ACSMceOnline℠
CECQUIZ onlinelearning-acsm.org
2 CECs

Physical Inactivity in Youth

Can Exercise Deficit Disorder Alter the Way We View Preventative Care?

by Gregory Walker, M.D., FAAP; Andrea Stracciolini, M.D. FAAP, FACSM; Avery D. Faigenbaum, Ed.D., FACSM; and Gregory D. Myer, Ph.D., FACSM, CSCS*D

Physical inactivity has been identified by the World Health Organization (WHO) as the fourth leading risk factor for global mortality. Increased physical activity in youth may improve cardiovascular and metabolic disease risk profiles; augment bone mineral density; reduce symptoms of depression; enhance a child's emotional, social and cognitive well-being; and increase fundamental movement skills. We have a disease-centric model of health care in the United States, where resources are allocated toward treatment of disease rather than prevention and a disease-free state. The monetary costs of such care are exorbitant when compared with the costs for preventative care. We propose the diagnosis of exercise deficit disorder (EDD) be used for youth who do not accumulate the required minimum of 60 minutes of daily moderate-to-vigorous physical activity (MVPA) consistent with positive health outcomes. With such a diagnosis, we can focus on early detection and implement cost-effective and more efficacious treatment before the onset of morbid conditions that are far more difficult to treat. In a recent publication, Lee et al. wrote that if 75% of U.S. children ages 8 to 11 years would perform high–calorie-burning exercise three times a week, $16.6 billion in direct medical costs and $23.6 billion in lost productivity could be avoided (1). This *Medical Report* discusses the importance of primary, secondary, and tertiary prevention as they pertain to pediatric physical inactivity, and as a means to improve quality of life, decrease disease and illness, and save financial resources.

INTRODUCTION

Half of the mortality in the United States is associated with preventable illness (2). Based on data from the U.S. Centers for Disease Control and Prevention's 1999 and 2000 National Health and Nutrition Examination Surveys, it was estimated that more than 400,000 deaths were secondary to poor diet and physical inactivity. Physical inactivity has been identified by the World Health Organization as the fourth leading risk factor for global mortality (3). Physical inactivity increases risk for many morbid conditions including, but not limited to, cancer, diabetes, hypertension, coronary disease, cerebrovascular disease, and overweight and obesity (4). A recent quantitative systematic review estimated that between 5% and 10% of U.S. health care spending was directly associated with treating the potentially preventable adverse health outcomes of overweight and obesity (5). It then follows that if we use the 2012 estimates of U.S. health care spending currently tallied at $2.8 trillion U.S. dollars, approximately $140 and $280 billion dollars would be accounted for with this calculation (6). Increased physical activity in youth may improve cardiovascular and metabolic disease risk profiles; augment bone mineral density; reduce symptoms of depression; enhance a child's emotional, social, and cognitive well-being; and increase fundamental movement skills (7–10). Furthermore, recent literature illustrates enhanced executive brain function, which is specifically important for reading and mathematics, concomitant with an increase in physical activity (11).

Exercise deficit disorder (EDD) is a condition observed in youth who do not accumulate the required minimum of 60 minutes of daily moderate-to-vigorous physical activity (MVPA) consistent with positive health outcomes (12). Based on recent reports of physical activity patterns in youth, EDD is rampant in the United States and is emerging as a global pandemic (13). The current trends in physical activity show that less than 25% of youth engage in 60 minutes of MVPA (14). In addition, we are seeing a decline in muscular fitness and motor skill performance in youth (15). Despite the rise in EDD, youth with EDD may not be readily recognized because they often do not possess associated adverse health conditions such as obesity and diabetes. However, our medical system is focused on treating consequential health manifestations of physical inactivity which is costly, inefficient, and ineffective (16,17). The American Academy of Pediatrics (AAP) Bright Futures primary care initiative recognized physical activity in youth, but it is not yet on the Bright Futures scorecard. Emphasis should be placed on the early identification of exercise-deficient states to promote early intervention and disease prevention.

