

# Feasibility and potential efficacy of Movement-Active-Physical-Play (M.A.P.P) physical activity program in New Zealand's early childhood education centres: A pilot cluster-randomised controlled trial

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## Abstract

**Objective:** To determine feasibility and potential efficacy of the M.A.P.P physical activity program in early childhood education (ECE) centres.

**Method:** Four ECE centres were randomised to intervention (n=2) or control (n=2). Participants included 46 children (3.9 ± 0.5 years, M = 22, F = 24), 8 female leaders, and 20 female teachers. The 10-week online M.A.P.P. intervention aimed to improve physical activity (PA) levels and the quality of movement environments. Potential efficacy was assessed using accelerometry; feasibility was explored via observations and interviews.

**Results:** Programme adherence was high (80%). Teachers, leaders and children reported M.A.P.P as enjoyable. No significant intervention effects were found for sedentary behaviour ( $\beta = 1.14$ , 95% confidence interval (CI): [-7.00, 9.27],  $p=0.244$ ), light PA ( $\beta = 11.5$ , 95% CI: [-0.97, 23.9],  $p=0.367$ ), moderate PA ( $\beta = -10.8$ , 95% CI: [-22.1, 0.49],  $p=0.685$ ), vigorous PA ( $\beta = -1.98$ , 95% CI: [-6.48, 2.51],  $p=0.458$ ), moderate-to-vigorous intensity PA ( $\beta = -13.5$ , 95% CI: [-27.1, 0.125],  $p=0.849$ ).

**Conclusions:** M.A.P.P. is feasible in ECE centres but its effects on PA require further investigation.

**Implications for public health:** Supporting ECE teachers to promote PA may provide public health benefits in early childhood.

**Key words:** physical activity, children, early childhood education

## Introduction

Optimal levels of physical activity (PA) and sedentary behaviour (SB) are critical for young children's health and development<sup>1</sup>, and PA is among the primary modifiable risk factors for the development of overweight and obesity in young children.<sup>2</sup> Thus, the importance of PA and movement in early childhood is increasingly being acknowledged by teachers, health professionals and government departments worldwide.<sup>3-5</sup> Importantly, the World Health Organisation recognises the prolonged effects of physical inactivity in children and, in response, have developed a Global Action Plan for Physical Activity, which aims to reduce physical inactivity by 15% by 2030.<sup>6</sup> The current global guidelines recommend that young children aged<sup>3-5</sup> years should

engage in at least 180 minutes of PA including 60 minutes of moderate-to-vigorous intensity PA (MVPA) each day, including both structured and unstructured play.<sup>6</sup> Furthermore, the findings suggest that it is important to establish high levels of MVPA in early childhood as children may then be more likely to maintain higher levels over time.<sup>7</sup>

Although it is not compulsory, almost all New Zealand (NZ) children attend an early childhood education (ECE) centre for a sustained period of time before starting school.<sup>8</sup> Once children reach the age of three years, ECE and care is the norm in the vast majority of the Organization for Economic Cooperation and Development countries, with an average enrolment rate of 74%.<sup>9</sup> ECE has been identified globally as a suitable location to promote PA.<sup>10-12</sup>

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It is widely believed that positive and enjoyable experiences of PA in the early years will encourage children to continue enjoying and benefitting from PA through to adulthood.<sup>13</sup> However, the existing framework of ECE centres does not necessarily support positive and enjoyable experiences of PA as children are conditioned to remain calm and often cautioned for engaging in too much activity or being too loud whilst indoors.<sup>14</sup> Concerningly, approximately 50% of young children do not meet the recommended levels of PA during the childcare day, spending around half of their time in SB activities,<sup>15</sup> even though the promotion of health and wellbeing is a mandated component of ECE centre curricula in NZ.<sup>16</sup>

Within an ECE centre, teachers have an influential role in promoting adequate PA,<sup>17,18</sup> and teacher-facilitated PA sessions have been shown to be feasible and effective in promoting high levels of MVPA.<sup>19–21</sup> However, according to Finch, Jones<sup>22</sup> and Wicks and Barton<sup>23</sup> who compared the interventions delivered by external experts and teachers, found that those interventions delivered by teachers were less effective. Additionally, similar studies in NZ, such as that by McLachlan et al.<sup>24</sup> suggest that more effective teaching practices and curriculum planning may lead to increased PA with enhanced motor skill development and Ali, McLachlan<sup>25</sup> describe a significant barrier to appropriate PA opportunities for young children in ECE centres is teachers' capacities to provide effective programmes.

