

## A Focus on Motor Competence as Alternative Strategy for Weight Management

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**Received:** May 30, 2017

**Accepted:** July 07, 2017

**Published:** July 12, 2017

**Citation:** Drenowatz C. 2017. A Focus on Motor Competence as Alternative Strategy for Weight Management. *J Obes Chronic Dis* 1(2): 31-38.

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### Abstract

The high prevalence of overweight and obesity has been identified as major threat to future public health. Excess body weight not only impairs individual quality of life but is also associated with considerable costs. The fact that obesity rates have been rising throughout the world despite considerable efforts suggests that alternative strategies for addressing this problem are warranted. One such strategy may be a stronger emphasis on the development of motor competence. This narrative review provides an overview of the major theoretical models describing the longitudinal associations of motor competence, physical activity and body weight along with empirical evidence supporting the potential contribution of motor competence in obesity prevention. It also gives some practical guidance for the implementation of interventions emphasizing the development of motor competence. Despite the fact that childhood and adolescence appear to be of particular importance for ensuring a high motor competence, it should be considered that even adults could benefit from increased motor competence. Well-developed motor competence is associated with higher motivation for participation in various forms of physical activity, and, therefore, facilitates an active lifestyle throughout adulthood. Taken together, it appears that emphasizing the development of motor competence at young ages provides a viable option for the sustainable promotion of physical activity, which is a crucial component in long-term weight management.

### Keywords

Motor skills, Motor abilities, Functional movement skill, Obesity, Overweight

### Introduction

Excess body weight has been identified as major health problem due the association with cardiovascular and metabolic disease, orthopedic problems, poor pulmonary function, depressive symptoms and overall quality of life [1-3]. With more than 2 billion people or roughly 30% of the world population being considered overweight or obese [4], these problems not only affect the individual but also put a significant burden on health care systems. Excess body weight has been associated with increased doctor's visits, hospital stays as well as decreased productivity [5, 6]. Accordingly, obesity has been shown to increase both inpatient and outpatient spending by 36% along with a 77% increase in costs for medications [7]. Overall, it has been estimated that 10% of all healthcare expenditures can be attributed to weight-related health issues [8]. Of particular concern is the increasing prevalence of overweight and obesity during childhood [9, 10], which increases the risk for metabolic problems already at young ages [11]. Further, excess body weight increases the risk for adult obesity [12]. Even in the absence of adult obesity, however, children with excess body weight have

an increased risk for chronic disease and premature death [13]. Accordingly, the prevention of childhood overweight and obesity has been declared one of the largest challenges of the 21<sup>st</sup> century [14].

## Limited Success of Current Intervention Strategies

Despite considerable efforts in addressing this obesity epidemic current strategies targeting weight loss and weight management have been of limited success [15]. In fact, the average body weight of children in the United States has increased by 5 kg during the last 3 decades [16]. Given the large number of intervention strategies in various settings, including schools and communities, this development indicates that our understanding of the complex interaction of key contributors to excess body weight remains limited. While biological and genetic factors need to be considered in the regulation of body weight, behavioral adjustments appear to be of particular importance due to the large shift in population weight in a relatively short period of time. Specifically, poor dietary choices and low physical activity (PA) have been suggested as key contributors to excess body weight [17, 18]. Even though these correlates of energy balance appear to be the obvious choice for behavioral interventions, not all current recommendations have been backed by scientific data. Data on the association between high-fat foods and sugar-sweetened beverages with overweight and obesity have been inconsistent [19-21]. Nevertheless, dietary intake should be considered an important contributor to a healthy lifestyle. Rather than demonizing specific foods, a balanced diet and regular meal pattern in children, however, should be emphasized in order to establish healthy dietary choices in the long-term [22, 23].

