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Motor Skill Competence and Physical Activity in Preschoolers: A Review

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Abstract *Objectives* Preschoolers 3–5 years of age are in a crucial stage of motor skill competence. While preschoolers develop their motor skill competence through engagement in physical activity, a majority of them fail to meet guideline-recommended physical activity level. This study reviews scientific evidence on the relationship between motor skill competence and physical activity among preschoolers. *Methods* This systematic review followed the PRISMA framework. Keyword and reference search were conducted in PubMed, Cochrane Library, PsycINFO, Web of Science, and Google Scholar. Inclusion criteria included—age: 3–5 years of age; setting: preschool environment (e.g., preschool, childcare, head start); main outcomes: motor skill competence and physical activity; study design: cross-sectional study, case–control study, retrospective cohort study, prospective cohort study, or randomized controlled trial; language: English; and article type: peer-reviewed publication. *Results* Eleven studies met the inclusion criteria, including 6 randomized controlled trials and 5 cross-sectional studies. Studies were conducted in 5 countries: United States (5), United Kingdom (2), Australia (2), Switzerland (1), and Finland (1). Eight out of the 11 studies included in the review reported a significant relationship between motor skill competence and physical activity. The specific pattern and strength of the relationship tend to differ by gender, physical activity intensity, motor skill type, and day of the week (weekdays versus weekends). *Conclusions* An association has been consistently documented between motor skill competence and physical activity. Future research is warranted to elucidate the underlining causal link, examine potential heterogeneity, and determine the role of environment in the relationship between motor skill competence and physical activity among preschoolers.

Keywords Physical activity · Motor skill competence · Preschooler · Systematic review

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Significance

Preschoolers 3–5 years of age are in a crucial stage of motor skill competence. While preschoolers develop their motor skill competence through engagement in physical activity, a majority of them fail to meet guideline-recommended physical activity level. This study adds to the literature by systematically reviewing scientific evidence on the relationship between motor skill competence and physical activity among preschoolers 3–5 years of age. It has a focus on the diverse measures adopted to assess motor skill competence and physical activity, and considers the potential heterogeneities in the relationship between motor skill competence and physical activity.

Introduction

According to D'Hondt et al. (2009), motor skill competence can be defined as a person's movement coordination quality when performing different motor skills, ranging on

a continuum from gross to fine motor skills. The preschool years (3–5 years of age) are known as the "golden age" of motor skill competence as many of the fundamental motor skills such as running, jumping, throwing, and catching are developed during this phase of life (Shenouda et al. 2011). Preschoolers develop their motor skill competence through engagement in physical activity. Preschoolers are recommended to engage in at least 60 min of structured physical activity and 60 min of unstructured physical activity on a daily basis (NASPE 2002, 2009). However, a majority of preschoolers fail to meet this guideline recommendation (Beets et al. 2011).

The relationship between motor skill competence and physical activity is likely to be reciprocal (Barnett et al. 2011; Hume et al. 2008; Kambas et al. 2012; Stodden et al. 2008). Children with greater motor skill competence were observed to spend more time in moderate-to-vigorous physical activity (Williams et al. 2008), whereas those with less developed motor skill competence appeared less physically active earlier in life (Shenouda et al. 2011). Intervention studies in youth found that greater motor skill competence increase physical activity participation, and increased structured physical activity may lead to greater motor skill competence (Barnett et al. 2011; Jaakkola and Washington 2013; Logan et al. 2011). Moreover, considerable variations in the relationship between physical activity and motor skill competence may exist across gender, age, type of physical activity involvement, and stage of human development (Azevedo et al. 2007; Jaakkola and Washington 2013; Junaid and Fellowes 2006; Logan et al. 2011; Thomas and French 1985; Trost et al. 2002; Williams and Monsma 2006).