Of concern, globally, teachers have reported low confidence levels in promoting PA,<sup>26</sup> although the implementation of effective PA requires highly competent ECE centre staff.<sup>5</sup> Remarkably, some teachers perceive PA not to be an issue, potentially due to the misconception that "children are active and full of energy."<sup>27,28</sup> Other variables include teacher behaviours and intentionality, provision of active opportunities, use of outdoor space and service quality.<sup>29</sup>

Previous studies carried out,<sup>30–32</sup> to increase child PA levels during the childcare day via teacher provision include professional development (PD). A common feature of effective interventions is teachers providing daily structured activity to children and limiting these activities to less than 20 minutes.<sup>33,34</sup> Accordingly, the novel 10-week Movement-Active-Physical-Play (M.A.P.P) intervention connects to the unique bi-cultural NZ early years curriculum and is made up of teacher PD and pre-recorded daily activities (15 minutes), refined by end users prior to implementation.

Interventions designed specifically with scalability and sustainability as the fundamental factors are a particular imperative.<sup>5</sup> Hence, supporting teachers as opposed to external experts may provide substantial public health benefits.<sup>3</sup> Due to the limited scope of previous similar interventions in a NZ context, we sought to evaluate the impact of M.A.P.P, delivered by teachers, on the PA levels of children aged 3–5 years attending ECE centre-based childcare.

## Methods

### Study design

A mixed methods approach was selected in this feasibility and potential efficacy study, which is made up of quantitative and qualitative data. This pilot cluster-randomised controlled trial adhered to the CONSORT 2025 Statement: updated guideline for reporting randomised trials<sup>35</sup> and feasibility studies<sup>36</sup> utilising a mixed methods approach. The study was retrospectively registered at

the Australian New Zealand Clinical Trials Registry and can be viewed elsewhere [ACTRN12624000754549](https://www.anzctr.org.au/Trial/Registration/Trial.asp?id=12624000754549).

### Recruitment and participants

Participants include ECE centres, leaders, teachers and children. An invitation to ECE centres (n=225) in one region of NZ to participate in the study was extended via direct email. Recruitment continued until the intended sample of ECE centres volunteered to participate. Leaders/teachers in these ECE centres were then invited to participate and none declined. Each ECE centre, leader and teacher all provided signed written consent. Inclusion criteria were that the ECE centres were licensed within the Ministry of Education region of NZ and teachers were qualified and fully or provisionally registered.

Following consent from the ECE centre recruitment packs for child participants (one per guardian of each enrolled child), a collection box for consent forms were delivered. Inclusion criteria for data collection were that children were aged 3–5 years and had parental/guardian consent. Children provided assent and their legal guardians/parents provided signed written consent. All children had the opportunity to participate in Movement-Active-Physical-Play (M.A.P.P) activities.

ECE centres were randomly allocated (using Microsoft Excel randomisation function, Microsoft(TM), Washington, USA) to the intervention or control (standard practice) group immediately following baseline data collection by the primary author. Ethics approval was obtained from the Auckland University of Technology Ethics Committee, NZ, on 12th April 2022 (Figure 1).

