

MOTOR SKILL INTERVENTIONS FOR YOUNG CHILDREN

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ABSTRACT

This study is a literature review that summarizes the current state of motor skill intervention programs for young children. An electronic search of the EBSCOhost data bases was conducted. Fifteen studies met the inclusion criteria of the study. In these studies, 659 children between the ages of 3 to 6 years participated in intervention programs, at their schools, designed to improve their fundamental motor skills. Findings indicated that children had developmental delays before the interventions and the interventions were arranged based on the children's needs. Locomotor skills, object control skills and stability skills were the targeted motor skills in the interventions. In addition, majority of the interventions were experimental studies and only four studies had retention tests. All interventions, regardless of their approach, were effective. Enhancing motor skill competence in preschoolers can facilitate an active lifestyle in later years.

Keywords: fundamental motor skills, motor skill interventions, young children, literature review

ÇOCUKLARDA MOTOR BECERİ UYGULAMALARI

ÖZET

Bu çalışmanın amacı okul öncesi çocuklar için hazırlanan motor beceri uygulamalarının alan yazın taraması yapılarak özetlenmesidir. Alan yazın taraması EBSCOhost veri tabaları kullanılarak yapılmış ve arama kriterlerine uyan on beş çalışma bulunmuştur. Bu çalışmalara 3 ve 6 yaş grubu arasında bulunan 659 çocuk katılmıştır. Katılımcıların büyük bir kısmının motor gelişim açısından geri olduğu tespit edilmiş ve programlar katılımcıların ihtiyaçları doğrultusunda oluşturulmuştur. Çalışmalarda yer değiştirme hareketleri, nesne kontrolü gerektiren hareketler ve denge hareketleri öğretilmiştir. Bu çalışmaların çoğunun deneysel çalışma olduğu görülmektedir ve dört çalışma, program bittikten sonra kalıcılık testi uygulanmıştır. Uygulanan programlar süre ve sıklık açısından farklılık gösterebilir, genel olarak motor beceri uygulamalarının etkili olduğu ortaya çıkmıştır. Sonuç olarak, okul öncesi çocukların motor becerilerinin geliştirilmesi aktif bir yaşam sürdürülebilmesi için büyük bir önem taşımaktadır, ve bu uygulamalarının artırılması gerekmektedir.

Anahtar sözcükler: temel motor becerileri, motor beceri uygulamaları, küçük çocuklar, alan yazın taraması

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INTRODUCTION

Physical inactivity is a common problem in all ages. One might think that preschoolers (i.e. 2-5 years old) are very active because of their nature; however, the reality is quite different. A systematic review on physical activity shows that preschoolers from different countries (e.g. Australia, Belgium, Estonia, Finland, Scotland, UK, and USA) are not participating in sufficient physical activity (Tucker, 2008). Therefore, many health agencies and organizations have published various reports, guidelines, and suggestions to increase the physical activity of children in order to facilitate the health benefits of being active. For instance, the National Association for Sport Physical Education (NASPE) has a series of guidelines to promote physical activity for children that is tailored to specific ages; from birth to 5 years, and from 5 to 12 years (NASPE, 2009). The Center for Control Disease and Prevention (CDC) frequently publishes updated information about the benefits of physical activity and provides guidelines for children on their webpage (www.cdc.gov). In addition, the American Heart Association promotes "Healthier Kids" programs and provides resources for children and their families (www.heart.org).

The main points of these guidelines are that a) children should participate in different kinds of physical activities at indoor and out settings, b) children should participate in at least one hour free play and structured physical activities every day, c) parents should encourage an active lifestyle for their children and d) fundamental motor skills defined as primary skills to engage in physical activities should be taught and developed during preschools. These guidelines and suggestions play a critical role in

increasing the public's attention for the need to develop physical activity habits in children. However, those programs may not be enough without understanding the underlying mechanisms of physical activity and inactivity.

"Motor skill competence" is a potential mechanism that can increase physical activity in children (Stodden et al., 2008). Motor skill competence includes having knowledge and ability to apply fundamental motor skills (e.g. catching, kicking or hopping). Fundamental motor skills (FMS) are the "ABC's of movement" and the "building blocks" of more complex movements (e.g. soccer or basketball skills) and future physical activities (Goodway & Robinson, 2006; Payne & Isaacs, 2011). The term FMS emphasizes the view that having these basic motor skills is necessary for later engagement in various forms of physical activities at indoor or outdoor settings.

