



HEALTH BENEFITS TO CHILDREN FROM CONTACT WITH THE OUTDOORS & NATURE

NOTE: The following are taken from five volumes of research developed by the Children & Nature Network (C&NN) and available at www.childrenandnature.org/research. These C&NN Annotated Bibliographies of Research and Studies were written by Cheryl Charles, Ph.D., President, Children & Nature Network and Alicia Senauer Loge, Yale University.

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Focus: Literature Reviews & Overview Documents

These articles summarize literature related to outdoor and nature contact and children's health and well-being.

Physical activity and exposure to nature are important to good health

In this literature review, Pretty and colleagues examine the role of physical activity and nature contact on health and well-being, with a particular focus on children. The authors discuss the current state of physical inactivity, the positive health benefits of nature contact, and the potential role of green exercise (activity in the presence of nature) toward improving health and well-being. Pretty and colleagues review three stages of childhood and their differing needs, evidence regarding children's physical activity levels, and the benefits of children's exposure to nature. The authors discuss the impact of urban design and green space in terms of physical activity and various health outcomes, including cognitive health and learning, as well as the impact of nature-based interventions, such as care farms and wilderness therapy, for children with special needs. Based on their review, Pretty and colleagues propose two conceptual pathways—healthy and unhealthy—that shape our lives and life outcomes. On the healthy pathway, people are active, connected to people and society, engage with natural places, and eat healthy foods and as a result tend to live longer and

have a better quality of life. On the unhealthy pathway, people are inactive, disconnected to people and society, do not engage with natural places, and eat unhealthy foods, and as a result die earlier and have a lower quality of life. In concluding their review, Pretty and colleagues make ten recommendations to improve people's well-being, including increasing children's outdoor free play and encouraging planners to incorporate access to green space.

Author Affiliation: Jules Pretty is with the University of Essex in the UK.

Pretty, J., Angus, C., Bain, M., Barton, J., Gladwell, V., Hine, R., et al. (2009). *Nature, childhood, health and life pathways*. University of Essex. This report is available online at: <http://www.essex.ac.uk/ces/occasionalpapers/Nature%20Childhood%20and%20Health%20iCES%20Occ%20Paper%202009-2%20FINAL.pdf> (Volume 5)

Being outdoors is important to our health

Godbey examines the health benefits of being outdoors, including the role these activities play in stress reduction. He also examines outdoor recreation as it relates to specific children's health issues, including obesity and attention-deficit hyperactivity disorder, and how spending time outdoors can benefit children with these health challenges. Godbey investigates children's connection with nature and the many variables that impact children's outdoor play. He discusses different approaches to measuring physical activity and participation in outdoor recreation, as well as recent trends in park visitation and outdoor activity participation. He also highlights numerous factors that impact participation in outdoor activities, including amount of leisure time, proximity to outdoor space, safety of parks, and park and playground design. Throughout the review, Godbey highlights specific research gaps that could help guide future efforts. He also discusses changing demographics as they relate to outdoor recreation and what these changes may mean in terms of successful policymaking.

Author Affiliation: Geoffrey Godbey is with Resources for the Future.

Godbey, G. (2009). *Outdoor Recreation, Health, and Wellness: Understanding and Enhancing the Relationship*. Washington DC: Resources for the Future. This report is available online at: <http://www.rff.org/documents/RFF-DP-09-21.pdf> (Volume 5)

Green environments are essential to human health

In this report, Kuo reviews evidence of the benefits that nature contact provides to our health. Kuo begins by discussing the development of nature-human health research and how in the last decade research has become incredibly diverse and rigorous. As a result of the research that has been conducted to date, she concludes that green environments are essential to human health. In the bulk of the report, Kuo reviews evidence of the benefits that nature contact provides to our social, psychological, and physical health. In each major section, she discusses evidence from a sampling of relevant studies that are diverse and of high quality. For example, she reviews evidence that nature contact promotes healthier social behavior and lessens social dysfunction, helps alleviate stress, improves resilience, promotes optimal psychological functioning, improves recovery from physical trauma, and reduces mortality. Kuo discusses current ideas on how nature might promote human health, including the role of physical activity, immune functioning, and stress reduction. She also discusses a set of larger themes that have emerged from the literature, such as that green environments must be experienced to have positive health impacts and that nature contact can take

many forms and occur at many different dosage levels. Kuo concludes her report by providing specific recommendations on how to increase people's nature contact and its associated health benefits by: 1) providing as much nature, in as many forms as possible; 2) bringing nature to people; and 3) bringing people to nature.

Author Affiliation: Frances Kuo is with the University of Illinois at Urbana-Champaign.

Kuo, F. E. (2010). *Parks and other green environments: essential components of a healthy human habitat*. National Recreation and Park Association. This report is available online at: [http://www.nrpa.org/uploadedFiles/Explore_Parks_and_Recreation/Research/Ming%20\(Kuo\)%20Reserach%20Paper-Final-150dpi.pdf](http://www.nrpa.org/uploadedFiles/Explore_Parks_and_Recreation/Research/Ming%20(Kuo)%20Reserach%20Paper-Final-150dpi.pdf) (Volume 5)

Nature provides a variety of mental health and well-being benefits

Townsend and Weerasuriya review the literature on the relationship between nature and health and well-being, with a specific focus on mental health and well-being. To conduct their review, the authors examined peer-reviewed journal articles, grey literature, and books, with an emphasis on articles published in the last decade. Townsend and Weerasuriya provide a very thorough and detailed report covering a range of valuable topics. The authors begin by discussing major theories about why or how nature contact impacts human health and well-being, including the biophilia hypothesis and attention restoration theory. The authors then review physical, mental, and social health benefits associated with nature contact, including benefits for specific populations (e.g., children and the elderly). Townsend and Weerasuriya then move on to discuss the benefits of nature contact to mental health for the population in general, as well as specific populations (e.g., children, prisoners, and indigenous populations). The authors then review specific types of landscapes and their therapeutic mental health impacts, including local parks, forests and gardens, as well as different therapeutic approaches, including wilderness therapy and horticulture therapy. Townsend and Weerasuriya also discuss evidence concerning impacts to mental health from animal contact, ranging from contact with pets to therapeutic programs with dolphins. The authors highlight various dimensions of mental health that can be positively impacted by nature contact, including cognitive functioning and stress reduction, depression, and attention-deficit hyperactivity disorder. In the last sections of the report, the authors discuss additional aspects of the relationship between nature and mental health, including physical activity and social connectedness, the relationship between climate change and mental health, and the linkages between urban environments and mental health.

Author Affiliation: Mardie Townsend is with Deakin University in Australia.

Townsend, M., & Weerasuriya, R. (2010). *Beyond blue to green: The benefits of contact with nature for mental health and well-being*. Melbourne, Australia. This report is available online at: http://www.beyondblue.org.au/index.aspx?link_id=59.1284 (Volume 5)

Natural environments may provide added health benefits above and beyond human-made environments

In recent years, a number of studies have examined the role of natural environments in human health. In this article, Bowler and colleagues conducted a systematic review of research to determine whether there is an "added benefit" from activities in natural environments that goes above and beyond those in more human-made environments. Bowler and colleagues specifically focused on

studies where there was a comparison of the same activity in natural and human-made environments so that the effect of the environment could be determined. The authors examined 25 studies that included a variety of types of natural environments (e.g., public parks or university campuses) and outcome measures (e.g., emotions or attention/concentration). In analyzing the study results, Bowler and colleagues found that activities in a natural environment resulted in reduced negative emotions (e.g., anger, fatigue and sadness) as compared to similar activities in a human-made environment. The authors also found that activity in a natural environment may result in improved attention as compared to a human-made environment, however, the added benefit disappeared when pretest differences were taken into account. Bowler and colleagues did not find strong evidence of differences in terms of other physiological variables examined, such as blood pressure, however, there were not many studies in this area to examine. This article provides a valuable contribution toward our understanding of the benefits of nature to human health. In concluding their article, the authors discuss characteristics of the studies they examined and suggest areas of future research.

Author Affiliation: Andrew Pullin is with Bangor University in the UK.

Bowler, D. E., Buyung-Ali, L. M., Knight, T. M., & Pullin, A. S. (2010). A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health*, 10(1), 456. This study may be available in a library near you or can be purchased online through the publisher at: <http://www.biomedcentral.com/bmcpublichealth/> (Volume 5)

Outdoor skills education supports our health, learning, and lifestyle

Cottrell and Raadik-Cottrell review the benefits that outdoor skills education and wildlife-related outdoor education provide to our health, learning, and lifestyle. In addition, the authors review information concerning the relationship between outdoor skills education and fishing and hunting participation. In developing this report, Cottrell and Raadik-Cottrell reviewed over 100 relevant documents, including industry and non-governmental organization reports and academic peer-reviewed articles. In their review, the authors discuss evidence regarding the benefits of outdoor skills education, including improved interpersonal and intrapersonal skills; environmental awareness and stewardship ethics; physical, mental, and social health; and ability to learn and concentrate. With regard to hunting and fishing, Cottrell and Raadik-Cottrell discuss indicators of recruitment and retention in these outdoor activities, including early life experiences, mentorship, and structured programs that are culturally appropriate and more holistic/ecologically oriented. The authors highlight some successful outdoor skills programs and provide a series of recommendations to enhance different types of programs, such as understanding volunteer expectations and providing continuous and progressive outdoor education experiences. Cottrell and Raadik-Cottrell conclude their report with a list of recommendations for future research.

Author Affiliation: Stuart Cottrell is with Colorado State University and Cottrell and Associates Environmental Consulting.

Cottrell, S., & Raadik-Cottrell, J. (2010). *Benefits of outdoor skills to health, learning and lifestyle: A literature review*. Association of Fish & Wildlife Agencies' North American Conservation Education Strategy. This report is available online at: http://outdoornebraska.ne.gov/Education/pdf/BenefitsofOutdoorSkills_WhitePaper_11-2010_Final%20with%20cover.pdf (Volume 5)

Wilderness programs improve participants' health, behavior, and attitudes

The connection between natural landscapes and human health provides an important avenue to support land conservation and human health. In this review, Hine and colleagues examine 70 studies related to the benefits of wilderness and nature-based experiences. Hine and colleagues describe numerous characteristics of these studies, including their methodological type (e.g., qualitative or quantitative), outcomes measured, location of the programs they evaluated, types of experiences (e.g., therapeutic intervention or general experience), and age and gender of participants. In examining study results, the authors found that wilderness and nature-based experiences resulted in a range of benefits including: physical and mental health benefits (e.g., reduced body fat, reduced anxiety and stress, and improved self-esteem); positive changes in behavior; enhanced connectedness to nature; and improved knowledge and skills acquisition. Hine and colleagues discuss limitations to the reviewed studies, including the lack of quantitative and longitudinal studies, small sample sizes, and the lack of control groups. The authors highlight the need for additional research to address current limitations and provide specific research recommendations.

Author Affiliation: Rachel Hine is with the University of Essex in the UK.

Hine, R., Pretty, J., & Barton, J. (2009). *Research project: Social, psychological and cultural benefits of large natural habitat & wilderness experience: University of Essex.* This report is available online at: <http://www.essex.ac.uk/ces/occasionalpapers/Kerry/Literature%20Review%20for%20WF.pdf> (Volume 5)

Place attachments are important to children's well-being

In this article, Jack reviews evidence about the relationship between place attachments and children's well-being. He discusses the meaning of place and place attachments and how place attachments develop in children. Jack also reviews evidence about how children use space, the various influences (from individual to family and community) on children's use of space, and how use of space affects place attachments. He then discusses studies that have found significant declines in children's independent mobility or freedom to use their local environment and factors contributing to this decline. Jack highlights three social policy approaches (laissez-faire, service-oriented, and space-oriented) and related programs in the UK and their impacts on children's independent use of their local environments. In the last section of this review, the author discusses the importance of place attachments for children who are in the social-care system and the lack of current focus on children's attachments to place in favor of attachments to people. Importantly, Jack provides suggestions on how people working with children in the social system can better support their place attachments and well-being.

Author Affiliation: Gordon Jack is with Durham University in the UK.

Jack, G. (2010). *Place Matters: The Significance of Place Attachments for Children's Well-Being. British Journal of Social Work, 40(3), 755-771.* This study may be available in a library near you or can be purchased online through the publisher at: <http://bjsw.oxfordjournals.org/> (Volume 5)

Parks and playgrounds encourage physical activity

In this report, Mowen synthesizes research about the relationship between parks and healthy, active lifestyles. He reviews studies across a range of populations, including children, adults, seniors, lower-

income families, and various racial and ethnic groups. Mowen reports a number of key findings. A few findings that pertain to children include the following:

- Children who live in close proximity to parks, use parks more and engage in more physical activity.
- Not everyone has equal access to parks. Lower-income populations and some racial and ethnic populations have poor access to parks.
- Certain park features seem to encourage more physical activity. For example, one study found that girls living close to parks with good lighting were more physically active.
- Perception of neighborhood safety influences whether parents encourage their children to use local playgrounds.
- Organized park programs and supervision may increase children's use of parks and their physical activity.
- Park renovations can increase children's use of playgrounds and their level of physical activity.

In concluding his literature review, Mowen highlights areas where future research is needed to continue to build the evidence base related to parks and active living.

Author Affiliation: Andrew Mowen is with The Pennsylvania State University.

Mowen, A. J. (2010). *Parks, playgrounds and active living*. Robert Wood Johnson Foundation. This report is available online at: <http://www.activelivingresearch.org/resourcesearch/summaries> (Volume 5)

Children's built environments influence their access to nutritious foods and physical activity

In this literature review, Rahman and colleagues examine the relationship between built environment characteristics and childhood obesity. The authors examine the role of the built environment in supporting physical activity, providing access to healthy foods, and limiting access to unhealthy foods. For example, the authors review evidence concerning students' access to fast-food restaurants and the benefits that can be gained from participation in neighborhood and/or school gardens. Rahman and colleagues also examine the role of the built environment in providing opportunities for children to be physically active. For example, the authors review evidence regarding neighborhood factors that influence how children get to and from school, as well as how often they are active outdoors. Rahman and colleagues conclude that changes to our built environment can help children be more active and eat healthier diets and can result in long-term, positive solutions to childhood obesity. The authors suggest different ways in which health professionals can help make positive changes in the built environment.

Author Affiliation: Tamanna Rahman is with the University of California at Los Angeles.

Rahman, T., Cushing, R. A., & Jackson, R. J. (2011). Contributions of Built Environment to Childhood Obesity. *Mount Sinai Journal of Medicine: A Journal of Translational and Personalized Medicine*, 78(1), 49-57. This study may be available in a library near you or can be purchased online through the publisher at: [http://onlinelibrary.wiley.com/journal/10.1002/\(ISSN\)1931-7581](http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1931-7581) (Volume 5)

Adventure playgrounds foster healthy child development

In this article, Staempfi provides an overview of what adventure playgrounds are and the role that they can play in enhancing child development. She discusses the changing nature of children's play, and the history of adventure playgrounds and their recent prominence in many European countries, as well as variations in adventure playground philosophy, structure, and setting. Staempfi highlights the unique role of trained professionals or playworkers at adventure playgrounds that serve as unobtrusive guides to facilitate children's development through play. She also discusses the developmental benefits of adventure playgrounds as well as positive community development outcomes. Staempfi examines the issue of safety and risk on playgrounds and the influence of society's values, beliefs, and legal system in shaping the development of adventure playgrounds. In concluding her article, Staempfi makes a number of recommendations for future research and highlights the importance of educational efforts to build awareness about the developmental benefits of adventure play.

Author Affiliation: Marianne Staempfi is with the University of Waterloo in Canada.

