

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

CHILD-CENTRED PHYSICAL ACTIVITY: EFFECT ON MOTOR SKILL DEVELOPMENT IN TODDLERS

A thesis presented in partial fulfilment for the requirements of a
Master of Science in Sport and Exercise Science at Massey
University, Albany, New Zealand

Deborah Susan Pigou

2013

ACKNOWLEDGEMENTS

I would first like to thank all of the children and their parents who took part in this study. It was wonderful to have such a positive response to the call for participants and I am so thankful to everyone who gave up their time to take part.

Acknowledgements must also go to my supervisors Dr. Ajmol Ali and Professor Claire McLachlan. Their assistance and advice has been invaluable in producing my Masters thesis. Many thanks must also go to the Ministry of Science and Innovation for funding the study and to Sophie Foster and the Jumping Beans licensees, particularly Chris Morris, for all their support and assistance.

I would also like to acknowledge the continued support of my family and friends, especially those who assisted with my data collection: Mum, Sarah, Rachel and Becky.

Finally, I would like to thank Mr Simon Bennett for always being willing to lend a helping hand, Paula Southworth and Vivian Lee for assisting with data collection and Mr Rory Yates for being my dedicated delivery/pick-up person.

This thesis has received approval from the following ethics committees:
Massey University Human Ethics Committee: Southern A (20th March 2013,
Application 11/84)

ABSTRACT

Background: Over the last 20-30 years, children's physical activity levels have decreased significantly resulting in obesity rates reaching epidemic levels. To date there has been very little research regarding physical activity in toddlers, with the majority of research focussing on young children (3-5 year-olds) or on children at risk of motor or neurological deficiencies. **Purpose:** To investigate the effects of a nine-week, child-centred physical activity programme on cognitive and motor skill development, safety skills, balance and parent supervision in typically developing 12-24 month-old children. **Methods:** In a randomised, controlled design, 90 toddlers (age 17.0 ± 2.6 months; 52.2% male) and their parents were split into two treatment groups stratified by age and gender at baseline. The intervention completed was either nine weeks (one school term) of one-hour child-centred physical activity classes or normal physical activity for nine weeks. In the school holiday periods prior to, and following the intervention period anthropometric measures (mass and height), overall development (Bayley Scales of Infant Development – Screening Test), safety skills (nine-skill test battery), balance measures (centre of pressure) and parent-child supervision were assessed. **Results:** The nine-week physical activity intervention was successful in improving the overall safety skills score ($p < 0.05$). In addition, the ability to climb over a small-runged A-frame while using a cylinder grip and safe face-the-slope dismount and the execution of a safety roll down a foam wedge were improved as the result of the intervention ($p < 0.05$). There was no effect of the exercise intervention on overall development, measures of balance or supervision aspects. A main effect of Age Group on the mean change score in all

subscales was reported with younger children (12-18 months) tending to show greater improvements as compared to older children (18-24 months). Regression analysis showed that 27.8% of the change in overall development could be predicted by knowing the age of the child and whether their day-to-day environment was mostly home care with their parent or other adult, or not.

Conclusions: This was the first randomised, controlled trial that examined the effects of a child-centred physical activity programme on overall development, safety skills, balance and supervision in 12-24 month-old children in New Zealand. There is a need for more randomised, controlled trials that incorporate a multitude of external factors that may influence development, namely cognitive and motor skill development.

