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# THE IMPACT OF STRUCTURED MOTOR SKILL INTERVENTIONS ON MANIPULATIVE SKILLS IN EARLY CHILDHOOD

Shivaraju K. [1], Dr. R. Ramakrishnan [2]

[1] Research Scholar, Department of Physical Education and Sports Sciences, Hindustan Institute of Technology and Science, Padur, Chennai, Tamil Nadu, India, 603103
[2] Assistant Professor (SG), Department of Physical Education and Sports Sciences, Hindustan Institute of Technology and Science, Padur, Chennai, Tamil Nadu, India, 603103

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## ABSTRACT

This study examined the effects of a 12-week structured motor skill intervention on manipulative skills in 6- to 7-year-old boys from a public school in Bengaluru, India. Sixty participants were randomly assigned to either an intervention group (n = 30) receiving thrice-weekly, 45-minute skill-focused sessions or a control group (n = 30) continuing standard physical education. The Test of Gross Motor Development-2 (TGMD-2) assessed six manipulative skills at baseline and after-intervention. Results revealed significant improvements in the intervention group, while the control group showed no meaningful change. ANCOVA confirmed superior post-test performance in the intervention group after controlling for baseline scores. The results show that organized, regular motor skill interventions can greatly improve the manipulative skills of young primary school children compared to regular physical education. The data show that targeted motor programs should be used in early childhood education to help kids learn basic movement skills. This could have long-term benefits for their physical activity levels.

**Keywords:** Motor Skill Intervention, Manipulative Skills, Fundamental Movement Skills, Childhood Development

## 1. INTRODUCTION

The early childhood years, from ages 3 to 8, are very important for human growth because that's when basic skills like motor skills are formed. As mentioned by Gallagher and Ozmun (2006) and Robinson et al. (2015), these Fundamental motor skills (FMS) are the building blocks for a healthy and active lifestyle. They not only prepare people to play sports and be active, but they also set the stage for their cognitive, social, and emotional development. Manipulative motor skills, which include controlling objects through actions like throwing, catching, kicking, striking, and dribbling, are the most important for doing well in organized sports, casual games, and everyday chores (Haywood & Getchell, 2020). These skills not only make it easier for kids to be active, but they also boost their confidence, help them make friends, and make them enjoy moving around.

Recent studies show an alarming trend: many kids don't know how to do these basic creative skills well enough when they start school (Barnett et al., 2016; Brian et al., 2017), even though they are very important. This developmental

delay isn't just a short-term problem; it often leads to long-lasting effects like less physical activity, a lower sense of athletic competence, less motivation to do movement-based activities, and even problems in school performance (Stodden et al., 2008; Lubans et al., 2010). These results are especially worrying because there is a lot of evidence that shows a link between motor skills and kids' mental health, self-control, and overall growth.

The development of manipulative motor skills can be roughly predicted, but it's not automatic. Children need regular, age-appropriate opportunities for guided instruction and purposeful practice (Goodway & Branta, 2003). Free or unstructured play can help with creativity and motor discovery, but more and more study shows that structured motor skill interventions work better. These kinds of interventions include tasks that are planned out based on a child's age and stage of development, with the goal of improving skills over time. Another piece of evidence that supports this method comes from a meta-analysis: Logan et al. (2012) found that planned motor programs could improve kids' object control skills by about 0.89 standard deviations compared to control groups. These benefits were especially clear for kids who didn't have very good skills to begin with (Brian et al., 2017). This is a very important finding because it suggests that structured interventions might be able to not only improve skills but also make motor performance more comparable across populations.

The complicated connection between motor skills and physical exercise can be better understood with the help of models like Stodden et al.'s (2008) developmental cascade model. This way of thinking says that being good at manipulating skills early on makes it easier to do many different kinds of physical tasks, which in turn makes it easier to practice and get better at those skills later on. This two-way street, which is sometimes called a "virtuous cycle," means that learning motor skills early on leads to more exercise and exercise leads to more exercise. But kids with motor delays might get stuck in a "negative spiral" of disengagement, where their lack of skill in these areas makes them less likely to do things, which in turn lowers their chances of growth. Importantly, studies show that kids who don't have the right movement skills when they start school usually don't get better on their own until they get intentional and specific help (Barnett et al., 2016).

Furthermore, the advantages of developing manipulative motor skills go beyond the physical world. Particularly in numeracy and literacy domains, a growing body of multidisciplinary research has connected object control proficiency to a range of positive developmental outcomes including enhanced executive functioning, improved social competency, and early cognitive achievement—particularly (Pitchford et al., 2016; Macdonald et al., 2018). These results support the idea that motor competency should not be seen in a vacuum but rather as a necessary component of overall child development with broad consequences for schooling, health, and well-being.

