CURRENT PROBLEMS IN

Pediatric and Adolescent health care

Using Nature and Outdoor Activity to Improve Children's Health

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Foreword

Within just 1 generation, the definition of "play" has changed dramatically among children in industrialized countries. Before the first computer games became available in the early 1980s, when the weather was pleasant, children were usually encouraged to play outside. Organized games such as kickball and baseball were played in neighborhood parks and school yards; children also engaged in less organized play—building tree houses and exploring in and near rivers and ponds. Many parents had a hard time getting children to come indoors at dinnertime.

With the explosion of personal computer use in the home, play has taken on a different connotation: it often means playing virtual games on electronic devices. A January 2010 report from the Kaiser Family Foundation documented that 8- to 18-year-old children now spend an average of more than 7.5 hours per day interacting with the screen of a computer or a television or listening to songs on their iPods. This not only deprives them of the opportunity to interact face to face with others, but it often keeps them indoors, thus depriving them of contact with nature. In this month's article, McCurdy and her colleagues synthesize the literature on the salutary effects of children's interactions with the natural environment.

The benefits of being outdoors have been known since ancient times. Beginning in the late 1800s, physicians in Germany, France, and Switzerland recommended mountain air as a treatment for patients with pulmonary tuberculosis. Now, a century later, pediatricians and the public are again paying attention to the issue; an emerging body of literature indicates that being outdoors in nature is increasingly important for children raised in highly industrialized urban environments. I commend this article to you because it presents the evidence for this relationship and appears within a few months of First Lady Michelle Obama's launch of the "Let's Move" campaign to solve the problem of childhood obesity within a generation. More information about that campaign is available at http://www.letsmove.gov/.

Ruth A. Etzel, MD, PhD
Associate Editor

Using Nature and Outdoor Activity to Improve Children's Health

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Childhood obesity affects 17% or 12.5 million of America's children, contributing to the rise in children's health disparities. Type 2 diabetes, asthma, vitamin D deficiency, and attention-deficit/hyperactivity disorder have also increased over the past few decades. A shift toward a sedentary lifestyle is a major contributor to the decline in children's health. Children spend more time indoors using electronic media and less time engaged in outdoor unstructured play. This article reviews the current evidence of the mental and physical health benefits associated with unstructured, outdoor activities and time spent in a natural environment such as a park or other recreational area. Pediatric health care providers should recommend outdoor activities for children and refer families to safe and easily accessible outdoor areas. Pediatric health care providers can incorporate this simple, lifestyle-based intervention into anticipatory guidance.

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Today's children may be the first generation at risk of having a shorter lifespan than their parents.[1] An increase in sedentary indoor lifestyles has contributed to childhood chronic conditions such as childhood obesity, asthma, attention-deficit/hyperactivity disorder (ADHD), and vitamin D deficiency, all of which have increased in prevalence in the US over the past few decades.[2,3] Such conditions may lead to pulmonary, cardiovascular, and mental health problems that can persist into adulthood. While myriad advances in pediatric health care have been made over the past few decades, they have been accompanied by vast increases in chronic health issues. The increase in chronic health conditions is disproportionately affecting children of minority and low-socioeconomic communities, creating increased disparities in children's health. More focus is needed on sustainable, long-term prevention methods that promote healthy lifestyle changes. More emphasis on promotion of outdoor activity in nature is needed in children's health care.

A critical dialogue has emerged in both the public health and the environmental education communities about the benefits of nature for children. Richard Louv, author of *Last Child in the Woods*,[4] coined the term "nature-deficit disorder" to describe children's lack of outdoor activity, replaced by electronic media and a demanding school schedule. These lifestyle changes have promoted physical inactivity, have social and psychological ramifications, and have aided in the increasing chronic disease trend. Meanwhile, a growing body of evidence has suggested that exposure to nature may directly benefit health. There is also a strong body of evidence attributing health to physical activity, and recent studies suggest that children who spend time outdoors are more active.[5-8] If integrated into pediatric care, outdoor activity in natural environments may have the potential to improve children's mental health and physical well-being. This article reviews the current evidence of the health benefits from outdoor physical activity and natural environments and proposes that providers do more to promote children's outdoor physical activity in natural settings.

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Children's Health and Sedentary Lifestyle

In the US in recent decades there has been a nationwide shift to a sedentary lifestyle, leaving children vulnerable to the negative effects of inactivity. Physical activity is known to reduce the risk of premature mortality, coronary heart disease, hypertension, diabetes mellitus, osteoporosis, colon cancer, depression, and anxiety.[9] Nonetheless, in 2006, approximately 40% of US adults reported no participation in any leisure-time physical activity.[10] Adult inactivity is likely to become a family routine. Parental health status is a key factor in influencing the habits and behaviors of children. A 1997 cohort study examining parental and child health data determined that parental obesity more than doubled the risk of a child becoming an obese adult.[11] Inactivity has also been measured in children and adolescents. Fifty percent of fifth and seventh grade students in Georgia are below healthy levels for cardiovascular fitness.[12] While research shows that adolescents who are physically active are more likely to be active during adulthood,[13,14] only 35% of high school students met currently recommended levels of physical activity in 2005.[15]

Children's lack of physical activity and their growing disconnect with the natural environment have been influenced by the rise in electronic media, decreased time for unstructured free play, and environmental barriers. The rapid progress and integration of technology and electronic media[a] in our society has brought about innovative ways to entertain, communicate, and share information at our own convenience. Unfortunately, it has also become the dominant force detracting from physical activity and outdoor time. Per capita visits to US national parks have decreased since 1987, coincident with the rise in electronic entertainment media, video game, and Internet use.[16] With the introduction and growing popularity of online social networking, more youth are likely to be using computers. In 2006, 21% played video or computer games or used a computer for something that was not schoolwork for at least 3 hours every day.[15]

