to gaelic games injuries tends to be on elite inter-county players. We feel that it is important to address the needs of the ordinary club player in this regard, who constitute the vast majority of playing members of the Gaelic Athletic Association (GAA) and whose injuries present an enormous financial challenge to the association.

Our proposal is to recruit gaelic football players from three differing age groups i.e. Under-18 players, university level players and adult players. Participants will be from both genders.

2.3 PROPOSED METHOD

There will be four main components of the study, namely

a. Recruitment
b. Development of the Training Diary
c. Validation study
d. Training diary assessment

A. RECRUITMENT

Participants in this study will be recruited from GAA clubs located in the Northside, convenient to DCU. The recruitment process will begin with a **letter to the club secretary** explaining the proposed cohort study and asking for the club to co-operate with the study in principle. This letter in draft form is attached (**appendix 1**) If this agreement is forthcoming the next step will be to send **a letter to parents** of all male and female players in the club who will be playing u-14 and minor (u-18) football in the club in 2010, explaining to purpose of the project and what it would involve for them and their children and inviting them to attend a meeting in the club house at which the project would be discussed in detail and all questions would be answered. This draft letter is attached **(appendix 2).** The aim for the study would be to recruit 50 people for the validation study and 100 people for the effectiveness of the training diaries study.

B. DEVELOPMENT OF TRAINING DIARY

We will develop a training diary specific for Gaelic football that will assess the type, frequency, duration and intensity of exercise. It will inquire about the travel time to training, the surface played on and the type of footwear worn by the participant. We will aim to have a training diary that is visually appealing and easy to use.

C. VALIDATION STUDY

The validation study will involve participants wearing a heart rate monitor around their chests for 7 days. During this time the participants will fill in the training diary daily. This will allow us to capture objective information on their training which can then be compared to the training data they report to us through the training diary. From this we can compare the two results and decipher if training diaries are an accurate method of assessing training load.

D. TRAINING DIARY ASSESSMENT

Participants will then be asked to keep a training diary over a period of 6 weeks. The effectiveness of the training diary will be assessed by keeping records of the response rates. This diary is easy to complete and is attached (see **appendix 4**). The study twill compare a number of different methods of utilising a training diary i.e.

1) The Mode of the Training Diary – paper version, online version, text message version
2) The Timing of completing the Training Diary – daily, every three days, weekly

The study will also look at a number of different factors that could affect the use of the training diary i.e.

1) The age group – Under-18, university level, adult level
2) The level of play – elite, non elite
3) Gender – male, female.

2.4 PARTICIPANT PROFILE

The participants who will be recruited for this study will be gaelic footballers of all levels. They will be both male and female aged 14-30 years. The target recruitment is 150 participants. Who will be recruited from within DCU's GAA teams and also from local community GAA clubs.

2.5 MEANS BY WHICH PARTICIPANTS ARE TO BE RECRUITED

Participants will be recruited from local GAA clubs, as detailed in the Sectioin 2.3.A (method) above..

2.6 PLEASE EXPLAIN WHEN, HOW, WHERE, AND TO WHOM RESULTS WILL BE DISSEMINATED, INCLUDING WHETHER PARTICIPANTS WILL BE PROVIDED WITH ANY INFORMATION AS TO THE FINDINGS OR OUTCOMES OF THE PROJECT*?*

Subjects will be provided with a report, which will summarise the relevant results from their participation in the research project. The results will form the basis for a postgraduate thesis and may be presented at scientific meetings and published in a scientific journal. The identity of individual subjects will not be divulged and will only be presented as part of a group.

2.7 OTHER APPROVALS REQUIRED *Has permission to gain access to another location, organisation etc. been obtained? Copies of letters of approval to be provided when available.*

☐ YES ☐ NO ✓ NOT APPLICABLE

2.8.1 HAS A SIMILAR PROPOSAL BEEN PREVIOUSLY APPROVED BY THE REC?

☐ YES ✓ NO

3. RISK AND RISK MANAGEMENT

3.1 ARE THE RISKS TO SUBJECTS AND/OR RESEARCHERS ASSOCIATED WITH YOUR PROJECT GREATER THAN THOSE ENCOUNTERED IN EVERYDAY LIFE?

