



# A Narrative Review of Children's Movement Competence Research 1997-2017

## Authors' contribution:

- A) conception and design of the study
- B) acquisition of data
- C) analysis and interpretation of data
- D) manuscript preparation
- E) obtaining funding

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## ABSTRACT

This paper reviews empirical research exploring primary/elementary school aged children movement competence assessment over the twenty year period, 1997-2017. The review occurs within the context of a recent global report into children's physical activity, sedentary behaviour, and movement competence revealing many children reach adolescence with poor movement competence attainment. A qualitative, narrative review of this extant literature on children's movement competence research was undertaken. Themes were interpretatively drawn from an examination of the summaries. The number of different test types and protocols used in this field of research complicates the comparison of findings and outcomes of the research. The most common reported upon factor in movement competence was gender. Evidence of an association between movement competence, physical activity intensity and habitual physical activity was found. The sameness of the findings over the past twenty years leads us to suggest that new and novel research methods would enhance understanding in this area, particularly with regards to programs that are successful in moving more children towards movement competence benchmarks.

primary, elementary, physical activity, narrative

## KEYWORDS

## Introduction

The purpose of this review was to consider what the movement competence research of the past 20 years reveals that can inform primary/elementary physical education (PE) teaching. It occurs within the context of The Global Matrix 2.0 on Physical Activity for Children and Youth report cards for 38 countries showing many developed countries with low/poor 'grades' for physical activity, the development of children and youth movement competency, and levels of sedentary behaviour (Active Healthy Kids Global Alliance, 2016). Further, there was a cogent argument for debate about both the rationale for promoting and importance of a serious focus on movement skill and its role in the promotion of physical activity (Barnett et al, 2016).

Movement competency development and the mastery of what is sometimes called "fundamental" or "essential" movement skills during childhood is suggested as the foundation or "building blocks" of an active lifestyle during adolescence and into adult life. The movement competency is often referred to as skills, classified into locomotor (e.g., running, hopping, skipping, etc.) and manipulative or object control skills (e.g., catching, throwing, striking, etc.) (Logan, Robinson, Wilson, & Lucas, 2011; Lubans, Morgan, Cliff, Barnett, & Okely,

2010). The area of movement competency development is an important area of physical literacy discussion and PE to focus on as alarmingly, it is suggested that in some countries as many as fifty percent of children will leave school without the “fundamental” or “essential” movement skills competency required for successful recreation games, sport, and physical activity (MacNamara, Collins, & Giblin, 2015; Morgan et al., 2013). There are also suggestions that poor motor coordination is often associated with poor academic attainment and cognitive deficits (Giblin, Collins, MacNamara, & Kiely, 2014). The importance of children attaining movement skill competency is indicated by research findings demonstrating that children with high “fundamental” or “essential” movement skills proficiency show little decline in physical activity as youth (Morgan et al., 2013).

It is generally acknowledged that while children may develop movement skill by being encouraged to “get outside and play”, movement competency is more likely to be achieved with appropriate practice, encouragement, feedback, and instruction (Lubans et al., 2010). PE teachers, youth sport coaches, and those trained in the teaching of “fundamental” or “essential” movement skills competency have been shown to significantly improve this proficiency (Morgan et al., 2013). However, the only place where all children can be assumed to get deliberately constructed learning environments for movement skill development is within their school PE programs.

## Method

Reviews assist experts and non-expert understanding from the volume of publications in a field. They may also assist experts, such as researchers, identify gaps in their reading and knowledge of a field (Byrne, 2016). This study was a qualitative review of the extant literature. A narrative approach was adopted. Narrative reviews can be structured in different ways (Ferrari, 2015), however, narrative reviews have in common an attempt to bring the elements of a situation together in order to examine the relationships of a situation or a phenomena, and the meanings that can be drawn from those relationships. There are a number of quantitative systematic reviews in the area of fundamental movement skill (FMS). In adopting a narrative approach, this review provides a different lens on the body of literature than found in quantitative systematic reviews exploring correlates.

Typically, reviews involve the identification of prominent or recurring themes, and summarise the findings of the literature under thematic headings. Summary tables, providing descriptions of the key points from the body of literature are produced. As the aim of the current review was to explore and conceptualise the issue of children’s movement competence within the context of reports of declining movement competence a narrative is initially provided by a table summarising the body of literature reviewed. This enables an interpretative synthesis in order to generate themes from the literature (Dixon-Woods, et al., 2005; Snilstveit, Oliver, & Vojtkova, 2012).

## Search strategy

A similar methodology to Wallhead and O’Sullivan (2005) and Stolz and Pill (2014) was employed. Initially, papers were sourced by a key word search in Google Scholar. From the initial search, additional papers were sourced through a ‘snowball’ approach whereby papers from Google Scholar led to data bases that could be searched for papers, and papers were sourced from the reference list of the papers being screened for inclusion. The following search threads were used to identify papers: ‘fundamental movement skill’, ‘movement skill’, ‘movement competence’, ‘movement ability’, ‘movement proficiency’, ‘motor performance’, ‘fundamental motor skill’, ‘motor skill’, ‘motor ability’, ‘motor proficiency’; and, ‘child’, ‘children’, ‘student’, ‘primary’, or ‘elementary’.

### **Inclusion and exclusion criteria**

Only papers from peer reviewed journals and peer reviewed conference proceedings were included. Reviews were not included. Extraction of papers occurred where participants were identified as primary/elementary school age, defined for the purpose of this literature search as grades/years 1-6, or age 5 to 12/13 years. Papers were initially reviewed for inclusion at abstract and if deemed suitable, the full text was accessed and compared against the inclusion criteria. The paper search included papers published from 1997 until the end of October 2017. Both observational and intervention studies were included.

### **Data extraction**

Table 1 (see supplementary documents) summarizes the empirical-scientific research included in this review. It shows a variety of research approaches and practices have been employed in investigation of primary/elementary school aged children's movement competency. It also demonstrates a multiplicity of research questions, addressing a spectrum of interests ranging from: the associations between movement competency and gender, weight status and participation in physical activity; the measurement of fundamental movement skill and motor skill attainment; the outcomes of interventions targeting improvements in movement competency from baseline to end of intervention with school groups and specific populations, such as children grouped as overweight for their age.

### **Analysis and interpretation**

The methodological studies included in this review (see supplementary documents Table 1) enabled themes to be interpretatively drawn from an examination of the summaries. The first step of the analysis involved tagging by recurring words, such as 'proficiency', 'competence', 'male', 'female', 'perceived', 'intervention', 'physical activity', 'test', 'improvement', 'weight', 'body mass index' (BMI), 'socio-economic status' (SES), and 'association'. These codes were then grouped and further analysed to reduce the groupings into a set of common themes – gender; influence of weight status; influence of SES; influence of physical activity and sport participation; and, influence of perceived competency.

### **Results**

Over the twenty year period 1997-2017 more methodological studies of children's movement competency have occurred in Australia than in any other country (n=26) (Table 1). Most of those studies have occurred in New South Wales (NSW). The other countries with a major focus on the assessment of children's movement competence were the United States (n=10) and Belgium (n=8) and the United Kingdom (n=6). One study compared Belgium and Australian children's motor competence finding Belgium students' demonstrated higher motor competence, however, both cohorts achieved significantly worse compared to a German sample from 1974 (Bardid et al., 2015). Another comparative study found that the achievement of Hong Kong students was superior to previously reported achievement in the USA, Brazil and Australia (Wai-Yin Pang et al., 2009).

The most common movement competence test used was the Test of Gross Motor Development (TGMD) (n=22 papers), followed by the Körperkoordinationstest für Kinder (KTK) test (n=10 studies), the Bruininks-Oseretsky Test of Motor Performance (BOTMP) (n=7 studies), and the Movement Assessment Battery for Children (MABC) (n=5 studies).

### **Gender**

The most common reported upon factor in movement competence was gender. Thirty-nine papers reported on gender achievement of movement competency. Boys outperformed or achieved better movement competency

scores in some or all of the tests when compared to girls (Abas et al., 2011; Bakhtiar, 2014; Booth et al., 1999; Butterfield et al., 2012; Cliff et al., 2011; Cohen et al., 2014; Coiro et al., 2013; De Meester et al., 2016; Hume et al., 2008; Junaid & Fellows, 2006; Laukkanen et al., 2014; Lopes et al., 2012a; Lopes et al., 2012b; McIntyre et al., 2006; McKenzie et al., 1998; McPhillips & Jordan-Black, 2007; Mei Yung Lam and Schiller, 2013; Milanese et al., 2010; Okely & Booth, 2004; Slotte et al., 2015; Sprinkle et al., 1997; Vedul-Kjelsas et al., 2013; Wai-yin Ping & Fong, 2009; Wrotniak et al., 2006; Ziviani et al., 2009). However, some studies reported no significant difference or difference in overall scores between genders (Choi, 2004; Duncan et al., 2013; Juakkola et al., 2016; Tsapakidou et al., 2014; Wright & Bos, 2012; Wrotniak et al., 2006). Boys were more likely to possess better movement competency in object control skills like catching and throwing. In contrast, girls were more likely to score better than boys at locomotor skills.

