Exercise-Deficit Disorder in Children: Are We Ready to Make This Diagnosis?

DOI: 10.3810/psm.2013.02.2003

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Abstract: Primary care physicians, particularly pediatricians, are expected to promote physical activity and prescribe exercise to patients. Unfortunately, many health care professionals do not have adequate skills or experience in this area, making exercise intervention logistically and psychologically challenging. Exercise-deficit disorder (EDD), which is a new term to the literature, is defined as reduced levels of moderate-to-vigorous physical activity, inconsistent with public health recommendations. Physicians are in a unique position to identify children who are deficient in exercise and initiate prevention strategies. To aid physicians in the diagnosis and treatment of children with EDD, we propose integrating exercise assessment into primary care practice, and, when appropriate, referral to a pediatric exercise specialist. This approach should ensure adequate development of muscle strength and motor skills that are required for successful physical activity participation. The timely identification of children with EDD is essential in preventing resistance to intervention. Connecting pediatric health care professionals with pediatric exercise specialists, culminating in an established professional collaborative system, is critical for promoting healthy behaviors throughout childhood and adolescence.

Keywords: exercise; exercise-deficit disorder; preventive medicine

Introduction

Preventive medicine in pediatrics suggests that positive health-related habits initiated early in life provide the basis for lifelong well-being.[1] Pediatric health care professionals are aware of the adverse effects of physical inactivity on health and the substantial resultant costs to society. Recent reports indicate that 80.3% of 13- to 15-year-old adolescents do not meet the recommended 60 minutes of moderate-to-vigorous physical activity daily.[2] Physicians (particularly pediatricians) are challenged in their attempts to promote exercise in children. Sedentary lifestyle and poor nutrition challenge children who are genetically predisposed to metabolic disease.[3] Currently, there is no comprehensive strategy for encouraging children to eat a healthy diet and engage in regular exercise.[4] Athough physicians are expected to intervene, most physicians lack formal training in exercise science and prescribing exercise for patients, who have different needs, goals, and abilities.[5] Children who are motorically deconditioned and exercise deficient are at risk for developing adverse health outcomes in adolescence and adulthood. This article addresses the role of the physician in the diagnosis and management of school-aged children with exercise-deficit disorder (EDD).

Exercise-deficit disorder is defined as reduced levels of moderate-to-vigorous physical activity that are inconsistent with long-term health and well-being.[6] This definition means that children who are deemed healthy according to current health

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care standards may actually require further evaluation and treatment. The diagnosis and treatment of EDD includes the following:

1. Early identification of physically inactive children by primary care physicians
2. Exercise prescription followed by intervention via consultation and treatment by a specialist trained in pediatric exercise science and youth fitness
3. Evidence-based training protocols that target motor skill deficiency and muscle weakness

These training protocols should also aim to build children and adolescents' confidence and enjoyment in engaging in physical activities

In order to gain a full understanding of EDD, it is critical that physicians recognize how all inactive children (regardless of body weight, shape, or physical ability) are at risk for disease. No child should be considered immune from developing or becoming vulnerable to diseases related to a sedentary lifestyle. Early intervention is essential because the window of opportunity is narrow and begins to close coincident with the decline in physical activity that can occur in childhood.[7] The adoption of an integrative team approach, drawing on the skills of primary care physicians and pediatric exercise specialists, is also important. Collectively, this group will have greater outreach to children with EDD. The importance of identifying and treating deficiencies in muscle strength and motor skills in childhood is essential, as lifestyle patterns established in childhood form the foundation for physical activity habits later in life.[8]

Once the child with EDD is identified, targeted exercise prescription aimed at building motor skills, physical competence, and perceived confidence can be delivered by pediatric exercise specialists or other qualified professionals. This collaborative process incorporates and expands on the skills of medical and exercise science professionals.