Research and practice still show notable gaps notwithstanding the growing body of evidence. First, even although many studies confirm the success of organized treatments, opinions on what really makes a perfect program vary. Important design factors like session frequency, duration, intensity, and instructional strategy still vary inconsistently or are not enough investigated (Lander et al., 2017). This diversity limits practitioners' and legislators' capacity to create evidence-based, standardized, population-specific initiatives. Second, most of the body of current studies has been school-centered, emphasizing conventional physical education settings. Although these contexts are crucial, alternate and maybe effective delivery models—such as parent-mediated home-based interventions, community leisure programs, or integrated classroom approaches—have gotten somewhat little attention (Jones et al., 2020).

Third, development of universal motor skills is seriously hampered by social and environmental inequalities. Children from low-income or underfunded backgrounds generally show reduced baseline motor ability and experience more difficulty finding quality physical exercise programs (hardy et al., 2018). These differences highlight the critical requirement of inclusive, easily available intervention options that give early childhood development top priority since they can help to sustain cycles of poverty. Finally, little longitudinal studies examining the sustainability of motor skill increases across time exist. Although short-term gains are frequently recorded, it is yet unknown whether these early benefits translate into long-term physical activity participation, academic achievement, or psychological benefits (Robinson et al., 2015).

This research seeks to enhance the design of successful, egalitarian, and developmentally suitable motor programs by assessing both immediate skill acquisition and long-term retention, as well as examining various intervention models and contextual factors. Ultimately, cultivating manipulative motor skill proficiency in early infancy transcends mere enhancement of physical capability; it involves providing children with the essential skills for enduring engagement, health, and achievement across various domains.

## 2. METHODOLOGY

The study involved a homogeneous sample of 60 typically developing boys aged 6-7 years from a public school in Bengaluru, India, intentionally selected to control for gender and developmental differences in motor skill acquisition. Participants were randomly seperated into two equal groups (intervention=30; control=30) after meeting inclusion criteria of no physical/cognitive impairments and obtaining parental consent. The age range was deliberately chosen as this developmental period shows high neural plasticity for fundamental movement skills.

The dependent variable was manipulative skills performance measured through the TGMD-2's object control subset. This standardized test assessed six discrete skills (throwing, catching, kicking, striking, dribbling, rolling) using 3-5 performance criteria per skill, scored dichotomously (0/1). The TGMD-2 was choosed for its recognized reliability (test-retest r=0.88-0.96) and validity in multicultural contexts. Pretest scores served as covariates to control for baseline differences.

The evidence-based 12-week intervention (36 sessions) featured three weekly 45-minute sessions following a structured progression: (1) dynamic warm-up (10-min), (2) guided skill practice (20-min) using task decomposition and bandwidth feedback (corrective cues only for significant errors), and (3) deliberate play applications (10-min) with equipment modifications. Fidelity was maintained through instructor training, session checklists, and 20% random video checks by an independent assessor. The control group continued standard PE (twice weekly, 30-minute sessions of unstructured play and basic drills), with activity logs confirming no contamination.

The study employed a combination of paired samples t-tests and analysis of covariance (ANCOVA) to examine intervention effects. For within-group comparisons, paired samples t-tests assessed pre-to-post changes in TGMD-2 manipulative skill scores separately for both intervention and control groups, with Bonferroni correction applied to account for multiple comparisons (adjusted $\alpha = 0.025$). Between-group differences were analyzed using one-way ANCOVA with post-test scores as the dependent variable, baseline scores as covariates, and group assignment (intervention vs. control) as the fixed factor. This approach statistically controls for initial skill differences while testing intervention efficacy. All statistical test were analsyised by using 0.05 level of significance.

## 3. RESULTS

**Table 1 Paired Samples T-Test for Manipulative Skills**

| Group | Pretest M (SD) | Post test M (SD) | Mean Diff | t(df=29) | p-value | Cohen's d [95% CI] |
|---|---|---|---|---|---|---|
| Intervention | 18.23 (3.45) | 26.85 (4.12) | +8.62 | 9.67 | <0.001 | 1.76 [1.32, 2.20] |
| Control | 17.89 (3.67) | 18.12 (3.81) | +0.23 | 0.89 | 0.380 | 0.06 [-0.07, 0.19] |

Above paired samples t-tests revealed notable improvements in manipulative skills for the intervention group following the 12-week program ($t(29) = 9.67$, $p < .001$). Participants showed a mean increase of 8.62 points (SD = 4.12) from pre-test (M = 18.23) to post-test (M = 26.85), with a large effect size (Cohen's d = 1.76, 95% CI [1.32, 2.20]). In contrast, the control group demonstrated no significant change ($t(29) = 0.89$, $p = .380$), with only a 0.23-point improvement (SD = 3.81) from pre-test (M = 17.89) to post-test (M = 18.12), yielding a negligible effect size (d = 0.06, 95% CI [-0.07, 0.19]).