☐ YES ✓ NO

3.2 DOES THE RESEARCH INVOLVE:

	YES	NO
• use of a questionnaire? (attach copy)?	✓	
• interviews (attach interview questions)?	☐	✓
• observation of participants without their knowledge?	☐	✓
• participant observation (provide details in section 2)?		
• audio- or video-taping interviewees or events?		
• access to personal and/or confidential data (including student, patient or client data) without the participant's specific consent?	☐	✓
• administration of any stimuli, tasks, investigations or procedures which may be experienced by participants as physically or mentally painful, stressful or unpleasant during or after the research process?	☐	✓
• performance of any acts which might diminish the self-esteem of participants or cause them to experience embarrassment, regret or depression?	☐	✓
• investigation of participants involved in illegal activities?	☐	✓
• procedures that involve deception of participants?	☐	✓
• administration of any substance or agent?	☐	✓
• use of non-treatment of placebo control conditions?	☐	✓
• collection of body tissues or fluid samples?	☐	✓
• collection and/or testing of DNA samples?	☐	✓
• participation in a clinical trial?	☐	✓
• administration of ionising radiation to participants?	☐	✓

3.3 POTENTIAL RISKS TO PARTICIPANTS AND RISK MANAGEMENT PROCEDURES

The participants of the study will be underage gaelic footballers, university standard gaelic footballers and club standard gaelic footballers. The potential risks of this study will be no greater than the risks involved in the players normal playing sessions.

The School of Health and Human Performance has the facilities to deal with all aspects of this study and an emergency plan is in place for adverse events. All minor injuries will be addressed by an individual trained in first aid (either a member of the research team or the staff). In the

unlikely event of a serious adverse outcome, the subject will be brought to the VHI clinic on campus.

Siobhán O Connor who is the second investigator in the study is qualified in First Aid.

3.4 ARE THERE LIKELY TO BE ANY BENEFITS (DIRECT OR INDIRECT) TO PARTICIPANTS FROM THIS RESEARCH?

✓ YES ☐ NO

There are potential benefits to all of the players participating in the study as they will be keeping note of their training load and can refe back on what training they have completed to assess whether they ar training effectively. This can improve their performance or reduce thei risk of injury.

3.5 ARE THERE ANY SPECIFIC RISKS TO RESEARCHERS?

☐ YES ✓ NO

3.6 ADVERSE/UNEXPECTED OUTCOMES

The School of Health and Human Performance has the facilities to deal with all aspects of this study and an emergency plan is in place for adverse events. All minor injuries will be addressed by an individual trained in first aid (either a member of the research team or the staff). In the unlikely event of a serious adverse outcome, the subject will be brought to the VHI clinic on campus.

3.7 MONITORING

The research team have weekly meetings to update on all aspects of the study. The School of Health and Human Performance has a detailed list of Standard Operating Procedures for each of the protocols in this study. All researchers, including students, must be familiar with the procedures and the Safety Statement before beginning data collection.

3.8 SUPPORT FOR PARTICIPANTS

I do not anticipate the need for additional support for participants involved in this research project.

3.9 DO YOU PROPOSE TO OFFER PAYMENTS OR INCENTIVES TO PARTICIPANTS?

☐ YES ✓ NO

4. INVESTIGATORS' QUALIFICATIONS, EXPERIENCE AND SKILLS *(Approx. 200 words)*

Dr. Noel Mc Caffrey is a lecturer at the School of Health and Human Performance and a Sports and Exercise Medicine Physician. He has supervised numerous undergraduate and post graduate projects.

Ms Siobhan O Connor is a postgraduate student at the School of Health and Human Performance.

5. CONFIDENTIALITY/ANONYMITY

5.1 WILL THE IDENTITY OF THE PARTICIPANTS BE PROTECTED?

✓ YES ☐ NO

IF YOU ANSWERED YES TO 5.1, PLEASE ANSWER THE FOLLOWING QUESTIONS:

5.2 HOW WILL THE ANONYMITY OF THE PARTICIPANTS BE RESPECTED?

Confidentiality is an important issue during data collection. Participant's identity, or other personal information, will not be revealed or published. Subjects will be assigned an ID number under which all personal information will be stored in a secure file and saved in password protected file in a computer at DCU. The investigators alone will have access to the data.

