The Fit-4-Fun Study:
Promoting physical activity and physical fitness in primary school-aged children

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MEd, The University of New England

Thesis submitted in fulfilment of the requirements for the award of the degree of

Doctor of Philosophy
The University of Newcastle
April 2014
Statement of Originality

The thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to the final version of my thesis being made available worldwide when deposited in the University’s Digital Repository, subject to the provisions of the Copyright Act 1968.

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Date: 15/04/2014

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I, Professor Philip Morgan, attest that Research Higher Degree candidate Narelle Eather contributed substantially in terms of study concept and design, data collection and analysis, and preparation of the following manuscripts.

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Associate Professor David, R. Lubans Date: 15/04/2013


3. Eather, N., P.J. Morgan, and D.R. Lubans, Improving the fitness and physical activity levels of primary school children: Results of the Fit-4-Fun group randomized controlled trial. Preventive Medicine, 2013. 56(1): p. 12–19. (IF=3.2)

Disclosure of editing services

Professional editor, Dr. Guenter Plum from FunctionalEdit.com, provided proofreading services, according to the guidelines laid out in the university-endorsed national ‘Guidelines for editing research theses’. Dr. Plum’s editing services included fixing typographical, spelling and common grammatical errors; checking in-text references against list of references; checking numbering of tables and figures; and checking consistency in lay-out.
Acknowledgments

I am eternally grateful to the many people who have been involved in the completion of this thesis.

Firstly, to my co-supervisors, Professor Philip Morgan and Associate Professor David Lubans, you have been amazing. Over the past six years you have spent countless hours guiding me through my PhD, reviewing my work and inspiring me to be the best researcher, lecturer and physical educator that I can be. You have both displayed an unwavering confidence in my work and have always put my needs first. The level of commitment and dedication that you have shown as my supervisors and mentors is unparalleled, and very much appreciated. Thank you!

Secondly, I would like to thank the schools, the teachers and children for participating in the Fit-4-Fun study. Without their involvement, this research project would not have been possible.

Thirdly, I would like to thank the students and staff at The University of Newcastle for volunteering to assist with data collection and assessments in the Fit-4-Fun study. It has been a wonderful experience sharing my journey with my students and colleagues, and a great opportunity to create links and promote the innovative work that researchers are undertaking in the community.

Finally, I would like to thank my family for their endless support in all that I do. My parents, David and Vivienne, have always encouraged me to work hard and aim high in all facets of my life; My twin sister Megan, who is my best friend, has travelled with me on the highs and lows of this journey and helps me keep perspective; My brother Dean, a fellow physical educator; My husband Darryn who has suffered the most during the creation of this thesis and has taken the burden of my time commitments (study, work and sport) – and still supports all that I do; and My two beautiful girls Chloe and Emily, who mean the world to me and give me the motivation to take on life’s challenges each and every day.
Publications

The following peer reviewed publications and presentations have been produced as a result of the research conducted for this thesis. I am the lead author for all four primary papers and am co-author for the two secondary papers.

The four primary papers are presented sequentially and provide published details relating to the design, implementation, development and evaluation of the Fit-4-Fun program. The program was specifically developed to target areas of both public health and educational concern, as identified in the literature, and the findings presented in this thesis will contribute greatly to the limited literature regarding successful multi-component school-based physical activity and physical fitness education programs for primary school children.

Primary Publications


3. Eather, N., P.J. Morgan, and D.R. Lubans, Improving the fitness and physical activity levels of primary school children: Results of the Fit-4-Fun group randomized controlled trial. Preventive Medicine, 2012. 56(1): p. 12–19. (IF=3.2)

Secondary Publications

Two secondary papers have been included as appendices in this thesis. These papers directly relate to specific aspects of the Fit-4-Fun study (fitness testing and the health benefits of muscular fitness in children), and provide a unique contribution to the limited literature in these areas of research. My contribution to each of the papers has been outlined below.


My contribution to the above study involved conducting all physical fitness assessments and reviewing the manuscript at all stages of writing.


