

Vigorous physical activity and obesity in children: the role of physical fitness

Abstract

We proposed a physical fitness oriented approach in the prevention of childhood obesity based on the literature and our own studies. We believe that obesity prevention should focus on various attributes of physical fitness using moderate and vigorous intensity physical activities. We specifically argued for the importance of vigorous physical activity in reaching energy balance and preventing obesity in children.

Keywords: moderate and vigorous physical activity, childhood obesity, physical fitness, cardiorespiratory fitness, physical training, child development

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Abbreviations: PA, physical activity; MVPA, moderate and vigorous physical activity; VPA, vigorous physical activity; CRF, cardiorespiratory fitness

Introduction

A plethora of epidemiological studies has consistently linked high levels of physical activity (PA) and cardiorespiratory fitness (CRF) with reduced obesity in children.^{1,2} Although CRF is hereditary to a large extent, physical training and exercise can increase CRF which is known to mediate the effects of PA on adiposity and cardiometabolic biomarkers in adults.^{3,4} In fact, it has been shown that improvement in CRF can lower all-cause mortality and cardiometabolic risk without a reduction in body weight or adiposity in adults. Although the pathway of influence of PA on adiposity is known,^{5,6} the mechanism of physical fitness in maintaining energy balance and attenuating adiposity remains unclear at this time.^{3,7,8} Speculatively, increased fat-free mass can raise energy expenditure above and beyond the energy burned during vigorous physical activity (VPA).⁹ Furthermore, it has been observed that energy expenditure remains elevated after high-intensity exercise sessions.^{10,11} For example, Yoshioka et al reported that post-exercise resting O₂ uptake and fat oxidation were greater after high-intensity PA (70-75% maximum O₂ uptake) than low to moderate intensity PA (35-40% maximum O₂ uptake) suggesting VPA induced a greater increase in resting metabolic rate.¹² There is evidence that energy intake does not significantly increase to compensate for increased energy expenditure following high-intensity PA.^{13,14} Finally, post-exercise thermic effect of food is increased especially following high-intensity exercise inversely to levels of adiposity in adults.¹⁵

PA and physical fitness are often presented as mutually inclusive constructs in the literature, disrespect the fact that the former is a behavioral quality, and the latter is a physiological quality.¹⁶ In most of the cases, CRF was incorrectly construed as physical fitness due to a conceptual misunderstanding on the part of the researchers. Physical fitness is defined as body's ability to achieve optimal levels of physical performance in dealing with physiological stress to the body. Ross Pate defined health-related physical fitness as "a state

characterized by (a) an ability to perform daily activities with vigor, and (b) demonstration of traits and capacities that are associated with low risk of premature development of the hypokinetic diseases (i.e., those associated with physical inactivity)".¹⁷ Attributes of physical fitness include CRF (or endurance), speed, muscle strength, agility, flexibility, and body composition.¹⁸ Sallis et al.,¹⁹ found that higher level of habitual PA was associated with five components of health-related fitness (the mile run, skin-fold tests, pull-ups, sit-ups, and the sit-and-reach test) in fourth-grade children. Because levels of CRF are closely associated with all-cause mortality and risk of chronic diseases such as cardiovascular disease and type 2 diabetes,² obesity intervention programs have primarily targeted CRF with aerobic activities while some also incorporated resistant training activities. However, majority of PA-focused programs have produced small effect due to inadequate intervention dose or poor program quality.²⁰⁻²²

We have successfully demonstrated that children's body composition is responsive to physical fitness oriented PA intervention that targets multiple attributes of physical fitness (i.e., more than CRF) and applies the physiological principles of physical training.²³⁻²⁵ Metabolically significant changes were observed in body fat percent, fat-free mass, and bone density in addition to measures of physical fitness. Participants in our studies were normal weight and overweight children ages 3 to 11 years enrolled in childcare centers and elementary schools. Important elements of our intervention programs included: offering daily opportunities for VPA, monitoring of activity intensity (target heart rate > 140 beats/minutes for VPA), using age-appropriate, fun activities for development of all attributes of physical fitness, providing lesson plans and additional equipment for reducing children's non-active (waiting) time, and training program staff on instruction and group management strategies. We have developed our intervention protocols based on feasibility demonstrated in experimental studies of similar age children.^{7,26} Currently we are conducting a randomized field trial to test the effects of a school-based intervention on body composition and physical fitness in 790 middle school students in three cities in China (ChiCTR-IOR-14005388). The PA intervention will target on CRF, muscle strength, agility, and flexibility during physical education class and an after-school exercise

program. Parents of the students in the intervention condition will receive training on promoting and supporting healthy lifestyle habits at home. The study will allow us to scrutinize the contributions of activity intensity and dose on all attributes and physical fitness as well as body composition in children.

There are legitimate concerns that VPA is not appropriate for children especially overweight and obese children and can increase the risk of injury.^{27,28} By following the physiological principles of physical training and child development, we and others have shown that children on wide spectrum of age and obesity can complete long-term programs of VPA (age-adjusted relative intensity: 70–80% of maximum heart rate).^{24,29,30} Risk for injury in intervention studies using VPA is no different from what is reported in children participating in recreational sport play.^{24,29,30} However, it is unrealistic to expect all children starting the program with all activities being vigorous. Carefully designed activities based on the progressive principle of physical training coupled with regular monitoring by trained staff can keep children safe, engaged, and motivated, and prevent drop-out during early stage of the program.³¹ Opting for a laissez-faire approach by not challenging children with sufficient amount of vigorous activities can only lead to a disappointing outcome that discourages future effort in child's pursue of healthy weight. Meanwhile, researchers must understand that children are not miniature adults in applying the training principles that were established for adult population.³²

Intervention approach with a “requisite induction of negative energy imbalance” has largely been ineffective in preventing childhood obesity.³³ Controversial to some, we have argued for a physical fitness oriented approach without dietary restriction to improve body composition in children that is characterized by vigorous physical activities targeting multiple attributes of physical fitness.^{28,34} Randomized intervention studies are needed to examine its efficacy and optimal dose in normal as well as overweight and obese children.^{35,36}

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Conflict of interest

The author declares no conflict of interest.

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