Along with changes in the food environment there has been a decline in physical demands of daily living [24, 25]. In youth these changes have promoted indoor activities and high media utilization [26], which resulted in a majority of youth not meeting current PA recommendations of 60 minutes of moderate to vigorous PA [27-29]. Given the well documented benefits of PA on weight management, cardiovascular, metabolic and skeletal health as well as psychological well-being [30-32] insufficient PA is considered another major health risk factor in youth [33]. As has been shown for obesity interventions, efforts to achieve sustainable increases in PA, however, have been of limited success [34]. In light of these data, it may be time to consider alternative approaches for the promotion of an active lifestyle that facilitates long-term weight management. Previous research indicates that low motor competence may have contributed to the high prevalence of obesity in youth [35-38]. In addressing the benefits of motor competence and its association with PA and body weight this narrative review emphasizes the development of motor competence as a potential strategy for a sustainable promotion of an active lifestyle, which is crucial in long-term weight management.

## Motor Competence: Terminology and Trends

Motor competence reflects a person's ability to execute

different motor tasks, including the coordination of fine and gross motor skills necessary to manage everyday tasks [39, 40]. It has recently been suggested to use motor competence as global term, which incorporates previously used terminologies such as motor proficiency, motor performance, motor ability, motor coordination, motor skills or fundamental movement skills [33]. Accordingly, motor competence forms the foundation for specialized skills that are required for successful participation in popular sports and active leisure activities, including locomotion and object control [41, 42]. Locomotor skills are defined as movements that propel the body through space (e.g., running, jumping, skipping, hopping) while object control relates to movements used in manipulating objects (e.g., throwing, kicking, catching) [43]. The development of motor competence is a critical determinant of children's general development as it influences physical, psychological and mental health along with overall well-being [33, 44-49].

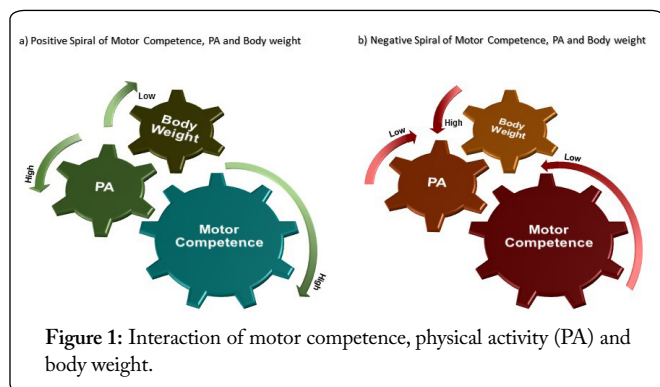
As has been shown for PA, available data on motor competence in youth indicate a decline [50, 51] resulting in low motor competence in children and adolescents [52, 53]. The limited success of current PA and weight loss interventions has, at least in part, been attributed to the lack of attention towards the development of motor competence, particularly in children with excess body weight [54]. Accordingly, it has been argued that weight loss intervention strategies in children should initially address deficiencies in motor competence in order to allow children to successfully participate in health-enhancing PA [55, 56]. As higher motor competence has been associated with increased motivation and enjoyment of being physically active [56-58], children with high motor competence have shown a less pronounced decline in PA as they progress through childhood and into adolescence [57, 59]. Accordingly, high motor competence during childhood has been associated with higher levels of moderate-to-vigorous PA in adults even though there was no difference in participation in organized sports [60]. These results emphasize the potential of focusing on the development of motor competence for the facilitation of a sustainable participation in various physical activities beyond the intervention period.

Even though rudimentary movement patterns develop naturally during childhood, the development of motor competence needs to be nurtured and is influenced by biological, psychological, social, cognitive and motivational factors [61]. Accordingly, appropriate instruction, practice, encouragement and feedback are necessary for the optimal development of motor competence [42, 62, 63]. Children need to be provided with opportunities to engage in a variety of movements including supervised exercise as well as free play [64, 65]. Free play has been shown to facilitate learning, particularly in younger children and it may provide opportunities for the development of additional movement skills in different contexts [66]. Further, play often induces movements associated with moderate-to-vigorous intensity [59]. Structured activities that emphasize various forms of locomotion and object control skills, nevertheless, could provide additional benefits. Accordingly, school and community programs that focus on developmentally appropriate movement experiences have been shown to

improve motor competence in children and adolescents [63, 67-69]. Given that motor competence has been considered a sustainable outcome, it could induce relatively permanent change of an individual's behavioral capability along with changes in behavioral preferences including higher physical activity levels [57, 70, 71].

