# Attention deficit hyperactivity disorder

Attention deficit hyperactivity disorder (ADHD) is a developmental disorder characterized by inattention, hyperactivity, and impulsivity. It is the most commonly diagnosed behavioral disorder of childhood, affecting between 3 - 5% of school-aged children. Although many people occasionally have difficulty sitting still, paying attention, or controlling impulsive behavior, people with ADHD find that these symptoms greatly interfere with everyday life. Generally, these symptoms appear before age 7 and can lead to difficulties in school and in social settings. One- to two-thirds of all children with ADHD continue to exhibit symptoms as adults. Diagnosis can be controversial, since there are no lab tests for ADHD and no objective way to measure behavior. There is also disagreement about the best way to treat ADHD, but early intervention can improve a child's educational and social development.

# Signs and Symptoms

A person is considered to have ADHD if they demonstrate at least 6 symptoms from the following categories for at least 2 months. In diagnosing children, the symptoms must appear before age 7 and pose a significant challenge to everyday functioning in at least two areas of life (usually home and school). Most children do not exhibit all the symptoms, and they may be different in boys and girls (with boys perhaps being more hyperactive and girls more inattentive).

**Inattention**

- Fails to pay close attention to details or makes careless mistakes
- Has difficulty sustaining attention in tasks or play activities
- Does not seem to listen when spoken to directly
- Does not follow through on instructions and fails to finish tasks
- Has difficulty organizing tasks and activities
- Avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as school work, homework)
- Loses things necessary for tasks or activities
- Is easily distracted
- Is forgetful in daily activities

**Hyperactivity and Impulsivity**

- Fidgets with hands or feet or squirms in seat
- Does not remain seated when expected to
- Runs or climbs excessively in inappropriate situations (in adolescents or adults, may be feelings of restlessness)
- Has difficulty playing or engaging in leisure activities quietly
- Acts as if "driven by a motor"

- Talks excessively
- Blurts out answers before questions are completed
- Has difficulty waiting his or her turn
- Interrupts or intrudes on others

# What Causes It?

No one is sure what causes ADHD. Although environment may play a role, researchers are increasingly looking to find answers in the structure of the brain.

- Altered brain function -- Brain scans have revealed a number of differences in the brains of ADHD children compared to those of non-ADHD children. For example, many children with ADHD tend to have altered brain activity in the prefrontal cortex, a region thought to be the brain's command center, which may impair their ability to control impulsive and hyperactive behaviors. Researchers also believe hyperactive behavior in children can be caused by excessive slow-wave (or theta) activity in certain regions of the brain.
- Heredity -- ADHD seems to run in families.
- Maternal or childhood exposure to certain toxins -- Women who smoke, drink, and are exposed to PCBs during pregnancy are more likely to have children with ADHD. Children who are exposed to lead or PCBs are more likely to develop the disorder.

# Risk Factors

- Heredity: children with ADHD usually have at least one first-degree relative who also has the disorder.
- Gender: ADHD is four to nine times more common in boys than in girls (some experts believe that the disorder is underdiagnosed in girls, however).
- Prenatal and early postnatal health: maternal drug, alcohol, and cigarette use; exposure of the fetus or infant to toxins, including lead and PCBs; nutritional deficiencies and imbalances.
- Other behavioral disorders, particularly those that involve excessive aggression (such as oppositional defiant or conduct disorder).

# What to Expect at Your Provider's Office

Because there is no objective test for ADHD, diagnosing the condition is difficult and a number of tests and observations may be used. For this reason, it is crucial to make sure the doctor who evaluates you or your child has training in diagnosing ADHD.

To evaluate a child, the doctor will take a complete medical history and do a thorough exam to check for conditions that may mimic ADHD, such as hyperthyroidism or

problems with vision, hearing, and sleeping. Because many symptoms show up at home or school rather than the doctor's office, you may be given questionnaires to fill out. Your child's teacher may be interviewed. Your doctor will seek to determine not only how the child behaves but also where the behavior occurs and how long it lasts. Children with ADHD have long-lasting symptoms that typically show up during stressful situations or situations that require sustained attention (such as schoolwork).

Diagnosing an adult with ADHD can be even more challenging. Because your symptoms would have appeared when you were young, your doctor may try to find out as much as they can about you when you were a child, getting information from your parents or former teachers. (If your symptoms are recent, you are not considered to have adult ADHD.) In addition to ruling out the other conditions mentioned above, your doctor may also check for depression and bipolar disorder, which can mimic ADHD.