Keywords: motor skill development, cognitive development, toddlers, physical activity, balance

TABLE OF CONTENTS

Acknowledgements	ii
Abstract	iv
Table of Contents	vi
List of Figures	ix
List of Tables	xi
List of Equations	xv
1.0 INTRODUCTION	1
1.1 Aims and Objectives	7
1.2 Hypotheses	8
1.3 Overview of Thesis	8
2.0 LITERATURE REVIEW	9
2.1 Methodology	9
2.2 Motor Development	10
2.2.1 Normal development	12
2.2.2 Associations with physical activity	15
2.2.3 Physical activity guidelines for infants	22
2.2.4 Intervention studies	25
2.2.5 Methods of measuring motor development	29
2.2.6 Associations with reducing injury rate	34
2.2.7 Development of safety skills and balance	36
2.3 Cognitive Development	39
2.3.1 Normal development	39
2.3.2 Associations with motor skill development	43
2.4 Attachment and Social Interaction	46
2.4.1 Normal development	46
2.4.2 Methods of measuring	49
2.4.3 Associations with cognitive and physical development	53
2.4.4 Intervention studies	55

2.5	Parental Factors	57
2.5.1	Associations with physical activity	57
2.5.2	Associations with injury rates and safety skills	58
2.5.3	Child-care versus home-care	59
2.6	Summary	61
3.0	METHODOLOGY	62
3.1	Research Design	62
3.2	Participants	63
3.2.1	Participant recruitment	63
3.2.2	Inclusion criteria	64
3.3	Study Design	65
3.4	Overview of Study Procedure	68
3.5	Description of the Intervention	70
3.6	Description of Tests and Assessments	71
3.6.1	Anthropometric and demographic assessments	71
3.6.2	Bayley Scales of Infant Development Screening Test	71
3.6.3	Safety skills assessment	72
3.6.4	Static balance test	76
3.6.5	Parent-child supervision questionnaire	78
3.7	Participant Control	79
3.8	Data Analysis	80
3.8.1	Quantitative analysis	80
3.8.2	Qualitative analysis	81
3.9	Summary	82
4.0	RESULTS	83
4.1	Descriptive Characteristics	83
4.2	Bayley Scales of Infant Development Screening Test	84
4.2.1	Cognitive ability subscale	85
4.2.2	Receptive communication subscale	87
4.2.3	Expressive communication subscale	89
4.2.4	Fine motor skill subscale	91
4.2.5	Gross motor skill subscale	93

4.2.6	Correlation analysis	95
4.2.7	Regression analysis	97
4.3	Safety Skills	99
4.3.1	Total safety skill score	99
4.3.2	Individual safety skills scores	100
4.3.3	Regression analysis	102
4.4	Balance	107
4.5	Parent-child Supervision	108
4.5.1	Protectiveness	108
4.5.2	Child's play time	109
4.5.3	Supervision	111
4.5.4	Risk tolerance	112
4.5.5	Trying new things	114
4.6	Summary	115
5.0	DISCUSSION	116
5.1	Safety Skills	116
5.2	Balance	122
5.3	Bayley Scales of Infant Development Screening Test	124
5.4	Parent-child Supervision	128
5.5	Descriptive Characteristics	129
5.6	Implications for Future Research and Policy or Practice	131
5.7	Limitations	133
5.8	Conclusions	134
5.9	Research Summary	135
	REFERENCES	136
	APPENDICES	151

List of Figures

Figure number		Page
2.1	Changes in specific fall types with age.	35
3.1	Schematic of the study design.	67
3.2	Flow chart detailing the study procedures and average time taken to complete each stage of the overall assessment.	69
3.3	Diagram of the layout of the safety skills equipment.	74
3.4	Photograph of the safety skills equipment layout.	75
3.5	Photograph of child standing on force plate.	77
4.1	Mean (\pm SD) change in cognitive ability score. Age groups on horizontal axis are based on ages of the children at baseline and post-intervention.	87
4.2	Mean (\pm SD) change in receptive communication score. Age groups on horizontal axis are based on ages of the children at baseline and post-intervention.	89
4.3	Mean (\pm SD) change in expressive communication score. Age groups on horizontal axis are based on ages of the children at baseline and post-intervention.	91