Staempfi, M. B. (2009). Reintroducing Adventure Into Children's Outdoor Play Environments. *Environment and Behavior*, 41(2), 268-280. This study may be available in a library near you or can be purchased online through the publisher at: <http://eab.sagepub.com/> (Volume 5)

Being physically active outdoors and in nature can improve children's health

Many children in the U.S. today have chronic health conditions such as obesity, asthma, and attention deficit/hyperactivity disorder. In this article, McCurdy and colleagues review the current status of children's health, including children's physical inactivity; increasing obesity; the prevalence of obesity-related diseases such as type 2 diabetes and hypertension; vitamin D deficiency; and mental health challenges such as depression and anxiety. The authors then review evidence regarding the benefits of physical activity, and in particular physical activity outdoors and in natural environments. In addition, the authors discuss the benefits natural environments can have on children's mental health, as well as additional potential health benefits, including improving asthma and nearsightedness. In concluding their article, McCurdy and colleagues examine the important role that pediatric health care providers play in the management of childhood obesity and other chronic health challenges. The authors review current guidance available to pediatricians and discuss a new initiative—The Children and Nature Initiative—which works with pediatric health care providers to increase the amount of time that children spend outside being physically active and in nature as a way to address chronic conditions and improve children's health.

Author Affiliation: Leyla McCurdy is with the National Environmental Education Foundation in Washington D.C.

McCurdy, L. E., Winterbottom, K. E., Mehta, S. S., & Roberts, J. R. (2010). Using nature and outdoor activity to improve children's health. *Current Problems in Pediatric and Adolescent Health Care*, 40(5), 102-117. This study may be available in a library near you or can be purchased online through the publisher at: [http://www.cppah.com/article/S1538-5442\(10\)00044-1/abstract](http://www.cppah.com/article/S1538-5442(10)00044-1/abstract) (Volume 5)

Greenspace supports children's quality of life

Bell and colleagues critically review the last 10 years of research that has examined relationships between greenspace and quality of life. Major areas reviewed in this report are: health and well-being, social and community value, economic value/impacts, environmental value, and planning and design. Research related to children is one of the main topics highlighted in the various sections of this report. In their review, Bell and colleagues also discuss their criteria for article inclusion, highlight methodological limitations of studies conducted to date, and identify key research gaps.

Author Affiliation: The authors are with the OPENspace research center in the UK.

Bell, S., Hamilton, V., Montarzino, A., Rothnie, H., Travlou, P., & Alves, S. (2008). Greenspace and quality of life: a critical literature review. Greenspace Scotland. This report is available online at: <http://www.greenspacescotland.org.uk/default.asp?page=465> (Volume 4)

Time spent outdoors supports many aspects of children's health

In this report, Muñoz reviews literature concerning the linkage between spending time outdoors and health, with a primary emphasis on research related to children. She reviews research and policy related to outdoor use and health more generally and then takes an in-depth look at topics related to children's use of the outdoors and relationships to their health. Specific topics Muñoz examines include research linking children's time spent outdoors to increased physical activity, healthy development, and overall well-being. She also examines research related to the design of children's play spaces, access to natural spaces, the use of outdoors in children's education, and research related to people and factors that constrain and enable children's outdoor play. Finally, in concluding her literature review, Muñoz identifies methodological considerations, research gaps, and provides suggestions for advancing knowledge in this area.

Author Affiliation: Muñoz is with the Sustainable Development Research Centre in Scotland.

Muñoz, S. A. (2009). Children in the outdoors: a literature review. Sustainable Development Research Centre. This report is available online at: <http://www.countrysiderecreation.org.uk/Children%20Outdoors.pdf> (Volume 4)

Readers may also be interested in the following related report:

Scottish Natural Heritage. (2009). Health and the natural heritage-the evidence base. Retrieved September 7, 2009, from <http://www.snh.org.uk/pdfs/strategy/Healthevidence.pdf>

Contact with nature provides a variety of health benefits

In this report, C. Maller and colleagues reviewed published literature demonstrating health and well-being benefits from contact with nature, with an emphasis on park settings. Particularly in urban areas, parks play an important role in providing people with access to nature. The authors encourage a reframing of our traditional view of parks as places for leisure and sport towards one that emphasizes a full range of physical, mental, and social health benefits. Maller and colleagues provide valuable background material on the concept of health and the connection between nature and health. The authors then review evidence of the health benefits of various forms of contact with nature, including viewing nature, being in nature, contact with plants, and contact with animals. Maller and colleagues provide a number of recommendations, including the need for additional

research, the repositioning of parks, and the integration of parks and nature into public health strategies and management actions. The authors present a number of useful summary tables, which provide quick access to major findings about the health benefits of contact with nature.

Maller, C., Townsend, M., St.Leger, L., Henderson-Wilson, C., Pryor, A., Prosser, L., and Moore, M. (2008). “The health benefits of contact with nature in a park context: A review of relevant literature.” Deakin University and Parks Victoria. The original 2002 review and annotated bibliography are available online at: http://www.parkweb.vic.gov.au/1process_content.cfm?section=99&page=16. The updated 2008 review is available for a nominal fee by contacting Mardie Townsend at mardie.townsend@deakin.edu (Volume 3)

Readers may also be interested in the following documents:

A fact sheet on the health benefits of the natural environment by the National Environmental Education Foundation. This fact sheet is available online at: <http://www.neefusa.org/assets/files/NIFactSheet.pdf>

An article by Howard Frumkin and Richard Louv about the important role natural landscapes play in protecting public health. This article is available online at: <http://atfiles.org/files/pdf/FrumkinLouv.pdf>

Children’s play in natural settings provides a suite of benefits

In this report, Stuart Lester and Martin Maudsley provide an extensive review of the literature related to children’s natural play. The authors begin by examining the human relationship with the natural world and the importance of play and direct interaction with the physical environment to children. Lester and Maudsley then review the important opportunities that natural play provides, such as the creation of special places, and the numerous documented and potential benefits of children’s play in natural settings, including the development of a sense of self and independence. The authors discuss evidence demonstrating a decline in children’s access and opportunities to play in natural spaces and provide a range of suggestions to support children’s opportunities to play in natural settings, such as through the design of effective playgrounds, school grounds, and environmental play projects, as well as ensuring adequate access to parks and nature reserves.

Lester, S., & Maudsley, M. (2006). “Play, naturally: A review of children’s natural play.” Children’s Play Council. This report is available online at: <http://www.playday.org.uk/PDF/play-naturally-a-review-of-childrens-natural%20play.pdf> (Volume 3)

The importance of designing spaces that support children’s contact with nature

In this book chapter, Robin Moore and Clare Cooper Marcus review health threats that face many of today’s children, including sedentary behavior and attention deficit disorder; the benefits that contact with nature provides to children’s mental, social, and physical health; and current barriers limiting children’s access to nature. The authors provide examples of designed environments, specifically in urban areas, that support children’s contact with nature, including examples of innovative childcare centers and preschools, school grounds, neighborhood parks, and community institutions. Moore and Marcus emphasize the importance of the residential environment and the need to understand and incorporate children’s ideas and preferences into the planning and design of spaces. The authors discuss four models of child-friendly residential neighborhood layouts with specific national and international case studies, including clustered housing and shared outdoor space, cul-de-sacs and greenways, alleys, and home zones. Moore and Marcus conclude by providing

a number of key recommendations to help ensure children's access to nature in residential environments.

Moore, R. C., & Cooper Marcus, C. (2008). "Healthy planet, healthy children: Designing nature into the daily spaces of childhood." In S. Kellert, J. Heerwagen & M. Mador (Eds.), *Biophilic design: Theory, science and practice*. Hoboken, NJ: John Wiley & Sons, Inc. This book chapter is available online at: http://www.naturalelearning.org/docs/MooreCooperMarcus_Healthy.pdf (Volume 3)

Direct experience in nature is critical and diminishing

Nature is important to children's development in every major way — intellectually, emotionally, socially, spiritually, and physically. In his newest book, *Building for Life: Designing and Understanding the Human-Nature Connection* (Island Press, 2005), Dr. Stephen R. Kellert of Yale University devotes a chapter to the subject of "Nature and Childhood Development." Combining his original research with well-documented references to the research of others, this chapter is a powerful synthesis of what we know, and what we do not know, about the importance of nature to children's healthy development. Kellert states, "Play in nature, particularly during the critical period of middle childhood, appears to be an especially important time for developing the capacities for creativity, problem-solving, and emotional and intellectual development." He includes research to indicate optimal learning opportunities at age-appropriate times and differentiates between indirect, vicarious, and direct experiences with nature — with the latter less and less available to children. He urges designers, developers, educators, political leaders and citizens throughout society to make changes in our modern built environments to provide children with positive contact with nature — where children live, play, and learn. (Original Research and Synthesis)

Kellert, Stephen R. "Nature and Childhood Development." In *Building for Life: Designing and Understanding the Human-Nature Connection*. Washington, D.C.: Island Press, 2005. Full book available via Amazon.com and other commercial sources. http://www.cnaturenet.org/02_rsrch_studies/PDFs/Kellert_BuildingforLife.pdf (Chapter 3). (Volume 1)

Unstructured free play brings cognitive, social and health benefits to children

Unstructured free play in the out-of-doors brings a host of benefits to children —from being smarter to more cooperative to healthier overall. This well-documented article by two physicians builds a strong case for the importance of unstructured free play in the out-of-doors for all age groups, and especially young children. While concerned about the "obesity epidemic" in young children, the authors say that the health benefits from outdoor play are only one aspect of the overall benefits. They suggest that the concept of "play" is more compelling and inviting to most adult caregivers, parents and guardians than "exercise." The authors cite cognitive benefits from play in nature, including creativity, problem-solving, focus and self-discipline. Social benefits include cooperation, flexibility, and self-awareness. Emotional benefits include stress reduction, reduced aggression and increased happiness. Children will be smarter, better able to get along with others, healthier and happier when they have regular opportunities for free and unstructured play in the out-of-doors. (Synthesis)

Burdette, Hillary L., M.D., M.S.; and Robert C. Whitaker, M.D, M.P.H. "Resurrecting Free Play in Young Children: Looking Beyond Fitness and Fatness to Attention, Affiliation and Affect." © 2005 American Medical Association.

Contact with nature is important for children

Andrea Faber Taylor and Frances E. Kuo have contributed important research to the understanding of the impact of nature on people's lives, and specifically to the well-being of children. This particular article is a recent review of the literature and establishes what is known, and what is still missing, about the effects of contact with nature on children's lives. While the evidence is growing, this article is an important call to action for further research.

Taylor, Andrea Faber; and Frances E. Kuo. "Is Contact with Nature Important for Healthy Child Development? State of the Evidence." In Spencer, C. & Blades, M. (Eds.), Children and Their Environments: Learning, Using and Designing Spaces. Cambridge, UK: Cambridge University Press, 2006.

<http://www.lhhl.uiuc.edu/documents/Faber2006Iscontactwithnature.pdf> (Volume 1)

City parks bring social, community health and economic benefits

The Trust for Public Land (TPL) is a premier conservation organization, responsible for protection of special public lands throughout several generations. Today TPL is concerned not just about setting lands aside for future generations, but making sure that young people and families enjoy them today. TPL recognizes that to connect with nature is to appreciate nature, now and for the long term. This comprehensive report, "The Benefits of Parks: Why America Needs More City Parks and Open Space," offers a clear look at socioeconomic factors affecting the availability of parks, the history of city parks, and the hopes for a revival of commitment to city parks. The report outlines benefits in a number of areas: physical, including remedies for inactivity and obesity; economic, with increased property values; environmental, with pollution abatement; and social, from crime reduction to strengthening communities. Add this report to your collection of those that serve to document how safe places for children to play contribute to everyone's health and well being.

http://www.tpl.org/content_documents/parks_for_people_Jul2005.pdf (Volume 1)

Focus: Mental Health Benefits

These articles examine relationships between children's contact with the outdoors and/or nature and their psychological and cognitive performance and functioning.

Urban and rural brains respond differently to stress

Over the years, a number of studies have found that city living increases the risk of certain mental health problems, such as mood and anxiety disorders, and is thought to be linked to stresses in the urban social environment. In this study, Lederbogen and colleagues placed 32 healthy German volunteers from urban areas, towns, and rural areas under stress and used functional magnetic-resonance imaging (fMRI) to scan their brains and examine their neural processes. In addition to examining where participants currently live (city, town, or country), researchers also assessed where participants grew up along the country to city spectrum. In analyzing the data, Lederbogen and colleagues found that urban and country residents' brains handled the stress from the experiment

differently in that different parts of their brains were activated. Researchers discovered that people living in the country had the lowest levels of activity in their amygdalas, structures responsible for processing and memory of emotional reactions such as environmental threats, while people living in towns had higher levels, and people living in the city had the highest levels of activity in their amygdalas. In addition, Lederbogen and colleagues discovered that whether people grew up in the city or country differentially impacted their perigenual anterior cingulate cortex (pACC), structures in the brain that helps regulate the amygdalas. Researchers found that people who spent more time growing up in the city had a more active pACC under stress, regardless of where they currently live. Importantly, Lederbogen and colleagues conducted two other similar experiments, one using a different stress test and the other using a different sample of participants, and found the same results. In addition, researchers examined the functional connectivity between the pACC and amygdalas and found that urban upbringing was associated with reduced connectivity, while current urban living had no impact, highlighting the importance of early urban exposure on brain processes. While this study may be limited due to its small sample size and inability to prove a causal relationship, it provides an important new understanding of the neural effects of different living environments on social stress processing.

Author Affiliation: Florian Lederbogen is with the University of Heidelberg in Germany.

Lederbogen, F., Kirsch, P., Haddad, L., Streit, F., Tost, H., Schuch, P., et al. (2011). City living and urban upbringing affect neural social stress processing in humans. *Nature*, 474(7352), 498-501. This article may be available in a library near you or can be purchased online through the publisher at: <http://www.nature.com/nature/index.html> (Volume 5)

Children with ADHD functioned better in the woods than in a built setting

Several studies have found that contact with nature may reduce symptoms of attention-deficit hyperactivity disorder (ADHD) in children. To build upon this work, van den Berg and van den Berg examined the behavior and cognitive and emotional functioning of 12 children, between the ages of 9 and 17, enrolled in a care program for children with ADHD at two farms in the Netherlands. As part of this study, researchers observed and tested the two groups of children during visits to a wooded area and a nearby town on consecutive days. At both of these locations, researchers observed children participating in a group activity (e.g., building a cabin or exploring a neighborhood), and had children evaluate their experience, describe their mood, and take a concentration test. In analyzing the data, van den Berg and van den Berg found that both groups performed better on a concentration task in the woods than in the town, however, they found that children's behavior and emotional functioning in the two settings differed. Researchers found that children in one group liked the woods better than the town and had more positive behaviors and feelings in the woods, whereas children from the other group liked the town and woods equally and displayed positive behaviors in both settings, although they showed somewhat less positive behaviors overall in the town than in the woods. While this study may be limited due to its small sample size and inability to control for a number of potentially influencing factors, its findings, in conjunction with previous research, suggest that the natural environment may help children better cope with ADHD.

Author Affiliation: A.E. van den Berg is with Wageningen University and Research Center in The Netherlands.