Stodden and his colleagues (2008) argued that low motor skill competence might lead to low levels of physical activity and high motor skill competence might positively affect the participation in physical activity. The study of Wrotniak and his colleagues (2006) supports this view with the findings of a positive association ($r = .33$) between motor competence and physical activity levels in 8 to 10 years old children. Raudsepp & Pall (2006) also found a positive relationship ($r = .44$) between motor skills and skill-specific physical activity among elementary school children (Mage= 7.6). A literature review on fundamental motor skills revealed a strong association between physical activity and motor competency in children and adolescents (between the age of 3 and 18) (Lubans, Morgan, Cliff, Barnett & Okely, 2010). However, a low correlation between FMS and physical activity was found among

preschoolers (Fisher et al., 2005). These mixed results demonstrate that the correlation between motor skill competence and physical activity might be weak during early years, but it becomes stronger later on in middle childhood (Stodden et al., 2008). For this reason, motor skill development is necessary during early childhood years, in order to enable and facilitate an active lifestyle in later years.

It should be also noted that motor competency has been associated with different health parameters (Lubans et al., 2010). D'Hondt and her colleagues (2009) reported that obese children (Mage= 8.4) had lower motor competence than normal weight children ($r = .34$). It is also found a negative correlation (e.g. $r = -.26$ for 8 years of children) between Body Mass Index (BMI) and motor coordination for children between the age of 6 and 14 (Lopes, Stodden, Bianchi, Maia, & Rodrigues, 2012). Furthermore, a literature review on FMS (21 studies) indicated a positive relation between cardiorespiratory fitness and fundamental motor skills of children (Lubans et al., 2010). It might be concluded from the findings of these studies that children should master motor skills as early as possible to take advantage of health benefits of motor competency and to use FMS to be physically active.

FMS need to be learned; they do not appear naturally as part of the maturation and physical growth process (Gallahue, Ozmun, & Goodway, 2012; Haywood & Getchell, 2008). Developmentally appropriate instructions, feedback and opportunities are necessary to develop FMS (Gabbard, 2011; Gallahue et al., 2012; Payne & Isaacs, 2011). The perfect time to teach FMS is early childhood years. For this reason, a variety of motor skill interventions are designed for children with typical development,

developmental delays or special motor disabilities during early childhood period (Kirk & Rhodes, 2011). Given the importance of motor skills competence for children during early childhood period, the purpose of this study was to conduct a literature review and provide a comprehensive summary of the available motor interventions for young children.

METHOD

The literature review was conducted using an electronic search in the EBSCOhost data bases: Academic Search Complete, Education Source, Education Research Complete, ERIC, Medline, Professional Development Collection, Psychology and Behavior Sciences Collection, and SPORTDiscus. The keywords used were: Fundamental motor skills, motor skill intervention, motor skill program, young children, preschoolers, and their combinations. The inclusion criteria for articles were: 1) the studies were intervention studies and fundamental motor skills were instructed in the intervention. 2) The participants were between the ages of 3 and 6. 3) The studies were published in a refereed journal. The exclusion criteria for articles were: 1) the participants had any disabilities or specific problems such as autism, cerebral palsy or developmental coordination disorders. 2) Single subject studies (i.e. case studies). 3) The studies were unpublished dissertations or conference papers.

Procedures

Initially, an electronic search of the data bases was done with the selected keywords by the main researcher. The articles were reviewed based on the inclusion and the exclusion criteria. The articles were also examined based on the title and the abstract of the article. If necessary, the full article was examined

to determine the appropriateness of it. Then, the reference lists of the selected articles were used for a second search. In addition, a search of articles by authors who are known as motor development specialists and conducted motor skill interventions in the past was also conducted. An independent researcher (a graduate student in sport pedagogy) performed the same procedures to ensure the adequacy of the search. After the independent researcher completed her research, the author and the independent researcher discussed and reviewed the articles to finalize the number of articles. A 100% agreement was reached and fifteen studies were included in the review. The studies were summarized based on the following information: the participants, setting, design of the study, targeted motor skills and other variables, test battery, intervention details, who intervened, intervention integrity, results and retention test.

RESULTS

The 15 reviewed studies are summarized in the following subsections. The general findings of the studies are provided in Table 1. More detailed results can be found inside the articles (see reference list).

