

Original article

Self-perceptions and social–emotional classroom engagement following structured physical activity among preschoolers: A feasibility study

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Abstract

Background: The well-rounded development of the child, including physical, cognitive, emotional, and social health, may be the most efficient route to well-being and academic success. The primary goal was to investigate the feasibility of implementing a 12-week structured program of physical activity (PA) incorporating cognitive, social, and emotional elements in preschool. Additionally, this study, using a within-subject design, examined the acute effects of a PA session on classroom engagement and changes on perceived competence and peer acceptance from the first to the last week of the program.

Methods: Twenty-seven preschoolers (mean age = 4.2 years) completed the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children before and after a twice-weekly PA program. Unobtrusive classroom observations were conducted for verbal, social, and affective engagement during the first and last week of the program, both following a structured PA session (experimental day) and on a day without PA (control day). Treatment fidelity was monitored to ensure that the intervention was delivered as designed.

Results: The children exhibited longer periods of verbal and social engagement during classroom periods that followed PA sessions than on non-PA days. Children also expressed more positive affect following PA sessions during the last week of the PA program. Despite high baseline scores, perceptions of general competence increased meaningfully ($\eta^2 = 0.15$, $p = 0.05$), driven by increase in perceptions of cognitive competence ($\eta^2 = 0.15$, $p = 0.06$).

Conclusion: This study demonstrates the feasibility of providing structured PA program to preschoolers. Moreover, these initial findings suggest that purposely designed, structured PA may help advance the social–emotional engagement and perceived competence of preschool children.

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Keywords: Acute; Intervention; Long-term effects; Movement; Peer acceptance; Perceived competence

1. Introduction

Despite a widespread belief that young children are very physically active, research shows that young children in preschool environments mostly engage in sedentary activities,¹ even during unstructured free play and recess periods.² Recent guidelines recommend that preschool children should engage in at least 60 min of structured physical activity (PA) daily (e.g., activities that focus on fundamental motor skill development) and at least 60 min of unstructured PA (e.g., through play, usually in the outdoor playground area).³ However, preschool children do not meet these guidelines⁴ and opportunities for physically active play led by the

teacher (both outdoors and indoors) are limited.⁵ In the US, standards that require daily PA in preschoolers exist only in few of the states.⁶ National organizations^{3,7} acknowledge that preschool programs provide opportunities for children to be physically active during the day. They also recommend possible actions for increasing the PA levels of preschool children, including structured PA. Programs that promote both structured and unstructured PA could contribute to increasing the PA levels of preschoolers according to a recent meta-analysis.⁸ Structured PA programs can also stimulate the development of fundamental motor skills,³ which may, in turn, lead to more competence⁹ and higher engagement in PA later in life.¹⁰ The relationship between PA and motor skill competence has been proposed to be reciprocal.¹¹ That is, children with higher levels of perceived and actual competence are more likely to engage in PAs, which, in turn, may lead to further skill development and increased perceived competence.^{10–12}

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Research has shown that the development of gross motor skills during preschool is associated with scholastic, social, and emotional development in the subsequent first year of school,¹³ as well as with cognitive function later in life.¹⁴ Diamond and Lee¹⁵ also identified cognitively engaging, structured PA programs to be beneficial for the cognitive function of children during the preschool and school years. In addition, a burgeoning literature supports the notion that PA could serve as the basis of a holistic approach to child development by supporting perceptions of physical and social competence.^{16,17} For example, participation in sport games has been found to be associated with fewer emotional and peer-relationship problems and more prosocial behaviors in 5-year-old children.¹⁸ Physical play in the preschool classroom has also been found to be positively associated with the emotional competence of boys in the context of dyadic relationships with peers.¹⁹ Harter²⁰ has considered the social environment to be very important in affecting feelings of competence and social acceptance. Moreover, perceived competence may affect motivation and behavior directly and to a greater extent than actual competence.²⁰

A PA environment that encourages accomplishments and is socially supportive may foster the development of high-quality peer relationships and perceptions of physical and social competence.^{21–23} Structured PA programs developed on the basis of motivation theories have successfully increased perceptions of physical competence among preschoolers.^{24,25} However, the effects of structured PA on perceptions of cognitive competence and peer acceptance among preschool children have not been examined. A recent review on PA and psychosocial well-being in early childhood highlighted that intervention studies are absent and even the number of cross-sectional studies is limited.²⁶ Thus, the primary purpose of the present study was to assess changes in perceptions of physical competence, cognitive competence, and peer acceptance from the beginning to the end of a 12-week structured PA program among preschoolers.