This *Medical Report* column discusses the importance of primary, secondary, and tertiary prevention as they pertain to pediatric physical inactivity, as a means to improve quality of life, decrease disease and illness, and save financial resources. With

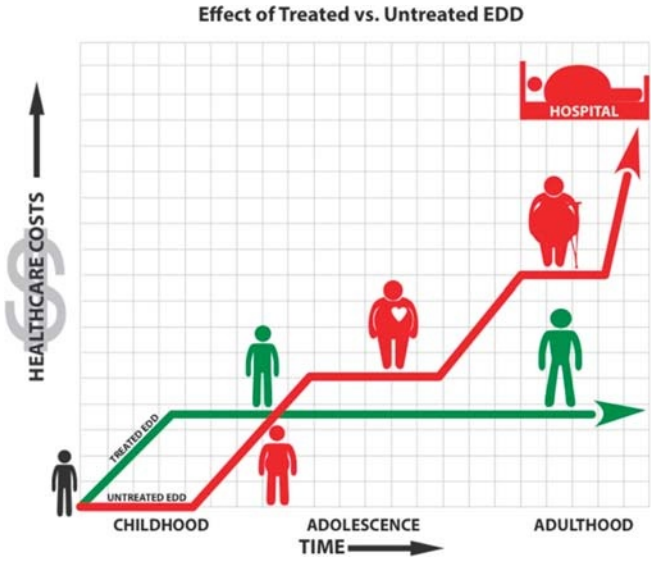
the current evidence highlighting the necessity for enhancing health- and skill-related fitness early in life to prevent further disease patterns later in life (18), the question still remains as to what barriers exist regarding early diagnosis and treatment of youth with EDD.

Tertiary Prevention: The Current Health Care Model for Treating Physical Inactivity

Tertiary prevention is defined as treatment of health complications arising from already existing disease (19). The current model of health care resource allocation in the United States places a large emphasis on tertiary care. This disease-centric model focuses on the treatment of disease rather than the prevention of disease. Throughout the twentieth century, the U.S. health care system shifted from disease prevention to disease treatment. This change is largely due to the emphasis on health care reimbursement for specialist and hospital-based care, as compared with primary or preventative medicine (20). As it stands, the system monetarily rewards specialists and hospital-based care while failing to support primary and secondary care. Tertiary care has proven to be costly, with $882.3 billion dollars spent on hospital care alone in 2012 (6).

Overweight and obesity have been shown to increase the probability for certain diseases and are responsible for 5% of global mortality (3). In addition, health care costs associated with treating obesity and overweight are substantial (5, 21). The costs continue to increase as one attains the adverse manifestations of physical inactivity (Figure). The scientific evidence illustrates that, for all adults in the United States, as one's body mass index (BMI) increases beyond the optimal 23.5 to 24.5 kg/m^2, there is

Figure. Proposed health care costs of treated EDD versus untreated EDD. RED, untreated EDD; GREEN, treated EDD. The individual at the left of the graph is someone with EDD before the onset of other morbid conditions associated with physical inactivity. As that child progresses into adulthood, we propose that if an investment in secondary prevention is not made (red line), catastrophic costs of tertiary prevention will eventually ensue. If that child receives secondary prevention (green line), an initial investment is made that pays significant dividends over the life of that individual.



an exponential increase in relative risk of death from all causes (22). In addition, it has been shown that the risk for adult coronary heart disease rises as adolescent BMI rises (23).

Secondary Prevention: A Model for Diagnosis and Early Treatment of EDD

Secondary prevention refers to treatment of disease before the onset of adverse manifestations of the disease (19). To engage in secondary prevention of disease, one must first identify disease. It has been proposed that primary care practitioners, specifically pediatricians, identify individuals with EDD (24). Primary care practitioners are uniquely suited to assess youth for EDD at annual well-child visits. However, well-child visit compliance starts to fall in school-aged youth, a critical age to initiate treatment (25). A recent Colorado report illustrated a dramatic decline in pediatric well-child visits beginning at age 3 to 5 years, which only worsened by ages 6 to 9 years (26). Remarkably, it has been shown that physical activity trajectories show a decline starting at age 7, which reinforces the need for interventions to start early in life (27).

PRACTICAL APPLICATION

Contrary to many of the numerous morbid conditions associated with EDD, there is no pharmacologic treatment for EDD. Treatment requires both an exercise prescription and intervention from a youth fitness specialist who has the prerequisite knowledge in developmental physiology, pediatric sports medicine, and child psychology and who understands how to teach and progress age-related skill- and strength-building exercises (24). The skill/strength-enhancing activities are the cornerstone of successful programs targeting inactive youth (28,29). Instead of activities focused on prolonged periods of monotonous aerobic training, youth programming should be designed to engage the child physically and mentally. Participants should receive regular feedback in game play environments, which can positively influence skill development, fitness performance, and motivation (12,30–34). The exercise prescription must be feasible, timely, and specific to the patient's abilities. Barriers to proper prescriptions include lack of knowledge of the following: avenues for physical activity, parental knowledge of the importance of daily physical activity, lack of fundamental movement skill (FMS) development, poor physical competence, and low perceived physical competence. Thus, it is vital to use the skills of a pediatric exercise specialist, who can further identify and treat deficits in FMS, optimize muscular fitness, and enhance motivation (28). One such program, integrative neuromuscular training (INT), uses an interventional approach that focuses on whole-body movements and strength-building exercises affording youth not only the ability to master fundamental motor skills, but also improve movement mechanics and muscle strength while gaining confidence in their physical abilities. Many studies have illustrated successful adaptation of youth with INT programs (35).