Participants and Settings

Young children between the ages of 4 and 6 years were the main participants of the studies. A total of 1087 (558 boys & 529 girls) children were recruited from Head Start Centers, Preschools, Early Education Centers and a University based learning center. A total of 659 children received a motor skill program at their school settings. Seven studies found that children had developmental delays before the interventions (Robinson, 2011; Robinson & Goodway, 2009; Robinson,

Rudisill, & Goodway, 2009; Goodway & Branta, 2003, Goodway, Crowe, & Ward, 2003; Hamilton, Goodway, & Haubenstricker, 1999; Goodway & Rudisill, 1996). Three studies emphasized that their participants were from economically disadvantaged populations (Bellows, Davies, Anderson, & Kennedy, 2013; Draper, Achmat, Forbes, & Lambert, 2012; Martin, Rudisill, & Hastie, 2009). Five studies did not mention whether their participants were at risk of developmental delays (Robinson et al., 2012, Deli, Bakle, & Zachopoulou, 2006; livonen, Sääkslahti, & Nissinen, 2011; Wang, 2004; Valentini & Rudisill, 2004). It seems that children were included in those five studies just because of their age group.

Design of the Studies

The study design in these 15 studies was: full experimental design with randomized pretest-posttest comparisons (4 studies), pretest-posttest quasi-experimental design (7 studies) and without clear descriptions about the intervention, the control groups, and the randomization (4 studies). In table 1, those latter 4 studies were defined as experimental designs. Retention tests were conducted in only four studies (livonen et al., 2011; Robinson & Goodway, 2009; Robinson et al., 2009; Valentini & Rudisill, 2004) and one study was a kind of a follow-up study in which a control group in a previous study received a motor skill intervention (Robinson, 2011). The other studies did not have any retention or follow up tests.

Intervention Aims and Outcomes

The main aim of the interventions was to examine the effectiveness of the motor skill or movement programs on children's motor development (13 studies), perceived competence (1 study),

perceived motor competence (3 studies), cognitive functioning (1 study), physical activity levels and weight status of children (1 study). In general, the interventions were found effective to improve children's locomotor skills, object control skills, stability or balance skills, perceived motor competence, perceived competence and cognitive functioning. However, children did not improve their object control skills and stationary skills in some studies (Iivonen et al., 2011; Robinson et al., 2012; Wang, 2004). In addition, no improvement was observed in terms of physical activity levels and weight status of children in Bellows and his colleagues study (2013). Nine studies were reported the magnitude of the effect sizes of the interventions (Deli et al., 2006; Goodway & Branta, 2003; Goodway et al., 2003; Hamilton et al., 1999; Martin et al., 2009; Robinson & Goodway, 2009; Robinson et al., 2009; Wang, 2004; Valentini & Rudisill, 2004). The effect sizes were reported for the locomotor skills improvement ranged from $\eta^2 = .07$ to $\eta^2 = .92$, for the object control skills improvement ranged from $\eta^2 = .32$ to $\eta^2 = .97$, and for the perceived motor competence $\eta^2 = .17$ to $\eta^2 = .44$.

Targeted Motor Skills and Test Batteries

Locomotor skills (such as running, hopping, skipping, jumping), object control skills (such as throwing, rolling, bouncing), and stability skills (such as balance) were the targeted motor skills in the interventions. Eight studies included both locomotor and object control skills in the interventions. Three studies only included object control skills and two studies only included locomotor skills in the interventions. The Test of Gross Motor Development (TGMD and TGMD-2) was the most used instrument to measure locomotor and objects control

skills (10 studies), because of the validity and reliability of the instrument (Ulrich, 2000). The Peabody Developmental Motor Scale-2 (Folio & Fewell, 2000) was used to measure gross motor skills and stability in two studies (Bellows et al., 2013; Wang, 2004) and The Test for Assessing Preschool Children's Perceptual and Motor skills (APM Inventory) was used for FMS in one study (Iivonen et al., 2011).

Perceived competence (1 study), perceived physical competence (3 studies), cognitive functioning (1 study) and physical activity levels of children (1 study) were the other variables that were measured to see whether the motor skill programs had any effects of them. The Pictorial Scale of Perceived Competence and Social Acceptance (PSPCSA, Harter & Pike, 1984) test was used to assess the perceived competence and perceived physical competence of children in four studies. The Herbst test (Herbst & Huysamen, 2000) was used to assess children's cognitive functioning in one study (Draper et al., 2012). Pedometers were used to measure children's physical activity levels in one study (Bellows et al., 2013).