# Preventive Care

Because the cause or causes of ADHD are not known, there is no way to prevent the condition. It may be managed with medication, behavioral therapy, and lifestyle changes.

# Treatment Options

How to treat ADHD, particularly in children, is subject to controversy. Current treatment involves therapy or medication, or a combination of both. In fact, studies show that medication by itself, without some form of therapy, is not likely to improve a child's outcome in the long-term. Family therapy, behavioral therapy, social skills training, and parent skills training are often employed. Many parents investigate nutritional therapies (such as elimination diets or high-dose vitamins), but so far there is no evidence that they are effective. Preliminary evidence indicates that homeopathy and mind-body techniques, particularly biofeedback, may help improve behavior in children with ADHD.

## Lifestyle

Parent skills training offered by skilled clinicians provides parents with tools and techniques for managing their child's behavior. Behavior therapy rewards appropriate behavior and discourages destructive behavior and can be performed by parents and teachers working together therapists and doctors. For example, older children with ADHD may be rewarded with points or tokens, or even written behavioral contracts with their parents. Creating charts with stars for good behavior may be effective for younger children. On the other hand, timeouts may be used to discourage undesirable behavior. Other techniques include:

- Establishing rules that are easily understood, developmentally appropriate, and not unduly harsh

- Avoiding repeated commands once the child has been reminded of the consequences
- Disciplining the child before becoming too angry and frustrated
- Following disciplinary actions with praise when the child adheres to the rules and behaves appropriately

In addition to behavioral intervention at home, modifications in the classroom environment (or work, in the case of adolescents or adults) are significant aspects of the treatment plan. Hyperactive children do best in highly structured circumstances under the direction of a teacher experienced in handling their disruptive behavior and capable of adapting to their distinctive cognitive style. Since group interactions are often particularly challenging, social skills training, appropriate classroom placement, and explicit rules of engagement with peers are essential.

Adults with ADHD may benefit from a variety of behavioral interventions including cognitive remediation, couple therapy, and family therapy.

## Drug Therapies

Stimulant medications are the most widely researched and commonly prescribed treatments for ADHD. Although researchers do not fully understand how these drugs improve ADHD symptoms, studies indicate that they boost the amount of dopamine in the brain, a chemical that is associated with activity; and serotonin, a chemical associated with mood and well-being. Medications prescribed for ADHD include:

- Methylphenidate (Ritalin) -- a stimulant and most commonly used medication for ADHD; effective in 75 - 80% of people with the condition; not recommended for children under 6 years of age
- Dextroamphetamine (Dexadrine) -- a stimulant that is effective in 70 - 75% of people with ADHD; not recommended for children under 3 years of age
- Atomoxetine (Strattera) -- the first nonstimulant medication approved to treat ADHD, Strattera increases the levels of both dopamine and norepinephrine in the brain. Strattera was first developed as an antidepressant and, as with all antidepressants, carries a "black box" warning that it may increase thoughts of suicide in young children and teenagers.

The most common side effects from these medications are trouble sleeping, decrease in appetite, and nervousness.

## Complementary and Alternative Therapies

According to a recent survey, many parents use complementary and alternative treatments for their children with ADHD, with nutritional therapies the most common. Although studies show at best conflicting results, if your child appears sensitive to certain foods, talk to your doctor about eliminating them for a brief period to see if his symptoms

improve. Putting a child on any diet should only be done under the supervision of your doctor.

**Diets**

The Feingold diet was developed in the 1970s by Benjamin Feingold, who believed that artificial colors, flavors, and preservatives, as well as naturally occurring salicylates (chemicals similar to aspirin that are found in many fruits and vegetables), were a major cause of hyperactive behavior and learning disabilities in children. Studies examining the diet's effect have been mixed. Most show no benefit, although there is some evidence that salicylates may play a role in hyperactivity in a small number of children. Because the Feingold diet is difficult to adhere to and also involves changes in family lifestyle (children are encouraged to participate in creating meals, for example), you should talk with your doctor before attempting it.