4.4	Mean (\pm SD) change in fine motor skill score. Age groups on horizontal axis are based on ages of the children at baseline and post-intervention.	93
4.5	Mean (\pm SD) change in gross motor skill score. Age groups on horizontal axis are based on ages of the children at baseline and post-intervention.	95
4.6	Mean safety skills total score (\pm SD) at baseline and post-intervention in the experimental and control groups	100
4.7	Summary of parental perceptions concerning protectiveness in the total sample (n=90)	108
4.8	Summary of parental perception concerning their child's play time in the total sample (n=90)	110
4.9	Summary of parental perceptions concerning supervision in the total sample (n=90)	111
4.10	Summary of parental perceptions concerning risk tolerance in the total sample (n=90)	113
4.11	Summary of parental perceptions concerning trying new things in the total sample (n=90)	114

List of Tables

Table number		Page
2.1	Typical milestones of motor development	13
2.2	Overview of infant assessments based on milestones	14
2.3	Studies investigating the link between childhood physical activity (PA) or fundamental movement skills and sport participation or proficiency in later life	18
2.4	Physical activity guidelines for infants and toddlers in selected Western countries	24
2.5	Components of the run and catch movement skills	33
2.6	Ages, stages and activities of cognitive development	40
2.7	Overview of early childhood cognitive assessments	43
2.8	Typical milestones of social emotional development	48
2.9	Classification of infants based on the Strange Situation Procedure	51
3.1	Method of recruitment	64
4.1	Descriptive characteristics of participants (n=90)	84
4.2	Mean (\pm SD) raw scores of Cognitive Ability [33 ^a] by age group	86

4.3	Mean (\pm SD) raw scores of Receptive Communication [24 ^b] by age group	88
4.4	Mean (\pm SD) raw scores of Expressive Communication [24 ^g] by age group	90
4.5	Mean (\pm SD) raw scores of Fine Motor Skill [27 ^h] by age group	92
4.6	Mean (\pm SD) raw scores of Gross Motor Skill [28 ^h] by age group	94
4.7	Correlation matrix for the change in BSID subscales and descriptive variables in the total sample (n=90)	96
4.8	Means, standard deviations and inter-correlations of predictor variables for the change in total development score	97
4.9	Forward step-wise linear regression analysis summary of predicting the change in total development score (n=90)	98
4.10	Mean safety skills total score (\pm SD) at baseline, post-intervention and the difference between baseline and post-intervention	99
4.11	Mean (\pm SD) individual safety skills scores (each out of 5) at baseline, post-intervention and the difference between baseline and post-intervention	101
4.12	Means, standard deviations and inter-correlations of predictor variables for the change in total safety skills score	102
4.13	Hierarchical multiple regression analysis summary for predicting the change in total safety skills score	103

4.14	Means, standard deviations and inter-correlations of predictor variables for the change in safety skill F score	104
4.15	Forward step-wise multiple regression analysis summary for predicting the change in safety skill F score	105
4.16	Means, standard deviations and inter-correlations of predictor variables for the change in safety skill G score	105
4.17	Forward step-wise multiple regression analysis summary for predicting the change in safety skill G score	106
4.18	Mean (\pm SD) measures of balance at baseline and post-intervention	107
4.19	Parent responses to “How protective are you of your child?” at baseline and post-intervention in the experimental and control groups	109
4.20	Parent responses to “How would you describe your actions during your child’s play time?” at baseline and post-intervention in the experimental and control groups	110
4.21	Parent responses to “How would you describe your supervision of your child?” at baseline and post-intervention in the experimental and control groups	112

- 4.22 Parent responses to “How would you describe your risk tolerance for your child?” at baseline and post-intervention in the experimental and control groups 113
- 4.23 Parent responses to “How often do you let your child try new things for themselves?” at baseline and post-intervention in the experimental and control groups 115

List of Equations

Equation number		Page
3.1	$\Delta \text{CoP}_x = \Delta M_y / F_z$	77
3.2	$\Delta \text{CoP}_y = \Delta M_x / F_z$	77