According to the American Academy of Pediatrics (AAP), the average child watches nearly 3 hours of television per day.[17] Young people spend roughly 7.5 hours a day consuming some form of electronic media—an hour more than was reported 5 years ago.[18] Exacerbating the issue, many children have television sets in their bedrooms: 32% of 2-7 year olds and 65% of 8-18 year olds.[19] Research has also suggested that excessive television viewing may negatively affect children's health. Increased television viewing has been linked to obesity, poor oral hygiene, and poor overall health. Additionally, each added hour of television significantly increases the odds of having social or emotional problems such as low self-esteem.[20] Toddler and preschool-aged children are also a major target group for electronic media companies. Television networks and computer software companies have been aggressively marketing to children as young as 9-12 months old.[21] The health implications of electronic media on toddlers need to be further researched, as this period of childhood is critical to social and cognitive development. An analysis of a national longitudinal sample of 1 to 3 year olds revealed that daily television watching was associated with developing attention problems by age 7.[22]

Free, unstructured play also affects the amount of physical activity children engage in each day. According to the AAP, play allows children to use their creativity and imaginations while building dexterity and physical strength. Unstructured play is also important for healthy brain development; children learn how to work in groups, share, negotiate, resolve conflicts, and learn self-advocacy skills.[23] Since the 1970s, children have lost roughly 12 hours a week of free time, including a 25% decrease in play and a 50% decrease in unstructured outdoor activities.[24] The No Child Left behind Act of 2001[25] prompted school districts nationwide to allocate more time and resources into reading and mathematics. As a result, school programs such as art, physical education, and recess suffered cutbacks.[26,27] Thirty percent of kindergarten classrooms are deprived of a recess period to account for increased academics.[28]

Furthermore, the built environment can affect the amount of opportunities available to children for outdoor activity. Certain factors in the built environment encourage active travel, such as connected streets, sidewalks, and access to recreational facilities. Conversely, the absence of community playgrounds and sidewalks, and overuse of cul-de-sacs, can discourage physical activity.[29] Children now spend more time in vehicles being transported from one indoor

[a] The term "media" refers to television, audio, computers, and video games, and now mobile media; including iPods/MP3 players, cell phones, and laptops.[18]

activity to another than outside in nature. Additionally, parents may keep their children indoors due to fears of crime, injury, insect bites and stings, and environmental health threats such as air pollution. Parents' encouragement and presence are actually key predictors of the amount of time children spend outdoors; authors of a 2009 ecological study observed that older children who had less adult supervision after school spent less time outside.[30]

Differences in the built environment also may contribute to racial and ethnic health disparities in the USA.[31] Minority children and those from lower socioeconomic classes generally have less access to recreational facilities, which is linked to decreased physical activity and overweight.[32] Access to healthy fresh foods is another factor contributing to health disparities. Neighborhoods with large minority populations, on average, have fewer supermarkets and produce stores.[33] Therefore, they must rely on convenience stores and fast food restaurants that carry food high in fat, sodium, and sugar that are also associated with a higher body mass index (BMI).[34,35] These factors have contributed to the rise in childhood obesity and chronic conditions, especially among disadvantaged children.

Overview of Children's Health

Childhood Obesity

Currently, obesity affects 17% or 12.5 million of America's children and adolescents aged 2-19 years.[36] According to the Institute of Medicine, the prevalence of obesity has doubled over the past 30 years for preschoolers and adolescents, and more than tripled for children aged 6-11.[37] Hospitalizations for obesity-related diseases have nearly doubled since 1999, which in turn has raised medical costs by $100 million.[38] Disparities in childhood obesity are also rising. While obesity prevalence increased by 10% for all US children from 2003 to 2007, children of lower socioeconomic status from high unemployment households saw a 23%-33% increase in obesity. Among Hispanic children, obesity prevalence increased by 24% from 2003 to 2007, and odds of obesity and overweight were twice as high for black and Hispanic children than white children.[39]

Obesity refers to the development of excess body fat, which occurs when energy intake is disproportionate to energy expenditure. Although definitions have changed over time, the Centers for Disease Control and Prevention (CDC) now uses the terms "overweight" to describe children aged 2-19 years old with BMI[b] at or above the 85th percentile and lower than the 95th percentile and "obese" for BMI at or above the 95th percentile for children of the same age and sex.[40] Obesity is a biological interaction involving multiple variables, including caloric intake, food choices, physical activity, hormone secretion, age and genetics, and psychological issues that may affect dietary behavior. Obesity and its comorbidities account for approximately 112,000 deaths per year,[41] and these comorbidities are now increasingly recognized in young children. Childhood obesity is associated with diseases in adulthood such as type 2 diabetes, hypertension, cardiovascular disease, nonalcoholic fatty liver disease, and obstructive sleep apnea.[42] The risk for metabolic syndrome, a combination of several of the above disorders, may be increasing in adolescents.[43] Developmental comorbidities of childhood obesity include early maturation and orthopedic issues.