Van Den Berg, A., & Van Den Berg, C. **A comparison of children with ADHD in a natural and built setting.** *Child: Care, Health and Development.* This study may be available in a library near you or can be purchased online through the publisher at: <http://www.wiley.com/bw/journal.asp?ref=0305-1862> (Volume 5)

Children with ADHD who regularly play in green settings have milder symptoms than children who play in built outdoor and indoor settings

In the United States, an estimated 4.4 million children have been diagnosed with Attention Deficit/Hyperactivity Disorder (ADHD). In this study, Faber Taylor and Kuo examined whether routinely experienced greenspaces—those that children visit on a daily or near daily basis—impact children’s ADHD symptoms. Researchers collected data via an internet survey from 421 parents of 5- to 18-year-old children with ADHD. Parents provided information about where their child played most of the time during the past week and the severity of their child’s ADHD symptoms. In analyzing the data, Faber Taylor and Kuo found that most children played in one of five settings: 1) Places where there are big trees and grass (Big Trees & Grass); 2) Places indoors where it feels very much indoors (Indoors); 3) Places where there is a lot of open grass (Open Grass); 4) Places that are paved or built (Built Outdoors); and 5) Other. Researchers examined the relationship between these five settings and the severity of children’s ADHD symptoms and found that children who regularly play in green play settings (Big Trees & Grass and Open Grass) have milder ADHD symptoms than children who play in built outdoor and indoor settings. Importantly, Faber Taylor and colleagues found that the impact of green play settings on children’s ADHD symptoms did not vary based on family income or the child’s gender. Interestingly, in examining differences between children with hyperactivity (ADHD) and without hyperactivity (ADD), researchers found that for children with hyperactivity only one of the green play settings--Open Grass--is associated with less severe symptoms, while for children without hyperactivity both green play settings--Open Grass and Big Trees & Grass--are associated with less severe symptoms. This study may be limited due to its reliance on parental reports and is correlational (not causal) in nature, however, it provides a valuable contribution to the growing research in this area as it is the first large study to examine linkages between greenspace exposure and ADHD symptoms. Faber Taylor and colleagues conclude their article by discussing the potential role of greenspace exposure to ADHD management and the need for randomized control trials to strengthen our understanding of the relationship between nature and ADHD symptoms.

Author Affiliation: Faber Taylor is with the University of Illinois at Urbana-Champaign.

Faber Taylor, A., & Kuo, F. E. M. (2011). Could exposure to everyday green spaces help treat ADHD? Evidence from children's play settings. *Applied Psychology: Health and Well-Being.* This study may be available in a library near you or can be purchased online through the publisher at: <http://www.wiley.com/bw/journal.asp?ref=1758-0846> (Volume 5)

Preschool children experiencing a weekly outdoor lesson have improved self-efficacy and early literacy skills

The Outdoor Discovery Center Macatawa Greenway--a non-profit entity that delivers outdoor, nature-based education and programming in Holland, MI--developed a nature-based program intervention to improve the health and well-being of preschool children and their families. As part of the intervention, naturalist educators visited six preschools on a weekly basis to deliver an hour-

long lesson focused on a science concept that was taught through outdoor activities. To understand the impact of the intervention on students, Trent-Brown and colleagues examined a number of health and well-being measures for over 100 preschool students, between the ages of 3 and 5, prior to and 6 months after the intervention began in both an experimental group that received the intervention, as well as a control group that did not receive the intervention. Researchers measured children's blood pressure, body mass index (BMI), activity preferences, self-efficacy, and early literacy skills. In analyzing the data for experimental and control groups, Trent-Brown and colleagues found that preschool students in the nature intervention program had significantly improved with regard to their self-efficacy and early literacy skills when compared to the control group. In examining relationships between outcomes for the control and experimental groups, researchers found that there was a more significant and positive relationship between activity preferences and self-efficacy and early literacy skills for the experimental group as compared to the control group, indicating that children with more active preferences tended to improve more with regard to self-efficacy and early literacy skills. While there were notable positive outcomes, researchers also found that preschool students in the nature intervention program had significantly elevated mean arterial blood pressure scores, as well as significant increases in the number of students classified as prehypertensive as compared to the control group, which did not experience these increases. With regard to BMI and activity preferences, researchers found no significant changes among the experimental or control groups. While this study may be limited due to student and teacher turnover in the classrooms, as well as a number of other factors that were not controlled as part of the study and therefore might influence study outcomes, such as nutrition and family health history, it provides an important contribution to the literature about the impact of nature programs on children's health and well-being. Importantly, this study will continue in future years, providing important information about the long-term impact of nature programs on students.

Author Affiliation: Trent-Brown is with Hope College in Holland, MI.

Trent-Brown, S. A., Vanderveen, J. D., Cotter, R., Hawkins, K., Schab, A., Dykstra, S., et al. (2011). *Effects of a nature-based science enrichment program on preschool children's health, activity preferences, self-efficacy, and cognition: Outdoor Discovery Center Macatawa Greenway.* This report may be available via the Outdoor Discovery Center Macatawa Greenway at <http://odcofwu.schoolwires.com/odcofwu/site/default.asp> (Volume 5)

Elementary school principals overwhelmingly believe recess has a positive impact on students' achievement, learning, and development

Children spend more time in school than almost anywhere else. At school, recess provides one of the few opportunities for children to play and to potentially be outdoors. Gallup conducted a nationwide survey of 1,951 elementary school principals from urban, suburban, and rural schools to understand principals' attitudes and experiences with recess. A few of the key findings include: 1) more than 80% of principals reported that recess has a positive impact on academic achievement; 2) 75% of principals stated that students are more focused in class after recess and listen better; and 3) more than 95% of principals believe that recess positively impacts students' social development and general well-being. Despite these benefits, researchers found that many principals reported offering very limited recess times. For example, 50% of principals reported that students receive 30 minutes or less of recess per day. In addition, over 75% of principals reported taking recess away from students as a punishment. According to principals, one of the biggest challenges with recess is

discipline-related problems. Principals identified additional staff, better equipment, and playground management training as ways to improve recess at schools.

Author Affiliation: The poll was conducted by Gallup with sponsorship from the Robert Wood Johnson Foundation and assistance from the National Association of Elementary School Principals and Playworks.

Robert Wood Johnson Foundation. (2010). The state of play: Gallup survey of principals on school recess. This study is available online at: <http://www.rwjf.org/files/research/stateofplayrecessreportgallup.pdf> (Volume 5)

Children with ADHD concentrate better after walking in a park

Building off of their recent work related to children with Attention-deficit hyperactivity disorder (ADHD) and different types of activity settings, in this study, Andrea Faber Taylor and Frances Kuo investigate the impacts of three different outdoor environments on the attention of seventeen 7- to 12-year-old children diagnosed with ADHD. After completing a series of puzzles that required focused attention, each child, over the course of three different weeks, participated in a 20 minute guided walk in three different outdoor settings (an urban park, a downtown area, and a residential area). After each guided walk, children completed a concentration test and answered several questions about their walking experience. Importantly, the authors controlled for a number of potential confounding factors, including the order of environments experienced, the time of day and day of week, terrain, and season. In analyzing the data, Faber Taylor and Kuo found that children concentrated better after walking in a park setting as compared to either a downtown or residential setting and that the effect of walking in a park on concentration helped close the gap between children with ADHD and those without ADHD with regard to the concentration measure used and that the effect was similar to that of two common types of ADHD medication. In addition, the authors found that children rated their experiences more positively in the park setting than in the other two settings. Faber Taylor and Kuo discuss these findings in light of Attention Restoration Theory and their previous studies related to different environments and children with ADHD and suggest additional avenues for research and the potential of using nature in the treatment of ADHD.

Faber Taylor, A., & Kuo, F. E. (2008). Children with attention deficits concentrate better after walk in the park. *Journal of Attention Disorders OnlineFirst*. This article will be published in print in 2009 and may be available in a library near you or can be purchased online at: <http://jad.sagepub.com>. (Volume 3)

Natural settings provide psychological benefits

“Coping with ADD: The Surprising Connection to Green Play Settings,” by Andrea Faber Taylor; Frances E. Kuo; and William C. Sullivan (2001) is one of the earliest studies to explore the potential for contact with nature to have a positive effect in reducing the impact of attention deficit disorder in children. The study was designed to test two hypotheses: 1) Attention deficit symptoms will be more manageable after activities in green settings than after activities in other settings; and 2) The greener a child’s everyday environment, the more manageable their attention deficit symptoms will be in general. The results were positive.

Taylor, Andrea Faber; Frances E. Kuo; and William C. Sullivan. In *Environment and Behavior*, Vol. 33, No. 1, January 2001. © 2001 Sage Publications, Inc. Available on the web site of the University of Illinois Urbana-Champaign. <http://www.lhhl.uiuc.edu/> (Volume 1)

Nature activities soothe ADD symptoms

Contact with the natural world can significantly reduce symptoms of attention deficit disorder in children as young as five. Here is another important study that supports this finding. In addition to access to reports of the primary research, the scholars provide a Power Point presentation that may be used in communities to disseminate this positive information based on sound research.

Kuo, Frances E.; and Andrea Faber Taylor. “A Potential Natural Treatment for Attention-Deficit/Hyperactivity Disorder: Evidence from a National Study.” In *American Journal of Public Health*, Vol 94, No. 9, September 2004. © American Public Health Association. The study and the educational Power Point are available on the web site of the University of Illinois Urbana-Champaign. <http://www.lhhl.uiuc.edu/> (Volume 1)

Nearby nature reduces stress in children

This study, reported in 2003, by Cornell assistant professor Nancy Wells, focuses on rural children and finds that even a view of nature — green plants and vistas — helps reduce stress among highly stressed children. Further, the more plants, green views and access to natural play areas, the more positive the results.

Wells, N.M., and Evans, G.W. “Nearby Nature: A Buffer of Life Stress Among Rural Children.” *Environment and Behavior*. Vol. 35:3, 311-330. This study is not available online without purchase; <http://www.sagepub.co.uk/journals/details/j0163.html> (Volume 1)

Nearby nature boosts children’s cognitive functioning

A precursor to Nancy Wells’ study reported above, this research, reported in 2000, shows that proximity to, views of, and daily exposure to natural settings increases children’s ability to focus and therefore enhances cognitive abilities.

Wells, N.M. “At Home with Nature: Effects of ‘Greenness’ on Children’s Cognitive Functioning.” *Environment and Behavior*. Vol. 32, No. 6, 775-795. This study is not available online without purchase; <http://cab.sagepub.com/cgi/content/abstract/32/6/775> (Volume 1)

Focus: Physical Health Benefits

These articles examine linkages between the design of children’s environments, children’s outdoor-related behavior and their physical health, including physical activity, development, and functioning.

Pregnant women living in areas with more trees had better birth outcomes

Donovan and colleagues investigated the effect that urban trees might have on adverse birth outcomes, including preterm birth and small for gestational age. Researchers examined all single live births in Portland, Oregon in 2006 and 2007 where the woman lived in a single-family home (approximately 5,700 women). Researchers also classified the amount of trees around each woman’s home. In examining the relationship between tree cover and birth outcomes, Donovan and colleagues found that women who had more trees within 50 meters of their home, and who lived

close to a private open space, had a significantly lower risk of having a baby being born that was small for gestational age. In fact, researchers found that a 10% increase in tree cover reduced the number of small for gestational age births by 1.42 in 1,000 births. Donovan and colleagues found no significant relationship between tree cover and preterm birth. While it is not known how trees might improve birth outcomes, researchers discuss several possible mechanisms, including stress reduction, improved social contacts, and increased physical activity. This study may be limited due to its observational nature, but through its large sample size and control of numerous individual and neighborhood factors, it highlights a valuable new area for future research on nature-health connections.

Author Affiliation: Geoffrey Donovan is with the USDA Forest Service in Portland, Oregon.

Donovan, G. H., Michael, Y. L., Butry, D. T., Sullivan, A. D., & Chase, J. M. (2010). Urban trees and the risk of poor birth outcomes. *Health & Place*. This study may be available in a library near you or can be purchased online through the publisher at: http://www.elsevier.com/wps/find/journaldescription.cws_home/30519/description (Volume 5)

Children who spend more time in outdoor sport activities and less time watching TV have better retinal microvascular structure

The condition of small (micro) blood vessels is critical to good health. Retinal blood vessels provide a unique opportunity to study microvascular health noninvasively and have been linked to cardiovascular disease risk factors and blood pressure. In this study, Gopinath and colleagues examined relationships between children's physical activity, sedentary behaviors, and retinal microvascular size. Researchers had the parents of almost 1,500 6-year-old children from 34 different schools in Sydney, Australia complete surveys regarding their children's physical activity (outdoor and indoor) and sedentary behavior. Researchers also took digital photographs of children's eyes and measured retinal vessel diameter. In analyzing the data, Gopinath and colleagues found that, on average, children spent 36 minutes per day engaged in physical activity and 1.9 hours per day engaged in screen time. In examining relationships between children's physical activity, sedentary behaviors, and retinal microvascular size, researchers found that children who engaged in more physical activity outdoors had better retinal vascular diameter (wider arterioles), while children who engaged in more screen time had worse retinal vascular diameter (narrower arterioles). Interestingly, researchers did not find a significant relationship between indoor sporting activities and children's retinal vascular diameter. Gopinath and colleagues also discovered that the size of arterial narrowing associated with each daily hour children watched TV was fairly comparable to a 10-mm Hg increase in systolic blood pressure. This study may be limited due to its reliance on parent reports and relationships examined are correlational (not causal). While additional research is needed to understand these relationships, researchers discuss how retinal arteriolar narrowing could be a potential indicator of future cardiovascular disease and thus efforts to decrease the amount of time children watch TV and increase the amount of time children spend in outdoor activities could be particularly valuable to improving children's health.

Author Affiliation: Bamini Gopinath is with the University of Sydney in Australia.

Gopinath, B., Baur, L. A., Wang, J. J., Hardy, L. L., Teber, E., Kifley, A., et al. (2011). Influence of Physical Activity and Screen Time on the Retinal Microvasculature in Young Children. *Arteriosclerosis, Thrombosis, and Vascular Biology*, 31(5), 1233. This study may be available in a library near you or can be purchased online through the publisher at: <http://atvb.ahajournals.org/> (Volume 5)

An outdoor program enhances children’s well-being, physical activity, and feelings of health, safety, and satisfaction

Many children in their teenage years face mental health challenges. Several studies have found that contact with nature and physical activity in a natural environment, what some call “green exercise,” improves psychological well-being. In this study, Wood and colleagues evaluated the impact of the Youth Outdoor Experience (YOE) project on participating children’s well-being and physical activity. The YOE project provides 11- to 18-year-old children from disadvantaged urban areas in England with opportunities to participate in a 12-week program where children engage in weekly structured outdoor activities. As part of this study, researchers had 14 participants complete a questionnaire to assess their well-being, connectedness to nature, and physical activity. Researchers also had 114 participants complete a questionnaire to assess the impact of the project on a range of well-being areas (e.g., being healthy, staying safe, and enjoying and achieving). Most participants completed both questionnaires at the start, middle, and end of the project. In analyzing the data, Wood and colleagues found a number of interesting results, including:

- Participants’ well-being increased from the start to the end of the program.
- Participants’ contact with nature varied a lot over the course of the project.
- Participants increased the number of days that they performed 30 minutes of moderate physical activity.
- Project leaders reported positive changes in participants’ attitudes, self-esteem, and behavior.
- Participants reported feeling healthier, safer, and more positive with regard to their school, home, and social lives, as well as their achievements.

While this study may be limited due to its small sample size and reliance on self-report measures, it highlights the need for additional research in this area and the potential role that nature-based activities can have on participants’ well-being, physical activity, and feelings of health, safety, and satisfaction.

Author Affiliation: Carly Wood is with the University of Essex in the UK.