Primary Prevention: A Model for Immunization Against EDD

Primary prevention involves protecting states of health, promoting psychosocial vigor, and preventing predictable diseases and conditions from ever happening (19). Examples of primary prevention include immunizations against communicable diseases, fluorination of drinking water, public health information on proper nutrition, legislation requiring seat belt and helmet use, and annual physical examinations with primary care practitioners. Primary prevention has been immensely helpful in certain areas of health care including vaccinations for the prevention of communicable diseases (36–38). Primary prevention of EDD has focused primarily on two areas: public health awareness, such as the Let's Go! national campaign, and physical education classes in school. National campaigns promoting physical activity may be helpful; still, we should not rely on such endeavors alone. For example, the AAP's Bright Futures has importantly outlined age-specific education on physical activity. However, the effectiveness of these types of campaigns on physical activity patterns in youth has not demonstrated a measurable benefit nationwide. In fact, children are less active, weaker, and have more fat than ever before (39). Rather, focusing health care on the evaluation and treatment of physical inactivity in youth emphasizes the identification and treatment of deficiencies in muscle strength and motor skill early in childhood because lifestyle patterns established in childhood form the foundation for physical activity habits later in life (40).

School-based physical education is an ideal setting to teach and reinforce the desired movement patterns and fitness abilities that are needed to regularly engage in different physical activities as an ongoing lifestyle choice. Moreover, regular participation in well-designed physical education lessons that support the holistic development of students can enhance the physical literacy of students (41). If school-age youth do not enhance their physical literacy by gaining confidence and competence in their physical abilities, they will be less likely to engage in the recommended amount of MVPA with energy, interest, and enthusiasm.

The time to act is now — we must shift the burden of health care away from expensive and burdensome tertiary prevention and move towards secondary and primary prevention.

CONCLUSIONS

Focusing efforts on tertiary prevention of physical inactivity is costly and ineffective. Because health care expenditures are now responsible for 17% of our gross domestic product, change is necessary to combat this unassailable cost of treating disease. Our society has created a huge burden of morbidity and mortality secondary to lifestyle decisions that allow for and reinforce physical inactivity during the growing years. Concomitantly, we have a disease-centric model of health care in the United States, where resources are allocated toward treatment of disease rather than prevention of disease. Undoubtedly, it is extraordinarily more expensive to treat individuals who acquire morbid conditions associated with physical inactivity. The time to act is now — we must shift the burden of health care away from expensive and burdensome tertiary prevention and move toward secondary and primary prevention. Youth today, for the first time in human history, will live shorter lives than their parents. By encouraging collaboration efforts between health care, education and fitness professionals, and promoting the early identification and treatment of EDD, we move primary and secondary prevention to the forefront.

...we have a disease-centric model of health care in the United States, where resources are allocated towards treatment of disease rather than prevention of disease.

