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# The Effect of Physical Activity Classes on Motor Skill in 12 - 24-Month-Old Children

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## Abstract

**Background:** Children with enhanced fundamental movement skills may benefit from improved physical, social and psychological development, resulting in an increased likelihood of an active lifestyle in later years. **Aim:** We investigated the effects of a nine-week, child-centred, physical activity programme on cognitive and motor skills in typically developing 12 - 24-month-old toddlers. **Methods:** In a randomised control trial, 90 toddlers (age  $17.0 \pm 2.6$  months; 52.2% male) were split into two groups stratified by age and sex. The intervention completed was either nine weeks of one-hour per week physical activity classes ( $n = 45$ ; EXP) or normal physical activity ( $n = 45$ ; control). Prior to and following the intervention period, safety skills (nine-skill test battery), anthropometric measures (mass and height), motor and cognitive development (Bayley Scales of Infant Development) were assessed. **Results:** EXP improved overall safety skills score ( $P = 0.04$ ), toddlers' abilities to climb over a small-runged A-frame while using a cylinder grip and safe face-the-slope dismount ( $P = 0.001$ ), and the execution of a safety roll down a foam wedge ( $P = 0.02$ ). Improvements in development as measured by the Bayley's Scales were attributed to typical development rather than the intervention. **Conclusions:** A 9-week, physical activity programme improved toddlers' safety skills but not overall cognitive or motor development.

## Keywords

Pre-School, Cognitive Skill, Safety Skills, Physical Literacy, Fundamental Movement Skills

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## 1. Introduction

Promoting young children's physical activity levels and motor skill proficiency positively contributes to their physical, social and psychological development, resulting in an increased likelihood of an active lifestyle (Lubans et al., 2010). Physical activity is associated with improving children's motor skill proficiency (Barnett et al., 2008b; Sääkslahti et al., 2004) and, when they grow to adolescence, young children with better motor skill proficiency have 10% - 20% higher chance of participating in vigorous physical activity (Barnett et al., 2009), enhanced cardiovascular fitness (Barnett et al., 2008b) and greater perceived sports competence (Barnett et al., 2008a). Children with better motor skills also show enhanced academic (Bittmann et al., 2005) and cognitive skills (Piek et al., 2006). Additionally, associations between motor skill development and injury rate have been reported (Agran et al., 2003). Infants 15 - 17 months old have the highest injury rates of all children before 15 years of age, possibly because the development of the upper body occurs earlier than that of the lower body, thereby enabling children to access more hazards, without having the motor skills to avoid injury (Agran et al., 2003). Fall-related injury accounts for 56% of the hospitalisations of children aged birth to four years in New Zealand (Safekids New Zealand, 2006). Thus, enhancing balance and coordination in infants may be an effective strategy to reduce the risk of fall-related injury.

The effects of physical activity on motor skills and physical activity levels of typically developing young children have been examined in a few intervention studies (Matvienko & Ahrabi-Fard, 2010; Reilly et al., 2006). Reilly et al. (2006) found that a 24-week physical activity intervention of three 30-min sessions per week promoted a significant improvement in 4-year-olds' (n = 545 at baseline) gross motor skills 6 and 12 months after the intervention. Matvienko & Ahrabi-Fard (2010) reported significant improvements in 5 - 7-year-old children's (n = 70) fundamental motor skills following a 4-week intervention that involved a 90-min physical activity session and a 15-min walk per day. A literature review by Altunsöz (2015) suggests that at least 540 min spent on developing children's fundamental movement skills are likely to produce a medium to large effect size. Altunsöz (2015) suggests that developmentally appropriate intervention programmes can improve young children's motor skills and that early intervention is desirable, but more research is needed regarding retention effects and interventions for typically developing children. Furthermore, little is known regarding the effects of physical activity interventions on younger children (birth-5 years).

Research suggests that between 4% - 10% of preschool children are not meeting physical activity guidelines that recommend 180 min of physical activity a day (Goldfield et al., 2012; Hnatiuk et al., 2012). Although there is limited research regarding New Zealand preschool children's physical activity, previous research suggests that teachers may lack knowledge and confidence of how to promote it in childcare (Kolt et al., 2005) and statistics on childhood obesity in New Zealand indicate that sedentary behaviour in homes and early childhood settings is a mitigating factor (Ministry of Health, 2014).

Therefore, we aimed to examine the effects of a physical activity intervention on cognitive, motor, and safety skill development and on balance in typically developing toddlers in New Zealand. We hypothesised that the intervention would positively affect cognitive and motor skill development and improve safety skills and balance in these toddlers. A further aim was to examine the effect of age on typical development of cognitive and motor skill in these New Zealand children.

## 2. Materials and Methods

### 2.1. Participants

Sample size was estimated using data from [Eickmann et al. \(2003\)](#) and an appropriate statistical software package (G-Power 3.1). A sample size of 38 participants per group ( $n = 76$ ) was found to be sufficient to detect an effect size of 0.65 at 80% power and a significance level of 0.05 in the psychomotor development index of the Bayley Scale of Infant Development. In addition, [Onwuegbuzie & Collins \(2007\)](#) suggest that 82 participants in total are sufficient for correlational or causal/comparative mixed-modelling studies. Therefore, based on above and allowing for participant attrition, we aimed to recruit 100 participants for this study.

We successfully recruited 100 toddlers (and their parents/caregivers) for this study using a variety of methods including promotion through local childcare centres, social media, word of mouth, and advertising in cafes. However, due to participant attrition, the data from 90 typically developing toddlers (age  $17.0 \pm 2.6$  months; 52.2% male) and their parents/caregivers from Auckland, New Zealand were used in results. The study was approved by the university's human ethics committee and undertaken with informed consent from the parents/caregivers. For all tests, the trained investigator was blinded to whether or not the children were in the experimental or control groups.

