CLINICAL REPORT Guidance for the Clinician in Rendering Pediatric Care

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™

Physical Activity Assessment and Counseling in Pediatric Clinical Settings

Felipe Lobelo, MD, PhD,[a] Natalie D. Muth, MD, MPH, FAAP, FACSM,[b] Sara Hanson, PhD,[c] Blaise A. Nemeth, MD, FAAP,[d] COUNCIL ON SPORTS MEDICINE AND FITNESS, SECTION ON OBESITY

Physical activity plays an important role in children's cardiovascular health, musculoskeletal health, mental and behavioral health, and physical, social, and cognitive development. Despite the importance in children's lives, pediatricians are unfamiliar with assessment and guidance regarding physical activity in children. With the release of the 2018 Physical Activity Guidelines by the US Department of Health and Human Services, pediatricians play a critical role in encouraging physical activity in children through assessing physical activity and physical literacy; providing guidance toward meeting recommendations by children and their families; advocating for opportunities for physical activity for all children in schools, communities, and hospitals; setting an example and remaining physically active personally; advocating for the use of assessment tools and insurance coverage of physical activity and physical literacy screening; and incorporating physical activity assessment and prescription in medical school curricula.

INTRODUCTION AND RATIONALE FOR PHYSICAL ACTIVITY ASSESSMENT AND COUNSELING

The 2017 Youth Risk Behavior Survey (YRBS) revealed that only 26.1% of American adolescents reported levels of activity consistent with current guidelines, and 15.4% of students reported not being physically active for at least 1 hour on a single day in the previous week.[1] With the exception of increased sports participation among high school female students, overall youth physical activity levels have decreased.[2] The lowest rates of physical activity occur among adolescent girls, children and youth with special health care needs (CYSHCN), and youth of minority status; rates of inactivity increased with age.[1,3] Although only approximately one-fourth of children report meeting physical activity guidelines, objective measurement of activity by accelerometer reveals that less than half of children and 8% of adolescents were meeting the 2008 Physical Activity Guidelines from the US Department of Health and Human Services of 60 minutes daily of moderate-to-vigorous physical activity (MVPA) as

abstract

[a]Hubert Department of Global Health and [c]Nutrition and Health Sciences Program, Laney Graduate School and Exercise is Medicine Global Research and Collaboration Center, Rollins School of Public Health, Emory University, Atlanta, Georgia; [b]Children's Primary Care Medical Group, Carlsbad, California; and [d]American Family Children's Hospital and School of Medicine and Public Health, University of Wisconsin–Madison, Madison, Wisconsin

Drs Lobelo, Muth, Hanson, and Nemeth served as coauthors of the manuscript, providing substantial input into content and revision; and all authors approved the final manuscript as submitted.

DOI: https://doi.org/10.1542/peds.2019-3992

Address correspondence to Blaise A. Nemeth, MD, FAAP. E-mail: bnemeth@ortho.wisc.edu

To cite: Lobelo F, Muth ND, Hanson S, et al. AAP COUNCIL ON SPORTS MEDICINE AND FITNESS, AAP SECTION ON OBESITY. Physical Activity Assessment and Counseling in Pediatric Clinical Settings. *Pediatrics.* 2020;145(3): e20193992

recently as 2016.[1,4,5] With rates of obesity rising over the last decades, annual relative increases of 4.8% in the incidence of type 2 diabetes mellitus,[6] and declines in estimated life expectancy at time of birth since 1993, the role of physical activity on child, and later adult, health remains an important component of preventive care and disease treatment.[7,8]

In 2006, the American Academy of Pediatrics (AAP) published the policy statement "Active Healthy Living: Prevention of Childhood Obesity through Increased Physical Activity."[9] That statement addressed not only the role of physical activity in obesity but also identification of individuals at risk for decreased physical activity, age-appropriate activity recommendations, and the role of schools in promoting activity.[9] Since that time, the AAP and other organizations have published statements on the assessment, prevention, and treatment of pediatric obesity that include recommendations to promote improved nutrition and sleep, decreased sedentary time, and increased physical activity, although details regarding how to achieve physical activity recommendations are limited.[10–13] Unfortunately, 5 years after the 2008 Physical Activity Guidelines were released, only 23% of family physicians and 33% of pediatricians were able to correctly identify current physical activity guidelines for children 6 to 18 years of age.[14,15] Physical activity is a "priority topic" in *Bright Futures: Guidelines for Health Supervision of Infants, Children and Adolescents, Fourth Edition*, for every health supervision visit starting at 18 months of age, with inclusion of recommending meeting the Physical Activity Guidelines beginning at 5 years of age.[16] The 2018 Physical Activity Guidelines outline the recommended physical activity levels for children and adolescents, provide guidelines for children younger than 6 years, and support the role of physical activity on not just physical health but also in development, mental health, and school performance (Table 1).[17] As such, this clinical report replaces the previous statement on active healthy living, augments existing statements, highlights the role of physical activity in all children's health, and provides guidance for physicians to better assist families in increasing physical activity.

PHYSICAL ACTIVITY AND HEALTH OUTCOMES IN CHILDREN AND YOUTH

The relationships between physical activity, cardiovascular health, and body composition have been well established. Morris et al[18] demonstrated decreased rates of adult coronary heart disease in active versus sedentary employees of the London Transport Executive in 1953. In the absence of longitudinal studies assessing the impact of childhood physical activity on adult mortality, studies have confirmed the benefit of physical activity on children's cardiorespiratory fitness, lipid profiles, insulin sensitivity, and serum glucose concentrations in individuals with obesity as well as associations with more optimal cardiovascular profiles in the most physically active children.[19–24] Importantly, for the developing child, aerobic activity and strength training result in increased muscle mass and decreased fat mass.[21,22,25] Physical activity also increases bone density and improves balance, protecting against falls and injury both in childhood and later in life.[26–30] Overall, strong evidence supports that MVPA improves cardiovascular and muscular fitness, bone health, weight status, and cardiometabolic risk factor status in children and adolescents, as outlined by the 2018 Physical Activity Guidelines Advisory Committee.[31]

Less widely appreciated, physical activity benefits behavioral, cognitive, and social aspects of child health. Increased physical activity has also been shown to be associated with decreased rates of smoking and fewer symptoms of depression, and increased rates of inactivity and sedentary activity can predict future alcohol and drug use in adolescents.[32–34] Both randomized controlled trials and systematic reviews support the effect of physical activity on academic performance, possibly even in a dose-response relationship.[35–41] Children who are provided opportunities to be physically active during school focus and behave better, including children with attention-deficit/hyperactivity disorder.[42–44] Benefits may be even greater in children with autism spectrum disorder who show decreased perseverative behavior and easier redirection after a bout of physical activity.[45,46] The 2018 Physical Activity Guidelines Advisory Committee concluded that in children ages 5 to 13 years, acute bouts of physical activity and regular MVPA

TABLE 1 2018 Physical Activity Guidelines Applicable to Children

Age	Activity Amount	Intensity
3–5 y	3+ h/d	Light, moderate, vigorous
6–17 y	≥60 min/d	Moderate or vigorous aerobic activity daily
		Vigorous at least 3 d/wk
		Muscle-strengthening activities at least 3 d/wk
		Bone-strengthening activities at least 3 d per wk
Children not meeting guidelines	Gradually increase activity in ways the child enjoys	Moderate-vigorous; increase time per d and No. days per wk; use multiple, smaller time increments in activity that are additive throughout the day

Adapted from US Department of Health and Human Services. *Physical Activity Guidelines for Americans*. 2nd ed. Washington, DC: US Department of Health and Human Services; 2018. Available at: https://health.gov/paguidelines/second-edition/pdf/Physical_Activity_Guidelines_2nd_edition.pdf. Accessed December 10, 2018.

improve cognition, including memory, processing speed, attention, and academic performance.[31]

Even more concerning than the rates of inactivity among children overall is the low rate of physical activity among CYSHCN.[3] CYSHCN represent a wide range of children with chronic physical, developmental, behavioral, or emotional conditions.[47] The benefits of physical activity for CYSHCN are substantial. Physical activity plays a vital role in strength, endurance, and bone health for all children and especially for children with neuromotor disorders such as spina bifida, muscular dystrophy and other myopathies, Prader-Willi syndrome, and cerebral palsy.[48–54] Beyond musculoskeletal benefits, activity may play a role in speech and fine motor development, possibly through opportunities for social interaction, postural control and positioning, and use of orofacial muscles required for breathing during physical activity.[55–60] Despite its pronounced benefits, rates of physical activity in CYSHCN are much lower than in health-normative peers.[3,61] Any successful effort to increase physical activity requires approaches tailored to an individual's unique needs.[62]

Physical activity may also create unexpected benefits in children with other chronic health conditions. Children with a history of cancer experience increased rates of cardiovascular events, and physical activity has been shown to improve cardiovascular risk factors in this population.[63–65] Physical activity also improves immune function, which may decrease pulmonary infection, and improves weight gain in children with cystic fibrosis.[66–69] Physical activity benefits cardiorespiratory function in, and may be engaged in safely by, children with congenital heart disease under properly advised and supervised programs.[70–72]

CURRENT PHYSICAL ACTIVITY GUIDELINES IN YOUTH

The 2018 Physical Activity Guidelines Advisory Committee reaffirmed the 2008 Physical Activity Guidelines, which recommend children and adolescents (6–17 years of age) engage in at least 60 minutes of physical activity every day, including vigorous-intensity as well as muscle- and bone-strengthening activities, at least 3 days per week (Table 1).[31] The AAP has advised that physical activity should also include a muscle-strengthening program that targets all major muscle groups, starts with no load and incrementally may add load once exercise technique is mastered, involves 2 to 3 sets of 8 to 15 repetitions, and is performed 2 to 3 days per week for at least 8 weeks.[73]

The 2018 Physical Activity Guidelines Advisory Committee concluded there is strong evidence that a greater volume of physical activity among children ages 3 to 5 years of age is associated with a decreased risk of excessive weight gain and improved bone health.[31] The committee concluded these children should aim to achieve at least the median level of physical activity of children this age, which is 3 hours or more of physical activity per day.[31] This is consistent with other guidelines that suggest that adults should provide opportunities for free play and unstructured physical activity for children 3 to 5 years of age,[15,74] including at least 180 minutes of physical activity throughout the day (approximately 15 minutes every hour while awake) that helps to develop movement skills in a variety of activities and in a variety of environments. The higher volume of activity recommendation for children 3 to 5 years of age is based on the nature of their activity being intermittent and typically of lower intensity than older children.[75] Infants should be physically active several times per day, mostly through interactive floor-based play.[75] The AAP clinical report "The Power of Play: A Pediatric Role in Enhancing Development in Young Children" offers guidance on appropriate approaches for young children.[76] *Caring for Our Children: National Health and Safety Performance Standards; Guidelines for Early Care and Education Programs* is another AAP publication providing guidance for child care settings.[77]

For all children and adolescents, it is important that activities are appropriate to a child's age, enjoyable, and varied.[75] Examples of child and youth physical activities as well as recommendations based on the principles of frequency, intensity, time, and type of activity are included in Tables 2 and 3.