The second purpose of this study was to evaluate the acute effects of structured PA on classroom engagement among preschoolers. The preschool years, when children are introduced to a school-like environment, are recognized for their crucial role in laying the foundation for school success. Child development experts emphasized that, to optimize academic outcomes, the education system should nurture the social, emotional, physical, and cognitive abilities of children.^{27,28} Students do not learn passively or in isolation but rather in synergy with educators and peers. The experiences that students derive from their classroom interactions determine their level of engagement and motivation.²⁹ These experiences are shaped by such factors as learning to regulate emotions, problem-solve, value contributions to the group, and communicate with teachers and peers. Collectively, these cognitive, social, and emotional skills help students thrive within a positive school environment that facilitates their comprehension of concepts, enhances their effort, fosters their overall growth, and, ultimately, promotes academic achievement.³⁰ Early social competence skills in the classroom have been associated with multiple outcomes across all major domains, including education, employment, and psychological well-being 20 years later.³¹ A recent meta analysis showed that school-based interven-

tions resulted in meaningful improvements (effect size = 0.57, 95% confidence interval (CI) from 0.48 to 0.67) in social and emotional skills, in addition to significant gains in attitudes, school conduct, and academic performance.³²

Experts asserted that PA environments provide multiple opportunities for the development of social and emotional skills.¹¹ However, supporting evidence focuses on adolescents.^{33–36} There is presently no evidence on the effects of PA programs on the social and emotional skills of preschoolers. Thus, the present study was based on the idea that exposure to structured PA, specifically targeting cognitive, social, and emotional elements, may have a positive immediate effect on classroom engagement.

To summarize, the overall goal of this study was to investigate the feasibility of implementing a 12-week structured PA program incorporating cognitive, social, and emotional elements in preschool. Two specific purposes were included under this general goal. The first purpose was to assess the changes in perceived physical competence, cognitive competence, and peer acceptance from the beginning to the end of the PA intervention. The second purpose was to examine the effects of a 30 min period of structured PA on the classroom engagement of preschoolers during the ensuing classroom period. To this end, classroom engagement was compared between a day with PA and a day without PA, both at the beginning and at the end of the 12-week PA intervention. We predicted that preschoolers would manifest higher levels of classroom engagement after PA and this benefit would be stronger at the end of the implementation period.

2. Materials and methods

2.1. Participants

The study was conducted at one early childhood center, located within a 1-mile radius from a midsize Midwestern city in the US. The early childhood center has 2 preschool classes for 3–5-year-old children. Twenty-seven preschoolers from these 2 classes (11 boys, 16 girls, aged 4.20 ± 0.64 years, 80% of enrolled children) participated with signed parental consent. Fifty-two percent of students were Caucasian, 40.5% were Asian, and 7.5% were African-American. The study was approved by the Iowa State University Institutional Review Board. Prior to the study, permission was granted by the director of the early childhood center and the teachers.

2.2. Design and treatments

The study used a within-subject design, with classes serving as their own controls. A 12-week structured PA curriculum was provided to all students. The PA sessions did not replace recess or any other regularly scheduled activities.

Perceptions of competence and peer acceptance were assessed individually, using pictorial self-report scales, before and after the implementation period. Furthermore, observations were conducted in a way that allowed the examination of both the longitudinal effect of the intervention and the acute effect of a PA sessions. Specifically, to examine the longitudinal effect of the intervention, observations of classroom behavior (from an adjacent observation room) were conducted during the first and last week of the 12-week implementation period at the same

time of day (between 10:30 a.m. and 11:30 a.m.). To assess the acute effect of a structured PA session, observations were conducted both immediately after a PA session (experimental day) and on a day without PA (control day).

All classroom observations were conducted by the same researcher. A research assistant also observed for 56% of the total observations. Both researchers had received prior training until >90% consistency was achieved. For the observed sessions during which both observers were present, inter-rater reliability was excellent ($k = 0.99$).