Wood, C., Hine, R., & Barton, J. (2011). *The health benefits of the Youth Outdoor Experience (YOE) project*. University of Essex. This report may be available through the University of Essex, Suffolk Wildlife Trust, or Natural England. (Volume 5)

The Berkeley School Lunch Initiative enhances students’ preference for and consumption of healthy foods, nutrition knowledge, and food-related attitudes

In 2005, the Berkeley Unified School District started the School Lunch Initiative and phased the Initiative into schools from 2006 to 2009. The School Lunch Initiative is a collaborative partnership that was developed to improve student health and understanding of sustainable food systems. The Initiative is a comprehensive program that features hands-on cooking classes, food and dining services changes, and curriculum changes. Rauzon and colleagues evaluated the School Lunch Initiative to examine its effects on students’ eating behaviors, attitudes about healthy eating and environmental responsibility, and knowledge about nutrition and food and the environment. To evaluate program impacts, researchers compared over 200 4th and 5th grade students over a period of 3 years from 4 different schools—2 with highly developed School Lunch Initiative programs and 2 with lesser-developed School Lunch Initiative programs. Participants completed food diaries and

answered questionnaires about their knowledge, attitudes, and behaviors as they related to nutrition, food, and the environment. In addition, researchers conducted interviews with school staff, observed food service environments, collected information on students' academic test scores and body mass index, and had parents of participating students complete a survey related to family and neighborhood characteristics. In analyzing the data, Rauzon and colleagues found that the School Lunch Initiative had positive impacts on students' nutrition knowledge, preference for and consumption of healthy foods, and food-related attitudes. A few of their findings include:

- *Parents reported that the program positively impacted their child's eating habits.* For example, 35% of parents with children in schools with advanced programs reported that school had improved their child's eating habits, as compared to 16% of parents with children in schools with lesser-developed programs.
- *Students' nutrition knowledge was higher.* Students attending schools with advanced programs had higher nutrition knowledge scores, compared to students attending schools with lesser-developed programs.
- *Younger students preferred more fruits and vegetables.* Younger students attending schools with advanced programs preferred more fruits and vegetables as compared to students attending schools with lesser-developed programs. These differences, however, with the exception of green leafy vegetables, disappeared as students moved into higher grades.
- *Middle school students had more positive food-related behaviors.* Middle school students attending schools with advanced programs had more positive attitudes toward eating school food and agreed more often that produce tasted better in-season and that eating choices can impact the environment, as compared to students attending schools with lesser-developed programs.
- *Younger students ate more fruits and vegetables.* Younger students attending schools with advanced programs ate nearly 1.5 more servings of fruits and vegetables daily as compared to students in schools with lesser-developed programs where consumption actually decreased by 0.4 servings.

Researchers also examined the impact of school programs on students' academic test scores and body mass index, but found no significant differences between students in advanced versus lesser-developed programs, which may have been due to the small sample size or length of time examined. This report provides a valuable contribution regarding the impact that innovative school programs can have on students' food-related behavior and attitudes. Researchers conclude their report with a series of recommendations to help enhance the current program and/or apply the program in other school districts.

Author Affiliation: Suzanne Rauzon is with the University of California at Berkeley.

Rauzon, S., Wang, M., Studer, N., & Crawford, P. (2010). *An evaluation of the school lunch initiative*. Berkeley, CA: University of California at Berkeley. This report is available online at: http://cwh.berkeley.edu/sites/default/files/primary_pdfs/An_Evaluation_of_the_School_Lunch_Initiative_Final%20Report_9.22.10.pdf (Volume 5)

Vitamin D deficient children are more likely to become obese over time

Vitamin D is essential for calcium absorption and may be important for numerous other bodily processes. Vitamin D is primarily produced in the skin after exposure to sunlight. Previous studies have found that vitamin D deficiency might be a risk factor for childhood obesity, however, these studies have been limited because they have examined this relationship at one point in time (a cross-

sectional design) and thus causality could not be determined. In this study, Gilbert-Diamond and colleagues investigated the relationship between vitamin D levels and various indicators of obesity over a 3-year period in a representative sample of nearly 500 low- and middle-income school-age children (5-12 years of age) from Bogota, Columbia. To examine this relationship, researchers collected a baseline blood sample from each child and various body measurements (e.g., height, weight, skinfold thickness, and waist circumference), and had parents complete a socio-demographic survey. Researchers collected body measurements from children each year for 3 years. Gilbert-Diamond and colleagues found that 11% of children were overweight, 10.2% were vitamin D deficient, and 46.4% were vitamin D insufficient. In examining the relationship between vitamin D levels and obesity measures, researchers found that vitamin D deficient children had a greater increase in body mass index over time as compared to vitamin D sufficient children. Researchers also found that vitamin D deficient children had a greater increase in their skinfold-thickness ratio and waist circumference, as compared to vitamin D sufficient children. In addition, Gilbert-Diamond and colleagues examined the relationship between vitamin D levels and children's linear growth (i.e., height). In examining the data, researchers found that vitamin D deficient girls had slower linear growth than vitamin D sufficient girls. While this study may be limited due to its measurement of vitamin D levels at baseline only, its assessment of body measurements over time and use of a large, representative sample provides a valuable contribution to the literature and our understanding of the relationship between vitamin D levels and obesity.

Author Affiliation: Diane Gilbert-Diamond is with Harvard University and Dartmouth College.

Gilbert-Diamond, D., Baylin, A., Mora-Plazas, M., Marin, C., Arsenault, J. E., Hughes, M. D., et al. (2010). Vitamin D deficiency and anthropometric indicators of adiposity in school-age children: a prospective study. *The American Journal of Clinical Nutrition*, 92(6), 1446. This study may be available in a library near you or can be purchased online through the publisher at: <http://www.ajcn.org/> (Volume 5)

Plants in classrooms benefit students' emotions, behavior, and health

The classroom environment can play an important role in students' learning and academic performance. Han examined the effect of living plants in a classroom on students' psychology, behavior, and health. To investigate this relationship, he conducted a study with two similar classrooms, located next to each other, of sophomore students at a high school in Taiwan. Han used surveys every 2 weeks to assess students' emotions and collected objective information on students' academic performance, health, and behavior. After an initial assessment period, he brought six small trees into the back of one of the classrooms. In comparing data from the two classrooms, Han found that shortly after the plants were introduced, students had significantly higher scores than the regular classroom in terms of preference, comfort, and friendliness. In addition, he found that students in the classroom with plants had significantly fewer sick leave hours and punishment records than students in the regular classroom. While this study may be limited due to its small sample size and there is the potential that other variables may have influenced the results, Han's research provides valuable insight into the benefits that even small amounts of nature can provide to students and suggests promising avenues for future research.

Author Affiliation: Ke-Tsung Han is with National Chin-Yi University of Technology in Taiwan.

Han, K. T. (2009). Influence of Limitedly Visible Leafy Indoor Plants on the Psychology, Behavior, and Health of Students at a Junior High School in Taiwan. [Article]. *Environment and Behavior*,

41(5), 658-692. This study may be available in a library near you or can be purchased online through the publisher at: <http://cab.sagepub.com/> (Volume 5)

Children who play more outside and watch less TV have lower BMIs

Kimbro and colleagues investigated linkages between outdoor play and TV watching and children's weight status, as well as linkages between the quality of children's residential environments and their activities. Researchers examined data for over 1,800 5-year-old children in major U.S. cities that took part in a large, longitudinal study on child well-being. Kimbro and colleagues examined children's body mass index (BMI), physical and sedentary activities as reported by mothers, various background and neighborhood characteristics, neighborhood social cohesion as reported by mothers (e.g., whether people are willing to help their neighbors), and physical conditions of the residential environment as measured by researchers (e.g., amount of litter nearby). Researchers found that 19% of children were overweight (between the 85th and 95th percentile) and 16% were obese (95th percentile or higher). Interestingly, Kimbro and colleagues found that children in the highest and lowest socioeconomic brackets had the lowest BMIs, while children in the middle socioeconomic brackets had the highest BMIs. Researchers also found that, on average, children played outside about 2 hours a day and watched television for more than 2.5 hours a day. In examining relationships between outdoor play, TV watching and children's weight, Kimbro and colleagues discovered that children who played more outdoors had lower BMIs, while children who watched more TV had higher BMIs. Researchers also found that the higher the ratio of outdoor time to television time, the lower the child's BMI. Kimbro and colleagues also investigated socio-demographic differences in children's outdoor and TV watching behavior. For example, researchers found that Black and Hispanic children spent less time outside than White children, but more time watching TV than White children. In examining the relationship between the quality of children's residential environments and activities, Kimbro and colleagues discovered that children whose mothers had higher perceptions of neighborhood social cohesion, played outside more, spent fewer hours watching TV, and made more trips to the park or playground. Interestingly, the researchers found that children living in public housing and areas with poorer neighborhood physical conditions played outside more and yet also watched more TV. Based on previous studies, Kimbro and colleagues suggest that children living in public housing and areas with poorer neighborhood physical conditions may have more unstructured time than children living in other conditions and thus are able to fill this time with more outdoor play as well as more television watching. While this study may be limited due to its reliance on mother-reported information and its inclusion of more poor and urban children, it provides a valuable addition to the literature regarding the role that children's environments have on their active and sedentary behavior.

Author Affiliation: Rachel Tolbert Kimbro is with Rice University.

Kimbro, R. T., Brooks-Gunn, J., & McLanahan, S. (2011). Young Children in Urban Areas: Links Among Neighborhood Characteristics, Weight Status, Outdoor Play, and Television-Watching. *Social Science & Medicine*. This study may be available in a library near you or can be purchased online through the publisher at: <http://journals.elsevier.com/02779536/social-science-and-medicine/> (Volume 5)

Children with better access to public parks and recreation programs are less likely to have significant increases in BMI over time

Wolch and colleagues investigated whether proximity to parks and recreational programs impacts the development of childhood obesity. Researchers gathered information on over 3,000 children, aged 9-10, from 12 communities in Southern California over an 8-year period. As part of this study, participants completed surveys and researchers measured children's height and weight on an annual basis. In addition, researchers evaluated public parks and recreation programs around children's homes. Wolch and colleagues found that 20% of children did not have access to recreation programs within 10km of their home and that over 50% of children did not have a park within 500m of their home. In examining the relationship between access to parks and recreation programs and children's body mass index (BMI), researchers found that children with better access to parks within 500m of their homes and recreation programs within 10km of their homes had a reduced risk of being overweight or obese at age 18. Wolch and colleagues found that the impact of recreation programs and parks was stronger for boys than girls and that the impact of recreation programs on BMI was stronger than that of parks. While this study did not consider private recreation space and programs or the influence of children's dietary intake, it provides a valuable contribution to the literature and demonstrates the important role that public parks and recreation programs can play in reducing the risk of childhood obesity.

Author Affiliation: Jennifer Wolch is with the University of California, Berkeley.

Wolch, J., Jerrett, M., Reynolds, K., McConnell, R., Chang, R., Dahmann, N., et al. (2010). Childhood obesity and proximity to urban parks and recreational resources: A longitudinal cohort study. *Health & Place*. This study may be available in a library near you or can be purchased online through the publisher at: <http://www.elsevier.com/> (Volume 5)

Children who spend more time outside are more physically active

Time spent outside is one potential factor that may influence children's physical activity. While previous studies have examined the relationship between time spent outside and children's physical activity, they have been limited due to their reliance on methods that use self-report, parent report, or direct observation. In this study, Cooper and colleagues used global positioning system (GPS) receivers to record the outdoor location of over 1,000 11-year-old children in the UK and matched this information with data from accelerometers that measured children's physical activity. Children wore the GPS units and accelerometers after school for four days. In analyzing the data, Cooper and colleagues found that children spent, on average, about 42 minutes outside after school each day. Researchers also found that children spent more time outdoors in the summer than in the winter months and that there were no significant differences between boys and girls with regard to time spent outside. In terms of physical activity, Cooper and colleagues found that physical activity was 2-3 times higher outside than inside, physical activity outdoors was higher in the summer than in the winter months, and that there was no seasonal variation in physical activity that took place indoors. In examining the relationship between time spent outside and physical activity, researchers found that the more time children spent outside, the more physically active they were. This study may be limited due to user operation of the instruments as well as misclassification of indoor/outdoor locations, however, it provides further evidence of the important linkage between children's time spent outside and their physical activity levels. This study also demonstrates the potential of combining GPS and accelerometer data to advance our understanding of this relationship.

Author Affiliation: Ashley Cooper is with the University of Bristol in the UK.

Cooper, A. R., Page, A. S., Wheeler, B. W., Hillsdon, M., Griew, P., & Jago, R. (2010). Patterns of GPS measured time outdoors after school and objective physical activity in English children: the PEACH project. *International Journal of Behavioral Nutrition and Physical Activity*, 7. This study may be available in a library near you or can be purchased online through the publisher at: <http://www.ijbnpa.org/> (Volume 5)

Urban children are most active in gardens and street environments

Jones and colleagues investigated environments where children are physically active. Researchers had 100 children between the ages of 9 and 10 from urban and rural locations in Norfolk, UK wear accelerometers and global positioning system receivers for 4 days during the summer to track their locations and physical activity. In analyzing the data, Jones and colleagues identified all 5 minute bouts of moderate to vigorous physical activity and matched this activity to children's locations with a geographic information system. Researchers found that boys were more active than girls and that children who spent more time outside were more active than children who spent less time outside, especially for girls and children living in rural locations. In addition, Jones and colleagues discovered that children were more active in their neighborhoods, but that boys and rural children engaged in more moderate to vigorous physical activity outside their neighborhoods. With regard to environments for physical activity, researchers found that urban children most commonly used gardens and the street environment for their moderate to vigorous physical activity, while rural children most commonly used farmland and grassland. While this study may be limited due to its small sample size, the researchers' use of objective measures provides a new and valuable way to understand supportive environments for children's physical activity.

Author Affiliation: Esther van Sluijs is with the Institute of Metabolic Science in the UK.

Jones, A. P., Coombes, E. G., Griffin, S. J., & van Sluijs, E. M. F. (2009). Environmental supportiveness for physical activity in English schoolchildren: a study using Global Positioning Systems. *International Journal of Behavioral Nutrition and Physical Activity*, 6. This article may be available in a library near you or can be purchased online through the publisher at: <http://www.ijbnpa.org/> (Volume 5)

9-year-old children who play outdoors after school and 15-year-old children who participate in sport clubs are more physically active

Many efforts aimed at preventing childhood obesity have targeted increasing physical activity. To successfully increase physical activity levels it is important to understand factors that influence children's physical activity. In this study, Nilsson and colleagues investigated four leisure time behaviors and their relationship to physical activity: 1) mode of transportation to school; 2) outdoor play after school; 3) participation in sport and exercise clubs; and 4) TV viewing. Researchers analyzed data for over 1,300 9- and 15-year-old children from three European countries (Norway, Estonia, and Portugal). Nilsson and colleagues measured children's moderate to vigorous physical activity with accelerometers and their leisure activities via a self-report questionnaire. In analyzing the data, researchers found significant differences between age and gender groups. For example, 9-year-olds more frequently reported active commuting, outdoor play, and exercise in clubs as compared to 15-year-olds; while boys reported playing more outdoors after school than girls. With regard to physical activity levels, researchers found that 9-year-olds were significantly more active than 15-year-olds and that boys were significantly more active than girls. In examining relationships between leisure activities and physical activity, Nilsson and colleagues discovered that playing

outdoors after school was associated with higher physical activity levels for 9-year-olds, while participating in sport clubs was associated with higher physical activity levels for 15-year-olds. These results indicate that children's physical activity behavior changes as they age. Nilsson and colleagues did not find a relationship between active commuting or TV viewing and physical activity levels. Researchers also did not find relationships between leisure time behaviors and the amount of time children spent being sedentary, suggesting that there may be different factors that influence sedentary behavior and physical activity. Although this study could not examine causation and may be limited due to its use of self-reported information, it provides useful information about leisure time behaviors that influence children's moderate-to-vigorous physical activity levels, which can help inform interventions designed to enhance children's health.