Other dietary therapies may concentrate on eating foods that are high in protein and complex carbohydrates, and eliminating sugar and artificial sweeteners from the diet. However, studies show no relation between sugar and ADHD. In one study, children whose diets were high in sugar or artificial sweeteners behaved no differently than children whose diets were free of these substances. This was true even among children whose parents described them as having a sensitivity to sugar.

**Vitamins and Minerals**

Magnesium (200 mg per day) -- Symptoms of magnesium deficiency include irritability, decreased attention span, and mental confusion. Some experts believe that children with ADHD may be exhibiting the effects of mild magnesium deficiency. In one preliminary study of 75 magnesium-deficient children with ADHD, those who received magnesium supplements showed an improvement in behavior compared to those who did not receive the supplements.

Vitamin B6 -- Adequate levels of vitamin B6 are essential for the synthesis of essential brain chemicals including serotonin, dopamine and norepinephrine, the chemicals affected in children with ADHD. One preliminary study found that B6 pyridoxine was slightly more effective than Ritalin in improving behavior among hyperactive children. However, the study used a high dose of B6, which could cause nerve damage (although none occurred in the study), and other studies have shown that B6 has no effect on behavior. Because high doses can be dangerous, do not give your child B6 without your doctor's supervision.

Zinc (35 mg per day) -- Zinc regulates the activity of neurotransmitters, fatty acids, and melatonin, all of which are related behavior. Several studies have found that zinc may help improve behavior, but the effects were modest at best. Higher doses of zinc can be dangerous, so talk to your doctor before giving zinc to a child or taking it yourself.

Essential fatty acids -- Fatty acids, such as those found in fish and fish oil (omega-3 fatty acids) and evening primrose oil (omega-6 fatty acids), are "good fats" that play a key role in normal brain function. Experts have suggested them as a treatment for ADHD; however, studies have shown no clear benefit in improving behavior.

L-carnitine -- L-carnitine is an amino acid derivative that is involved in energy production in the body. One study found that 54% of a group of boys with ADHD showed improvement in behavior when taking L-carnitine, but further research is needed to confirm any benefit. Because L-carnitine has not been studied for safety in children, talk to your doctor before giving a child L-carnitine.

**Herbs**

The use of herbs is a time-honored approach to strengthening the body and treating disease. Herbs, however, can trigger side effects and can interact with other herbs, supplements, or medications. For these reasons, herbs should be taken with care, under the supervision of a health care provider.

Several herbal remedies for ADHD are sold in the United States and Europe, but few scientific studies have investigated whether these herbs improve symptoms of ADHD. One or more of the following calming herbs may be recommended for people with ADHD:

- Roman chamomile (*Chamaemelum nobile*)
- Valerian (*Valerian officinalis*)
- Lemon balm (*Melissa officinalis*)
- Passionflower (*Passiflora incarnata*)

Other herbs commonly contained in botanical remedies for ADHD include:

- Gingko (*Gingko biloba*) -- used to improve memory and mental sharpness.
- American ginseng (*Panax quinquefolium* ) and gingko -- One study suggests that gingko in combination with ginseng may improve symptoms of ADHD.

**Massage**

Relaxation techniques and massage can reduce anxiety and activity levels in children and teens. In one study, teenaged boys with ADHD who received 15 minutes of massage for 10 consecutive school days showed significant improvement in behavior and concentration compared to those who were guided in progressive muscle relaxation for the same duration of time.

**Homeopathy**

Before prescribing a remedy, homeopaths take into account a person's constitutional type -- your physical, emotional, and psychological makeup. An experienced homeopath

assesses all of these factors when determining the most appropriate treatment for each individual.

In a study of 43 children with ADHD, those who received an individualized homeopathic remedy showed a significant improvement in behavior compared to children who received placebo. The homeopathic remedies found to be most effective included:

- *Stramonium* -- for children who are fearful, especially at night
- *Cina* -- for children who are irritable and dislike being touched; whose behavior is physical and aggressive
- *Hyoscyamus niger* -- for children who have poor impulse control, talk excessively or act overly exuberant

**Biofeedback**

Mind-body techniques such as hypnotherapy, progressive relaxation, and biofeedback may be useful in treating children and adolescents. Through these techniques, children are often able to learn coping skills that will stay with them for the rest of their lives. These treatments allow children to gain a sense of control and mastery, increase self-esteem, and decrease stress.

Biofeedback operates on the principle that children can be trained to modify brain activity associated with ADHD and increase brain activity associated with attention. Several studies have shown positive results.