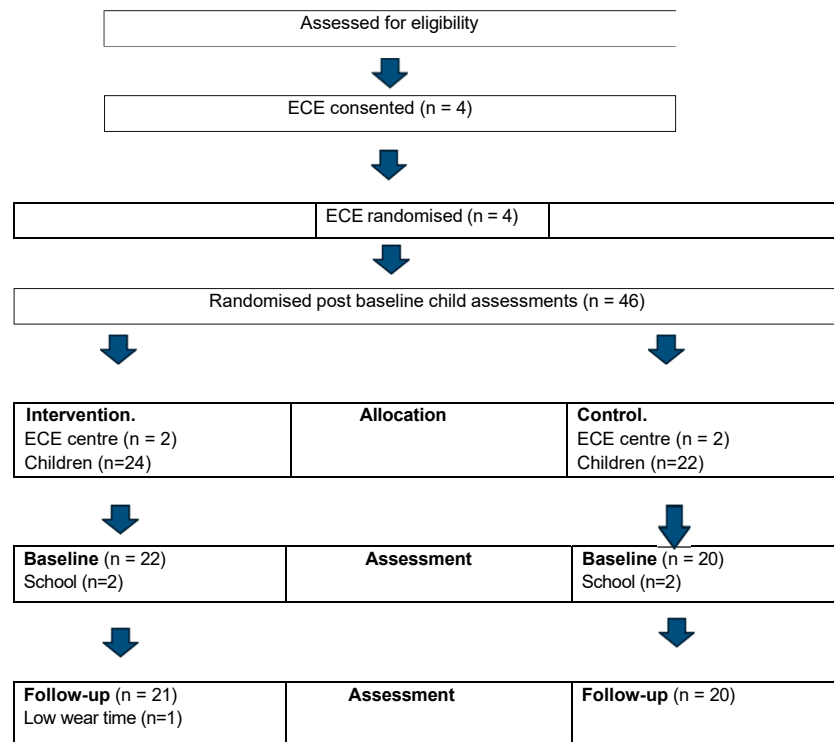
### Intervention

M.A.P.P was underpinned by social cognitive theory,<sup>37</sup> and was inspired by the NZ indigenous peoples' (Māori) holistic model of health.<sup>38</sup> M.A.P.P is connected to the principles, strands, goals and learning outcomes of Te Whāriki (NZ bi-cultural early childhood curriculum) and is designed to improve teachers' self-efficacy in delivering PA during the childcare day to increase PA levels for children. The four components of M.A.P.P each have an associated character with specific active play characteristics and action songs; Movement Max, Active Ann, Physical Piri and Playful Pip.

The 10-week M.A.P.P program, carried out from August to October 2022, was developed by the primary author with feedback from end users (ECE centres n=2 and teachers n=4) prior to the present study. M.A.P.P online PD is made up of an implementation guide, seven narrated webinars, seven readings and fifty pre-recorded activity videos. Teacher PD was self-paced, completed during work hours and took no longer than 30 minutes per session, once per week. Webinars include a M.A.P.P overview, PA in ECE, Active Teaching, Planning for PA, Notice, Recognise and Respond to PA as learning. The pre-recorded activity videos were made up of specific activities related to characters; Monday, balance with Movement Max; Tuesday, fundamental movement skills with Active Ann; Wednesday, power and proprioception with Physical Piri; Thursday, body and spatial awareness with Playful Pip and Friday, active play. Each activity session has predictability and routine with music and movement as the warmup and walking with hand on heart as the cool down.

Each week teachers watch one webinar, engage in the prescribed reading, implement new knowledge in daily practice and deliver a daily (Monday to Friday) 15-minute activity alongside children. Each

Figure 1: Flow of participants through the M.A.P.P study.



webinar, reading and activity builds knowledge on the prior, scaffolding learning for teachers so they can prioritise child interest in intentional planning, spontaneous active play and environmental provocations for PA. The M.A.P.P program has been detailed elsewhere.<sup>39</sup>

### Control

Control ECE continued with their usual PA standard practice.

## Efficacy outcomes

### Accelerometers

To assess the primary outcome (percentage of time that children spent in PA behaviours), reliable and valid Axivity AX3 (Axivity Ltd. Newcastle Upon Tyne, United Kingdom) accelerometers<sup>40</sup> attached to the wrist were used during the childcare day (9.00am to 3.00pm). A day was considered a valid monitoring day if daily wear time was at least 70% of the childcare day. Non-wear time was defined as intervals with at least 20 consecutive minutes of zero counts. Wear time was calculated by subtracting non-wear time from the total monitoring time for the day. The monitor was programmed to store data at second-by-second epoch daily. Wrist-worn accelerometers were fitted when the child arrived at the ECE centre in the morning by a teacher or parent/caregiver and removed when they leave the ECE centre in the afternoon for five days at baseline and five days directly following the 10-week intervention. A standardised monitoring end time of 3.00pm was chosen to align with the typical majority leaving time for children in an ECE centre. The Roscoe and James<sup>41</sup> cut points were used to define the time spent in PA behaviours and were implemented using the GGIR R package.<sup>42</sup>

