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# **Change4Life Evidence Review**

## **Rapid evidence review on the effect of physical activity participation among children aged 5 – 11 years**

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## Executive summary

In summer 2015, the Change4Life campaign will focus on promoting physical activity to children aged 5 – 11 years. The aim of this rapid evidence review was to identify relevant literature on the physiological, psychological, social, and behavioural outcomes of physical activity participation among children aged 5 – 11 years, and provide an indication of the strength of the evidence for each outcome.

The physiological outcomes with the strongest evidence for a positive association with physical activity among 5 – 11 years olds are: cardio-metabolic health; muscular strength; bone health; and cardiorespiratory fitness. The psychological outcomes with the strongest evidence are: self-esteem; anxiety/stress; academic achievement; cognitive functioning; and attention/concentration. The social outcomes with positive associations with physical activity are confidence and peer acceptance. There was insufficient evidence on any of the behavioural outcomes included in the review.

# Introduction

The importance of physical activity for children and young people's health is well established and there is increasing recognition of the potential of physical activity to impact on a wide variety of health and wellbeing outcomes. Despite concerted efforts to encourage children to be more physically active, worrying gaps still remain; with 79% boys and 84% girls aged 5-15 years in England not meeting the current physical activity recommendations [1].

The World Health Organization advocates that public education, through large scale, evidence based communication campaigns, is a cornerstone of physical activity promotion [2]. Change4Life is the Department of Health's national public health campaign, which began in January 2009. A key focus of the campaign is the promotion of physical activity to both adults and children.

In summer 2015, the Change4Life campaign will focus on promoting physical activity to children aged 5 – 11 years. The aim of this rapid evidence review was to identify relevant literature on the physiological, psychological, social, and behavioural outcomes of physical activity participation among children aged 5 – 11 years, to summarise the evidence, and provide an indication of the strength of the evidence for each outcome. Our review underpins and informs the construction of appropriate messages for parents and children for the Change4Life campaign.



## Methods

We undertook a purposive search to identify relevant literature on the physiological, psychological, social and behavioural outcomes of physical activity participation among children aged 5 – 11 years. The search primarily focused on review level evidence, with the addition of searches of primary research papers in areas lacking a recent review (undertaken in PubMed). We used a set of broad MeSH terms (Medical Subject Headings) to capture the most current studies published post reviews. For example, “confidence” AND “physical activity” AND “children”. Data on each outcome of interest were extracted by a member of the research team and verified by a second member. We also validated all findings with key physical activity reports and texts, eg Start Active, Stay Active: A report on physical activity for health from the four home countries’ Chief Medical Officers [3]. We limited our review to focus on the brief; namely the benefits of physical activity for children aged 5-11 years, however this age range was extended to teenage years where appropriate.

We developed criteria to rate the current state of the evidence for each outcome, based on the number of studies, the types of study design adopted, and the direction and strength of the reported associations. We constructed an overall summary statement on the evidence for each outcome, based on the NICE Public Health Methods Manual [4].

The research team (AC, KM, CF) came to a consensus on each area and coded the strength of the evidence for each outcome as green, amber, or red. Green outcomes reflected a body of research with strong or at least sufficient evidence for a positive association with physical activity. We feel these outcomes should form the basis of any messages used in the Change4Life campaign.

Amber outcomes did not have a strong evidence base; either because the evidence came from a small number of studies, the studies were of poor quality, or the evidence was equivocal ie studies showed mixed/contradictory results. Outcomes coded red, were those where there was not enough evidence to make any statements regarding potential associations with physical activity. We recommend that any variables coded amber or red do not feature in the Change4Life campaign.

We produced a summary table of results and short evidence statements on each outcome.

## Summary findings

Table 1: Summary of the strength of the association between physical activity and each health outcome

Physiological	Psychological	Social	Behavioural
Cardio-metabolic health	Self-esteem	Confidence	Physical activity in adolescence/adulthood
Muscular strength	Anxiety/stress	Peer acceptance	Sleep
Bone health	Academic achievement	Positive relationships	Risk taking behaviour
Cardiorespiratory fitness	Cognitive functioning	Social & communication skills	
Motor skills/development	Attention/concentration	Self-resilience	
Body composition	Self-efficacy	School engagement	
	Mood		
	Memory		
	Body image		



Green outcomes have consistent evidence



Amber outcomes have inconsistent evidence, or evidence from a small number of studies



Red outcomes have insufficient evidence

# Supporting evidence

## Physiological outcomes

There is a large body of research into the physiological benefits of physical activity participation, much of which has been summarised in high-level review documents including Start Active, Stay Active: A report on physical activity for health from the four home countries' Chief Medical Officers [3] and the U.S physical activity guidelines committee report [5]. In this review we included the six physiological/physical outcomes which have been the focus of much research into the benefits of physical activity among children: cardio-metabolic health; muscular strength; bone health; cardiorespiratory fitness; motor skills/development; and body composition.