Motor Skill Intervention Details

Motor skill intervention programs had different lengths; the shortest one was completed in 6 weeks while the longest took 18 weeks to complete. Two studies, however, had a much longer intervention program; 8 months (Draper et al., 2012; Iivonen et al., 2011). The general trend about the frequencies of the practice day was two days per week. Only in one study, the motor skill program was performed every day during a 6 week period (Martin et al., 2009). The duration of the single lessons varied in the studies from 15 to 60 min. Generally, a motor development specialist or a physical

education teacher applied the programs to the children (Robinson, 2011; Robinson & Goodway, 2009; Robinson et al., 2009; Martin et al., 2009; Deli et al., 2006; Valentini & Rudisill, 2004; Goodway & Branta, 2003; Goodway et al., 2003; Goodway & Rudisill, 1996). Other individuals who delivered the motor skill programs were: classroom teachers, early childhood education majors, preschool teachers, parents, and paraprofessionals under the guidance of the investigators. In order to apply motor skill programs, classroom teachers, parents and early childhood education majors had special training sessions on the study protocol or the lesson plans, just before the lessons or the intervention (Bellows et al., 2013; Goodway & Branta, 2003; Goodway et al., 2003; Hamilton et al., 1999; Goodway & Rudisill, 1996; Iivonen et al., 2011; Robinson et al., 2012).

Intervention approach

In the motor skill programs, different teaching approaches were applied to effectively improve FMS, perceived competence, or cognitive functioning of young children. These approaches included: direct instruction method (i.e. low autonomy of the children), mastery motivational climate approach, music integrated movement instruction and creative movement program (see Table 1). Some studies were part of specific projects or programs named as SKIP (Successful Kinesthetic Instruction for Preschoolers), Early Steps Project, the Mighty Moves and Little Champs Program.

The direct instruction model is a traditional instructional model in which children have low autonomy about all decisions of the class period (Graham, Holt-Hale, & Parker, 2007). Specifically, the teacher plans the structure of the

lesson and makes all decisions such as the type of activities/challenges, start/end time of the activities etc. The children simply follow the instructions of the teacher. In contrast to the direct instruction, in mastery motivational climate environments the children have more flexibility to choose the activities and spend some time based on their own decisions (Ames, 1992). Developmentally appropriate activities (a variety of tasks with different difficulty levels) are created by the instructor but the child's intrinsic motivation plays an essential role in these environments which encourage children to do the activities they like (Alderman, Beighle, & Pangrazi, 2006).

Intervention Integrity

The extent to which the intended lesson plans were implemented successfully by the individuals responsible for applying them varied. The strategies for measuring the intervention integrity were as follows: teacher survey (Bellows et al., 2013), videotape recording all sessions and manipulation checks (Robinson, 2011; Robinson & Goodway, 2009; Robinson et al., 2009; Valentini & Rudisill, 2004), progress reports filled by the instructor (Valentini & Rudisill, 2004) evaluation of the lesson plans after each session (Goodway & Branta, 2003; Goodway et al., 2003; Goodway & Rudisill, 1996) and observations (Hamilton et al., 1999).

DISCUSSION

The purpose of this study was to show the current status of research on motor skill interventions for children and make suggestions for further investigations. For this review, fifteen studies (published between 1996 to 2013) were found. In general, the motor skill interventions were effective in developing motor skills in preschoolers whether they

had developmental delays or not. This promising finding suggests that motor skill interventions should be applied for preschoolers. Future studies should focus on the retention effect of the interventions which was an unknown issue in most of the current studies.

Some of the interventions were part of projects which their content was explained in detail (e.g. Deli et al., 2006; Robinson & Goodway, 2009). However, some studies did not provide detailed information about the motor skill intervention (e.g. Wang, 2004). In future motor skill interventions, a sample of lesson plan of one session should be provided (in a table or figure with the picture or shapes). This will be very helpful to see what a typical lesson plan looks like and how the FMS are delivered.

FMS were emphasized in the studies as essential for children's physical growth and their future physical activity engagement. However, most of the interventions (ten studies) were applied for children who were at risk of developmental delays or who had such delays. For these children, direct instruction (in four studies), parent assisted instruction (in one study) and mastery motivational climate approaches (in five studies) were designed in the interventions. The content of motor skill interventions and instructional strategies were organized based on the children's current level of development or their ability level in majority of the studies. Rink's (1996) pedagogical strategies (e.g. using clear directions, providing key words and feedback for the skills or demonstrating critical elements of the skill) were used during the interventions. In addition, task modifications (e.g. increasing the difficulty level of activity) and equipment arrangements (e.g. increasing the weight of the objects or

using different objects) were performed for the motor skills.