THE IMPORTANCE OF PHYSICAL LITERACY IN SHAPING PHYSICAL ACTIVITY PARTICIPATION

Attention to physical literacy, defined by the Aspen Institute as "the ability, confidence, and desire to be physically active for life" may provide an opportunity to increase and sustain physical activity across childhood and adolescence.[85] Ability includes competence in fundamental movement skills including throwing, catching, jumping, striking, running, kicking, agility, balance, and coordination. Fundamental movement skills emerge starting with gross motor skill development in infancy and early childhood, progress throughout early and midchildhood, and are honed in preadolescence and adolescence (see Table 4).[85] Competency in fundamental movement skills is a strong predictor of both current and future physical activity levels, cardiovascular fitness, BMI, and risk of overweight and obesity.[86–88] Confidence, or self-efficacy in one's ability to play sports or enjoy physical activity, develops from early positive experiences with physical play and a variety of sports that are inclusive and welcoming of

TABLE 2 Examples of Types of Physical Activity

	MET	Physical Symptoms	Examples of Activities
Rest	1	—	—
Light	<3	Easily able to converse No sweating or shortness of breath	Household chores Walking Playing catch Fishing
Moderate	3–6	Some difficulty talking Feeling warm Light sweating Slight shortness of breath	Yardwork Jogging or fast walking Tag Movement portion of ball sports
Vigorous	>6	Unable to talk Short of breath Face red Sweating	Manual labor Run Skipping rope Skiing, skating
Wheelchair use or use of assistive devices (crutches or ankle-foot orthoses)	Comparable METs expended for comparable examples noted above (eg, wheeling on a smooth surface = light; wheeling fast or up an incline or as part of ball sports = moderate; wheelchair racing or sit-skiing = vigorous) (use of crutches or ankle-foot orthoses involves higher METs but usually not enough to increase the level of PA, eg, from light to moderate)	—	—
Muscle strengthening	—	Pushing and/or pulling one's body or an object	Climbing Pushups, curl-ups, or resistance training Wheeling a wheelchair
Bone strengthening	—	Increased impact	Jumping rope Tumbling Running

Data are from references 78–82. MET, metabolic equivalent of task; PA, physical activity; —, not applicable.

all children, regardless of their abilities.[85] Desire encompasses the interest and enjoyment in physical activity and movement.[85]

Teenagers report the strongest facilitators of physical activity include a favorable attitude toward physical activity; motivation; perception of competence and body image; fun; influence of friends, family, and physical education teachers; and environmental physical activity opportunities.[91] Higher physical literacy is associated with higher physical activity levels and cardiorespiratory fitness in children and adolescents.[92,93] On the other hand, children who do not develop fundamental movement skills are unlikely to develop the confidence and desire to be active and are at increased risk for sedentary lifestyle and its associated risks, as demonstrated by children with developmental coordination disorder who experience increased rates of obesity.[94,95]

Children who do not engage in regular physical activity miss out on important benefits such as improved self-esteem, leadership and team building skills, decreased stress and anxiety, decreased depression, and fun, as well as improved physical and brain health.[74] Because physical activity is essential to normal pediatric development and health, the term "exercise deficit disorder" has been proposed to identify children who, for a variety of reasons, do not engage in sufficient physical activity to promote overall health.[96]

Many groups experience barriers to being physically active and developing fundamental movement skills, such as girls, children of minority status, children from low-income households (rural and urban), and CYSHCN.[85] If these skills do not develop, the likelihood of being physically inactive later in life increases, creating an integral role for the pediatrician in screening for physical literacy, physical activity opportunities, and exercise deficit disorder[97] and referring to a youth fitness specialist, physical education teacher, or physical and/or occupational therapist because structured programming improves fitness, strength, and functional movement skills.[98,99] National standards outline physical literacy as the primary purpose of physical education classes in schools.[100]

The role of early physical activity and literacy on later adult health may play a role in fracture risk beyond effects of impact activities on bone density and geometry.[101] Multidirectional ball sports earlier in life appear to protect against stress fractures in adolescent runners.[102] Physical function or, rather, dysfunction has been found to be a contributor to adult "fragility"

TABLE 3 Age-Appropriate Recommendations for Increased Physical Activity

	Infant (0–1 y)	Toddler (1–3 y)	Preschool (3–5 y)	Elementary (5–10 y)	Middle School (11–14 y)	Adolescence (15–18 y)
Frequency	Daily	Daily	Daily	Daily	Daily	Daily
Intensity	Any	Any	Any, including some moderate to vigorous	Moderate to vigorous	Moderate to vigorous	Moderate to vigorous
Time	Several times per day	At least 180 min/d	At least 180 min/d, of which at least 60 min are moderate-to-vigorous intensity	At least 60 min/d	At least 60 min/d	At least 60 min/d
Type	Interactive floor-based play and at least 30 min of tummy time spread throughout the day while awake	Activities that develop gross motor skills; examples include walking in the neighborhood, unorganized free play outdoors, walking through a park or zoo, or playing on a playground for toddlers	Activities that develop gross motor skills; unorganized free play in a safe environment; activities include walking, running, swimming, tumbling, throwing, and catching	Aerobic daily; vigorous activity, muscle, and bone- strengthening at least 3 d/wk; include free play with opportunities for fundamental movement skill development through walk, dance, jump rope. Introduce organized sports with flexible rules and short instruction time with a focus on enjoyment rather than competition	Aerobic daily; vigorous activity, muscle, and bone-strengthening at least 3 d/wk; incorporate activities that are enjoyable and encourage socialization; avoid sports specialization	Aerobic daily; vigorous activity, muscle, and bone-strengthening at least 3 d/wk; incorporate activities that are enjoyable and encourage socialization and competition, when appropriate

Data are from references 9, 15, 73, 75, 83, and 84.

fracture risk.[103] Because osteopenia only explains part of fracture risk, the role of sarcopenia, the loss of muscle, especially with aging, has been proposed as an important risk factor to the extent that, similar to exercise deficit disorder, the term "dysmobility syndrome" has been coined for adults, both resulting from dynapenia, the loss of muscle.[104,105]

INACTIVITY AND SEDENTARY TIME

The typical preschooler spends more than 6 hours per day in sedentary activity and just under 15 minutes per day in MVPA.[106] More than 20% of children watch 3 or more hours of television per day on school days,[1] and the average 8- to 18-year-old spends more than 7 hours per day in front of a screen.[107]

The health effects of a sedentary lifestyle are an area of intense research and emerging concern. For adults, physical inactivity is associated with increased all-cause mortality, cardiovascular disease incidence and mortality, cancer incidence and mortality, and diabetes incidence,[108] among other harmful health consequences. The 2018 Physical Activity Guidelines Advisory Committee concluded that there is limited available scientific evidence linking sedentary behavior to health outcomes; however, given the high prevalence of physical inactivity in youth, especially CYSHCN, replacing some sedentary time with MVPA could improve health, given the strong association.[31,109] More research is needed to better understand the effects of time spent sitting and in light-intensity physical activity among children and adolescents.[110]

Although the advent of exergaming, or active video games, pose an attractive option to promote physical activity in children drawn to electronic media and video games and averse to traditional physical activity, exergaming primarily

TABLE 4 Supporting Physical Literacy

Infancy: supporting rudimentary motor skill development
Grasping (3–4 mo)
Offer toys to support hand-eye coordination
Roll over (4–6 mo)
Tummy time to build core strength
Sitting (6 mo)
Tummy time to increase strength and coordination
Crawling (7–10 mo)
Place toys to help build strength and balance
Cruising (9 mo)
Offer a safe environment to explore which increases strength and balance
Walking (12 mo)
Create a safe environment to explore which improves balance and coordination
Toddler or preschool age: support development of fundamental skills
Encourage fun and socialization, incorporating activities preferred by the child, family walks, and chores (picking up, retrieving items, helping clean)
Running (by 2 y)
Play chase, visit parks, and offer a safe environment to practice
Throwing (2 y)
Play catch with easy-to-grasp foam or fabric balls
Catching (2+ y)
Create a "basket" with arms to catch
Kicking (2 y)
Play soccer with light, foam balls
Swimming (1–4 y)
Enroll in swimming lessons
Skating (4 y)
Elementary school age: improve fundamental skills and develop self-efficacy
Encourage fun and socialization, incorporating fitness preferences (such as dance, yoga, running, hiking, sports), active transportation (walking, cycling to school and activities), and chores (walking the dog)
Running
Build fitness and skills with tag, introduce sports like soccer by age 6
Throwing and catching
Falling and tumbling
Helps decrease injury by learning to tuck head, knees, and arms
Hopping and jumping
Hopscotch and jump rope
Cycling
Teach a child to ride a bike
Striking sports
Practice at home with a plastic ball and bat, hockey stick, etc; introduce sports programs
Dribbling sports
Fine motor skills develop through practice and repetition
Gymnastics
One of the best activities for agility, balance, coordination, strength, and flexibility
Skiing
Low center of gravity makes it easier; it helps with balance
Preadolescence and adolescence: honing physical literacy
Encourage fun and socialization, incorporating fitness preferences (such as dance, yoga, running, hiking, sports), active transportation (walking, cycling to school and activities), and chores (walking the dog)
Identify gaps in fundamental movement skills development, confidence, or desire to be active and devise a plan to remedy (eg, motivational interviewing, physical therapy, community program)
Introduce skill development and strategy through coaching and camps
Introduce more complex sports that incorporate multidirectional movement and attention (eg, sports with equipment and strategy and/or plays)
Introduce resistance training with supervision and instruction on proper technique
Avoid sports specialization until mid-to-late teenaged years

Data are from references 16, 76, 83–85, 89, and 90.

promotes only light physical activity, with few games demonstrating effectiveness in increasing activity to moderate or vigorous levels.[111] Although MVPA occurs with specific games in structured settings, applicability to home settings and the ability to achieve sustained, or cumulative, durations necessary to meet physical activity guidelines has not been demonstrated.[112,113]

The AAP advises that parents develop a family media use plan to help children limit screen time activities to ensure they do not replace adequate sleep, physical activity, and other behaviors essential to health.[114] Likewise, *Bright Futures: Guidelines for Health Supervision of Infants, Children and Adolescents, Fourth Edition*, recommends physical activity and play as alternatives to screen time, as well as a way to promote family routine and social interaction, in addition to benefitting normal growth and development.[16]

EVIDENCE IN SUPPORT OF PHYSICAL ACTIVITY PROMOTION IN PEDIATRIC CARE SETTINGS

Among adults, substantial international evidence supports the use of multiprong physical activity counseling and referral strategies, particularly those linking health care and community-based resources, to improve physical activity levels.[115,116] Meta-analyses and systematic reviews have shown that physician counseling (odds ratio, 1.42; 95% confidence interval, 1.17–1.73) and exercise referral systems (relative risk, 1.20; 95% confidence interval, 1.06–1.35) promote improvements in adult patients' physical activity for up to 12 months,[117–120] with evidence supporting the notion that physical activity counseling can be successfully implemented in routine clinical practice[121,122] and that protocols are acceptable among health care providers.[123] Integration of physical activity counseling and referral strategies into adult primary

care settings has also been found to be cost-effective,[124–128] provide early return on investment because of lower health care use and costs,[129,130] and have been successfully scaled to national levels with adequate sustainability.[128]

Although the experience from adult medicine shows that multicomponent intervention approaches can be effectively implemented within established primary care practices making use of existing resources and personnel, evidence on the effectiveness of physical activity promotion in pediatric settings is more limited.[131] To date, most interventions have been centered on multiple health behaviors including sedentary time and healthy diet in the context of weight management. For example, the Patient-Centered Assessment and Counseling for Exercise Plus Nutrition (PACE+) intervention showed that computer-assisted, individually tailored counseling for physical activity in children 11 to 15 years of age can be effective in reducing sedentary time and improving compliance with physical activity guidelines at 12 months, particular among boys.[132]

The Physical Activity Guidelines for Americans Midcourse Report assessed evidence-based recommendations to increase youth physical activity across multiple sectors.[31] In this report, the authors found insufficient evidence to support specific strategies for physical activity promotion in the clinical setting.[31] The 2018 Physical Activity Guidelines Advisory Committee remarked that this could be improved with more robust and standardized strategies incorporating additional team members and tools such as motivational interviewing and a specific exercise prescription.[31] The committee also noted that individually focused interventions delivered in a variety of settings can successfully increase youth physical activity, especially when families and schools are incorporated into the interventions.[31]

The Healthcare Effectiveness Data and Information Set measure on Weight Assessment and Counseling for Nutrition and Physical Activity for Children/Adolescents assesses the percentage of patients 2 to 17 years of age who had an outpatient visit with a primary care provider and who had evidence of BMI percentile documentation, counseling for nutrition, and counseling for physical activity during the measurement year.[133] Depending on insurance type, 60% or fewer pediatric visits contained documentation of counseling for physical activity or referral for physical activity on the basis of administrative data or medical record review that included a note indicating the date and at least one of the following activities: (1) discussion of current physical activity behaviors (eg, exercise routine, participation in sports activities, examination for sports participation); (2) checklist indicating physical activity was addressed; (3) counseling or referral for physical activity; (4) member received educational materials on physical activity; or (5) anticipatory guidance for physical activity. Examples of notations that do not count toward this requirement include "notation of 'cleared for gym class' alone without any documentation of a discussion" or "notation of 'health education' or 'anticipatory guidance' without any specific mention of physical activity."[133]