### 2.2. Inclusion Criteria

Participants were required to be available for the 9-week duration of the study and to attend one 60-min class per week with their toddler, if assigned to the intervention group. Participants received their randomised group allocation, achieved with randomisation software (<https://www.randomizer.org/form.htm>) where separate randomisations based on gender were completed. In addition, participants needed to be available for both baseline and post-intervention assessments and be proficient in English. Toddlers were required to meet the criteria for typical development of balance function adapted from [Hsu et al. \(2009\)](#), needed to be able to stand unaided for approximately 20 s, and had not attended *Jumping Beans* classes or similar programmes prior to the study.

### 2.3. Demographic and Anthropometric Information

Demographic information about the toddlers and parents and anthropometric

information of the toddlers at birth was collected through an online questionnaire (**Table 2**). Body mass of each toddler was measured using scales accurate to 0.1 kg and standing height was measured using a stadiometer.

#### 2.4. Bayley Scales of Infant and Toddler Development

Toddlers completed a BSID Screening Test from the Bayley Scales of Infant and Toddler Development Third Edition (BSID-III; Bayley, 2006). The BSID provided information regarding cognition, receptive communication, expressive communication and fine and gross motor skills. The administration of the BSID Screening Test was completed according to the instructions outlined in the Screening Test Manual (Bayley, 2006). Administration of the test took between 15 - 40 min depending on the age and ability of the child, with older, more developed children requiring a longer testing period due to their further progression through the scales. The total sample was split into three age groups that corresponded to the ages set out by the BSID-Screening Test Manual (Bayley, 2006) that relate to the cut scores i.e. three categories of development: “competent”, “emerging” and “at-risk” corresponding to certain raw scores for each subscale.

#### 2.5. Safety Skills

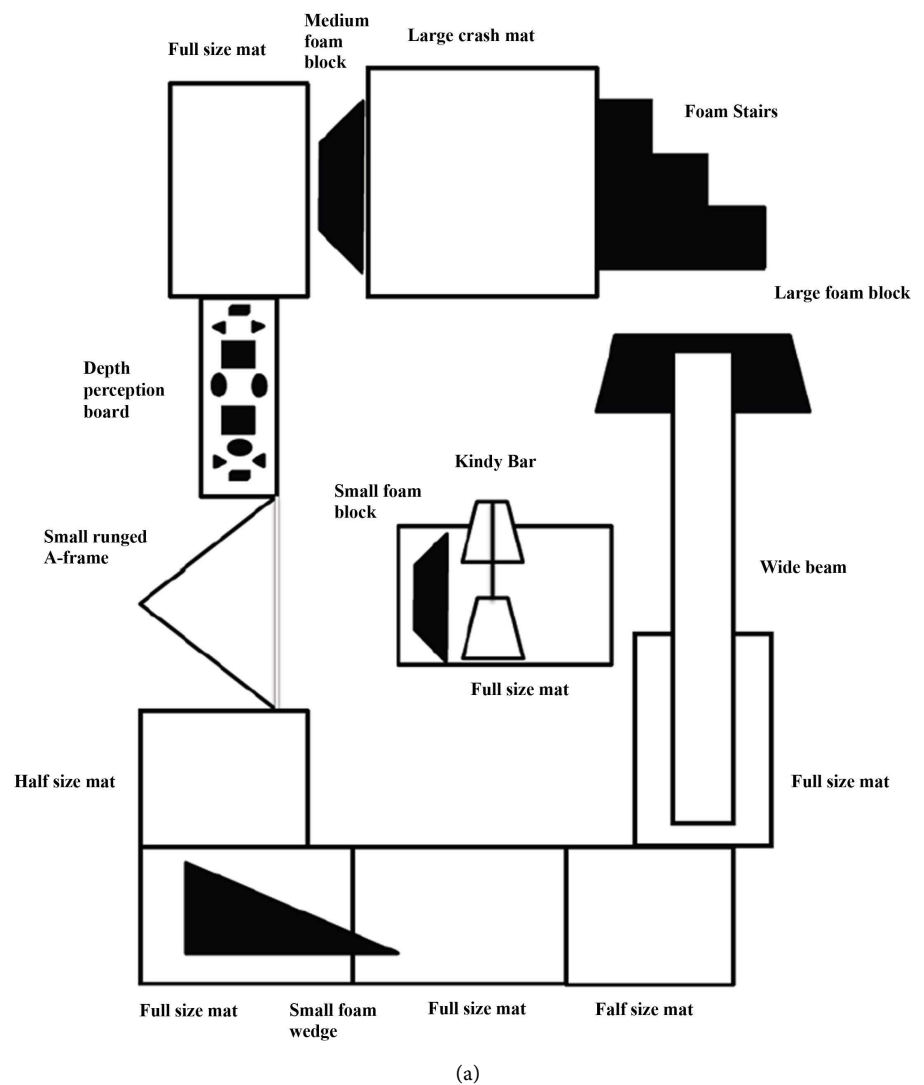
The toddlers were assessed in nine safety skills (**Table 1**), and attempted each skill a maximum of three times, and without assistance from the researcher or parent. The assessment criteria for each skill were based on pilot testing and input from various physical activity instructors. The level of competency for each skill was assessed using a 6-point Likert scale: 0. not attempted; 1. fully assisted; 2. partially assisted; 3. supported; 4. independent; 5. mastery.