The interventions provided for typical children (only five studies) were also followed different instructional approaches such as mastery motivational climate approach, a creative movement program or movement program with music. These interventions were delivered by the professionals for children. Instructional strategies were similar to the interventions provided for children who had delays or at risk of developmental delays. It should be noted that typical children also need developmentally appropriate programs or interventions to develop FMS. For this reason, future research is needed in order to design motor skill interventions for typically developing children from various school settings at different regions.

In the motor skill interventions, direct instruction and mastery motivational climate (MMC) approaches were commonly applied (see Table 1). The studies using the direct instruction or MMC approaches were found as effective to improve the motor skills of preschoolers. Four studies were reported large effect sizes ranged from $\eta^2 = .63$ to $\eta^2 = .97$ for the significant improvement in locomotor and object control skills as a result of the interventions (Goodway & Branta, 2003; Goodway et al., 2003; Hamilton et al., 1999; Valentini & Rudisill, 2004). The studies that used both approaches at the same time emphasized that children improved their motor skills (Robinson & Goodway, 2009; Valentini & Rudisill, 2004). However, one study reported that children in the MMC group had improved their motor skills whereas the children in the low autonomy group did not (Martin et al., 2009). In this study, medium effect sizes for the intervention effect were reported for the locomotor ($\eta^2 = .45$) and object control skills ($\eta^2 = .32$).

For the perceived motor competence, the MMC groups had better improvement ($\eta^2 = .44$ and $\eta^2 = .17$) in two studies (Robinson et al., 2009; Valentini & Rudisill, 2004).

Another approach used in one study was music integrated movement program in which rhythmic education was the basis for teaching gross motor skills (Deli et al., 2006). Creative movements and dance were used to enhance children's motor skills in Wang's study (2004). Both studies indicated positive results for the motor skills of the preschoolers. However, small effect sizes for the significant improvement in gross motor skills were reported in Wang's study (2009). Overall, majority of the studies (8 studies) were reported medium to large effect sizes for the intervention effects on motor development of children. However, some studies did not reported the effect sizes (Bellows et al., 2013; Draper et al., 2012; Goodway & Rudisill, 1996; Iiovenen et al., 2011; Robinson, 2011; Robinson et al., 2012) or small effect size was reported in one study (Wang, 2004). It is obvious that more research is needed to understand the efficacy of the interventions. In addition, future studies should compare the effectiveness of interventions with different approaches.

In addition to different approaches used in the interventions, various implementation procedures were designated by the researchers, such as length of the intervention and duration of the sessions. The criteria for intervention length and duration of the sessions were not clear in the studies. However, the studies having medium or large effect sizes included at least 540 min (instructional time was ranged from 540 min to 1080 min) instructional time to develop FMS. Future researchers should provide their decision criteria to help other

researchers or professionals organize effective programs.

Intervention integrity was another essential issue in the interventions. Various approaches (teacher survey, videotaping of sessions, manipulation checks, progress reports by the instructor, and observation) were applied in the studies. However, some studies did not mention the intervention integrity procedures in their interventions. Leff and his colleagues emphasized that the intervention integrity is a critical topic for the intervention studies (Leff, Hoffman, & Gullman, 2009).

Another essential issue was who intervened as an instructor and how the instructor was trained. Classroom teachers, motor development specialist, coaches or parents delivered the interventions. Detailed descriptions about their training sessions should be given by the researchers to recognize the best procedures for training sessions. In addition, the role of the parents in child development should be taken into consideration for the motor skill interventions. Only one study recruited parents to the intervention (Hamilton et al., 1999) which resulted in success. In the literature, parent based interventions were mostly seen in physical activity promotion studies (Salmon, Booth, Phongsavan, Murphy, & Timperio, 2007), obesity prevention studies (Berry et al., 2004) and special education (Dempsey & Keen, 2008). Motor development specialists should try to increase the parent involvement in their interventions. This can be done by explaining to the parents the important role of motor competence for their children's physical activity habits. Children's engagement in the interventions may be more productive with their parents. In addition, parents may realize the role of fundamental motor skills on their children's overall

development and they may encourage their children to perform motor skills at home environment as well.

CONCLUSION

Fundamental motor skills are important for movement capacities of individuals and they should be instructed as early as possible. Typically developing children and children who have potential for developmental delays should be involved in early motor skill interventions

to improve their motor development. Children can improve their motor skills when developmentally appropriate programs are organized for them. These intervention programs may increase the children's participation in physical activity in the future as a result of improving their perceived motor skill competence. When children know what they can do, they may not hesitate to participate in physical activities or sports.