I am second author for the above systematic review and my contribution to this paper included: identifying and screening relevant articles, assessing articles for eligibility, assessing the risk of bias of each study, checking extracted data for accuracy, writing sections of the paper and reviewing the paper at all stages of writing / review.
Presentations – Refereed Conference Abstracts


### List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Term</th>
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<tbody>
<tr>
<td>BC</td>
<td>body composition</td>
</tr>
<tr>
<td>BMI</td>
<td>body mass index</td>
</tr>
<tr>
<td>BMI-Z</td>
<td>body mass index Z score</td>
</tr>
<tr>
<td>CRF</td>
<td>cardiorespiratory fitness</td>
</tr>
<tr>
<td>CVD</td>
<td>cardiovascular disease</td>
</tr>
<tr>
<td>HRF</td>
<td>health-related fitness</td>
</tr>
<tr>
<td>MF</td>
<td>muscular fitness</td>
</tr>
<tr>
<td>MVPA</td>
<td>moderate-vigorous physical activity</td>
</tr>
<tr>
<td>NCD</td>
<td>non-communicable disease</td>
</tr>
<tr>
<td>NSW</td>
<td>New South Wales</td>
</tr>
<tr>
<td>PA</td>
<td>physical activity</td>
</tr>
<tr>
<td>PDHPE</td>
<td>Personal Development, Health and Physical Education</td>
</tr>
<tr>
<td>PE</td>
<td>physical education</td>
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<tr>
<td>RCT</td>
<td>randomized controlled trial</td>
</tr>
<tr>
<td>sd</td>
<td>standard deviation</td>
</tr>
<tr>
<td>VO\textsubscript{2}Max.</td>
<td>maximum oxygen uptake</td>
</tr>
<tr>
<td>VPA</td>
<td>vigorous physical activity</td>
</tr>
<tr>
<td>WC</td>
<td>waist circumference</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
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<tr>
<td>20m SRT</td>
<td>20 metre Shuttle Run Test</td>
</tr>
<tr>
<td>SCT</td>
<td>Social Cognitive Theory</td>
</tr>
<tr>
<td>CMT</td>
<td>Competence Motivation Theory</td>
</tr>
<tr>
<td>HR</td>
<td>heart rate</td>
</tr>
<tr>
<td>PF</td>
<td>Physical fitness</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Physical activity</td>
<td>Physical activity is defined as: ‘...any body movement produced by the skeletal muscles and resulting in a substantial increase over the resting energy expenditure (p.11)’ [1], and includes four components: volume, intensity, frequency and type.</td>
</tr>
<tr>
<td>Cardiorespiratory fitness</td>
<td>Cardiorespiratory fitness is a direct indicator of an individual’s physiological status and reflects the overall capacity of the cardiovascular and respiratory system [2].</td>
</tr>
<tr>
<td>Vigorous physical activity</td>
<td>Vigorous physical activity in children has been defined as expending more than 7 Metabolic Equivalents (METs), or a minimum of 7.5 kilo cal/min, or working at a minimum of 70% of maximum heart rate, or 70% of VO₂max (e.g., running, sprinting, jumping, skipping) [3].</td>
</tr>
<tr>
<td>Moderate intensity physical activity</td>
<td>Moderate intensity physical activity has been defined as expending 3–4 METs, or approximately 5–7.5 kilo cals per min, or exercising at 60–70% of maximum heart rate, or at 60% of VO₂max (e.g., swimming, cycling, brisk walking) [3].</td>
</tr>
<tr>
<td>Body Composition</td>
<td>Body composition is the body’s relative amount of fat mass (e.g., adipose tissue, essential fats and non-essential fats) to fat-free mass (e.g., bone, water, muscle, and tissues) [4].</td>
</tr>
<tr>
<td>Muscular Fitness</td>
<td>Muscular strength and muscular endurance are health-related fitness components that are often combined and labelled ‘muscular fitness’. Generally defined, muscular strength is the ability to generate maximal force with a muscle or group of muscles; whereas, muscular endurance is the ability to perform repeated contractions with a muscle or group of muscles [5].</td>
</tr>
<tr>
<td>Child</td>
<td>In this thesis the term child refers to individuals aged 5-12 years.</td>
</tr>
<tr>
<td>Adolescent</td>
<td>In this thesis the term adolescent refers to individuals aged 13-18 years.</td>
</tr>
<tr>
<td>Mediator</td>
<td>A variable acting as a mediating agent and accounts for the relation between the predictor and the criterion [6].</td>
</tr>
</tbody>
</table>
### Table of Contents

Statement of Originality ................................................................................................................ ii

Supervisors .................................................................................................................................... ii

Statement of Authorship .............................................................................................................. iii

Statement of Contribution of Others ........................................................................................... iv