**Table 1.** Descriptions of 9-test safety skills battery.

Safety skill	Description
A	Safe climbing down foam stairs facing the slope, from placement at the top of the stairs facing forwards
B	Safe face-the-slope drop from foam block, from placement at the top of the stairs facing forwards or from climbing up and over stairs
C	Jump to land on two feet
D	Walking on stepping stones (depth perception board)
E	Climbing down a small-runged A-frame, from placement at the top of the A-frame or from climbing up and over
F	Climbing over a small-runged A-frame, sitting at top and using cylinder grip and safe face-the-slope, leg-over dismounting techniques
G	Execution of safety roll (Aikido roll) down a foam wedge
H	Locomotion across a wide beam
I	Hanging from a horizontal bar or trapeze, supporting body weight using a whole-hand grip

## 2.6. Physical Activity Intervention

The intervention involved nine weeks of *Jumping Beans* “*Toddler Beans*” classes. Child-centred “*Toddler Beans*” classes cater to children aged approximately 12 - 24 months and are 60 min in duration. These classes incorporate movement to music, ball skills, movement through the custom-designed gym equipment and games using fine manipulative equipment, and have a special focus on learning safety skills (Foster & Hartigan, 2006; **Figure 1**). Activity classes led by qualified instructors begin with free play on the custom-designed equipment. Movement to music, that includes cross-lateral patterning and socialisation aspects, follows free play. The lead instructor then explains the structure and function of the equipment set up and children and parents resume use of equipment with the assistance of two class instructors. Fine manipulative equipment is brought out approximately 15 min before the end of the class. This equipment also changes every two weeks and often includes balls, scarves, feathers, bubbles or spinning tops. A final parachute activity concludes each activity class.





(b)

**Figure 1.** Layout of 9-test battery of safety skills; (a) diagrammatic representation and (b) photographs of layout.

## 2.7. Statistical Analysis

Statistical analysis was completed using the Statistical Package for the Social Sciences (Chicago, IL). All continuous data were inspected visually and statistically for normality and variance. Normally distributed data with equal variance is described using mean  $\pm$  SD and non-normally distributed data using median [25, 75 percentiles]. Categorical data is described using frequency percentages. Independent t-tests (for parametric data) and Mann-Whitney tests (non-parametric data) were used to determine any differences between descriptive characteristics at baseline. Independent t-tests were used to determine the differences between treatment groups in the change variable of each major dependent variable. Analysis of variance (ANOVA) was used to determine the difference between conditions across various age groups. Post-hoc analysis with Bonferroni adjustments determined where the differences lay.

Correlation between outcome measures and anthropometric and demographic variables was assessed using either Pearson's or Spearman's correlation coefficients, dependent on whether data were parametric or not. An  $r$ -value of  $\pm 0.1$  represents a weak correlation,  $\pm 0.3$  a moderate correlation, and  $\pm 0.5$  a strong correlation (Field, 2009). In addition, multiple regression testing was used to examine the associations between outcome measures while controlling for variables that significantly influence the outcome measures. Statistical significance

was considered to exist when  $P < 0.05$ . Effect sizes (Cohen's  $d$ ) were calculated to show practical significance (Field, 2009). Cohen's  $d$  effect size values of  $\pm 0.20$  represent a small effect,  $\pm 0.50$  a medium effect and  $\pm 0.80$  a large effect (Leech et al., 2008).

### 3. Results

#### 3.1. Descriptive Characteristics

The intervention and control groups were closely matched at baseline, with the only notable difference being birth order (Table 2).

#### 3.2. Safety Skills

##### *Total Safety Skill Score*

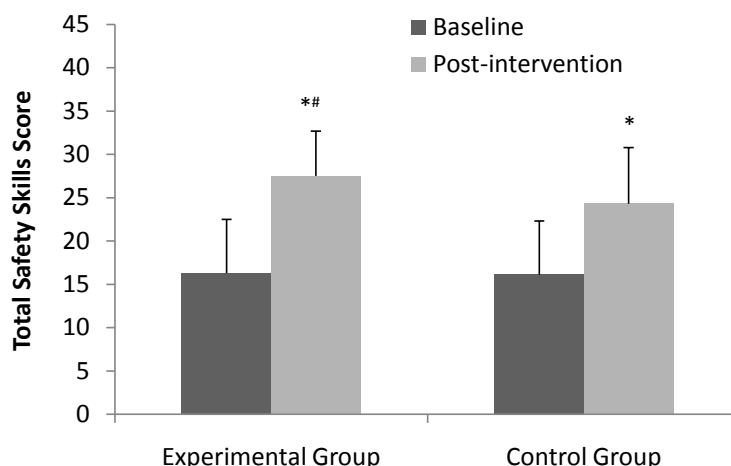
On average, EXP demonstrated a significant improvement in the post-intervention safety skills total score ( $P = 0.04$ ). There was a medium effect of the physical activity programme on the post-intervention safety skills total score in EXP ( $P = 0.02$ ,  $d = 0.53$ ) which was also reflected in the change in total score. Safety skill scores at post-intervention were greater than the total safety skills scores at baseline in both the intervention group ( $P < 0.01$ ) and the control group ( $P < 0.01$ ; Figure 2). Age group did not account for the changes in total safety skills ( $P = 0.12$ ), however, the change in total safety skills score was significantly correlated with being the youngest child in the family ( $r_{pb} = 0.22$ ,  $P = 0.04$ ).