The PA program consisted of a 30 min structured PA session during the morning, 2 days per week for 12 consecutive weeks, based on the National Standards for children aged 3–5 years.²⁴ The sessions took place at either a gymnasium or an atrium adjacent to the school and were delivered by one of the researchers, aided by trained undergraduate students, all with previous experience in instructing PAs to preschool children.

Each session consisted of (1) a 2–3 min introduction and warm-up activity, (2) a 25 min period of developmentally appropriate physical games focusing on fundamental motor skills, with appropriate progression and on opportunities for cognitive, social, and emotional skills, and (3) a 2–3 min closure for reflection and discussion. Examples of the games and their foci are presented in Table 1. Randomly selected PA sessions (45% of the total number) were observed by a researcher and a trained undergraduate student (not involved in the design of the study) and a fidelity checklist was completed.

2.3. Measures

2.3.1. Fidelity checklist

A fidelity checklist was developed to assess whether the PA program was implemented as originally planned (Table 2). Specifically, the checklist assessed whether the PA intervention provided opportunities to preschoolers for: (1) cognitive engagement (i.e., to respond verbally to questions or act in cognitively challenging and unstable tasks), (2) self-control (i.e., to show inhibition and not act spontaneously), (3) social or emotional engagement (i.e., to acknowledge, express, or regulate emotions and communicate or collaborate with their peers and teacher), (4) fundamental motor skill development (i.e., tasks that target practicing locomotor, nonlocomotor, and manipulative movement skills), and (5) moderate-to-vigorous PA (i.e., walking or higher intensity of activities). In addition, the total duration of the lesson was recorded.

2.3.2. Classroom engagement

The observer rating sheet developed for this study was based on the social–emotional model of Denham and Brown³⁰ and was modeled after a similar classroom engagement tool for adolescents, developed by Reeve et al.³⁷ It included observations for the following: (1) verbal engagement (i.e., asks and answers questions, participates in discussions), (2) social engagement (i.e., interacts with other children, plays with at least one other child), and (3) affective engagement (i.e., negative affect = looks bored, unhappy, sad, angry through facial expressions and visible bodily manifestations; neutral affect = does not express any affective tone; positive affect = looks interested in the assigned activity,

Table 1

Examples of structured physical activity program and the focus in the psychomotor, cognitive, and social–emotional domain.

Domain	Physical activity game
<p>Psychomotor: locomotor skills (run, skip, gallop)</p> <p>Cognitive/self-control: pick one beanbag, color identification and selection, start/stop with signal</p> <p>Social–emotional: avoid others while moving around, protect personal space</p>	<p>Empty nest: A story was presented in which hula hoops are nests and beanbags are little birds that have left their nests. Children need to place beanbags in the hula hoops. All of the beanbags are spread out. On the signal, children are asked to use a locomotor skill (e.g., run, skip, gallop) and pick up one beanbag at a time and bring it back placing it in the hula hoop. The game continues until children have picked up and returned all beanbags to the hoops. Next, children feed the birds, and now the beanbags are the food. Children are asked to pick up specific color of foods (e.g., yellow as for bananas) and take it to the nests.</p>
<p>Psychomotor: animal moves</p> <p>Cognitive/self-control: freeze when the elephant turns around</p> <p>Social–emotional: express emotions</p>	<p>Track the elephant: In this game the teacher is the elephant and the children are the trackers. The elephant moves slowly and the children follow quietly. When the teacher turns around the children have to freeze and hold their position as if they were statues. Next, children take turns in becoming the elephants and specific instructions follow, such as, move like a happy, sad, angry, tired elephant.</p>
<p>Psychomotor: locomotor skills (walk, gallop, slide)</p> <p>Cognitive/self-control: color identification and space awareness</p> <p>Social–emotional: work with other children of the same color of butterfly to change places</p>	<p>Monarch mania: This game resembles “musical chairs”. Poly spots are used to ensure each child has their own space. A colored butterfly is placed randomly to the poly spots using a variety of colors of butterflies. While movement music is playing, children begin walking around the poly spots which are placed in a circle formation. When the music stops, the teacher shout out a color—i.e., “blue, change places”. All children standing on a blue butterfly move to a different poly spot occupied by a blue butterfly. The game continues and each time a different color is announced.</p>
<p>Psychomotor: body movement exploration</p> <p>Cognitive/self-control: identify body parts, start/stop with music</p> <p>Social–emotional: find a partner, express emotions through movement and music</p>	<p>Busy bee: Children dance to music. When the music stops, the teachers says “busy bee—(elbows)” and children stop dancing and find a friend to touch elbows together. Continue with various body parts. Different types of music are used and children improvise as they dance following the music. Emphasis is placed on expression of emotions.</p>
<p>Psychomotor: tossing/catching, chasing, fleeing</p> <p>Cognitive/self-control: start/stop with music, space awareness</p> <p>Social–emotional: avoid other pairs, work with a partner</p>	<p>Freeze mania: In this game each child works with a partner. Children begin tossing and catching a small beach ball back and forth between them. When music stops, children stop catching and whoever has the ball begins chasing the child without the ball around the play area trying to tag them with the ball—until the signal to stop (or the music starts again).</p>
<p>Psychomotor: locomotor skills, balancing, movement exploration</p> <p>Cognitive/self-control: find ways to move based on self-exploration</p> <p>Social–emotional: happy/sad moves</p>	<p>It’s not easy being bunny-book: The role playing game is about a story with a bunny that is not happy and wants to be something else. The teacher reads the book and assigns a movement or activity for every different action in the book. For example, the bunny went to live with the moose, “Can you gallop around like a moose?” Throughout the story emotions are emphasized, such as, “Can you gallop like a happy moose?” and “Can you move showing that you are happy to see your friends?” “What makes you happy/sad?”</p>