### Movement Environment Rating Scale

To examine the ECE centre environmental movement quality, the Movement Environment Rating Scale (MOVERS) observation scale<sup>43</sup> was used. The scale comprises 11 items, which are distributed into four subscales. Subscale 1: curriculum, environment and resources for physical development (items 1–4); Subscale 2: pedagogy for physical development (items 5–7); Subscale 3: supporting PA and critical thinking (items 8–10) and Subscale 4: parents/carers and staff (item 11). Each item consists of several indicators that describe practice. Items are rated on a 7-point scale: 1 = inadequate; 3 = minimal; 5 = good and 7 = excellent. The items within each subscale were averaged to form subscale score, and all items were averaged to calculate the total mean score.

The observation was conducted by a non-blinded trained researcher on-site for a full day (9.00 a.m. to 4.00 p.m.) at the baseline and post intervention. This was followed by a discussion with an ECE centre leader and supplemented by a review of documentation, including ECE centre policies to provide additional information to describe teacher practice. Observations took place from August to October 2022.

MOVERS test-retest reliability has been determined previously (intraclass correlation coefficient 0.959;  $p < 0.001$ ), demonstrating excellent reliability (0.904;  $p = 0.001$ ). Internal consistency of the scale has been determined using Cronbach's  $\alpha$ , producing  $\alpha = 0.94$  for the first MOVERS observations and  $\alpha = 0.89$  for the second MOVERS observations.<sup>44</sup>

### Feasibility outcomes

Feasibility was determined by intervention fidelity and acceptability between August and October 2022. An assessment of feasibility and

acceptability is an important part of process evaluation of a novel intervention to highlight study design aspects that may need to be modified.<sup>45</sup>

We assessed self-reported teacher fidelity data, PD webinars completed and M.A.P.P sessions delivered across the 10-week intervention timeframe. An observation by the primary author of one teacher-led M.A.P.P activity session implementation in each intervention ECE centre was carried out to determine programme adherence.

The feasibility questions of the study were to evaluate the acceptability of M.A.P.P in ECE centres with leaders, teachers and children and to determine intention to use M.A.P.P in the future. To answer these feasibility questions, interviews were carried out by the primary author. These interviews were semi-structured, each lasting 30–60 minutes with a casual approach adapted for the specific age group to facilitate engagement. The semi-structured interview is more powerful than other types of interviews for qualitative research because it allows for researchers to acquire in-depth information and evidence from interviewees while considering the focus of the study.<sup>46</sup>

Table 1 describes the child interview questions. Children participated in the group interview if they were attending ECE on that day (n=16).

Table 2 describes the ECE centre leaders and teachers' interview questions. All intervention ECE centre leaders (n=4) and teachers (n=10) participated in an interview.

### Data analysis of efficacy outcomes

Data analysis commenced following the completion of data collection. Individual-level missing outcome data were not imputed, in keeping with the pilot nature of the study. Analyses were based on complete cases. As this trial is pragmatic in intent and design, all efficacy analyses were based on a strictly interpreted intention-to-treat analysis set. PA behaviour data were conveyed in terms of percentage of time spent in each intensity, SB, light PA, moderate PA, vigorous PA and MVPA; the raw minutes in each intensity divided by the total minutes worn, adjusting for any differences in total wear time that might have occurred between the baseline and follow-up time points. Intervention and interaction effects were quantified using generalised linear mixed models, a technique that copes with nested outcomes and not normally distributed data (i.e. children nested within ECE centres was specified as the random effect). The fixed effect was the group (intervention or control) and the dependent variable was the post-intervention outcomes variables (e.g. % of time spent in MVPA). Model covariates were sex (male and female), age (years) and the baseline value of the outcome, to adjust for any imbalances between the intervention and control groups at the baseline.<sup>47</sup> Uncertainty in all estimates were expressed as 95% confidence intervals (CIs).