Childhood obesity is also a predictor of adult morbidity and mortality.[42] Up to 80% of obese youth grow up to be obese adults.[11] Obese adults are susceptible to additional health consequences, including cancer, hypertension, stroke, liver and gallbladder disease, osteoarthritis, and gynecologic problems. Adults with obesity also have an increased risk of dementia and Alzheimer's disease.[44] Furthermore, obese children are more likely to grow up with a negative self-image, lower levels of advanced education, lower family income, and a lower rate of marriage as adults.[45]

Obesity-Related Diseases

Type 2 Diabetes. Type 2 diabetes is being diagnosed with increasing frequency in children. Due to the increase in prevalence over the past few decades, the definition has now changed from its previous title, "adult-onset" diabetes. Approximately 186,300 children had diabetes in 2007, and up to 3700 additional children are diagnosed with type 2 diabetes each year.[46] According to the CDC, 1 in 3 children born in 2000 will eventually develop diabetes mellitus if present rates of obesity continue.[47]

Obesity, a known risk factor for type 2 diabetes, can exacerbate insulin resistance and glucose tolerance, eventually leading to the disease.[48] Impaired glucose toler-

[b] BMI is calculated using the formula: weight (lb)/(height (in))^2 × 703.

ance was found to be prevalent in severely obese children and adolescents.[49] Other risk factors for childhood type 2 diabetes include age, race, and ethnicity.[46]

Children with type 2 diabetes are at risk for the comorbidities associated with insulin resistance. These include hyperlipidemia and hypertension. These diseases, in turn, place this group at greater risk for premature cardiovascular disease. However, physical activity and cardiorespiratory fitness are shown to improve insulin sensitivity in children with type 2 diabetes, and increased physical activity and healthy eating are at the core of recommendations for type 2 diabetes management.[50]

Hypertension. Hypertension in children has increased because of the childhood obesity epidemic, with 10% of obese children having elevated blood pressure.[51] Hypertension is a major risk factor for heart disease, stroke, congestive heart failure, and kidney disease. Lifestyle factors such as weight control, exercise, and healthy diet improve high blood pressure. Sedentary behavior, therefore, may influence the development of hypertension in children. For example, high blood pressure in children aged 3 through 8 years old has been associated with high periods of television viewing and screen time.[52] Possible explanations for this relationship include the effects of physical inactivity while watching television and the unhealthy behaviors associated with watching television, such as the increased consumption of foods high in fat, sugar, and salt.[53-55]

Cardiovascular Disease and Metabolic Syndrome. Overweight adolescents are at an increased risk of coronary heart disease and premature death. Most overweight and obese children have at least one risk factor for cardiovascular disease, including higher cholesterol levels, abnormal glucose tolerance, high blood pressure, and elevated triglycerides.[42] Cardiovascular disease is the leading cause of death and morbidity in the USA. In 2006, 630,000 or approximately 26% of all US deaths were attributable to heart disease.[56]

An analysis of the National Health and Nutrition Examination Survey (NHANES) from 1999 to 2006 revealed that 65% of 12-19 year olds were obese or overweight, and 20% had at least 1 abnormal lipid level.[57,c] Conversely, from 1988 to 1994, only 10% of 12-19 year olds surveyed had abnormal lipid and triglyceride levels.[58]

Physical activity and diet can alter the course of the disease process. Intervention strategies include lifestyle changes for children and adolescents at higher risk for cardiovascular disease. The AAP now recommends screening overweight or obese children for high cholesterol and prescribing cholesterol-lowering drugs, if needed.[59]

Metabolic syndrome is a collection of risk factors for cardiovascular disease and diabetes mellitus that includes insulin resistance, glucose intolerance, hyperlipidemia, obesity, and hypertension.[60] The prevalence of metabolic syndrome among the adolescent population is 910,000 (~4%); among overweight adolescents, 30% have metabolic syndrome.[43]

Nonalcoholic Fatty Liver Disease. Nonalcoholic fatty liver disease refers to the fatty infiltration of the liver without excessive alcohol consumption. It is closely related to obesity and insulin resistance. The degree of severity can range from fatty infiltration of the liver, or steatosis, to inflammation of the liver, or steatohepatitis. Nonalcoholic fatty liver disease is among the most common type of liver disease in the pediatric population.[61] A population-based study estimated that the prevalence of nonalcoholic fatty liver disease among children aged 2-19 at nearly 10%, and that the prevalence of fatty liver among obese children at 38%.[62]

Obstructive Sleep Apnea. Obesity is a well-documented risk factor for the development of obstructive sleep apnea in adults, and it may be a risk factor for sleep apnea in children as well.[63,64] This relationship is not entirely understood; however, it may be related to the deposition of adipose tissue within the muscles and soft tissues surrounding the upper airway.[65] Obesity may also increase a child's risk for the consequences of obstructive sleep apnea. For example, obstructive sleep apnea was found to be an independent predictor of nocturnal hypertension.[66] In addition, morbidly obese children with obstructive sleep apnea may experience neurocognitive deficits.[67]

Asthma. Approximately 7 million American children (9.4%) have asthma, a percentage that has doubled since the 1980s.[68] Children who are overweight or obese are more likely to have asthma symptoms.[69,70] Obesity is related to allergy symptoms and higher serum IgE levels, a biomarker of atopy among children aged 2-19 years.[71] In adults, a large waist size

[c] Determination of abnormal lipid level was based on cutoff points for high LDL-C (>130 mg/dL), low HDL-C (<35 mg/dL), and high triglyceride levels (>150 mg/dL).

is associated with increased asthma prevalence and severity, especially among women.[72]