The US Preventive Services Task Force recommends that clinicians screen children 6 years and older for obesity and offer them or refer them to comprehensive, intensive behavioral intervention that includes physical activity and nutritional counseling to promote improvement in weight status. Rated as a "B" recommendation, this strategy must be included in health plans under the Affordable Care Act's Prevention and Health Promotion activities.[134] Similarly, the AAP clinical report on obesity prevention also underscores the importance of physical activity promotion by pediatricians and other health care providers.[10] Given the critical importance of play in childhood, of which physical play is one type, the AAP recommends that clinicians write a "prescription for play" at well-child visits in the first 2 years of life.[76] *Bright Futures: Guidelines for Health Supervision of Infants, Children and Adolescents, Fourth Edition*, encourages play as a way to decrease screen time starting at 18 months of age, promoting behavioral management and social development starting at 2 years of age, and advancing to promotion of physical activity guidelines at 5 years of age for growth and development.[16] As such, physical activity is a component of the *Bright Futures* health supervision priorities of social and emotional well-being, school readiness and performance, and risk-behavior reduction.[16]

ROLE OF PARENTS IN PHYSICAL ACTIVITY FOR CHILDREN

Early in life, opportunities for the development of physical literacy occur at home. Parents are integral, not only in role-modeling movement, but also in playing with their children to allow for acquisition of necessary skills.[76] The role of parents is even more important in CYHSCN given the complexity of needs and barriers to participation that children with disabilities face.[135] Free-play is the primary exposure of necessity.[76] Playing catch, climbing structures and natural elements, such as boulders and trees, and tag address skills in travel, hand-eye coordination, and balance and strength through natural exploration and fun play. Organized sports are unnecessary at early ages but are beneficial for more specific skill development once a child is ready on the basis of physical,

cognitive, and behavioral readiness.[136] Children who engage in a variety of different activities and sports, especially those that help build fundamental movement skills such as gymnastics, swimming, and track will be more likely to develop physical literacy as well as enjoyment of physical activity and attain recommended levels of MVPA.[85] Sport specialization, as outlined in the AAP statement "Sports Specialization and Intensive Training in Young Athletes," is discouraged before puberty because there is no evidence that young children will benefit from early sport specialization in the majority of sports, and some data suggest that early specialization leads to higher rates of overuse injury and burnout from concentrated activity.[83,137,138] Exposure to nature has also been shown to have its own benefits on health; thus, opportunities for play and movement outdoors, even in the smallest of green spaces, are important and create an increased appreciation of movement and nature.[139,140]

ROLE OF SCHOOLS IN PROMOTING PHYSICAL ACTIVITY IN YOUTH

In many areas, school provides the primary opportunity for physical activity and acquisition of physical literacy. In fact, the 2018 Physical Activity Guidelines Advisory Committee found strong evidence that interventions that affect multiple components of schools are effective for increasing youth physical activity, particularly among those at highest risk of physical inactivity, such as adolescent girls and children with limited access to safe and affordable activity opportunities outside of school.[31] The American Heart Association calls for schools to become the central element in a community system that ensures that students participate in enough physical activity to develop healthy lifestyles.[141] Developing physical education curricula that promotes enjoyment of movement and skill development is important, especially including CYSHCN, as is providing opportunities for movement before, during, and after school.[142] National standards outline the role of physical education classes in physical literacy.[100] It is important to recognize that in physical education classes at school, a number of factors have been shown to result in children spending less than 50% of class time engaged in MVPA.[143,144] Opportunities for additional movement throughout the day through active classrooms benefit not only the child through increased physical activity but also the learning environment as a result of improved behavior.[36,42,145] Opportunities for recess and physical education during school that maximize movement and minimize sedentary and/or standing time and encourage social interaction are critical.[146,147] Schools also provide a safe place for physical activity before and after school that many children do not have at home, especially outside, increasing the time spent in MVPA.[148–150] SHAPE America, the Society of Health and Physical Educators, discourages the use and withholding of physical activity as punishment in schools.[100]

TOOLS FOR ASSESSING PHYSICAL ACTIVITY IN PEDIATRIC CLINICAL SETTINGS

In a nationally representative sample (N = 811) of US primary care physicians caring for children and adolescents (pediatrics and family medicine), most physicians reported assessing physical activity in youth using general questions about the amount of physical activity (98%).[14] However, a lower proportion (66%) asked specific questions about duration, intensity, and type of physical activity, and only a minority reported using a standardized questionnaire (7%) or other written physical activity assessments (6%).[14] In comparison, 98% of physicians reported regularly measuring weight objectively on a scale in the office setting.[14] That the majority of pediatric primary care physicians report somehow assessing physical activity levels in their clinical practice is encouraging, but the study by Huang et al[14] that revealed fewer than one-third of pediatricians could correctly identify guidelines calls into question the degree to which providers are correctly screening for insufficient physical activity or adequately counseling adolescents and their families on the recommended "dose" of physical activity for health.

Several methods have been used to assess physical activity in children and adolescents including questionnaires, activity logs, pedometers, and research-grade and consumer-oriented accelerometers. Practicality, validity, and reliability are important considerations when deciding appropriate methods to assess physical activity levels in clinical settings.[120] Although physical activity is important, assessment of physical literacy (Table 4) is first necessary to quantify current activity, create appropriate goals for improvement, and allow for dose-response relationships to changes in other health parameters (and subsequent studies to demonstrate benefit or lack thereof) (Table 5). In the absence of opportunities to directly assess movement, quantification of physical activity may serve as a surrogate measure for younger children in representing opportunities for development of physical literacy. Simply asking children about their enjoyment of movement may provide insight into their physical literacy.[105]

In the adult population, systematic assessment of physical activity levels in clinical settings has been established through the integration of a self-reported physical activity vital sign (PAVS) into electronic health records (EHRs).[151] The PAVS has

TABLE 5 Steps Toward Integrating Physical Activity Assessment and Counseling Into Clinical Practice

1. Ask about current physical activity frequency and duration and enjoyment of movement.
2. If it is an acute or subspecialty visit, connect benefit of physical activity to current health condition and advise on restrictions in physical activity (if applicable).
3. If it is a health supervision visit, assess physical literacy and any gap between current and recommended activity level. Assess the patient and family interest in discussing promotion of physical activity.
   a. If not interested, provide information on the benefit of physical activity to current health, if the patient has any chronic issues, and/or future health (including athletic performance).
   b. If interested, discuss the reason for interest and potential area of change and establish a specific, attainable incremental goal to progress toward physical activity guidelines. Connect patient and/or family to resources to support achievement of goal, such as a physical education teacher, exercise specialist, physical or occupational therapist, or coach.
4. Recommend scheduling an appointment to discuss achievement toward goal; identify obstacles to change and establish new goals.

been promoted through the Exercise is Medicine initiative of the American College of Sports Medicine.[115,152–154] The PAVS consists of 2 questions (Fig 1), adapted from the Behavioral Risk Factor Surveillance System and validated to screen for inactivity in clinical settings.[155–157] Integration of the PAVS into the EHR of large health care systems resulted in greater physical activity–related counseling, weight change in adult patients with obesity, and hemoglobin A1c changes in those with diabetes.[158,159] The Institute of Medicine (now National Academy of Medicine) has supported the inclusion of the PAVS and/or objective assessment of physical activity in EHRs.[160]

Assessment of physical activity levels in youth via self-report is a more complex undertaking because youth are less likely to make accurate self-report assessments than adults because of developmental differences, especially in the ability to perform detailed recall and understand concepts regarding physical activity duration and intensity.[161,162] In addition, youth have an activity pattern that is more variable and intermittent compared with adults.[163] Furthermore, sports practices involve MVPA for only a fraction of the time, and the amount of time varies greatly by sport.[164] A thorough review of physical activity assessment tools is included in the Supplemental Information.

STRATEGIES TO OVERCOME BARRIERS TO PHYSICAL ACTIVITY ASSESSMENT, COUNSELING, AND REFERRAL IN CLINICAL PRACTICE

Physicians face many barriers to implementing physical activity assessment, counseling, and referral in the clinical setting.[151] Clinical visit times are short, and the list of preventive guidance to incorporate into well-child checks is long.[151] Solutions will likely require interprofessional approaches and engagement with community organizations in development of tools to provide interventions and track physical activity, integration of measurements of activity into the EHR, and identification of associations with health outcomes.[151] Regardless, physical activity assessment, counseling, and promotion follows the same approach as used in other areas of lifestyle change for chronic disease, yet it is applicable to all patients (Table 5).[165]

Pediatricians will need efficient workflows to incorporate physical activity assessment, counseling, and referral into the clinical visit. This could be accomplished through a PAVS in the medical record, previsit questionnaires, or screening performed by support staff.[151] EHR companies and health care institutions are encouraged to include tools to measure, document, report, and investigate physical activity measures and association with other health outcomes, including assessing for physical literacy. For example, the Intermountain Healthcare system developed and integrated into their EHR system a pediatric PAVS for use at preventive care visits for children ages 6 to 18 years.[151] This tool combines the PACE+ validated item with the addition of questions to assess activity participation on specific settings and domains (physical education, recreation, sports, transportation, home, after school, sedentary or screen time) in an effort to facilitate compliance assessment and guide goal-setting and domain-specific counseling.[151] Since 2011, the Kaiser Permanente Health System integrated into its EHR system and clinical workflows the pediatric exercise vital sign, modeled after the YRBS questions, for youth 5 to 18 years (Fig 1).[166] Although not yet formally validated in children, implementing the PAVS as a part of the health visit and within the EHR represents a starting point in initiating the conversation around physical activity in primary care and assessing the potential to predict future disease risk[158] as well as determining the validity of the PAVS in pediatric practice.[167] Brief tools for assessing physical activity are included in Table 6 (see the Supplemental Information for a full discussion regarding the tools and methodology used to identify advantages and disadvantages of each).

Similar to adult-based approaches, once the current physical activity level of the child is understood, providers can offer more specific, developmentally tailored physical activity advice or set an appropriate incremental goal for increase in activity and can include further guidance and referral resources in the after-visit summary.[120] For children identified as needing further intervention, a brief follow-up visit could be scheduled, or the patient could be referred to a community

a. ACSM Exercise is Medicine PAVS (minutes per week of MVPA)

Question 1. On average, how many days per week do you engage in moderate-to-strenous exercise (like a brisk walk)?

_____days

Question 2. On average, how many minutes do you engage in exercise at this level?

_____minutes

PAVS (minutes per week) = _____ days × _____ minutes

b. YRBS physical activity question (days per week of ≥60 minutes of MVPA)

During the past 7 days, on how many days were you physically active for a total of ≥60 minutes/day (add up all the time you spent in any kind of physical activity that increased your heart rate and made you breathe hard some of the time)?

_____days

c. Intermountain Healthcare pediatric PAVS

On average, how many days per week does your child get ≥60 minutes of MVPA or play (heart beating faster than normal, breathing harder than normal)?

_____days/week

On most days of the week, does your child

- walk or bike to school? ____Yes ___No
- participate in physical education class at school? ____Yes ___No
- participate in organized physical activity (sports, dance, martial arts, etc) or spend 30 minutes or more playing outside? ____Yes ___No

On average, how many hours per day of recreational screen time (video games, television, Internet, phone, etc) does your child get?

_____hours/day

Is physical activity an area that you want to work on with your family to improve?