Nine studies reported on the results of interventions designed to test the effect of a movement skill program (Austin & Haynes, 2004; Byrant et al., 2016; Cliff et al., 2011; Dru Marshall & Bouffard, 1997; Johnson et al., 2017; McKenzie, Alcaraz, & Sallis, 1998; Sprinkle et al., 1997; van Beurden et al., 2003; Wright et al., 2008). All interventions demonstrated improvement in movement competence for both boys and girls, however, these increases were not always statistically significant. McKenzie et al., (1998) and Sprinkle et al. (1997) observed that boys improved more than girls.

### **Influence of weight status**

Results from the current review yielded some evidence of an association between weight status and motor competence. For example, overweight students were more likely to be less competent than non-overweight children across all grades and genders (Cliff et al., 2011; D'Hondt et al., 2013; D'Hondt et al., 2014; Duncan et al., 2013; Gentier et al., 2013; Graf et al., 2004; 2013; Jones et al., 2010; Lopes et al., 2012a; Morrison et al., 2012; Okely et al., 2004; Poulsen et al., 2011; Predel & Dordel, 2004; Slotte et al., 2015; Southall et al., 2004; Woll et al., 2013). BMI was found to be associated with movement competency in primary/elementary school age groups (D'Hondt et al., 2009; D'Hondt et al., 2013; Duncan et al., 2013; Graf et al., 2004; Kemp & Pienaar, 2013; Luz et al., 2017; Okely et al., 2004; Poulsen et al., 2011; Slotte et al., 2015; Wright & Bos, 2012; Wrotniak et al., 2006). However, some studies found BMI was not significantly correlated or associated with movement competency scores (Hume et al., 2008; Juakkola et al., 2016; Milanese et al., 2010). Dru Marshall and Bouffard (1997) observed improvements in movement competence regardless of weight status or BMI of the children.

### **Influence of socioeconomic status (SES)**

There are conflicting findings regarding the influence of SES on movement competency in the current review. One study found no consistent association between SES and movement competency scores (Okely et al., 2004). Alternatively, three studies reported children from high SES or 'advantaged schools' outperforming students from lower SES or disadvantaged schools (McPhillips & Jordan-Black, 2007; Rudd et al., 2015; Zehra et al., 1999). Hardy et al. (2012) found that children from non-English speaking backgrounds were more likely to have low movement competency, and girls from low SES were more likely to be less competent in locomotor skills. Vandenendriessche et al. (2012) found sports club membership and participation was greater with high SES, while hours of sport participation was observed with better scores for motor coordination.

### **Influence of physical activity and sport participation**

Some correlation with movement competence and physical activity was noted through the current review. For example, movement competence was associated with MVPA (Cohen et al., 2014; De Meester et al., 2017; Hume

et al., 2008; Jones et al., 2010), habitual physical activity (Castelli & Valley, 2007; Laukkanen et al., 2014), and physical activity correlated with motor competence (Luz et al., 2017; Morrison et al., 2012; Wrotniak et al., 2006). Object control proficiency was associated with physical activity of boys (Hume et al., 2008) and locomotor proficiency of girls (Hardy et al., 2012; Slykerman et al., 2016; van Beurden et al., 2003). Hardy et al. (2012) found a clear association between low object control proficiency and boys not meeting physical activity recommendations. Predel and Dordel (2004) suggested that children with the highest volume of physical activity achieved the best movement competence scores. Vandenendriessche et al. (2012) reported sport participation as a significant covariate for motor coordination test scores, Vandorpe et al. (2012) found high motor quotients associated with sport participation, and D'Hondt et al. (2013) found a positive association between sport club participation and predictions of movement competency. Raudsepp and Pall (2006) stated movement competency was related with skill-specific (such as sport training) outside school physical activity but not with general levels of physical activity. Lopes et al (2012b) suggested sedentariness as discriminating between low and high motor control. Aerobic fitness was also associated with movement competence (Castelli & Valley, 2007; Dru Marshall & Bouffard, 1997; Khodaverdi et al., 2016; Larouche et al., 2014). However, Tsapakidou et al (2014) reported no statistical difference in the motor skills assessed between children participating in sports clubs and those that did not.

### **Influence of perceived competency**

Although Bardid et al. (2016) found that perceived competence impacted motivation for sport, the current review noted the relationship between perceived competence and actual competence is equivocal. For example, Barnett et al. (2015) found that actual control and perceived object control were positively associated, while Khodaverdi et al. (2013) and De Meester et al. (2016) reported high positive perception of motor competence promotes physical activity engagement, and Liong et al. (2015) found a significant correlation between boys perceived and actual object control skills. Raudsepp and Liblik (2002) also found perceived and actual motor were related, with boys showing higher perceived competence for some tests, but in this study the tests were of 'fitness' rather than motor skill or FMS. However, previous research has noted a lack of significant associations between perceived competence and children's actual competence has also been indicated (Liong et al., 2015). For example, researchers have suggested that children are not necessarily good at assessing personal motor competence and may lack the reasoning capacity to correctly assess their own competence (Bardid et al., 2016; Raudsepp & Liblik, 2002).

Improvements in movement competence were observed regardless of weight status or BMI of the children (Dru Marshall & Bouffard, 1997). Some studies reported improvements in volume and/or intensity of physical activity (Bryant et al., 2016; Johnson et al., 2017; van Beurden et al., 2003), however, the improvements were not necessarily significant (van Beurden et al., 2003). Interventions also led to an increase in children's perceived movement competence (Bryant et al., 2016).

### **Discussion**

The results of this review bring forward interesting comparisons about the key topics of interest covered by the movement competency research on children, and what the focus of interest may be in various parts of the world. For example, in the United States, it appears gender and physical activity are a study priority, with physical activity in schools and notions of quality PE a primary focus of the discussion. In Europe, there appears to be more multi-variate studies examining gender, weight, SES and participation in the same study, with researchers highlighting the importance of community sport participation and physical activity. In Asia, the focus appeared to be on gender comparisons in the achievement of movement competency, while in Australia there was an interest in weight status and physical activity levels. In other regions, there were insufficient numbers of studies to determine a trend. The differences in study design and research focus may result in different emphasis in PE

and sport policy trends and discourses in different regions/countries, such as those discussed recently by Hyndman and Pill (2017).

Gender comparison appears to be a major interest, appearing as a variable in almost every study included in the review. Much of it appears as Oliver and Kirk (2016) have described as the general trend of physical activity and PE research focussed on girls since the 1980's, a reproductive cycle of telling the "same old story". We suggest the field of movement research on girls' movement competency attainment and development could benefit from more pragmatically pedagogically approached research where the focus is on actions that can make the situation better for girls: such as the activist approach proposed by Oliver and Kirk (2016). What is apparent from this review is that male children continue to be more likely than female children to develop the movement competency that seems to feed into the personal confidence to seek to be physically active.

Furthermore, we suggest the types of studies contained in this review and their associated research methodologies, methods and designs are at a point of saturation where they are essentially "telling the same story". A more methodologically diverse approach to the investigation of movement competency and FMS development should therefore be considered. Two issues are apparent: firstly, due to fact that we reviewed a number of studies it is apparent a lot of resources (i.e., time and money, the latter possibly funded by grants) have been invested in demonstrating essentially the same findings; and secondly, there is no research from a strengths-based approach or educative focussed "pedagogical" position that would consider what is working in promoting fundamental or essential movement skill competency development from the 'naturalistic' work of the PE teacher. Although there are intervention studies showing the possibilities of upskilling teachers to deliver FMS and movement skill programs, particularly in Australia, overall, there is an absence of qualitative research evident in this review. A qualitative approach to research in this area could give valuable perspectives on the sociological and pedagogical perspectives pertaining to children's movement competency development and attainment, informing curriculum and instructional decision making by teachers and schools. Again, the previously mentioned activist work of Oliver and Kirk (2016) is an excellent example that could be considered. Within these studies, mixed method longitudinal designs involving case studies and action research cycles could be employed to examine multiple sociological aspects of movement competence development and attainment with children. Qualitative data can add a level of richness to the quantitative data currently being collected in the reviewed studies (i.e., children's physical activity levels, movement competency, perceived competence, etc.) because it would offer researchers the opportunity to consider the context and situation within which these quantitative data were collected (Harvey, Cushion, Cope, & Muir, 2013). These proposed studies could incorporate considerations of the impact of PE curriculum design and the pedagogical choices of teachers on movement competency development, from both the macro perspective of 'models based practice' and physical literacy for curriculum, and the micro perspective of specific instructional strategies, styles (for example, Mosston & Ashworth, 2002) and/or skills needed to promote developments in children's movement competency.