Understanding the Physical Needs of Children With EDD

An accurate assessment of physical activity in children by health care practitioners is central to evaluating its influence on health outcomes. The American Academy of Pediatrics currently endorses evidenced-based activity for both cardiovascular health and obesity prevention. Cardiovascular health promotion for 5- to 10-year-olds recommends the grade A (ie, strongly recommend) category, which involves moderate-to-vigorous physical activity for 1 hour per day and vigorous-intensity physical activity 3 days per week.[9] Examples of moderate-to-vigorous physical activity include jogging and baseball, while vigorous activity includes running, singles tennis, and soccer.[9] However, children who are deficient in muscle strength and motor skill competence require a more individualized and specialized approach in order to develop the muscular fitness and fundamental movement skills (eg, jumping, throwing, running, and balancing) required for successful participation in recreational physical activities and sports.[10–13] Although jogging exemplifies moderate exercise, most physically inactive children are unable, and often unwilling, to participate in continuous aerobic exercise for a prolonged period.

Baranowski et al[14] describe health behavioral-change models in guiding prevention efforts. The Health Belief Model (HBM) incorporates perceived susceptibility, severity, benefits, barriers, as well as self-efficacy. The primary motivation to change within HBM is the level of perceived threat or risk of a specific condition (eg, readiness to act). The primary resource for change within HBM is self-efficacy or confidence. Individuals with greater confidence are more likely to engage in a specific behavior, persist until they get it right, and maintain the behavior.[14] A child who is sedentary and lacks motor skill competence and confidence is often unsuccessful in his or her attempt to move "from the couch to the playing field." A successful transition requires skilled training by professionals who can deliver evidenced-based interventions that are safe, effective, and enjoyable.[15,16]

The Physician's Role in EDD

Primary care health providers, pediatricians, and family practitioners should be valued in their efforts to promote fitness and enhance health by way of regular exercise. Although medical practitioners often perform health screenings related to vision, hearing, and body mass index, patient interactions are typically void of any meaningful assessment of physical activity. The well-child visit, which was created to assess a patient's health, screen for disease, and provide anticipatory guidance, is an example of a missed opportunity for practitioners to evaluate a child's daily exercise habits. Physicians need to be equipped with a screening mechanism that is efficient, sensitive, and logistically feasible in a busy clinical environment. Rapid delivery and response is a priority if patient and practitioner compliance is expected. Screening for a disorder (eg, developmental delay, autism, or EDD) encourages early detection by health care practitioners and promotes intervention, often via referral to specialists. If a child with EDD is identified, the pediatric

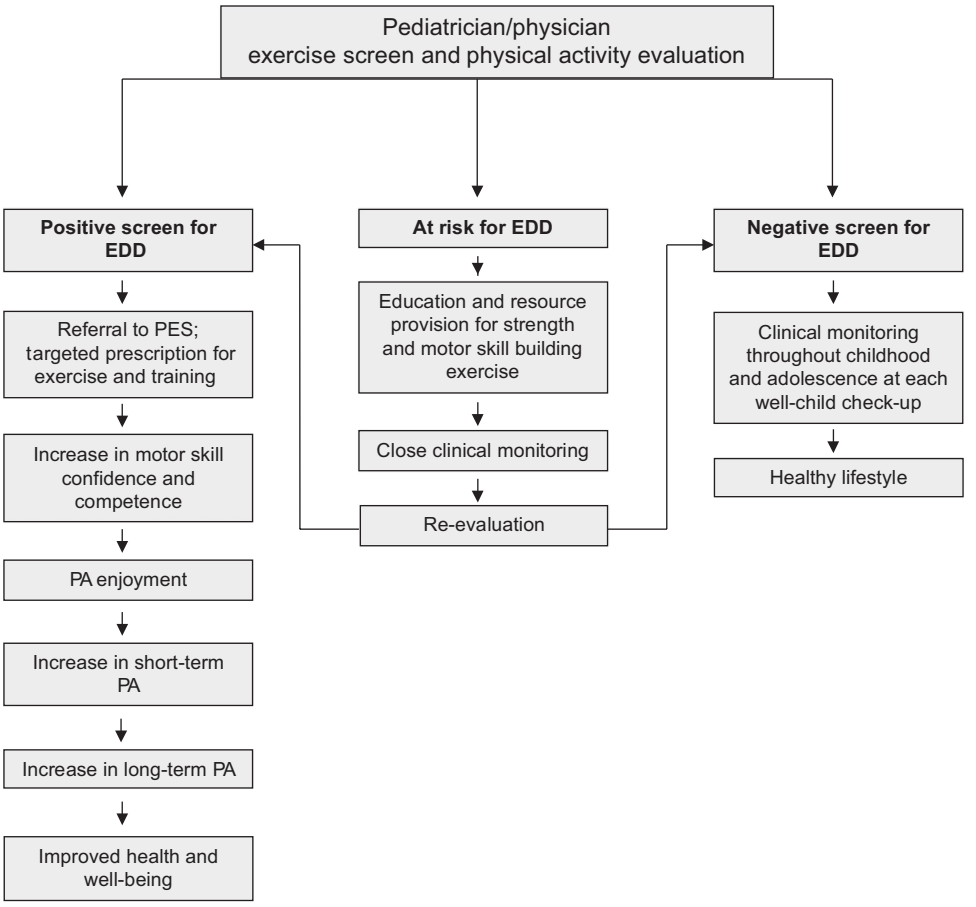
exercise specialist can provide an age-appropriate treatment plan that is progressive, effective, and fun.[17] School-based programs for exercise interventions have been shown to improve health- and skill-related fitness[15] and to increase physical activity.[18] Schools offer an easily accessible system that is already in place for instituting exercise programs.[19] Large-scale, school-based exercise-intervention programs can be safe, effective, temporally and financially sensitive, developmentally appropriate, skill building, evidence based, and fun. Figure 1 provides a theoretical treatment algorithm for physicians treating children with EDD.

