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What Is Neurofibromatosis Type 1?

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We use "NF" to refer to a group of genetic conditions that cause tumors to grow around the nerves. NF includes neurofibromatosis type 1 (NF1), and all types of schwannomatosis (SWN), including *NF2*-related schwannomatosis (*NF2*-SWN). Each of these types of NF is a different condition, and one type does not lead to another type.

Neurofibromatosis type 1 is the most common type of neurofibromatosis. It affects 1 in every 2,500 people born worldwide. The cause of NF1 is a change in a gene. A gene is a sequence of DNA, which is the genetic code that is passed down from parents to children. Because of this, a child can inherit NF1 from a parent who has the disorder. About half of the time, however, a child with NF1 is the only person in the family who has the disorder. In such instances, the NF1 gene change occurred as the result of “spontaneous mutation”—a random error in the process of copying genetic information.

Neurofibromatosis 1 is not the consequence of drug, alcohol, or X-ray exposure, or any other factor under the control of the child’s parents. NF1 is not contagious. Contact between an affected child and an unaffected child cannot transmit the condition.

The NF1 gene is responsible for the production of neurofibromin, a protein that keeps cells from growing too quickly. Without this control, the cells can continue to grow and divide around the nerves, producing the tumors commonly found in NF1.

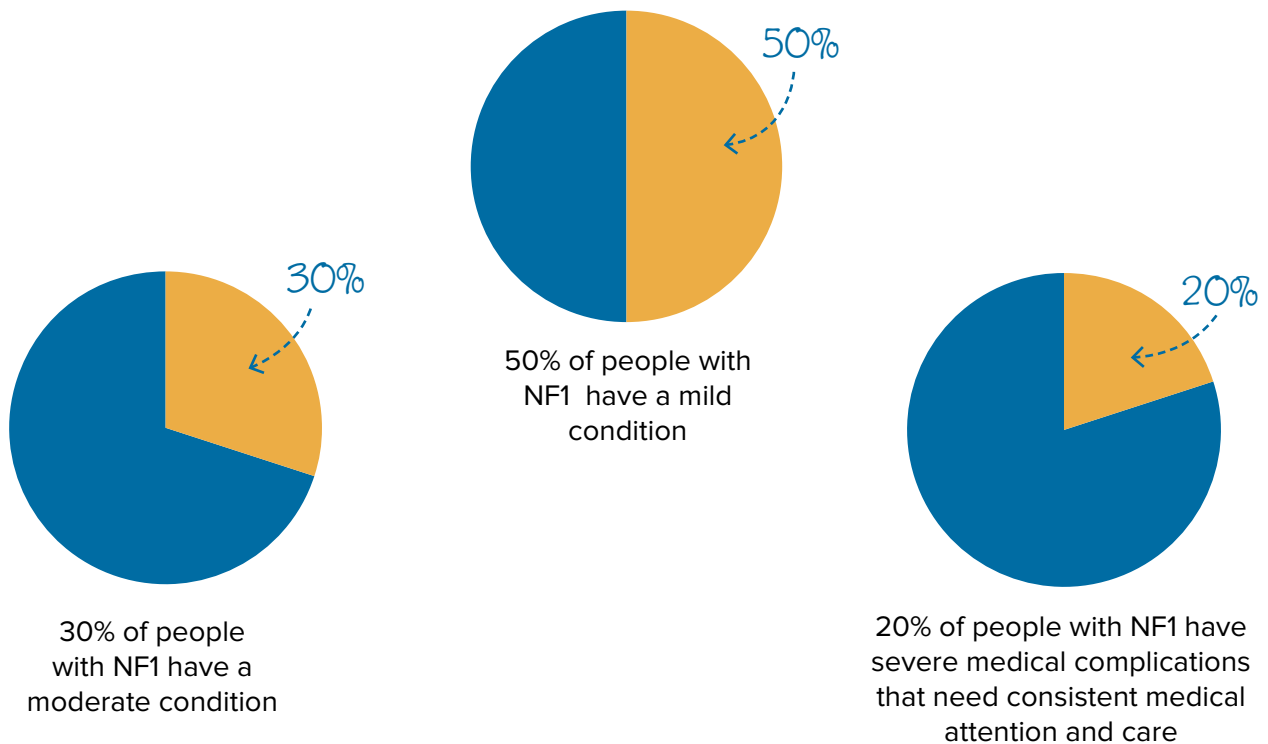
Neurofibromin is also involved in processing nerve signals, including signals inside the brain and those that send messages between the brain and the muscles. That is why problems with neurofibromin affect how the brain receives, processes, stores, and sends information.