It appears that the influence of parents and/or the family on children's movement competency attainment has been the subject of little research focus in the area of FMS and children's movement competence attainment measurement, other than in relation to perceived movement competence. Family is possibly the primary socialisation agency in movement participation and active living (Harvey, Jung, & Kirk, 2013), and therefore, movement competency research could expand to include information pertaining to the journey of movement competency development and sociocultural factors (i.e., family, school and community) that contribute to this attainment. This seems particularly relevant given the studies contained in this review suggest children from higher socio-economic status (SES) backgrounds may be more active, and therefore a more complete picture of the development of movement competence may provide insights that feed into initiatives that facilitate children from low SES backgrounds to be more active. The considerations that we have mentioned here are important as physical activity and motor competence have been found to have a positive reciprocal relationship across children of primary school age into adolescence and children of secondary school age (Lima et al., 2017;

Stodden et al., 2014). Further, there is some evidence that individuals with a high cultural capital associated with high SES in childhood and adolescence are more likely to be active as adults and later in life (Engstrom, 2008).

With regards to the studies that have occurred within the context of school PE, we note the absence of connections to standardized and national PE curricula and frameworks. This may be because the studies are largely quantitative and not constructed to consider the education policy, pedagogical considerations, and curriculum structures within which the teaching for student achievement of outcomes and standards related to movement competence occurs. A broader scope for the research which includes these sociological dimensions would be able to consider the impact that changes at school, region and national level on policy and the practice of curriculum tools (such as timetables and subject time which determine the time allocated to delivery of PE in schools) have on movement competency development within the context of primary/elementary school PE teaching and its situated complexity. This research direction would be consistent with calls for “inside the black box” (Locke, 1997) research, and address concerns from Hastie (2017) that quantitative PE research is often a type of “tourist” research where variables are examined but the type of PE designed and delivered “everyday” is not considered. Chen, Chen, and Zhu (2012) have also called for more research consideration of the meaningful curriculum and pedagogical variables in quantitative research.

Understanding the movement competency literature is potentially complicated for PE teachers and youth sport coaches by the diversity of assessment protocols and processes evident in the literature. Further, assessment of FMS competency is predominately based on observational processes measures where the individual child’s movement performance is compared to a standardized model of the most efficient form of the movement skill. This exacerbates the lack of sociological and cultural theorizing about the development of FMS and the influence of socio-cultural PE conditions on student movement skill development. Failure to consistently demonstrate the movement sequence summation as illustrated in the idealized model results in “not proficient”. What we conclude from the review is that globally there is an issue with many children reaching secondary school age without assured coordination and control of the “fundamental” movement skills. In standardized curriculum frameworks, such as the Australian Curriculum for Health and Physical Education (ACHPE) (Australian Curriculum and Assessment Authority (ACARA), 2017) these skills are benchmarked for consistent demonstration of competency by around Year 4, or age 9-10. For example, the ACHPE student achievement standard expectation progresses from the refinement of FMS by the end of Year 4 to the demonstration of performance of specialized movement skills by the end of Year 6, or age 11-12 (ACARA, 2017) – which is also the last year of primary school in most states in Australia. The failure to meet the movement development expectations set forth in such curricula during the primary/elementary school years has clear implications for student success in secondary PE and youth sport programs, and the associated psycho-social effects of such failure (i.e., negative attitudes to and perceptions of PE and high youth sport drop-out rates). It appears clear that adequately addressing the content and pedagogical capacity of teachers to meet the student achievement expectations of primary/elementary PE curriculum (Kirk, 2005), sufficiently resourcing teachers to be able to deliver the curriculum, and providing adequate curriculum time to enable meaningful student progression along the continuum of achievement needs elevation in the discourse addressing the decline in movement competency, physical activity engagement and increasing sedentariness of children and youth.

## Conclusion

The review of research we present adds to the evidence that globally many children leave primary/elementary schooling without the movement ability necessary to provide the competency, and possibly the feelings of

confidence and efficacy, to engage with more complex forms of movement such as full rules sport encountered in adolescence. Further, considered within the context of school PE it would appear many children progress to secondary school having not met the movement competence and motor control benchmarks established in standardized curriculum frameworks. The quality of the primary/elementary school PE teaching, as well as suitable time provision within each school for PE, is necessary to ensure the optimal development of movement competence that are associated with children attaining actual and perceived movement capability that underpin optimism in their ability to continue movement development in more complex and combined forms of movement. Ensuring this quality of teaching needed and suitable curriculum provision is especially necessary so all children, regardless of SES and the opportunities afforded outside of school to children of high SES circumstances, have the opportunity to develop movement competence and confidence as school is the only place we can be sure all children have the opportunity for movement education. Fundamental or essential movement skill competence cannot be assumed to develop automatically as a consequence of growth and development, or through simply providing opportunities for children to play without quality instruction and feedback (Hattie, 2009). The learning of movement skill requires prolonged engagement, deliberate guidance, and encouragement in a range of physical activity contexts. In other words, a deliberately considered learning environment where the teacher provides the children with an appropriate level of challenge (Hattie, 2009).

The review of the literature suggests children's' movement competency research has been dominated by correlational research. There is a sense of a common global issue with movement competence development, and the association of this with declining levels of physical activity and increasing sedentary behaviour. The "sameness" in research findings over the twenty years of literature considered in this review leads us to conclude that it seems opportune to be considering new research directions. This could include both critical work and that focused on using appreciative inquiry and/or a strengths-based approach. The latter provides researchers with the opportunity to case study teachers and school settings in the specific context in which they work (i.e., PE and/or youth sport development programs) and investigate the specific ways in which these teachers and school sport coaches are effective in addressing student achievement relative to movement competency development. This would include research within the "natural" socio-cultural context of PE, including that occurring where teachers report against standardized curriculum framework student achievement standards, outcomes or competency descriptions.

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Table 1. An overview of literature reviewed for the paper, Children's Movement Competence Research 1997-2017: A Review of Selected Literature

Authors/s	Sample	Data Tools	Findings
<b>1. Australia</b>			
Sprinkle, J., Wilson, S., Dickson, S., & Vine, K. (1997).	Children aged 10 (N=75)	FMS intervention using Minkey Hockey Pre and post-test comparison of selected FMS	Boys outperformed girls on pre and post-test. Both genders FMS scores improved as a result of the intervention.
Booth, M. L., Okely, T., McLellan, L., Phongsavan, P., Macaskill, P., Patterson, J., Wright, J., & Holland, B. (1999).	Forty-five primary schools classes were selected at random to participate	Six fundamental motor skills were assessed: run, vertical jump, catch, overhand throw, forehand strike and kick.	The prevalence of skill mastery was directly associated with socioeconomic status more consistently among girls than among boys.
Van Beurden, E., Barnett, L. M., Zask, A., Dietrich, U. C. Brooks, L. O., & Beard, J. (2003).	Children from 19 primary schools (9 control and (intervention) across Year 3 and 4 (N=1045)	Pre and post observation measurements of 8 FMS. Measurement of lesson time spent in MVPA and VPA.	Prevalence of mastery and near-mastery of each FMS at baseline was low. Intervention realised non-significant increases in MVPA and significant increase in VPA. Improvements in every FMS were observed in the intervention group.
Okely, A. D., & Booth, M. L. (2004).	Children from 18 primary schools with one class chosen at random from each of Years 1 through 3 (N=1288)	Assessment of selected FMS in 18 metropolitan schools across grades 1-3 (N=12880).	Prevalence of mastery and near-mastery of each FMS was low. Boys performed better than girls at run and some object control skills, whereas, girls performed better than boys at skip. No consistent association between skill mastery and SES.
Okely, A. D., Booth, M. L., & Chey, T. (2004).	Data were collected as part of the New South Wales Schools Fitness and Physical Activity Survey, 1997, and FMS data from children in grades 4, 6, 8, 10	Height and weight measured, and then BMI calculated. Six FMS were assessed-run, vertical jump, catch, overhand throw, forehand strike, and kick-using process-oriented checklists. Sociodemographic data collected.	Overweight students were approximately twice as likely as non-overweight students to be in the lowest FMS quintile, consistent across all grades and genders. Non-overweight boys and girls were two to four times more likely to be advanced in both locomotor skills than overweight boys and girls. BMI and waist circumference were significant predictors of FMS proficiency in primary school age groups. FMS proficiency was inversely related to BMI and waist circumference.