It appears that the medical community underrates the potential role of exercise promotion through primary care. Hernandez et al[20] investigated parental perceptions of healthy body weight in children. Parents were asked to classify their child's body weight via images of children in 3 different weight class categories. They found that $>$ 70% of parents misclassified their child's body weight. Importantly, the absence of a pediatrician's comment on children's body weight strongly predicted misclassification; pediatricians were regarded as highly valued weight counselors.[20] The pediatric primary care team is well positioned to provide effective interventions to promote healthful behaviors among families of young children.[21] Well-child visits occur at least annually from ages 2 to 6 years, and additional problem-oriented visits provide other opportunities for the physician to develop a relationship with the child and family.

Pediatricians have a vital role in promoting daily physical activity in children. Approximately 80% of children and families have contact with their primary care physician/pediatrician, and subsequent behaviors are significantly influenced by their guidance.[20–22] Lastly, despite physician knowledge and acceptance of the energy equation, there is a notable discrepancy between adolescents receiving dietary advice and exercise counseling.[23]

The following vignettes are designed to help physicians identify young patients with EDD and to develop strategies to increase or continue participation in a variety of

Figure 1. Physician detection-and-intervention algorithm for EDD in children.



Abbreviations: EDD, exercise-deficit disorder; PA, physical activity; PES, pediatric exercise specialist.

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age-appropriate physical activities. Talking to school-aged children about play and sports, educating parents about the exercise–health link, and consulting with pediatric exercise specialists will allow physicians to practice skills and initiate management plans that enhance their young patients' health and well-being. These conversations and clinical treatment plans can serve as a critical prevention tool, with the goal of promoting daily physical activity, establishing healthy lifestyle choices, and reducing the likelihood of adverse health consequences later in life.

Case Reports

Case 1

Jayson is a healthy 6-year-old boy who participates in physical education once per week at school. His growth is deemed normal in terms of his height, body weight, and body mass index. Developmentally, he is on target, in that he walked by age 14 months. However, his parents reported that he never crawled. He has been noted to have low muscle tone on earlier routine health assessments, but there was no intervention undertaken and he is not on an individualized education program. During recess, he avoids climbing play structures and prefers more ground-based activities. He does not readily join other children during recess for organized sports. He likes to play video games in his free time and watches $>$ 3 hours of television on most school days. He takes the bus to school and enjoys hanging out with his friends. His parents do not participate regularly in any planned physical activities or recreational sports. He sleeps soundly most nights, but struggles to fall asleep often, and needs significant encouragement to go to bed in a timely fashion.

