Evaluation of a School-based Physical Activity and Fundamental Movement Skill Intervention for Children Living in Low-income Communities: The Supporting Children’s Outcomes using Rewards, Exercise and Skills (SCORES) Cluster Randomised Controlled Trial

Kristen Emilie Cohen (nee Weaver)

University of Newcastle, Australia
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Kristen Emilie Cohen (nee Weaver)

B Teaching (Secondary) / B Health and Physical Education (Hons)

University of Newcastle, Australia

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

Doctor of Philosophy

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Statement of Originality

This 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.

Signed: ________________________________

Name: Kristen Emilie Cohen (nee Weaver)

Date: 22/12/2015
Thesis by Publication

I hereby certify that this thesis is in the form of a series of published papers of which I am a joint author. I have included as part of this thesis a written statement from each co-author, endorsed by the Faculty Assistant Dean (Research Training), attesting to my contribution to the joint publications.

Signed: __________________________

Name: Kristen Emilie Cohen (nee Weaver)

Date: 22/12/2015
Supervisors

**Primary supervisor**

Professor David Lubans  
Priority Research Centre for Physical Activity and Nutrition  
School of Education  
Faculty of Education & Arts  
University of Newcastle, Australia

**Co-supervisors**

Professor Philip Morgan  
Priority Research Centre for Physical Activity and Nutrition  
School of Education  
Faculty of Education & Arts  
University of Newcastle, Australia

Professor Ronald Plotnikoff  
Priority Research Centre for Physical Activity and Nutrition  
School of Education  
Faculty of Education & Arts  
University of Newcastle, Australia
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Publications arising from this thesis

This thesis is presented as a series of six papers. I am the lead author on four papers and am co-author for two papers. At the time of submission, five of these papers were published and one was under review.

Manuscripts in peer-reviewed journals: Published


**Manuscripts in peer-reviewed journals: Under review**

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**Additional Publications Co-authored During Candidature**

**Manuscripts in peer-reviewed journals: Accepted for publication**

Presentations arising from this thesis

I presented results arising from this thesis at two international and two national conferences (three oral presentations; one poster presentation). Co-authors presented results arising from this thesis at one international and one national conference (two oral presentations).

Presentations: Refereed Conference Abstracts


# Table of Contents

Statement of Originality ................................................................................................................... ii  
Thesis by Publication ........................................................................................................................... iii  
Supervisors ........................................................................................................................................ iv  
Acknowledgements ............................................................................................................................... v  
Publications arising from this thesis .................................................................................................. vi  
Presentations arising from this thesis ................................................................................................. viii  
Table of Contents ............................................................................................................................... x  
List of Tables ..................................................................................................................................... xvii  
List of Figures ................................................................................................................................... xix  
List of Abbreviations .......................................................................................................................... xxi  
Definitions ........................................................................................................................................ xxii  
Thesis Abstract ................................................................................................................................... xxiii  
Contribution Statement ....................................................................................................................... xxviii  
Awards received during candidature ................................................................................................. xxxi

## Chapter 1. Introduction ..................................................................................................................... 1