Of the 7 million children reported to have asthma in 2003-2006, black and Puerto Rican children have the highest prevalence.[73,74] Asthma is more prevalent in urban environments; factors contributing to this disparity include indoor and outdoor air pollution, housing and neighborhood conditions, poverty, health care inequities, and social and psychosocial stressors.[75] Black children are 1.6 times more likely to be diagnosed with asthma when compared with white children. Puerto Rican children have the highest prevalence of asthma of all racial and ethnic groups; they are 2.4 times more likely than white children to have asthma.[76]

The relationship between asthma and obesity may also reflect sedentary lifestyle behaviors. For example, low physical fitness may be linked to the development of asthma. In a prospective, community-based study beginning in 1985, 757 children without asthma symptoms were followed for 10 years. Physical fitness was measured in 1985 and again in 1996 using a maximal progressive exercise test, which induced airway narrowing. Over the 10-year period, 6.7% of the previously asymptomatic children developed asthma. A weak correlation was observed between low physical fitness in 1985 and airway reactivity in 1996.[77] More research is needed to investigate the relationship between asthma and sedentary behavior.

Television viewing has also been associated with asthma. In a prospective longitudinal cohort study, authors investigated the association between duration of television viewing and the development of asthma in young children. The study followed children with no wheeze up to the age of 3.5 years and then gathered follow-up data for these children at 11.5 years. Television viewing was associated with increased prevalence of asthma at 11.5 years, and children who watched television for more than 2 hours a day were almost twice as likely to develop asthma compared with those who watched television for 1 to 2 hours a day.[78] Additionally, a population-based study investigated the relationship of BMI with wheezing and asthma in 20,016 children. The authors found that subjects who spent 5 or more hours a day watching television were more likely to experience wheeze and asthma in comparison with those who watched television less than 1 hour a day.[79]

Vitamin D Deficiency

Children continue to demonstrate evidence of vitamin D deficiency, as noted in an analysis of the 2001-2004 NHANES. It indicated that 9% of the pediatric population, or 7.6 million US children and adolescents, were vitamin D deficient. Additionally, 61% or 50.8 million children and adolescents had insufficient levels of vitamin D.[80,d] If the body becomes extremely deficient in vitamin D, only about 10%-15% of dietary calcium and 50%-60% of dietary phosphorus are absorbed. This can lead to skeletal abnormalities in children typically defined as rickets, which can inhibit growth, weaken the immune system, and cause seizures.[81] Medical centers have detected an increase in rickets.[82-85] Additionally, low levels of vitamin D may lead to osteoporosis,[86] cardiovascular disease, metabolic syndrome, hypertension, diabetes, myocardial infarctions, and peripheral arterial disease.[87,88]

Physical activity may be associated with vitamin D levels. In a cohort study conducted in Japan in 2003, authors evaluated the degree of association between vitamin D and lifestyle factors in Japanese women aged 19-25 years. Lifestyle factors included nutrient intake, physical activity, and duration of sunlight exposure. Two main findings of the study were that daily energy expenditure and numbers of steps taken per day were positively associated with vitamin D. Furthermore, the average amount of time per day spent in sedentary activity was negatively associated with vitamin D.[89]

Asthma may also be related to vitamin D deficiency. In a cross-sectional study of 616 Costa Rican children between the ages of 6 and 14 years, lower vitamin D levels were associated with increased markers of allergy and asthma severity. Twenty-eight percent of the children with asthma had insufficient levels of vitamin D.[90]

Historically, the main source of vitamin D comes from synthesis in the skin after exposure to UVB light. The AAP states that vitamin D deficiency among children and adolescents reflects modern-day lifestyle changes, and vitamin D supplements during infancy, childhood, and adolescence are now rec-

[d] 25-Hydroxyvitamin D (25[OH]D) levels are the most commonly measured indicator of vitamin D status. 25[OH]D levels below 15 ng/mL are considered deficient, and 25[OH]D levels 15-29 ng/mL are considered insufficient.

ommended.[91] According to the American Medical Association, the body needs 10-15 minutes of sun exposure at least twice a week to receive adequate amounts of vitamin D.[86]

Mental Health

Children and adolescents are increasingly being prescribed medication for depression, anxiety, or behavioral difficulties.[92] Six percent of adolescents 14-18 years old have been diagnosed with depressive disorders, as well as 3% of children younger than 13 years old.[93] Stress is also a top health concern for adolescents in the USA, according to a 2009 survey by the American Psychological Association. The survey found that nearly half of adolescents in the USA said that their level of stress had increased in the past year, and 14% of adolescents categorized their stress as extreme.[94]

The prevalence of ADHD has increased considerably in recent decades, labeled by the CDC as "a serious public health problem."[95] The results of the National Health Interview Survey showed that 9% of children have ADHD.[96] Another study in 2005 found that 5% of US children between the ages of 4 and 17 were prescribed medication for difficulties with emotions or behavior, and 90% of these were treatment for symptoms of ADHD.[97]

Health Benefits of Physical Activity and Natural Environments

Health and Physical Activity

The physical activity guidelines of the US Department of Health and Human Services (DHHS) state that regular physical activity helps build and maintain healthy bones and muscles, reduces the risk of obesity and chronic diseases such as diabetes and cardiovascular disease, reduces feelings of depression and anxiety, and promotes psychological well-being.[98] Numerous scientific studies provide additional evidence of the benefits of physical activity. In a prospective, randomized controlled study, physical activity was shown to reduce systolic and diastolic blood pressure in young children over an 8-month period.[99] An examination of 6 hypertensive adolescents revealed a significant reduction in blood pressure after 3 to 7 months of weight-lifting.[100]