Measures of physical activity and motor skill competence are complex. Physical activity can be examined qualitatively (e.g., types of exercises) or quantitatively (e.g. frequency, duration, and intensity), and in the form of self-report (e.g. questionnaires and diaries) or objective scale (e.g. pedometer, accelerometer, heart rate monitor) (Warren et al. 2010). Motor skill competence can be assessed qualitatively by process-based measures (e.g., how the body is positioned, which limbs are moved, and how they move) or quantitatively by product-based measures (e.g., the time to run 100 m, the number of shuttle runs completed, and the distance a ball is thrown) (Williams and Monsma 2006).

A few review articles pertain to the present study. Hinkley et al. (2008) reviewed correlates of preschoolers' physical activity but found inconclusive evidence linking motor skill competence to physical activity level. Tucker (2008) reviewed methodological issues on measuring physical activity in preschoolers, but did not examine the relationship between physical activity and motor skill competence in particular. Timmons et al. (2012) reviewed 4 studies that examined physical activity in relation to motor skill competence in children 4 years of age and younger. One of them was a randomized controlled trial (RCT) targeting infants, whereas the other 3 (2 RCTs and 1 observational study) focused on preschoolers. Timmons et al. (2012) found that the three studies focusing on preschoolers improved motor skill competence through physical activity programming; one of which had a bi-weekly dance classes component (Venetsanou and Kambas 2004). Another review study finds a positive association between motor skill competence and physical activity, but the magnitude of these associations remains unclear (Lubans et al. 2010). Holfelder and Schott (2014) reviewed the relationship between fundamental motor skills and physical activity in children and adolescents 3–18 years of age. A positive relationship between motor skill competence and organized physical activities was evident in cross-sectional studies, whereas a causal link remains to be demonstrated due to limited experimental data. Most recently, a systematic review Logan et al. (2015) have found consistent correlations between motor skill competence and physical activity in 12 studies. Robinson and colleagues' comprehensive review about relationships between motor skill competence and physical activity confirm these previously highlighted findings (Robinson et al. 2015).

This study adds to the literature by systematically reviewing scientific evidence on the relationship between motor skill competence and physical activity among preschoolers 3–5 years of age. It has a focus on the diverse measures adopted to assess motor skill competence and physical activity, and considers the potential heterogeneities in the relationship between motor skill competence and physical activity.

Methods

Study Selection Criteria

This systematic review followed the PRISMA framework (PRISMA 2009). Studies that met the following inclusion criteria were included in the review—age: 3–5 years of age; setting: preschool environment (e.g., preschool, childcare, head start); main outcomes: motor skill competence and physical activity; study design: cross-sectional study, case–control study, retrospective cohort study, prospective cohort study, or randomized controlled trial; language: English; and article type: peer-reviewed publication. Studies targeting participants with specific health conditions (e.g., children with motor disabilities) and studies that used neither product- nor process-based