1.1. Background .................................................................................................................................. 2  
1.1.1. Physical activity .................................................................................................................. 2  
1.1.2. Cardiorespiratory fitness ................................................................................................... 5  
1.1.3. Fundamental movement skills ......................................................................................... 6  
1.2. Influences on physical activity in children ............................................................................... 9  
1.2.1. Correlates of physical activity in children ........................................................................ 9  
1.2.2. Mediators of physical activity in children ....................................................................... 12  
1.2.3. Theories of health behaviour ............................................................................................ 14  
1.3. Physical activity interventions for children ............................................................................ 19  
1.3.1. School-based physical activity interventions for children ........................................... 19  
1.4. Chapter 1 summary .................................................................................................................... 26  
1.5. Research aims ............................................................................................................................. 27  
1.5.1. Primary aim ..................................................................................................................... 27  
The primary aim of this thesis was: ............................................................................................... 27  
1.5.2. Secondary aims .................................................................................................................. 27  
1.6. Thesis structure ........................................................................................................................... 28
1.6.1. Chapter 1: Introduction ................................................................. 28
1.6.2. Chapter 2: Fundamental movement skill interventions in youth: A systematic review and meta-analysis ........................................ 28
1.6.3. Chapter 3: Rationale and study protocol for the Supporting Children’s Outcomes using Rewards, Exercise and Skills (SCORES) cluster randomised controlled trial: A physical activity and fundamental movement skills intervention for primary schools in low-income communities .......................................................... 29
1.6.4. Chapter 4: Fundamental movement skills and physical activity among children living in low-income communities: A cross-sectional study ..... 29
1.6.5. Chapter 5: Physical activity and skills intervention: SCORES cluster randomised controlled trial .......................................................... 30
1.6.6. Chapter 6: Improvements in fundamental movement skill competency mediate the effect of the SCORES intervention on physical activity and cardiorespiratory fitness in children ......................................... 30
1.6.7. Chapter 7: Psychological, social and physical environmental mediators of the SCORES intervention on physical activity among children living in low-income communities ........................................ 30
1.6.8. Chapter 8: Discussion .................................................................. 31

Chapter 2. Fundamental movement skill interventions in youth: A systematic review and meta-analysis .................................................. 32

2.1. Background .................................................................................... 34
2.2. Methods ......................................................................................... 35
  2.2.1. Eligibility criteria .............................................................. 35
  2.2.2. Information sources and search ........................................... 37
  2.2.3. Study selection .............................................................. 37
  2.2.4. Data collection process ...................................................... 37
  2.2.5. Risk of bias in individual studies ........................................... 38
  2.2.6. Synthesis of results ............................................................ 39
2.3. Results ......................................................................................... 39
  2.3.1. Overview of studies ............................................................ 39
  2.3.2. Study characteristics .......................................................... 40
2.3.3. Risk of bias within studies ................................................................. 41
2.3.4. Measurement of FMS ........................................................................ 41
2.3.5. Types of interventions ....................................................................... 42
2.3.6. Theoretical frameworks or pedagogical approach guiding the interventions ............................................................................................ 42
2.3.7. Evidence for FMS outcomes ............................................................... 43
2.3.8. Meta-analysis of FMS intervention effects ......................................... 43
2.4. Discussion ............................................................................................... 45
2.4.1. Evidence from RCTs .......................................................................... 46
2.4.2. FMS intervention characteristics and pedagogical approaches employed 
2.4.3. Implications and recommendations ................................................... 49
2.4.4. Strengths and limitations ................................................................. 50
2.5. Conclusion .................................................................................................. 50

Chapter 3. Rationale and study protocol for the supporting children’s outcomes using rewards, exercise and skills (SCORES) cluster randomised controlled trial: a physical activity and fundamental movement skills intervention for primary schools in low-income communities........ 66

3.1. Background .................................................................................................. 68
3.2. Methods / design ........................................................................................ 70
3.2.1. Study design .......................................................................................... 70
3.2.2. Setting and participants ....................................................................... 70
3.2.3. Sample size calculation ....................................................................... 71
3.2.4. Blinding and randomization ................................................................. 72
3.2.5. Intervention ........................................................................................... 72
3.2.6. Outcomes ................................................................................................ 76
3.2.7. Process evaluation ............................................................................... 79
3.2.8. Statistical methods .............................................................................. 80
3.3. Discussion ..................................................................................................... 81

Chapter 4. Movement skills and physical activity among children living in low-income communities: A cross-sectional study ........................................... 86