Physical activity is particularly important in the treatment of type 2 diabetes in children because of its potential to improve insulin sensitivity and maintain both short- and long-term metabolic control.[101] Lack of physical activity may contribute to type 2 diabetes in children. A 2008 study assessed cardiorespiratory fitness in adolescent boys with previously diagnosed type 2 diabetes during a progressive exercise test. Cardiorespiratory fitness levels were 18% lower in adolescent males with type 2 diabetes compared with males of equal age and BMI. The youth with diabetes also spent about 60% less time per day in moderate to vigorous physical activities compared with the control group. Although childhood type 2 diabetes is caused by a complex interaction of genetic and environmental factors, physical inactivity may also contribute through a lack of stimulation of glucose uptake in skeletal muscle.[50]

The AAP recommends promoting lifelong habits of physical activity to achieve sustained weight loss rather than short bouts of aerobic exercise.[102] Long-term weight loss is facilitated by regular physical activity, which requires a change in mindset to achieve success.[103] Various programs around the country are striving to address childhood obesity and some have been effective in reducing children's BMI. For example, a program focusing on lifestyle-based activities such as outdoor games, household chores, gardening, beach hikes, and international children's games encouraged children to be more physically active. One- and 2-year evaluations of the program determined a significant decrease in BMI in the children who participated in the intervention group (95% CI: 0.01, 0.18; 95% CI: 0.21, 0.32). The program appears to have resulted in a sustained change because the children continued to have weight loss 2 years later.[104]

A decline in physical activity from childhood to adulthood is a strong predictor of adult obesity and insulin resistance.[105] Programs should be aimed at maintaining high physical activity levels from childhood into adulthood. To accomplish this, the AAP recommends that parents help their children be physically active in other ways than organized sports alone, and to plan outdoor activities for the entire family such as biking or playing outdoors. Additionally, AAP recommends that children spend as much time outdoors as possible.[102]

Physical Activity in Parks and Other Natural Environments

Research has indicated that time spent outdoors is associated with increased physical activity. Parents of

preschool children reported that physical activity usually occurs during outdoor playtime as opposed to during indoor activities.[106] One study among 10- to 12-year-old children found that for every additional hour spent outdoors, physical activity increased by 27 minutes a week and prevalence of overweight dropped from 41% to 27%.[5] Parks, schools, trails, and recreation facilities provide settings that can facilitate physical activity. However, due to increasing urbanization and population density, many people live in residential areas lacking vegetation, parks, and other natural environments, limiting the availability of easily accessible and safe outdoor play settings for children.

"Green" school grounds, which contain a greater diversity of environmental features such as trees, gardens, and nature trails, may affect the quantity and quality of physical activity among elementary schoolchildren. Asphalt and turf grounds are only conducive to certain activities, such as basketball, which not all children may be interested in or able to play. Offering a natural environment with which children can interact at school may stimulate physical activity in greater numbers. Recently, schools have engaged in efforts to emphasize these features in an effort to encourage children to be more active and imaginative. An evaluation of these initiatives was conducted at 59 schools across Canada by surveying teachers, parents, and administrators. The survey evaluated to what extent the "green" features in their school yards influenced physical activity of students. Seventy percent of respondents indicated that the initiative resulted in increased light to moderate physical activity, and 50% also reported that their "green" school ground promoted more vigorous activity. Respondents also indicated that their school grounds appealed to a greater breadth of student interests and support a wider variety of play activities.[6]

As residential areas become more populated and overdeveloped, "green space," which refers to areas of dense, healthy vegetation, becomes increasingly important as an outlet for physical activity and a means to sustain a healthy weight. A retrospective cohort study in 2008 followed low-income children aged 3-16 years old for 2 years. Authors calculated their change in BMI and measured the amount of vegetation in each child's neighborhood using satellite images. After adjusting for age and gender, increased vegetation was associated with lower odds of increased change in BMI, independent of residential density (OR: 0.87, 95% CI: 0.79, 0.97). Although physical activity was not directly measured, a change in BMI may imply increased physical activity. However, this study is limited by selection bias, as socioeconomic status may influence the choice of a home location with respect to natural surroundings.[7]

Proximity to parks may also influence children's weight. A Canadian study examined the association between healthy weight status among children and the availability of 13 specific park facilities within 1 km of their residences, which contained features such as paved and unpaved trails, playgrounds, meadows, wooded areas, and sports facilities. Logistic regression was used to analyze the relationship between the proximity of a particular park facility to childhood BMI, while controlling for neighborhood residence, age, gender, and parental BMI. Children who lived within a kilometer of a park facility that contained playground equipment were almost 5 times more likely to be classified at a healthier weight than children without accessible playgrounds. The association between playground availability and normal BMI suggested that children were getting the physical activity needed to maintain a normal BMI.[8]

Finally, access to natural environments may reduce health inequalities by promoting physical activity and offering protection from the biological effects of poverty-related stress. To determine if exposure to "green space" such as parks, forests, rivers, creeks, and play fields was a determinant of good health, more than 40 million people from England were classified based on level of income and access to natural environments. Records for all causes of mortality, as well as circulatory, lung cancer, and intentional self-harm, were obtained from 2001 to 2005 to determine if there was an association with income deprivation and exposure to "green space." The major finding was that the group living in the areas with the most nature had the lowest level all-cause mortality and mortality due to circulatory diseases related to income deprivation. The authors suggested that exposure to natural environments could play a vital role in reducing health inequalities.[107]