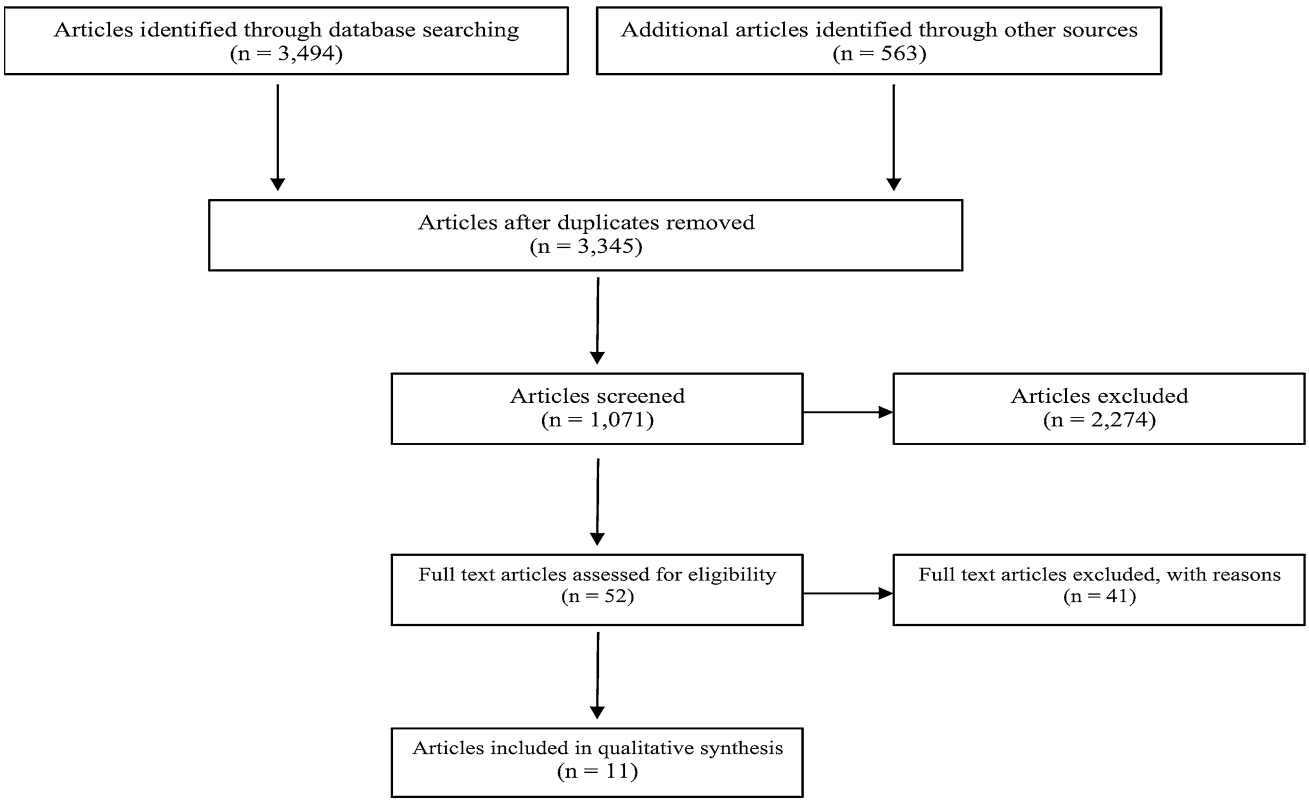

Fig. 1 Study selection flowchart using PRISMA flowchart framework (Moher et al. 2009)

instruments to assess motor skill competence were excluded.

Search Strategy

Keyword search was conducted in PubMed, Cochrane Library, PsycINFO, Web of Science, and Google Scholar. The search algorithm included all possible combinations of keywords from the following 3 groups: (1) "motor competence", "motor development", "motor ability", "motor performance", "fundamental motor skills", "motor skills", or "motor coordination"; (2) "physical activity", "physical education", "activity level", "play", or "recreation"; and (3) "preschool children", "preschoolers", "young children", or "early childhood". Titles and abstracts of the articles identified through keyword search were screened against the study selection criteria. Potentially relevant articles were retrieved for evaluation of the full text.

A reference list search (backward reference search) and a cited reference search (forward reference search) were performed based on full-text articles identified from keyword search that met the study selection criteria. Articles identified through backward/forward reference search were further screened and evaluated using the same study selection criteria. We repeated backward/forward reference search on all newly identified articles until no additional relevant articles were found. The entire search was completed on March 31st, 2015. Additionally, other sources identified three articles that pertained relevant to this review. Those were added to the pooled of identified articles and were given the same screening procedures as the rest (Fig. 1).

Data Extraction and Synthesis

A standardized data extraction form was used to collect the following methodological and outcome variables from each included study: author(s), publication year, country where a study was conducted, study design, setting, sample size, measure(s) on motor skill competence, measure(s) on physical activity, statistical approach, and main finding(s).

Analysis was limited to a narrative synthesis of the included studies with general themes summarized. A meta-analysis was not pursued for the purposes of this study due to unexplained heterogeneity (Anderson et al. 2011).