Table 2
Fidelity checklist for structured PA program.

	Not evident	Evident during PE	
		1–3 times	>4 times
Cognitive engagement (%)	0	25	75
Self-control (%)	0	35	65
Social–emotional engagement (%)	0	42.5	57.5
Skill 1 (%)	0	100	–
Skill 2 (%)	5	95	–
Duration (min)	29.35 ± 2.21	–	–
MVPA ^a (min)	11.88 ± 4.07	–	–

^a Based on SOFIT³⁷ observational categories.

Abbreviations: PA = physical activity; PE = physical education; MVPA = moderate-to-vigorous physical activity.

smiles, laughs, expresses signs that she/he is having fun). Observations were recorded using the Behavioral Evaluation Strategy and Taxonomy (BEST) software which allows data collection in real time using a computer keyboard.³⁸ Mutually exclusive buttons were used for different levels of the same behavior. The researchers recorded classroom behavior by switching their focus from child to child in a specific predetermined sequence at 30 s intervals, without breaks between observations (i.e., simultaneously recording while observing using the computer keyboard). All participating children were observed at least twice during a 20 min period. The percentage of time a behavior was observed during the observation period was estimated for the entire class, as is a common practice in observational research.³⁹

2.3.3. Perceived competence and peer acceptance

The Pictorial Scale of Perceived Competence and Social Acceptance for Young Children (PSPCSAYC),⁴⁰ which yields scores for perceived physical competence, perceived cognitive competence, and perceived social (peer) acceptance, was used. General competence, operationalized by the mean of the cognitive and physical competence subscales, was also considered. Each subscale consists of 6 items that are presented in pictorial plates, separately for boys and girls. Two of the questions on peer acceptance were not asked (“this person doesn’t get to eat dinner at friends’ houses” and “doesn’t stay overnight at her friends’ houses very often”) because these behaviors are rare at the preschool age. Students were asked to select the picture that is most like them (e.g., “This girl is pretty good at puzzles and this girl isn’t pretty good at puzzles. Which of these girls is most like you?”). Next, they indicated the level of their perceived competence for each item. The response scale ranged from 1 (*not very good at. . .*) to 4 (*really good at. . .*). The perceived maternal acceptance subscale was not included as it was unrelated to the purposes of this study. Cronbach’s α coefficients of internal consistency were modest (Table 3), consistent with the original findings of Harter and Pike,⁴⁰ who reported a range from 0.50 to 0.85.

