

Exercise Deficit Disorder in Youth: Play Now or Pay Later

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Abstract

Although the benefits of regular physical activity are widely acknowledged, recent epidemiological findings indicate that a growing number of youth are not as active as they should be. The impact of a sedentary lifestyle during childhood and adolescence on lifelong pathological processes and associated health care costs has created a need for immediate action to manage, if not prevent, unhealthy behaviors during this vulnerable period of life. The concept of identifying children with exercise deficit disorder early in life and prescribing effective exercise interventions to prevent the cascade of adverse health outcomes later in life is needed to raise public awareness, focus on primary prevention, and impact the collective behaviors of health care providers, government officials, school administrators, public health agencies, and insurance companies.

children at risk for physical inactivity and promote positive lifestyle choices.

Childhood is a sensitive period of life, which is characterized by dynamic changes in physiological and psychological development as well as the establishment of healthy or unhealthy behaviors. Physical activity, like cigarette smoking, is a learned behavior that is influenced by one's family, friends, and environment (32). Thus, children who are not exposed to an environment with opportunities to enhance motor skill proficiency (*e.g.*, catching, kicking, and hopping) tend to be less active during adolescence, which may manifest into sedentary lifestyle habits

Introduction

Global health recommendations state that children and adolescents should accumulate 60 min or more of moderate to vigorous physical activity (MVPA) each day (49,50). In addition to enhancing cardiorespiratory and musculoskeletal fitness, regular physical activity has the potential to enhance a child's emotional, social, and cognitive well-being (9,35). Yet recent epidemiological reports indicate that contemporary youth are not as active as they used to be, and this decline in physical activity seems to emerge by age 6 (36,47). Since physical fitness in youth is recognized as a powerful marker of health (35), evidenced-based interventions and public health policies are needed to identify

during adulthood (3,4,44). That is, children who do not develop the prerequisite motor skills early in life may not be able to break through a hypothetical "proficiency barrier" later in life that would allow them to participate in a variety of sports and activities with confidence and vigor (42). The eventual decline and disinterest in physical activity, which seems to be a contemporary corollary of low motor skill proficiency, starts even earlier in overweight children who may perceive physical activity to be boring or discomforting (6,26). Recent findings indicate that infants (3 to 18 months) with high subcutaneous fat were 2.3 times more likely to demonstrate delayed motor development compared with infants with less subcutaneous fat (43). These data indicate that increased body fat and motor development delay are linked even during infancy.

Children who do not participate regularly in a variety of physical activities early in life may not develop the motor skill repertoire and perceived confidence to meet or exceed national recommendations for physical activity (24,45). In support of these observations, accelerometry-measured MVPA at age 5 was a predictor of adjusted fat mass at ages 8 and 11 in boys and girls (22). In the aforementioned report (22), boys and girls in the highest quartile of MVPA at age 5 had a lower fat mass at ages 8 and 11 than 5-year-old children in the lowest MVPA quartile. These findings highlight the importance of encouraging regular MVPA in young children as one strategy to limit fat gains during preadolescence.

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The impact of a sedentary lifestyle during childhood and adolescence on lifelong pathological processes (e.g., diabetes and cardiovascular disease) and associated health care costs has created a need for immediate action to manage, if not prevent, unhealthy behaviors such as physical inactivity during this vulnerable period of life (23,39,46). As illustrated in Figure 1, children who do not develop fundamental motor skills and gain competence and confidence in their ability to perform various movements are less likely to engage in regular exercise and more likely to have disease risk factors and eventually experience negative health outcomes. Because many chronic diseases that become clinically manifest during the adult years are influenced by lifestyle habits established during the growing years, participation in meaningful physical activities early in life may prevent the development of risk factors and pathological processes later in life. This view is supported by the current prevalence of overweight and obesity in sedentary youth and the troubling diagnosis of type 2 “adult-onset” diabetes in adolescents who, for the most part, are obese (30,33,39).

Exercise Deficit Disorder

Exercise deficit disorder or EDD is a term used to describe a condition characterized by reduced levels of regular physical activity (<60 min of daily MVPA) that are below recommendations consistent with positive health outcomes (12,14). The use of this term conveys a fresh view of this conventional health care concern that can be used to raise public awareness about the importance of regular exercise for the developing body. Despite noteworthy efforts from professional organizations and public health agencies,



Figure 1: The cascade of adverse events that may result from a lack of fundamental movement skill (FMS) development during childhood.

contemporary youth are not as active as they should be, and we need to pay greater attention to lifestyle modification during childhood to prevent the progression of risk factors and pathological processes.