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symptoms

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Although genetically linked, all affected family members may not experience the same symptoms. Both the severity and the symptoms themselves may vary.



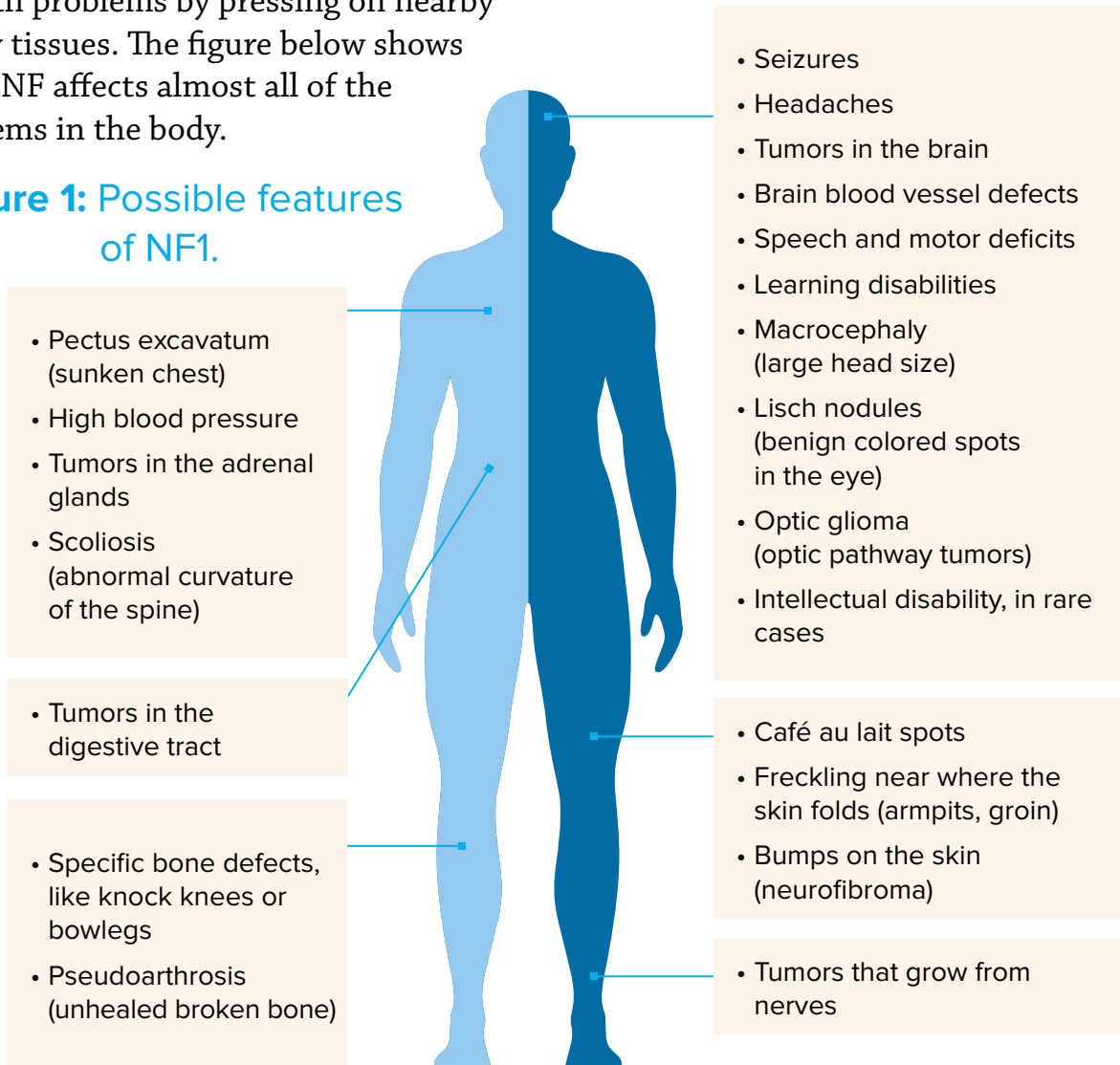
symptoms

Symptoms of NF1

Light brown skin spots called *café au lait* spots and *neurofibromas*, which are small noncancerous tumors that grow on or under the skin, are the most common features of NF1. These tumors can cause health problems by pressing on nearby body tissues. The figure below shows how NF affects almost all of the systems in the body.

For more information about all types of NF and its symptoms, please visit www.ctf.org/education.

Figure 1: Possible features of NF1.



symptoms

Common Symptoms of NF1 at Each Age

The ways that NF affects your child will change as your child grows up. The chart below gives you an idea of medical problems to watch for over the course of your child's lifetime.

Figure 2: Emergence of common symptoms of NF1 at each age.

	Congenital 0 to 2 years	Preschool 2 to 6 years	Late Childhood and Adolescence 6 to 16 years	Adulthood 16+ years
Café au lait spots	Shaded			
Diffuse plexiform neurofibromas	Shaded			
Superficial or nodular plexiform neurofibromas	Shaded	Shaded		
Tibial dysplasia	Shaded	Shaded		
Skinfold freckling	Shaded	Shaded	Shaded	
Optic pathway tumors	Shaded	Shaded		
Learning disabilities	Shaded	Shaded	Shaded	
High blood pressure	Shaded	Shaded	Shaded	Shaded
Headaches	Shaded	Shaded	Shaded	Shaded
Neurofibromas			Shaded	Shaded
Scoliosis	Shaded	Shaded	Shaded	
MPNST	Shaded	Shaded	Shaded	Shaded

MPNST = malignant peripheral nerve sheath tumors.

research

Differences in the Brain

Research has found that in some people with NF1, parts of the brain have a different form and can be “wired” in a different way. Compared to a brain without NF, a brain with NF may have changes in the connections between brain cells called *neurons* and a different amount and distribution of a substance called *neurotransmitters*. A neurotransmitter allows neurons to communicate with one another to transfer information. In doing so, they help regulate a wide range of psychologic and physical functions, including emotion, movement, learning, and memory.