1. Lee BY, Adam A, Zenkov E, *et al*. Modeling the economic and health impact of increasing children's physical activity in the United States. *Health Aff*. 2017; 36(5):902–8.
2. Mokdad AH, Marks JS, Stroup DF, Gerberding JL. Actual causes of death in the United states, 2000. *JAMA*. 2004;291(10):1238–45.
3. World Health Organization Web site [Internet]. Geneva (Switzerland): World Health Organization; [cited 2018 Jan 4]. Available from: http://www.who.int/healthinfo/global_burden_disease/en/.
4. Knight JA. Physical inactivity: associated diseases and disorders. *Ann Clin Lab Sci*. 2012;42(3):320–37.
5. Tsai AG, Williamson DF, Glick HA. Direct medical cost of overweight and obesity in the USA: a quantitative systematic review. *Obes Rev*. 2011;12(1):50–61.
6. Centers for Medicare & Medicaid Services Web site [Internet]. Baltimore (MD): Centers for Medicare & Medicaid Services. [cited 2018 Jan 4]. Available from: http://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/downloads/highlights.pdf.
7. Lubans DR, Morgan PJ, Cliff DP, Barnett LM, Okely AD. Fundamental movement skills in children and adolescents: review of associated health benefits. *Sports Med*. 2010;40(12):1019–35.
8. Janssen I, Leblanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *Int J Behav Nutr Phys Act*. 2010;7:40.
9. Davis CL, Tomporowski PD, McDowell JE, *et al*. Exercise improves executive function and achievement and alters brain activation in overweight children: a randomized, controlled trial. *Health Psychol*. 2011;30(1):91–8.
10. Ortega FB, Ruiz JR, Castillo MJ, Sjöström M. Physical fitness in childhood and adolescence: a powerful marker of health. *Int J Obes (Lond)*. 2008;32(1): 1–11.
11. Hillman CH, Pontifex MB, Castelli DM, *et al*. Effects of the FITKids randomized controlled trial on executive control and brain function. *Pediatrics*. 2014;134(4): e1063–71.
12. Faigenbaum AD, Myer GD. Exercise deficit disorder in youth: play now or pay later. *Curr Sports Med Rep*. 2012;11(4):196–200.
13. Nader PB, Bradley RH, Houts RM, McRitchie SL, O'Brien M. Moderate-to-vigorous physical activity from ages 9 to 15 years. *JAMA*. 2008;300(3):295–305.
14. Tremblay MS, Barnes JD, González SA, *et al*. Global Matrix 2.0: report card grades on the physical activity of children and youth comparing 38 countries. *J Phys Act Health*. 2016;13(11 Suppl 2):S343–66.
15. Faigenbaum AD, Lloyd RS, MacDonald J, Myer GD. Citius, Altius, Fortius: beneficial effects of resistance training for young athletes: narrative review. *Br J Sports Med*. 2016;50(1):3–7.
16. Katzmarzyk PT, Gledhill N, Shephard RJ. The economic burden of physical inactivity in Canada. *CMAJ*. 2000;163(11):1435–40.
17. Colditz GA. Economic costs of obesity and inactivity. *Med Sci Sports Exerc*. 1999; 31(11):S663.
18. Myer GD, Faigenbaum AD, Stracciolini A, *et al*. Exercise deficit disorder in youth: a paradigm shift toward disease prevention and comprehensive care. *Curr Sports Med Rep*. 2013;12(4):248–55.
19. Institute for Work & Health Web site [Internet]. Toronto, Ontario (Canada): Institute for Work & Health; [cited 2017 September 8]. Available from: http://www.iwh.on.ca/wrmb/primary-secondary-and-tertiary-prevention.
20. Sandy LG, Bodenheimer T, Pawlson LG, Starfield B. The political economy of U.S. primary care. *Health Aff*. 2009;28(4):1136–45.
21. Finkelstein EA, Trogdon JG, Cohen JW, Dietz W. Annual medical spending attributable to obesity: payer and service-specific estimates. *Health Aff*. 2009; 28(5):w822–31.
22. Calle EE, Thun MJ, Petrelli JM, Rodriguez C, Heath CW Jr. Body-mass index and mortality in a prospective cohort of U.S. adults. *N Engl J Med*. 1999;341(15): 1097–105.
23. Twig G, Yaniv G, Levine H, *et al*. Body-mass index in 2.3 million adolescents and cardiovascular death in adulthood. *N Engl J Med*. 2016;374(25):2430–40.
24. Stracciolini A, Myer GD, Faigenbaum AD. Exercise-deficit disorder in children: are we ready to make this diagnosis? *Phys Sportsmed*. 2013;41(1):94–101.
25. Selden TM. Compliance with well-child visit recommendations: evidence from the Medical Expenditure Panel Survey, 2000–2002. *Pediatrics*. 2006;118(6): e1766–78.
26. CMS-416: Colorado's Annual EPSDT Participation Report. [cited 2018 Jan 4]. Available from: https://www.cms.gov/Medicare/CMS-Forms/CMS-Forms/downloads/CMS416.pdf.

