



Original research

Promoting ball skills in preschool-age girls

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ABSTRACT

Objectives: Evidence supports that girls are less proficient than boys at performing ball skills. This study examined the immediate and long-term effects of a ball skill intervention on preschool-age girls' ball skill performance.

Design: Randomized controlled trial.

Methods: Girls ($M_{age} = 47.24 \pm 7.38$ months) were randomly assigned to a high autonomy, mastery-based 9-week motor skill intervention (the Children's Health Activity Motor Program; CHAMP, 540 min; $n = 38$) or a control group (free-play; $n = 16$). Ball skill proficiency was assessed at pretest, posttest, and retention test (after 9 weeks) using the object control subscale of the Test of Gross Motor Development – 2nd Edition. Treatment efficacy was examined using linear mixed models. Two models were fit: one for short-term changes (pretest to posttest) and one for long-term changes (pretest to retention).

Results: Linear mixed models revealed a significantly time*treatment interaction for both models. Post hoc analysis confirmed that girls in CHAMP experienced significant gains in ball skills from pretest to posttest ($p < .001$) and pretest to retention ($p < .001$). Moreover, girls in CHAMP were no different from the control group at pretest ($p > .05$) but had significantly higher ball skills scores at both posttest ($p < .001$) and retention ($p < .001$).

Conclusions: This study demonstrates the positive effects of a ball skill intervention (i.e., CHAMP) on improving girls' ball skills both short- and long-term. Findings suggest that early childhood interventions that focus on the development of ball skills in young girls might be an avenue to improve girls' ball skill performance.

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1. Introduction

Fundamental motor skills (FMS) involve using the large muscles in the body¹ and develop across childhood. FMS serve as the foundational building blocks for future and advanced motor behaviors.² Often FMS are divided into two categories: (1) locomotor skills, that propel the body through space (e.g. run, jump, and skip) and (2) ball skills (also known as manipulative or object control skills), that propel or receive an object through space (e.g. throw, kick, and strike). FMS do not solely develop through maturation.^{3,4} The literature supports that FMS are not innate but rather must be “taught, practiced, and reinforced” through developmentally appropriate motor opportunities.⁴ This view aligns with the extant literature where FMS interventions have been successful at promoting skill development across the childhood years.^{5–7}

Recent reviews support the critical role of FMS in promoting and maintaining healthy developmental trajectories.^{8,9} Robinson et al. found that FMS competence is positively related to physical activity engagement, physical fitness, and perceived motor competence while being inversely related to weight status.⁸ Logan et al. concluded that increased motor skill competence during childhood is related to physical activity.⁹ Additionally, several empirical studies provide evidence that FMS are important for cognitive, social, and language development.^{10,11} A recent systematic review on the relationship between cognition and motor skills in typically developing children supports that weak to strong relations may exist between motor skills and underlying components of higher order cognition.¹² This relationship appears to be strongest in pre-pubescent children.¹² These findings support that FMS competency has a cascading effect on a child's health and development.

With the importance of motor skills, deficiencies in FMS could have widespread consequences such as poorer cognitive performance, language and social skills, and limited opportunities to participate in sports or other types of physical activity. Currently,

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children and especially preschoolers demonstrate low levels of motor skill competency.^{13,14} The literature also shows that sex differences exist in motor skill competence where girls experience deficiencies in ball skills compared to their male counterparts. Historically, these sex differences in throwing performance can be seen in the Michigan State University Motor Performance Study.¹⁵ At age 63 months, 60% of the boys reached a mature one-handed overarm throwing pattern, while in girls this percentage was not reached until 102 months of age. These trends continue in the present literature with boys outperforming girls in preschool,^{16–18} elementary school,¹⁹ and high school.²⁰ One study tracked ball skill proficiency in Australian children across thirteen years and found that both elementary and high school boys had better ball skills (e.g. catch, kick, and overarm throw) than girls.¹⁹ Barnett et al. also found that Australian boys were significantly more proficient than girls in ball skills (i.e., kicking, catching, and throwing) during the childhood and adolescence years.²⁰

It is clear that sex differences are present in ball skills. Barnett et al. found that the development of ball skills during childhood appears to be an important predictor of physical activity during adolescence.^{21,22} This study examined FMS and physical activity longitudinally across seven years in 276 children. Results indicated that time spent in moderate-to-vigorous and organized physical activity during the adolescence years (mean age = 16.4 years) was positively associated with childhood ball skill proficiency at age 10.²² Spessato et al. also noted FMS sex differences in over 1200 Brazilian children. Specifically, boys exhibited superior ball and locomotor skills compared to girls which supports the need for interventions and developmentally appropriate FMS programs that target girls.¹⁸