Table 2: ECE centre leaders/teachers' questions.

Topic area	Questions
Enjoyment	What did you enjoy about the intervention?
	What was your favourite activity and why?
	Was your favourite activity also the children's favourite activity?
	What worked well in the intervention?
Barriers/challenges	What did not work well in the intervention?
	What was the activity that you did not like and why?
	Were there any barriers to implementing the intervention?
Sustainability	Would you do the intervention again?
	Will you carry on using the intervention?

ECE = early childhood education.

MOVERS scores are presented in the form of component (each question and subscale) and overall total score with data expressed as mean  $\pm$  standard deviation.

### Data analysis of feasibility outcomes

As the purpose of the interviews was to explore participants' perspectives of the intervention, a predefined categorisation matrix and coding was developed focusing on important intervention elements, such as barriers to implementation. Segmenting and coding the data allow themes to emerge that were based upon study aims.<sup>48,49</sup> All interviews were audio recorded, and de-identified with each participant assigned a code. Following transcription and re-reading of the transcripts, coding of the transcripts based on the pre-determined categorisation matrix occurred.

## Results

### Recruitment and participants

Participants represented the Hawkes Bay region, (population: 185,000, socio-economic deprivation index: 6.0, slightly above the NZ deprivation index of 5.6) NZ.<sup>50</sup> Four ECE centres, response rate (2.6%), 8 leaders, response rate (100%), 20 teachers, response rate (100%), 46 children (28.2%) provided assent, intervention (n=24) and control (n=22). Lost at the baseline were four participants, two from intervention and two from control due to ceasing attendance at the ECE centre to attend primary school. Lost at follow-up was intervention (n=1) due to low wear time.

Table 3 displays the overall participants' descriptives, children, ECE centres, leaders and teachers.

### Preliminary efficacy

Table 4 displays PA outcomes from baseline to 10-week follow-up. There was no overall significant intervention effect observed. However, a significant interaction effect was observed between sex and moderate-intensity PA ( $p=0.031$ ), and sex and MVPA ( $p=0.013$ ). Time in both intensities decreased for both boys and girls, but to a lesser extent for girls.

### ECE movement environment quality

Table 5 displays MOVERS baseline to follow-up results. Although MOVERS results were not statistically tested, descriptive results for subscale 1 "Curriculum, environment, & resources for physical development" show a mean score increase change for both control

Table 1: Child interview questions.

Topic area	Questions
Enjoyment	What did you like about the programme?
	What was your favourite activity and why?
Barriers/challenges	What didn't you like about the programme?

**Table 3: Overall participant descriptives.**

Children	Intervention	Control	All
	Mean (SD)	Mean (SD)	Mean (SD)
Age	4.0 (0.5)	3.8 (0.5)	3.9 (0.5)
	N	N	N
Ethnicity			
Māori	12	3	15
NZ European	9	9	18
Other	3	10	13
Sex			
Male	9	13	22
Female	15	9	24
Total	24	22	46
ECE centres	2	2	4
ECE leaders	4	4	8
ECE qualified and registered teachers	10	10	20
Sex			
Female	28		28
Male	0		0
Total			28

ECE = early childhood education; SD = standard deviation.

(0.5) and intervention (1.1). Subscale 2 “Pedagogy for physical development” a mean score increase change for both control (0.3) and intervention (1.1). However, S 3 “Supporting physical activity and critical thinking” showed a mean score change decrease for control (-0.4) and an increase for intervention (0.9). Subscale 4 “Parents/carers and staff” showed a mean score decrease for control (-0.5) and no score change for intervention. Total scores showed a decrease in

mean score change for control (-0.1) and increase for intervention (0.7).

### Intervention feasibility

#### Fidelity

A total of seven webinars were completed (100% adherence) by intervention teachers (n=10); however, not all were completed during the childcare day. A total of 40 of the 50 sessions were delivered (80% adherence) by intervention ECE centres (n=2) and no adverse events occurred. Activity session observations by the primary author revealed intervention delivery fidelity adhered to stated activity session programme; however, complete fidelity remains uncertain.