<p>Southall, J. E., Okely, A. D., &amp; Steele, J. R. (2004).</p>	<p>Children in Grade 5 and 6 (N= 142), with 109 classified as non-overweight and 33 overweight</p>	<p>Test of Gross Motor Development – 2 (TGMD-2) was used to assess motor skills. Perceived competence assessed using an expanded version of the Athletic Competence subscale of the Self-Perception Profile for Children (SPPC).</p>	<p>Overweight children had significantly lower actual and perceived physical competence.</p>
<p>Austin, B., Haynes, J., &amp; Miller, J. (2004).</p>	<p>Children in Year 6 from a primary school in rural NSW (average age 11 years) (N=28)</p>	<p>5 FMS assessed pre and post intervention using the NSW Get Skilled Get Active skill checklist (2000). Students FMS assessed by self, peer and trained assessors. Surveys completed by the children designed to determine their sporting involvement. Soccer was the sport chosen for the intervention and so a specific focus on improvement of the kick occurred.</p>	<p>At pre-test, the two most poorly performed skills included the kick; and the two-handed strike. The initial findings of self and peer assessment showed that students considered themselves to be proficient kickers. Post-test results showed overall improvements in the level of mastery performance of the kick.</p>
<p>McIntyre, F., Hands, B., &amp; Parker, H. (2006).</p>	<p>Children aged 6-8 from metropolitan Perth (N=187)</p>	<p>Step count measured over a 7 day period. Perceived motor competence assessed using a self-description questionnaire. Actual motor competence of 4 FMS's assessed.</p>	<p>No significant difference between genders for perceived motor competence. Boys' actual motor competence significantly higher. Boys significantly higher daily mean step counts.</p>
<p>Wright, J., Konza, D., Hearne, D., &amp; Okely, T. (2008).</p>	<p>Children from 20 primary schools in four districts within NSW in Years K, 2, 4, and 6</p>	<p>Parents were asked to provide information on their child's movement competence and parents of students in Years K and 2, also reported on their child's physical activity and sedentary recreation habits. Measurement of students' FMS before and after the Program.</p>	<p>The intervention resulted in students improving their FMS'. Non-specialist teachers need and welcome support in teaching physical education in primary schools.</p>
<p>Hume, C., Okely, A., Bagley, S., Telford, A., Booth, M., Crawford, D., &amp; Salmon, J. (2008).</p>	<p>Children from Grade 5 in 3 primary schools in low SES areas of metropolitan Melbourne (N=311)</p>	<p>Physical activity measured using accelerometers worn for 8 days. Height and weight measured, and then BMI calculated. Fundamental movement skill measurement of 3 object control and 4 locomotor skills.</p>	<p>Mastery and near-mastery of the three object-control skills lower among girls than boys. Boys higher total FMS and mean object control proficiency. No differences between genders in locomotor skills. Significant positive but weak correlations with total FMS proficiency score, movement skill proficiency and MVPA among boys. Significant positive but weak correlations with movement skill proficiency and MVPA with object-control proficiency with boys. BMI not significantly correlated with any FMS or physical activity scores with boys. Volume of physical activity significant but weak correlation with both total FMS</p>

			proficiency and locomotor proficiency score with girls.
Ziviani, J., Poulsen, A., & Hansen, C. (2009).	Children from 4 Brisbane state primary schools (N=124)	Movement Assessment Battery for Children (MABC) used to measure motor performance. BMI calculated from height and weight measurements.	A significant positive association was found between gender and ball skills.
Pill, S., & Priest, T. (2009).	Children in Year 7 from 14 Catholic primary schools in South Australia	The DECCD (2006) Fundamental Motor Skills resource was used to assess FMS.	More boys were assessed as competent at each FMS, than were girls.
Jones, R. A., Okely, A. D., Caputi, P., & Cliff, D. P. (2010).	Children from 20 government primary schools in NSW aged 5 to 7 years (N=1299)	Parental report of time spent in physical and sedentary activities, time spent with parents, parental working hours, and parental perceptions of their child's physical competence. Children's actual physical competence. Physical activity measured using pedometer step counts.	Overweight girls spent more time watching television on weekends compared with their non-overweight peers and were less proficient in overall actual competence, particularly overall locomotor skill proficiency. Parents of overweight boys perceived them to be less competent in the skill of running than parents of non-overweight boys. Having age appropriate ball skills did result in greater but not significant levels of physical activity for all children.
Poulsen, A. A., Desha, L., Ziviani, J., Griffiths, L., Heaslop, A., Khan, A., & Leong, G. M. (2011).	Children aged 6 to 11 in Qld (N=116) with the overweight group (N=87) and comparison group recruited from the KOALA study	BMI calculated from height and weight measurements. Bruininks-Oseretsky Test of Motor Performance (BOTMP) used to assess four motor area composites. Self-Description Questionnaire – 1 (SDQ-1) used to measure self-concept perception.	Children who were overweight scored significantly lower on all FMS tests and tests of self-concept perception. Association between increasing BMI and poor gross motor skill performance. Object control proficiency in childhood was associated with adolescent cardiorespiratory fitness.
Cliff, D. P., Okley, A. D., Morgan, P. J., Steele, J. R., Jones, R. A., Colvas, K., & Baur, L. (2011).	Data from the Hunter Illawarra Kids Challenge Using parent Support (HIKUPS) study, with children aged 5.5 to 9 years (N=216)	Movement skill proficiency (Test of Gross Motor Development – 2), Perceived athletic competence (Self-Perception Profile for Children (SPPC)), accelerometer-assessed. physical activity, and parent-reported time spent in screen behaviours were assessed at baseline, 6 months, and 12 months.	Participating overweight children exhibited low movement skill proficiency at baseline. Activity and activity + diet programs were efficacious in improving overweight children's movement skill proficiency.
Cliff, D. P., Okley, A. D., Morgan, P. J., Jones, R. A., Steele, J. R., & Baur, L. (2012).	Overweight or obese children aged 5.5 to 10 years (N=165) in NSW	Test of Gross Motor Development – 2 (TGMD-2) was used to assess 6 motor skills. Height and weight measured, and then BMI calculated.	Boys performed better at object control skills. Girls performed better at locomotor skills. Gross motor quotient scores showed both genders scores ranked in the bottom <1% for overall FMS proficiency.
Hardy, L. L., Reinten-Reynolds, T., Espinel, P., Zask, A., & Okely, A. D. (2012).	Cross-sectional representative school-based	Measured students' height, weight, and assessed FMS	Prevalence of students with low motor skill competency was high.

	survey of Australian elementary and high school students ( $n = 6917$ ) conducted in 2010	and cardiorespiratory endurance (fitness).	Girls with low socioeconomic status (SES) were twice as likely to be less competent in locomotor skills compared with high SES peers. A strong association between boys' low competency in FMS and the likelihood of being from non-English-speaking cultural backgrounds. Clear and consistent association between low competency in FMS and inadequate cardiorespiratory fitness. Clear association between low competency in object-control skills and not meeting physical activity recommendations for boys. The odds of being inactive were doubled among girls who had low competency in locomotor skills.
Cohen, K. E., Morgan, P., Plotnikoff, R. C., Callister, R., & Lubans, D. (2014).	Data from the Supporting Children's Outcomes using Rewards, Exercise and Skills (SCORES) group randomised controlled trial from 16 primary schools in NSW (N=460) was used	Physical activity measured using accelerometers for 7 consecutive days. Test of Gross Motor Development – 2 (TGMD-2) in 6 locomotor and 6 object control skills. Height was recorded to the nearest 0.1 cm using a portable stadiometer, and then BMI calculated.	Girls were more competent, on average, in locomotor skills. Boys were found to be more competent in object-control skills and spent more minutes in MVPA for all time periods. Object control skill was positively associated with MVPA.
Bardid, F., Rudd, J., Lenoir, M., Polman, R., & Barnett, L. M. (2015).	Children aged 6 to 8 in (N=496) from 4 schools in Melbourne (N=252) and 5 schools in Flanders (N=244)	Motor competence evaluated using the Körperkoordinationstest für Kinder (KTK) test.	Overall, children in Belgium demonstrated higher motor competence. 21.3% of Belgium and 39.3% of Australian children scored 'below average'. Both countries samples scored significantly worse than the German standardised sample of children from 1974.
Rudd, J., Barnett, L. M., Butson, M. L., Farrow, D., Berry, J., & Polman, R. C. J. (2015).	Children aged 6 to 10 (N=337), Gymnasts (N=37) and non-gymnasts	Test of Gross Motor Development – 2 (TGMD-2) in 6 locomotor and 6 object control skills. To measure stability 3 additional gymnastics training skills were assessed – the rock, log roll, and back support.	The gymnasts outperformed the non-gymnasts in all skills. Children from high SES outperformed children from medium and low SES on the stability of skill performance.
Liong, G. H. E., Ridgers, N., & Barnett, L. M. (2015).	Children from one primary schools aged 5 to 8 (N=136)	Test of Gross Motor Development – 2 (TGMD-2) in 6 locomotor and 6 object control skills. Pictorial Scale of Perceived Movement Skill Competence for Young Children assessed perceived movement skill competence in same skills as tested in TGMD-2.	Lack of significant associations between children's actual and perceived competence. Significant correlation between boys perceived and actual object control skills. Parent's accurately perceived boys object control skills and girls locomotor control skills.