## Cardio metabolic health

Children with good cardio-metabolic health have lower-risk of developing a range of risk factors for cardiovascular disease including type 2 diabetes, hypertension, and obesity. There is strong evidence for a positive association between physical activity and cardio-metabolic health among children within the age range of interest, with higher doses of physical activity associated with higher levels of cardiovascular and metabolic health [6]–[8]. Studies typically focus on the relationship between physical activity and risk factors for chronic disease, ie cardiovascular disease and type 2 diabetes, and fasting insulin levels, lipids, and inflammatory markers. Although not the primary focus of the review, research among adolescents shows that the relationship between physical activity and cardio metabolic health is particularly evident among those with an elevated risk status at baseline [9],[10]. Some research suggests that the associations between physical activity and risk factors for cardiovascular disease and type 2 diabetes may differ by gender, although the findings are equivocal [11],[12].

## Muscular strength

There is strong evidence that strength training leads to improvements in muscle strength among children, although the optimal mode, intensity, volume and duration of strength training exercises is yet to be determined [13]. In experimental studies, most training programmes have lasted between 8 and 12 weeks, with 2-3 training sessions per week. These studies consistently report improvements in muscle strength as a result of resistance training, and a reduction in muscle strength when the training is ceased [14]. Furthermore, resistance training has been shown to improve muscle strength in children without causing adverse effects on growth or maturation [14]. While much of the research has been conducted with males only, resistance training has also been shown to improve muscle strength among females [14].

## Bone Health

Bone health refers primarily to the maintenance of bone mineral density and is important for preventing conditions such as osteoporosis in later life. There is sufficient evidence that physical activity is associated with improved bone health in children. Bone-loading physical activity increases both bone mineral content and density. Although the majority of research focuses on girls, several high quality studies have shown the same association among boys [15]–[18]. The exact dose of physical activity to improve bone health among children is yet to be determined.

## Cardiorespiratory fitness

Cardio-respiratory fitness (commonly referred to as aerobic fitness or endurance) relates to the ability to perform sustained bouts of physical activity. There is strong evidence from a large number of high quality studies that physical activity is associated with cardiorespiratory fitness among children. Participation in ‘endurance’ activities, including brisk walking, running, cycling, stair climbing and sports leads to improved cardiorespiratory fitness (5% to 15% increase in endurance performance) in both boys and girls [5].

## Motor skills/development

‘Motor skills’ is the term used to describe the ability of the body to perform tasks, such as walking, balancing, catching and throwing. There is some evidence of a relationship between physical activity and motor skill acquisition in children within the age range of interest [19]. Much of the research into physical activity and motor skill development has been conducted in children of pre-school age. However it is suggested that this activity may need to be delivered by physical education specialists to ensure it is developmentally appropriate [20]. In addition, it is likely that sustained participation, as opposed to a single acute episode of physical activity, is required [21]. Some research suggests that children with higher motor proficiency are likely to be more physically active [22], emphasising the importance of developing motor skills to increase participation in physical activity and sports in childhood, although motor skills competency is not a strong predictor of physical activity in adulthood [23].

## Body composition

The term body composition is used to describe the percentages of fat, bone, muscle and water in the body. There is a large body of evidence into the relationship between physical activity and body composition, and in particular BMI and percentage body fat. However, due to natural changes in body composition which occur with chronological

age and associated changes in growth and maturation, these studies can be difficult to interpret [24]. In addition, the pattern and direction of these natural changes differs between boys and girls. Overall it appears that programmes aimed at increasing physical activity among normal weight children typically have little effect on adiposity [5]. Among children who are overweight/ obese, physical activity is associated with reductions in overall adiposity and visceral adiposity [25]–[28]. However, there is some contradictory evidence on this relationship, and the evidence regarding the pattern of association in terms of dose-response is inconsistent [5].

## Psychological Outcomes

In addition to the physiological benefits, there are a wide range of psychological outcomes associated with participation in physical activity. Upon reviewing the evidence on the psychological benefits of physical activity, we found the greatest volume of research related to nine principal outcomes: self-esteem; anxiety/stress; academic achievement; cognitive functioning; attention/concentration; self-efficacy; mood; memory; and body image.