Acknowledgments ........................................................................................................................ vi

Publications ................................................................................................................................... vii

Presentations – Refereed Conference Abstracts ......................................................................... ix

List of Abbreviations ...................................................................................................................... x

Definitions .................................................................................................................................... xi

Table of Contents ........................................................................................................................ xii

List of Tables ................................................................................................................................ xvii

List of Figures ............................................................................................................................. xviii

Abstract ....................................................................................................................................... xix

Overview ........................................................................................................................................ 1

Chapter One Introduction ............................................................................................................. 3

1.1 Background and Context ..................................................................................................... 3

1.2 Limitations of Existing School-Based Physical Activity Interventions ......................... 5

1.3 Purpose of Study ................................................................................................................. 6

1.4 Research Questions ............................................................................................................. 6

1.5 Significance of Study............................................................................................................ 7

1.6 Thesis Structure ................................................................................................................... 8

Chapter Two The Importance of Physical Activity and Physical Fitness for Children........... 11

2.1 Physical Activity and Health .............................................................................................. 11

2.2 Physical Activity Recommendations .................................................................................. 13

2.3 Physical Activity Patterns of Children and Measurement Issues ................................... 14

2.4 Summary ............................................................................................................................. 18
2.5 Rationale for Promoting Physical Fitness in Children .............................................................. 19
2.6 Health-Related Physical Fitness and Health ............................................................................. 19
2.7 Assessment of Fitness Levels .................................................................................................. 23
2.8 Physical Fitness Levels of Children ........................................................................................ 24
2.9 Conclusion ............................................................................................................................... 27

Chapter Three The Role of the School and the Effect of School-based Interventions on Improving Physical Activity and Physical Fitness ......................................................... 29
3.1 Physical Activity Interventions ............................................................................................... 30
3.2 The Role of Schools in the Promotion of Physical Activity and Fitness ................................. 30
3.3 School-Based Physical Activity Interventions ........................................................................ 31
  3.3.1 The Effectiveness of Single Component School-Based Programs .................................. 38
  3.3.2 Physical Education Programs ......................................................................................... 40
  3.3.3 Recommendations for Developing Effective School-Based Physical Activity and Physical Fitness Interventions ......................................................................................... 44
3.4 Exploring Mechanisms of PA Behaviour Change in Children .................................................. 46
  3.4.1 Correlates of Physical Activity in Children ....................................................................... 46
  3.4.2 Mediators of Physical Activity in Children ....................................................................... 46
3.5 A Review of Key Theories ........................................................................................................ 48
  3.5.1 Social Cognitive Theory .................................................................................................. 49
  3.5.2 Competence Motivation Theory ...................................................................................... 52
  3.5.3 Health Promoting School Framework ............................................................................ 54
  3.5.4 Socio-Ecological Theory ............................................................................................... 56
3.6 Conclusions .............................................................................................................................. 58

Chapter Four Feasibility and preliminary efficacy of the Fit-4-Fun intervention for improving physical fitness in a sample of primary school children: A pilot study ........................................ 60
4.1 Abstract ................................................................................................................................... 61
4.2 Introduction ............................................................................................................................... 62
4.3 Methods / Design .................................................................................................................... 65
4.4 Results ..................................................................................................................................... 75
7.3 Methods .......................................................................................................................... 125
7.4 Results ............................................................................................................................. 136
7.5 Discussion ...................................................................................................................... 140
7.6 Conclusion ...................................................................................................................... 145
7.7 Financial disclosure ....................................................................................................... 146
7.8 Author contributions ..................................................................................................... 146
7.9 Competing interests ...................................................................................................... 146

Chapter Eight Discussion ................................................................................................. 147
8.1 Introduction ................................................................................................................... 147
8.2 Purpose of the study ...................................................................................................... 147
8.3 Fit-4-Fun Pilot Study ..................................................................................................... 147
8.4 The Fit-4-Fun Cluster Randomized Controlled Trial ..................................................... 150
8.5 Significance and Strengths .......................................................................................... 153
8.6 Limitations ..................................................................................................................... 155
8.7 Recommendations / Future Directions ........................................................................ 156
8.8 Future Research Directions for the Fit-4-Fun Program ................................................ 159
8.9 Conclusions .................................................................................................................. 161
8.10 Reference List .............................................................................................................. 162