Author Affiliation: Andreas Nilsson is with Örebro University in Sweden.

Nilsson, A., Andersen, L. B., Ommundsen, Y., Froberg, K., Sardinha, L. B., Piehl-Aulin, K., et al. (2009). Correlates of objectively assessed physical activity and sedentary time in children: a cross-sectional study (The European Youth Heart Study). *BMC Public Health*, 9. This study may be available in a library near you or can be purchased online through the publisher at: <http://www.biomedcentral.com/bmcpublichealth/> (Volume 5)

Having other children that play outdoors helps minimize physical activity declines in adolescent girls

Previous research has demonstrated a decline in children's physical activity in the middle-school years. To gain additional insight into factors that might be associated with this physical activity decline, Evenson and colleagues investigated relationships between perceived neighborhood characteristics and transportation and adolescent girls' non-school physical activity and sedentary behavior over a 2 year period. Researchers had nearly 850 girls from 36 schools in 6 states wear accelerometers for 6 days and complete a questionnaire about their neighborhood environment and after-school transportation when they were in the 6th and 8th grades. In analyzing the data, Evenson and colleagues found that girls' non-school moderate to vigorous physical activity declined between the 6th and 8th grades, while non-school sedentary behavior increased. With regard to the relationship between perceived neighborhood characteristics and transportation and declines in girls' physical activity, researchers found three significant factors, 2 of which were counter to the researchers' expectations: 1) reporting that other children do not play outdoors in their neighborhood was associated with physical activity declines; 2) reporting that their neighborhood was well lit was associated with physical activity declines; and 3) reporting that there were trails in their neighborhood was associated with physical activity declines. The authors discuss several potential explanations for their findings, including that these relationships change as children age. In addition, Evenson and colleagues found no relationships between neighborhood and transportation characteristics and changes in girls' non-school sedentary behavior, which suggests there may be different factors impacting children's physical activity and sedentary behaviors. While additional research is needed to understand determinants of the decline in children's physical activity, this study's longitudinal design and use of an objective physical activity measure makes an important contribution to the literature.

Author Affiliation: Kelly Evenson is with the University of North Carolina, Chapel Hill.

Evenson, K. R., Murray, D. M., Birnbaum, A. S., & Cohen, D. A. (2010). Examination of perceived

neighborhood characteristics and transportation on changes in physical activity and sedentary behavior: The Trial of Activity in Adolescent Girls. *Health & Place*, 16(5), 977-985. This article may be available in a library near you or can be purchased online through the publisher at: <http://www.elsevier.com/> (Volume 5)

Children have higher physical activity levels in greenspace as compared to non-greenspace

Wheeler and colleagues investigated children's physical activity after school in outdoor greenspace, outdoor non-greenspace, and indoors. Researchers examined over 1,000 10- to 11-year-old children's after school physical activity locations and levels by having children wear accelerometers for 7 days and global positioning system receivers for 4 days between the end of school and bedtime. In analyzing the data, Wheeler and colleagues found that children spent only 13% of their time outdoors and most of this time was spent in non-greenspace (11%) as compared to greenspace (2%). Researchers discovered, however, that 30% of children's physical activity and 35% of their moderate to vigorous physical activity occurred outdoors, with more intense physical activity occurring in greenspace as compared to non-greenspace, especially for boys. For example, boys were 1.37 times more likely (and girls 1.08 times more likely) to engage in moderate to vigorous physical activity in greenspace as opposed to non-greenspace. While this study may be limited due to potential misclassification of indoor and outdoor time, the researchers' use of objective measurement instruments and a large dataset helps improve our understanding of the role of specific land uses in supporting children's physical activity. As a result of their research, Wheeler and colleagues suggest that both green and non-green urban environments may be important to children's physical activity.

Author Affiliation: Benedict Wheeler is with the University of Bristol in the UK.

Wheeler, B. W., Cooper, A. R., Page, A. S., & Jago, R. (2010). Greenspace and children's physical activity: A GPS/GIS analysis of the PEACH project. *Preventive Medicine*, 51(2), 148-152. This article may be available in a library near you or can be purchased online through the publisher at: <http://www.elsevier.com/> (Volume 5)

Green areas on elementary school grounds support the highest level of children's moderate physical activity

Dyment and colleagues examined the relationship between school ground design and children's physical activity levels. Researchers collected information from two elementary schools, one in Australia and the other in Canada. The Australian school was selected because of its diversity of play areas, while the Canadian school was selected because of its long-term school ground greening efforts. At each school, Dyment and colleagues observed the location and intensity of children's play behaviors (sedentary, moderately active, or vigorously active) during lunch and recess periods. In analyzing the data, researchers found that in Australia the greatest number of students spent time in the green area and paved sporting courts, while in Canada the greatest number of students spent time in the open asphalt area and open playing field. In terms of physical activity levels, children at both schools engaged in vigorous physical activity the most in areas with manufactured equipment (e.g., slides, swings, monkey bars, etc.), while children engaged in moderate physical activity the most in green areas (e.g., large grassy areas, gardens, etc.). With regard to children's sedentary behavior, researchers found that sedentary behavior was highest in the paved sporting courts and paved courtyard at the Australian school and the treed grassy berm, treed concrete steps, and open asphalt areas at the Canadian school. Dyment and colleagues highlight gender differences in area use,

discuss their results in terms of other studies, and highlight potential design and cultural factors that might suggest why certain school ground areas are related to vigorous, moderate, and sedentary activity. While this study may be limited due to its focus on only two schools and its reliance on observational data, it demonstrates the important role that green areas on school grounds can play in enhancing children's moderate physical activity levels, especially for children who are not interested or able to play vigorous games in more traditional areas.

Author Affiliation: Janet Dymont is with the University of Tasmania in Australia.

Dymont, J. E., Bell, A. C., & Lucas, A. J. (2009). The relationship between school ground design and intensity of physical activity. *Children's Geographies*, 7(3). This study may be available in a library near you or can be purchased online through the publisher at: <http://www.tandf.co.uk/journals/titles/14733285.asp> (Volume 5)

Children are less sedentary if they live in neighborhoods with certain environmental features

The amount of time children spend being sedentary (e.g., watching television, using the computer, or playing electronic games) is considered an important factor in childhood obesity. In this study, Veitch and colleagues investigated the relationship between features of children's physical and social neighborhood environment and the amount of time they spend in sedentary behaviors outside of school. To examine this relationship, researchers had parents of 171 5- to 6-year-old children complete surveys in 2004 about their physical and social neighborhood environment (e.g., quality of parks, amount of social contacts, and neighborhood safety), as well as complete a survey in 2004 and 2006 about the amount of time their child spent watching TV, using the computer, and playing electronic games. In addition, children wore accelerometers in 2004 and 2006 to measure their activity levels and researchers identified and visited the public open space closest to each child to assess its features. In examining the data for 2004, Veitch and colleagues found that certain physical features of children's neighborhood environment, but not social features, influenced their sedentary behavior. Researchers found that children whose closest public open space had a water feature and who had parents that were more satisfied with public open space quality spent less time with computer/electronic games. In addition, they found that children whose closest public open space was larger spent less time watching TV. In examining data from 2004 to 2006, Veitch and colleagues found that children that lived in a cul-de-sac spent less time watching TV and children who had parents that were more satisfied with public open space quality spent less time using computer/electronic games. Contrary to their other findings, researchers discovered that children whose closest public open space had a walking path spent more time with computer/electronic games, possibly because walking paths are not important or of interest to 5-6-year-old children. This study may be limited due to its small sample size and focus on the closest public open space, however, it provides important information, using a variety of measures across multiple years, about the relationship between the built environment and children's sedentary behaviors.

Author Affiliation: Jenny Veitch is with Deakin University.

Veitch, J., Timperio, A., Crawford, D., Abbott, G., Giles-Corti, B., & Salmon, J. (2011). Is the Neighbourhood Environment Associated with Sedentary Behaviour Outside of School Hours Among Children? *Annals of Behavioral Medicine*, 1-9. This study may be available in a library near you or can be purchased online through the publisher at: <http://www.springer.com/medicine/journal/12160> (Volume 5)

Children living in neighborhoods where parents believe that there are good parks and sidewalks spend less time engaged in screen-based behaviors, are more physically active, and are more likely to walk or bike to and from school

Parents play a large role in determining what children can and cannot do. In this study, Carson and colleagues investigated whether parents' perceptions of their neighborhood environments are associated with children's screen time, physical activity, and active transport to and from school. Researchers gathered data from over 3,000 fifth grade students from 148 schools in Alberta, Canada. Children and parents completed several surveys on physical activity, screen time, active transport, and neighborhood perceptions. Carson and colleagues found that 59% of fifth grade students in Alberta engaged in less than 2 hours of screen time a day, 27% of students were physically active, and 39% walked or biked to and from school. In examining associations between parents' perceptions and children's screen time, physical activity, and active transport, researchers grouped parental perceptions into three areas: 1) satisfaction/services (satisfaction with where you live and access to sports, recreation, and stores); 2) safety (traffic and crime); and 3) sidewalks/parks (access to good sidewalks and parks). In analyzing the data, Carson and colleagues found that good satisfaction/services and sidewalks/parks were associated with less screen time and more physical activity in children and neighborhoods with good sidewalks/parks were also associated with more children using active transport to and from school. Researchers found no significant associations between neighborhood safety and children's physical activity, screen time, or active transport. This study may be limited due to its reliance on child and parental reports and is correlational (not causal) in nature, however, it suggests that interventions that increase access to parks, sidewalks, and sports and recreation programs could help increase children's physical activity and active transport, while reducing their sedentary behaviors.

Author Affiliation: Valerie Carson is with the University of Alberta in Canada.

Carson, V., Kuhle, S., Spence, J. C., & Veugelers, P. J. (2010). Parents' perception of neighbourhood environment as a determinant of screen time, physical activity and active transport. *Canadian Journal of Public Health, 101(2)*, 124-127. This study may be available in a library near you or can be purchased online through the publisher at: <http://jpubhealth.oxfordjournals.org/> (Volume 5)

Children living closer to parks and greenspace participate in more active sports and have higher levels of moderate to vigorous physical activity

Outdoor spaces may be important places for children to be active, however, little is known about how specific outdoor spaces, such as parks and greenspaces, might be linked to children's physical activity. In this study, Boone-Heinonen and colleagues investigated the influence of different outdoor spaces on children's leisure-time moderate to vigorous physical activities. Researchers examined outdoor space and physical activity data for over 10,000 7th through 12th grade children from across the U.S. Researchers used a geographic information system (GIS) to examine outdoor spaces around each child's home, including greenspace coverage within 3km of each child's home and distance to the nearest neighborhood park and major park. Researchers also questioned each child regarding their physical activities, including how frequently they participated in specific activities (e.g., baseball, roller-skating, and jogging) during the past week. In analyzing the data, Boone-Heinonen and colleagues found that boys reported more moderate to vigorous physical activity than girls for all activities except exercise. In examining linkages between specific outdoor spaces and children's physical activity, researchers found that children who lived closer to

neighborhood and major parks participated in more active sports. Researchers also discovered that girls who lived closer to major parks participated in more wheel-based activity and that girls who lived closer to neighborhood parks were more likely to participate in at least 5 weekly bouts of moderate to vigorous physical activity. With regard to amount of greenspace, Boone-Heinonen and colleagues found that children with more greenspace nearby were more likely to participate in at least 5 weekly bouts of moderate to vigorous physical activity, and that girls with more greenspace nearby participated in more exercise. While this study is cross-sectional and relies on self-reported physical activity data, it provides important information about the role that specific outdoor spaces might play in encouraging children to be physically active and highlights how outdoor spaces might be particularly important for girls.

Author Affiliation: Penny Gordon-Larson is with the University of North Carolina at Chapel Hill.

Boone-Heinonen, J., Casanova, K., Richardson, A. S., & Gordon-Larsen, P. (2010). Where can they play? Outdoor spaces and physical activity among adolescents in US urbanized areas. *Preventive Medicine*. This study may be available in a library near you or can be purchased online through the publisher at: http://www.elsevier.com/wps/find/journaldescription.cws_home/600644/description#description (Volume 5)

Forest School sessions increase children's and families' play in natural environments and provide numerous benefits

Forest Schools were developed in many European countries, starting in the 1960s, to encourage children to access natural places. In this study, Ridgers and colleagues investigated the impact of Forest School sessions on children's natural play and their families' participation in nature-based activities. To conduct this study, researchers observed, interviewed, and surveyed 17 children, 6 to 7 years of age, before and after they participated in 12 Forest School outdoor sessions that were each 2 hours long at a school in the UK's Mersey Forest. Researchers also interviewed and surveyed 15 parents before and after they participated in a related engagement project, designed to reconnect families to natural play opportunities in the Mersey Forest through organized activities and targeted information. In examining the data, Ridgers and colleagues found that, overall, children increased their natural play and experienced a variety of benefits as a result of the Forest School sessions. Researchers also found that, overall, families participated in more natural play as a result of the Forest School activities. In their reports, researchers discuss many findings, including the following:

- Children's social skills and confidence increased as a result of the Forest School sessions. For example, there was a 7.8% increase in pro-social interactions between children.
- Children engaged in more moderate intensity physical activity following the Forest School sessions.
- Children reported being able to play more on playgrounds and football fields after the Forest School sessions.
- Children increased their knowledge and understanding of the natural environment as a result of their experiences.
- Some parents changed the restrictions they placed on their child's outdoor behavior as a result of their experiences.
- Parents made more of an effort to play in natural environments with their children as a result of their experiences.

- Parents reported seeing positive changes in their children as a result of the Forest School sessions.

While this study may be limited due to the small number of participants and focus on a single Forest School program, very few evaluations of this sort have been completed. This study provides valuable information that can support future research and intervention efforts.

Author Affiliation: Nicola Ridgers is with John Moores University in the UK.

Ridgers, N. D., & Sayers, J. (2010). *Natural play in the forest: Forest school evaluation (Children): Natural England*. This report may be available from Natural England or The Mersey Forest. (Volume 5)

Ridgers, N. D., & Sayers, J. (2010). *Natural play in the forest: Forest school evaluation (Families): Natural England*. This report may be available from Natural England or The Mersey Forest. (Volume 5)

Older children who spend more time outside tend to be more physically active and are less likely to be overweight

Cleland and colleagues investigated whether the amount of time children spend outdoors is related to their physical activity levels and being overweight. About 200 five- to six-year-old and 350 ten- to twelve-year-old children from 19 randomly selected elementary schools in Melbourne, Australia participated in this study. In 2001 and 2004, parents reported the amount of time their children spent outdoors and researchers recorded children's physical activity levels using an accelerometer and measured children's weight and height. In their paper, Cleland and colleagues report many findings, some of which are discussed below. The researchers found, for example, that children spent significantly more time outdoors during warmer months as compared to cooler months; boys had significantly higher levels of moderate and vigorous physical activity (MVPA) on weekdays than girls; the prevalence of overweight increased significantly between 2001 and 2004 for both younger and older children, as well as boys and girls; and among the older children, boys generally spent significantly more time outside than girls. Cleland and colleagues also found that older children who spent more time outside were generally more physically active and had a lower prevalence of overweight than children who spent less time outside. For example, the researchers found that each additional hour older girls spent outside during the cooler months was associated with an extra 26.5 minutes per week of MVPA and that each additional hour older boys spent outside during the cooler months was associated with an extra 21 minutes of MVPA. When examining changes over the three-year period, Cleland and colleagues found that the more time older girls and boys spent outside on weekends at baseline (2001), the higher their MVPA on weekends at follow-up (2004). In addition, the researchers found that in 2004, the prevalence of overweight among older children was 27-41% lower for those children who spent more time outside in 2001. With regard to younger children, Cleland and colleagues found few associations between time spent outdoors, physical activity, and overweight. While this study may be limited due to its reliance on parental self-report of children's time spent outside, the cross-sectional and longitudinal nature of this study and objective measurement of physical activity provide an important contribution to the literature. The results of this study suggest that encouraging 10- to 12-year-old children to spend more time outdoors may help increase physical activity levels and reduce the prevalence of overweight.