Study Quality Assessment

The quality of each study included in the review was assessed by the presence or absence of 7 dichotomous

criteria rooted in current methodological discussions from both fields (i.e., physical activity and motor skill competence) (Williams and Monsma 2006; Stodden et al. 2008; Robinson et al. 2015). (1) Was the study a randomized control trial? (2) Did the study employ a sample of at least 100 preschoolers 3–5 years of age? (3) Was physical activity measured by accelerometer? (4) Was motor skill competence measured by a product-based instrument? (5) Was the relationship between motor skill competence and physical activity adequately explained in the study? (6) Did the study explore potential heterogeneity in the relationship between motor skill competence and physical activity by gender? (7) Did the study explore potential heterogeneity in the relationship between motor skill competence and physical activity by age group? A total study quality score ranging from 0 to 7 was obtained for each study by summing up these criteria. Quality score helped measure the strength of the study evidence but was not used to determine the inclusion of studies.

Results

Study Selection

A total of 3345 articles were identified in the keyword and backward/forward reference search, among which 3293 were excluded in title/abstract screening. The remaining 52 articles were further evaluated in full text against the study selection criteria. Among them, 41 articles were excluded due to one or more of the following reasons: age ineligibility, studies that did not measure motor skill competence or physical activity, review articles rather than original research, and program evaluation or randomized controlled trial follow-up studies that did not examine the relationship between motor skill competence and physical activity. Excluding the above articles yielded a final pool of 11 studies (Table 1).

Basic Characteristics of the Included Studies

Table 1 summarizes the 11 studies included in the review, including 6 RCTs (Alhassan et al. 2012; Bellows et al. 2013; Bonvin et al. 2013; Fisher et al. 2005; Jones et al. 2011; Robinson et al. 2012) and 5 cross-sectional studies (Cliff et al. 2009; Foweather et al. 2014; O'Neill et al. 2014; Sääkslahti et al. 1999; Williams et al. 2008). Studies were conducted in 5 countries: United States (5) (Alhassan et al. 2012; Bellows et al. 2013; O'Neill et al. 2014; Robinson et al. 2012; Williams et al. 2008), United Kingdom (2) (Fisher et al. 2005; Foweather et al. 2014), Australia (2) (Cliff et al. 2009; Jones et al. 2011), Switzerland (Bonvin et al. 2013) and Finland (1) (Sääkslahti et al. 1999). Studies included in the review represent relatively recent work published between 1999 and 2014. Six studies were conducted in preschools (Alhassan et al. 2012; Bellows et al. 2013; Cliff et al. 2009; Foweather et al. 2014; O'Neill et al. 2014; Williams et al. 2008), 3 studies were conducted in childcare centers (Bonvin et al. 2013; Jones et al. 2011; Robinson et al. 2012), whereas the other 2 did not specify study settings (Fisher et al. 2005; Sääkslahti et al. 1999).

The 11 studies included in the review had an average sample size of 196 preschoolers aged between 3 and 5 years. Sample size in individual studies ranged from 34 (Robinson et al. 2012) to 648 (Bonvin et al. 2013). Boys and girls were largely equally represented in study samples, and 5 of the 11 studies included in the review provided gender-specific estimates (Bellows et al. 2013; Cliff et al. 2009; Robinson et al. 2012; Sääkslahti et al. 1999; Williams et al. 2008).