4.1. Background .................................................................................................. 88
4.2. Methods ....................................................................................................... 90
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.1.</td>
<td>Study design</td>
<td>90</td>
</tr>
<tr>
<td>4.2.2.</td>
<td>Setting and participants</td>
<td>90</td>
</tr>
<tr>
<td>4.2.3.</td>
<td>Measures</td>
<td>91</td>
</tr>
<tr>
<td>4.2.4.</td>
<td>Statistical analyses</td>
<td>93</td>
</tr>
<tr>
<td>4.3.</td>
<td>Results</td>
<td>93</td>
</tr>
<tr>
<td>4.3.1.</td>
<td>Participant characteristics</td>
<td>93</td>
</tr>
<tr>
<td>4.3.2.</td>
<td>Locomotor skills and MVPA</td>
<td>94</td>
</tr>
<tr>
<td>4.3.3.</td>
<td>Object-control skills and MVPA</td>
<td>94</td>
</tr>
<tr>
<td>4.4.</td>
<td>Discussion</td>
<td>94</td>
</tr>
<tr>
<td>4.4.1.</td>
<td>Strengths and limitations</td>
<td>98</td>
</tr>
<tr>
<td>4.5.</td>
<td>Conclusions</td>
<td>98</td>
</tr>
<tr>
<td>5.1.</td>
<td>Background</td>
<td>104</td>
</tr>
<tr>
<td>5.2.</td>
<td>Methods</td>
<td>105</td>
</tr>
<tr>
<td>5.2.1.</td>
<td>Study design and participants</td>
<td>105</td>
</tr>
<tr>
<td>5.2.2.</td>
<td>Sample size calculation and randomization</td>
<td>107</td>
</tr>
<tr>
<td>5.2.3.</td>
<td>Intervention</td>
<td>108</td>
</tr>
<tr>
<td>5.2.4.</td>
<td>Assessments and measures</td>
<td>109</td>
</tr>
<tr>
<td>5.2.5.</td>
<td>Statistical analyses</td>
<td>112</td>
</tr>
<tr>
<td>5.3.</td>
<td>Results</td>
<td>113</td>
</tr>
<tr>
<td>5.3.1.</td>
<td>Primary outcomes at mid-program (6-months post baseline)</td>
<td>114</td>
</tr>
<tr>
<td>5.3.2.</td>
<td>Primary outcomes at posttest (12-months post baseline; study’s primary time point)</td>
<td>114</td>
</tr>
<tr>
<td>5.3.3.</td>
<td>Process outcomes</td>
<td>114</td>
</tr>
<tr>
<td>5.4.</td>
<td>Discussion</td>
<td>116</td>
</tr>
<tr>
<td>5.4.1.</td>
<td>Strengths and limitations</td>
<td>121</td>
</tr>
<tr>
<td>5.5.</td>
<td>Conclusions</td>
<td>121</td>
</tr>
<tr>
<td>6.1.</td>
<td>Introduction</td>
<td>126</td>
</tr>
</tbody>
</table>

Chapter 5. Physical activity and skills intervention: SCORES cluster
randomised controlled trial ......................................................... 102

Chapter 6. Improvements in fundamental movement skill competency mediate
the effect of the SCORES intervention on physical activity and
cardiorespiratory fitness in children................................................. 124
Chapter 7. Psychological, social and physical environmental mediators of the SCORES intervention on physical activity among children living in low-income communities