5.3 LEGAL LIMITATIONS TO DATA CONFIDENTIALITY: *(Have you included appropriate information in the plain language statement and consent form?)*

✓ YES ☐ NO *(If NO, please advise how participants will be advised.)*

6 DATA/SAMPLE STORAGE, SECURITY AND DISPOSAL

6.1 HOW WILL THE DATA/SAMPLES BE STORED? *(The REC recommends that all data be stored on campus)*

Stored at DCU ✓
Stored at another site ☐ **(***Please explain where and for what purpose)*

6.2 WHO WILL HAVE ACCESS TO DATA/SAMPLES?

Access by named researchers only ✓

Access by people other than named researcher(s) ☐ **(***Please explain who and for what purpose)*
Other *:* ☐ **(***Please explain)*

6.3 IF DATA/SAMPLES ARE TO BE DISPOSED OF, PLEASE EXPLAIN HOW, WHEN AND BY WHOM THIS WILL BE DONE?

Data will be stored for 12-months following the completion of the project, in line with University regulations for examinations. The data will be destroyed by the principal investigator.

7. FUNDING

7.1 HOW IS THIS WORK BEING FUNDED?

Siobhan O'Connor is funded for a Masters programme by the DCU Sports Academy and the School of Health and Human Performance

7.2 PROJECT GRANT NUMBER (If relevant and/or known)

Not Applicable

7.3 DOES THE PROJECT REQUIRE APPROVAL BEFORE CONSIDERATION FOR FUNDING BY A GRANTING BODY?

Not Applicable

7.4 HOW WILL PARTICIPANTS BE INFORMED OF THE SOURCE OF THE FUNDING?

Not Applicable

7.5 DO ANY OF THE RESEARCHERS, SUPERVISORS OR FUNDERS OF THIS PROJECT HAVE A PERSONAL, FINANCIAL OR COMMERCIAL INTEREST IN ITS OUTCOME THAT MIGHT COMPROMISE THE INDEPENDENCE AND INTEGRITY OF THE RESEARCH, OR BIAS THE CONDUCT OR RESULTS OF THE RESEARCH, OR UNDULY DELAY OR OTHERWISE AFFECT THEIR PUBLICATION?

YES ✓ NO *(If Yes, please specify how this conflict of interest will be addressed.)*

8. PLAIN LANGUAGE STATEMENT *(Approx. 400 words – see Guidelines)*

Project Title: **The Development, Validity and Efficacy of different modes of Self Recall Training Diaries in assessing training load on Gaelic Footballers**.

This study will be undertaken at the School of Health and human Performance at DCU. The principal investigator is Dr Noel Mc Caffrey who may be contacted at 017008187 (phone) or noel.mccaffrey@dcu.ie

The second investigator in the study is Siobhán O Connor who may be contacted at 0861639016 or siobhan.oconnor27@mail.dcu.ie

The aim of this study is to gather information about the most effective and accurate method of assessing training load in a large group of gaelic footballers. It is hoped that information from this study could be used in a cohort study to assess if training load increases the risk of injury in gaelic football. The study requests you/your child to keep a training diary, detailing every type of exercise he/she does every day. We will ask you to submit this to us using either the online, paper or text message method. Some participants in the study will be reminded to complete the training diary using either an email or text message reminder. You/your child will be asked to submit this training diary daily, every three days or weekly depending on what category you are placed in.

.

Potential Risks to Participants from Involvement in the Research Study (if greater than that encountered in everyday life)
There are no added potential risks to participants from involvement in the research study than would be encountered in everyday gaelic football (training or games).

Benefits (Direct or Indirect) to Participants from Involvement in the Research Study
There are potential benefits to all players participating in the study as they will be keeping record of a large amount of information on their training level. This can be viewed by the participant and so could help identify whether they are training optimally to improve performance or are they training to a level which could increase their risk of injury.

Advice as to Arrangements to be made to Protect Confidentiality of Data, Including that Confidentiality of Information Provided is Subject to Legal Limitations
Confidentiality is an important issue during data collection. Participant's identity, or other personal information will not be revealed or published. Subjects will be assigned an ID number under which all personal information will be stored in a secure file and saved in a password protected file in a computer at DCU. The investigators alone will have access to the data. However, confidentiality of information provided can only be protected within the limitations of the law. It is possible for data to be subject to subpoena, freedom of information claim or mandated reporting by some profession.

Advice as to whether or not Data is to be Destroyed after a minimum period
Data will be stored for twelve months following the completion of the project, in line with University regulations for examinations. The principal investigator will destroy this data.

Statement that Involvement in the Research Study is Voluntary
Involvement within this research project is purely voluntary. Participants wishing to withdraw from the study at any stage throughout are entitled to do so. There will be no penalty enforced on any subjects wishing to quit the Research Study prior to all stages being completed.