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Table 1: Summary of the Motor Skill Interventions

Authors (Year)	Participants	Setting	Design	Targeted Variables	Test Battery	Intervention Details	Who Intervened	Intervention Integrity	Results	Retention Test
Bellows, Davies, Anderson & Kennedy (2013)	201 children (111 male & 90 female) 98 in intervention & 103 in control group (At baseline, 132 in intervention group (Mage =53 months) 131 in control group (Mage =51.5 months))	Four Head Start centers from rural and urban settings	A randomized intervention study	Stability Locomotor skills (running, hopping, skipping) Object manipulation skills Physical activity levels Weight status	PDMS-2	The Mighty Moves intervention 18 weeks, 4 days per week for 15-20 min each session	Classroom teachers	Teacher survey	Improvement in motor skills for the intervention group ($F(1, 186)=7.89, p=.006$ for main effect for treatment group) No changes in physical activity levels of children and their weight status	No retention test
Robinson, Webster, Logan, Lucas, & Barber (2012)	14 children (8 male & 6 female) (Mage =4.61) No control group	A university based learning center from the Southeast region of USA	Experimental study	Locomotor skills & Object control skills	TGMD-2	MMC 11 weeks, 2 days per week for 30 min each session	Early childhood education majors	NA	Improvement in total performance ($t(13)=3.0, p<.05$) and locomotor skills ($t(13)=1.9, p=.037$) No improvement in object control skills ($t(13)=2.3, p=.079$)	No retention test

Authors (Year)	Participants	Setting	Design	Targeted Variables	Test Battery	Intervention Details	Who Intervened	Intervention Integrity	Results	Retention Test
Draper, Achmat, Forbes, & Lambert (2012)	118 children 60 (35 male & 25 female) in intervention group (<i>Mage</i> =4.6) 58 (24 male & 34 female) in control group (<i>Mage</i> =4.4)	An early childhood dev. center from South Africa	Quasi-experimental study with a posttest only control group design	Gross motor skills Cognitive functioning	TGMD-2 The Herbst Test	Little champs program 8 months, once a week for 45-60 min each session	Little champs coaches	NA	Improvement in locomotor ($p<.005$), object control skills ($p<.01$) and cognitive functioning ($F(1,81)=239.18$, $p<.0001$) for the intervention group	No retention test
Robinson (2011)	40 children (24 male & 16 female) (<i>Mage</i> =52.48 months) No control group	A Head Start Center from an urban Midwest city	Experimental study	Object control skills Perceived physical competence	TGMD-2 PSPCSA	MMC 9 weeks, 2 days per week for 30 min each session	Motor dev. specialist	Instructional sessions were videotaped	Improvement in object control skills ($F(1,39)=163.19$, $p<.001$) and perceived physical competence $F(1,39)=106.39$, $p<.001$ for object control skill score)	This was a follow up study
Iivonen, Sääkslahti, & Nissinen (2011)	84 children (<i>Mage</i> = 55 months) 39 (23 male & 16 female) in intervention group 45 (23 male & 22 female) in control group	Four preschool from urban central Finland	Experimental study	Balance skills Running speed Standing broad-jump Manipulative skills	The APM inventory	A preschool physical education curriculum (part of Early Steps project) 8 months, 2 days per week for 45 min each session	Preschool teachers	NA	Improvement in balance skills ($F(1,20)=8.71$, $p=.008$) (for girls, not for boys), in running speed ($F(1,49)=6.86$, $p=.012$) (linear development for boys, not for girls), standing broad jump (non-linear improvement for girls, linear development for boys) ($F(1,33)=4.94$, $p=.033$) No improvement in manipulative skills	Three months after the intervention