As ball skill proficiency during childhood may be an important predictor of physical activity during adolescence, intervening at a young age to improve ball skills might therefore be critical in preventing the decline in moderate to vigorous physical activity (MVPA) and organized physical activity during adolescence. Robinson and Goodway examined the effect of a 9-week motor skill intervention on object control skills in Head Start preschoolers ($N=117$), who often demonstrate developmental delays in FMS. They found significant improvements in object control skills in the intervention group over time, while there were no differences observed in the control group.²³ Authors also found that these improvements remained significant at a retention test 9-weeks after the cessation of the original intervention. Sex differences were not reported so the effect of the ball skill intervention in girls is not understood. As girls tend to have poorer ball skills, there is a need to target interventions to improve these skills in girls. The purpose of this study was to examine the immediate effects of a ball skill intervention on preschool-age girls and to assess the retention of these skills over a 9-week period. We hypothesized that the intervention would be effective in promoting ball skills in girls and that these positive changes would be maintained over time.

2. Methods

All aspects of this study took place in an accredited Head Start center located in a large city in the United States. Head Start programs are funded through the United States government to provide comprehensive early childhood education, health, nutrition, and services to low-income children and families. The goal of Head Start is to promote healthy development in United States' children ages three to five years from families whose income is at or below the national poverty level (i.e., a family of four's annual income \leq \$23,550 USD). Fifty-four girls ($n=54$; $M_{age}=47.24 \pm 7.38$ months) served as participants. Race and ethnicity of the girls' were 77.8% African American, 5.6% Caucasian American, 11.1% Hispanic,

5.6% other and represents the demographics of individuals living in the proximity of the center (i.e., 24–32 km radius). Girls within the center were randomly assigned to one of two treatment groups: (1) a motor skill intervention group (CHAMP, $M_{age}=45.74 \pm 7.72$, $n=38$) or a (2) control group ($M_{age}=50.81 \pm 5.10$, $n=16$). Participants were assigned a random number and were then divided to either the intervention or control group. Thus, one preschool class included both intervention and control participants. Participants in the motor skill intervention were exposed to the Children's Health Activity Motor Program (CHAMP). CHAMP is a high quality, evidence-based program that has been shown to improve fundamental motor skill competence in preschool age children.^{4,14} The intervention was implemented two times per week for nine weeks and targeted six ball skills – *throw, catch, strike off a tee, kick, dribble, and roll*. The program consisted of 2½ min of skill introductory activity, followed by 25 min of ball skill instruction and activity, and concluded with a 2½ min closure activity. Two of six different ball skills were taught daily, resulting in 30 min of motor skill instruction and activity per session, with each ball skill being taught six times across the intervention. The total dosage of motor skill intervention was 540 min with 423–468 min of pure motor skill instruction. Two Ph.D. students in Motor Behavior with extensive experience in implementing developmentally appropriate motor programs served as the instructors (i.e., 1 lead instructor and 1 assistant) for all CHAMP sessions.

Participants in the control condition were exposed to the standard movement opportunities of the preschool (i.e., outdoor recess/free play). All children enrolled in the Head Start center were provided a 30-min outdoor free play session for each day, totaling 540 min. This time is predominately self-directed and does not incorporate specific instruction, feedback, and practice in motor skills from an instructor. During outdoor recess/free play, the preschoolers had access to an open space with typical playground equipment such as swings, slides, various play structures, and toys. No data was collected on the preschoolers' engagement during the outdoor recess/free play session.

Ball skill proficiency was assessed using the object control subtest of the Test of Gross Motor Development-2nd edition (TGMD-2).²⁴ The TGMD-2 is a reliable, valid assessment used to measure motor skill competence in children ages 3–10 years. This process-oriented assessment measures performance on six ball skills: throwing, catching, striking off a tee, kicking, dribbling, and rolling. Each of the six skills is divided into three to five specific performance criteria. During test trials, a child receives a score of one when correctly executing a performance criterion whereas failure to correctly execute a criterion results in a score of zero. The TGMD-2 was administered so that a child watches a demonstration of a correctly executed skill and then performs the skill three times: one practice trial and two test trials. Only test trials were scored. If a child was unable to demonstrate skill understanding during the practice trial, a re-demonstration of a correctly executed skill was provided. No additional demonstrations were given. In the present study, all trials were video recorded and test trials later coded by a single researcher blinded to the study who had 98% inter-rater reliability with an expert in the field. The object control subtest of the TGMD-2 is worth a total of 48 raw points. All raw score values were used in subsequent analysis.

Prior to the start of the study, Institutional Review Board approved all procedures and both parental consent and child assent were obtained. After obtaining permission, girls were randomly assigned to one of the groups (CHAMP or control). Girls in the control condition made no changes to their daily routines; girls in the CHAMP condition replaced their outdoor free play sessions with CHAMP two days each week. The intervention lasted for a total of 9-weeks (18 lessons, 540 min of skill intervention). Ball skill proficiency of all participants was assessed three times: prior to the start

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