Physical activity was measured by accelerometer in 7 studies (Alhassan et al. 2012; Bonvin et al. 2013; Cliff et al. 2009; Fisher et al. 2005; Foweather et al. 2014; Jones et al. 2011; Williams et al. 2008), and by pedometer (Bellows et al. 2013; Robinson et al. 2012), diary (Sääkslahti et al. 1999), and observation method (O'Neill et al. 2014) in the other 4 studies. Among the 7 studies that assessed physical activity using accelerometer, 6 used ActiGraph® products (Alhassan et al. 2012; Bonvin et al. 2013; Cliff et al. 2009; Foweather et al. 2014; Jones et al. 2011; Williams et al. 2008). Motor skill competence was measured by the Test of Gross Motor Development Second Edition (TGMD-2) in 6 studies (Alhassan et al. 2012; Cliff et al. 2009; Foweather et al. 2014; Jones et al. 2011; O'Neill et al. 2014; Robinson et al. 2012), and by the APM Inventory (Sääkslahti et al. 1999), the CHAMPS Motor Skill Protocol (CMSP) (Williams et al. 2008), the Movement Assessment Battery (Fisher et al. 2005), Zurich Neuromotor Assessment (ZNA) (Bonvin et al. 2013) and the Peabody Developmental Motor Scales Second Edition (PDMS-2) (Bellows et al. 2013) in the other 5 studies.

Relationship Between Motor Skill Competence and Physical Activity

Eight out of the 11 studies included in the review reported a statistically significant relationship between motor skill competence and physical activity. The only study that reported a null finding was a head start center-based intervention that aimed to enhance preschoolers' gross motor skill competence (Bellows et al. 2013). This null finding was likely due to low intervention intensity, as the authors concluded that "[t]he intervention dose was adequate for enhancing gross motor skill performance but not for increasing physical activity levels…" Also, the

Table 1 Studies included in the review

References	Country	Setting	Study design	Sample size	Outcome measure	Statistical method	Study finding
Alhassan et al. (2012)	US	Preschool	RCT	71 (35 boys, 36 girls)	PA: Actigraph GT1 M accelerometer; MSC: TGMD-2	*t* test, Wilcoxon rank sum test, MANCOVA, Chi square test	The implementation of a teacher-taught, locomotor skill-based physical activity program was found to improve locomotor skills and reduce sedentary time of minority preschoolers. Treatment group exhibited a significant reduction in during-preschool and total daily percent time spent in sedentary activity. Treatment group also exhibited significant improvement in leaping skills
Bellows et al. (2013)	US	Head start center	RCT	201 (98 treatment, 103 control; gender unspecified)	PA: W4L pedometer; MSC: PDMS-2	*t* test, Pearson correlation, ANOVA, regression	(1) The intervention led to significant changes in gross motor skills in the experimental group compared with the control group and was a strong predictor of overall gross motor performance (gross motor quotient), locomotor, stability, and object manipulation skills (2) No intervention effect was found for physical activity levels or weight status
Bonvin et al. (2013)	Switzerland	Child care Center	RCT	648 (313 treatment, 49 % girls)	PA: Actigraph GT1 M; MSC: Zurich Neuromotor Assessment (ZNA)	Mixed linear and logistic regression	This governmentally led physical activity program in child care centers, did not lead to improvements in child motor skills
Cliff et al. (2009)	Australia	Preschool	Cross-sectional	46 (25 boys, 21 girls)	PA: ActiGraph 7164 uniaxial accelerometer; MSC: TGMD-2	Kolmogrov-Smiranov test, *t* test Pearson correlation, Spearmen rank-order correlation	(1) Boys and girls were found to be equally proficient at performing object control skills, although girls scored higher than boys for locomotor skills and subsequently for the gross motor quotient (2) Fundamental motor skills were positively correlated with objectively measured habitual physical activity in preschool boys and negatively correlated to habitual physical activity in preschool girls (3) For boys, object-control skills held stronger positive associations with physical activity outcomes (percent of time in moderate physical activity and moderate-to-vigorous physical activity, and total physical activity) than locomotor skills. While for girls, locomotor skills held stronger negative associations with habitual physical activity outcomes (percent of time in moderate physical activity and moderate-to-vigorous physical activity) than object-control skills