7.1. Background

7.2. Methods

7.2.1. Study design

7.2.2. Setting and participants

7.2.3. Study arms

7.2.4. Outcomes

7.2.5. Statistical analyses

7.3. Results

7.3.1. Overview

7.3.2. Action theory test

7.3.3. Conceptual theory test

7.3.4. Significance test of mediated effect

7.4. Discussion

7.4.1. Strengths and limitations

7.5. Conclusions

Chapter 8. Discussion
8.1. Previous FMS interventions in young people ............................................. 166
8.1.1. Review of FMS interventions in children and adolescents .............. 166
8.1.2. Strengths and limitations ................................................................. 168
8.2. FMS competency and physical activity in children .................................. 169
8.2.1. FMS competency and break-time and after-school physical activity in children ................................................................. 169
8.2.2. Strengths and limitations ................................................................. 171
8.3. The impact of the SCORES intervention .............................................. 172
8.3.1. Study outcomes for physical activity, cardiorespiratory fitness and FMS ................................................................. 172
8.4. Understanding the mechanisms of physical activity behaviour change in the SCORES intervention ................................................................. 175
8.4.1. Mediators of the SCORES intervention ........................................ 175
8.4.2. Strengths and limitations ................................................................. 177
8.5. Recommendations ............................................................................. 179
8.5.1. FMS interventions in young people .............................................. 179
8.5.2. FMS and physical activity in children ............................................ 180
8.5.3. The impact of the SCORES intervention ...................................... 182
8.5.4. Understanding the mechanisms of physical activity behaviour change in the SCORES intervention ................................................................. 184
8.6. Significance and future directions of the SCORES intervention .......... 186
8.6.1. Significance of the SCORES intervention ...................................... 186
8.6.2. Future directions of the SCORES intervention ................................ 187
8.7. Concluding remarks ........................................................................... 188
References ................................................................................................. 189
Appendix 1. Statements of contribution .................................................... 236
Appendix 2. University of Newcastle ethics approval letter ....................... 248
Appendix 3. NSW Department of Education and Communities approval letter 252
Appendix 4. Principal information statement and consent form ............... 255
Appendix 5. Teacher information statement and consent form ................ 261
Appendix 6. Parent information statement and consent form .................... 267
Appendix 7. Assessment protocol booklet ................................................ 273
Appendix 8. Student questionnaires ................................................................. 300
Appendix 9. Teacher questionnaire ................................................................. 315
Appendix 10. Parent questionnaire ................................................................. 329
Appendix 11. SCORES lesson observation form ........................................... 337
List of Tables

Table 1.1 Prevalence of FMS competency among boys and girls by year group from the NSW Schools Physical Activity and Nutrition Survey [13] ........................................8

Table 1.2 Systematic reviews of correlates of physical activity in children [72] .....10

Table 2.1 Risk of bias checklist ................................................................................38

Table 2.2 Study and FMS intervention characteristics and findings ..........................51

Table 2.3 Risk of bias assessment in intervention studies examining changes in FMS in youth ..........................................................................................................................64

Table 3.1 SAAFE teaching principles and strategies .................................................76

Table 3.2 Intervention components, behavior change techniques and targeted constructs in the SCORES intervention ..................................................................................83

Table 4.1 Descriptives and sex differences for children’s background, fundamental movement skills and physical activity ..........................................................100

Table 4.2 Relationships between MVPA minutes and locomotor skills .............101

Table 4.3 Relationships between MVPA minutes and object-control skills ........101

Table 5.1 Characteristics of study sample ...............................................................113

Table 5.2 Changes in primary outcomes measures and group differences at mid-program (6-months) ..............................................................122

Table 5.3 Changes in primary outcomes measures and group differences at posttest (12-months) ..................................................................................123

Table 6.1 Action theory test, conceptual theory test and significance of the mediated effect on physical activity (MVPA minutes) at post-test (12-months) ..........142

Table 6.2 Action theory test, conceptual theory test and significance of the mediated effect on cardiorespiratory fitness at post-test (12-months) .....................142
Table 7.1 Hypothesised mediators, intervention strategies and scale descriptions. 160

Table 7.2 Action theory test, conceptual theory test and significance of the mediated effect on total physical activity (MVPA minutes) at post-test (12-months).............. 164
List of Figures

Figure 1.1 Structure of Chapter 1 ........................................................................................................ 1

Figure 1.2 Adapted ecological model of the correlates of physical activity [72] ............... 9

Figure 1.3 Levels of influence in the socio-ecological model [87] ............................... 15

Figure 1.4 Self-determination theory [95] ...................................................................................... 16

Figure 1.5 The self-determination continuum [96] ...................................................................... 17

Figure 1.6 Competence Motivation Theory model (Harter’s (1987) model of global self-worth customised for the physical domain [97]) ................................................................. 18

Figure 2.1 PRISMA flowchart of studies through the review process .............................. 40