## Longitudinal Associations and Theoretical Models of the Development of Motor Competence

In order to consider the development of motor competence as a viable intervention targeting increased PA and a healthy body weight it should, however, be clarified whether increased motor competence increases subsequent participation in PA or whether it is the result of increased engagement in PA [72]. Most likely there exists a reciprocal, synergistic relationship between motor competence, PA and body weight [73-76]. Nevertheless, it has been suggested that directionality and strength of the developmentally dynamic relationship between motor competence and PA varies from infancy throughout childhood and into adolescence [76]. Particularly middle childhood has been proposed as a critical time, where either positive or negative trajectories of motor competence, PA, and body weight begin to diverge [33] (Figure 1). Two theoretical models have addressed the longitudinal association between the development of motor competence and PA along with the implications for weight progression – the dynamic association model [76] and the hierarchical model [77].



The dynamic association model emphasizes the reciprocal relationship between PA, actual and perceived motor competence with variations in strength and directionality between these components [76]. It also acknowledges that the relationship between PA and motor competence is low during early childhood due to environmental and parental influences on these parameters as well as limited prior experience with structured movement programs. Initially, PA appears to be necessary in order to develop unspecific motor skills or motor milestones at young ages [78, 79]. The need of PA to develop rudimentary motor skills may also be indicated by an infant's drive to move. As children with higher PA will enhance their motor competence this association strengthens during the transition into middle and late childhood but also starts to shift in directionality. As children start to compare their motor competence to peers their perceived or actual

motor competence may become the primary determinant of PA participation. During the transition into adolescence the association continues to strengthen with reverse directionality. Those with enhanced actual and perceived motor competence will be more motivated to participate in different forms of PA, which further contributes to the development of motor competence [78, 79]. Accordingly, motor competence has been suggested as a primary determinant for participation in PA and exercise during adolescence and into adulthood, particularly in activities consisting of moderate and vigorous PA [64, 76, 80]. This is also in line with the competence motivation theory [81], which suggests that motivation to engage in various activities such as PA is influenced by competence and enjoyment of the respective activity. Low motor competence, on the other hand, may result in less pleasant experiences with various movement activities, which would increase the risk for low PA. Further, it has been shown that low motor competence reduces the motivation to engage in more challenging activities [78, 82], which impairs the refinement of motor skills and contributes to a vicious cycle of low motor competence and low PA. This reinforcing association between PA and motor competence will also affect weight status over time. Accordingly, longitudinal data showed a positive trajectory for healthy weight and increased motor competence, while low motor competence was associated with increased risk for overweight and obesity [57, 59, 73, 83-85].

The hierarchical model puts an even stronger emphasis on motor competence as prerequisite for engagement in PA. As a result of growth, maturation and experience children progress through four levels of motor competence consisting of reflexes, fundamental motor skills, transitional motor skills, and sport specific skills [77]. Of particular importance are so-called proficiency barriers as these most likely affect motivation for a sustainable engagement in various forms of PA and sports. Children, whose motor competence exceeds the proficiency barrier are more likely to maintain higher PA levels throughout the lifespan while those who do not break through the proficiency barrier are less likely to continue their engagement in PA. Accordingly, Lopes et al. showed an attenuation of the age-related decline in elementary school children with higher motor competence while low motor competence augmented the decline in PA [59]. Specifically, object control skills have been shown to affect PA participation [57, 86], which may be attributed to their importance in many popular sports. Another explanation could be that object control skills require specific environmental stimuli, including learning opportunities with feedback and instructions, that are influenced by socio-economic factors, which are associated with PA as well. Limited movement experience and low motor competence would also make it more difficult to motivate adults for participation in various forms of PA at later stages in their lives and, therefore, hinder traditional PA programs.

Besides the association between motor competence and PA there is evidence that motor competence affects change in adiposity independent of PA during elementary school years [58]. Body weight, however, also influences the development of motor competence. Previous research showed a slower development of motor competence in overweight/

obese children compared to their normal weight peers [87, 88]. Weight loss, on the other hand, has been associated with a more pronounced development of motor competence. The development of object control skills, however, has been shown to be less affected by body weight [80] and, therefore, a focus on motor competence may still be a viable option when targeting excess weight gain.