Natural Environments and Mental Health

Exposure to a natural environment may have a beneficial effect on psychological health. One study investigated the relationship between morbidity and the amount of natural land around a residential environment, which excluded small-scale natural features

such as gardens and residential trees. Multivariate logistic regression was used to control for demographic factors, socioeconomic characteristics, and whether the surroundings were urban or rural. The authors found 24 clusters of disease and determined that the prevalence rates for 15 of these 24 clusters were lower in environments with more natural environments. This relation was apparent for all 7 disease categories, including cardiovascular, musculoskeletal, mental, respiratory, neurological, digestive, and miscellaneous. Depression and anxiety disorder showed the strongest association to the amount of nature in people's living environments, especially in children. Owing to its cross-sectional study design, it is difficult to determine whether the relationship between natural space and morbidity is causal. Authors also stressed the importance of natural environments close to home for both children and lower socioeconomic groups.[108]

Childhood stress has also become an increasing issue of concern for pediatric health care providers. The workload of school and extracurricular activities has the potential to create more stress on a child, thereby influencing cognitive development. Natural environments may moderate the impact of stressful life events for children. The psychological effects of stressful life events, such as family relocation, being picked on at school, and peer pressure, and the amount of "nature" in each child's environment were evaluated among 330 rural children in grades 3-5. In the study, "nature" meant the amount of trees and vegetation in the window view, the number of live plants indoors, and the outdoor landscape. Hierarchical regression analyses were used to examine the effects of nearby nature on stressful life events, while controlling for family income. The children felt less psychological distress if they lived in an area with more natural surroundings. Specifically, higher amounts of exposure to natural environments indicated lower levels of stress in a child. The authors postulated that nearby nature both provided social support in rural settings and restored children's capacity for attention that helps them to better think through problems.[109]

Physical activity in natural environments may benefit both physiological and psychological health. One study examined the health effects of physical activity while being exposed to various forms of nature. In this study, adult subjects in the intervention group ran on a treadmill while being shown 4 different themes of pictures: rural pleasant, urban pleasant, rural unpleasant, and urban unpleasant photographs. The researchers measured subjects' blood pressure, self-esteem, and mood. The pleasant rural and urban nature pictures were linked to a significant reduction in blood pressure and a more positive effect on mood. Furthermore, participants in the rural pleasant group had the largest reduction in blood pressure and the most significant increase in self-esteem. The authors suggested that "green exercise" not only has a greater effect on blood pressure than exercise alone, but also contains potential benefits for psychological health.[110]

Natural environments may improve attention, especially for children with ADHD. These studies are based on the idea that nature can restore the mental fatigue that occurs after prolonged concentration, which is characterized by having difficulty focusing on tasks, feeling irritable, and being easily distracted. Nature has been described to effortlessly engage the human mind away from daily stressors, offering an opportunity for reflection and escape.[111] Furthermore, mental fatigue and ADHD may be linked to the same underlying mechanism in the brain.[112-114] A number of studies have measured the benefits of natural environments on children's attention, especially among those with attention disorders.

In 2001, Taylor et al investigated whether time spent in natural settings affects the inattentive symptoms of attention deficit disorder, sometimes known as attention deficit disorder without hyperactivity. The authors surveyed parents to compare their child's symptoms when engaging in leisure activities in an indoor setting, such as a windowless room, and a natural outdoor setting, such as a park, farm, or neighborhood space. They identified 4 inattentive symptoms as outcome measures for this study: (1) inability to stay focused on unappealing tasks, (2) inability to complete tasks, (3) inability to listen and follow directions, and (4) being easily distracted. The results showed that activities taking place in natural settings were more likely to be nominated by survey participants as helpful in reducing inattentive symptoms. In addition, as tree cover within the settings increased, symptoms of attention deficit disorder decreased in severity.[115]

A nationwide study published in 2004 by the same authors examined if "green" settings reduced symptoms of ADHD. The authors surveyed parents of children who had been diagnosed with ADHD on the perceived effect of common after-school and weekend activities on their child's symptoms. Activities chosen by the authors represented a broad range of physical settings and social contexts. Parents were asked to

indicate whether each activity resulted in the child's symptoms being (a) worse than usual, (b) same as usual, (c) better than usual, or (d) much better than usual. Authors measured the distribution of after-school and weekend activities by conducting *t*-tests. A repeated analysis of variance examined the association between reported ADHD symptoms and natural outdoors vs. built indoor/outdoor activities. Natural outdoor activities significantly reduced symptoms and natural outdoor activities reduced ADHD symptoms significantly more than activities conducted in built outdoor settings or indoor settings. The limitations of the study included systematic error in parental perceptions of different settings, in part because "green" activities were not uniformly defined.[116]

Cognitive functioning was also examined in low-income urban children from 2 separate home environments. One environment consisted of fewer natural elements, and the other environment contained plants and views of nature. Children's cognitive functioning was measured in each home environment using the Attention-Deficit Disorders Evaluation Scale. Children who experienced the greatest increase in natural elements in the home had the greatest ability to focus attention a few months later.[117] ADHD-diagnosed children from another recent study were guided through a 20-minute walk in 3 different environments: a city park, an urban area, and a residential area. The guided walks were single-blinded controlled trials. Prior to each of the walks, children completed a series of puzzles that were selected to cause a degree of mental fatigue. After the walks, children completed tests of concentration and impulse control. Concentration was significantly better after a walk in a city park than the other 2 settings.[118] Limitations included low external validity due to small sample size. However, these findings add to the body of evidence of nature's effect on attention in children.