Figure 2.2 Meta-analysis comparing the effects of FMS interventions on overall gross motor skill proficiency .............................................................................................................. 44

Figure 2.3 Meta-analysis comparing the effects of FMS interventions on locomotor skill proficiency ......................................................................................................................... 44

Figure 2.4 Meta-analysis comparing the effects of FMS interventions on object-control motor skill proficiency ........................................................................................................... 44

Figure 3.1 Study design and flow .......................................................................................... 71

Figure 3.2 SCORES intervention components, potential mediators and outcomes .. 73

Figure 5.1 Study design and flow of participants through the study with primary outcome measures. aChildren either arrived late at school or left school early on the assessment day; bchildren were absent on the assessment day; children left the school; dchildren withdrew from the program ................................................................. 106

Figure 6.1 Mediation model showing the mediators of the effect of the SCORES intervention on physical activity and cardiorespiratory fitness ................................. 131
Figure 7.1 Mediation model showing the hypothesised mediators of the effect of the SCORES intervention on physical activity .............................................................. 151
**List of Abbreviations**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>Body mass index</td>
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<tr>
<td>BMI z-score</td>
<td>Body mass index z-score</td>
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<tr>
<td>CI</td>
<td>Confidence interval</td>
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<tr>
<td>CMT</td>
<td>Competence Motivation Theory</td>
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<tr>
<td>CONSORT</td>
<td>Consolidated Standards Of Reporting Trials</td>
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<tr>
<td>FMS</td>
<td>Fundamental movement skills</td>
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<tr>
<td>Kg</td>
<td>Kilogram</td>
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<tr>
<td>Min</td>
<td>Minutes</td>
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<tr>
<td>MVPA</td>
<td>Moderate-to-vigorous physical activity</td>
</tr>
<tr>
<td>N</td>
<td>Number</td>
</tr>
<tr>
<td>NSW</td>
<td>New South Wales</td>
</tr>
<tr>
<td>PA</td>
<td>Physical activity</td>
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<td>PE</td>
<td>Physical education</td>
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<tr>
<td>RCT</td>
<td>Randomised controlled trial</td>
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<td>SCORES</td>
<td>Supporting Children’s Outcomes using Rewards, Exercise and Skills</td>
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<tr>
<td>SD</td>
<td>Standard deviation</td>
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<td>SDT</td>
<td>Self-Determination Theory</td>
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<tr>
<td>SEIFA</td>
<td>Socio-economic indices for areas</td>
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<td>SES</td>
<td>Socio-economic status</td>
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<td>SPANS</td>
<td>Schools Physical Activity and Nutrition Survey</td>
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<tr>
<td>TGMD-2</td>
<td>Test of Gross Motor Development 2</td>
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<td>WHO</td>
<td>World Health Organisation</td>
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</table>

*Note.* This list represents the abbreviations used in the main text of this thesis. Additional abbreviations in tables are defined in the bottom row.
## Definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adolescent</td>
<td>Individuals 13-18 years of age.</td>
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<tr>
<td>Child</td>
<td>Individuals 5-12 years of age.</td>
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<tr>
<td><strong>Fundamental movement skills</strong></td>
<td>Gallahue and Donnelly define FMS as ‘an organised series of basic movements that involve the combination of movement patterns of two or more body segments’ [1]. In this thesis FMS will be categorised as locomotor skills (i.e., run, jump, skip, side gallop, gallop, and hop), object-control skills (i.e., overarm throw, underhand roll, kick, two-hand strike, catch, and dribble) and overall FMS (i.e., locomotor skills and object-control skills).</td>
</tr>
<tr>
<td>Physical activity</td>
<td>The WHO defines physical activity as ‘any bodily movement produced by skeletal muscles that requires energy expenditure’ [2].</td>
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<tr>
<td>Youth</td>
<td>Individuals 5-18 years of age.</td>
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Thesis Abstract