Although signs, symptoms, and test results are often used to identify diseases or disorders, the construct of EDD is unique because there are not any clinical markers or laboratory tests that can be used to diagnose this condition. Rather, a specific exercise history or “play history” can be used to aid in the identification and treatment of physically inactive individuals before they become resistant to lifestyle interventions. Recently, Sallis (41) suggested that health care providers should obtain an “exercise vital sign” on every adult patient they see. In the same light, pediatric health care providers should screen all youth with a “play history” to identify young patients who do not meet the current recommendations for 60 min or more of MVPA each day (i.e., 420 min·wk⁻¹). Youth with EDD should be treated with the same energy and resolve as a pediatric patient who has hypertension or dyslipidemia. Although most youth are resistant to shots and medications, the treatment for EDD is regular physical activity that is age-appropriate and enjoyable. Of note, there are no medications to treat deficiencies in movement skill or physical inactivity.

Since primary prevention is designed to prevent disease rather than treat it, the first step is to identify children who are not participating in 60 min or more of MVPA each day. While the optimal amount and type of exercise may vary with age, gender, and exercise history, participating daily in a variety of developmentally appropriate activities for at least 60 min is consistent with established guidelines (49,50). Identification of asymptomatic children who do not participate in the recommended amount of MVPA can facilitate the development of a management plan, which should include treatment as well as plans for long-term follow-up and family education about healthy lifestyle choices. Since most parents of inactive children wrongly consider their children to meet or exceed current physical activity recommendations (8), identifying youth with EDD and providing parents with specific recommendations for achieving physical activity goals can help to encourage positive behavior change that is supportive within the family structure.

While the term *physical activity* generally refers to any bodily movement produced by skeletal muscle that results in energy expenditure, the term *exercise* connotes a type of physical activity that is planned and regular. The use of the term exercise in EDD does not suggest that free play during childhood is inconsequential but rather emphasizes the premise that habitual physical activity should be “prescribed” by health care providers, pediatric fitness professionals, and physical education teachers. Viewed from this perspective, participation in outdoor play, recreational activities, fitness programs, physical education classes, and sports practice can all contribute to the physical and psychosocial development of a child provided these activities are consistent with the needs, abilities, and interests of the participants. As Rowland (38) has emphasized, regular exercise early in life is a “stratagem of preventive medicine” that will reduce adult disease risks later in life.

If current trends continue, the health-related consequences of physical inactivity and childhood obesity will likely pose

an unprecedented burden on youth, their families, and our health care system (21). Nowadays, computers and video games have decreased youngsters' desire to move, and in some communities, crime and perceptions of unsafe conditions understandably limit physical activity at parks and playgrounds. Some observers suggest that unless effective interventions are developed and opportunities are created for youth to participate regularly in physical activity, youth of today may, on average, live shorter lives than their parents do (34). The enormity of this issue requires a change in the current paradigm.

Health care providers who treat children (*e.g.*, physicians, nurses, physical therapists, certified athletic trainers, and pediatric exercise physiologists) should assess current exercise habits and, when appropriate, provide age-appropriate recommendations that are safe, convenient, worthwhile, and fun. Moreover, physical education teachers need to identify physically inactive youth and, with the support of the school district, provide meaningful opportunities for these children to participate in a variety of skill-enhancing games and physical activities in a supportive environment. A convincing body of evidence has found that school-based interventions and after-school programs are effective in improving physical activity levels and reducing the prevalence of childhood obesity (5,17). Parents also play a key role and should be cognizant of the long-term consequences of physical inactivity and should reduce television viewing, promote daily physical activity, and serve as active role models for their children.

Current evidence and clinical observations support the need to identify and treat youth who do not accumulate 60 min or more of MVPA each day. We presently underinvest in preventive care in the United States with less than 3% of our health care budget targeted for preventive services (20). Furthermore, despite the potential salutary effects of daily physical education, the mean physical education budget for schools in the United States is only \$764 per annum (31). By comparison, it is estimated that medical-related expenses for obesity will reach \$348 billion by 2018 (48). Health care concerns related to physical inactivity during childhood are emerging, and the identification of EDD in youth by qualified professionals will help to emphasize the message that a lack of regular exercise during childhood and adolescence is not consistent with long-term health and well-being. The general public is now aware of obesity-related health threats facing children, and there seems to be strong public support for interventions aimed at improving the health and well-being of children and adolescents (10).

Exercise Prescription for Youth

If exercise is medicine, specific details of the “therapy” (including safety concerns) need to be properly prescribed and monitored by qualified professionals who are knowledgeable of the physical and psychosocial uniqueness of younger populations. Clearly, if the pleiotropic benefits of regular exercise early in life are to be realized during adulthood, exercise programs for children must be developmentally appropriate, meaningful, and enjoyable. Children are not miniature adults, and as such, exercise programs and training paradigms designed for older populations are suboptimal for

children. Perhaps the most visible difference between children and adults is that children tend to be “metabolic non-specialists” regarding exercise performance (2). Unlike adults who tend to specialize in sports such as weightlifting or long-distance running, the strongest child in physical education class is likely to be a leader in an endurance run as well.