**Table 2.** Descriptive characteristics of participants ( $n = 90$ ).

	Experimental ( $n = 45$ )	Control ( $n = 45$ )	$P$ -value
Age (months)	17.2 $\pm$ 2.5	16.9 $\pm$ 2.6	0.51
Sex (% male)	53.3%	51.1%	0.83
Height (cm)	80.0 [76.0, 81.0]	80.0 [75.5, 82.5]	0.72
Mass (kg)	11.4 $\pm$ 1.5	11.4 $\pm$ 1.4	0.89
Birth weight (kg)	3.4 $\pm$ 0.5	3.4 $\pm$ 0.7	0.74
Head circumference (cm)	34.7 $\pm$ 1.6	34.4 $\pm$ 1.6	0.48
Mother's age group 31 - 35 years	37.8%	44.4%	0.36
Father's age group 31 - 35 years	28.9%	44.4%	0.50
Mother's education level (% tertiary)	86.7%	95.6%	0.14
Father's education level (% tertiary)	77.8%	95.6%	0.38
Gestational term (37 - 42 weeks)	97.8%	95.6%	0.56
Ethnicity (% Pākehā; NZ European)	82.2%	84.4%	0.81
Birth order (% youngest born)	57.8%	35.6%	0.04*
Day-to-day care environment (% mostly home care with parent)	68.9%	68.9%	0.95

\*Significant difference between groups ( $P < 0.05$ ). Note: Demographic information about the toddlers and parents and anthropometric information of the toddlers at birth was collected through an online questionnaire.





**Figure 2.** Mean safety skills total score ( $\pm$ SD) at baseline and post-intervention in the experimental and control groups.

### ***Individual Safety Skills Scores***

All individual safety skills improved over the duration of the study within both treatment groups ( $P < 0.01$ ). The ability to climb over the small-runged A-frame while using a cylinder grip and safe face-the-slope, leg-over dismount (Skill F;  $P = 0.001$ ) and the execution of a safety roll (Skill G;  $P = 0.02$ ) were significantly improved for those toddlers in the intervention group (Table 3). While age group did not account for the change in Skill F ( $P = 0.19$ ) nor on the change in Skill G ( $P = 0.32$ ), the changes in Skill F and G were both positively correlated with being the youngest in the family ( $r_{pb} = 0.25$ ,  $P = 0.02$  and  $r_{pb} = 0.29$ ,  $P = 0.01$  respectively).

### ***Regression analysis***

A hierarchical multiple linear regression showed that birth order significantly predicted the change in total safety skills score ( $P = 0.04$ , adjusted  $R^2 = 0.038$ ), with only 3.8% of the variance in the change in total safety skills score predicted by knowing whether the child was the youngest born or not. Knowing the sex of the toddler and whether they were the youngest in the family ( $P = 0.02$ , adjusted  $R^2 = 0.064$ ) predicted 6.4% of the variance in the change in total safety skills score. A forward step-wise linear regression demonstrated that birth order significantly predicted the change in Skill F score ( $P = 0.02$ , adjusted  $R^2 = 0.051$ ), however, as indicated by the adjusted  $R^2$ , only 5.1% of the variance in the change in Skill F score could be predicted by knowing whether the child was the youngest born or not. Birth order also significantly predicted the change in Skill G score ( $P = 0.007$ , adjusted  $R^2 = 0.072$ ). However, only 7.2% of the variance in the change in Skill G score could be predicted by knowing whether the child was the youngest born or not.

## **3.3. BSID-Screening Test**

### ***Cognitive ability subscale***

One significant post-intervention difference was found between treatment

**Table 3.** Mean ( $\pm$ SD) individual safety skills scores (each out of 5) at baseline, post-intervention and the difference between baseline and post-intervention

Safety Skills	Experimental Group			Control Group		
	Baseline	Post	Difference	Baseline	Post	Difference
A	1.6 $\pm$ 0.9	2.5 $\pm$ 0.7*	0.9 $\pm$ 1.2	1.8 $\pm$ 0.9	2.6 $\pm$ 0.8*	0.8 $\pm$ 1.2
B	2.1 $\pm$ 0.7	3.2 $\pm$ 0.9*	1.1 $\pm$ 1.1	1.8 $\pm$ 0.9	2.9 $\pm$ 0.9*	1.0 $\pm$ 1.2
C	1.1 $\pm$ 0.8	2.1 $\pm$ 1.0*	1.0 $\pm$ 1.1	0.9 $\pm$ 0.4	2.0 $\pm$ 1.2*	1.2 $\pm$ 1.1
D	2.1 $\pm$ 0.9	3.0 $\pm$ 0.8*	0.9 $\pm$ 1.2	2.1 $\pm$ 1.1	2.7 $\pm$ 1.1*	0.7 $\pm$ 1.4
E	2.1 $\pm$ 1.1	3.4 $\pm$ 0.8*	1.3 $\pm$ 1.3	2.0 $\pm$ 1.0	2.9 $\pm$ 0.7*	0.9 $\pm$ 1.2
F	1.5 $\pm$ 0.8	3.3 $\pm$ 1.0*	1.8 $\pm$ 1.1 <sup>#</sup>	1.6 $\pm$ 0.9	2.5 $\pm$ 1.0*	1.0 $\pm$ 1.2
G	1.6 $\pm$ 0.9	3.0 $\pm$ 0.5*	1.4 $\pm$ 1.1 <sup>ω</sup>	1.7 $\pm$ 1.0	2.5 $\pm$ 0.8*	0.8 $\pm$ 1.2
H	2.1 $\pm$ 1.2	3.4 $\pm$ 1.1*	1.3 $\pm$ 1.1	2.1 $\pm$ 1.2	2.9 $\pm$ 1.2*	0.9 $\pm$ 1.5
I	2.0 $\pm$ 1.3	3.5 $\pm$ 1.2*	1.4 $\pm$ 1.8	2.2 $\pm$ 1.2	3.2 $\pm$ 1.3*	0.9 $\pm$ 1.5