Authors (Year)	Participants	Setting	Design	Targeted Variables	Test Battery	Intervention Details	Who Intervened	Intervention Integrity	Results	Retention Test
Robinson & Goodway (2009)	117 children 38 (20 male & 18 female) in Low Autonomy group (<i>M</i> age =46.6 months) 39 (10 male & 20 female) in Mastery Motivation Climate group, (<i>M</i> age =47.6 months) 40 (24 male & 16 female) in comparison group (<i>M</i> age = 48.3 months)	Two Head Start centers from an urban Midwest city	Randomized pretest-posttest comparison group design with retention test	Object control skills	TGMD-2	A low autonomy program MMC 9 weeks, 2 days per week for 30 min each session	Motor dev. specialist	Instructional sessions were videotaped and integrity checks were done	Improvement in object control skills for both Low Autonomy and MMC groups ($F(2,114)=77.83$), $p=.001$, $\eta^2=.57$)	9 weeks after the intervention
Robinson, Rudisill, & Goodway (2009)	The same as in the study of Robinson & Goodway (2009)	The same	The same	Perceived physical competence	PSPCSA	The same	The same	The same	Improvement in perceived physical competence for MMC group ($F(2,114)=44.75$), $p=.001$, $\eta^2=.44$)	The same
Martin, Rudisill, & Hastie (2009)	64 children 42 (18 male & 24 female) in Mastery Motivation Climate group (<i>M</i> age =5.72) 22 (12 male & 10 female) in Low Autonomy group (<i>M</i> age =5.43)	Two preschools from two South-eastern rural towns	Pretest posttest quasi-experimental design	Locomotor skills Object control skills	TGMD-2	A low autonomy program MMC 6 weeks, every day for 30 min each session	Physical education teacher	NA	Improvement in object control skills ($F(1,54)=42.61$), $p=.001$, $\eta^2=.45$) and Locomotor skills for MMC group ($F(1,53)=24.37$), $p=.001$, $\eta^2=.32$)	No retention test

Authors (Year)	Participants	Setting	Design	Targeted Variables	Test Battery	Intervention Details	Who Intervened	Intervention Integrity	Results	Retention Test
Deli, Bakle, & Zachopoulou (2006)	75 children (<i>Mage</i> =5.4) 25 (11 male & 14 female) in movement group (intervention) 25 (12 male & 13 female) in movement and music group (intervention) 25 (13 male & 12 female) in free play group (control)	A preschool center	Pretest posttest quasi-experimental design	Locomotor skills	TGMD	A movement program A music & movement program (exploratory teaching style) 10 weeks, 2 days per week for 35 min each session	Physical education teacher	NA	Improvement in running ($F(2,71)=4.15, p<.05$), $\eta^2=.24$), hopping ($F(2,71)=3.28, p<.05$), $\eta^2=.43$), leaping ($F(2,71)=5.19, p<.01$), $\eta^2=.21$), jumping ($F(2,71)=5.32, p<.01$), $\eta^2=.50$), and skipping($F(2,71)=8.17, p<.01$), $\eta^2=.44$) for the movement program Improvement in running ($F(1,24)=19.20, p<.001$), $\eta^2=.43$), hopping ($F(1,24)=6.75, p<.05$), $\eta^2=.45$), leaping ($F(1,24)=19.82, p<.001$), $\eta^2=.45$), jumping ($F(1,24)=21.30, p<.001$), $\eta^2=.48$), and skipping($F(1,24)=23.45, p<.001$), $\eta^2=.43$) for music & movement program	No retention test
Wang (2004)	60 children (23 male & 37 female) (ages between 36 months through 71 months) 30 in experiment group 30 in control group	A preschool from Taiwan	Experimental study	Gross motor skills Locomotion Object manipulation skills Stationary skills	PDMS-2	A creative movement program 6 weeks, 2 days per week for 30 min each session	A creative dance teacher	NA	Improvement in Gross Motor Skills ($F(1,57)=4.32, p=.042$, $\eta^2=.04$) and locomotion in intervention group ($F(1,57)=5.82, p=.02$, $\eta^2=.07$) No improvement in object manipulation skills and stationary skills in both groups	No retention test