Author Affiliation: Cleland, Crawford, Hume, Timperio, and Salmon are with Deakin University in Australia. Baur is with the University of Sydney in Australia.

Cleland, V., Crawford, D., Baur, L. A., Hume, C., Timperio, A., & Salmon, J. (2008). A prospective examination of children's time spent outdoors, objectively measured physical activity and overweight. *International Journal of Obesity*, 32(11), 1685-1693. This study may be available in a library near you or can be purchased online through the publisher at: <http://www.nature.com/ijo/index.htm> (Volume 4)

Green school grounds improve quantity and quality of elementary school children's physical activity

In recent years, there has been increasing interest in greening school grounds to diversify children's play experiences, such as through the planting of trees, building of ponds, and development of vegetable gardens. Dymont and Bell investigated how green school grounds affect the physical activity of elementary school children by sending questionnaires to a diversity of Canadian schools that had greened their school grounds. Questionnaires were completed by 105 individuals from 59 schools who had been involved in their school's greening project. In analyzing the study data, Dymont and Bell found that green areas were an important place for physical activity: respondents reported that 66% of students use green areas for active play. Interestingly, the researchers found that green areas tended to support more moderate and light activity as opposed to the more vigorous activity that generally takes place in traditional turf and asphalt areas. Dymont and Bell found that nearly 50% of the respondents reported that their school ground promotes more vigorous activity after greening, while about 70% reported more moderate and/or light physical activity taking place after greening. In addition, the researchers found that 90% of respondents reported that their school ground appeals to a wider variety of student interests after greening; 85% reported that their school ground now supports a wider variety of play activities; and 84% reported that since greening, their school ground encourages more exploration of the natural world. While this study may be limited due to its reliance on retrospective self-report, it provides important insight into the benefits of green school grounds and their potentially significant role in complementing more traditional school ground areas and improving the quantity and quality of elementary school children's physical activity.

Author Affiliation: Dymont is with the University of Tasmania in Australia. Bell is with Evergreen in Canada.

Dymont, J. E., & Bell, A. C. (2008). Grounds for movement: green school grounds as sites for promoting physical activity. *Health Education Research*, 23(6), 952-962. This study may be available in a library near you or can be purchased online through the publisher at: <http://her.oxfordjournals.org/> (Volume 4)

Schoolyard size and landscape quality influence children's satisfaction and weight

Outdoor school grounds are an important environment to consider when striving to promote children's physical activity and reduce childhood obesity. In this study, Ozdemir and Yilmaz investigate linkages between the physical characteristics of children's schoolyard environments and their attitudes, physical activity, and body mass index (BMI). The researchers interviewed nearly 300 3rd and 4th grade students, as well as teachers, and administrators in five public schools in Ankara, Turkey. Ozdemir and Yilmaz also measured students' weight and height, and had professionals assess the schoolyard environment based on factors such as size, material, vegetation cover, and maintenance. Although schoolyards differed, the researchers found that students generally had no direct contact with vegetation and that the amount of outdoor space was limited given the number

of students using the space. While most students were satisfied with their schoolyard, which the researchers speculate may be due to acclimation, unsatisfied students highlighted the lack of trees and greenery as the primary reason for their dissatisfaction. Among their many findings, Ozdemir and Yilmaz report that the size of the schoolyard was significantly related to students' BMI, with students in larger yards having lower BMI values than students in smaller yards. The researchers also found that yard landscape characteristics were significantly associated with children's BMI values, but in the opposite direction than expected: students from schools with "advanced" landscape features had higher BMI values than students from schools with "low" landscape features, although BMI values were still in the normal range. While this study may be limited due to its relatively small sample size and reliance on self-report measures, it highlights the importance of participatory and well-thought-out school landscape design, as well as the need for adequate financing and maintenance of schoolyards.

Author Affiliation: The authors are with Ankara University in Turkey.

Ozdemir, A., & Yilmaz, O. (2008). Assessment of outdoor school environments and physical activity in Ankara's primary schools. *Journal of Environmental Psychology, 28(3)*, 287-300. This study may be available in a library near you or can be purchased online through the publisher at: http://www.elsevier.com/wps/find/journaldescription.cws_home/622872/description#description (Volume 4)

Children in greener neighborhoods have lower body weight changes

Bell and colleagues examined the medical records of 4,000 three- to sixteen-year-old children that lived in Marion County, Indiana, received care from a particular clinic network between 1996 and 2002, had height and weight measurements for two consecutive years, and lived at the same residential address for at least two years. The majority of participants in this study were non-Hispanic black and enrolled in Medicaid (an indicator of socioeconomic status). Bell and colleagues geocoded each participant's address using a Geographic Information System and measured greenness at these locations using satellite images and a vegetation index. The researchers speculated that neighborhood greenness might serve as an indicator of children's access to spaces that promote physical activity or increased time outside. In analyzing the study data, Bell and colleagues found that the amount of vegetation in a child's neighborhood was inversely correlated with their Body Mass Index (BMI) score at the year two measurement. That is, in general, the more vegetation a child had in their neighborhood, the lower their body weight changes. The researchers also found that children in more vegetated settings were less likely to have a higher BMI over 2 years as compared to children in less vegetated settings. Importantly, Bell and colleagues controlled for a number of other factors in their analyses, such as residential density. While the study is observational and thus cannot causally link neighborhood greenness and body weight changes, this research highlights the role that neighborhood vegetation could play in policies and programs aimed at preventing childhood obesity.

Author Affiliation: Bell is with the University of Washington. Wilson is with Indiana University-Purdue University. Liu is with Indiana University.

Bell, J. F., Wilson, J. S., & Liu, G. C. (2008). Neighborhood greenness and 2-year changes in Body Mass Index of children and youth. *American Journal of Preventive Medicine, 35(6)*, 547-553. This study may be available in a library near you or can be purchased online through the publisher at: <http://www.ajpm-online.net/> (Volume 4)

Community design can promote and support children's physical activity

This article is a policy statement by the American Academy of Pediatrics' Committee on Environmental Health regarding the influence that community design has on children's opportunities to be physically active. The Committee highlights the role of neighborhood design in promoting recreational and incidental or "utilitarian" physical activity, such as the availability of parks and recreational facilities, as well as children's ability to walk to school. The Committee also highlights important factors influencing children's physical activity, including traffic danger, the presence of sidewalks, and perception and fear of crime. Finally, the Committee provides a number of specific recommendations for pediatricians and government to promote children's physical activity in the built environment and support more active lifestyles.

Binns, H. J., Forman, J. A., Karr, C. J., Osterhoudt, K., Paulson, J. A., Roberts, J. R., et al. (2009). The built environment: designing communities to promote physical activity in children. *Pediatrics*, 123(6), 1591-1598. This study may be available in a library near you or can be purchased online through the publisher at: <http://www.jpeds.com/> (Volume 4)

Children with a park playground near their home are more likely to be of a healthy weight

Physical activity is thought to play an important role in childhood obesity. While research results to date are somewhat mixed, parks can provide important opportunities for children to be physically active. In this study, Potwarka and colleagues examine whether children's weight is related to park space and the availability of specific park facilities within 1km of children's homes. Researchers collected information on 108 two- to seventeen-year-old children from four neighborhoods in a mid-sized city in Ontario, Canada. Parents reported their child's height and weight, while researchers used a Geographic Information System to assess park space for each child and a database and trained observers to assess park facilities. In analyzing the study data, Potwarka and colleagues found that proximity to park space was not significantly related to children's weight status. The researchers did find, however, that when examining park facilities, children with a park playground within 1 km of their homes were five times more likely to be of a healthy weight than children without a park playground near their homes. While this study may be limited due to its relatively small sample size, reliance on parental report, and focus on availability as opposed to actual use of park space, this study provides valuable insight into the potential importance of children's proximity to specific park facilities as opposed to park space in general.

Author Affiliation: The authors are with the University of Waterloo in Canada.

Potwarka, L. R., Kaczynski, A. T., & Flack, A. L. (2008). Places to play: association of park space and facilities with healthy weight status among children. *Journal of Community Health*, 33(5), 344-350. This study may be available in a library near you or can be purchased online through the publisher at: <http://www.springer.com/public+health/health+promotion+&+disease+prevention/journal/10900> (Volume 4)

Public open space features may influence children's physical activity

Public open spaces may be important places for children to play and be physically active. Timperio and colleagues investigated relationships between the specific features of public open spaces and

children's physical activity by examining data collected as part of a neighborhood study in Melbourne, Australia. Participants in this study included 163 eight- to nine-year-old children and 334 thirteen- to fifteen-year-old children. Participants wore an accelerometer for one week to measure their physical activity and researchers used a Geographic Information System and trained observer to identify and analyze the closest public open space to each child's home. In analyzing the data, Timperio and colleagues found that younger children spent significantly more time engaged in moderate to vigorous physical activity (MVPA) on weekdays and weekends as compared to adolescents. While there were no gender differences among younger children, among adolescents researchers found that boys spent significantly more time engaged in MVPA on weekdays and weekends as compared to girls. With regard to public open space, Timperio and colleagues found that participants, on average, lived about 300 meters from their closest public open space. When examining relationships between features of children's closest public open space and physical activity, researchers obtained somewhat mixed and inconsistent results. For example, researchers found that playgrounds were positively associated with younger boys' weekend physical activity, the number of recreational facilities was inversely associated with younger girls' physical activity after school and on the weekend, and the presence of trees and signage regarding dogs were positively associated with adolescent girls' physical activity after school. While this study provides one of the few examinations of public open space features and children's physical activity, additional research is needed to better understand children's actual use of public open space and the quantity and quality of public open space features.

Author Affiliation: Timperio, Crawford, Andrianopoulos, Ball, Salmon, and Hume are with Deakin University in Australia. Giles-Corti is with the University of Western Australia.

Timperio, A., Giles-Corti, B., Crawford, D., Andrianopoulos, N., Ball, K., Salmon, J., et al. (2008). Features of public open spaces and physical activity among children: findings from the CLAN study. *Preventive Medicine*, 47(5), 514-518. This study may be available in a library near you or can be purchased online through the publisher at: www.elsevier.com/locate/amepre (Volume 4)

Neighborhood recreation facilities positively influence children's physical activity levels

Tucker and colleagues examined children's physical activity levels in relation to several neighborhood environmental factors and parents' perceptions of recreation opportunities. Over 800 eleven- to thirteen-year-old children in London, Ontario completed a questionnaire regarding their physical activity levels on the preceding day. In addition, parents completed a questionnaire evaluating their child's home environment and researchers used a Geographic Information System to analyze each child's neighborhood environment. In analyzing the data, Tucker and colleagues found that, on average, children engaged in about 160 minutes of physical activity a day. In addition, researchers found that neighborhood recreational opportunities significantly and positively influenced children's physical activity levels. For example, Tucker and colleagues found that children with two or more recreation facilities in their neighborhood engaged in almost 17 more minutes of physical activity after school as compared to children with less than 2 recreation facilities and were almost 2 times as likely to be in the upper quartile for after school physical activity. Importantly, researchers controlled for a number of other factors in their analyses, including season and demographic factors. Tucker and colleagues also found that land use mix and percentage of park coverage did not significantly influence children's physical activity levels. While this study is cross-sectional in nature, relied on self-report, and focused on quantity and not quality of recreation

facilities, it provides valuable insight into how neighborhood recreation opportunities may influence children's physical activity levels.

Author Affiliation: Tucker, Irwin, Gilliland, and Larsen are with the University of Western Ontario in Canada. He is with Brescia University College and Middlesex London Health Unit. Hess is with the University of Toronto in Canada.

Tucker, P., Irwin, J. D., Gilliland, J., He, M., Larsen, K., & Hess, P. (2009). Environmental influences on physical activity levels in youth. *Health & Place, 15(1), 357-363.* This study may be available in a library near you or can be purchased online through the publisher at: http://www.elsevier.com/wps/find/journaldescription.cws_home/30519/description#description (Volume 4)

Adolescents' local environments influence their physical activity and food consumption

Eating well and being physically active are important to good health and well-being. In this article, Tucker and colleagues review the impact of home, school, and neighborhood environments on adolescents' food behavior and physical activity, and investigate adolescents' perceptions of these environments. As part of this study, researchers interviewed 60 twelve- to fourteen-year-old adolescents in focus groups in London, Ontario, Canada. Tucker and colleagues analyzed the content of information discussed in each focus group to understand influences on participants' food consumption and physical activity. Researchers found that schools, nearby parks, and recreation facilities, as well as other structural opportunities around homes (e.g., yards and other kids) influenced adolescents' physical activity and served as both a facilitator and barrier to their physical activity. For example, the majority of adolescents reported using parks often, however, some participants commented on the small size of local parks, amount of garbage, and the lack of opportunities for older children. Tucker and colleagues also found that adolescents identified the availability of fast-food restaurants, convenience stores, and other restaurants as impacting their food consumption and that a number of participants identified the lack of healthy foods in their schools and neighborhoods. While this study may be limited due to its small sample size and reliance on volunteers, it offers important insight into the local environment's influence on adolescents' physical activity and food consumption.

Author Affiliation: Tucker is with the Middlesex-London Health Unit in Canada. Irwin and Gilliland are with the University of Western Ontario in Canada. He is with the University of Texas at San Antonio.

Tucker, P., Irwin, J. D., Gilliland, J., & He, M. (2008). Adolescents' perspectives of home, school and neighborhood environmental influences on physical activity and dietary behaviors. *Children, Youth and Environments, 18(2), 12-35.* This article is available online at: http://www.colorado.edu/journals/cye/index_issues.htm. (Volume 4)

Neighborhood parks play an important role in promoting physical activity in children

Although the American Academy of Pediatrics has recommended that children be physically active for at least 60 minutes a day and limit sedentary activity to less than 2 hours a day, many children do not meet these recommendations. In this article, Victoria Floriani and Christine Kennedy review the latest research findings with regard to the promotion of physical activity in children. For example, the authors discuss a number of studies which have found that access to a neighborhood park or playground is associated with higher levels of physical activity in children and that specific park

amenities, such as lighting after dark, may be important in facilitating park use. Floriani and Kennedy also summarize research on sedentary behavior and how evidence, while often inconclusive, indicates that the less time children spend in sedentary behaviors, the more physically active they may be. In addition, the authors highlight recent research exploring the relationship between mental health and physical activity. While there is still much to be learned about this relationship, preliminary research has found a positive relationship between higher levels of physical activity and positive mental health outcomes, such as increased feelings of self-efficacy and confidence. Floriani and Kennedy conclude the article by encouraging pediatric health care providers to discuss physical activity with their patients and strategize with them on ways to incorporate activity into their daily lives.

Floriani, V., & Kennedy, C. (2008). "Promotion of physical activity in children." *Current Opinion in Pediatrics*, 20(1), 90-95. This article is available online at: http://www.parks.sfgov.org/wcm_recpark/SPTF/Floriani.pdf (Volume 4)

Readers may also be interested in the following recent articles that investigate specific factors related to physical activity in children and adolescents.