Management Plan

Jayson exemplifies a child who is inactive and likely lacks muscle strength, motor skill, and perceived confidence in physical activity. Jayson is at significant risk for a physically inactive lifestyle and associated adverse health consequences. Encouraging Jayson to simply run more or play organized sports by the primary care physician is a set up for failure. Lacking in motor skill, muscle strength, and perceived confidence, Jayson may not enjoy or succeed in prolonged periods of aerobic-based physical activities or competitive sports that require skill, coordination, balance, and neuromuscular control. Intervention by the primary care physician should be required. Referral to a pediatric exercise specialist for comprehensive evaluation and treatment is critical. This professional should be qualified to teach age-appropriate skills and activities that are designed to enhance muscle strength and motor skill development in a fun and challenging environment. This type of professional may be found at a recreation center, fitness center, after-school program, or outpatient hospital-based center. In addition, Jayson's parents should provide opportunities for playground activity after school and more physical activities at home. Creating more opportunities for Jayson to engage in free play provides an alternative to sedentary behaviors, while encouraging enjoyable physical activity with peers and promoting the development of physical abilities. Increasing daily physical activity will also promote better sleep habits and encourage enjoyable and less stressful social interactions with peers. Jayson requires follow-up every 6 to 8 weeks in the office, with phone follow-up approximately every 3 weeks by a health care provider to ensure compliance with his daily physical activity prescription. A critical component for achieving the desired physical activity goals is to provide both parents and siblings with activity options that will contribute to the overall success of Jayson's intervention and promote healthy lifestyle choices.

Case 2

Beth is a healthy 9-year-old girl who participates in physical education twice per week. She likes to listen to music and dance with her friends. At the encouragement of her parents, Beth joined an after-school dance class at the local recreation center. The class was held for two 60-minute sessions each week. Beth watches 2 hours of television on most days of the school week, although this amount increases to 3 hours per day on the weekends. She is an excellent student and enjoys reading and practicing her new writing skills. Her parents do not participate in fitness activities or sports, but her mother walks her to and from school (15 minutes each way) every school day. She has no history of developmental delays and enjoys recess, but when given the choice, prefers socializing with her friends compared with active recreation.

Management Plan

Beth may not meet the criteria for the diagnosis of EDD, but demonstrates at-risk behavior that requires immediate attention in order to support and encourage regular participation in physical activity. Ideally, the intervention should include activities to improve her motor skills and muscle strength related to her interest in dance, as well as close monitoring and more frequent follow-up regarding her physical activity habits. An increasing number of recreation centers, community centers, and schools offer youth fitness classes that enhance health- and skill-related components of physical fitness. These classes include games and other

fitness activities, which make them reasonable options for Beth. Parents should also be notified of the exercise–health link and be advised to plan fun family activities that are active, challenging, and worthwhile. Encouraging outdoor play with her family and friends will also promote physical and social skills. In addition, encouraging Beth to spend more time outside playing games, such as hopscotch or double-dutch, at the local playground accomplishes 2 goals. First, it places her in a setting separate from the television and computer. Second, it promotes muscle strength and motor skill–strengthening activities. It also incorporates dance and rhythm in a social environment, which are all activities that Beth enjoys. Incorporating friends in physical activities is critical for preadolescents because social interactions and relationship development with friends often take priority during this period. Beth requires support from her parents and close monitoring from her health care providers with regard to her physical activity level because she is at substantial risk for future inactivity and associated adverse health consequences. Follow-up for re-evaluation is recommended in 3 months, with suggested phone calls or brief clinical follow-up for continued close surveillance at 6 to 8 weeks and thereafter as needed.

Case 3

Steve is a healthy 13-year-old boy who plays school football and baseball and participates in physical education 5 times per week during the school year. He participates in a 1-hour off-season strength and conditioning program at the local school during the winter and summer months and enjoys playing recreational basketball with his friends. Steve has a history of Osgood–Schlatter disease, which was successfully treated with a relative rest program and physical therapy and was augmented by his strength and conditioning program. Steve sleeps 7 to 8 hours per night and enjoys skateboarding in his free time. He often rides his bike to school. He watches $<$ 1 hour of television per day, and on the weekends, he participates in sports and recreational activities with his family.