Appendices ......................................................................................................................... 234
Appendix 1: Supervisors’ Acknowledgement of Contribution ........................................... 234
Appendix 2: Paper 5 ............................................................................................................. 235
Appendix 3: Paper 6 ............................................................................................................. 236
Appendix 4: Published Version Paper 1 ............................................................................ Error! Bookmark not defined.
Appendix 5: The University of Newcastle Ethics Approval .............................................. Error! Bookmark not defined.
Appendix 6: The Newcastle / Maitland Catholic Schools Ethics Approval Error! Bookmark not defined.
Appendix 7: Fit-4-Fun Principal / Teacher / Parent & Child Information Package .......... Error! Bookmark not defined.
Appendix 8: Fit-4-Fun Curriculum Program.................................. Error! Bookmark not defined.
Appendix 9: Fit-4-Fun Home Program........................................ Error! Bookmark not defined.
Appendix 10: Fit-4-Fun Break-time Program.............................. Error! Bookmark not defined.
Appendix 11: Fit-4-Fun Incentive Scheme.................................. Error! Bookmark not defined.
Appendix 12: Fit-4-Fun Assessment Protocols ......................... Error! Bookmark not defined.
Appendix 13: Fit-4-Fun Questionnaires.................................... Error! Bookmark not defined.
Appendix 14: Published Version Paper 2................................ Error! Bookmark not defined.
Appendix 15: Published Version Paper 3................................ Error! Bookmark not defined.
Appendix 16: Published Version Paper 4................................ Error! Bookmark not defined.
List of Tables

Table 2.1: Proportion of children and adolescents meeting physical activity recommendations ................................................................. 16

Table 2.2: Fitness Levels and Trends of Children and Adolescents ......................................................... 25

Table 3.1: Findings from recent school-based physical activity and physical fitness interventions .................................................................................................................. 33

Table 3.2: Reviews of Physical Activity Interventions Targeting Children and Adolescents (since 2000) .................................................................................................................... 36

Table 3.3: Reported correlates of physical activity for children and adolescents ......................... 47

Table 3.4: Key concepts of Social Cognitive Theory ....................................................................................... 50

Table 4.1: 'Fit-4-Fun' program content and alignment with theoretical constructs .................. 68

Table 4.2: Baseline demographic data of participants in the control and intervention groups (Australia, March 2010) ................................................................................................................. 76

Table 4.3: Participants Health-Related Fitness scores at baseline and 10-week follow-up and ANCOVA results and effect sizes for HRF and PA measures (Australia, April – June, 2010) .......................................................................................................................................................................................................................................................................................................................... 79

Table 5.1: 'Fit-4-Fun' program content and alignment with theoretical constructs ................... 92

Table 6.1: 'Fit-4-Fun' Program components (Australia, 2011) ................................................................. 109

Table 6.2: Baseline demographic data, health-related fitness and physical activity scores (Australia, April 2011) ................................................................................................................................................................. 112

Table 6.3: Fit-4-Fun Study intervention effects (Australia, 2011) ................................................................. 114

Table 6.4: Overall participant satisfaction for the Fit-4-Fun Program (Australia, 2011) ....... 115

Table 7.1: 'Fit-4-Fun' program content and alignment with theoretical .............................................. 127

Table 7.2: Description and psychometric properties of hypothesized mediator scales ....... 135

Table 7.3: Action theory test, conceptual theory test and significance of the mediated effect on physical activity (step count) – Baseline to 3-months (April – June, 2011) and baseline to 6-months (April – December, 2011) Australia .................................................................................................................................................................................................................................................................................................................. 139
List of Figures

Figure 2.1: Structure of Chapter Two ................................................................. 11
Figure 2.2: Health-related fitness components .................................................... 19
Figure 3.1: Structure of Chapter Three ............................................................... 29
Figure 3.2: Reciprocal determinism ................................................................. 49
Figure 3.3: Bandura’s structural paths of influence on health-promoting behaviour [475] . 51
Figure 3.4: Harter’s Competence Motivation Theory Model (adapted for the physical domain by Weiss 2000 [429]) ................................................................. 53
Figure 3.5: Health Promoting Schools Framework ............................................. 56
Figure 3.6: Levels of influence in the Socio-Ecological Model ......................... 58
Figure 4.1: Flow of participants through the Fit-4-Fun study (Australia, 2010) .... 67
Figure 5.1: Flow of participants through the Fit-4-Fun ........................................ 90
Figure 6.1: Flow of participants through the Fit-4-Fun trial (Australia, 2011) ....... 113
Figure 7.1: Mediation analysis overview ............................................................ 134
Abstract

Physical fitness is an important predictor of physical and psychological health in children and adolescents, yet evidence confirms that a large proportion of children are unfit and do not participate in physical activity of sufficient volume and intensity to accrue the associated health benefits. Given that children’s fitness levels also decline with age, there is an urgent need to develop and evaluate interventions that promote high intensity physical activity, that are appealing to children and adolescents and contribute to the development and maintenance of high levels of physical fitness.