____Yes ___No

FIGURE 1

Brief office-based assessments of physical activity. Adapted from Joy EA, Lobelo F. Promoting the athlete in every child: physical activity assessment and promotion in healthcare. *Br J Sports Med*. 2017;51(3):143–145. Adapted from Exercise is Medicine. Healthcare providers' action guide. Available at: https://exerciseismedicine.org/assets/page_documents/Complete%20HCP%20Action%20Guide_2016_01_01.pdf. Accessed September 5, 2018. Adapted from Centers for Disease Control and Prevention. YRBS Questionnaire Content - 1991–2017. Available at: https://www.cdc.gov/healthyyouth/data/yrbs/pdf/2017/YRBS_questionnaire_content_1991-2017.pdf. Accessed September 5, 2018. ACSM, American College of Sports Medicine.

resource (such as a teacher or community center).[120] In addition, support staff could receive appropriate training to elaborate on a provider's physical activity prescription and connect patients with community and technology resources to fill the prescription.[120] Special emphasis on addressing barriers for CYSHCN may be needed to assist patients and families with underlying mobility issues.[168,169] Further guidance for CYSHCN may be found in the AAP clinical report "Promoting the Participation of Children With Disabilities in Sports, Recreation, and Physical Activities."[128]

Institutional support of pediatric physical therapists, occupational therapists, athletic trainers, exercise specialists, social workers, and other professionals is necessary to assist in addressing the needs of the children most at risk for inactivity, such as CYSHCN; children of minority, rural, and urban status who experience insufficient access or resources to physical activity; and adolescent girls.[116,170] Ideal partnerships result in access to programs that are safe, close to home, financially feasible, fun, and culturally appropriate and offer adaptive experiences and intellectually appropriate programming (eg, Special Olympics) so that children facing barriers receive the same opportunities as their peers (Table 6).[168]

Insurance companies can play a role by providing coverage for necessary services and reducing reasons for payment denials because improved physical literacy and physical activity, even for nonambulatory individuals, result in later health benefit and savings in health care expenditures.[171]

ROLE OF PHYSICIANS IN PROMOTING PEDIATRIC PHYSICAL ACTIVITY OUTSIDE OF DIRECT PATIENT CARE

Many patients, families, and community organizations look to pediatricians to provide physical activity recommendations for sports participation, modifications for children with special needs or an acute or chronic injury, and increasingly for management of many physical and behavioral conditions such as prediabetes and attention-deficit/hyperactivity disorder.[172] Yet many pediatricians may feel they do not have the experience or training needed to guide their patients toward meeting physical activity recommendations. In medical school, they likely received little to no training in exercise prescription.[173] Most did not fare any better in residency, with only 26% of pediatric residency programs reported having a curriculum in physical activity counseling, with the greatest barrier being the lack of faculty with training in physical activity counseling, limiting provider knowledge and self-efficacy.[174–176] Encouragingly, training pediatric residents in physical activity counseling has been shown to improve the physical activity of

TABLE 6 Resources for Pediatricians on Physical Activity Assessment and Counseling

Institute for Healthy Childhood Weight: http://ihcw.aap.org
Exercise is Medicine: www.exerciseismedicine.org
National Physical Activity Plan: http://www.physicalactivityplan.org
National Association of Physical Literacy: http://naplusa.org
SHAPE America: 2016 Shape of the Nation: https://www.shapeamerica.org/advocacy/son/default.aspx
Prescription for Activity: https://www.prescriptionforactivity.org/
Lifestyle Medicine Education Collaborative: http://lifestylemedicineeducation.org/
National Recreation and Park Association: "Prescribing Parks for Better Health Success Stories": https://www.nrpa.org/contentassets/f768428a39aa4035ae55b2aaff372617/final-prescribing-parks-for-better-health-success-stories.pdf
National Association for the Education of Young Children: https://www.naeyc.org/ (including *Developmentally Appropriate Practice in Early Childhood Programs Serving Children from Birth through Age 8, Third Edition*, as a resource for schools)

SHAPE, Society of Health and Physical Educators.

patients.[177] Implementing curricula and providing education is an effective first step (Table 7), which could be expanded to continuing medical education for practicing clinicians.

Clinicians have a responsibility to model physical activity for their patients and families through their own physical activity and community engagement. Several studies have shown that physicians' personal physical activity behaviors are an important correlate of their attitudes and clinical practice regarding physical activity.[178,179] Interestingly, the greatest predictor of asking about physical activity by pediatricians is being personally "fit and healthy" themselves.[180] In addition, physical activity is integral to personal well-being for the health care professional, improving quality of life and work-life balance and decreasing burnout.[181–184] The AAP has published a clinical report on the subject.[185]

RECOMMENDATIONS

Pediatricians are encouraged to promote physical literacy and activity in children and progress toward recommended physical activity guidelines in one or more of the following ways.

1. Assess and document gross motor skills and physical activity as appropriate at health care visits (Table 5, Fig 1).
   a. Assess gross motor skill development, physical literacy, and physical activity levels at all health supervision visits, with early referral to assess and treat identified delays or deficits (Table 4). A PAVS may be a useful screening tool to guide specific counseling (Fig 1).
   b. For CYSHCN, discuss physical activity prescription and any physical activity limitations with subspecialists who are sharing in a patient's care. Clearly document a patient's individual physical activity prescription so that other providers, therapists, caretakers, and parents can help a child implement the prescription.
   c. For children who are insufficiently active, identify barriers to activity and use behavioral strategies such as motivational interviewing to help patients and families identify doable strategies to increase activity.
2. Discuss the role and benefits of physical activity on physical and social growth and development and management of other health conditions as well as in mental health, school performance, behavioral management, and risk-behavior reduction specifically related to the patient.
3. Encourage parents to not only "do as I say" but also "do as I do" because children who grow up in families with active parents are much more likely to be active themselves.
4. Provide specific tools and resources to help families build skills. Assist families in overcoming barriers to physical activity by referring families to community advocates and community-based activity programs and other places to be active, such as sports clubs, recreation centers, parks, walking and biking trails, skate parks, and playgrounds.
5. Advocate with health care organizations, insurance providers, schools, and community organizations to increase opportunities for physical activity for all children.
   a. Encourage healthy child care centers and preschools to provide ample opportunities for children to move in ways

TABLE 7 Recommendations for Promoting Physical Activity Assessment and Counseling in Medical Education

1. Demonstrate assessment and counseling in practice for learners.
a. Primary care pediatricians and health care providers: general physical activity assessment and screening, counseling and goal-setting, and activity or exercise prescription and referral to community partners and resources.
b. Subspecialists: guidance on physical activity benefits and restrictions as related to relevant medical condition to patient, family, and other physicians involved in the patient's care.
2. Advocate for the inclusion of education regarding physical activity guidelines within medical school and residency training.
3. Advocate for the inclusion of education regarding physical activity counseling and exercise prescription as part of longitudinal curricula within medical school and residency training.

that they were designed to move, that is, in frequent, short bursts.

b. Support education policies that engineer physical education and literacy back into the school day and shared use policies that allow for safe, accessible, affordable access to recreational space.

c. Support the development of programs that provide resources for physical activity of children who are hospitalized (and their siblings) and for children needing additional resources to be physically active, such as CYSHCN and those who experience socioeconomic barriers.

6. Identify opportunities for physical activity assessment and prescription for children facing barriers to activity. Those most at risk for inactivity include children of minority, urban, and rural status, adolescent girls, and CYSHCN. In many cases, school-based physical activity interventions are the most promising approach to increase physical activity.[186]

7. Advocate for the inclusion of physical activity assessments within EHRs and use the assessments to provide patient-specific physical activity recommendations for pediatric patients.

a. Advocate for payment from public and private payers for administration of validated physical activity assessment instruments.

b. Investigate the type and effects of physical activity on health outcomes of pediatric patients.

8. Work with medical schools, residency programs, and health care institutions to develop curricula in exercise prescription and methods for physical activity assessment and prescription that include the recommended frequency, intensity, duration, and type of activity, taking into consideration the child's current health, fitness, and preferences (Table 7).

LEAD AUTHORS

Felipe Lobelo, MD, PhD
Natalie D. Muth, MD, MPH, FAAP, FACSM
Sara Hanson, PhD
Blaise A. Nemeth, MD, MS, FAAP

COUNCIL ON SPORTS MEDICINE AND FITNESS EXECUTIVE COMMITTEE, 2017–2018

Cynthia R. LaBella, MD, FAAP, Chairperson
M. Alison Brooks, MD, FAAP
Greg Canty, MD, FAAP
Alex B. Diamond, DO, MPH, FAAP
William Hennrikus, MD, FAAP
Kelsey Logan, MD, MPH, FAAP
Kody Moffatt, MD, FAAP
Blaise A. Nemeth, MD, MS, FAAP
K. Brooke Pengel, MD, FAAP
Andrew R. Peterson, MD, MSPH, FAAP
Paul R. Stricker, MD, FAAP

LIAISONS

Donald W. Bagnall – National Athletic Trainers' Association

STAFF

Anjie Emanuel, MPH

SECTION ON OBESITY EXECUTIVE COMMITTEE, 2017–2018

Christopher F. Bolling, MD, FAAP, Chairperson
Sarah Armstrong, MD, FAAP
Matthew Allen Haemer, MD, MPH, FAAP
Natalie D. Muth, MD, MPH, FAAP
John Rausch, MD, MPH, FAAP
Victoria Rogers, MD, FAAP
Stephanie Moore Walsh, MD, FAAP

LIAISON

Alyson B. Goodman, MD, MPH – *Centers for Disease Control and Prevention*

STAFF

Mala Thapar, MPH

ABBREVIATIONS

AAP: American Academy of Pediatrics
CYSHCN: children and youth with special health care needs
EHR: electronic health record
MVPA: moderate-to-vigorous physical activity
PACE+: Patient-centered Assessment and Counseling for Exercise plus Nutrition
PAVS: physical activity vital sign
YRBS: Youth Risk Behavior Survey

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

FINANCIAL DISCLOSURE: Dr Muth receives royalties from the American Academy of Pediatrics and F.A. Davis and previously had a consulting relationship with the American Council on Exercise; Drs Hanson, Lobelo, and Nemeth have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: No external funding.

POTENTIAL CONFLICT OF INTEREST: Dr Muth receives royalties from the American Academy of Pediatrics and F.A. Davis and previously had a consulting relationship with the American Council on Exercise; Drs Hanson, Lobelo, and Nemeth have indicated they have no potential conflicts of interest to disclose.