#### Acceptability

Via semi-structured interviews, children described M.A.P.P activities as enjoyable and fun. The specific activity most enjoyed was tug of war where both teachers and children participated together. Teachers noticed how happy children were when participating in activities. Demonstrations of acceptability were manifest in comments such as

“M.A.P.P was fun (with lots of laughing) “... “They all seemed to enjoy it when they were doing it”

When asked about what worked well in the M.A.P.P intervention, teachers described accessibility to online professional learning and pre-recorded activities at a time that was suitable for them. Similarly, the opportunity to increase PA knowledge through narrated webinars and readings to then immediately put that knowledge into practice during the childcare day. Illustrations of increased teacher PA knowledge are

**Table 4: Baseline to follow-up physical activity results.**

	Control		Intervention		Estimated mean difference (Intervention – Control), [95% Confidence interval]	p value	Beta coefficient, [95% confidence interval]	Standard error
	Baseline (n=20) Mean (SD)	Follow-up (n=20) Mean (SD)	Baseline (n=22) Mean (SD)	Follow-up (n=21) Mean (SD)				
Sedentary behaviour (%)								
Overall	24.7 (11.1)	23.7 (11.6)	21.7 (14.6)	24.8 (9.77)	3.52, [-2.41, 9.46]	0.244	1.14, [-7.00, 9.27]	4.15
Girls	25.8 (14.2)	25.9 (11.8)	21.8 (15.9)	23.2 (10.2)				
Boys	24.1 (9.69)	22.3 (11.7)	21.6 (12.9)	28.0 (8.59)				
Light PA (%)								
Overall	16.1 (6.51)	21.4 (19.6)	15.8 (7.63)	18.5 (4.81)	-4.19, [-13.3, 4.91]	0.367	11.5, [-0.971, 23.9]	6.35
Girls	15.0 (6.31)	28.5 (29.0)	15.6 (7.86)	18.1 (4.53)				
Boys	16.7 (6.79)	16.7 (8.27)	16.1 (7.74)	19.2 (5.64)				
Moderate PA (%)								
Overall	50.4 (14.1)	46.8 (16.0)	51.3 (14.1)	48.9 (9.65)	1.71, [-6.54, 9.96]	0.685	-10.8, [-22.1, 0.495]	5.76
Girls	51.7 (18.0)	40.7 (17.0)	51.5 (15.4)	50.6 (10.9)				
Boys	49.7 (12.3)	50.9 (14.5)	51.0 (12.6)	45.6 (5.92)				
Vigorous PA (%)								
Overall	8.76 (3.18)	8.02 (6.22)	11.2 (9.67)	7.77 (5.73)	-1.25, [-4.53, 2.04]	0.458	-1.98, [-6.48, 2.51]	2.29
Girls	7.50 (2.58)	4.88 (3.36)	11.2 (10.4)	8.06 (6.89)				
Boys	9.45 (3.36)	10.1 (6.90)	11.3 (9.02)	7.19 (2.47)				
MVPA (%)								
Overall	59.2 (16.5)	54.8 (20.2)	62.5 (19.8)	56.7 (12.0)	0.968, [-8.97, 10.9]	0.849	-13.5, [-27.1, 0.125]	6.93
Girls	59.2 (19.9)	45.6 (18.9)	62.6 (21.0)	58.6 (13.4)				
Boys	59.1 (15.2)	61.0 (19.4)	62.3 (19.0)	52.7 (7.97)				

ECE = early childhood education; MVPA = moderate-to-vigorous intensity physical activity; PA = physical activity; SD = standard deviation.

Table 5: MOVERS baseline to follow-up results.