New insights into the design of youth exercise programs may prove to be valuable for pediatric health care providers and other professionals who develop and prescribe exercise programs for younger populations. While supervised and well-designed strength and conditioning programs have proven to be safe and effective for children (16), integrative neuromuscular training (INT), which includes general and specific exercises that are designed to enhance both health-related (*e.g.*, muscular strength and cardiorespiratory endurance) and skill-related (*e.g.*, agility, balance and coordination) components of physical fitness, is a novel approach for school-age youth (11,28). INT provides an opportunity for children to master fundamental movement skills (*e.g.*, locomotor, object-control, and stability skills), increase muscle strength, improve movement mechanics, and gain confidence in their physical abilities. Fundamental movement skill proficiency during the growing years has a strong influence on developing and maintaining adequate physical fitness (3,25,44). Consequently, a child's motor skill competence and perceived confidence, which can be enhanced with INT, can *drive* participation in MVPA (including fitness and sport activities), which, in turn, may increase the likelihood that this positive lifestyle choice will be carried over into adulthood (Fig. 2).

INT programs that target the development of motor skills and muscle strength in a socially supportive environment



Figure 2: Potential influence of INT on MVPA, fitness and sports participation, and lifetime wellness.

can be an effective approach for improving the physical fitness of school-age youth. Children are at an optimal age in terms of motor skill learning when they are in primary school (27,29), and unlike adolescents, they have not yet developed bad habits and are not as self-conscious about making a mistake in front of their peers. Because neuromotor performance (*e.g.*, muscle strength, speed of movement, and coordination) of children has significantly declined over the past two decades (7,40), the integration of INT into physical education, sports practice, and after-school recreation programs may be an important “first step” in enhancing basic fundamental movement skills and in promoting physical fitness in younger populations. In our view, getting a sedentary 8-year-old boy away from a high-tech computer game and actively involved in a low-tech INT program with his friends is a success.

INT may be even more beneficial for children with a decreased genetic potential for motor development because cognitive and motor capabilities are highly “plastic” and amenable early in life (18,19,37). There may be an optimal window of opportunity during preadolescence in which physically inactive youth can be targeted with INT when their neuromuscular system is most responsive to this type of training (29). Considering the potential for motor skill learning, INT that is designed to enhance the development of fundamental movement skills during this critical period may provide the most lasting benefits during childhood and adolescence (24,27).

Although there is not one program of INT that provides the safest or most effective means for enhancing motor skills and muscle strength in all youth, body weight exercises may be particularly beneficial for the development of health- and skill-related fitness measures. Medicine balls, dumbbells, and elastic bands also may provide a unique and challenging stimulus for school-age youth provided the program is age-appropriate and supervised by qualified teachers and fitness professionals (15). By integrating different training modalities and gradually progressing the program, training adaptations will be optimized and the likelihood of plateaus in performance will be reduced (29). In the long term, INT programs that are sensibly progressed will allow participants to make even greater gains because they will be challenged to adapt to even greater demands over time (13,28).

When working with children who are physically inactive, it is important to remember that the goal of the program should not be limited to increasing time spent in MVPA. Developing fundamental movement skills, enhancing physical literacy, building self-confidence, and providing a challenging program that gives participants a more positive attitude toward exercise are equally important. This is where the art and science of developing a youth program come into play because the principles of progressive overload and training specificity need to be balanced with individual needs, goals, and abilities to optimize gains, prevent boredom, and promote exercise adherence.

The available data indicate that supervision, instruction, and program design should be provided by qualified youth fitness professionals who understand pediatric training guidelines and who are knowledgeable of the physical and psychosocial uniqueness of children and adolescents (13,28). These professionals should have practical experience working with

youth and a philosophy about physical activity and fitness training that is consistent with the needs, goals, and abilities of younger populations. Ideally, pediatric fitness professionals should be linked to the health care industry and available to offer community-based interventions that are safe, enjoyable, and effective. A nationally recognized certification in pediatric fitness may be needed to ensure safe participation in youth programs while enhancing training outcomes for children and adolescents.

Conclusions

In adult populations, only a modest fraction of the total cardiovascular risk burden is now being eliminated, and nonadherence to therapeutic interventions is considered a risk factor in and of itself (23). Clearly, a population-wide approach for prevention is required, and novel strategies for identifying inactive children, prescribing effective exercise programs, and raising public awareness are desperately needed. The importance of promoting regular physical activity as part of a healthy lifestyle is so compelling that the American College of Sports Medicine recently launched the Exercise is Medicine® program to promote physical activity for all people (1). This public health initiative calls on health care providers to assess and review every patient’s physical activity habits and for fitness professionals to educate clients about the medicinal benefits of exercise.

Without such public health initiatives and interventions that focus on disease prevention and health promotion early in life, youth may not develop the competence and confidence to be physically active later in life and new health care concerns will continue to emerge. The concept of identifying asymptomatic children who are deficient in exercise could effectively impact the collective behaviors of health care providers, government officials, school administrators, public health agencies, and insurance companies to question the current symptom-reactive paradigm in an attempt to obviate the need for extensive and expensive medical procedures later in life. Comprehensive, innovative, and aggressive strategies are desperately needed to identify youth with EDD and promote regular participation in age-appropriate physical activities.

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