REFERENCES

1. Kann L, McManus T, Harris WA, et al. Youth risk behavior surveillance - United States, 2015. *MMWR Surveill Summ*. 2018;67(8):1–479
2. Bassett DR, John D, Conger SA, Fitzhugh EC, Coe DP. Trends in physical activity and sedentary behaviors of United States youth. *J Phys Act Health*. 2015;12(8):1102–1111
3. Woodmansee C, Hahne A, Imms C, Shields N. Comparing participation in physical recreation activities between children with disability and children with typical development: a secondary analysis of matched data. *Res Dev Disabil*. 2016;49–50:268–276
4. Troiano RP, Berrigan D, Dodd KW, Mâsse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc*. 2008;40(1):181–188
5. Li K, Haynie D, Lipsky L, Iannotti RJ, Pratt C, Simons-Morton B. Changes in moderate-to-vigorous physical activity among older adolescents. *Pediatrics*. 2016;138(4):e20161372
6. Mayer-Davis EJ, Lawrence JM, Dabelea D, et al; SEARCH for Diabetes in Youth Study. Incidence trends of type 1 and type 2 diabetes among youths, 2002-2012. *N Engl J Med*. 2017;376(15):1419–1429
7. Arias E, Heron M, Xu J. United States Life Tables, 2012. In: *Natl Vital Stat Rep*, vol. 65. 2016:1–65
8. Xu J, Murphy SL, Kochanek KD, Arias E. Mortality in the United States, 2015. In: *NCHS Data Brief*. 2016:1–8
9. Council on Sports Medicine and Fitness; Council on School Health. Active healthy living: prevention of childhood obesity through increased physical activity. *Pediatrics*. 2006; 117(5):1834–1842
10. Daniels SR, Hassink SG; Committee on Nutrition. The role of the pediatrician in primary prevention of obesity. *Pediatrics*. 2015;136(1). Available at: www.pediatrics.org/cgi/content/full/136/1/e275
11. Barlow SE; Expert Committee. Expert Committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics*. 2007;120(suppl 4): S164–S192
12. Styne DM, Arslanian SA, Connor EL, et al. Pediatric obesity-assessment, treatment, and prevention: an Endocrine Society clinical practice guideline. *J Clin Endocrinol Metab*. 2017;102(3):709–757
13. Spear BA, Barlow SE, Ervin C, et al. Recommendations for treatment of child and adolescent overweight and obesity. *Pediatrics*. 2007;120(suppl 4): S254–S288
14. Huang TT, Borowski LA, Liu B, et al. Pediatricians' and family physicians' weight-related care of children in the U.S. *Am J Prev Med*. 2011;41(1):24–32
15. US Department of Health and Human Services. Physical activity guidelines. 2008. Available at: www.health.gov/PAGuidelines. Accessed January 7, 2013
16. Hagan JF Jr, Shaw JS, Duncan PM, eds. *Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents*. 4th ed. Elk Grove, IL: American Academy of Pediatrics; 2017
17. US Department of Health and Human Services. *Physical Activity Guidelines for Americans*. 2nd ed. Washington, DC: US Department of Health and Human Services; 2018. Available at: https://health.gov/paguidelines/second-edition/pdf/Physical_Activity_Guidelines_2nd_edition.pdf. Accessed December 10, 2018
18. Morris JN, Heady JA, Raffle PA, Roberts CG, Parks JW. Coronary heart-disease and physical activity of work. *Lancet*. 1953;262(6796):1111–1120; concl
19. Herrmann SD, Angadi SS. Children's physical activity and sedentary time and cardiometabolic risk factors. *Clinical J Sport Med*. 2013;23(5): 408–409
20. Belcher BR, Berrigan D, Papachristopoulou A, et al. Effects of interrupting children's sedentary behaviors with activity on metabolic function: a randomized trial. *J Clin Endocrinol Metab*. 2015;100(10): 3735–3743
21. van der Baan-Slootweg O, Benninga MA, Beelen A, et al. Inpatient treatment of children and adolescents with severe obesity in the Netherlands: a randomized clinical trial. *JAMA Pediatr*. 2014;168(9):807–814
22. Davis CL, Pollock NK, Waller JL, et al. Exercise dose and diabetes risk in overweight and obese children: a randomized controlled trial. *JAMA*. 2012;308(11):1103–1112
23. Moore JB, Beets MW, Brazendale K, et al. Associations of vigorous-intensity physical activity with biomarkers in youth. *Med Sci Sports Exerc*. 2017;49(7): 1366–1374
24. Tarp J, Child A, White T, et al; International Children's Accelerometry Database (ICAD) Collaborators. Physical activity intensity, bout-duration, and cardiometabolic risk markers in children and adolescents [published correction appears in *Int J Obes (Lond)*. 2019;43(11):2346]. *Int J Obes (Lond)*. 2018;42(9):1639–1650
25. Sigal RJ, Alberga AS, Goldfield GS, et al. Effects of aerobic training, resistance training, or both on percentage body fat and cardiometabolic risk markers in obese adolescents: the healthy eating aerobic and resistance training in youth randomized clinical trial. *JAMA Pediatr*. 2014;168(11):1006–1014
26. Hind K, Burrows M. Weight-bearing exercise and bone mineral accrual in children and adolescents: a review of controlled trials. *Bone*. 2007;40(1): 14–27
27. Wu F, Callisaya M, Wills K, Laslett LL, Jones G, Winzenberg T. Both baseline and change in lower limb muscle strength in younger women are independent predictors of balance in middle age: a 12-year population-based prospective study. *J Bone Miner Res*. 2017;32(6):1201–1208
28. Collard DC, Verhagen EA, Chinapaw MJ, Knol DL, van Mechelen W. Effectiveness of a school-based physical activity injury prevention program: a cluster randomized controlled trial. *Arch Pediatr Adolesc Med*. 2010;164(2): 145–150
29. MacKelvie KJ, Khan KM, Petit MA, Janssen PA, McKay HA. A school-based exercise intervention elicits substantial bone health benefits: a 2-year randomized controlled trial in girls.

Pediatrics. 2003;112(6 pt 1). Available at: www.pediatrics.org/cgi/content/full/112/6/e447

30. Detter F, Rosengren BE, Dencker M, Lorentzon M, Nilsson J, Karlsson MK. A 6-year exercise program improves skeletal traits without affecting fracture risk: a prospective controlled study in 2621 children. *J Bone Miner Res*. 2014; 29(6):1325–1336

31. Physical Activity Guidelines Scientific Advisory Committee. *Physical Activity Guidelines Advisory Committee Report*. Washington, DC: US Department of Health and Human Services; 2018

32. Ali MM, Amialchuk A, Heller LR. The influence of physical activity on cigarette smoking among adolescents: evidence from Add Health. *Nicotine Tob Res*. 2015;17(5):539–545

33. Korhonen T, Kujala UM, Rose RJ, Kaprio J. Physical activity in adolescence as a predictor of alcohol and illicit drug use in early adulthood: a longitudinal population-based twin study. *Twin Res Hum Genet*. 2009;12(3):261–268

34. Korczak DJ, Madigan S, Colasanto M. Children's physical activity and depression: a meta-analysis. *Pediatrics*. 2017;139(4):e20162266

35. Van Dusen DP, Kelder SH, Kohl HW III, Ranjit N, Perry CL. Associations of physical fitness and academic performance among schoolchildren. *J Sch Health*. 2011;81(12):733–740

36. Mullender-Wijnsma MJ, Hartman E, de Greeff JW, Doolaard S, Bosker RJ, Visscher C. Physically active math and language lessons improve academic achievement: a cluster randomized controlled trial. *Pediatrics*. 2016;137(3): e20152743

37. Ardoy DN, Fernández-Rodríguez JM, Jiménez-Pavón D, Castillo R, Ruiz JR, Ortega FB. A physical education trial improves adolescents' cognitive performance and academic achievement: the EDUFIT study. *Scand J Med Sci Sports*. 2014;24(1):e52–e61

38. Martin A, Saunders DH, Shenkin SD, Sproule J. Lifestyle intervention for improving school achievement in overweight or obese children and adolescents. *Cochrane Database Syst Rev*. 2014;(3):CD009728

39. Bass RW, Brown DD, Laurson KR, Coleman MM. Physical fitness and academic performance in middle school students. *Acta Paediatr*. 2013; 102(8):832–837

40. Rauner RR, Walters RW, Avery M, Wanser TJ. Evidence that aerobic fitness is more salient than weight status in predicting standardized math and reading outcomes in fourth- through eighth-grade students. *J Pediatr*. 2013; 163(2):344–348

41. Lamming L, Pears S, Mason D, et al; VBI Programme Team. What do we know about brief interventions for physical activity that could be delivered in primary care consultations? A systematic review of reviews. *Prev Med*. 2017;99:152–163

42. Mahar MT. Impact of short bouts of physical activity on attention-to-task in elementary school children. *Prev Med*. 2011;52(suppl 1):S60–S64

43. Carlson JA, Engelberg JK, Cain KL, et al. Implementing classroom physical activity breaks: associations with student physical activity and classroom behavior. *Prev Med*. 2015;81:67–72

44. Silva AP, Prado SO, Scardovelli TA, Boschi SR, Campos LC, Frère AF. Measurement of the effect of physical exercise on the concentration of individuals with ADHD. *PLoS One*. 2015; 10(3):e0122119

45. Neely L, Rispoli M, Gerow S, Ninci J. Effects of antecedent exercise on academic engagement and stereotypy during instruction. *Behav Modif*. 2015; 39(1):98–116

46. Oriel KN, George CL, Peckus R, Semon A. The effects of aerobic exercise on academic engagement in young children with autism spectrum disorder. *Pediatr Phys Ther*. 2011;23(2): 187–193

47. McPherson M, Arango P, Fox H, et al. A new definition of children with special health care needs. *Pediatrics*. 1998; 102(1 pt 1):137–140

48. Schoenmakers MA, de Groot JF, Gorter JW, Hillaert JL, Helders PJ, Takken T. Muscle strength, aerobic capacity and physical activity in independent ambulating children with lumbosacral spina bifida. *Disabil Rehabil*. 2009;31(4): 259–266

49. Jansen M, van Alfen N, Geurts AC, de Groot IJ. Assisted bicycle training delays functional deterioration in boys with Duchenne muscular dystrophy: the randomized controlled trial "no use is disuse". *Neurorehabil Neural Repair*. 2013;27(9):816–827

50. Voet NB, van der Kooi EL, Riphagen II, Lindeman E, van Engelen BG, Geurts AC. Strength training and aerobic exercise training for muscle disease. *Cochrane Database Syst Rev*. 2010;(1):CD003907

51. Reus L, Pillen S, Pelzer BJ, et al. Growth hormone therapy, muscle thickness, and motor development in Prader-Willi syndrome: an RCT. *Pediatrics*. 2014; 134(6). Available at: www.pediatrics.org/cgi/content/full/134/6/e1619

52. Chad KE, Bailey DA, McKay HA, Zello GA, Snyder RE. The effect of a weight-bearing physical activity program on bone mineral content and estimated volumetric density in children with spastic cerebral palsy. *J Pediatr*. 1999; 135(1):115–117

53. Henderson RC, Lark RK, Gurka MJ, et al. Bone density and metabolism in children and adolescents with moderate to severe cerebral palsy. *Pediatrics*. 2002;110(1 pt 1). Available at: www.pediatrics.org/cgi/content/full/110/1/e5

54. Szalay EA, Cheema A. Children with spina bifida are at risk for low bone density. *Clin Orthop Relat Res*. 2011; 469(5):1253–1257

55. Coleman A, Weir KA, Ware RS, Boyd RN. Relationship between communication skills and gross motor function in preschool-aged children with cerebral palsy. *Arch Phys Med Rehabil*. 2013; 94(11):2210–2217

56. Visscher C, Houwen S, Scherder EJ, Moolenaar B, Hartman E. Motor profile of children with developmental speech and language disorders. *Pediatrics*. 2007;120(1). Available at: www.pediatrics.org/cgi/content/full/120/1/e158

57. Oudgenoeg-Paz O, Volman MC, Leseman PP. Attainment of sitting and walking predicts development of productive vocabulary between ages 16 and 28 months. *Infant Behav Dev*. 2012;35(4): 733–736

58. Oudgenoeg-Paz O, Volman MC, Leseman PP. First steps into language? Examining the specific longitudinal relations between walking, exploration and linguistic skills. *Front Psychol*. 2016;7: 1458

59. Apkon SD, Grady R, Hart S, et al. Advances in the care of children with spina bifida. *Adv Pediatr*. 2014;61(1): 33–74

60. Casey AF, Emes C. The effects of swim training on respiratory aspects of speech production in adolescents with down syndrome. *Adapt Phys Activ Q*. 2011;28(4):326–341

61. Pan CY, Tsai CL, Chu CH, Sung MC, Ma WY, Huang CY. Objectively measured physical activity and health-related physical fitness in secondary school-aged male students with autism spectrum disorders. *Phys Ther*. 2016; 96(4):511–520

62. Murphy NA, Carbone PS; American Academy of Pediatrics Council on Children With Disabilities. Promoting the participation of children with disabilities in sports, recreation, and physical activities. *Pediatrics*. 2008; 121(5):1057–1061

63. Mulrooney DA, Yeazel MW, Kawashima T, et al. Cardiac outcomes in a cohort of adult survivors of childhood and adolescent cancer: retrospective analysis of the Childhood Cancer Survivor Study cohort. *BMJ*. 2009;339: b4606

64. Järvelä LS, Kemppainen J, Niinikoski H, et al. Effects of a home-based exercise program on metabolic risk factors and fitness in long-term survivors of childhood acute lymphoblastic leukemia. *Pediatr Blood Cancer*. 2012; 59(1):155–160

65. Järvelä LS, Niinikoski H, Heinonen OJ, Lähteenmäki PM, Arola M, Kemppainen J. Endothelial function in long-term survivors of childhood acute lymphoblastic leukemia: effects of a home-based exercise program. *Pediatr Blood Cancer*. 2013;60(9): 1546–1551