Objective

The primary aim of this thesis was to evaluate an eight-week school-based physical fitness education intervention (Fit-4-Fun) for improving the physical activity and physical fitness levels of Grades 5 and 6 primary school children. The secondary aim of this thesis was to explore potential mediators of physical activity in the Fit-4-Fun program.

Methods

Study type and participants

1) In 2010, a pilot randomized controlled trial (RCT) with a three-month wait-list control group was conducted in two primary schools, in the Hunter Region, NSW, Australia. Children from Grades 5 and 6 were recruited for the studies (n = 49; mean age 10.9 years ± 0.7) and were randomized by school into the Fit-4-Fun intervention (n = 32) or the control (n = 17) conditions.

2) In 2011, a cluster RCT with a six-month wait-list control group was conducted in four primary schools in the Hunter Region, NSW, Australia. Children from Grades 5 and 6 were recruited for the studies (n = 213; mean age = 10.72 years ± 0.6) and were randomized by school into the Fit-4-Fun intervention (n = 118 students) or the control (n = 95) conditions.

Treatment conditions

The Fit-4-Fun intervention was a theoretically grounded eight-week physical fitness education program that included: 8 x 60 min Health and Physical Education (HPE) lessons (theory and practical – replacing the existing HPE program), a daily break-time activity program (recess and lunch) and a home fitness program. The control group participated in their usual weekly 60min health and physical education lesson.
Measures and statistical analysis

1) In the pilot study, assessments were taken at baseline and immediate post-intervention to determine changes in health-related fitness levels (cardiorespiratory fitness, muscular fitness, flexibility, and body composition), physical activity and changes in constructs from Social Cognitive Theory and Competence Motivation Theory. Intervention effects in the pilot study were assessed using analysis of covariance (ANCOVA).

2) In the cluster RCT, assessments were taken at baseline, immediate post-intervention and at six-months to determine changes in health-related fitness levels, physical activity and changes in constructs from Social Cognitive Theory and Competence Motivation Theory. Intervention effects were assessed using linear mixed models and mediation analysis was conducted using Preacher and Hayes’ multiple mediation regression SPSS macro.

Process evaluation measures of recruitment, retention, adherence and satisfaction were also assessed in both trials to determine program feasibility.

Results

Pilot RCT: children in the intervention group improved in all health-related fitness measures with significant group x time effects ($p < .05$) observed in the seven-stage sit-up test ($d = 0.9$), the sit and reach tests (right leg $d = 1.0$, left leg $d = 0.9$, both legs $d = 1.1$) and the wall squat tests (right leg $d = 0.9$, left leg $d = 0.6$). No significant group x time effect was found in the beep test, basketball throw, physical activity measure or psychological measures. Process evaluation findings demonstrated high levels of recruitment, retention, adherence and satisfaction. Minor changes were made to the home activity program and program components based on feedback provided by participants and process evaluation results.

Cluster RCT: After six-months, significant treatment effects were found for cardiorespiratory fitness (20mSRT adjusted mean difference, 1.14 levels, 95% CI = 0.74 to 1.55 $p < 0.001$), body composition (BMI adjusted mean difference -0.96 kg/m², 95% CI = -1.42 to -0.5, $p < 0.001$ and BMI-Z adjusted mean difference -0.47 Z-scores, 95% CI = -0.70 to -.25, $p < 0.001$), flexibility (sit and reach adjusted mean difference 1.52cm, 95% CI = -0.65 to 3.68, $p = 0.0013$), muscular fitness (sit-ups) (adjusted mean difference 0.62 stages, 95% CI = -0.97 to -0.27, $p = 0.003$) and physical activity (mean, 3253 steps/day, 95% CI = 1776 to 4730, $p < 0.001$). There were no significant treatment effects for three of the muscular fitness measures.