\*Significant difference from baseline score ( $P < 0.01$ ); <sup>#</sup>Significant difference from control group ( $P < 0.01$ ); <sup>ω</sup>Significant difference from control group ( $P < 0.05$ ).

groups, in terms of cognitive ability: in Age Group 2 only, toddlers from the control group demonstrated greater improvements in cognitive ability than those from the intervention group (EXP vs. CON,  $1.6 \pm 4.5$  vs.  $5.2 \pm 2.4$ ,  $P = 0.01$ ,  $d = -0.25$ ). No other significant cognitive differences were found between treatment groups, however, within both the intervention and control groups, Age Group 1 toddlers demonstrated a significantly greater improvement in cognitive ability (TOTAL,  $4.9 \pm 4.7$ ,  $P < 0.001$ ; EXP,  $4.8 \pm 5.0$ ,  $P = 0.001$ ; CON,  $5.0 \pm 4.6$ ,  $P = 0.001$ ) than those in Age Group 3 (TOTAL,  $-1.2 \pm 3.7$ ; EXP  $-1.7 \pm 2.6$ ; CON,  $-0.8 \pm 4.5$ ). Within the control group and within the total sample, Age Group 2 cognitive ability improved more than Age Group 3 (TOTAL,  $3.3 \pm 4.0$ ,  $P < 0.001$ ; CON,  $5.2 \pm 2.4$ ,  $P = 0.001$ ).

#### ***Receptive communication subscale***

There were no significant differences between treatment groups in terms of the change in receptive communication. However, toddlers in Age Group 1 showed greater improvements in receptive communication (TOTAL,  $5.0 \pm 4.6$ ,  $P < 0.001$ ; EXP,  $4.7 \pm 5.0$ ,  $P = 0.02$ ; CON,  $6.6 \pm 4.1$ ,  $P < 0.001$ ) than those in Age Group 3 (TOTAL,  $-0.6 \pm 4.1$ ; EXP,  $-0.8 \pm 4.0$ ; CON,  $-0.5 \pm 4.3$ ). Furthermore, Age Group 2 demonstrated greater improvement in receptive communication (TOTAL,  $3.7 \pm 5.5$ ,  $P = 0.003$ ; CON,  $4.0 \pm 4.7$ ,  $P = 0.03$ ) than Age Group 3, within the control group and the total sample.

#### ***Expressive communication subscale***

There were no differences between treatment groups in terms of the change in expressive communication score. Again, differences in age groups were apparent, with toddlers in Age Group 1 showing more improvement in expressive communication (TOTAL,  $3.2 \pm 4.6$ ,  $P = 0.01$ ; CON  $3.2 \pm 4.4$ ,  $P = 0.05$ ) than those in Age Group 3 (TOTAL,  $-0.1 \pm 4.1$ ,  $P = 0.03$ ; CON,  $-0.3 \pm 3.4$ ,  $P = 0.01$ ), within both the total sample and the control group. Changes in expressive

communication were also greater for children in Age Group 2 (TOTAL,  $2.9 \pm 4.3$ ; CON,  $4.0 \pm 3.4$ ) than those in Age Group 3, within the control group and total sample.

#### ***Fine motor skill subscale***

There were no significant fine motor skill differences between treatment groups, however, Age Group 1 showed greater improvement in fine motor skills (TOTAL,  $2.1 \pm 2.8$ ,  $P < 0.01$ ; CON  $1.8 \pm 2.3$ ,  $P = 0.01$ ) than Age Group 3 (TOTAL,  $-0.3 \pm 2.6$ ; CON,  $-0.7 \pm 2.5$ ). Also, Age Group 2 fine motor skills improved more (TOTAL,  $2.2 \pm 2.3$ ,  $P = 0.001$ ; CON,  $3.1 \pm 1.9$ ,  $P < 0.001$ ) than Age Group 3, within the control group and total sample.

#### ***Gross motor skill subscale***

Age Group 2 CON exhibited greater improvements in their gross motor skill than the Age Group 2 EXP (EXP vs. CON,  $0.9 \pm 1.9$  vs.  $3.0 \pm 2.8$ ;  $P = 0.03$ ,  $d = 0.88$ ). Changes in gross motor skills were also apparent across age groups, with greater gross motor skill improvement in Age Group 1 (TOTAL,  $3.4 \pm 3.1$ ,  $P < 0.001$ ; EXP,  $3.1 \pm 3.0$ ,  $P = 0.05$ ; CON,  $3.7 \pm 3.4$ ,  $P = 0.006$ ) than in Age Group 3 (TOTAL,  $0.2 \pm 3.3$ ; EXP,  $0.5 \pm 3.5$ ; CON,  $-0.1 \pm 3.3$ ). Age Group 2 gross motor skills improved more (CON,  $3.0 \pm 2.8$ ,  $P = 0.04$ ) than Age Group 3, within the control group only.