Table 1 continued

References	Country	Setting	Study design	Sample size	Outcome measure	Statistical method	Study finding
Fisher et al. (2005)	UK	Not specified	RCT	394 (209 boys, 185 girls)	PA: CSA WAM 7164 accelerometer; MSC: Movement Assessment Battery	Pearson correlation, Kruskal–Wallis test, Mann–Whitney test	Total physical activity ($r = 0.10$, $p < 0.05$) and percent time spent in moderate to vigorous physical activity (MVPA) ($r = 0.18$, $p < 0.001$) were significantly correlated with total movement skills score. Time spent in light-intensity physical activity was not significantly correlated with motor skills score ($r = 0.02$, $p > 0.05$)
Foweather et al. (2014)	UK	Nursery school	Cross-sectional	99 (52 boys, 47 girls)	PA: Actigraph 7164 accelerometer; MSC: TGMD-2	*t* test, multilevel mixed linear regression	(1) Total skill score was positively associated with weekend moderate-to-vigorous physical activity ($p = 0.034$) but not weekday physical activity categories ($p > 0.05$) (2) Object-control skills was positively associated with light physical activity on weekdays ($p = 0.008$) and with light ($p = 0.033$), moderate-to-vigorous ($p = 0.028$) and light- and moderate-to-vigorous ($p = 0.008$) physical activity at weekends. Locomotor skill competency was positively associated with moderate-to-vigorous physical activity on weekdays ($p = 0.016$) and light physical activity during the weekend ($p = 0.035$) (3) Boys were more active than girls and had higher object-control skill competency
Jones et al. (2011)	Australia	Child care center	RCT	97 (52 treatment, no gender data)	PA: Actigraph 7164 accelerometer; MSC: TGMD-2	ANCOVA, *t* test	Improvements in individual skills (and by nature overall skill proficiency) was greater in the intervention group. However, direct comparison of the individual skills is limited, as effect sizes for the above studies could not be calculated
O'Neill et al. (2014)	US	Preschool	Cross-sectional	264 (137 boys, 127 girls)	PA: OSRAC-P; MSC: TGMD-2	ANCOVA, generalized linear mixed model	Children in the highest locomotor tertile engaged in more dancing than children in the lowest tertile ($p = 0.04$). Children in the highest object control tertile engaged in throwing more frequently than children in lower tertiles ($p < 0.05$)
Robinson et al. (2012)	US	Child care center	RCT	34 (22 boys, 12 girls)	PA: Yamax SW-200 Digiwalker pedometers; MSC: TGMD-2	Pearson correlation, ANOVA, regression	Preschoolers' locomotor ability, measured by their ability to run, jump, hop, leap, slide, and gallop, accounted for 21 % ($p = 0.007$) of the variance in their school-day physical activity

Table 1 continued

References	Country	Setting	Study design	Sample size	Outcome measure	Statistical method	Study finding
Sääkslahti et al. (1999)	Finland	Not specified	Cross-sectional	105 (50 boys, 55 girls)	PA: Parental diary 5-min units in nine different activity categories over one weekend; MSC: APM Inventory	Pearson correlation, *t* test, Wilcoxon rank sum test	(1) Physical activity is weakly related to fundamental motor skills. The associations between physical activity and motor skills were highly gender-dependent (2) Boys benefited from interacting with parents, whereas girls benefited from independence
Williams et al. (2008)	US	Preschool	Cross-sectional	198 (100 boys, 98 girls)	PA: Actigraph GT1 M accelerometer MSC: CHAMPS Motor Skill Protocol (CMSP)	Pearson correlation, ANCOVA	(1) Young children with better-developed motor skills spent significantly more time in both moderate-to-vigorous physical activity and vigorous physical activity and significantly less time in sedentary behaviors than children with less well-developed motor skills (2) Girls in the low and intermediate tertiles of motor skills had greater percent time spent in vigorous physical activity, whereas boys in the highest tertile of motor skills spent significantly more percent time in vigorous physical activity (3) Age may be an important factor in elucidating the relationship between level of motor skill performance and physical activity in preschoolers

In the column of "outcome measure", PA denotes physical activity and MSC denotes motor skill competence

government-led child care center physical activity intervention aiming at improving motor skill competence found non-significant results (Bonvin et al. 2013).