Background

Many Australian children are insufficiently active to accrue the associated health benefits. Physical activity levels are also consistently lower among children of low socio-economic status (SES) than children of middle- and high-SES. Physical activity levels decline dramatically during adolescence and evidence suggests that competency in a range of fundamental movement skills (FMS) may serve as a protective factor against this trend. Schools offer an ideal setting to promote physical activity and increase FMS competency in children. However, previous school-based interventions have had small effects on increasing children’s physical activity, which may be attributed to the lack of a theoretical framework for guiding behaviour change, failure to address the multiple components that influence physical activity behaviour in and beyond the school setting, and methodological weaknesses. Currently, an evidence gap exists for effective, theoretically framed, multi-component school-based physical activity and FMS interventions for children located in low-income communities.

Objectives

This thesis by publication presents a series of studies that were conducted to address this gap in the literature. Overall, these studies relate to: i) the utility of FMS for promoting physical activity in children and the effectiveness of FMS interventions; and ii) the development of the primary school-based Supporting Children’s Outcomes using Rewards, Exercise and Skills (SCORES) intervention and its evaluation via a cluster randomised controlled trial (RCT).

The primary aim of this thesis was to evaluate the impact of the SCORES intervention on moderate-to-vigorous physical activity (MVPA), cardiorespiratory fitness and FMS competency among children attending primary schools located in low-income communities. Further, the thesis presents a series of studies investigating four key secondary aims, which are briefly described below. As these studies provide important context for the primary aim, the thesis is presented in the following order:
Secondary Aim 1: To systematically review the evidence of interventions designed to improve FMS competency in typically developing children and adolescents.

A literature search with no date restrictions was conducted across seven databases. Studies included any school-, home-, or community-based intervention for typically developing youth with clear intent to improve FMS competency and that reported statistical analysis of FMS competence at both pre-intervention and at least one other post-intervention time-point. Study designs included RCTs using experimental and quasi-experimental designs and single group pre-post trials. Risk of bias was independently assessed by two reviewers. Twenty-two articles (six RCTs, 13 quasi-experimental trials, three pre-post trials) describing 19 interventions were included. All but one intervention were evaluated in primary/elementary schools. All studies reported significant intervention effects for ≥ one FMS. Meta-analyses revealed large effect sizes for overall gross motor proficiency (standardized mean difference [SMD] = 1.42, 95% confidence interval [CI] 0.68 to 2.16, Z = 3.77, \( p < .0002 \)) and locomotor skill competency (SMD = 1.42, 95% CI 0.56 to 2.27, Z = 3.25, \( p = .001 \)). A medium effect size for object control skill competency was observed (SMD = 0.63, 95% CI 0.28 to 0.98, Z = 3.53, \( p = .0004 \)). Risk of bias was high among the majority of studies.

Secondary Aim 2: To examine the association between FMS competency and objectively measured MVPA during time periods of the day that represent key physical activity opportunities (i.e., lunchtime, recess and after-school) among children attending primary schools located in low-income communities.

Using baseline data from the SCORES cluster RCT, multilevel linear mixed models were used to assess the cross-sectional associations between FMS and objectively measured MVPA. After adjusting for age, sex, BMI and SES (measured at the individual level), locomotor skill competency was positively associated with total MVPA (\( p = 0.002, r = 0.15 \)) and after-school MVPA (\( p = 0.014, r = 0.13 \)). Object-control skill competency was positively associated with total MVPA (\( p < 0.001, r = 0.20 \)), lunchtime MVPA (\( p = 0.03, r = 0.10 \)), recess (\( p = 0.006, r = 0.11 \)) and after-school MVPA (\( p = 0.022, r = 0.13 \)).
Primary Aim: To evaluate the impact of the Supporting Children’s Outcomes using Rewards, Exercise and Skills (SCORES) intervention on MVPA, cardiorespiratory fitness and FMS competency among children attending primary schools located in low-income communities.