66. Boas SR, Danduran MJ, McBride AL, McColley SA, O'Gorman MR. Postexercise immune correlates in children with and without cystic fibrosis. *Med Sci Sports Exerc*. 2000; 32(12):1997–2004

67. van de Weert-van Leeuwen PB, Slieker MG, Hulzebos HJ, Kruitwagen CL, van der Ent CK, Arets HG. Chronic infection and inflammation affect exercise capacity in cystic fibrosis. *Eur Respir J*. 2012;39(4):893–898

68. van de Weert-van Leeuwen PB, Hulzebos HJ, Werkman MS, et al. Chronic inflammation and infection associate with a lower exercise training response in cystic fibrosis adolescents. *Respir Med*. 2014;108(3):445–452

69. Selvadurai HC, Blimkie CJ, Meyers N, Mellis CM, Cooper PJ, Van Asperen PP. Randomized controlled study of in-hospital exercise training programs in children with cystic fibrosis. *Pediatr Pulmonol*. 2002;33(3):194–200

70. Duppen N, Etnel JR, Spaans L, et al. Does exercise training improve cardiopulmonary fitness and daily physical activity in children and young adults with corrected tetralogy of Fallot or Fontan circulation? A randomized controlled trial. *Am Heart J*. 2015; 170(3):606–614

71. Takken T, Giardini A, Reybrouck T, et al. Recommendations for physical activity, recreation sport, and exercise training in paediatric patients with congenital heart disease: a report from the Exercise, Basic & Translational Research Section of the European Association of Cardiovascular Prevention and Rehabilitation, the European Congenital Heart and Lung Exercise Group, and the Association for European Paediatric Cardiology. *Eur J Prev Cardiol*. 2012;19(5):1034–1065

72. Lantin-Hermoso MR, Berger S, Bhatt AB, et al; Section on Cardiology; Cardiac Surgery. The care of children with congenital heart disease in their primary medical home. *Pediatrics*. 2017;140(5):e20172607

73. McCambridge TM, Stricker PR; American Academy of Pediatrics Council on Sports Medicine and Fitness. Strength training by children and adolescents. *Pediatrics*. 2008;121(4): 835–840

74. US Department of Health and Human Services. Physical Activity Guidelines for Americans Midcourse Report: strategies to increase physical activity among youth. 2012. Available at: www.health.gov/paguidelines/midcourse/pag-mid-course-report-final.pdf. Accessed September 27, 2016

75. Lipnowski S, Leblanc CM; Canadian Paediatric Society, Healthy Active Living and Sports Medicine Committee. Healthy active living: physical activity guidelines for children and adolescents. *Paediatr Child Health*. 2012;17(4):209–212

76. Yogman M, Garner A, Hutchinson J, Hirsh-Pasek K, Golinkoff RM; Committee on Psychosocial Aspects of Child and Family Health; Council on Communications and Media. The power of play: a pediatric role in enhancing development in young children. *Pediatrics*. 2018;142(3):e20182058

77. American Academy of Pediatrics; American Public Health Association; National Resource Center for Health and Safety in Child Care and Early Education. *Preventing Childhood Obesity in Early Care and Education: Selected Standards From Caring for Our Children: National Health and Safety Performance Standards*, 4th ed. Itasca, IL: American Academy of Pediatrics; 2019

78. Garber CE, Blissmer B, Deschenes MR, et al; American College of Sports Medicine. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Med Sci Sports Exerc*. 2011;43(7):1334–1359

79. Jetté M, Sidney K, Blümchen G. Metabolic equivalents (METS) in exercise testing, exercise prescription, and evaluation of functional capacity. *Clin Cardiol*. 1990;13(8):555–565

80. Conger SA, Bassett DR. A compendium of energy costs of physical activities for individuals who use manual wheelchairs. *Adapt Phys Activ Q*. 2011; 28(4):310–325

81. Clanchy KM, Tweedy SM, Boyd RN, Trost SG. Validity of accelerometry in ambulatory children and adolescents with cerebral palsy. *Eur J Appl Physiol*. 2011;111(12):2951–2959

82. Butte NF, Watson KB, Ridley K, et al. A youth compendium of physical activities: activity codes and metabolic

intensities. *Med Sci Sports Exerc*. 2018; 50(2):246–256

83. Brenner JS; Council on Sports Medicine and Fitness. Sports specialization and intensive training in young athletes. *Pediatrics*. 2016;138(3):e20162148

84. Denny SA, Quan L, Gilchrist J, et al; Council on Injury, Violence, and Poison Prevention. Prevention of drowning. *Pediatrics*. 2019;143(5):e20190850

85. The Aspen Institute. Physical literacy in the United States: A model, strategic plan, and call to action. Available at: https://assets.aspeninstitute.org/content/uploads/files/content/docs/pubs/PhysicalLiteracy_AspenInstitute.pdf. Accessed January 18, 2020

86. 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):1019–1035

87. O' Brien W, Belton S, Issartel J. The relationship between adolescents' physical activity, fundamental movement skills and weight status. *J Sports Sci*. 2016;34(12):1159–1167

88. Jaakkola T, Yli-Piipari S, Huotari P, Watt A, Liukkonen J. Fundamental movement skills and physical fitness as predictors of physical activity: a 6-year follow-up study. *Scand J Med Sci Sports*. 2016; 26(1):74–81

89. Centers for Disease Control and Prevention. CDC's developmental milestones. Available at: https://www.cdc.gov/ncbddd/actearly/milestones/index.html. Accessed May 4, 2019

90. US Olympic and Paralympic Committee. American Development Model. Available at: https://www.teamusa.org/About-the-USOC/Programs/Coaching-Education/American-Development-Model. Accessed May 4, 2019

91. Martins J, Marques A, Sarmento H, Carreiro da Costa F. Adolescents' perspectives on the barriers and facilitators of physical activity: a systematic review of qualitative studies. *Health Educ Res*. 2015;30(5): 742–755

92. Belanger K, Barnes JD, Longmuir PE, et al. The relationship between physical literacy scores and adherence to Canadian physical activity and sedentary behaviour guidelines. *BMC Public Health*. 2018;18(suppl 2):1042

93. Lang JJ, Chaput JP, Longmuir PE, et al. Cardiorespiratory fitness is associated with physical literacy in a large sample of Canadian children aged 8 to 12 years. *BMC Public Health*. 2018; 18(suppl 2):1041

94. Hendrix CG, Prins MR, Dekkers H. Developmental coordination disorder and overweight and obesity in children: a systematic review. *Obes Rev*. 2014; 15(5):408–423

95. Cairney J, Hay JA, Faught BE, Hawes R. Developmental coordination disorder and overweight and obesity in children aged 9-14 y. *Int J Obes (Lond)*. 2005; 29(4):369–372

96. Myer GD, Faigenbaum AD, Stracciolini A, Hewett TE, Micheli LJ, Best TM. Exercise deficit disorder in youth: a paradigm shift toward disease prevention and comprehensive care. *Curr Sports Med Rep*. 2013;12(4):248–255

97. Kantomaa MT, Purtsi J, Taanila AM, et al. Suspected motor problems and low preference for active play in childhood are associated with physical inactivity and low fitness in adolescence. *PLoS One*. 2011;6(1):e14554

98. Farhat F, Masmoudi K, Hsairi I, et al. The effects of 8 weeks of motor skill training on cardiorespiratory fitness and endurance performance in children with developmental coordination disorder. *Appl Physiol Nutr Metab*. 2015;40(12):1269–1278

99. Faigenbaum AD, Rial Rebullido T, MacDonald JP. The unsolved problem of paediatric physical inactivity: it's time for a new perspective. *Acta Paediatr*. 2018;107(11):1857–1859

100. Society of Health and Physical Educators; American Heart Association. 2016 Shape of the Nation report: status of physical education in the USA. 2016. Available at: https://www.shapeamerica.org/advocacy/son/. Accessed May 4, 2019

101. Scerpella TA, Bernardoni B, Wang S, Rathouz PJ, Li Q, Dowthwaite JN. Site-specific, adult bone benefits attributed to loading during youth: a preliminary longitudinal analysis. *Bone*. 2016;85: 148–159

102. Tenforde AS, Sainani KL, Carter Sayres L, Milgrom C, Fredericson M. Participation in ball sports may represent a prehabilitation strategy to prevent future stress fractures and promote bone health in young athletes. *PM R*. 2015;7(2):222–225

103. Cawthon PM, Fullman RL, Marshall L, et al; Osteoporotic Fractures in Men (MrOS) Research Group. Physical performance and risk of hip fractures in older men. *J Bone Miner Res*. 2008; 23(7):1037–1044

104. Binkley N, Krueger D, Buehring B. What's in a name revisited: should osteoporosis and sarcopenia be considered components of "dysmobility syndrome?". *Osteoporos Int*. 2013; 24(12):2955–2959

105. Faigenbaum AD, Rebullido TR, MacDonald JP. Pediatric inactivity triad: a risky PIT. *Curr Sports Med Rep*. 2018; 17(2):45–47

106. Dolinsky DH, Brouwer RJ, Evenson KR, Siega-Riz AM, Østbye T. Correlates of sedentary time and physical activity among preschool-aged children. *Prev Chronic Dis*. 2011;8(6):A131

107. Kaiser Family Foundation. Generation M2: media in the lives of 8- to 18-year-olds. 2010. Available at: http://kff.org/other/event/generation-m2-media-in-the-lives-of/. Accessed September 29, 2016

108. Biswas A, Oh PI, Faulkner GE, et al. Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults: a systematic review and meta-analysis [published correction appears in *Ann Intern Med*. 2015;163(5):400]. *Ann Intern Med*. 2015;162(2):123–132

109. Lobenius-Palmér K, Sjöqvist B, Hurtig-Wennlöf A, Lundqvist LO. Accelerometer-assessed physical activity and sedentary time in youth with disabilities. *Adapt Phys Activ Q*. 2018; 35(1):1–19

110. Cliff DP, Hesketh KD, Vella SA, et al. Objectively measured sedentary behaviour and health and development in children and adolescents: systematic review and meta-analysis. *Obes Rev*. 2016;17(4):330–344

111. Biddiss E, Irwin J. Active video games to promote physical activity in children

and youth: a systematic review. *Arch Pediatr Adolesc Med*. 2010;164(7):664–672

112. Barnett A, Cerin E, Baranowski T. Active video games for youth: a systematic review. *J Phys Act Health*. 2011;8(5):724–737

113. Lamboglia CM, da Silva VT, de Vasconcelos Filho JE, et al. Exergaming as a strategic tool in the fight against childhood obesity: a systematic review. *J Obes*. 2013;2013:438364

114. Council on Communications and Media. Media use in school-aged children and adolescents. *Pediatrics*. 2016;138(5):e20162592

115. Lobelo F, Stoutenberg M, Hutber A. The exercise is medicine global health initiative: a 2014 update. *Br J Sports Med*. 2014;48(22):1627–1633

116. Vuori IM, Lavie CJ, Blair SN. Physical activity promotion in the health care system. *Mayo Clinic Proc*. 2013;88(12):1446–1461

117. Orrow G, Kinmonth AL, Sanderson S, Sutton S. Effectiveness of physical activity promotion based in primary care: systematic review and meta-analysis of randomised controlled trials. *BMJ*. 2012;344:e1389

118. Williams NH, Hendry M, France B, Lewis R, Wilkinson C. Effectiveness of exercise-referral schemes to promote physical activity in adults: systematic review. *Br J Gen Pract*. 2007;57(545):979–986

119. Sanchez A, Bully P, Martinez C, Grandes G. Effectiveness of physical activity promotion interventions in primary care: a review of reviews. *Prev Med*. 2015;76(suppl):S56–S67

120. Lobelo F, Rohm Young D, Sallis R, et al; American Heart Association Physical Activity Committee of the Council on Lifestyle and Cardiometabolic Health; Council on Epidemiology and Prevention; Council on Clinical Cardiology; Council on Genomic and Precision Medicine; Council on Cardiovascular Surgery and Anesthesia; and Stroke Council. Routine assessment and promotion of physical activity in healthcare settings: a scientific statement from the American Heart Association. *Circulation*. 2018;137(18):e495–e522