2.4. Data analysis

As noted, data derived from observations of classroom engagement (i.e., verbal, social, affective) were at the level of the entire class, not at the level of individual children. Since these data preclude the use of hypothesis testing (due to absence of an index

Table 3
Descriptive statistics of the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children ($n = 24$).

Variable	Pre		Post		d	Cronbach’s α	
	Mean	SD	Mean	SD		Pre	Post
General competence	3.49	0.33	3.65*	0.37	0.46	0.74	0.69
Physical competence	3.40	0.40	3.53	0.48	0.30	0.51	0.66
Cognitive competence	3.59	0.37	3.77 [#]	0.36	0.49	0.54	0.59
Peer acceptance	3.38	0.63	3.45	0.70	0.11	0.77	0.85

* $p = 0.05$, [#] $p = 0.06$, compared with pre mean value.

of inter-individual variability), the data are presented descriptively. In the case of verbal engagement, the data are expressed as time (in second), whereas for social and affective engagement, the data are expressed as the percentage of observation time during which the children exhibited overt signs of the respective construct.

The data on perceived cognitive competence, perceived physical competence, perceived general competence (derived as the average of cognitive and physical), and perceived peer acceptance were collected via self-reports at the level of individual children. They were analyzed with a repeated-measures analysis of variance (ANOVA), with time (pre, post) as the within-subject independent variable.

3. Results

3.1. Fidelity of the PA intervention

Inter-rater agreement for the total number of qualities of the PA sessions was 88%, which is considered acceptable. As shown in Table 2, each of the observed PA sessions focused on 2 fundamental motor skills and provided multiple opportunities for cognitive engagement, self-control, and social–emotional engagement.

3.2. Classroom engagement

The level of verbal engagement immediately after a PA session differed relatively little from a non-PA day during the first week of implementation (difference of 32.64%, in favor of the non-PA day). In the last week, verbal engagement was considerably higher during the classroom period following the PA session compared to the non-PA day (difference of 65.68%, in favor of the PA day). From the first to the last week of the intervention, verbal engagement was higher on both the PA and non-PA days. However, the increase was larger after the PA sessions than on the non-PA days (5.3 times vs. 1.6 times) (Table 4).

The percentage of time children were socially engaged was higher after the PA session than after typical classroom activities, during both the first (25.19%) and last week (14.93%) of the intervention. Social engagement remained stable in PA days from the first to the last week of the program (66.06% vs. 66.77%). Although there was an increase on non-PA days from the first to the last week of the intervention (40.87% vs. 51.84%), the level on the last week was still lower compared to the PA day (51.84% vs. 66.77%) (Table 4).

During the first week of the intervention, children expressed lower levels of positive affect during the classroom period that

Table 4

Acute and longitudinal effects of structured physical activity (PA) program on social-emotional classroom engagement.

	First week			Last week		
	Non-PA	PA	Difference	Non-PA	PA	Difference
Verbal engagement (s)	40.13	27.03	-13.10 (32.64) ^a	102.41	169.67	67.26 (65.68) ^a
Social engagement (%)	40.87	66.06	25.19	51.84	66.77	14.93
Positive affect (%)	30.57	14.66	-15.91	11.29	31.94	20.65

^a Percentage difference.

followed the PA session compared to the non-PA day (-15.91%). In contrast, during the last week, positive affect was higher after the PA session than the non-PA day (20.65%). On the non-PA days, the percentage of time during which the children expressed positive affect decreased from the first (30.57%) to the last week (11.29%) of program implementation. In contrast, on PA days, the percentage of time increased from 14.66% during the first week to 31.94% during the last week (Table 4). Although expressions of negative affect were also observed, the data are omitted because expressions of negative affect were virtually absent.

3.3. Perceived competence and peer acceptance

The ANOVA for perceived general competence was marginally significant ($F(1, 23) = 4.01, p = 0.05, \eta^2 = 0.15$). The effect size (partial η^2) indicates that 15% of the variance in perceived general competence is accounted for by the independent variable, time. This level of η^2 is equivalent to Cohen's effect size $f = 0.42$ ($f = \sqrt{(\eta^2 / (1 - \eta^2))}$), which is characterized as "large".⁴¹ The effect was driven mainly by an equally meaningful effect for perceived cognitive competence, which narrowly approached statistical significance ($F(1, 23) = 3.89, p = 0.06, \eta^2 = 0.15$). As shown in Table 3, students reported higher perceived general and cognitive competence at the end of the intervention ($p = 0.05$ and $p = 0.06$, respectively). In contrast, the Time effects for perceived physical competence ($F(1, 23) = 2.01, p = 0.17, \eta^2 = 0.08$) and peer acceptance ($F(1, 23) = 0.21, p = 0.65, \eta^2 = 0.01$) did not approach statistical significance.