### Self-esteem

There is strong evidence that participation in physical activity and sport is associated with self-esteem. One systematic review of randomised controlled trials (RCTs) [29] found several trials which indicated that exercise has positive short term effects on self-esteem in children. A review of reviews [30] looking at physical activity and mental health in children reported on three reviews which all showed a positive association between participation and self-esteem. Furthermore, one longitudinal study [31] investigated participation in organised sports and found that participation was significantly associated with social skills and self-esteem. A recent RCT [32] reported significant positive association following a 10 week community based physical activity intervention; furthermore these gains were retained after 6 months follow-up.

### Anxiety/stress

There is sufficient evidence to support the association of physical activity and anxiety in this age range. Four systematic reviews have reported a small negative association between physical activity and anxiety [30]. In addition, one longitudinal study involving 200 children investigated the effects of participation in extra-curricular sport on the development of social anxiety symptoms and found a negative association between those participating in team sports and social anxiety [35].

## Academic achievement

There is sufficient evidence that physical activity is associated with academic achievement. Of the studies reviewed, academic achievement frequently included indicators of cognitive skills, academic performance, academic concepts, cognitive ability and executive function [36],[37]. There is also emerging evidence for an association with cognitive flexibility and brain function and performance [38]. Over and above any other psychological outcome included in this review, we found a large body of good quality evidence supporting this association. This ranged from support for single bouts of exercise on academic performance [39] as well as acute physical exercise on executive function [40] to a positive long term association with moderate to vigorous physical activity on academic attainment [41].

## Cognitive functioning

There is strong evidence that physical activity is associated with cognitive development. Seven reviews have consistently reported a positive association between physical activity and cognitive functioning [30]. Among them was a large meta-analysis of 44 studies which found a significant and positive relationship between physical activity and cognitive functioning. Middle school aged students showed the biggest effect size followed by young elementary students [42].

## Attention/concentration

There is sufficient evidence that children's attention and concentration are associated with physical activity. Two studies reported a positive association between physical activity and concentration and attention, as well as on-task behaviour [43]. This provides further support to an earlier review [44] which found a significant association between physical activity and concentration and classroom behaviour from cross sectional observations.

## Self-efficacy

There is some evidence to support the association between physical activity and self-efficacy in this age range, although the evidence comes from only a small number of studies. Results from a recent review show that, among the age group of interest, there is moderately strong evidence to suggest that participation in physical activity programs/interventions is associated with improved self-efficacy [33]. This adds strength to an earlier review which reported that self-efficacy had 'indeterminate' relations with children's physical activity [34].

## Mood

There is equivocal evidence that participation in physical activity is associated with mood. One longitudinal study [46] of over 6,000 primary and secondary school children reported mixed associations between physical activity and mood, and associations varied by gender and school level.

## Memory

There is insufficient evidence that participation in physical activity is associated with memory. Only one study was found [45], which consisted of a nine month RCT. Although this study found that physical activity and cardiorespiratory fitness are associated with improvements in the cognitive control of working memory in preadolescent children (aged 7 – 9 years), further research is needed in this area.

## Body image

There is insufficient evidence that participation in physical activity is associated with body image in this age group. Only one longitudinal study was found [47] of 821 elementary school children (aged 7 – 9 years). Among both boys and girls, weak evidence was found for the relationship between physical activity and body dissatisfaction and these relationships were no longer significant after adjusting for percent body fat.

## Social Outcomes

Social outcomes are closely related to psychological outcomes and in the papers included in this review were often described in generic terms or mixed with psychological variables. We summarised clusters of outcomes under generic titles but acknowledge there are considerable differences in the use and consistency of terms between primary studies. For example the 'positive relationships' outcome included studies that examined children's relationships with a range of adults (teachers, coaches, neighbours) and peers.

We report results for six principle outcomes which were found to feature commonly in the literature: confidence; peer acceptance; positive relationships; social and communication skills; self-resilience; and school engagement. The majority of studies within this section were cross-sectional so any inference of direct causation between physical activity and the outcome is unproven.