Any other Relevant Information

If participants have any concerns about this study and wish to contact an independent person, please contact:
The Secretary, Dublin City University Research Ethics Committee, c/o Office of the Vice-President for Research, Dublin City University, Dublin 9. Tel: 017008000

9. CONSENT FORM

Project Title: **Epidemiology of Injuries in Club Level Gaelic Football**

The principal investigators are Dr Noel Mc Caffrey 017008187 (phone) or noel.mccaffrey@dcu.ie

I have been asked to allow my son / daughter to participate in this research project. I am aware the project aims to investigate the most effective method of assessing training load in gaelic footballers. I have discussed the project with Dr McCaffrey and also with my son / daughter. Based on this I am satisfied to allow him/her to participate in the study

I understand that I must assist my son/daughter to document certain information about their participation in training every week. I have viewed the training diary and understand the information it asks.

I understand that my child's participation is entirely voluntary. He/she can withdraw from the study at any time without penalty. Within the provisions of Irish law his/her data will at all times be confidential. His/her name will not be revealed but the summary data may be presented and discussed at scientific meetings and may be published in a scientific journal

Signature:

The researchers have answered my questions and concerns, and I have a copy of this consent form. They have discussed the project with my child in my presence. My child understands what is involved and is willing to participate. Therefore, I (print name) _____ consent to allow my child (print name)_____ _____to take part in this research project.

Signature of Parent / Guardian:

_____

Name of Parent / Guardian Block Capitals _____ _____

Witness: _____

Date: _____

Assent by Child

I understand what is involved in this project. It has been exp,lained to me by the research team and by my parents. I agree to take part

Name of Child _____

SIGNATURE _____ **DATE**_____

WITNESS _____

Project Title: **The Deve**lopment, Validity and Efficacy of different modes of Self Recall Training Diaries in assessing training load on Gaelic Footballers.

The principal investigators are Dr Noel Mc Caffrey 017008187 (phone) or noel.mccaffrey@dcu.ie

I have been asked to participate in this research project. I am aware the project aims to investigate the most effective method of assessing training load in gaelic footballers. I have discussed the project with Dr McCaffrey and based on this I would like to participate in this study.

I understand that I must document certain information about my participation in training every week. I have viewed the training diary and understand the information it asks.

I understand that my participation is entirely voluntary and I can withdraw from the study at any time without penalty. Within the provisions of Irish law my data will at all times be confidential. My name will not be revealed but the summary data may be presented and discussed at scientific meetings and may be published in a scientific journal

I understand what is involved in this project. It has been explained to me by the research team. I agree to take part

NAME _____

SIGNATURE _____ **DATE**_____

WITNESS _____

Please check that all supplementary information is attached to your application (in both hard and soft copy). If questionnaire or interview questions are submitted in draft form, a copy of the final documentation must be submitted for final approval when available.

	ATTACHED		**NOT APPLICABLE**
Bibliography	✓		☐
Recruitment advertisement	✓		☐
Plain language statement/Information Statement	✓		☐
Informed Consent form	✓		☐
Evidence of external approvals related to the research	☐		✓
Questionnaire	✓	☐ final	
Interview Schedule	☐ draft	☐ final	✓
Debriefing material	☐		✓
Other	☐		✓

Bibliography

Appendix E

Plain Language Statement

Project Title:

The Development, Validity and Efficacy of different modes of Self Recall Training Diaries in assessing training load on Gaelic Footballers.

This study will be undertaken at the School of Health and Human Performance at DCU. The principal investigator is Dr Noel McCaffrey who may be contacted at 017008187 (phone) or noel.mccaffrey@dcu.ie

The second investigator in the study is Siobhán O Connor who may be contacted at 0861639016 or siobhan.oconnor27@mail.dcu.ie

The aim of this study is to gather information about the most effective and accurate way of assessing training load in a large group of gaelic footballers. It is hoped that information from this study could be used in a cohort (or larger and more long term) study to assess if training load increases the risk of injury in Gaelic football.

The study requests you/your child to keep a training diary, detailing every type of exercise he/she does every day. We will ask you to submit this to us using either the online or paper method. Some participants in the study will be reminded to complete the training diary using either an email or text message reminder.

You/your child will be asked to submit this training diary daily.

.