Babey, S. H., Hastert, T. A., Yu, H. J., & Brown, E. R. (2008). Physical activity among adolescents – "When do parks matter?" *American Journal of Preventive Medicine*, 34(4), 345-348. This study may be available in a library near you or can be purchased online through the publisher at: <http://www.elsevier.com>

de Vries, S. I., Bakker, I., van Mechelen, W., & Hopman-Rock, M. (2007). "Determinants of activity-friendly neighborhoods for children: Results from the SPACE study." *American Journal of Health Promotion*, 21(4), 312-316. This study may be available in a library near you or can be purchased online through the publisher at: <http://www.healthpromotionjournal.com/>

Roemmich, J. N., Epstein, L. H., Raja, S., & Yin, L. (2007). "The neighborhood and home environments: Disparate relationships with physical activity and sedentary behaviors in youth." *Annals of Behavioral Medicine*, 33(1), 29-38. This study may be available in a library near you or can be purchased online through the publisher at: <http://www.springer.com/psychology/health+and+behavior/journal/12160>

Many U.S. children are vitamin D deficient and this deficiency is associated with cardiovascular risk factors

Vitamin D is primarily produced in the skin after exposure to sunlight and is essential for calcium absorption and may be important to numerous other body processes. In this study, Kumar and colleagues investigated the prevalence of vitamin D deficiency among U.S. children and whether vitamin D deficiency is associated with cardiovascular risk factors. The researchers analyzed data for nearly 10,000 children from the 2001-2004 National Health and Nutrition Examination Survey (NHANES), a nationally representative survey of the U.S. population where participants were interviewed and given physical examinations. In analyzing the data, Kumar and colleagues found that 9% of 1- to 21-year-old children were vitamin D deficient, representing 7.6 million U.S. children, and 61% were vitamin D insufficient, representing 50.8 million U.S. children. In examining factors associated with vitamin D deficiency, researchers found that children who were older, female, non-Hispanic black or Mexican American, obese, drank milk less than once a week, did not take vitamin D supplements, and were engaged in more than 4 hours of screen time a day, were more likely to be vitamin D deficient. In addition, Kumar and colleagues found that vitamin D deficiency was

associated with a number of cardiovascular risk factors, including higher systolic blood pressure and higher lipoprotein cholesterol, when compared to children without vitamin D deficiency. While this study may be limited due to its cross-sectional design, Kumar and colleagues' work using a large, nationally representative sample provides valuable information on an understudied topic.

Author Affiliation: Kumar, Kaskel, and Melamed are with the Albert Einstein College of Medicine in New York. Muntner is with the Mount Sinai School of Medicine in New York. Hailpern is with the Centers for Disease Control and Prevention.

Kumar, J., Muntner, P., Kaskel, F. J., Hailpern, S. M., & Melamed, M. L. (2009). Prevalence and associations of 25-Hydroxyvitamin D deficiency in US children: NHANES 2001-2004. *Pediatrics*(August 3). This study may be available in a library near you or can be purchased online through the publisher at: <http://www.jpeds.com/> (Volume 4)

Readers may also be interested in the following related articles:

Reis, J. P., von Muhlen, D., Miller, E. R., Michos, E. D., & Appel, L. J. (2003). Vitamin D status and cardiometabolic risk factors in the United States adolescent population. *Pediatrics*(August 3).

Misra, M., Pacaud, D., Petryk, A., Collett-Solberg, P. F., & Kappy, M. (2008). Vitamin D deficiency in children and its management: Review of current knowledge and recommendations. *Pediatrics*, 122(2), 398-417.

Spending time outdoors, among other factors, is associated with higher levels of physical activity in preschool children

Physical activity provides important health benefits to children. Unfortunately, not much is known about the prevalence of preschool children's physical activity levels and the factors that most influence physical activity in this age group. In this paper, T. Hinkley and colleagues review 24 studies published between 1980 and 2007 that investigated factors related to physical activity levels in preschool children. The authors examined a total of 39 different variables, such as gender and time spent outdoors, and coded the results to identify consistency/inconsistency across studies. In the end, Hinkley and colleagues found support for the following findings: 1) boys are more active than girls, 2) a child's age and body mass index are not related to physical activity, 3) children who have parents that participate in physical activity with them are more active than children who have parents that do not participate with them in physical activity, and 4) children who spend more time outdoors are more active than children who spend less time outdoors. The authors also found that psychological, cognitive, emotional, and behavioral variables have not been studied enough to yield conclusive results with regard to their association to physical activity levels in preschool children. Hinkley and colleagues review the strengths and weaknesses of studies to date, compare their results to those found for older children and adolescents, and highlight future research needs in order to better understand the many factors that influence preschool children's physical activity.

Hinkley, T., Crawford, D., Salmon, J., Okely, A. D., & Hesketh, K. (2008). "Preschool children and physical activity - A review of correlates." *American Journal of Preventive Medicine*, 34(5), 435-441. This study may be available in a library near you or can be purchased online through the publisher at: <http://www.elsevier.com> (Volume 3)

Readers may also be interested in a 2000 review by Sallis and colleagues that summarizes research on correlates of physical activity behaviors in children and adolescents.

Sallis, J. F., Prochaska, J. J., & Taylor, W. C. (2000). "A review of correlates of physical activity of children and adolescents." *Medicine and Science in Sports and Exercise*, 32(5), 963-975. This study may be available in a library near you or can be purchased online through the publisher at: <http://www.ms-se.com/>

Many children and adolescents are vitamin D deficient

Worldwide, there is a high prevalence of vitamin D deficiency among infants, children, and adolescents. Vitamin D deficiency is a risk factor for rickets and may be a risk factor for development of a number of chronic diseases, such as cardiovascular diseases and cancer. In this paper, S.Y. Huh and C.M. Gordon review the sources of vitamin D, which includes endogenous synthesis (the first step of which is the absorption of ultraviolet B radiation), how vitamin D deficiency is defined and measured, and the prevalence of and risk factors for vitamin D deficiency, which includes reduced sun exposure. In addition, the authors review the health effects of vitamin D deficiency and its prevention and treatment. Huh and Gordon stress the importance of additional research to determine the optimum concentration of vitamin D for children of different ages and to compare different regimens designed to prevent and treat vitamin D deficiency as well as to better understand short and long-term impacts on critical health outcomes.

Huh, S. Y., & Gordon, C. M. (2008). "Vitamin D deficiency in children and adolescents: Epidemiology, impact and treatment." *Reviews in Endocrine & Metabolic Disorders*, 9(2), 161-170. This study may be available in a library near you or can be purchased online through the publisher at: <http://www.springer.com/medicine/internal/journal/11154> (Volume 3)

Street trees may help prevent early childhood asthma

The prevalence of childhood asthma in the U.S. has increased dramatically in the past 20 years and is particularly high in poor urban communities. While the exact cause for this increase remains unknown, environment and lifestyle changes are believed to be possible contributors. Trees may help prevent asthma by changing local air quality or by encouraging children to play outdoors, exposing them to a variety of microbes. In this study, G.S. Lovasi and colleagues investigate whether there is an association between street trees and childhood asthma by examining data, grouped by specific hospital geographic areas, on the prevalence of asthma for 4-year-old and 5-year-old children, hospitalizations as a result of asthma for children younger than 15, number of street trees, census data, and proximity to pollution sources. In analyzing the data, the authors found that higher street density was associated with a lower prevalence of childhood asthma, but that there was not a significant association between street trees and hospitalizations. In their analysis, Lovasi and colleagues controlled for a number of other factors that may have influenced the results, such as proximity to pollution sources and sociodemographic characteristics. Based on these findings, the authors estimate that an increase in tree density of 343 trees per square kilometer would be associated with a 29% lower prevalence of early childhood asthma. It is important to note that this analysis does not demonstrate that trees cause or prevent asthma for an individual child. While the results of this study are encouraging, additional research is needed to better understand the effects of trees on the prevalence of childhood asthma.

Lovasi, G. S., Quinn, J. W., Neckerman, K. M., Perzanowski, M. S., & Rundle, A. (2008). "Children living in areas with more street trees have lower prevalence of asthma." *Journal of Epidemiology and*

Community Health, 62(7), 647-649. This study may be available in a library near you or can be purchased online at: <http://jech.bmj.com/> (Volume 3)

Spending time outdoors helps prevent myopia in 12-year-olds

In recent decades, myopia or nearsightedness has become increasingly common in young children. While the cause(s) of myopia remain unknown, environmental factors, such as reading that requires children to focus at a close distance, are thought to play an important role. Using data from the Sydney, Australia Myopia study, K. A. Rose and colleagues investigate the relationship between near work, midworking distance, and outdoor activities with the prevalence of myopia in 6- and 12-year-old children. Between 2003 and 2005, 1,765 6-year-olds and 2,367 12-year-olds received a comprehensive eye exam and completed questionnaires about their activities during weekdays and weekends (parents completed the questionnaires for the 6-year-old children). The authors grouped children's activities into near work (e.g., drawing and reading), midworking distance (e.g., watching television and using the computer), and outdoor activities (e.g., bicycle riding and outdoor sport). After adjusting for a number of potentially confounding factors (e.g., parental myopia and ethnicity), Rose and colleagues found that while there was no association between the prevalence of myopia and activity among 6-year-olds that higher levels of total time spent outdoors were associated with a lower prevalence of myopia among 12-year-olds. The authors found that 12-year-olds with the highest levels of near work activity and lowest levels of outdoor activity were two to three times more likely than their peers to develop myopia, whereas 12-year-olds with the lowest levels of near work activity and highest levels of outdoor activity were less likely than their peers to develop myopia. The authors also found that participation in sports did not seem to be a significant factor in explaining this protective effect. Rose and colleagues suggest that light intensity may be an important factor in explaining the impact of outdoor activity on the development of myopia and that additional research is needed to help understand this relationship.

Rose, K. A., Morgan, I. G., Ip, J., Kifley, A., Huynh, S., Smith, W., et al. (2008). Outdoor activity reduces the prevalence of myopia in children. *Ophthalmology*, 115(8), 1279-1285. This study may be available in a library near you or can be purchased online at: <http://www.ajo.com/>. (Volume 3)

Play in natural environments improves kindergarten children's motor abilities

Fjortoft examined the impact of kindergarten children's play environment on their motor development in Telemark, Norway. As part of this study, one kindergarten group, consisting of 46 children, was provided opportunities to play in a nearby 19 acre forest for one to two hours a day, while the other kindergarten group, consisting of 29 children from two kindergartens, continued to play on traditional playgrounds for one to two hours a day. Fjortoft conducted a pre-test of all children's motor fitness, followed by a 9 month observational period and post-test. With regard to children's motor abilities, she found that play in the natural environment improved all motor abilities except flexibility. In the comparison group, however, children's motor fitness improved in only 3 of the 9 motor tests. When examining differences between the two groups, Fjortoft found the experimental group to be significantly better than the comparison group in terms of balance and coordination.

Fjortoft, I. (2004). Landscape as playscape: the effects of natural environments on children's play and motor development. *Children, Youth and Environments*, 14(2), 21-44. This article is available online at: http://www.colorado.edu/journals/cye/index_issues.htm. (Volume 2)

Focus: Other Health Benefits

These articles highlight other health benefits from children's contact with the outdoors and/or nature, as well as benefits to children's development of life assets, such as attitudes and behaviors towards the environment.

An outdoor program enhances children's well-being, physical activity, and feelings of health, safety, and satisfaction

Many children in their teenage years face mental health challenges. Several studies have found that contact with nature and physical activity in a natural environment, what some call "green exercise," improves psychological well-being. In this study, Wood and colleagues evaluated the impact of the Youth Outdoor Experience (YOE) project on participating children's well-being and physical activity. The YOE project provides 11- to 18-year-old children from disadvantaged urban areas in England with opportunities to participate in a 12-week program where children engage in weekly structured outdoor activities. As part of this study, researchers had 14 participants complete a questionnaire to assess their well-being, connectedness to nature, and physical activity. Researchers also had 114 participants complete a questionnaire to assess the impact of the project on a range of well-being areas (e.g., being healthy, staying safe, and enjoying and achieving). Most participants completed both questionnaires at the start, middle, and end of the project. In analyzing the data, Wood and colleagues found a number of interesting results, including:

- Participants' well-being increased from the start to the end of the program.
- Participants' contact with nature varied a lot over the course of the project.
- Participants increased the number of days that they performed 30 minutes of moderate physical activity.
- Project leaders reported positive changes in participants' attitudes, self-esteem, and behavior.
- Participants reported feeling healthier, safer, and more positive with regard to their school, home, and social lives, as well as their achievements.

While this study may be limited due to its small sample size and reliance on self-report measures, it highlights the need for additional research in this area and the potential role that nature-based activities can have on participants' well-being, physical activity, and feelings of health, safety, and satisfaction.

Author Affiliation: Carly Wood is with the University of Essex in the UK.

Wood, C., Hine, R., & Barton, J. (2011). *The health benefits of the Youth Outdoor Experience (YOE) project*. University of Essex. This report may be available through the University of Essex, Suffolk Wildlife Trust, or Natural England. (Volume 5)

Plants in classrooms benefit students' emotions, behavior, and health

The classroom environment can play an important role in students' learning and academic performance. Han examined the effect of living plants in a classroom on students' psychology, behavior, and health. To investigate this relationship, he conducted a study with two similar classrooms, located next to each other, of sophomore students at a high school in Taiwan. Han used

surveys every 2 weeks to assess students' emotions and collected objective information on students' academic performance, health, and behavior. After an initial assessment period, he brought six small trees into the back of one of the classrooms. In comparing data from the two classrooms, Han found that shortly after the plants were introduced, students had significantly higher scores than the regular classroom in terms of preference, comfort, and friendliness. In addition, he found that students in the classroom with plants had significantly fewer sick leave hours and punishment records than students in the regular classroom. While this study may be limited due to its small sample size and there is the potential that other variables may have influenced the results, Han's research provides valuable insight into the benefits that even small amounts of nature can provide to students and suggests promising avenues for future research.

Author Affiliation: Ke-Tsung Han is with National Chin-Yi University of Technology in Taiwan.

Han, K. T. (2009). Influence of Limitedly Visible Leafy Indoor Plants on the Psychology, Behavior, and Health of Students at a Junior High School in Taiwan. [Article]. *Environment and Behavior*, 41(5), 658-692. This study may be available in a library near you or can be purchased online through the publisher at: <http://eab.sagepub.com/> (Volume 5)

Preschool children experiencing a weekly outdoor lesson have improved self-efficacy and early literacy skills

The Outdoor Discovery Center Macatawa Greenway--a non-profit entity that delivers outdoor, nature-based education and programming in Holland, MI--developed a nature-based program intervention to improve the health and well-being of preschool children and their families. As part of the intervention, naturalist educators visited six preschools on a weekly basis to deliver an hour-long lesson focused on a science concept that was taught through outdoor activities. To understand the impact of the intervention on students, Trent-Brown and colleagues examined a number of health and well-being measures for over 100 preschool students, between the ages of 3 and 5, prior to and 6 months after the intervention began in both an experimental group that received the intervention, as well as a control group that did not receive the intervention. Researchers measured children's blood pressure, body mass index (BMI), activity preferences, self-efficacy, and early literacy skills. In analyzing the data for experimental and control groups, Trent-Brown and colleagues found that preschool students in the nature intervention program had significantly improved with regard to their self-efficacy and early literacy skills when compared to the control group. In examining relationships between outcomes for the control and experimental groups, researchers found that there was a more significant and positive relationship between activity preferences and self-efficacy and early literacy skills for the experimental group as compared to the control group, indicating that children with more active preferences tended to improve more with regard to self-efficacy and early literacy skills. While there were notable positive outcomes, researchers also found that preschool students in the nature intervention program had significantly elevated mean arterial blood pressure scores, as well as significant increases in the number of students classified as prehypertensive as compared to the control group, which did not experience these increases. With regard to BMI and activity preferences, researchers found no significant changes among the experimental or control groups. While this study may be limited due to student and teacher turnover in the classrooms, as well as a number of other factors that were not controlled as part of the study and therefore might influence study outcomes, such as nutrition and family health history, it provides an important contribution to the literature about the impact of nature

programs on children's health and well-being. Importantly, this study will continue in future years, providing important information about the long-term impact of nature programs on students.