Barnett, L. M., Ridgers, N. D., & Salmon, J. (2015).	Children in 3 primary schools aged 5 to 8 (N=102)	Test of Gross Motor Development – 2 (TGMD-2) measured object control skill. Physical activity assessed for 8 consecutive days using accelerometers. Pictorial Scale of Perceived Movement Skill Competence for Young Children assessed perceived movement skill competence is same skills as tested in TGMD-2.	Actual object control and perceived object control were positively associated. Neither perceived or actual object control were associated with physical activity. Girls perceived and actual object control, and physical activity, was lower than boys.
Slykerman, S., Ridgers, N. D., Stevenson, C., & Barnett, L. M. (2016).	Children from two primary schools in Victoria aged 4 to 8 (N=136)	Test of Gross Motor Development – 2 (TGMD-2) in 6 locomotor and 6 object control skills. Pictorial Scale of Perceived Movement Skill Competence for Young Children assessed perceived movement skill competence is same skills as tested in TGMD-2. MVPA assessed for 8 consecutive days using accelerometers.	Boys had higher actual and perceived object control skills. No significant gender difference in actual or perceived locomotor control skills. Locomotor skills were a significant predictor of MVPA for girls.
Barnett, L. M., Ridgers, N. D., Hesketh, K., & Salmon, J. (2017).	Data drawn from two samples: 1. the 2008 Melbourne Infant Feeding Activity and Nutrition Trial (InFANT) and 2013 follow up when children were 5 years; and 2. Study investigating children aged 5 to 8 movement skills at two Melbourne schools.	In both samples children completed perceived skill in active play assessment using the Pictorial Scale of Perceived Movement Skill Competence for Young Children.	Perceived active play competence was not related to MVPA in the younger sample but was in the older sample.
<b>2. United Kingdom</b>			
Junaid, K. A., & Fellowes, S. (2006).	Randomly selected children in Coquitlam School District, British Columbia (N=103) aged 7 to 8	Movement Assessment Battery for Children (MABC) Test for 8 motor skill items	Significant difference between boys and girls manual dexterity and ball skills scores, with girls performing better on manual dexterity items and boys on ball skills. No significant difference by gender on balance skills.
McPhillips, M., & Jordan-Black, J-A. (2007).	Children from 4 primary schools in Northern Ireland's Belfast and Lisburn districts (Year 1 students N=258; Year 4 students N=294)	Year 1 and 4 students assessed on motor skills using the Movement ABC standardised tests and language using a standardised receptive language tests, the British Picture Vocabulary Scale	Year 1 sample: Significant main effects observed for school type, and children from the advantaged schools scored considerably higher than children in the disadvantaged school on motor skill tests. Girls showed a marked advantage in both school types. A significant main effect of gender and manual dexterity

		and the Basic Reading sub test.	Year 4 sample: Children from the advantaged schools scored considerably higher than children in the disadvantaged school on motor skill tests. Girls showed a marked advantage in both school types. For motor skill there was significant main effect of school type. Significant main effects observed for gender for manual dexterity and balance. Significant main effects observed for school type and manual dexterity.
Duncan, M. J., Stanley, M., & Ledington Wright, S. (2013).	Children aged 7-10 from a primary school in Central England (N=90)	Height and body weight recorded, and then BMI calculated. The Functional Movement Screen™ (FMS™) used to assess functional movement.	Total FMS score was significantly, negatively correlated with BMI. No significant difference in total functional movement screen and functional movement scores between genders. Total functional movement screen score was significantly different between normal weight, overweight and obese children, with scores significantly higher in normal weight compared to overweight children and obese children, and also significantly higher in overweight compared to obese children.
Bryant, E. S., Duncan, M., & Birch, S. L. (2014).	Children from a primary school in Central England aged 6 to 11 (N=281)	8 FMS's measured using the guidelines from the Process Orient Checklist (POC) from the Move it Groove it Report. Height and body weight recorded, and then BMI calculated.	For 6 of 8 FMS' the majority of children were rated at non-mastery. Catch and Balance were the only FMS' where a majority rated at near mastery. No significant interaction between gender, weight, and FMS attainment. Boys significantly better at kick and throw than girls, girls significantly better at balance.
Bryant, E. S., Duncan, M., Birch, S. L., & James, R. S. (2016).	Children from 3 primary schools in Central England in Years 4 and 5 (N=83)	Height and body weight recorded, and then BMI calculated. FMS pre and post intervention measured using the Process Orient Checklist (POC). Habituated physical activity measured over 4 days using pedometers. Self-perception of skill ability assessed using a modified Perceived Physical Competence Subscale for Children.	An increase in skill mastery from pre to post test for both genders in both control and intervention groups was observed, with intervention groups improving by a greater magnitude. Children in the intervention group were associated with higher daily step counts than the control group. Perceived physical competence scores significantly increased from pre intervention to post tests.
Johnson, A., Hughes, A. R., Janssen, X., & Reilly, J. J. (2017).	Children from seven Scottish primary schools in Grades 1-5 (N=257)	Habituated physical activity measured over 4 days using accelerometers. Pre and post intervention FMS measured using the Test of Gross Motor Development – 2 (TGMD-2). 5 month Go2Play Active Play intervention.	Intervention group showed decrease in percent time in sedentary behaviour, an increase in total physical activity, and percent time in light physical activity. Intervention group had a statistically significant increase in locomotor skills and object control skills score. Control group had an increase in locomotor skills and object control skills score but increases were not statistically significant.

McIntyre, F., Parker, H., Chivers, P., & Hands, B. (2017).	Children from Perth metropolitan primary schools aged 6 to 8 years (N=201)	Physical activity measured using pedometers over a 7 day period. Actual motor competence measured using an observation protocol of four skills from the Fundamental Movement Skills Teacher resource manual (EDWAQ, 2001). Perceived competence measured using the Self-Description Questionnaire – I (SDQ-I).	Prediction that perceived competence would significantly contribute to physical activity behaviour was not supported. Actual motor competence was more important for higher physical activity levels. The significance of actual motor competence to physical activity appeared earlier for boys than girls.
<b>3. Asia</b>			
Choi Tse, K.-C. (2004).	Children aged 6 to 11 years in Hong Kong (N=30)	Test of Gross Motor Development – 2 (TGMD-2).	Most students were below average level and poor on all aspects of the TGMD examined. No significant difference in gender for level of gross motor skill level.
Wai-Yin Pang, A., & Tik-Pui Fong, D. (2009).	Children from 6 primary schools aged 6 to 9 (N=167) in Hong Kong	Test of Gross Motor Development – 2 (TGMD-2) in 6 locomotor and 6 object control skills.	Both genders scored highly in locomotor and object control skills with performances in locomotor tests better than object control tests. Achievement of Hong Kong students was superior to previously reported data in the USA, Brazil and Australia.
Mei Yung Lam, H., & Schiller, W. (2013).	Children from 8 schools aged 5 to 6 (N=320) in Hong Kong	Bruininks-Oseretsky Test of Motor Performance (BOTMP) used to assess 5 motor area composites.	Significant difference between boys and girls on the items of running speed, agility and balance, with boys' superior at the running speed and agility tests. Boys scored higher on strength and upper-limb coordination tests, and girls higher on tests of balance and bilateral coordination. Results in running speed and agility were below the test norms for both genders.
Bakhtiar, S., (2014).	Children from urban and rural Padang, Indonesia, in elementary school, aged 6 to 7 years (N=67)	Test of Gross Motor Development – 2 (TGMD-2) used to measure locomotive and manipulative FMS.	Boys locomotor skills higher than girls, but not significantly. Manipulative skills were higher for girls compared to boys, but not significantly. More children from the urban area were assessed as advanced in motor skills. More children from the rural areas were assessed at average in motor skills than from the urban areas.
<b>4. South Asia</b>			
Zehra, H., Westcott, S., & Valvano, J. (1999).	Children from two private schools (N=90) and four orphanages and one low SES school from Malir Pakistan (N =168)	Upper and lower extremity strength and flexibility, spinal flexibility, and coordination screened using a test developed by the primary investigator. Functional tests of balance include the Functional Reach Test (FRT), Timed Up and Go (TUG), Running Speed and Agility (RSA), and Balance (BA) subtests of the Bruininks-Oseretsky	Significant differences between boys and girls and high and low SES groups on the four balance tests. In the high SES sample boys performed significantly better than girls on all balance tests In the low SES sample girls performed statistically significantly better on the BA subtest compared with boys, however, boys performed significantly better than girls on the TUG and RSA subtest. The high SES girls sample performed significantly better on the FRT, TUG, and balance subtest when compared with the