## Confidence

There is sufficient evidence that participation in physical activity is associated with confidence. This evidence comes from longitudinal research and RCTs, as well as cross-sectional studies. A recent RCT reported improvements in confidence following a 10-week community based physical activity intervention among girls aged 10 – 16 years [32]. In addition, longitudinal research shows that team or individual sport participation is associated with positive youth development among the age group of interest, in comparison to participation in development programs, performing arts, arts and crafts, school clubs, volunteering, religious groups, and paid work [48]. Evidence from cross-sectional studies also supports the association between physical activity and positive development among children, even after controlling for total time spent in the activities and the duration of sport participation [49],[50].

## Peer acceptance

There is sufficient evidence that peer acceptance and friendship is associated with physical activity and sport. One cross-sectional study of UK children aged 7 – 9 years reported that peer acceptance was an important moderator of participation in physical activity when combined with age related maturity [51]. Participation in sports supported and reinforced friendships. A recent review of cross-sectional, longitudinal and experimental evidence reported that there is a relationship between peer and/or friend variables and adolescents' physical activity [52]. Clearly the importance of peer support may increase with age but the principle of the promotion of peer support for physical activity and the encouragement of peer acceptance, approval, and friendship in sports to increase motivation and participation in physical activity is unlikely to do harm.

## Positive relationships

There is some, but little, evidence that participation in physical activity is associated with positive relationships. One longitudinal study reported some improvements in co-operation, and one cross-sectional study reported that children participating in both sports and clubs had higher social skill scores compared with children who did not participate in any outside-school activity [31],[53].

## Social and communication skills (negotiation, co-operation, sharing, problem solving)

There is equivocal evidence that children's social and communication skills are associated with their physical activity behaviour, and results are inconsistent by gender and age [31],[49],[50],[53]–[56]. Social and communication skills are also mediated by parental support for physical activity and social status [57].



## Self-resilience

There is some evidence that self-resilience is associated with participation in physical activity but the evidence is of poor quality and from adolescent samples as opposed to the age group of interest [58]–[60]. Among adolescents, participation in both “formal” and “informal” sports has been shown to be related to enhanced emotional and behavioural wellbeing, and those participating in formal sports also reported significantly lower levels of emotional and social problems compared to those participating in fewer formal sports [61]. In addition, one pre-post study reported increases in resilience scores for Canadian Aboriginal adolescents following participation in an outdoor education intervention [62].

## School engagement

There is insufficient evidence and it is of poor quality that school engagement is associated with physical activity in or out of school. One recent pilot intervention study reported that physically active academic lessons may positively influence time-on-task in children, which can contribute to academic success in the long term [63]. In addition, one cross-sectional study reported that high overall sports participation was associated with a reduced risk of truancy [64]. However more research is needed in this area.

## Behavioral Outcomes

The impact of physical activity participation on other behaviours is a relatively under-explored area of research. Of particular interest is whether the establishment of regular physical activity patterns in childhood leads to sustained participation throughout adolescents and adulthood. We reviewed the evidence for this ‘tracking’ of physical activity behaviour. We also searched for evidence of a relationship between physical activity and other behaviours, such as sleep and risk taking behaviour such as smoking, drug-taking, and alcohol use.

## Physical activity into adolescence/ adulthood

There is some evidence from longitudinal studies that physically active children continue to be active throughout adolescence and adulthood, although this evidence comes from a small number of studies. A study tracked 6,458 10 years olds over a 32 year period and reported that those with frequent sports participation at age 10 were significantly more likely to participate in sport and/or physical activity at age 42, although the same relationship was not observed for active play [65]. Another study tracked 2,309 individuals over a 21 year period, and suggested that some evidence of tracking may exist, although the association was weak to moderate, and more evident among males

than females [66]. Although these studies suggest that some tracking of behaviour may exist, the evidence is by no means conclusive and comes from only two longitudinal studies.

## Sleep

The evidence on the relationship between physical activity and sleep comes from cross-sectional studies and the findings are equivocal. While one recent study reported that moderate to vigorous physical activity may be associated with better quality sleep in some children [67], other studies show that higher levels of physical activity are associated with less sleep, lower sleep efficiency and increased sleep fragmentation [68],[69].

## Risk taking behaviour (smoking, drug taking, alcohol abuse)

No evidence was found on the association between physical activity and risk-taking behaviour in the age group of interest.

# Conclusions

From this rapid review of the evidence on the outcomes of physical activity participation among children aged 5 – 11 years, the strongest evidence exists for a positive association between physical activity and cardio-metabolic health, muscular strength, bone health, cardiorespiratory fitness, self-esteem, anxiety/stress, academic achievement, cognitive functioning, attention/concentration, confidence, and peer friendship. Therefore these outcomes should underpin the messages used in the new Change4Life campaign.

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