Author Affiliation: Trent-Brown is with Hope College in Holland, MI.

Trent-Brown, S. A., Vanderveen, J. D., Cotter, R., Hawkins, K., Schab, A., Dykstra, S., et al. (2011). *Effects of a nature-based science enrichment program on preschool children's health, activity preferences, self-efficacy, and cognition: Outdoor Discovery Center Macatawa Greenway.* This report may be available via the Outdoor Discovery Center Macatawa Greenway at <http://odcofwu.schoolwires.com/odcofwu/site/default.asp> (Volume 5)

Elementary school principals overwhelmingly believe recess has a positive impact on students' achievement, learning, and development

Children spend more time in school than almost anywhere else. At school, recess provides one of the few opportunities for children to play and to potentially be outdoors. Gallup conducted a nationwide survey of 1,951 elementary school principals from urban, suburban, and rural schools to understand principals' attitudes and experiences with recess. A few of the key findings include: 1) more than 80% of principals reported that recess has a positive impact on academic achievement; 2) 75% of principals stated that students are more focused in class after recess and listen better; and 3) more than 95% of principals believe that recess positively impacts students' social development and general well-being. Despite these benefits, researchers found that many principals reported offering very limited recess times. For example, 50% of principals reported that students receive 30 minutes or less of recess per day. In addition, over 75% of principals reported taking recess away from students as a punishment. According to principals, one of the biggest challenges with recess is discipline-related problems. Principals identified additional staff, better equipment, and playground management training as ways to improve recess at schools.

Author Affiliation: The poll was conducted by Gallup with sponsorship from the Robert Wood Johnson Foundation and assistance from the National Association of Elementary School Principals and Playworks.

Robert Wood Johnson Foundation. (2010). The state of play: Gallup survey of principals on school recess. This study is available online at: <http://www.rwjf.org/files/research/stateofplayrecessreportgallup.pdf> (Volume 5)

Forest School sessions increase children's and families' play in natural environments and provide numerous benefits

Forest Schools were developed in many European countries, starting in the 1960s, to encourage children to access natural places. In this study, Ridgers and colleagues investigated the impact of Forest School sessions on children's natural play and their families' participation in nature-based activities. To conduct this study, researchers observed, interviewed, and surveyed 17 children, 6 to 7 years of age, before and after they participated in 12 Forest School outdoor sessions that were each 2 hours long at a school in the UK's Mersey Forest. Researchers also interviewed and surveyed 15 parents before and after they participated in a related engagement project, designed to reconnect families to natural play opportunities in the Mersey Forest through organized activities and targeted information. In examining the data, Ridgers and colleagues found that, overall, children increased their natural play and experienced a variety of benefits as a result of the Forest School sessions.

Researchers also found that, overall, families participated in more natural play as a result of the Forest School activities. In their reports, researchers discuss many findings, including the following:

- Children's social skills and confidence increased as a result of the Forest School sessions. For example, there was a 7.8% increase in pro-social interactions between children.
- Children engaged in more moderate intensity physical activity following the Forest School sessions.
- Children reported being able to play more on playgrounds and football fields after the Forest School sessions.
- Children increased their knowledge and understanding of the natural environment as a result of their experiences.
- Some parents changed the restrictions they placed on their child's outdoor behavior as a result of their experiences.
- Parents made more of an effort to play in natural environments with their children as a result of their experiences.
- Parents reported seeing positive changes in their children as a result of the Forest School sessions.

While this study may be limited due to the small number of participants and focus on a single Forest School program, very few evaluations of this sort have been completed. This study provides valuable information that can support future research and intervention efforts.

Author Affiliation: Nicola Ridgers is with John Moores University in the UK.

Ridgers, N. D., & Sayers, J. (2010). *Natural play in the forest: Forest school evaluation (Children): Natural England.* This report may be available from Natural England or The Mersey Forest. (Volume 5)

Ridgers, N. D., & Sayers, J. (2010). *Natural play in the forest: Forest school evaluation (Families): Natural England.* This report may be available from Natural England or The Mersey Forest. (Volume 5)

Children's connection to nature influences their interest in participating in nature-based activities and performing environmentally friendly behaviors

Cheng and Monroe developed a new children's connection to nature index and used this index to examine children's connection to nature and factors influencing children's nature-related interests and pro-environmental choices. In developing this new instrument, researchers identified key factors presented in the literature to date regarding people's attitudes towards nature, experiences with nature, and interest in environmentally friendly practices, including sympathy, empathy, interest in nature, experience with nature, and self-efficacy. In addition, Cheng and Monroe conducted interviews with fourth grade students to understand their attitudes toward nature and nature experiences and pilot test index questions. Once the final index was developed, researchers had almost 1,500 fourth-grade students in Brevard County, Florida complete the survey after participating in an environmental education program. In analyzing the data, Cheng and Monroe found that there were 4 main dimensions to children's connection to nature: 1) enjoyment of nature; 2) empathy for creatures; 3) sense of oneness; and 4) sense of responsibility. Cheng and Monroe also developed several models to explore factors that best predict children's interest in participating in nature-based activities and performing environmentally friendly behaviors. In analyzing the data, researchers found that children's connection to nature was the strongest factor in predicting students' interest in participating in nature-based activities, while children's connection to nature,

previous experience with nature, perceived family value toward nature, and their perceived control most strongly influenced their interest in performing environmentally friendly behaviors. Cheng and Monroe discuss the implications of their research in terms of future research needs, as well as the development of environmental education programs. This study may be limited due to its cross-sectional design and focus on a specific age group, however, it provides an encouraging new instrument to predict children's interest in participating in nature-based activities and performing environmentally friendly behaviors.

Author Affiliation: Judith Cheng is with Tamkang University in Taiwan.

Cheng, J. C. H., & Monroe, M. C. (2010). Connection to Nature: Children's Affective Attitude Toward Nature. *Environment and Behavior*. This article may be available in a library near you or can be purchased online through the publisher at: <http://eab.sagepub.com/> (Volume 5)

Non-formal outdoor environmental education programs can improve children's environmental orientations

Although there are many environmental education programs, few studies have examined the impact of non-formal (i.e., out-of-school) outdoor environmental education programs on children's environmental orientations. Larson and colleagues conducted an exploratory study to investigate differences in children's environmental orientations in terms of gender, age, and ethnicity, as well as to evaluate the impacts of a one-week, non-formal outdoor environmental education program on children's environmental orientations. As part of this study, 133 6- to 13-year-old children in Athens-Clarke County, Georgia participated in a five-day Eco-Explorer Camp, while another group of 69 students participated in traditional after-school programs. Researchers measured children's environmental orientations, including eco-affinity (personal interest in nature and intention to engage in pro-environmental behavior) and eco-awareness (cognitive understanding of environmental issues), as well as environmental knowledge prior to and after the camp/after school program. In addition, researchers gathered more qualitative data on children's camp experiences through interviews and evaluations. In analyzing the data in terms of gender, age, and ethnicity, Larson and colleagues found no gender differences in terms of children's environmental orientations, however, researchers found that older children had lower eco-affinity levels than younger children and African-American children had lower eco-awareness and environmental knowledge scores than White children. In analyzing the data in terms of the impact of the environmental education program, Larson and colleagues found that after the program children scored significantly higher in terms of eco-affinity and environmental knowledge across all gender, age, and ethnicity groups, however, the program did not impact children's eco-awareness. In talking with children about their camp experiences, researchers discovered that children preferred activities that involved physical activity and "having fun" was a critical component. Researchers also found interesting ethnicity differences, such as that White children were more than twice as likely to report engaging in solitary nature-based activities than African American children. While this study may be limited due to its small sample size and inability to control for numerous differences between camp and after school groups, this study provides valuable insight into the potential positive impacts of a non-formal outdoor environmental education program on children's environmental orientations.

Author Affiliation: Lincoln Larson is with the University of Georgia.

Larson, L. R., Castleberry, S. B., & Green, G. T. (2010). Effects of an Environmental Education Program on the Environmental Orientations of Children from Different Gender, Age, and Ethnic Groups. *Journal of Park and Recreation Administration*, 28(3), 95-113. This article may be available in a library near you or can be purchased online through the publisher at: <http://journals.sagamorepub.com/ebooks/> (Volume 5)

Direct nature experiences are important for changing environmental attitudes & behavior

Many environmental education programs strive to positively influence children's environmental behavior, however, we currently know very little about program elements and experiences that lead to changes in environmental behavior. In this study, Duerden and colleagues investigated the relationship between indirect and direct nature experiences and children's environmental knowledge, attitudes, and behavior. Researchers used surveys, focus groups, and observations to evaluate the experiences of 108 middle and high school students that participated in an international immersion environmental education program, which included a preparatory program (indirect nature experience), a 7-14 day international field workshop (direct nature experience), and a post-trip service project. Duerden and colleagues surveyed participants at multiple stages in the program, as well as a comparison group of 49 middle and high school students who did not participate in the program. In analyzing the data, researchers found that program participants had a significant increase in environmental knowledge as compared to the comparison group. In examining the impact of different program components, Duerden and colleagues found that during the indirect nature experience (i.e., the preparatory program) children's environmental knowledge increased more than their environmental attitudes and environmental attitudes had a stronger impact on children's environmental behavior, while during the direct nature experience (i.e., the international workshop) both children's environmental knowledge and attitudes developed rather equally and both environmental knowledge and attitudes were related to environmental behavior. In addition, researchers discovered that while children's indirect experiences led to enhanced environmental knowledge, it was their direct experiences that led to attitude and behavior development. Interestingly, Duerden and colleagues found that the nature of children's direct experience was vital to the impact it had on children. For example, researchers discovered that children perceived experiences to be more direct if they were afforded freedom and autonomy during the experience. While this study may be limited due to its small sample size, reliance on self-report data, and environmental program variability, the researchers' study design and mix of methods provides an important contribution to the literature. In concluding their article, Duerden and colleagues highlight program implications from their research, as well as future research needs.

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Duerden, M. D., & Witt, P. A. (2010). The impact of direct and indirect experiences on the development of environmental knowledge, attitudes, and behavior. *Journal of Environmental Psychology*(April 3). This article may be available in a library near you or can be purchased online through the publisher at: <http://www.elsevier.com/> (Volume 5)

Green School Gyms improve children's health

BTCV is a charitable organization in the United Kingdom that created Green Gyms to improve people's health and the environment. As part of Green Gyms, individuals participate in a range of conservation and gardening projects outdoors, such as planting trees and constructing footpaths.

From 2007 to 2009, BTCV implemented Green Gyms in 9 primary schools. As part of these School Green Gyms, a weekly 1 to 1.5 hour session was provided for 10 weeks for groups of about 10 children at each school. During these sessions, children participated in environmental activities on their school grounds or nearby open spaces. BTCV commissioned a university to evaluate the School Green Gyms. As part of this evaluation, children completed a questionnaire before and after participation in the program. In analyzing the data, researchers found that children's psychosocial health and overall health significantly improved after the Green Gyms program. In addition, they found that children's weekend physical activity levels significantly increased after the program and that children felt very positive about the program. While the study data is based on self-reported information and it is difficult to separate the impact of the program activities from the outdoor context, this evaluation provides valuable information about the impact of an innovative program on children's health.

BTCV. (2009). Evaluation findings: health and social outcomes 2009. BTCV. This report is available online at: http://www2.btcv.org.uk/display/greengym_research (Volume 4)

Children benefit from appropriate risk-taking during outdoor play

Play is critical to children's healthy development. Little and Wyver examine outdoor play with a focus on early childhood education and urban Western culture. The authors review a number of social and environmental factors that have influenced children's outdoor play experiences in recent years (e.g., traffic, lack of space, other time demands, and parental fears). Little and Wyver discuss the importance of children's experience with risk to healthy development, including children's ability to develop and refine their motor skills and enjoy and gain confidence in being physically active. The authors also review literature related to the impacts of not providing children with opportunities to engage in challenging and risk-related experiences, including children's engagement in inappropriate risk-taking and underdevelopment of decision-making skills related to making sound risk judgments. Little and Wyver discuss the inability of many early childhood educators to provide challenging and stimulating outdoor experiences to children due to restrictive regulations and a cultural emphasis on eliminating or minimizing physical risk. The authors review the difference between "hazard" and "risk" and emphasize the importance of considering risk within the larger context of children's development, as well as the need to focus on identifying and fostering a risk balance that is appropriate for each individual child. In concluding their article, Little and Wyver articulate a model they developed that illustrates possible pathways from specific factors (e.g., poor outdoor environments or fear of litigation) to minimization of risk-taking and developmental outcomes, and emphasize the need to examine early childhood education policy and practice.

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Little, H., & Wyver, S. (2008). Outdoor play - does avoiding the risks reduce the benefits? *Australian Journal of Early Childhood*, 33(2), 33-40. This study may be available in a library near you or can be purchased online through the publisher at: http://www.earlychildhoodaustralia.org.au/australian_journal_of_early_childhood/about_ajec.html (Volume 4)

Outdoor experience for teens has self-reported life-changing results

A classic 1998 study by Dr. Stephen R. Kellert of Yale University, with assistance from Victoria Derr, remains the most comprehensive research to date to examine the effects on teenage youth of participation in outdoor education, specifically wilderness-based programs. Subjects were participants in programs offered through three old and well-respected organizations: the Student Conservation Association (SCA), the National Outdoor Leadership School (NOLS), and Outward Bound. The researchers used quantitative and qualitative research techniques, and parallel use of both retrospective and longitudinal study techniques. Results indicate that the majority of respondents found this outdoor experience to be “one of the best in their life.” Participants report positive effects on their personal, intellectual and, in some cases, spiritual development. Pronounced results were found in enhanced self-esteem, self-confidence, independence, autonomy and initiative. These impacts occurred among both the retrospective and longitudinal respondents in this study, which means, in part, that these results persisted through many years.

Kellert, Stephen R.; with the assistance of Victoria Derr. “A National Study of Outdoor Wilderness Experience.” New Haven: Yale University, 1998.

<http://www.nols.edu/resources/research/pdfs/kellert.complete.text.pdf> (Volume 1)

Access to nature nurtures self-discipline

This study focuses on the positive benefits to inner city youth, particularly girls, from access to green spaces for play. Even a view of green settings enhances peace, self-control, and self-discipline. While the results are most notable for girls, the evidence is not limited to the positive impact on girls. (Original Research)

Taylor, Andrea Faber; Frances E. Kuo; and William C. Sullivan. “Views of Nature and Self-Discipline: Evidence from Inner City Children.” In the *Journal of Environmental Psychology*, 21, 2001. © 2001 Academic Press. Available on the Web site of the University of Illinois Urbana-Champaign. <http://www.lhhl.uiuc.edu/> (Volume 1)

This annotated bibliography has been developed by the Children & Nature Network (C&NN), www.childrenandnature.org and is available worldwide at no charge as a means by which to make relevant research easily available, and to encourage additional research. The vision of the Children & Nature Network is a world in which all children play, learn and grow with nature in their everyday lives. C&NN is leading a movement to connect all children, their families and communities to nature through innovative ideas, evidence-based resources and tools, broad-based collaboration and support of grassroots leadership. For additional information, contact info@childrenandnature.org.

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