121. Eakin EG, Brown WJ, Marshall AL, Mummery K, Larsen E. Physical activity promotion in primary care: bridging the gap between research and practice. *Am J Prev Med*. 2004;27(4):297–303

122. Grandes G, Sanchez A, Sanchez-Pinilla RO, et al; PEPAF Group. Effectiveness of physical activity advice and prescription by physicians in routine primary care: a cluster randomized trial. *Arch Intern Med*. 2009;169(7):694–701

123. Aittasalo M, Miilunpalo S, Kukkonen-Harjula K, Pasanen M. A randomized intervention of physical activity promotion and patient self-monitoring in primary health care. *Prev Med*. 2006;42(1):40–46

124. Garrett S, Elley CR, Rose SB, O'Dea D, Lawton BA, Dowell AC. Are physical activity interventions in primary care and the community cost-effective? A systematic review of the evidence. *Br J Gen Pract*. 2011;61(584):e125–e133

125. Murphy SM, Edwards RT, Williams N, et al. An evaluation of the effectiveness and cost effectiveness of the National Exercise Referral Scheme in Wales, UK: a randomised controlled trial of a public health policy initiative. *J Epidemiol Community Health*. 2012;66(8):745–753

126. Hogg WE, Zhao X, Angus D, et al. The cost of integrating a physical activity counselor in the primary health care team. *J Am Board Fam Med*. 2012;25(2):250–252

127. Anokye NK, Lord J, Fox-Rushby J. Is brief advice in primary care a cost-effective way to promote physical activity? *Br J Sports Med*. 2014;48(3):202–206

128. Edwards RT, Linck P, Hounsome N, et al. Cost-effectiveness of a national exercise referral programme for primary care patients in Wales: results of a randomised controlled trial. *BMC Public Health*. 2013;13:1021

129. Nguyen HQ, Ackermann RT, Maciejewski M, et al. Managed-Medicare health club benefit and reduced health care costs among older adults. *Prev Chronic Dis*. 2008;5(1):A14

130. Ackermann RT, Williams B, Nguyen HQ, Berke EM, Maciejewski ML, LoGerfo JP. Healthcare cost differences with participation in a community-based group physical activity benefit for Medicare managed care health plan members. *J Am Geriatr Soc*. 2008;56(8):1459–1465

131. Meriwether RA, Lobelo F, Pate RR. Themed review: clinical interventions to promote physical activity in youth. *Am J Lifestyle Med*. 2008;2(1):7–25

132. Patrick K, Calfas KJ, Norman GJ, et al. Randomized controlled trial of a primary care and home-based intervention for physical activity and nutrition behaviors: PACE+ for adolescents. *Arch Pediatr Adolesc Med*. 2006;160(2):128–136

133. National Committee for Quality Assurance. *Weight Assessment and Counseling for Nutrition and Physical Activity for Children/Adolescents (WCC)*. Washington, DC: National Committee for Quality Assurance

134. Grossman DC, Bibbins-Domingo K, Curry SJ, et al; US Preventive Services Task Force. Screening for Obesity in Children and Adolescents: US Preventive Services Task Force Recommendation Statement. *JAMA*. 2017;317(23):2417–2426

135. Yazdani S, Yee CT, Chung PJ. Factors predicting physical activity among children with special needs. *Prev Chronic Dis*. 2013;10:E119

136. Logan K, Cuff S; Council on Sports Medicine and Fitness. Organized sports for children, preadolescents, and adolescents. *Pediatrics*. 2019;143(6):e20190997

137. LaPrade RF, Agel J, Baker J, et al. AOSSM early sport specialization consensus statement. *Orthop J Sports Med*. 2016;4(4):2325967116644241

138. Jayanthi NA, LaBella CR, Fischer D, Pasulka J, Dugas LR. Sports-specialized intensive training and the risk of injury in young athletes: a clinical case-control study. *Am J Sports Med*. 2015;43(4):794–801

139. Tremblay MS, Gray C, Babcock S, et al. Position statement on active outdoor play. *Int J Environ Res Public Health*. 2015;12(6):6475–6505

140. Aggio D, Gardner B, Roberts J, et al. Correlates of children's independent outdoor play: cross-sectional analyses from the Millennium Cohort Study. *Prev Med Rep*. 2017;8:10–14

141. Pate RR, Davis MG, Robinson TN, Stone EJ, McKenzie TL, Young JC; American Heart Association Council on Nutrition, Physical Activity, and Metabolism (Physical Activity Committee); Council on Cardiovascular Disease in the Young; Council on Cardiovascular Nursing. Promoting physical activity in children and youth: a leadership role for schools: a scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism (Physical Activity Committee) in collaboration with the Councils on Cardiovascular Disease in the Young and Cardiovascular Nursing. *Circulation*. 2006;114(11):1214–1224

142. Jin J, Yun J, Agiovlasitis S. Impact of enjoyment on physical activity and health among children with disabilities in schools. *Disabil Health J*. 2018;11(1):14–19

143. Sutherland R, Campbell E, Lubans DR, et al. Physical education in secondary schools located in low-income communities: physical activity levels, lesson context and teacher interaction. *J Sci Med Sport*. 2016;19(2):135–141

144. Hollis JL, Williams AJ, Sutherland R, et al. A systematic review and meta-analysis of moderate-to-vigorous physical activity levels in elementary school physical education lessons. *Prev Med*. 2016;86:34–54

145. Beets MW, Banda JA, Erwin HE, Beighle A. A pictorial view of the physical activity socialization of young adolescents outside of school. *Res Q Exerc Sport*. 2011;82(4):769–778

146. Dobbins M, Husson H, DeCorby K, LaRocca RL. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. *Cochrane Database Syst Rev*. 2013;(2):CD007651

147. Murray R, Ramstetter C; Council on School Health; American Academy of Pediatrics. The crucial role of recess in school. *Pediatrics*. 2013;131(1):183–188

148. Cradock AL, Barrett JL, Giles CM, et al. Promoting physical activity with the Out of School Nutrition and Physical Activity (OSNAP) Initiative: a cluster-randomized controlled trial. *JAMA Pediatr*. 2016;170(2):155–162

149. Madsen K, Thompson H, Adkins A, Crawford Y. School-community partnerships: a cluster-randomized trial of an after-school soccer program. *JAMA Pediatr*. 2013;167(4):321–326

150. Harmon BE. Rethinking physical activity for children: implications for the working poor. *Transl Behav Med*. 2017;7(1):69–71

151. Joy EA, Lobelo F. Promoting the athlete in every child: physical activity assessment and promotion in healthcare. *Br J Sports Med*. 2017;51(3):143–145

152. Sallis RE, Baggish AL, Franklin BA, Whitehead JR. The call for a physical activity vital sign in clinical practice. *Am J Med*. 2016;129(9):903–905

153. Sallis R. Exercise is medicine: a call to action for physicians to assess and prescribe exercise. *Phys Sportsmed*. 2015;43(1):22–26

154. Sallis RE, Matuszak JM, Baggish AL, et al. Call to action on making physical activity assessment and prescription a medical standard of care. *Curr Sports Med Rep*. 2016;15(3):207–214

155. Coleman KJ, Ngor E, Reynolds K, et al. Initial validation of an exercise "vital sign" in electronic medical records. *Med Sci Sports Exerc*. 2012;44(11):2071–2076

156. Ball TJ, Joy EA, Gren LH, Shaw JM. Concurrent validity of a self-reported physical activity "vital sign" questionnaire with adult primary care patients. *Prev Chronic Dis*. 2016;13:E16

157. Ball TJ, Joy EA, Goh TL, Hannon JC, Gren LH, Shaw JM. Validity of two brief primary care physical activity questionnaires with accelerometry in clinic staff. *Prim Health Care Res Dev*. 2015;16(1):100–108

158. Grant RW, Schmittdiel JA, Neugebauer RS, Uratsu CS, Sternfeld B. Exercise as a vital sign: a quasi-experimental analysis of a health system intervention to collect patient-reported exercise levels. *J Gen Intern Med*. 2014;29(2):341–348

159. Mann DM, Palmisano J, Lin JJ. A pilot randomized trial of technology-assisted goal setting to improve physical activity among primary care patients with prediabetes. *Prev Med Rep*. 2016;4:107–112

160. Institute of Medicine. *Capturing Social and Behavioral Domains and Measures in Electronic Health Records: Phase 1*. Washington, DC: National Academies Press; 2014

161. Rangul V, Holmen TL, Kurtze N, Cuypers K, Midthjell K. Reliability and validity of two frequently used self-administered physical activity questionnaires in adolescents. *BMC Med Res Methodol*. 2008;8:47

162. Ekelund U, Tomkinson G, Armstrong N. What proportion of youth are physically active? Measurement issues, levels and recent time trends. *Br J Sports Med*. 2011;45(11):859–865

163. Sallis JF. Self-report measures of children's physical activity. *J Sch Health*. 1991;61(5):215–219

164. Leek D, Carlson JA, Cain KL, et al. Physical activity during youth sports practices. *Arch Pediatr Adolesc Med*. 2011;165(4):294–299

165. AuYoung M, Linke SE, Pagoto S, et al. Integrating physical activity in primary care practice. *Am J Med*. 2016;129(10):1022–1029

166. McGlynn EA, Lieu TA, Durham ML, et al. Developing a data infrastructure for a learning health system: the PORTAL network. *J Am Med Inform Assoc*. 2014;21(4):596–601

167. Adirim T, Meade K, Mistry K; Council on Quality Improvement and Patient Safety; Committee on Practice and Ambulatory Management. A new era in quality measurement: the development and application of quality measures. *Pediatrics*. 2017;139(1):e20163442

168. Buffart LM, Westendorp T, van den Berg-Emons RJ, Stam HJ, Roebroeck ME. Perceived barriers to and facilitators of physical activity in young adults with childhood-onset physical disabilities. *J Rehabil Med*. 2009;41(11):881–885

169. Shields N, Synnot A. Perceived barriers and facilitators to participation in physical activity for children with disability: a qualitative study. *BMC Pediatr*. 2016;16:9

170. Bloemen MA, Verschuren O, van Mechelen C, et al. Personal and environmental factors to consider when aiming to improve participation in physical activity in children with

spina bifida: a qualitative study. *BMC Neurol*. 2015;15:11

171. Cradock AL, Barrett JL, Kenney EL, et al. Using cost-effectiveness analysis to prioritize policy and programmatic approaches to physical activity promotion and obesity prevention in childhood. *Prev Med*. 2017;95(suppl): S17–S27

172. Leijon ME, Stark-Ekman D, Nilsen P, et al. Is there a demand for physical activity interventions provided by the health care sector? Findings from a population survey. *BMC Public Health*. 2010;10:34

173. Connaughton AV, Weiler RM, Connaughton DP. Graduating medical students' exercise prescription competence as perceived by deans and directors of medical education in the United States: implications for Healthy People 2010. *Public Health Rep*. 2001; 116(3):226–234

174. Cardinal BJ, Park EA, Kim M, Cardinal MK. If exercise is medicine, where is exercise in medicine? Review of U.S. medical education curricula for physical activity-related content. *J Phys Act Health*. 2015;12(9):1336–1343

175. Stoutenberg M, Stasi S, Stamatakis E, et al. Physical activity training in US medical schools: preparing future physicians to engage in primary prevention. *Phys Sportsmed*. 2015; 43(4):388–394

176. Goff SL, Holboe ES, Concato J. Pediatricians and physical activity counseling: how does residency prepare them for this task? *Teach Learn Med*. 2010;22(2):107–111

177. Stahl CE, Necheles JW, Mayefsky JH, Wright LK, Rankin KM. 5-4-3-2-1 go! Coordinating pediatric resident education and community health promotion to address the obesity epidemic in children and youth. *Clin Pediatr (Phila)*. 2011;50(3):215–224

178. Lobelo F, Duperly J, Frank E. Physical activity habits of doctors and medical students influence their counselling practices. *Br J Sports Med*. 2009;43(2): 89–92