Human evolutionary history may be related to nature's potential ability to restore mental health. Humans have evolved living close to the land as hunter-gatherers, and it is only recently that we have congregated into densely populated cities.[119] A sense of spending time in the natural world may bring about a positive effect on mood. Factors that lead to attention restoration may also increase a person's experiential sense of feeling connected to nature. Participants who spent 15 minutes walking in a natural setting or urban settings, or by watching a video of 1 of these settings, reported increased feelings of connectedness to nature, improved attention, positive emotional well-being, and an increased ability to reflect on a life problem.[120]

Researchers have offered multiple reasons to why nature may be benefiting children with attention disorders. Children with ADHD may benefit from time spent outdoors in nature, whether during a break in the school day, an after-school trip to the park, or a weekend outing to a nature center. Simply observing various forms of nature has been shown to provide restorative benefits and enhance a sense of well-being in children. Evidence suggests that natural-environment interventions may be a beneficial component of cognitive behavioral therapy; however, more research is needed.[121]

Additional Potential Health Benefits of Nature

Outdoor activity in nature may also benefit children's health by improving asthma, myopia, chronic pain issues, and childhood development. For example, a recent ecological study conducted in New York City suggested that being exposed to a natural environment may be correlated with less childhood asthma. Authors collected both tree density information and asthma prevalence data on 4- and 5-year-old children living in the city. The authors also measured the proximity to pollution sources that have previously been associated with asthma. Results revealed that tree density was correlated with a lower prevalence of childhood asthma, after controlling for potential confounding factors including sociodemographic characteristics, population density, and proximity to pollution sources. Due to the design of the study, the results of the analysis merely serve to generate hypotheses surrounding tree density and asthma. The extent to which trees and vegetation play a role in the control of pediatric asthma remains unknown.[122]

Myopia, or nearsightedness, has been acknowledged by the World Health Organization as one of its top priorities to control in preventing avoidable blindness in the world by 2020. In the USA, the prevalence rate of myopia has substantially risen in the past 30 years.[123] Roughly 9.2% of children in America are myopic.[124] Profound increases in myopia prevalence may potentially be exacerbated by external factors such as increased illuminated screen viewing and reading time. Time spent outdoors may reduce a child's risk of myopia. A recent cross-sectional study among 12-year-old participants found that higher levels of outdoor time were associated with less myopia and higher hyperopic mean refraction. Outdoor activ-

ity should be promoted by the public health community and included in school curricula.[125] Additionally, a 2009 cohort study of 1249 teenage students in Singapore revealed significantly less myopia in adolescents who spent more time outdoors (OR: 0.90; 95% CI: 0.84, 0.96; $P = 0.004$).[126] Further research is currently being conducted on the protective effects of outdoor activities on myopia.

Although currently studies examining pain reduction and the restorative effects of nature for children are not available, studies on adult pain management may form a basis for further research. In a 1984 study, patients with a view of deciduous trees took fewer doses of strong pain medication than a group viewing a brown brick wall, had shorter postoperative hospital stays, and fewer postsurgical complications.[127] Another study examined a group of patients during flexible bronchoscopy. Nature scene murals were placed at patients' bedsides, and they were provided with a tape of nature sounds to listen to before, during, and after the procedure. The patients with views and sounds of nature were more likely to report better pain control during the procedure.[128]

Because evidence suggests that natural environments encourage physical activity, increasing the amount of time children spend playing outside in natural environments has the potential to decrease the risk of childhood obesity. In addition, outdoor time in nature may decrease stress in children, instill a sense of well-being, and improve capacity for attention in children with ADHD. Natural environments may also reduce children's susceptibility to other diseases, although much more research needs to be conducted.

Pediatric Care

Pediatric health care providers have an important role to play in the management of childhood obesity, its comorbidities, and other chronic problems in childhood including vitamin D deficiency and ADHD. Although children's health care providers play an important role, they cannot manage the intricacies of childhood obesity on their own. A cooperative effort between parents, health care providers, schools, government agencies, and nongovernmental organizations, as well as the children themselves, is crucial to the success of any program. Interventions should be scientifically based, yet balanced with the practical needs of the patient.

Pediatric health care providers have a unique presence in the lives of children and their parents. Too often, however, parents rely on the Internet, friends, or other nonprofessionals for medical advice, which may not be scientifically sound. Pediatric health care providers should recognize that they are, and should be, a key link between children, their parents, and optimal health. They are clinicians and leaders and should be trusted sources of new information. Pediatric health care providers interact with children and their parents on a level that transcends daily public interactions and media messages. Therefore, they are in a position to provide parents with an understanding of the causes of childhood obesity and empowering them to make lifestyle changes to protect their children. An additional part of this educational responsibility is to direct patients to appropriate, evidence-based Internet sites for information.

The AAP has provided a blueprint for pediatricians to educate and advise families about ways to prevent childhood obesity. The AAP's Committee on Nutrition recently completed the 5th edition of the *Pediatric Nutrition Handbook*, which is a comprehensive reference designed for the clinician.[129] It provides advice on all aspects of nutrition, from the premature infant up to the adolescent. Another source that the AAP has developed is *A Parent's Guide to Childhood Obesity: A Road Map to Health*,[130] a resource developed for the parent. Further information about these and other nutritional related resources can be found at the AAP Nutrition web site.[131] Other AAP recommendations to the pediatric health care community include promoting healthy eating, and monitoring children's nutritional intake and BMI.