Management Plan

Steve currently participates in a variety of sports and recreational activities that will enhance his physical fitness, while improving his motor skill development and athletic prowess. This places him at an advantage with regard to minimizing the risk of burnout and overuse injury. To further improve his healthy lifestyle, Steve should be encouraged to continue participating in a well-designed off-season strength and conditioning program that is directed by qualified physical education teachers and/or fitness professionals. These programs should address neuromuscular deficiencies, enhance strength and power, and allow time for active rest and recovery between competitive sports seasons. Programs of this type are especially important for young athletes during growth periods. The physician's physical activity assessment of Steve includes continued support and encouragement for strength and conditioning activities that may reduce his risk of injury, enhance performance, and encourage participation in physical activity as an ongoing lifestyle choice. In addition, it is important to support his choice to participate in a variety of sports and recreational physical activities, while recognizing the importance of adequate sleep and proper nutrition, both of which influence general health and well-being. Annual monitoring of Steve's physical activity and performance is suggested to ensure age-appropriate fitness programming and sports participation, including periods of less intense training and planned rest and recovery.

Physician Screening for Children With EDD

More prospective research is needed for health care professionals to effectively identify exercise-promotion strategies in children. Exercise interventions by physicians are not easy considering the range of patient ages, levels of motivation, extent of parental support, individual interests, physical capabilities, socioeconomic levels, and availability of recreational facilities with qualified youth fitness professionals.[24] Pediatricians are proficient at the early recognition of deficient states in children, especially when using a screening mechanism that is efficient and sensitive. Thus, the development of a clinical tool is required. This tool should encourage physicians to quickly and accurately identify EDD in children. The tool should also be designed to make the process of identification logistically possible and palatable to physicians. It should also be followed with the allocation of resources and reimbursement for trained evidence-based interventions.

Current public health guidelines state that children and adolescents should participate in $\geq$ 60 minutes of moderate-to-vigorous physical activity daily.[25] Physicians have found the designation of clinical cut-offs to be useful in daily practice, as they aid in the standardization of care. Thus, it is suggested that the normal value be set at 60 minutes daily of moderate-to-vigorous physical activity (ie, $\geq$ 420 minutes/week). The early identification of a child's deviation from normal will preclude the physician from deeming the child as healthy at the well-child visit. Effective identification of

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children who are at high risk for EDD should prompt health care professionals to intervene with a management strategy that is targeted specifically for children with EDD.[26] A child with EDD may be identified as slow and clumsy by his or her critical peers. In order to help the child avoid socially stressful situations that may culminate in a negative health cascade, physicians should be prepared to identify and treat these children.

The early identification approach requires a dual process: routine surveillance and screening specifically for the disorder to be performed on all children to first identify those at risk, followed by more targeted interventions. When and how often should exercise surveillance/screening be performed? The American Academy of Pediatrics stresses the importance of a flexible, continual, developmental-surveillance process at each well-child visit, and recommends eliciting and valuing parental concerns, probing regarding age-appropriate skills in each developmental domain, and observing each child.[27] Developmentally and logistically, age 5 years works well. Five-year-old children are easy to engage, eager to learn, and often readily follow instructions. Moreover, physicians are inundated with screening requirements for other common pediatric disorders during the infant and toddler years.

Infants aged 3 to 18 months with high subcutaneous fat were 2.3 times more likely to demonstrate delayed motor development when compared with infants with less subcutaneous fat.[28] Body mass index should be calculated from the earliest pediatrician visits. Questions surrounding infant motor developmental milestone achievement may be key to the identification of a child who possesses core weakness, poor balance, and coordination,[29] as well as low muscle tone and strength, which are all factors that potentially correlate with decreased physical activity in childhood.[30] The decreased dynamic stability of overweight and obese children, as compared with children who are not obese, is postulated as being caused by excess weight without underlying postural instability.[31] However, it is unclear whether the increased body weight in obesity leads to decreased stability, or if the greater adiposity of obesity is the consequence of proprioceptive inadequacy (postural instability) and reduced activity.[32] Indirect assessment of these critical motor proficiencies (eg, balance, stability, coordination) may be achieved by identifying children who avoid climbing play structures, prefer more sedentary types of play, and have an aversion to physical education class and organized sports. Questioning family members about outdoor playtime has been shown to be a measure of physical activity in preschool children and is thus worthy of inquiry.[33] Asking about the frequency of physical education class and whether the child prefers playing sports may reveal important indicators of exercise enjoyment, tolerance, and amount.