		Test of Motor Performance (BOTMP).	low SES girls, however, the latter had higher scores on the RSA subtest. High SES male sample did significantly better on FRT and BA subtest compared with low SES boys' sample, however, the latter group performed significantly better on the TUG and RSA subtest.
Abas, J., Shanker, Tedla, J., & Krishnan, S. (2011).	Children aged 9 ½ to 14 ½ from 4 schools in India (N=197)	Bruininks-Oseretsky Test of Motor Performance (BOTMP) used to assess motor proficiency.	In the 9 ½ to 10 ½ age group there were significant gender differences in running agility and upper limb coordination between genders. In the 10 ½ to 11 ½ age group were significant gender differences in response speed between genders. In the 12 ½ to 13 ½ age group were significant gender differences in bilateral coordination and upper limb coordination between genders. In the 13 ½ to 14 ½ age group were significant gender differences in running agility and upper limb coordination between genders.
<b>5. Europe</b>			
Raudsepp, L., & Liblik, R. (2002).	Children randomly selected from 3 schools from the city of Tartu, Estonia (N=270)	Perceived competence was assessed using the Children's Physical Self-Perception Profile. Three tests from EUROFIT test battery were used as an objective measure of actual motor competence.	Perceived and actual motor competence in three items of motor competence (aerobic fitness, strength, and body fatness) were related. Age and perceived motor competence items, corresponding to actual motor competence, predicted only a small amount of variance in actual motor competence. Boys and girls differed in perceived competence and actual motor competence, with boys showing higher perceived competence on four scores. Authors concluded 10- to 13-yr.-old children can only moderately assess personal motor competence.
Graf, C., Koch, B., Kretschmann-Kandel, E., Falkowski, G., Christ, H., Coburger, S., Lehmacher, W., Bjarnason-Wehrens, B., Platen, P., Tokarski, W., Predel, H. G., & Dordel, S. (2004).	Children from 12 primary schools in Year 1 (N=668)	Gross motor development tested by the Korperkoordinationstest fur Kinder (KTK). Endurance capacity measured with 6-min run. Height and body weight recorded, and then BMI calculated. Information on the children's physical activity behaviour was given by their parents about organised activity.	A weak inverse correlation between BMI and test results was found for both genders. The motor quotient of the obese and overweight children was worse than the motor quotient of the normal-weight and underweight children. An inverse correlation between BMI and the test result was evident. Markedly worse results observed in overweight/obese children in gross motor development and endurance performance, even after adjustment for gender and age when compared to other children.
MacCobb, S., Greene, S., Nugent, J. K., & O'Mahony, P. (2005).	Children aged 9 from Dublin (N=76)	Bruininks-Oseretsky Test of Motor Performance (BOTMP) used to assess motor proficiency.	The BOTM scoring of the sample was generally above average. Study evidence suggests multiple motor skill abilities are relatively independent of each other.
Raudsepp, L., & Pall, P. (2006).	Outside-school physical activity of 133	A modified observational method and accelerometers was used to measure	Developmental levels of both overhand throwing and jumping were significantly

	elementary school children	outside-school physical activity. Developmental level of overhand throwing and jumping was assessed using total-body developmental sequences.	correlated with the skill-specific physical activity. Results support that the developmental level of fundamental motor skills is related to skill-specific outside-school physical activity but not general physical activity levels of elementary-aged children.
D'Hondt, E., Deforche, B., De Bourdeaudhuij, I., & Lenoir, M. (2009).	Children between the age of 5 to 10 years (N=117) from ten schools in Flanders	BMI was calculated for each participant. Motor competence measured using the Movement Assessment Battery for Children (MABC). Physical activity (PA) was assessed using accelerometers for 7 days.	Gender did not significantly interact with BMI-group for any of the MABC scores and no main gender effect occurred. Main effect of BMI-group was shown with absolute cluster scores always better in normal and overweight children compared with their obese counterparts. Scores for manual dexterity, ball skills and total MABC were not significantly different between both SES-groups, but children from low SES performed worse than those from high SES in the balance cluster score. All cluster scores as well as the total MABC score were negatively correlated with moderate to high intensity PA except for manual dexterity. Results demonstrated that childhood obesity is associated with lower total MABC scores.
Milanese, C., Bortolami, O., Bertucco, M., Verlato, G., & Zancanaro, C. (2010).	Children aged 6-12 in Italy (N=152)	Height, body weight and skinfolds recorded, and then BMI calculated. Motor fitness assessed using standing long jump and 30m sprint.	In general, boys performed better at motor performance than girls. Boys ran significantly faster than girls in the age range 8-12 years and jumped significantly longer in the age range 8-9 years. Skinfolds inversely correlated with standing long jump in girls aged over 8 years of age. Skinfolds and velocity negatively correlated in boys aged 6-7.
Lopes, V. P., Stodden, D. F., Bianchi, M. M., Maia, J. A. R., & Rodrigues, L. P. (2012).	Children aged 6 and 14 attending public school in 4 regions of Portugal (N=7175)	Height and body weight recorded, and then BMI calculated. Motor coordination was assessed using the Körperkoordination-Test für Kinder (KTK) test.	Boys outperformed girls in motor coordination at every age. Higher motor control was associated with lower BMI, with correlation values similar in boys and girls of primary school age. Normal weight children had significantly higher motor control scores than overweight children, and obese children had significantly lower scores.
Lopes, L., Santos, R., Pereira, B., & Lopes, V. P. (2012).	Children from 13 urban public elementary schools from a city in north Portugal (N=213) aged 9-10 years	Height and waist circumference were measured. Motor coordination was assessed using the Körperkoordination-Test für Kinder (KTK) test. Physical activity and sedentary time assessed using accelerometers over 5 days.	Girls showed lower levels of motor control and fewer minutes of MVPA than boys. Boys showed less sedentary time than girls. Sedentary time significantly discriminates between children with low motor control and high motor control.
Vandenendriessche, J. B., Vandorpe, B. F. R., Vaeyens, R., Malina, R. M., Lefevre, J., Lenoir,	Children aged 6 to 11 years from primary schools throughout the	Height, body weight, percentage body fat recorded.	Percentage of sports club membership increases with higher SES and the effect was significant for boys with high SES

M., & Philippaerts, R. M. (2012).	Flemish region of Belgium (N=1955)	Fitness was assessed with items of the Eurofit test battery. Motor coordination was assessed using the Körperkoordination-Testfür-Kinder (KTK) test.	boys showing greater sport participation than lower SES boys. High SES girls had significantly greater sport participation than low and middle SES peers, and descriptive statistics were similar for boys. High SES children have, on average, lower weight, BMI and percentage fat than low and middle SES children. Sport participation is a significant covariate for all fitness variables. Hours of sport participation is a significant covariate for the motor coordination tests, with scores better for high SES compared with low and middle SES girls. Low SES boys have higher BMIs than middle and high SES boys who do not differ.
Morrison, K. M., Bugge, A., El-Naaman, B., Eisenmann, J. C., Froberg, K., Pfeiffer, K. A., & Anderson, L. B. (2012).	Children (mean age 6.7 years) from 18 schools in 2 communities in Denmark (N=498)	Habituated physical activity measured using accelerometers worn for at least 3 days. Height and body weight recorded, and then BMI calculated. Motor performance was assessed using the Körperkoordination-Testfür-Kinder (KTK) test.	Physical activity was not significantly correlated with % body fat. Physical activity was significantly correlated with boys' motor performance. Boys and girls with lower % body fat had significantly higher motor performance than boys and girls with higher % body fat.
Vandorpe, B., Vandendriessche, J., Vaeyens, R., Pion, J., Matthys, S., Lefevre, J., Philippaerts, R., & Lenoir, M. (2012).	Children from 13 school in Belgium (N=638) participated in this longitudinal study, with children aged 6-9 in 2007 and 8-11 in 2009	Motor coordination was assessed using the Körperkoordination-Testfür-Kinder (KTK) test. Information about participation in organised sports obtained by the Flemish Physical Activity Computerized Questionnaire.	Sports participation and high motor quotients in Year 1 were a significant predictors of sport participation in Year 3 of the study.
Woll, A., Worth, A., Mundermann, A., Holling, H., Jekauc, D., & Bos, K. (2013).	Conducted as part of the Motorik-Modul (MoMo) study in Germany, children aged 4-17 years from 167 cities were involved in data collection on physical fitness and physical activity	Jumping side-to-side test used to measure gross motor coordination. Single leg stance used to assess static gross motor coordination. Backward balance was used to measure dynamic gross motor coordination. Reaction time was used to measure reaction. Tracing lines and pen sorting used to measure fine motor coordination. Physical fitness tests included PWC170 bike test for aerobic endurance, push up test for upper body dynamic strength, and standing long jump for power.	Overweight and obese boys had lower physical fitness vales and motor coordination scores than normal weight children.