	Control			Intervention		
	Baseline (n = 2)	Follow-up (n = 2)	Mean change	Baseline (n = 2)	Follow-up (n = 2)	Mean change
<b>MOVERS</b>						
<b>Subscale 1</b>						
Curriculum, environment, & resources for physical development	3.5 (1.1)	4.0 (0.4)	0.5	3.4 (0.9)	4.5 (0.4)	1.1
<b>Subscale 2</b>						
Pedagogy for physical development	4.2 (0.2)	4.5 (0.2)	0.3	3.6 (0.0)	4.5 (0.2)	1.1
<b>Subscale 3</b>						
Supporting physical activity and critical thinking	3.7 (0.5)	3.3 (0.4)	-0.4	3.3 (0.0)	4.2 (0.2)	0.9
<b>Subscale 4</b>						
Parents/ carers and staff	4.5 (0.7)	4.0 (0.0)	-0.5	4.0 (0.0)	4.0 (0.0)	0.0
<b>Total score</b>	<b>4.0 (0.7)</b>	<b>3.9 (0.5)</b>	<b>-0.1</b>	<b>3.6 (0.4)</b>	<b>4.3 (0.3)</b>	<b>0.7</b>

MOVERS 11 item scale (1= inadequate, 3= minimal, 5= good, 7= excellent).  
MOVERS = Movement Environment Rating Scale.

*“I’ve enjoyed current research and theory because it really validates what we do, it gives us purpose and it gives us meaning about why we do things and why it is so important” ... “I’ve probably enjoyed most the learning side of things and being able to have different experiences to offer the children that I wouldn’t normally do”*

In addition, teachers and leaders described an increase in confidence after taking part in M.A.P.P professional learning, such as

*“I just think M.A.P.P has been really beneficial, when I look at the children before M.A.P.P and then I look at them now, and I look at the teaching team as well I, feel like we are more equipped to notice, recognise and respond to PA as learning”*

One teacher increased their own fitness and sense of wellbeing

*“My fitness has improved too, it’s good for your wellbeing you know a bit of exercise, so it has been good for me”.*

Teachers commented that time to carry out all M.A.P.P components within the childcare day was a challenge, as well as the competing demands of an ECE such as children needing intensive support.

*“Finding the time to deliver activity sessions and complete M.A.P.P professional learning” ... “Everyday busyness of the ECE environment such as mixed age groups and open plan setting”*

Barriers raised by leaders included limited understanding of teacher knowledge regarding PA; therefore, an effect on prioritisation of PA during the childcare day. All teachers commented on the challenges of inconsistent staffing due to either sickness or teacher shortages such as not being able to permanently fill teaching roles.

*“A lack of understanding from teachers regarding the importance of PA for children” ... “In the early stages of bedding in a programme you need consistent staff, and we have not had that”.*

## Discussion

The aims of our study were to determine feasibility and potential efficacy of M.A.P.P. As this was a pilot study with a small sample size, generalisability of the results to broader populations is restricted and the findings should be interpreted in this context. Key findings demonstrate that there was no overall significant intervention effect observed, and time in moderate-intensity PA and MVPA decreased for both boys and girls but to a lesser extent for girls. M.A.P.P was reported as enjoyable by participants and quality of the ECE centre movement environment signalled improvement. Feasibility studies, focusing on fidelity and acceptability, and preliminary evaluations of potential efficacy have provided formative evidence, designed with

scalability and sustainability in mind, to inform the development of future full-scale public health interventions.<sup>45</sup>

Importantly, children in our formative study described M.A.P.P as fun, and intervention teachers reported M.A.P.P worked well with whole staff accessibility and opportunity to immediately implement new knowledge into practice, promoting PA with confidence during the childcare day. Health promotion interventions that can be integrated into daily routines are more likely to be implemented,<sup>51</sup> and similar studies<sup>52</sup> suggest that when teachers facilitate program activities on a daily basis, the fidelity of program implementation is high; thus, teacher facilitation is a strategy that facilitates future sustainability. For changes to be embedded into everyday routines in ECE centres, ongoing PD is critical.<sup>53</sup>

Not surprisingly, Tucker and Bruijns<sup>3</sup> suggest the position of a teacher as an influencer of positive health behaviours and role model in an ECE centre is important. Leaders in our study described teachers as being more equipped to notice, recognise and respond to PA as learning following M.A.P.P PD; therefore, the increase in the quality of the ECE centre movement environments may be attributable to the PD component of M.A.P.P. Our findings complement similar studies such as those of Krogager<sup>11</sup> and Zhang<sup>54</sup> where high quality environments resulted in better outcomes. Zhang and Kuzik<sup>54</sup> found that childcare process quality, particularly curriculum and pedagogy, appeared important to PA in preschoolers, whilst Krogager and Aadland<sup>11</sup> described positive associations between PA and pedagogy, highlighting the importance of teachers promoting children’s PA.