#### ***Correlations***

There were high positive correlations between the change scores of all subscales of the BSID ( $P < 0.01$ ). All subscales were negatively correlated with children's height and age at baseline ( $r = -0.35$  to  $r = -0.59$ ;  $P < 0.01$ ). Changes in cognitive ability ( $r = 0.24$ ), receptive communication ( $r = 0.21$ ) and expressive communication ( $r = 0.31$ ) were positively correlated with the child being in-home care ( $P < 0.05$ ). Due to the high correlations between the subscales of the BSID Test, further analysis was completed using the change in total development score. Similarly, due to the high correlation between height at baseline and age group ( $r = 0.57$ ,  $P < 0.001$ ) further analysis was completed using age group only. Age Group significantly predicted the change in total development score ( $P < 0.01$ , adjusted  $R^2 = 0.24$ ). Being cared for at home improved prediction of the change in total development score ( $P < 0.01$ , adjusted  $R^2 = 0.28$ ). Therefore, being in the younger age groups contributes most to predicting the improvement in development, but the day-to-day environment of the child also contributes to this prediction.

## **4. Discussion**

This was the first randomised control trial that examined the effects of a child-centred physical activity programme on overall development, safety skills and balance in typically developing 12 - 24-month-old toddlers, in New Zealand. The main finding was that the intervention improved toddlers' score within a battery of safety skills, but did not affect overall cognitive or motor development. Moreover, younger children (12 - 18 months) tended to be more likely to show greater improvements in all developmental subscales as compared to older

children (18 - 24 months).

Safety skills improved in the toddlers as a result of the physical activity classes. In particular, the ability to climb over a small-runged A-frame while using a cylinder grip, safe face-the-slope dismount, and the execution of a safety roll down a foam wedge was significantly improved. Although this study did not examine the effect of learning safety skills on the risk of injury from falls, anecdotal evidence suggests that attending these types of physical activity classes has some success in both reducing falls and injury from falls (Foster & Hartigan, 2006). Notably, toddlers who were youngest in their family, regardless of treatment group, were more likely to have a greater improvement in the total safety skills score and in particular Safety Skill F and G. The reasons underpinning the association between birth order and safety skills development in this study are unknown, however, it is possible that factors such as time spent with parent or siblings and older peers or enhanced parental learning may contribute to this association. More research is warranted to examine these issues further.

Non-significant improvements in cognitive and motor development occurred between baseline and post-intervention for the total sample. Possibly, these improvements can be attributed to typical development. This is supported by the age-group analysis that showed younger toddlers (12 - 18 months) were more likely to have greater improvements in all subscales of development than older toddlers (18 - 24 months). As the early work of Bayley (Bayley, 1936) suggests, development, particularly motor control, occurs very rapidly until approximately 21 months and then slows down. Therefore, it may be more appropriate to design interventions after children reach 21 months to help factor out changes due to typical development. However, as development of neural pathways occurs most rapidly in the first two years, there is an argument for the earlier the better (with regards to physical activity intervention).

A longer or more intense intervention may have had more impact on the toddlers' cognitive and motor skills (Altunsöz, 2015; Matvienko & Ahrabi-Fard, 2010; Reilly et al., 2006). While many intervention studies have concentrated on children with neurological or motor deficits or as prevention programmes for children at risk of obesity (Angulo-Barroso et al., 2008; Bluford et al., 2007; Valvano & Rapport, 2006), more research is needed regarding the design and effect of interventions for typically developing children (Altunsöz, 2015), particularly young children and toddlers. Moreover, the BSID screening test, which was designed predominantly to detect if children are progressing according to normal expectations (Bayley, 2006), may not have been sensitive enough to detect the impact of a nine-week intervention in this particular typically developing sample.

Another key result of this study was that almost one third (27.8%) of the change in overall development can be predicted by knowing the age of the child and whether they are primarily in a home-care environment. Children in child-care are less likely to achieve daily requirements for physical activity than child-

ren at home, but physical activity is influenced by gender, weight, ethnicity and parental patterns of activity (Campbell & Hesketh 2007). There is an established link between parental education, parental physical activity and eating habits and child outcomes (Østbye et al., 2013) however literature regarding the associations between attending childcare and physical activity is equivocal. Knowing whether a child attends childcare or not, may not be sufficient to determine the contributing effect on physical activity or development. A number of studies have reported that children attending early childhood centres with supportive environments, including opportunities to be active, appropriate play equipment, and a sufficient amount of space both indoors and outdoors, are more likely to achieve higher levels of moderate to vigorous physical activity (MVPA) than children attending less supportive early childhood centres (Bower et al., 2008; Gubbels et al., 2012). Gubbels et al. (2012) reported that attending an early childhood centre between the ages of one and two years was positively associated with a greater increase in body mass index. Sugiyama et al. (2012) reported that children who attended early childhood centres were mostly sedentary and spent between 12 - 36 min per day in MVPA, results supported by Pate et al. (2008) who reported that children were engaged in MVPA for less than 3% of observation intervals. Further research is required to examine the effectiveness of teachers' practices in supporting infants' and toddlers' physical activity and development in the childcare setting.

There were a number of limitations with this study that should be addressed for future research. The short-duration intervention may have limited the potential improvements in all of the safety skills and overall development, or, it may be that toddlers require longer interventions than older children to enhance fundamental movement skills. Matvienko & Ahrabi-Fard (2010) showed improvements in fundamental movement skills in 5 - 7-year-olds following a 4-week physical activity intervention; we see a need for further research regarding the effectiveness of interventions, particularly for typically developing toddlers. Due to the time constraints of this study, it was not possible to achieve reliability and validity testing prior to data collection. Therefore, unestablished methodology was used to assess safety skills, ergo, data presented is not necessarily reliable and valid. However, the testing was conducted by an investigator who was blinded to whether children were in the experimental or control groups, and not involved in delivery of the classes. Finally, due to the differences between the sample in this study and the demographics of New Zealand, any results from this study cannot be generalised to wider populations. However, it is tempting to speculate that the physical activity intervention may have been more beneficial in lower socioeconomic groups as our cohort came from a predominantly affluent, New Zealand European background. Research into the impact of physical activity classes within different socioeconomic and ethnic groups is certainly warranted; in New Zealand children living in socioeconomically deprived areas (65% of Māori and 78% of Pacific Island people live in socioeconomically deprived neighbourhoods) are more likely to be obese and tend to

engage in sedentary behaviours more often (Ministry of Health, 2014).