Authors (Year)	Participants	Setting	Design	Targeted Variables	Test Battery	Intervention Details	Who Intervened	Intervention Integrity	Results	Retention Test
Valentini & Rudisill (2004)	<p><u>Intervention 1</u> 39 children</p> <p>19 (7 male & 12 female) in Low Autonomy Group (<i>Mage</i> =5.40)</p> <p>20 (7 male & 13 female) in MMC group (<i>Mage</i> =5.45)</p> <p><u>Intervention 2</u> 67 children</p> <p>38 (17 male & 21 female) in MMC (<i>Mage</i> =5.1)</p> <p>29 (14 male & 15 female) in control group (<i>Mage</i> =5.27)</p>	An early education center from a Southeast urban city	A randomized pretest posttest design	<p>Locomotor skills</p> <p>Object control skills</p> <p>Perceived physical competence</p>	TGMD PSPCSA	<p>A low autonomy program</p> <p>MMC</p> <p>12 weeks, 2 days per week for 35 min each session</p>	Motor dev. specialist	<p>A manipulation checklist</p> <p>Observations</p> <p>Instructor weekly progress reports</p>	<p>Improvement in locomotor ($F(1,37)=415.75, p=.0001, \eta^2=.91$), and object control skills($F(1,37)=237.10, p=.0001, \eta^2=.86$) for both low autonomy and MMC groups</p> <p>More improvement in locomotor and perceived physical competence ($F(1,37)=17.06, p=.001, \eta^2=.32$) for MMC group in intervention 1</p> <p>MMC group maintained their development in locomotor skills ($F(2,53)=11.34, p=.001, \eta^2=.30$), and object control skills ($F(2,53)=12.31, p=.0001, \eta^2=.32$) and perceived physical competence ($F(1,33)=6.89, p=.013, \eta^2=.17$) in intervention 2</p>	<p>No retention test in experiment 1</p> <p>6 months after the intervention in experiment 2</p>
Goodway & Branta (2003)	<p>59 children</p> <p>31(15 male & 16 female) in intervention group (<i>Mage</i> = 4.74)</p> <p>28 (14 male & 14 female) in control group (<i>Mage</i> = 4.74)</p>	A mandatory preschool (Head Start) from a Midwest urban city	Pretest posttest quasi-experimental design	<p>Locomotor skills</p> <p>Object control skills</p>	TGMD-2	<p>Motor skill intervention with direct Instruction</p> <p>12 weeks, 2 days per week for 45 min each session</p>	<p>Motor dev. specialist</p> <p>Classroom teacher</p> <p>PP</p>	Evaluation of the lesson plan after each session	Improvement in locomotor ($F(1,57)=134.23, p<.001, \eta^2=.70$) and object control skills ($F(1,57)=161.55, p<.001, \eta^2=.74$) for intervention group	No retention test

Authors (Year)	Participants	Setting	Design	Targeted Variables	Test Battery	Intervention Details	Who Intervened	Intervention Integrity	Results	Retention Test
Goodway, Crowe, & Ward (2003)	63 children 33 (17 male & 16 female) in intervention group (<i>Mage</i> = 4.9) 30 (12 male & 18 female) in comparison group (<i>Mage</i> = 5.0)	An elementary school (Head Start) from a Southern urban city	Pretest posttest quasi-experimental design	Locomotor skills Object control skills	TGMD	Motor skill intervention with direct instruction (SKIP) 9 weeks, 2 days per week for 35 min each session	Motor dev. specialist Classroom teacher PP	Evaluation of the lesson plan after each session	Improvement in locomotor ($F(1,61)=101.04, p<.001, \eta^2=.63$) and object control skills ($F(1,61)=99.05, p<.001, \eta^2=.63$) for intervention group	No retention test
Hamilton, Goodway, & Haubenstriker (1999)	27 children 15 (9 male & 6 female) in intervention group (<i>Mage</i> =47.1 months) 12(7 male & 5 female) in control group (<i>Mage</i> =47.5 months)	Two mandatory preschools (Head Start) from a Midwest urban city	Quasi-experimental design using a non-equivalent control group	Object control skills	TGMD	A parent assisted motor skill intervention 8 weeks, 2 days per week for 45 min each session	Parents	Investigator observed parents for each session and gave feedback	Improvement in object control skills ($F(1,26)=12.55, p<.002, \eta^2=.97$) for intervention group	No retention test
Goodway & Rudisill (1996)	59 children 31 (15 male & 16 female) in intervention group (<i>Mage</i> =4.74) 28 (14 male & 14 female) in control group (<i>Mage</i> =4.74)	Three mandatory preschools (Head Start) from a Midwest urban city	Pretest posttest quasi-experimental design	Perceived competence	PSPCSA	Motor skill intervention 12 weeks, 2 days per week for 45 min each session	Motor dev. specialist Classroom teacher PP	Evaluation of the lesson plan after each session	Improvement in perceived physical competence ($F(1,56)=5.41, p=.02$), peer acceptance ($F(1,56)=5.12, p=.028$), and perceived maternal acceptance ($F(1,56)=4.12, p=.045$) for intervention group	No retention test

Note. APM = The Test for Assessing Preschool Children's Perceptual and Motor Skills; Dev.=Development; MMC = Mastery Motivational Climate Approach; NA = Not Available; PDMS = Peabody Developmental Motor Scale; PSPCSA = Pictorial Scale of Perceived Competence and Social Acceptance; PP= Paraprofessionals; SKIP = Successful Kinesthetic Instruction for Preschoolers; TGMD = Test of Gross Motor Development; USA=United States of America.