179. Lobelo F, de Quevedo IG. The evidence in support of physicians and health care providers as physical activity role models. *Am J Lifestyle Med*. 2016;10(1): 36–52

180. Binns HJ, Mueller MM, Ariza AJ. Healthy and fit for prevention: the influence of clinician health and fitness on promotion of healthy lifestyles during health supervision visits. *Clin Pediatr (Phila)*. 2007;46(9):780–786

181. Dyrbye LN, Satele D, Shanafelt TD. Healthy exercise habits are associated with lower risk of burnout and higher quality of life among U.S. medical students. *Acad Med*. 2017;92(7): 1006–1011

182. Olson SM, Odo NU, Duran AM, Pereira AG, Mandel JH. Burnout and physical activity in Minnesota internal medicine resident physicians. *J Grad Med Educ*. 2014;6(4):669–674

183. Weight CJ, Sellon JL, Lessard-Anderson CR, Shanafelt TD, Olsen KD, Laskowski ER. Physical activity, quality of life, and burnout among physician trainees: the effect of a team-based, incentivized exercise program. *Mayo Clin Proc*. 2013; 88(12):1435–1442

184. Jonsdottir IH, Rödjer L, Hadzibajramovic E, Börjesson M, Ahlborg G Jr.. A prospective study of leisure-time physical activity and mental health in Swedish health care workers and social insurance officers. *Prev Med*. 2010;51(5):373–377

185. McClafferty H, Brown OW; Section on Integrative Medicine; Committee on Practice and Ambulatory Medicine; Section on Integrative Medicine. Physician health and wellness. *Pediatrics*. 2014;134(4):830–835

186. Owen MB, Curry WB, Kerner C, Newson L, Fairclough SJ. The effectiveness of school-based physical activity interventions for adolescent girls: a systematic review and meta-analysis. *Prev Med*. 2017;105:237–249

187. Chinapaw MJ, Mokkink LB, van Poppel MN, van Mechelen W, Terwee CB. Physical activity questionnaires for youth: a systematic review of measurement properties. *Sports Med*. 2010;40(7):539–563

188. Adamo KB, Prince SA, Tricco AC, Connor-Gorber S, Tremblay M. A comparison of indirect versus direct measures for assessing physical activity in the pediatric population: a systematic review. *Int J Pediatr Obes*. 2009;4(1): 2–27

189. Helmerhorst HJ, Brage S, Warren J, Besson H, Ekelund U. A systematic review of reliability and objective criterion-related validity of physical activity questionnaires. *Int J Behav Nutr Phys Act*. 2012;9:103

190. Cancela JM, Ayán C, Castro A. An evaluation of questionnaires assessing physical activity levels in youth populations. *J Child Health Care*. 2013; 17(3):274–293

191. Biddle SJ, Gorely T, Pearson N, Bull FC. An assessment of self-reported physical activity instruments in young people for population surveillance: Project ALPHA. *Int J Behav Nutr Phys Act*. 2011;8:1

192. Strath SJ, Kaminsky LA, Ainsworth BE, et al; American Heart Association Physical Activity Committee of the Council on Lifestyle and Cardiometabolic Health and Cardiovascular, Exercise, Cardiac Rehabilitation and Prevention Committee of the Council on Clinical Cardiology, and Council. Guide to the assessment of physical activity: clinical and research applications: a scientific statement from the American Heart Association. *Circulation*. 2013;128(20): 2259–2279

193. Booth ML, Okely AD, Chey T, Bauman A. The reliability and validity of the physical activity questions in the WHO Health Behaviour in Schoolchildren (HBSC) survey: a population study. *Br J Sports Med*. 2001;35(4):263–267

194. Crocker PR, Bailey DA, Faulkner RA, Kowalski KC, McGrath R. Measuring general levels of physical activity: preliminary evidence for the Physical Activity Questionnaire for Older Children. *Med Sci Sports Exerc*. 1997; 29(10):1344–1349

195. Bacardi-Gascón M, Reveles-Rojas C, Woodward-Lopez G, Crawford P, Jiménez-Cruz A. Assessing the validity of a physical activity questionnaire developed for parents of preschool children in Mexico. *J Health Popul Nutr*. 2012;30(4):439–446

196. Brener ND, Kann L, McManus T, Kinchen SA, Sundberg EC, Ross JG. Reliability of the 1999 Youth Risk Behavior Survey questionnaire. *J Adolesc Health*. 2002; 31(4):336–342

197. Brener ND, Collins JL, Kann L, Warren CW, Williams BI. Reliability of the Youth

Risk Behavior Survey questionnaire. *Am J Epidemiol*. 1995;141(6):575–580

198. Troped PJ, Wiecha JL, Fragala MS, et al. Reliability and validity of YRBS physical activity items among middle school students. *Med Sci Sports Exerc*. 2007; 39(3):416–425

199. Prochaska JJ, Sallis JF, Long B. A physical activity screening measure for use with adolescents in primary care. *Arch Pediatr Adolesc Med*. 2001;155(5): 554–559

200. Martínez-Gómez D, Martínez-De-Haro V, Del-Campo J, et al. [Validity of four questionnaires to assess physical activity in Spanish adolescents] [in Spanish]. *Gac Sanit*. 2009;23(6):512–517

201. Ridgers ND, Timperio A, Crawford D, Salmon J. Validity of a brief self-report instrument for assessing compliance with physical activity guidelines amongst adolescents. *J Sci Med Sport*. 2012;15(2):136–141

202. Liu Y, Wang M, Tynjälä J, et al. Test-retest reliability of selected items of Health Behaviour in School-aged Children (HBSC) survey questionnaire in Beijing, China. *BMC Med Res Methodol*. 2010;10: 73

203. Hardie Murphy M, Rowe DA, Belton S, Woods CB. Validity of a two-item physical activity questionnaire for assessing attainment of physical activity guidelines in youth. *BMC Public Health*. 2015;15:1080

204. Patrick K, Sallis JF, Prochaska JJ, et al. A multicomponent program for nutrition and physical activity change in primary care: PACE+ for adolescents. *Arch Pediatr Adolesc Med*. 2001;155(8): 940–946

205. World Health Organization. *Global School-Based Student Health Survey (GSHS)*. Geneva, Switzerland: World Health Organization; 2013

206. Haug E, Rasmussen M, Samdal O, et al; HBSC Obesity Writing Group. Overweight in school-aged children and its relationship with demographic and lifestyle factors: results from the WHO-Collaborative Health Behaviour in School-aged Children (HBSC) study. *Int J Public Health*. 2009;54(suppl 2): 167–179

207. Pate RR, McIver KL, Dowda M, Schenkelberg MA, Beets MV, Distefano C. EASY-an instrument for surveillance of physical activity in youth. *Med Sci Sports Exerc*. 2018;50(6):1216–1223

208. Trost SG, O'Neil M. Clinical use of objective measures of physical activity. *Br J Sports Med*. 2014;48(3):178–181

209. Guthrie N, Bradlyn A, Thompson SK, et al. Development of an accelerometer-linked online intervention system to promote physical activity in adolescents. *PLoS One*. 2015;10(5): e0128639

210. Lobelo F, Kelli HM, Tejedor SC, et al. The wild wild West: a framework to integrate mHealth software applications and wearables to support physical activity assessment, counseling and interventions for cardiovascular disease risk reduction. *Prog Cardiovasc Dis*. 2016;58(6): 584–594

211. Paridon SM, Alpert BS, Boas SR, et al; American Heart Association Council on Cardiovascular Disease in the Young, Committee on Atherosclerosis, Hypertension, and Obesity in Youth. Clinical stress testing in the pediatric age group: a statement from the American Heart Association Council on Cardiovascular Disease in the Young, Committee on Atherosclerosis, Hypertension, and Obesity in Youth. *Circulation*. 2006;113(15):1905–1920

212. Welk GJ, Going SB, Morrow JR Jr., Meredith MD. Development of new criterion-referenced fitness standards in the FITNESSGRAM® program: rationale and conceptual overview. *Am J Prev Med*. 2011;41(4 suppl 2):S63–S67

213. Lobelo F, Pate RR, Dowda M, Liese AD, Ruiz JR. Validity of cardiorespiratory fitness criterion-referenced standards for adolescents. *Med Sci Sports Exerc*. 2009;41(6):1222–1229

214. 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

215. Bai Y, Saint-Maurice PF, Welk GJ, Allums-Featherston K, Candelaria N, Anderson K. Prevalence of youth fitness in the United States: baseline results from the NFL PLAY 60 FITNESSGRAM Partnership Project. *J Pediatr*. 2015;167(3):662–668

216. Janz KF, Broffitt B, Levy SM. Validation evidence for the Netherlands physical activity questionnaire for young children: the Iowa Bone Development Study. *Res Q Exerc Sport*. 2005;76(3): 363–369

217. Chen X, Sekine M, Hamanishi S, et al. Validation of a self-reported physical activity questionnaire for schoolchildren. *J Epidemiol*. 2003;13(5): 278–287

218. Godin G, Shephard RJ. A simple method to assess exercise behavior in the community. *Can J Appl Sport Sci*. 1985; 10(3):141–146

219. Sallis JF, Buono MJ, Roby JJ, Micale FG, Nelson JA. Seven-day recall and other physical activity self-reports in children and adolescents. *Med Sci Sports Exerc*. 1993;25(1):99–108

220. Fulkerson JA, Sherwood NE, Perry CL, Neumark-Sztainer D, Story M. Depressive symptoms and adolescent eating and health behaviors: a multifaceted view in a population-based sample. *Prev Med*. 2004;38(6): 865–875

221. Gao S, Harnack L, Schmitz K, et al. Reliability and validity of a brief tool to measure children's physical activity. *J Phys Act Health*. 2006;3(4):415–422

222. Scerpella TA, Tuladhar P, Kanaley JA. Validation of the Godin-Shephard Questionnaire in prepubertal girls. *Med Sci Sports Exerc*. 2002;34(5):845–850

223. Koo MM, Rohan TE. Comparison of four habitual physical activity questionnaires in girls aged 7-15 yr. *Med Sci Sports Exerc*. 1999;31(3): 421–427

224. Janz KF, Witt J, Mahoney LT. The stability of children's physical activity as measured by accelerometry and self-report. *Med Sci Sports Exerc*. 1995; 27(9):1326–1332

225. Treuth MS, Hou N, Young DR, Maynard LM. Validity and reliability of the Fels Physical Activity Questionnaire for children. *Med Sci Sports Exerc*. 2005; 37(3):488–495

226. Burdette HL, Whitaker RC, Daniels SR. Parental report of outdoor playtime as a measure of physical activity in preschool-aged children. *Arch Pediatr Adolesc Med*. 2004;158(4):353–357

227. Schmidt GJ, Walkuski JJ, Stensel DJ. The Singapore Youth Coronary Risk and Physical Activity study. *Med Sci Sports Exerc*. 1998;30(1): 105–113

228. Ihmels MA, Welk GJ, Eisenmann JC, Nusser SM. Development and preliminary validation of a Family Nutrition and Physical Activity (FNPA) Screening Tool. *Int J Behav Nutr Phys Act*. 2009;6:14

229. Christison AL, Daley BM, Asche CV, et al. Pairing motivational interviewing with a nutrition and physical activity assessment and counseling tool in pediatric clinical practice: a pilot study. *Child Obes*. 2014;10(5):432–441

230. Janz KF, Lutuchy EM, Wenthe P, Levy SM. Measuring activity in children and adolescents using self-report: PAQ-C and PAQ-A. *Med Sci Sports Exerc*. 2008; 40(4):767–772

231. Park JM, Han AK, Cho YH. Construct equivalence and latent means analysis of health behaviors between male and female middle school students. *Asian Nurs Res (Korean Soc Nurs Sci)*. 2011; 5(4):216–221

232. Fernald DH, Froshaug DB, Dickinson LM, et al. Common Measures, Better Outcomes (COMBO): a field test of brief health behavior measures in primary care. *Am J Prev Med*. 2008;35(5 suppl):S414–S422