The AAP also has resources and advice about another equally important component of any strategy to treat and prevent childhood obesity: the promotion of an appropriate amount of physical activity. This should be a combination of more outdoor play, and less indoor "screen time," which has been shown to replace physical activity.[132] The AAP recommends that children older than 2 years old watch no more than 1-2 hours per day of television and that television sets should not be in children's sleeping rooms.[17] A policy statement was released by the AAP in 2006 by the Council on Sports Medicine that goes into greater detail about the level of physical activity children should achieve. In summary, the AAP recommends age-appropriate outdoor physical activity while recognizing the role of the cultural environment for the

child, where work, education, family life, and leisure time all impact the process. Clinicians should (1) adopt a healthy lifestyle as a role model, (2) limit screen time, (3) measure the number of times per week spent in 30 minutes of outdoor play, (4) encourage at least 60 minutes per day of physical activity (includes accumulated activity from multiple, shorter periods), and (5) encourage the parents of overweight children to have a participatory role in the activity process.[102]

Natural environments may reduce stress and improve attention. The natural outdoor environment is an ideal way of increasing physical activity. Activities that family members can participate in together enhance the social and supportive benefits of physical activity, which is taken advantage of in outdoor, natural environments. Nurturing a love of nature in children cannot only inspire them to protect the environment, it can also instill lifelong behaviors of an active lifestyle. This should be a lifestyle change and there is no better person to recommend that change than the child's primary health care provider.

Children and Nature Initiative

The National Environmental Education Foundation has launched an initiative that links 2 issues—rising childhood health concerns and the need to reconnect children to nature. The Children and Nature Initiative works with pediatric health care providers to encourage children to spend more time outdoors and connects children and their families to parks and other natural environments that are easily accessible to diverse populations.

The idea to prescribe nature to children to increase physical activity and improve health is similar to a new strategy that has emerged in adult health care. The American Medical Association and the American College of Sports Medicine have launched the Exercise is Medicine program, which encourages health professionals to include exercise when designing treatment plans for their patients, providing physical activity prescriptions and referrals.[133] This approach has been shown to be effective in increasing physical activity levels and is more cost-effective than other interventions because it mainly uses existing infrastructure.[134] A study conducted in Sweden during a 2-year period measured the effectiveness of issuing 6300 physical activity referrals. Half of the patients reached reported increased physical activity both at 3 months and at 12 months. In addition, the proportion of inactive patients decreased from 33% at baseline to 17% at 3 months and 20% at 12 months.[135] A program in Spain from 2003 to 2004 recruited around 4000 physically inactive patients and provided physical activity referrals to approximately half of them. Six months later, the patients who had received the referrals were more active.[136]

The Children and Nature Initiative is applying this approach to children's health care not only to increase physical activity, but also to get children to spend more time outside. The initiative, which is guided by an advisory committee of experts and stakeholders including members from leading health care organizations, educates pediatric health care providers about prescribing outside activities to children. The program also connects health care providers with local parks and nature centers, so that they can refer families to safe and easily accessible outdoor areas. The Children and Nature Initiative employs the highly successful Faculty Champions model, which has trained thousands of health care providers on environmental health issues to date.[137] Pediatric health care providers participate in a train-the-trainer workshop, which prepares them to serve as Nature Champions in their communities. These Nature Champions in turn train other providers in their local communities. The National Environmental Education Foundation provides them with the tools and resources they need to be effective, including the Children's Health and Nature Fact Sheet, which highlights the scientific basis for the health benefits of nature, and the Pediatric Environmental History Form, which includes questions for pediatric health care providers to encourage outdoor time for children.[138]

Through the Children and Nature Initiative, health care providers, parents, outdoor organizations, schools, federal, state, and local agencies, community groups, and other institutions can work together to encourage children to spend more time outdoors and teach them how to protect their health and the environment.[139]

Conclusions

Physical activity is shown to improve children's health, and a growing body of evidence suggests that exposure to natural environments can improve attention and decrease stress in children. Advising outdoor play in nature is a practical method for pediatric health care providers to address chronic conditions such as

childhood obesity, as well as mental health; and one that is cost-effective and easily sustainable. The DHHS and AAP recommend physical activity for children for at least 60 minutes a day.[96,102] The CDC stresses the important role of communities, schools, and families in promoting physical activity for youth[140] and encourages children to engage in healthy outdoor activities in nature and parks.[141] The DHHS advises physical activity through age-appropriate, enjoyable activities such as hiking or going to the park[96] and the AAP recommends that pediatricians promote free, unstructured play.[23]

Pediatric health care providers should promote increased physical activity for their patients and consider encouraging outdoor activities in natural environments as a physical activity routine.

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Erratum

The following corrections to the article by McCurdy, et al titled "Using Nature and Outdoor Activity to Improve Children's Health" (2010;5:102-177; doi 10.1016/j.cppeds.2010.02.003) published in the May/June issue of Current Problems in Pediatric and Adolescent Health Care, were submitted post production by the authors:

Page 108, 1st paragraph, 6th line, should read: ". . . prevalence of overweight was 27-41% lower among those spending more time outdoors.[5]"

Page 113, 1st column, 1st paragraph; both the citations for reference 96 should be replaced with reference 98.

Page 116, 2nd column, bottom; the reference numbering should be listed as follows:

127. Ulrich RS. View through a window may influence recovery from surgery. Science 1984;224:420-1.
128. Diette GB, Lechtzin N, Haponik E, Devrotes A, Rubin HR. Distraction therapy with nature sights and sounds reduces pain during flexible bronchoscopy. Chest 2003;123: 941-8.
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