The SCORES intervention, which was a multi-component physical activity and FMS intervention for primary schools located in low-income communities, was evaluated using a cluster RCT. The socio-ecological model provided a framework for the 12-month intervention, which included the following components: teacher professional learning, student leadership workshops, physical activity policy review, equipment packs, parental engagement via newsletters, FMS homework and a parent evening, and community partnerships with local sporting organisations. The sample included 25 classes from eight primary schools located in low-income communities. Participants were 460 children (54.1% girls) aged 8.5 ± 0.6 years. Primary outcomes were objectively measured MVPA (ActiGraph GT3X and GT3X+ accelerometers), FMS competency (TGMD-2; six locomotor and six object-control skills), and cardiorespiratory fitness (20 meter multistage fitness test) assessed at baseline, mid-program (6-months) and posttest (12-months). Linear mixed models, adjusted for sex, age, BMI-z score, SES, ethnicity and school class (as a random factor), were used to assess the impact of the intervention. At mid-program, there were no significant intervention effects for any of the outcomes. At posttest, (study’s primary time point), there were intervention effects for daily MVPA (adjusted mean difference, 12.7 MVPA mins/day; 95% CI 5.0 to 20.5), overall FMS competency (4.9 units; 95% CI -0.04 to 9.8), and cardiorespiratory fitness (5.4 laps; 95% CI 2.3 to 8.6).

Secondary Aim 3: To determine if changes in FMS competency and perceived competence mediate the effect of the SCORES intervention on MVPA and cardiorespiratory fitness among children attending primary schools located in low-income communities.

Mediation analyses were conducted using multilevel linear analysis in MPlus. There were significant treatment effects for locomotor skills (A = 1.76, SE = 0.88, p = 0.044) and overall FMS (A = 4.09, SE = 2.08, p = 0.049). Changes in MVPA were
associated with changes in object-control skills ($B = 0.86$, $SE = 0.15$, $p < 0.001$), overall FMS ($B = 0.51$, $SE = 0.10$, $p < 0.001$) and perceived competence ($B = 0.48$, $SE = 0.36$, $p = 0.027$). Overall FMS had a significant mediating effect on MVPA ($AB = 2.09$, 95% CI 0.01 to 4.55). Overall FMS ($AB = 1.19$, 95% CI 0.002 to 2.79) and locomotor skills ($AB = 0.74$, 95% CI 0.01 to 1.69) had a significant mediating effect on cardiorespiratory fitness.

Secondary Aim 4: To determine if changes in individual, social and physical environmental constructs mediate the effect of the SCORES intervention on MVPA among children attending primary schools located in low-income communities.

Hypothesised mediators measured in children via questionnaire were enjoyment of physical activity, perceived sport competence, and perceived social support. Hypothesised mediators measured in parents via questionnaire were social support from family, access to physical activity facilities and equipment at home, and perceived access to physical activity opportunities in the local community. Mediation analyses were conducted using multi-level linear analysis in MPlus. There were significant intervention effects for social support from teachers ($A = 1.73$, $SE = 0.88$, $p = 0.048$) and perceived access to physical opportunities in the local community ($A = 2.69$, $SE = 1.12$, $p = 0.016$). There were significant associations between changes in perceived sport competence ($B = 0.48$, $SE = 0.36$, $p = 0.027$), perceived access to physical activity opportunities in the local community ($B = 0.60$, $SE = 0.26$, $p = 0.021$), and changes in total MVPA. Perceived access to physical activity opportunities in the local community was found to have a significant mediating effect on total MVPA ($AB = 1.61$, 95% CI 0.06 to 3.95).