27. Farooq MA, Parkinson KN, Adamson AJ, *et al*. Timing of the decline in physical activity in childhood and adolescence: Gateshead Millennium Cohort Study. *Br J Sports Med*. 2017. Epub ahead of print.
28. Faigenbaum AD, Lloyd RS, Sheehan D, Myer GD. The role of the pediatric exercise specialist in treatment of EDD in youth. *Strength Cond J*. 2013;35: 34–41.
29. Faigenbaum AD, Myer GD. Exercise deficit disorder in youth: implications for fitness professionals. *ACSMs Cert News*. 2012;22(2):6.
30. Faigenbaum AD, Farrell A, Fabiano M, *et al*. Effects of detraining on fitness performance in 7-year-old children. *J Strength Cond Res*. 2013;27:323–30.
31. Faigenbaum AD, Farrell A, Fabiano M, *et al*. Effects of integrative neuromuscular training on fitness performance in children. *Pediatr Exerc Sci*. 2011;23: 573–84.
32. Faigenbaum AD, Myers G, Farrell A, *et al*. Integrative neuromuscular training and sex-specific fitness performance in 7-year-old children: an exploratory investigation. *J Athl Train*. 2014;49:145–53.
33. Myer GD, Faigenbaum AD, Chu D, *et al*. Integrative training for children and adolescents: techniques and practices for reducing sports-related injuries and enhancing athletic performance. *Phys Sportsmed*. 2011;39:74–84.
34. Tomporowski PD, McCullick BA, Horvat M. The role of contextual interference and mental engagement on learning. In: Edvardsen F, Kulle H, editors. *Educational Games: Design, Learning and Application*. Hauppauge (NY): Nova Science Publishers; 2010, 127–55.
35. Myer GD, Faigenbaum AD, Ford KR, Best TM, Bergeron MF, Hewett TE. When to initiate integrative neuromuscular training to reduce sports-related injuries and enhance health in youth? *Curr Sports Med Rep*. 2011;10(3):155–66.
36. Liao MT, Chang MH, Lin FG, Tsai IJ, Chang YW, Tsau YK. Universal hepatitis B vaccination reduces childhood hepatitis B virus-associated membranous nephropathy. *Pediatrics*. 2011;128(3):e600–4.
37. Berg P, Westerling R. A decrease in both mild and severe bicycle-related head injuries in helmet wearing ages—trend analyses in Sweden. *Health Promot Int*. 2007;22(3):191–7.
38. Centers for Disease Control and Prevention Web site [Internet]. Atlanta (GA): Centers for Disease Control and Prevention; [cited 2017 September 8]. Available from: http://www.cdc.gov/vaccines/pubs/pinkbook/pert.html- epi.
39. Katzmarzyk PT, Lee IM, Martin CK, Blair SN. Epidemiology of physical activity and exercise training in the United States. *Prog Cardiovasc Dis*. 2017;60(1): 3–10.
40. Telama R. Tracking of physical activity from childhood to adulthood: a review. *Obes Facts*. 2009;2(3):187–95.
41. SHAPE America. *Grade-Level Outcomes for K-12 Physical Education*. Reston (VA): Author. 2013.

Disclosure: *The authors declare no conflict of interest and do not have any financial disclosures.*

Contributors' Statement: Dr. Walker conceptualized and designed the article, drafted the initial manuscript, and approved the final manuscript as submitted. Drs. Stracciolini, Faigenbaum, and Myer critically reviewed and revised the manuscript, and approved the final manuscript as submitted.

Gregory A. Walker, M.D., FAAP, *is an attending physician in the Department of Sports Medicine at Cincinnati Children's Hospital Medical Center and an assistant professor in the Department of Pediatrics at the University of Cincinnati. Dr. Walker, who specializes in pediatrics and sports medicine, sees the immense impact of physical inactivity on our youth. He has an interest in improving assessment and treatment of physical inactivity in youth and recently coauthored a chapter focusing on the medical complications for the pediatric endurance athlete.*

Andrea Stracciolini, M.D., FAAP, FACSM, *is a primary care sports medicine physician at Boston Children's Hospital in Boston, MA. Dr. Stracciolini is the director of the section on Performing Arts Athletes in the Division of Sports Medicine. She is board certified in Pediatrics, Pediatric Emergency Medicine, and Sports Medicine. Dr. Stracciolini graduated from the University of Pennsylvania School of Medicine and trained in Pediatrics at the Children's Hospital of Philadelphia. Dr. Stracciolini specializes in musculoskeletal ultrasound with a unique focus on pediatric and young adult hip preservation.*

Avery D. Faigenbaum, Ed.D., FACSM, *is a full professor in the Department of Health and Exercise Science at The College of New Jersey. His research interests focus on pediatric exercise science, integrative neuromuscular training, and preventive medicine.*

Gregory D. Myer, Ph.D., FACSM, CSCS*D, *is the director of Research at The Human Performance Laboratory for the Division of Sports Medicine at Cincinnati Children's Hospital Medical Center and maintains his primary faculty appointment in the departments of Pediatrics and Orthopaedic Surgery in the College of Medicine at the University of Cincinnati. Over the past decade, Dr. Myer has published more than 250 articles in peer-reviewed medical journals and has published books and several book chapters related to his research on injury biomechanics, human performance, pediatric exercise science, preventative medicine, and sensorimotor neuroscience.*