Exercise prescription for the inactive child should be a family project. It is important for the physician to possess an understanding of the activity habits of all household members. A child's fitness potential is difficult to predict. Asking about the parents' previous participation in school athletics may be helpful in the pursuit of an EDD diagnosis. This provides clues to the child's family-based capabilities for exercise performance, as well as to the support she or he is likely to receive for improving exercise habits.[1] Investigating parental physical activity attitudes and habits may be predictive of long-term future physical activity in children.[34] It may be useful to ask about the family's perceived level of concern with regard to physical inactivity as well because in isolation, this could be a significant barrier to prevention and treatment.

The question concerning sleep quality and quantity and its relationship to exercise in children is worthy of pursuit. Identifying a child's sleep habits may be helpful in identifying a child with EDD, as most parents and practitioners agree that an effective way to promote an early and efficient bedtime, as well as improve sleep quality, is a full day of physical activity. Evidence has shown that short sleep duration is a risk factor for weight gain and obesity. Interestingly, the obesity epidemic has been accompanied with a parallel increase in chronic sleep deprivation.[35] Although sleep deprivation may influence weight through multiple effects, including appetite and thermoregulation, it seems reasonable to connect sleep deprivation, fatigue, and physical activity diminution. Research is lacking regarding the relationship between sleep deprivation and physical activity. Gupta et al[36] reported a strong association between short sleep duration and obesity, with the odds of obesity increasing 5-fold for every 1-hour reduction in sleep. Future research efforts will be devoted to the creation of a simple but sensitive diagnostic tool that is logistically feasible to health care professionals in their daily practice.

Physician Barriers to Exercise Prescription

Health care professionals may encounter barriers to physical activity intervention, such as financial restraints, space limitations, and lack of priority.[37] Patient-centered barriers include the inability of caregivers to miss work (56%), transportation difficulties (59%), children having to miss school (55%), parent and/or the child perceiving no benefit from visits

(36%), and the cost of clinic visits (23%).[38] Reasons for failure on the medical front include skepticism regarding effectiveness of advice in changing lifestyle behaviors, lack of existing evidence-based methods for successful physical activity prescription, lack of formal training for primary care providers with regard to physical activity counseling and the question of the impact of counseling in isolation, and lack of reimbursement and office time for counseling patients on exercise/daily physical activity.[39] Therefore, an effective exercise prescription requires physicians to possess a model that is timely, sensitive, and cost-effective. The patients require a mechanism whereby they can be trained by an expert with minimal financial burden that promotes confidence and has readily observable gains. As medical professionals, we are aware that our patients desire quick fixes. Financial, physical, and psychological life constraints make the lack of a pill a significant barrier, particularly in a society that encourages immediate gratification.

The lack of acknowledgment or awareness of the current state of physical inactivity in children calls for immediate atention because of demographic challenges. Neither the patient nor the family is likely to identify the existence of the potential problem or the seriousness of its ramifications. Recent research has shown that parents of overweight children are less likely to enroll their children in prevention trials because they fail to acknowledge that their children have a weight problem.[40] The early identification of a child who has EDD is required. It is a disorder that we believe can be treated successfully by trained fitness professionals before physical inactivity becomes the norm. The ultimate goal is to promote enjoyment and success in physical activity throughout all of the stages of life.

Conclusion

Connecting the medical community with the fitness community, beginning with medical education and ending in professional collaboration and consultation, should be a future goal and health care priority. Because many physicians are well positioned to detect EDD in children, a critical link can be joined between the health care practitioner and the pediatric exercise specialist. Diagnosing and treating EDD accomplishes several goals. It enables the physician to identify the physically inactive child, directs prevention efforts of disease to the forefront (as opposed to the treatment of potential disease), improves children's health by promoting successful and enjoyable physical activity participation, and encourages lifelong physical fitness throughout the child's life. There are significant medical, social, and economic challenges in this endeavor. However, without this collaborative effort, the struggle will continue in promoting sustained physical activity as an ongoing lifestyle choice.

Conflict of Interest Statement

Andrea Stracciolini, MD, Gregory D. Myer, PhD, and Avery D. Faigenbaum, EdD, disclose no conflicts of interest.

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