The nature and strength of the relationship between motor skill competence and physical activity in preschoolers may differ by physical activity intensity and/or type of motor skills. Fisher et al. (2005) found total movement skill score to be significantly associated with percent time spent in moderate-to-vigorous physical activity but not light-intensity physical activity. Sääkslahti et al. (1999) found physical activity in children 3–4 years of age to be related to motor skill competence but highly dependent on gender. O'Neill et al. (2014) found that preschoolers in the highest locomotor tertile engaged in more dancing than children in the lowest tertile; whereas children in the highest object-control tertile engaged in throwing more frequently than children in lower tertiles.

The relationship between motor skill competence and physical activity in preschoolers tends to differ by gender. Cliff et al. (2009) found motor skill competence to be positively associated with objectively measured habitual physical activity in preschool boys but negatively associated with that in preschool girls. Moreover, object-control skill competence had stronger positive associations with physical activity than locomotor skill competence among boys; whereas locomotor skill competence had stronger negative associations with habitual physical activity than object-control skill competence among girls. Williams et al. (2008) found that girls in the low and intermediate tertiles of motor skill competence had greater percent time spent in vigorous physical activity, whereas boys in the highest tertile of motor skill competence spent significantly more percent time in vigorous physical activity. Sääkslahti et al. (1999) found that preschool boys had greater gross motor skill competence by playing with parents, whereas preschool girls benefited the most from playing independently.

There is some preliminary evidence that the relationship between motor skill competence and physical activity in preschoolers differed between weekends and weekdays. Foweather et al. (2014) found that total motor skill score was positively associated with weekend moderate-to-vigorous physical activity but not weekday physical activity categories. Moreover, object-control skill competence were positively associated with light-intensity physical activity on weekdays and with both light-intensity and moderate-to-vigorous physical activity at weekends; whereas locomotor skill competence were positively associated with moderate-to-vigorous physical activity on weekdays and light-intensity physical activity at weekends.

Study Quality

Table 2 reports the results of study quality assessment. Studies included in the review on average met 3.6 out of 7 quality criteria, but the distribution in quality score differed substantially across criteria. All but one studies explained the relationship between motor skill competence and physical activity in some detail, and 6 studies employed a sample of at least 100 preschoolers 3–5 years of age (Bellows et al. 2013; Bonvin et al. 2013; Fisher et al. 2005; O'Neill et al. 2014; Sääkslahti et al. 1999; Williams et al. 2008) or used accelerometer to measure physical activity (Alhassan et al. 2012; Bonvin et al. 2013; Cliff et al. 2009; Fisher et al. 2005; Foweather et al. 2014; Jones et al. 2011; Williams et al. 2008). In contrast, only 2 studies used a product-based assessment tool to measure motor skill competence (Bellows et al. 2013; Fisher et al. 2005) or examined potential heterogeneity in the relationship between motor skill competence and physical activity by age group (Cliff et al. 2009; Williams et al. 2008).

Table 2 Study quality assessment

Item	Criterion of study quality	Percent that met criteria/mean
1	Was the study a randomized control trial?	45 %
2	Did the study employ a sample of at least 100 preschoolers 3–5 years of age?	55 %
3	Was physical activity measured by accelerometer?	64 %
4	Did a product-based instrument measure motor skill competence?	18 %
5	Was the relationship between physical activity and motor competence adequately explained in the study?	91 %
6	Did the study explore potential heterogeneity in the relationship between motor skill competence and physical activity by gender?	64 %
7	Did the study explore potential heterogeneity in the relationship between motor skill competence and physical activity by age group?	27 %
8	Overall study quality score by summing up Item 1 through 7	3.63

Item 1 through 7 are all dichotomous variables

Discussion

This study reviewed existing scientific evidence on the relationship between motor skill competence and physical activity among preschoolers 3–5 years of age. A total of 11 studies that met the inclusion criteria were identified through keyword and reference research. Eight of them documented a significant association between motor skill competence and physical activity. The nature and strength of the relationship between motor skill competence and physical activity in preschoolers tends to differ by gender, physical activity intensity, motor skill type, and day of the week (weekdays versus weekends).