Gentier, I., D'Hondt, E., Shultz, S., Deforche, B., Augustijn, M., Hoorne, S., Verlaecke, K., De Bourdeaudhuij, I., & Lenoir, M. (2013).	Children from an obesity treatment centre in Belgium (N=34) and healthy weight children from through a Belgium primary school (N=34)	The obese weight children were measured and assessed prior to treatment at the clinic. Height and body weight recorded, and then BMI calculated. Bruininks-Osersky Test of Motor Proficiency (BOTMP) was used to assess fine and gross motor skills.	Healthy-weight group obtained significantly higher raw scores than the obese-weight group for 6 of the 9 BOT-2 test items on gross motor skill competence. Obese-weight group obtained significantly lower overall fine precision scores than the healthy-weight group.
D'Hondt, E., Deforche, B., Gentier, I., De Bourdeaudhuij, I., Vaeyens, R., Philippaerts, R., & Lenoir, M. (2013).	Children from 13 randomly selected primary schools in Belgium (N=487 children completing gross motor coordination test in 2007 and 2009)	Motor coordination was assessed using the Körperkoordination-Test für Kinder (KTK) test. Height and body weight recorded, and then BMI calculated. Physical activity levels measured using the Flemish Physical Activity Questionnaire (FPAQ).	The progression in the level of gross motor coordination over the two years was found to be different depending on the weight status of the children. A widening gap in gross motor coordination between normal weight and over-weight children occurred over time. Both BMI (negative relationship) and sports club participation (positive relationship) were significant predictors of gross motor coordination two years later, with BMI at baseline explaining the largest variance between normal weight and over-weight children occurring over time.
Vedul-Kjelsås, V., Stensdotter, A-K., & Sigmundsson, H. (2013).	Children in 6 <sup>th</sup> grade at a city primary school aged 11 years (N=67)	The Movement Assessment Battery for Children (MABC) used to assess motor competence.	There was a significant difference between girls and boys in the scores of ball skills tasks of MABC and in one of the balance tasks (jumping and clapping), in favour of boys. No significant differences observed between genders in the manual dexterity tasks and in the total MABC scores.
Laukkanen, A., Pesola, A., Havu, M., Saakslanti, A., & Finni, T. (2014).	Children aged 5 to 8 years from 19 kindergartens and 37 primary schools (N=84) in Finland	Height and body weight recorded, and then BMI calculated. Physical activity measured using accelerometers worn for at least 3 days. Motor coordination was assessed using the Körperkoordination-Test für Kinder (KTK) test.	Gross motor skills were identified both in pre-schoolers and primary schoolers as normally developed. Boys performed better in motor control than girls at both pre-school and primary school ages. Motor control was associated with time spent at vigorous intensity activity in primary school girls. Gross motor skills are positively associated with habitual physical activity and negatively associated with sedentary time in 5-8-year-old children.
D'Hondt, E., Deforche, B., Gentier, I., Verstuyf, J., Vaeyens, R., De Bourdeaudhuij, I., Philippaerts, R., & Lenoir, M. (2014).	Secondary analysis of data from children in the Flemish Sports Compass, 2007-2009 (N=2517 in 2007; N=754 in 2009)	Motor coordination was assessed using the Körperkoordination-Test für Kinder (KTK) test. Height and body weight recorded, and then BMI calculated. Physical activity levels measured using the Flemish Physical Activity Questionnaire (FPAQ).	A lower performance on the KTK test at baseline significantly predicted an increase in BMI score, and a higher baseline BMI also predicted a decrease in KTK test score. Respondents to FPAQ had significantly lower BMI than non-respondents. A reciprocal causal relationship between children's weight status and their level of gross motor coordination across developmental time was identified.

Tsapakidou, A., Anastasiadis, T., Zipopoulou, D., & Tsompanaki, E. (2014).	Children aged 8 and 9 (N=100) from public elementary schools in Thessaloniki.	Motor skills assessed using the Test of Gross Motor Development – 2 (TGMD-2).	Children from the higher SES status school differed significantly in participation in sports clubs. No statistical differences between the two schools in locomotor movement skills. No statistical difference in scores found between genders, and between those that participated in sports clubs and those that did not. Maternal level of education had a statistically significant difference on children's performance.
Slotte, S., Saakslähti, A., Metsamuuronen, J., & Rintala, P. (2015).	Children from Tampere, Finland, (mean age 8.6 years) (N=304)	Height, body weight and waist circumference recorded, and then BMI calculated. Test of Gross Motor Development – 2 (TGMD-2) used to assess FMS.	Boys were more proficient at object control skills and scored significantly higher for total FMS compared to girls. Girls were more proficient at locomotor skills. FMS proficiency was significantly lower among overweight/obese children. For both genders, BMI, waist circumference and weight were higher in the low FMS group compared with the high FMS group.
Juakkola, T., Yi-Pipari, S., Huotari, P., Watt, A., & Liukkonen, J. (2016).	Convenience sample of children in Grade 7 (M age + 12.41) from 2 middle schools in Central Finland (N=224)	Physical activity measured using the International Physical Activity Questionnaire (IPAQ). FMS tests included Flamingo standing test for balance, Leaping test, Figure-8 dribbling test for manipulative skill. Physical fitness tests for aerobic fitness (Cooper test) and 1500m run, and Curl-up test for muscular endurance. Height and body weight recorded, and then BMI calculated. Previous physical activity engagement at baseline measured by the Health Behaviour in School Aged Children Research Protocol.	Gender was not a statistically significant determinant in any of the criterion categories. FMS predicted metabolic equivalents (METs). BMI a negative determinant of METs. BMI a significant indicator of later physical activity engagement. Students categorized as normal weight are significantly more active than overweight/obese students. No difference between normal weight and overweight/obese students in FMS.
Bardid, F., De Meester, A., Tallir, I., Cardon, G., Lenoir, M., & Haerens, L. (2016).	Convenience sample of children in Grade 3 and 4 (N=161) from 6 primary schools in Flanders	Motor competence measured using The Körperkoordinationsstest für Kinder (Body Coordination Test for Children) (KTK). Self-perception of motor competence measured using the Self-Perception Profile for Children (SPPC). Autonomous motivation for sport measured using the Behavioural Regulations in Exercise Questionnaire (BREQ).	Children with relatively low levels of perceived motor competence had significantly lower autonomous motivation for sports than children with relatively high levels of motor competence. Children with high levels of actual motor competence and low levels of perceived motor competence demonstrated lower levels of autonomous motivation for sport than children with low actual motor competence and high perceived motor competence. The high percentage of children displaying divergent levels of actual and perceived competence suggest many young children lack the cognitive capacity to correctly assess competence.

Luz, C., Rodrigues, L. P., De Meester, A., & Cordovil, R. (2017).	Children from public schools in the Lisbon district (mean age 10.8) (N=546)	Health related fitness measured using the PACER progressive shuttle run test and the handgrip test. Motor competence measured using the quantitative instrument developed by Luz and colleagues (2016). Height and weight measured, and then BMI calculated.	Locomotor skills found to have the strongest relationship with health related fitness across all age groups and genders. Manipulative skills more often correlated with health related fitness in boys compared to girls. BMI found to be a significant predictor of motor competence. The relationship between overall motor control and health related fitness is strong and stable across childhood.
<b>6. Middle East</b>			
Khodaverdi, Z., Bahram, A., Khalaji, H., & Kazemnejad, A. (2013).	Children from Grade 3 in one urban primary school in Tehran Province (N=352)	Motor control measured using the Test of Gross Motor Development – 2 (TGMD-2). Physical activity measured using the Physical Activity Questionnaire for Older Children (PAQOC). Perceived physical ability measured using Self-Description Questionnaire-1.	Mastery of motor skills and high positive perception of motor competence promotes physical activity participation. Motor skill competence was a better predictor of physical activity than perceived motor control.
Khodaverdi, Z., Bahram, A., Stodden, D., & Kazemnejad, A. (2016).	Female children from Grade 3 in public schools in urban Tehran province, Iran (N=352)	Motor control measured using the Test of Gross Motor Development – 2 (TGMD-2). Health-related physical fitness measured using field tests from the FITNESSGRAM. Perceived motor competence measured using Self-Description Questionnaire-1. Physical activity measured using the Physical Activity Questionnaire for Older Children.	Health-related physical fitness were above the minimum for their age. Physical activity generally in the moderate range. Mean motor skill standard scores higher than age-specific normative scores. Perceived motor competence and aerobic fitness mediated the relationship between locomotor skill competence and physical activity. Health-related physical fitness were not associated to actual motor competence or physical activity.
<b>7. North America</b>			
Dru Marshall, J., & Bouffard, M. (1997).	Children from Grade 1 to Grade 4	Movement competency measured using the Test of Gross Motor Development (TGMD). Physical fitness measured using aerobic fitness (20 m shuttle run) test.	Quality Daily Physical Education (QDPE) programs were found to facilitate the development of movement skill in those children who are less movement competent to begin with, regardless of their obesity status. Aerobic fitness level was predictive of the TGMD scores.
McKenzie, T. L., Alcaraz, J. E., & Sallis, J. F. (1998).	Children from 7 schools in Grade 4 and 5 in the suburb of San Diego California (N=403)	The SPARK PE curriculum was implemented in the 4 schools. Three manipulative skills tests used to assess throwing, catching and kicking.	Age found to be significantly correlated with the baseline manipulative skills. Skill improvement was not correlated with age. Generally, boys were more skilled than girls. Boys improved more than girls in all skills. Children's manipulative skills can be improved by quality physical education programs delivered by PE specialists and classroom teachers with substantial training.