4. Discussion

This investigation was predicated on the idea that providing physical games through PA to preschool children in a structured format is both appropriate and beneficial for the healthy whole-child development of preschoolers. Thus, the objective of this feasibility study was to explore the idea that PA may promote the holistic development of preschool children, with benefits extending beyond psychomotor development. Specifically, the study addressed whether offering structured PA to preschoolers can promote cognitive and social-emotional classroom engagement, as well as cognitive self-perceptions, which are presumed to be crucial to academic success.

In evaluating the preliminary results reported here, it is important to take account of the fact that this innovative line of inquiry is still in the process of developing and refining ideas and methods. Studies with preschool children face well-documented methodological challenges, as most children cannot read study materials, cannot stay focused over extended testing sessions, and generally exhibit poor compliance with investigator instructions. The result

of the totality of these challenges is less-than-perfect adherence to experimental protocols and a high degree of random measurement error, resulting in reduced reliability and, thus, loss of statistical power. Therefore, an important function of this paper is reporting the experiences derived from testing a specific PA intervention focusing on developmentally appropriate physical games and assessing a specific range of outcomes (classroom engagement, perceived competence, peer acceptance) with specific measures. The reliability estimates and effect sizes presented in Table 3 should be of value to future investigations, as they will provide an initial empirical basis for power calculations.

Experience gained from the present study demonstrates that providing opportunities for physical games to preschool children in a structured and objective-oriented format, with specific opportunities for the development of fundamental motor, social, and emotional skills, is feasible. The fidelity assessments showed that the teacher-trainees were able to deliver the content as intended. By necessity, evaluation of the results relies on the examination of the direction of mean changes and effect sizes. The results, while clearly in need of replication, suggest that physical games implemented within a structured PA program have the potential to help preschool children improve their social-emotional engagement and perceptions of competence.

The level of verbal engagement generally increased from the beginning to the end of the intervention period, likely reflecting a "maturation" effect (e.g., developing group cohesion, overall engagement with the class, tighter integration with peer network, evolving bond with teachers). More importantly for this study, the children demonstrated longer periods of verbal engagement during a classroom period that followed PA than during a classroom period that had not followed PA. It is possible that the PA sessions promoted verbal communication among children because the specific physical games that were selected required continuous interaction and collaboration with peers and the teacher, as well as constant cognitive engagement. Verbal communication is one component of engagement that may lead to better academic performance and school success.³⁰

Furthermore, while the levels of social engagement showed little change from the beginning to the end of the intervention, the observations showed that the children were consistently more socially engaged during classroom periods that followed sessions of PA. This finding is consistent with cross-sectional studies showing that sport participation is associated with fewer peer-relationship problems.¹⁸ Experiencing positive social interactions and developing a sense of relatedness are associated with higher academic engagement and better performance.^{42,43}

The results pertaining to positive affect showed an interesting reversal. While preschoolers initially expressed somewhat

lower levels of positive affect (e.g., smiles, laughs, signs of having fun) in class after PA, compared to a class period that had not followed PA, they expressed more positive affect after PA in the last week of the intervention. This observation may be attributed to the initial lack of familiarity and connectedness the children may have felt with the new teachers and the format of the PA sessions. However, after several weeks of exposure to the instructors and the PA content, the children expressed more positive affect during the classroom period that followed PA. This interpretation is consistent with cross-sectional results showing that physical play and sport participation are positively associated with emotional competence among preschool and kindergarten children.^{18,19}