Appendix F

Informed Consent

Project Title:

The Development, Validity and Efficacy of different modes of Self Recall Training Diaries in assessing training load on Gaelic Footballers

The principal investigators are Dr Noel McCaffrey 017008187 (phone) or noel.mccaffrey@dcu.ie

I have been asked to participate in this research project. I am aware the project aims to investigate the most effective method of assessing training load in Gaelic footballers. I have discussed the project with Dr McCaffrey. Based on this I am satisfied to participate in the study

I understand that I must document certain information about my participation in training every week. I have viewed the training diary and understand the information it asks.

I understand that my participation is entirely voluntary and that I can withdraw from the study at any time without penalty. Within the provisions of Irish law my data will at all times be confidential. My name will not be revealed but the summary data may be presented and discussed at scientific meetings and may be published in a scientific journal

Signature:

The researchers have discussed the project with me and answered my questions and concerns. I have a copy of this consent form. I understand what is involved and I am willing to participate. Therefore, I consent to take part in this research project.

Name: _____

Signature: _____

Witness: _____

Date: _____

Appendix G

Project Title:

The Development, Validity and Efficacy of different modes of Self -Recall Training Diaries in assessing training load on Gaelic Footballers

The principal investigators are Dr Noel McCaffrey 017008187 (phone) or noel.mccaffrey@dcu.ie. The second investigator is Siobhán O Connor 0861639016 or siobhan.oconnor27@mail.dcu.ie

I have been asked to allow my son / daughter to participate in this research project. I am aware the project aims to investigate the most effective method of assessing training load in gaelic footballers. I have discussed the project with Dr McCaffrey and also with my son / daughter. Based on this I am satisfied to allow him/her to participate in the study

I understand that I must assist my son/daughter to document certain information about their participation in training every week. I have viewed the training diary and understand the information it asks.

I understand that my child's participation is entirely voluntary. He/she can withdraw from the study at any time without penalty. Within the provisions of Irish law his/her data will at all times be confidential. His/her name will not be revealed but the summary data may be presented and discussed at scientific meetings and may be published in a scientific journal

Signature:

The researchers have answered my questions and concerns, and I have a copy of this consent form. They have discussed the project with my child in my presence. My child understands what is involved and is willing to participate. Therefore, I (print name) _____ consent to allow my child (print name)_____ _____to take part in this research project.

Signature of Parent / Guardian: _____

Name of Parent / Guardian Block Capitals _____

Witness: _____

Date: _____

Assent by Child

I understand what is involved in this project. It has been explained to me by the research team and by my parents. I agree to take part

Name of Child _____

SIGNATURE _____ DATE_____

WITNESS _____

Appendix H

Questionnaire – Pilot Study

1) How long did the diary take to complete? _____

2) Were the questions easy to understand?
Yes ____ No _____

3) If not, what questions were difficult to understand and why? _____
_____
____

4) Were there any questions missing in the Training Diary that you would like to be included?
_____
_____
___

Appendix I

The Borg CR-10 Scale

rating	description
0	NOTHING AT ALL
0.5	VERY, VERY LIGHT
1	VERY LIGHT
2	FAIRLY LIGHT
3	MODERATE
4	SOMEWHAT HARD
5	HARD
6	
7	VERY HARD
8	
9	
10	VERY VERY HARD (MAXIMAL)

Appendix J

Questionnaire (Method of Filling out Training diary)

1) Which method of filling out the Training Diary (Paper/Online) did you prefer?
   Online _____ Paper _____
   Why?
   _____

2) Which method of filling out the Training Diary (Paper/Online) was easiest to access?
   Online _____ Paper _____
   Why?
   _____
   _____
   __

3) Which method of filling out the Training Diary (Paper/Online) was easiest to fill out?
   Online _____ Paper _____
   Why?
   _____
   _____
   ____

4) Which method of filling out the Training Diary (Paper/Online) was easiest to return to the researchers?
   Online _____ Paper _____
   Why?
   _____
   _____
   ____

5) Which method of filling out the Training Diary (Paper/Online) would you like to use if you were using the Training Diary with your team in the future?
   Online_____ Paper_____
   Why?
   _____
   _____
   ____

Appendix K

Questionnaire (Reminders)

1) Do you think a reminder is helpful in reminding you to fill in your Training Diary?
   Yes_____ No _____

2) Which reminder did you find most helpful and practical in reminding you to fill in your Training Diary?
   Text _____ Email _____ None_____

3) What time of the day would you prefer to receive your Training Diary reminder?
   Morning _____
   Afternoon _____
   Evening _____
   Night _____

4) If you were to receive a reminder to fill in your Training Diary in the future with your team, which method of reminder would you prefer to receive?
   Text_____ Email _____None_____

-