## 5. Conclusion

The aim of this study was to examine the effects of a 9-week, child-centred physical activity programme on overall development, safety skills and balance in 12 - 24-month-old toddlers. The physical activity programme significantly improved total safety skills score, particularly the ability to climb over the 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. However, there were no significant improvements in overall development that can be attributed to the intervention. Younger children (12 - 18 months) tended to be more likely to show greater improvements in all developmental subscales as compared to older children (18 - 24 months) and it is possible that any development improvements in overall development are a result of typical development. Almost one third (27.8%) of the change in overall development can be predicted by knowing the age of the child and whether their day-to-day environment is mostly home care with their parent or other adults, or not. This suggests that future studies should examine children's day-to-day environments, which have the potential to affect a variety of outcome variables.

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## Conflicts of Interest

When the study was completed there were no conflicts of interest; data analysis and draft write-up was conducted by DP (recipient of a Ministry of Science and Innovation Education Fellowship for this study). One of the authors (AA) is currently a partner of Jumping Beans Ltd.

## References

- Agran, P. F., Anderson, C., Winn, D., Trent, R., Walton-Haynes, L., & Thayer, S. (2003). Rates of Pediatric Injuries by 3-Month Intervals for Children 0 to 3 Years of Age. *Pediatrics*, *111*, e683-e692. <https://doi.org/10.1542/peds.111.6.e683>
- Altunsöz, I. H. (2015). Motor Skills Interventions for Young Children. *Journal of Physical Education and Sports Science*, *9*, 133-148.
- Angulo-Barroso, R., Burghardt, A. R., Lloyd, M., & Ulrich, D. A. (2008). Physical Activity in Infants with Down Syndrome Receiving a Treadmill Intervention. *Infant Behavior and Development*, *31*, 255-269. <https://doi.org/10.1016/j.infbeh.2007.10.003>
- Barnett, L. M., Morgan, P. J., van Beurden, E., & Beard, J. R. (2008a). Perceived Sports Competence Mediates the Relationship between Childhood Motor Skill Proficiency and Adolescent Physical Activity and Fitness: A Longitudinal Assessment. *International Journal of Behavioral Nutrition and Physical Activity*, *5*, 40-52.

- <https://doi.org/10.1186/1479-5868-5-40>
- Barnett, L. M., van Beurden, E., Morgan, P. J., Brooks, L. O., & Beard, J. R. (2009). Childhood Motor Skill Proficiency as a Predictor of Adolescent Physical Activity. *Journal of Adolescent Health, 44*, 252-259. <https://doi.org/10.1016/j.jadohealth.2008.07.004>
- Barnett, L. M., van Beurden, E., Morgan, P. J., Brooks, L. O., & Beard, J. R. (2008b). Does Childhood Motor Skill Proficiency Predict Adolescent Fitness? *Medicine & Science in Sports & Exercise, 40*, 2137-2144. <https://doi.org/10.1249/MSS.0b013e31818160d3>
- Bayley, N. (2006). *Bayley Scales of Infant and Toddler Development 3rd Edition: Screening Test Manual*. San Antonio, TX: Harcourt Assessment, Inc. <https://doi.org/10.1037/t14978-000>
- Bayley, N. (1936). The Development of Motor Abilities during the First Three Years: A Developmental Study of Sixty-One Infants Tested Repeatedly. *Monographs of the Society for Research in Child Development, 1*, 26-61. <https://doi.org/10.2307/1165480>
- Bittmann, F., Gutschow, S., Luther, S., Wessel, N., & Kurths, J. (2005). On the Functional Relationship between Postural Motor Balance and Performance at School. *Deutsche Zeitschrift für Sportmedizin, 56*, 348-352.
- Bluford, D. A., Sherry, B., & Scanlon, K. S. (2007). Interventions to Prevent or Treat Obesity in Preschool Children: A Review of Evaluated Programs. *Obesity, 15*, 1356-1372. <https://doi.org/10.1038/oby.2007.163>
- Bower, J. K., Hales, D. P., Tate, D. F., Rubin, D. A., Benjamin, S. E., & Ward, D. S. (2008). The Childcare Environment and Children's Physical Activity. *American Journal of Preventive Medicine, 34*, 23-29. <https://doi.org/10.1016/j.amepre.2007.09.022>
- Campbell, K. J., & Hesketh, K. D. (2007). Strategies Which Aim to Positively Impact on Weight, Physical Activity, Diet and Sedentary Behaviours in Children from Zero to Five Years. A Systematic Review of the Literature. *Obesity Reviews, 8*, 327-338. <https://doi.org/10.1111/j.1467-789X.2006.00305.x>
- Eickmann, S. H., Lima, A. C., Guerra, M. Q., Lima, M. C., Lira, P. I., Huttly, S. R., & Worth, A. A. (2003). Improved Cognitive and Motor Development in a Community-Based Intervention of Psychosocial Stimulation in Northeast Brazil. *Developmental Medicine & Child Neurology, 45*, 536-541. <https://doi.org/10.1111/j.1469-8749.2003.tb00953.x>
- Field, A. (2009). *Discovering Statistics Using SPSS* (3rd ed.). Singapore: SAGE Publications Asia-Pacific.
- Foster, S., & Hartigan, J. (2006). *Move, Baby, Move*. Random House, Auckland, New Zealand.
- Goldfield, G. S., Harvey, A., Grattan, K., & Adamo, K. B. (2012). Physical Activity Promotion in the Preschool Years: A Critical Period to Intervene. *International Journal of Environmental Research and Public Health, 9*, 1326-1342. <https://doi.org/10.3390/ijerph9041326>
- Gubbels, J. S., Van Kann, D. H., & Jansen, M. W. (2012). Play Equipment, Physical Activity Opportunities, and Children's Activity Levels at Childcare. *Journal of Environmental and Public Health, 2012*, Article ID: 326520. <https://doi.org/10.1155/2012/326520>
- Hnatiuk, J., Ridgers, N. D., Salmon, J., Campbell, K., McCallum, Z., & Hesketh, K. (2012). Physical Activity Levels and Patterns of 19-Month-Old Children. *Medicine & Science in Sports & Exercise, 44*, 1715-1720. <https://doi.org/10.1249/MSS.0b013e31825825c4>
- Hsu, Y., Kuan, C., & Young, Y. (2009). Assessing the Development of Balance Function in Children Using Stabilometry. *International Journal of Pediatric Otorhinolaryngology, 73*, 737-740. <https://doi.org/10.1016/j.ijporl.2009.01.016>