Discussion

The studies included in this thesis contribute to the growing body of evidence for the utility of FMS to promote physical activity in children and the effectiveness of FMS and physical activity interventions. This thesis revealed that school- and community-based programs that include developmentally appropriate FMS learning experiences delivered by physical education (PE) specialists or highly trained classroom teachers significantly improve FMS competency in young people. In addition, object-control
skill competency was found to be a better predictor of children’s MVPA during school-based physical activity opportunities than locomotor skill competency. In contrast, both object-control and locomotor skill competency were important for engagement in after-school MVPA. The SCORES intervention maintained daily MVPA, improved overall FMS competency and increased cardiorespiratory fitness among children attending primary schools in low-income communities. Of note, these effects were achieved without allocating additional curriculum time to PE or school sport. This provides evidence for the effectiveness of theoretically-framed, multi-component school-based physical activity and FMS interventions for children. Further, this was the first study to explore the mediating effects of FMS competency in a physical activity intervention in children. Improvements in overall FMS competency acted as a causal mechanism for physical activity behaviour change and subsequent improvements in cardiorespiratory fitness among children. Perceived access to physical activity opportunities in the local community was also identified as a mechanism of physical activity behaviour change in children. Additional research is needed to replicate the novel findings in this thesis and follow-up assessments beyond the post-intervention time point are needed to determine any sustained or long-term effects of future physical activity and FMS interventions.
**Contribution Statement**

This thesis contains four peer reviewed publications that relate to the SCORES cluster RCT. I was the sole PhD student of this study and I was involved in all aspects of the design, implementation and evaluation of the intervention. A summary of the contributions that I made to this study is provided below.

**Intervention development**

In collaboration with my supervisors, I lead the development of the following SCORES intervention components.

1) Professional learning workshops for teachers
   - Content and resources for the Stage 2 teachers’ professional learning workshops.
   - Content and resources for the whole-school professional learning workshops.

2) Student leadership
   - Content and resources for the student leadership workshop.
   - SCORES Leader handbook for students.

3) Policy and environment
   - Conducted a review of effective school physical activity policies which guided the development of the school physical activity policies.
   - Implementation strategies and resources for the school physical activity policies.
   - Selected and ordered appropriate equipment that would promote physical activity and FMS development in the school.

4) Parental engagement
   - Content for the four parent newsletters.
   - Content and resources for the parent evenings.
   - Content and resources for the FMS homework.
5) Community links

- Local sporting organisations information sheets.

Data collection, entry and management

With our research assistant, I was responsible for planning and coordinating the comprehensive study assessments. The participants completed three assessment sessions over the 12-month study period at their primary school. With our research assistant, I created a standardised protocol manual for completing and administering the assessments. I also conducted comprehensive training sessions for all study assessors. With assistance from our research assistants, I was involved in the assessments at all time-points, as well as conducted a detailed process evaluation. I assisted the study research assistants with data entry, and was responsible for cleaning all entered data.

Program implementation

With support from my supervisors, I successfully implemented the five intervention components, as listed below, in the four intervention schools and following study completion, in the four control schools. Further, I was also the contact person for schools and parents during the study and was responsible for managing all enquiries.

1) Professional learning workshops for teachers
   - Conducted one Stage 2 teachers’ professional learning workshop.
   - Conducted four whole-school professional learning workshops.
   - Conducted three PE lesson observations for 12 Stage 2 teachers.

2) Student leadership
   - Conducted four student leadership workshops.

3) Policy and environment
   - Conducted four school physical activity policy meetings with school principals.
   - Conducted four whole-school workshops on
implementation of the school physical activity policies.
• Distributed sporting equipment to four schools.

4) Parental engagement
• Distributed the four newsletters to parents / carers of the study participants.
• Organised and conducted four parent evenings.
• Distributed and explained the FMS homework to four schools.

5) Community links
• Organised six visits to each school from local sporting organisations.
• Distributed local sporting organisations information sheets.

Data analysis
With support from my supervisors, I completed the statistical analysis for the studies in Chapters Four to Seven of this thesis.

Presentation of Results
During my candidature, I presented results from my thesis at two international and two national conferences. These presentations are listed in the ‘Presentations arising from this thesis’ section.
Awards received during candidature

In 2014, I won an award at the Priority Research Centre for Physical Activity and Nutrition for ‘best published paper’ in the Physical Activity and Nutrition in Schools theme. In 2015, I won a University award for best paper in the Faculty of Education and Arts.