**Table 2 ANCOVA Results for Overall Manipulative Skills**

| Group | Mean | Source | Sum of Squares | df | Mean Square | F | p |
|---|---|---|---|---|---|---|---|
| Intervention | 26.71 | Between | 128.45 | 1 | 128.45 | 15.32 | 0.000 |
| Control | 18.27 | Within | 467.91 | 57 | 8.39 | | |

The ANCOVA results presented in Table 2 demonstrate statistically significant effects of the motor skill intervention after controlling for baseline differences. The intervention group showed notable higher adjusted mean scores (26.71)

compared to the control group (18.27) after accounting for pre-test performance ($F = 15.32$, $p < .001$). This indicates the intervention was effective in improving manipulative skills beyond what would be expected from normal development.

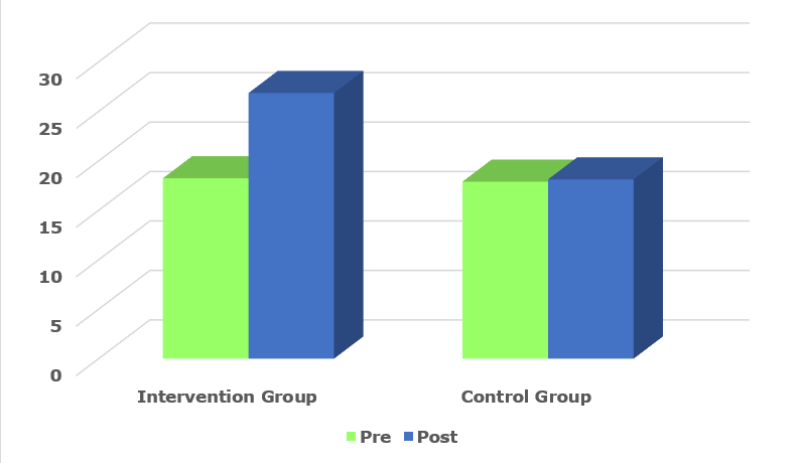


**Figure 1** Illustrating the Pretest and Post-Test Scores for Both Groups.

## 4. DISCUSSION

This study shows that an organized motor skill intervention that lasted 12 weeks made a big difference in the manipulative skills of boys ages 6 to 7 compared to a control group that got regular physical education. The big effect sizes (Cohen's $d = 1.76$ for improvement within the group; partial $\eta^2 = 0.43$ for changes between groups) show effects that are both statistically and practically important. These results are in line with other research that has shown that structured treatments are best for helping young children learn basic movement skills (Logan et al., 2012; Brian et al., 2017). The intervention probably worked because it used teaching methods that have been shown to work, like task progression, extra feedback, and deliberate practice. These methods are in line with Dynamic Systems Theory (Thelen & Smith, 1994), which says that motor skills develop when individual, task, and environmental factors interact. The fact that the control group didn't improve significantly backs up earlier research that suggested open physical education might not be enough to teach manipulative skills (Lander et al., 2017). These results have important real-world implications. They show that instead of just relying on free play, early childhood physical education programs should include structured skill instruction. The results are especially important because they show that early motor skills can predict later amounts of physical activity (Stodden et al., 2008). However, the study's limitations, such as the fact that it only looked at boys, had a short-term follow-up, and used a group from a single school, point the way for future research. Overall, this study makes a strong case for putting focused motor skill programs into early childhood education settings to help kids learn basic movement skills and maybe even start healthy habits that they will keep for life. Children's motor skills can be improved significantly with short, well-structured interventions. The strong results seen after only 12 weeks show that this is possible.

## 5. CONCLUSION

This study demonstrates that a structured 12-week motor skill intervention significantly improves manipulative skills in 6-7-year-old boys compared to standard physical education, with large effect sizes confirming both statistical and practical significance. The findings support the effectiveness of targeted skill instruction during early childhood, particularly for low-performing children, and align with Dynamic Systems Theory by highlighting how structured environmental constraints optimize motor development. Based on these results, we recommend integrating evidence-based motor skill programs into early primary physical education curricula, with at least three 45-minute weekly sessions dedicated to systematic skill development. Teacher training should emphasize critical instructional strategies like task progression, augmented feedback, and deliberate practice, while schools should adopt standardized assessments (e.g., TGMD-2) for screening and progress monitoring. Future research should investigate long-term skill retention, examine intervention effects across diverse populations including girls and different socioeconomic groups, and explore technology-enhanced delivery methods. At the policy level, developing national guidelines for fundamental movement skill instruction and allocating resources for school-based motor skill programs could help maximize

children's developmental outcomes. These recommendations aim to translate research into practice, ensuring that early childhood movement education effectively promotes motor competence and establishes foundations for lifelong physical activity.

## CONFLICT OF INTERESTS

None.

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