## Practical Implications

Interventions targeting an improvement in motor competence have been shown to be effective in children [63, 68, 89]. In addition, motor competence appears to be a sustainable outcome in children and adolescents and has important implications for lifespan PA and body weight [49, 90, 91]. Given the fact that health promotion should target sustainable behavior change or facilitate the maintenance of healthy behaviors (i.e. sufficient PA), targeting motor competence should be considered as viable strategy in the promotion of an active lifestyle that facilitates long-term weight management. Despite low correlations between motor competence and health related outcomes (e.g., PA, body weight) during early childhood, it has been argued that motor competence provides the foundation for an active lifestyle [42, 76]. The necessity to specifically nurture the development of motor competence in young ages, however, is often overlooked. During early childhood, a focus should be on a wide variety of movement experiences in order to provide the foundation for future development. As elementary-school years have been suggested as the optimal time for the development of motor competence [42, 92], this age group should be provided with a range of tasks that promote the development of various broad movement skills. An overview of key characteristics for the selection of movement experiences targeting the promotion of motor competence is provided in Table 1.

**Table 1:** Key characteristics of movement experiences for the promotion of motor competence (based on Kosel A. [108])

<b>Self-determined Difficulty</b>	Children determine the difficulty of the task based on their experience and learn to evaluate their current abilities
<b>Self-selected Activities</b>	Children participate in and potentially develop movement tasks under guidance (f.ex. balance beam can be crossed in various ways, which is determined by the student)
<b>High Engagement</b>	Avoidance of waiting times by engaging all children in a variety of activities
<b>High Practice Time</b>	Children need to have sufficient practice time to engage in motor learning via trial and error
<b>Group Work</b>	Working in groups or with a partner allows children to support each other in the learning process

High motor competence subsequently provides the foundation for learning more specialized sport-specific skills [42], which increases children's motivation for a continued engagement in various sports during adolescence and into adulthood [76, 83]. Lower competence, on the other

hand, is likely associated with increased frustration due to limited success in sports participation during childhood and adolescence and contributes to a vicious cycle of limited participation in sports and PA, low motor competence and increased risk for overweight and obesity [93]. In addition to the beneficial association between motor competence, PA and body weight, there is evidence on positive associations with physical fitness and academic performance [44, 56, 61, 63, 80, 94-101], which may be an additional argument for an implementation of motor competence into physical education curricula.

## Summary and Conclusion

Overall, the development of motor competence is a crucial contributor to optimal physical development and health [44, 102]. Most likely there exists a bi-directional, synergistic association between motor competence and PA as well as body weight. Youth with a better motor competence are more likely to sustain a higher level of PA, which is associated with lower body weight. Low motor competence, on the other hand, impairs engagement in sports or general PA and potentially contributes to further weight gain [58, 98, 103]. Given the inverse association of motor competence with body weight and the direct association with PA, the promotion of motor competence should be considered a viable option in the fight against insufficient PA and excess body weight in youth [59, 63, 98, 104]. The reciprocal relationship between body weight and motor competence further emphasizes the need for an early intervention in order to prevent a vicious cycle of low motor competence, excess body weight and low PA [105]. Addressing poor motor competence and low PA levels at early ages is also crucial as attitudes and habits regarding PA are developed primarily during the adolescent years [106]. Despite the fact that elementary school years have been shown to be of particular importance for the development of motor abilities [107], available research indicates beneficial effects of improved motor competence on body weight in adolescents as well. Given the limited success of previous intervention strategies to improve PA in overweight and obese youth along with the well-documented benefits of motor competence on various health-related parameters, motor competence appears to be a viable intervention strategy to promote sustainable behavioral changes that facilitate an active and healthy lifestyle. Given that high motor competence is an important step towards the establishment of a lifelong commitment to PA [57, 63, 68, 76], such strategies should not only target children and adolescents but could also be of importance in adults.

## Conflict of Interest

No external funding was used for this project. The author has no conflict of interest that is directly relevant to the content of this review.

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