Although our study was not designed to detect significant changes in efficacy outcomes, our results provide a base as formative research for a better informed future full trial, such as that of Bourke and Bruijns<sup>55</sup> who found that an eLearning course was highly successful at improving early childhood educators’ capacity pertaining to PA and SB; furthermore, Carroll and Spring<sup>20</sup> describe that a teacher-guided and -led indoor preschool PA intervention is a feasible approach.

Findings in our study signalled an overall decrease in both moderate-intensity PA and MVPA; however, it is interesting to note, girls to a lesser extent. Similarly, to Engel, Broderick<sup>56</sup> and Pate and Brown<sup>57</sup> found that girls, but not boys, significantly increased MVPA. In contrast, Tonge and Jones<sup>58</sup> reported that boys are typically more active than girls and more likely to meet PA recommendations during

the childcare day as girls generally engage in more sedentary contexts and experiences, such as manipulative, dramatic and fine motor play.<sup>59</sup> M.A.P.P activities were sex-neutral and there was equal sex representation in characters; therefore, it is plausible to suggest that the improvement with girls may be associated with different programme elements such as intentional teacher-led daily PA and active play provocations rather than SB activities. However, boys may prefer active play with peers rather than intentional teacher-led PA.

Interestingly, only one of the four ECE centres in our study had a PA policy in place; however, this policy did not recommend specifics on the amount and type of PA. ECE centres are well placed to influence children's PA behaviours and policies in these settings need to provide specific recommendations on the amount and type of PA children should do in care.<sup>60</sup> In contrast of this view Jerebine, Heering<sup>61</sup> and Jago and Salway<sup>62</sup> describe the significance of the individual context of each ECE centre or school and the perceptions, attitudes and experiences of staff are likely to impact PA provision; therefore, not a one-size-fits-all approach. Both context and cultural considerations would be valuable in the development of the policy, particularly in NZ. Despite the potential influence of ECE centres and teachers on children's PA behaviours, there is clearly a need to support and promote the development of policy and capacity building in this setting. Further, policy is necessary to implement sustainable change in ECE centres to achieve high levels of fidelity and overcome barriers to implementation,<sup>63</sup> identifying the requirement for a whole ECE centre approach to PA promotion during the childcare day supported by strong PA policy, PD and training. Therefore, coupling the implementation of policy with capacity building can improve teachers' practice.<sup>52,64</sup>

A strength of our study is the novel multi-component M.A.P.P intervention, refined by ECE centres prior to implementation, which included a whole ECE centre approach to modify PA practices, also validated and reliable instruments were used to collect data. The mixed method study design approach, qualitative and quantitative data integration enhances overall findings and contributes to a more holistic understanding of the impact of M.A.P.P. However, there are the challenges associated with this design, such as the complexity of data integration and the potential for conflicting results. Further limitations in our study include a small cohort of participants, only one region of NZ and one follow-up time point post intervention. In addition, the challenge of ensuring unbiased questions, especially with spontaneous or unscripted follow-ups in semi-structured interviews and further potential bias due to lack of blinding by the assessor.

## Conclusion

The delivery of M.A.P.P was feasible, movement environment quality of ECE centres signalled improvement; however, this was not statistically tested. Although there was no overall intervention effect in terms of PA, these findings provide a formative base for future investigations; thus, a larger study is warranted.

## Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Ethics and consent

Ethics approval was obtained from the Auckland University of Technology Ethics Committee, NZ on 12th April 2022. Children provided assent and their legal guardians/ parents provided signed written consent. Each ECE, leader and teacher all provided signed written consent.

## Author contributions

WP and NH conceived the study. All authors critically reviewed and approved the manuscript.

## Data sharing statement

Some de-identified aggregate data can be shared on request.

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## Appendix A Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.anzjph.2025.100286>.