- Kolt, G. S., Schofield, G. M., McLachlan, C. J., Oliver, M., Lucas, P., Maddison, R., & Walters, S. (2005). *Active Movement: Scoping Exercise and Programme Evaluation*. Auckland: Centre for Physical Activity and Nutrition Research, Auckland University of Technology.
- Leech, N. L., Barrett, K. C., & Morgan, G. A. (2008). *SPSS for Intermediate Statistics: Use and Interpretation*. New York, NY: Taylor & Francis Group.
- Lubans, D. R., Philip, J. M., Dylan, P. C., Barnett, L. M., & Okely, A. D. (2010). Fundamental Movement Skills in Children and Adolescents: Review of Associated Health Benefits. *Sports Medicine*, *40*, 1019-1035. <https://doi.org/10.2165/11536850-000000000-00000>
- Matvienko, O., & Ahrabi-Fard, I. (2010). The Effects of a 4-Week After-School Program on Motor Skills and Fitness of Kindergarten and First-Grade Students. *American Journal of Health Promotion*, *24*, 299-303. <https://doi.org/10.4278/ajhp.08050146>
- Ministry of Health (2014). *Annual Update of Key Results 2013/14: New Zealand Health Survey*. Wellington: Ministry of Health. [http://www.moh.govt.nz/notebook/nbbooks.nsf/0/997AF4E3AAE9A767CC257F4C007DDD84/\\$file/annual-update-key-results-2014-15-nzhs-dec15-1.pdf](http://www.moh.govt.nz/notebook/nbbooks.nsf/0/997AF4E3AAE9A767CC257F4C007DDD84/$file/annual-update-key-results-2014-15-nzhs-dec15-1.pdf)
- Onwuegbuzie, A. J., & Collins, K. M. (2007). A Typology of Mixed Methods Sampling Designs in Social Science Research. *The Qualitative Report*, *12*, 281-316.
- Østbye, T., Malhotra, R., Stroo, M., Lovelady, C., Brouwer, R., Zucker, N., & Fuemmeler, B. (2013). The Effect of the Home Environment on Physical Activity and Dietary Intake in Preschool Children. *International Journal of Obesity*, *37*, 1314-1321. <https://doi.org/10.1038/ijo.2013.76>
- Pate, R. R., McIver, K., Dowda, M., Brown, W. H., & Addy, C. (2008). Directly Observed Physical Activity Levels in Preschool Children. *Journal of School Health*, *78*, 438-444. <https://doi.org/10.1111/j.1746-1561.2008.00327.x>
- Piek, J. P., Baynam, G. B., & Barrett, N. C. (2006). The Relationship between Fine and Gross Motor Ability, Self-Perceptions and Self-Worth in Children and Adolescents. *Human Movement Science*, *25*, 65-75. <https://doi.org/10.1016/j.humov.2005.10.011>
- Reilly, J. J., Kelly, L., Montgomery, C., Williamson, A., Fisher, A., McColl, J. H., & Grant, S. (2006). Physical Activity to Prevent Obesity in Young Children: Cluster Randomised Controlled Trial. *BMJ*, *333*, 1041-1043. <https://doi.org/10.1136/bmj.38979.623773.55>
- Sääkslahti, A., Numminen, P., Varstala, V., Helenius, H., Tammi, A., Viikari, J., & Välimäki, I. (2004). Physical Activity as a Preventive Measure for Coronary Heart Disease Risk Factors in Early Childhood. *Scandinavian Journal of Medicine & Science in Sports*, *14*, 143-149. <https://doi.org/10.1111/j.1600-0838.2004.00347.x>
- Safekids New Zealand (2006). *Factsheet: Childhood Fall Injury*. Auckland: Safekids New Zealand.
- Sugiyama, T., Okely, A. D., Masters, J. M., & Moore, G. T. (2012). Attributes of Child Care Centers and Outdoor Play Areas Associated with Preschoolers' Physical Activity and Sedentary Behavior. *Environment and Behavior*, *44*, 334-349. <https://doi.org/10.1177/0013916510393276>
- Valvano, J., & Rapport, M. J. (2006). Activity-Focused Motor Interventions for Infants and Young Children with Neurological Conditions. *Infants Young Children*, *19*, 292-307. <https://doi.org/10.1097/00001163-200610000-00003>