Mediation Analysis: Teacher social support was found to have a significant mediating effect on physical activity in the cluster RCT (AB = 445, 95% CI = 77 to 1068 steps, proportion = 13%).
and perceived school environment approached significance (AB = 434, 95% CI = -415 to 1507 steps, proportion = 13%). The targeted constructs of enjoyment, social support from parents and friends, and self-efficacy did not meet the criteria for mediation.

**Process Evaluation:** Measures of recruitment, retention, adherence and satisfaction were very high. In both trials all invited schools’ principals and teachers agreed to participate in the Fit-4-Fun study.

1) In the pilot RCT, 85.7% of children invited to participate in the trial gained informed consent, all program sessions were delivered and 94% of participants were retained in follow-up assessments. Scores for the evaluation surveys ranged from 4.63 to 5.62 of a possible 6 for the 14 items in the evaluation survey, implying high-to-very high satisfaction rates for the Fit-4-Fun program.

2) In the cluster RCT, 93.8% of the 226 eligible participants completed all baseline assessments, 86.7% completed the 10-week follow-up measures and 90.7% completed the six-month assessments. All eight curriculum sessions were presented at the treatment schools with an attendance rate of 94% and mean scores for the evaluation survey categories ranged from 4.29 to 5.33 of a possible 6 for the 14 items in the evaluation survey – also indicating high to very high overall satisfaction rates for the Fit-4-Fun program.

In both trials, students reported difficulties with adhering to the home component which relied on parent/family involvement in the program with a mean score of 2.84 (pilot RCT) and 3.33 (cluster RCT) of a possible 6 for perceived parental and family involvement.

**Conclusion**

A multi-component, curriculum-based health-related fitness intervention for primary school children that targeted the three areas of a health promoting school and targeted teacher social support for participation in physical fitness activities is feasible and efficacious in improving health-related fitness and physical activity levels in children.
Overview

Fit-4-Fun study

The Fit-4-Fun program is a novel intervention purposely designed, implemented and evaluated as a PhD study. The program was specifically developed to target areas of both public health and educational concern, as identified in the literature. An outline of the contribution that I, Narelle Eather, made to the Fit-4-Fun study is outlined below.

Program design and development

I was responsible for the design and development of the entire Fit-4-Fun program. This included designing all program components (including program sessions, student and staff resources, and presentations), and amending specific program components for the RCT based on participant feedback and the results of the pilot study.

Ethics and safety approval

I was responsible for gaining ethics approval from the University of Newcastle and the Newcastle–Maitland Catholic Schools Office, for registering the trial with the Australian New Zealand Clinical Trial Registry (ACTRN12611000976987), and for completing all related safety and child protection procedures relating to the implementation of both trials in the primary school setting. This included: developing a study proposal and justification, completing all ethics forms, developing information statements and consent forms for teachers, parents, children and school Principals, developing assessment protocols and forms for all physical assessments, developing the student and staff questionnaires and evaluation surveys, and ensuring all mandated child protection checks were completed for research staff.

Measurement of study outcomes, data collection and entry

In correspondence with my supervisors, appropriate outcome measures were decided upon. I was wholly responsible for training more than 70 volunteer research assistants in conducting the physical fitness tests, organising assessment sessions (including ordering and organising all equipment and scheduling sessions in the school) and supervising research assistants during all assessment sessions. The research assistants recorded participants’ results and I was responsible for entering the data onto the computer and for the safe handling of all confidential participant information.
**Intervention delivery**

I was entirely responsible for delivering all program sessions at all intervention schools in both the pilot and RCT of the Fit-4-Fun study. This included face-to-face delivery of the program sessions (56 sessions in total) and associated organisation of tasks and resources.

**Analysis of data**

In correspondence with my supervisors, the methods of statistical analysis were decided upon and I completed all analyses using appropriate computer software (SPSS and SAS Statistical Packages), interpreted the results and presented the data in either text, table or figure formats.

**Acquiring funding**

I was responsible for applying for grants related to the Fit-4-Fun study. This included two successful grants from Sports Medicine Australia and the Priority Research Centre in Physical Activity and Nutrition at the University of Newcastle.

**Presenting study results at conferences**

I was responsible for presenting the findings of the Fit-4-Fun study (both oral and / or poster presentations) at several conferences (local and international) and in the University Three-Minute Thesis competition (see page ix for full details).