The studies included in the review have limitations regarding measures on physical activity and motor skill competence. Accelerometry is long considered as the "gold standard" for measuring physical activity level in adults and children, including preschoolers (Bornstein et al. 2011). Among the 11 studies included in the review, 7 used accelerometer while the other 4 adopted other measures, including pedometer (Bellows et al. 2013; Robinson et al. 2012), parental self-report questionnaire (Sääkslahti et al. 1999), and observational tool (O'Neill et al. 2014). Compared to process-based motor skill measures, product-based measures facilitates better the comparison of a child's performance to their chronological peers (Williams and Monsma 2006). However, only 2 studies assessed motor skill competence in preschoolers using a product-based measure (Bellows et al. 2013; Fisher et al. 2005). Future research is warranted to design developmentally appropriate product-based measures of motor skill competence and integrate them with process-based measures to comprehensively capture the multifaceted motor skill competence pattern and trajectory among preschoolers.

The relationship between motor skill competence and physical activity documented in the studies included in the review is largely cross-sectional and observational. It remains to demonstrate a causal link between these 2 outcomes of interest independent of potential confounders. Alhassan et al. (2012) found the implementation of a teacher-taught, locomotor skill-based intervention to reduce sedentary time of preschoolers. However, an intervention targeting gross motor skills was not found to increase physical activity levels (Bellows et al. 2013). This null finding could be due to insufficient intervention intensity as indicated by the authors, but might also reflect the lack of a true relationship. Stodden et al. (2008) suggested that physical activity in early childhood influenced motor skill competence but not vice versa.

Although the presence of gender differences in the relationship between motor skill competence and physical activity has been largely agreed upon (Cliff et al. 2009; Hume et al. 2008; Jaakkola and Washington 2013; Junaid and Fellowes 2006; Okely et al. 2001), to date not much consensus could be reached regarding the exact roles of gender as a key moderator in determining and modifying the relationship in physical activity and motor skill competence. Moreover, the specific trajectory of motor skill competence in preschoolers and its interaction with the environment where children live, study, and play are poorly understood. Nationwide nearly 12.5 million preschoolers participate in center- or home-based childcare (U.S. Census Bureau 2013). Childcare setting has been considered an essential predictor of physical activity level (Finn et al. 2002). However, among the 11 studies included in the review, only 3 were conducted in childcare setting (Bonvin et al. 2013; Jones et al. 2011; Robinson et al. 2012). Future studies should reach out to center- or home-based childcare in an effort to examine the role of early childhood environment in the relationship between motor skill competence and physical activity.

In conclusion, this study reviewed existing scientific evidence on motor skill competence in relation to physical activity among preschoolers 3–5 years of age. A significant positive association between motor skill competence and physical activity was consistently documented. The specific pattern and strength of the relationship may differ by gender, measurement of the variable, physical activity intensity, motor skill type, and day of the week. Implications of the findings would include further exploration of whether preschool children as part of these types of studies are given opportunities to meet physical activity guideline recommendations and its effect in the relationship between motor skill competence and physical activity. Future studies are also warranted to examine these heterogeneities, elucidate the underlining causal link of physical activity on motor skill competence in early childhood, and determine the role of environment in the relationship between motor skill competence and physical activity. In order to have future success in examining this relationship, it is also warranted to set standard criteria in conducting such studies, in order to determine causal link and timely effective interventions.

Compliance with Ethical standards

Conflict of interest No conflict of interest was declared.

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