The interpretation of self-reported outcomes, such as the components of perceived competence, requires a different framework compared to the interpretation of results from unobtrusive observations. While positive self-perceptions are universally presumed to be important prerequisites for academic success (aiding children in setting higher goals and persisting in the face of adversity), typically developing preschool children tend to have relatively undifferentiated (i.e., global) and exaggerated perceptions of competence. Thus, besides the aforementioned contributors to measurement error (e.g., carelessness, misunderstanding), exaggerated perceptions of competence lead to the added psychometric challenge of reduced variance (e.g., ceiling effects, as evidenced by the very high PSPCSAYC scores of 3.38–3.59 on a 4-point scale at baseline). In the present study, a borderline significant pre-to-post change in general perceived competence was evidently driven by an increase in perceived cognitive competence (assessed with such items as good at puzzles, gets stars on paper, knows names of colors, good at counting, knows alphabet, knows first letter of name). Given that preschool children typically receive uniformly positive performance feedback on cognitive tasks,⁴⁴ it is noteworthy that a meaningful ($\eta^2 = 0.15$, $p = 0.06$) increase in perceived cognitive competence was found despite the limited reliable variation (29%–35%) afforded by the self-report measure of competence. While it does not appear that the implementation of the PA program impeded changes in perceived cognitive competence, whether the intervention contributed to the positive 12-week change should be examined in a follow-up controlled investigation. The absence of a significant change in perceived physical competence is perhaps unsurprising given that several of the physical skills identified in the PSPCSAYC were not specifically targeted in this PA intervention (e.g., swinging, climbing, tying shoes). Overall, it is noteworthy that all PSPCSAYC scale scores showed increases and it is, thus, possible that an intervention with higher frequency of PA sessions or longer duration may produce more robust effects.

This was a feasibility study; therefore, several limitations should be taken into consideration both in planning future projects and in interpreting the present results. In this study, emphasis was placed on the role that a preceding PA session may play in subsequent classroom engagement. Thus, the observations were limited to classroom activities while the behavior of children during the PA sessions themselves was not recorded. This was outside the scope of the present investigation because, anecdotally, children showed nearly maximal levels of engage-

ment and positive affect during physical games. Nevertheless, it would be useful for future studies to track the full trajectory of these variables from the PA session and into the subsequent classroom periods, to investigate whether there is, in fact, continuity indicative of a carry-over effect.

This study used a within-subject design, examining the acute effect of structured PA on subsequent classroom engagement, compared to a typical classroom lesson (non-PA day), both at the beginning and at the end of the intervention period. Future studies should account for geographic, socioeconomic, curricular, and resource-related differences and class/teacher effects (i.e., the hierarchical structure of the data). It is also important to note that the small sample size of this study limits statistical power, reduces the precision of estimates, and restricts generalizability to the broader population of preschoolers. In addition, as previously emphasized, the measurement of the outcome variables is a critical challenge in research involving preschool children. Our selection of measures for this study followed literature standards (i.e., observations for classroom behavior and PSPCSAYC for perceived competence and peer acceptance). However, due to logistical constraints, we were unable to have 2 independent observers for 100% of the observation periods, as originally intended (although this limitation is balanced somewhat by the 99% interrater agreement during those periods for which both observers were present). Furthermore, it is clear that all self-report measures used with the preschool population present psychometric challenges and should be interpreted with these challenges in mind. We, therefore, encourage the continued comparative evaluation of measures, guided by theoretical considerations.²⁷ A new scale based on the PSPCSAYC focuses specifically on perceived fundamental motor skill competence for young children and should be given consideration in future studies.⁴⁵

In closing, this area of research may have several important implications that should be explored. From an educational perspective, it is worth considering whether including more structured physical games in the preschool curriculum could help preschoolers develop skills and acquire early positive experiences that could facilitate their transition to the school environment, thus preparing them for future academic success. From a health perspective, it is becoming increasingly clear that proactive steps must be taken to reengineer structured PA and the development of physical competencies and motor skills into the lives of young children. The potential value of PA as a vehicle in helping children develop cognitively, emotionally, socially, and physically should not be overlooked.^{15,46}

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Authors' contributions

SV conceived of and designed the study, amended the measures, was in charge of the data acquisition and data analysis, and drafted the manuscript; CM coordinated data processing and contributed in data analysis; GL contributed in the design of the study and data interpretation; JSK contributed in the

design of the intervention program. All authors have read and approved the final version of the manuscript, agreed to be accountable for all aspects of the work, and agreed with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

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