# Other Considerations

## Prognosis and Complications

As many as half of all children with ADHD who receive appropriate treatment learn to control symptoms and function well as adults. Research suggests that children who receive treatment that combines therapies such as medication, behavioral therapy, and biofeedback are less likely to have behavioral problems as they grow up. In most cases, ADHD can be effectively managed throughout life.

# Supporting Research

American Academy of Pediatrics. Clinical practice guideline: diagnosis and evaluation of the child with attention-deficit/hyperactivity disorder. *Pediatrics*. 2000;105(5):1158-1170.

Arnold LE, Pinkham SM, Votolato N. Does zinc moderate essential fatty acid and amphetamine treatment of attention deficit/hyperactivity disorder? *J Child Adolesc Psychopharmacol*. 2000;10:111-117.

Arnold LE, Kleykamp D, Votolato N, Gibson RA, Horrocks L. Potential link between dietary intake of fatty acid and behavior: pilot exploration of serum lipids in attention-deficit hyperactivity disorder. *J Child Adolesc Psychopharmacol*. 1994;4(3):171-182.

Baumgaertel A. Alternative and controversial treatments for attention-deficit/hyperactivity disorder. *Pediatr Clin of North Am*. 1999;46(5):977-992.

Bekaroglu M, Aslan Y, Gedik Y. Relationships between serum free fatty acids and zinc, and attention deficit hyperactivity disorder: a research note. *J Child Psychol Psychiatry*. 1996;37(2):225-227.

Blumenthal M, ed. *The Complete German Commission E Monographs: Therapeutic Guide to Herbal Medicines.* Boston, Mass: Integrative Medicine Communications; 1998:160, 107.

Burgess J, Stevens L, Zhang W, Peck L. Long-chain polyunsaturated fatty acids in children with attention-deficit hyperactivity disorder. *Am J Clin Nutr.* 2000; 71(suppl):327S-330S.

Carter CM, Urbanowicz M, Hemsley R, et al. Effects of a few food diet in attention deficit disorder. *Arch Dis Child*. 1993;69:564-568.

Daruna JH, Dalton R, Forman MA. Attention deficit hyperactivity disorder. In: Behrman RE, Kliegman RM, Jenson HB, eds. *Nelson Textbook of Pediatrics.* 16th ed. Philadelphia, Pa: W.B. Saunders Company; 2000:100-103.

Field T, Quintino O, Hernandez-Reif M, Koslovsky G. Adolescents with attention deficit hyperactivity disorder benefit from massage therapy. *Adolescence*. 1998;33(129):103-108.

Frei H, von Ammon K, Thurneysen A. Treatment of hyperactive children: increased efficiency through modifications of homeopathic diagnostic procedure. *Homeopathy*. 2006 Jul;95(3):163-70.

Gutgesell H, Atkins D, Barst R, et al. Cardiovascular monitoring of children and adolescents receiving psychotropic drugs: a statement for healthcare professionals from the Committee on Congenital Cardiac Defects, Council on Cardiovascular Disease in the Young, American Heart Association. *Circulation.* 1999; 99(7):979-82.

Heinrich H, Gevensleben H, Strehl U. Annotation: neurofeedback - train your brain to train behaviour. *J Child Psychol Psychiatry*. 2007 Jan;48(1):3-16.

Holtmann M, Stadler C. Electroencephalographic biofeedback for the treatment of attention-deficit hyperactivity disorder in childhood and adolescence. *Expert Rev Neurother*. 2006 Apr;6(4):533-40. Review.

Kanarek R. Does sucrose or aspartame cause hyperactivity in children? *Nutr Rev.* 1994;52(5):173-175.

Kidd P. Attention deficit / hyperactivity disorder (ADHD) in children: rationale for its integrative management. *Altern Med Rev.* 2000;5(5):402-428.

Knochel JP. Disorders of magnesium metabolism. In: Fauci AS, Braunwald E, Isselbacher KJ, eds. *Harrison's Principles of Internal Medicine.* 14th ed. New York, NY: McGraw-Hill Companies, Inc; 1998:2263.

Kozielec T, Starobrat-Hermelin B. Assessment of magnesium levels in children with attention deficit hyperactivity disorder. *Magnes Res*. 1997;10(2):143-148.