<p>Wrotniak, B. H., Epstein, L. H., Dorn, J. M., Jones, K. E., &amp; Kondilis, V. A. (2006).</p>	<p>Children aged 8-10 from Erie County, New York (N=65)</p>	<p>Self-perception of physical activity measured using Children's Self-Perceptions of Adequacy in the Predilection for Physical Activity Scale (CSAPPA). Height and mass measured, and then BMI calculated. Motor proficiency measured using the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP). Habituated physical activity measured using accelerometers for 7 days.</p>	<p>No differences between genders in the activity data or the overall BOTMP score. Boys had faster times in running speed and agility, and scored higher in throwing a ball at a target and response speed. There were significant associations between BOTMP standard score and activity counts/minute, percentage of time in sedentary activity, moderate physical activity and MVPA. There was significant negative correlations between BMI and activity counts/minute, percentage of sedentary time, percentage of time in sedentary activity, moderate physical activity and MVPA. No differences in the relationship among motor proficiency, BMI and physical activity by gender. Motor proficiency found to be positively associated with physical activity.</p>
<p>Castelli, D. M., &amp; Valley, J. A. (2007).</p>	<p>Representative sample of children living in the Midwest enrolled in a summer program, aged 7- 12 years (N=230)</p>	<p>Parents and children were each asked to complete a 7-day physical activity recall of the child's physical activity engagement. Fitnessgram testing was used to measure fitness relative to NASPE (2004) Standard 4. To assess motor competence as it related to NASPE (2004) Standard 1 the South Carolina Physical Education Assessment Program (SCPEAP) testing protocols and scoring criteria were used. To measure physical activity engagement during the summer activity program, pedometers were worn during activity programs.</p>	<p>The results suggest physical fitness and motor competence are predictors of physical activity. Children who had medium or low levels of physical activity were likely inhibited by their aerobic fitness or lack of motor competence.</p>
<p>Erwin, E. E., &amp; Castelli, D. M. (2008).</p>	<p>Children from 4<sup>th</sup> and 5<sup>th</sup>, ages 9–12 recruited from four elementary schools in the mid-western United States (N=180)</p>	<p>The South Carolina Physical Education Assessment Program (SCPEAP) protocols for basketball, educational gymnastics and overhand throwing were used to assess motor competency relative to NASPE (2004) Standard 1. Structured interviews about strategies were conducted with each participant immediately following the motor assessments to assess competency relative to NASPE (2004) Standard 2. The ACTIVITYGRAM was used to assess habituated physical activity relative to NASPE (2004) Standard 3.</p>	<p>Boys scored significantly higher than girls in motor skill assessment, Boys significantly outperformed girls on cardiovascular fitness.</p>

		The FITNESSGRAM five components - aerobic endurance, muscular strength, muscular endurance, flexibility, and body composition were relative to NASPE (2004) Standard 4.	
Wright, M. J., & Bos, C. (2012).	Children 8 to 11 years from a school and community Scout group in Canada (N=84)	Motor ability measured using the Community Balance and Mobility Scale (CB&M) tasks that are representative of the motor skills. Height and weight measured, and then BMI calculated.	There were no significant differences in the CB&M total scores between genders. Age (older children scored higher) and BMI category (overweight/obese scored lower) were significant predictors of the CB&M total scores. Overweight and obese children had relatively lower CB&M total scores.
Butterfield, S. A., Angell, R. M., & Mason, C. A. (2012).	Children aged 5 to 14 years in a rural school in the United States (N=186)	Test of Gross Motor Development (TGMD-2) subtest used to assess object control skill.	A larger proportion of boys performed a mature pattern for each skill. The most significant difference was in throwing, for which two-thirds of boys demonstrated a mature pattern, and slightly more than two-thirds of girls did not demonstrate a mature pattern. Gender differences favouring boys were observed for throwing and striking.
Larouche, R., Boyer, C., Tremblay, M. A., & Longmuir, P. (2014).	Children in grades 4 to 7 in Ottawa, Canada (N=679)	Physical activity measured by pedometers for 7 consecutive days. Cardiovascular fitness was measured with the Progressive Aerobic Cardiovascular Endurance Run (PACER) test. Upper body muscle strength was assessed with a Takei handgrip dynamometer. Trunk flexibility was evaluated with the sit and reach test. Torso muscular endurance was measured with the plank isometric position test. Body composition measurements were performed following the Canadian Society for Exercise Physiology (2003) protocols. Motor skills were assessed with a newly developed obstacle course.	Step counts were moderately associated with greater predicted aerobic power and shorter obstacle course time. Step counts were weakly associated with better obstacle course score, greater plank time and greater handgrip strength. Children with greater aerobic fitness and motor skills engaged in higher amounts of physical activity. Gender moderated the relationship between aerobic fitness and physical activity. Aerobic fitness and motor skill are independently associated with children's physical activity.

De Meester, A., Stodden, D., Goodway, J., Brian, A., True, L., Cardon, G., Tallir, I., & Haerens, L. (2016).	Convenience sample of children (mean age 9.49) from one urban school district in Ohio, a rural school in Texas, and a before/after school program in Michigan	Motor control measured using the Test of Gross Motor Development – 2 (TGMD-2). Perceptions of motor competence assessed using the Self-Perception Profile for Children (SPPC). Habituated physical activity measured over a minimum of 5 days using accelerometers. Height and mass measured, and then BMI calculated.	Children had low levels of actual motor competence. Children reported high levels of perceived motor competence. Boys and girls did not significantly differ with respect to actual motor competence. Boys found to be significantly more physically active than girls. A combination of high actual and perceived motor competence is related to higher levels of physical activity and lower weight status.
Meester, A., Stodden, D., Goodway, J., True, L., Brian, A., Ferkel, R., & Haerens, L. (2017).	Convenience sample of children (mean age 9.49) from three states in the USA (N=361)	Motor control measured using the Test of Gross Motor Development – 2 (TGMD-2). Perceptions of motor competence assessed using the Self-Perception Profile for Children (SPPC). Habituated physical activity measured over a minimum of 5 days using accelerometers.	Children with average or high actual motor competence were more likely to meet the MVPA guideline than children with low actual motor control. Boys were more likely to meet the MVPA guideline than girls. Nearly 90% of children with low actual motor control did not meet the MVPA guideline of 60 minutes minimum of MVPA/day.
<b>8. South America</b>			
Coiro Spessato, B., Gabbard, C., Valentini, N., & Rudisill, M. (2013).	Children aged 3 to 10 from 50 public schools and daycare centres in Porto Alegre, Brazil (N=1248)	Motor control measured twice (test and re-test) within a 10 day period using the Test of Gross Motor Development – 2 (TGMD-2).	Motor skill performance significantly improved with age and boys outperformed girls. Boys did significantly better in than girls in all age groups, and significantly better in the two older age groups (age 7-8, age 9-10). The differences in motor skill performance between genders were not significantly different in the two younger age groups (age 3-4, age 5-6).
<b>9. Africa</b>			
Kemp, C., & Pienaar, A. E. (2013).	Children from the North West Province of South Africa in Grade 1 (N=880)	Height, weight and skinfolds measured, and then BMI calculated Motor proficiency measured using the short form Bruininks-Oseretsky Test of Motor Proficiency (BOTMP). Gross motor development measured using the Test of Gross Motor Development – 2 (TGMD-2).	Fine motor precision was the only variable that showed a significant relationship with all three body composition measures (BMI, skinfold, waist circumference). Running speed and agility were significantly negatively correlated with BMI and skinfold. Normal weight children showed significantly better strength and balance skills than the obese group.

Source: own study.