Krummel D, Seligson FH, Guthrie HA. Hyperactivity: is candy causal? *Critical Reviews in Food Science and Nutrition*. 1996;36(1 and 2):31-47.

Lamont J. Homoeopathic treatment of attention deficit hyperactivity disorder; a controlled study. *Br Homoeopath J.* 1997;86:196-200.

Linden M, Habib T, Rodojevic V. A controlled study of the effects of EEG biofeedback on cognition and behavior of children with attention deficit disorder and learning disabilities. *Biofeedback Self Regul*. 1996;21(1):35-49.

Lubar J, Swartwood MO, Swartwood JN, O'Donnell PH. Evaluation of the effectiveness of EEG neurofeedback training for ADHD in a clinical setting as measured by changes in TOVA scores, behavioral ratings and WISC-R performance. *Biofeedback Self Regul*. 1995;20(1):83-99.

Lyon MR, Cline JC, Totosy de Zepetnek J, et al. Effect of the herbal extract combination *Panax quinquefolium* and *Ginkgo biloba* on attention-deficit hyperactivity disorder: a pilot study. *J Psychiatry Neurosci.* 2001;26(3):221-228.

Mitchell EA, Aman MG, Turbott SH, Manku M. Clinical characteristics and serum essential fatty acid levels in hyperactive children. *Clin Pediatr (Phila).* 1987;26:406-411.

MTA Cooperative Group. A 14-month randomized clinical trial of treatment strategies for attention-deficit/hyperactivity disorder. *Arch Gen Psychiatry.* 1999;56:1073-1086.

Noorbala AA, Akhondzadeh S. Attention-deficit/hyperactivity disorder: etiology and pharmacotherapy. *Arch Iran Med*. 2006 Oct;9(4):374-80. Review.

Richardson AJ. Omega-3 fatty acids in ADHD and related neurodevelopmental disorders. Int Rev Psychiatry. 2006 Apr;18(2):155-72. Review.

Richardson AJ, Puri BK. The potential role of fatty acids in attention-deficit/hyperactivity disorder. *Prostaglandins Leukot Essent Fatty Acids*. 2000;63(1/2):79-87.

Starobrat-Hermelin B, Kozielec T. The effects of magnesium physiological supplementation on hyperactivity in children with attention deficit hyperactive disorder (ADHD): positive response to magnesium oral loading test. *Magnesium Research*. 1997; 10(2):149-156.

Stevens LJ, Zentall SS, Abate ML, Kuczek T, Burgess JR. Omega-3 fatty acids in boys with behavior, learning and health problems. *Physiol Behav*. 1996;59(4/5):915-920.

Stevens LJ, Zentall SS, Deck JL, et al. Essential fatty acid metabolism in boys with attention-deficit hyperactivity disorder. *Am J Clin Nutr*. 1995;62:761-768.

Stubberfield TG, Wray JA, Parry TS. Utilization of alternative therapies in attention-deficit hyperactivity disorder. *J Paediatr Child Health*. 1999;35:450-453.

Tan G, Schneider S. Attention-deficit hyperactivity disorder: pharmacotherapy and beyond. *Postgrad Med*. 1997;101(5):201-222.

Thompson L, Thompson M. Neurofeedback combined with training in metacognitive strategies: effectiveness in students with ADD. *Appl Psychophysiol Biofeedback*. 1998;23(4):243-263.

Toren P, Eldar S, Sela BA, et al. Zinc deficiency in attention-deficit hyperactivity disorder. *Biol Psychiatry*. 1996; 40:1308-1310.

Van Oudheusden LJ, Scholte HR. Efficacy of carnitine in the treatment of children with attention-deficit hyperactivity disorder. *Prostaglandins Leukot Essent Fatty Acids*. 2002;76:33-8.

Volkow ND, Wang G, Fowler JS, et al. Therapeutic doses of oral methylphenidate significantly increase extracellular dopamine in the human brain. *J Neurosci.* 2001;15;21(2):RC121.

Wender PH, Wolf LE, Wasserstein J. Adults with ADHD. An overview. *Ann N Y Acad Sci*. 2001;931:1-16.

Werbach M. *Nutritional Influences on Illness.* New Canaan, Conn: Keats Publishing; 1988:221-226.

Wolraich M. Addressing behavior problems among school-aged children: traditional and controversial approaches. *Pediatr Rev*. 1997;18(8):266-270.