Many proteins are critical to brain development. Neurofibromin is one of these essential proteins. The NF1 gene provides the instructions for making neurofibromin (see “What Is Neurofibromatosis Type 1?” on page 12). Although it is known that neurofibromin is important in the brain development and wiring process before and after birth, it is not understood exactly how. Doctors are currently conducting research to better understand the role of neurofibromin in normal brain development. It is known that early identification of NF1 and subsequent intervention may help with brain development after birth.

These “wiring” and structural differences in the brain can result in a variety of difficulties.

People with NF1 may have challenges in the following areas:



Visual perception



Language



Motor skills



Attention



Behavior



Executive function



Social skills

development

Motor and Social Development in Children With NF1

When raising a child with NF1, you may notice some problems with his or her motor development.

These problems can include

- low muscle tone (muscles may feel softer compared with others)
- loss of muscle strength at rest
- mild delay in the development of motor skills
 - walking delayed by 4 to 5 months
- delayed handwriting and pronunciation of speech

There are also some social development obstacles that children and teens with NF1 may face, including



difficulty relating to other children



communication problems



feelings of isolation



difficulty making friends



being bullied



depression



anxiety

learning

Learning and NF1

Difficulty learning can dramatically affect the quality of life of those with NF1. Although the frequency of intellectual disability is low, as many as 90% of children and adults may need some form of learning assistance. Many people with NF1 have difficulty making sense of what is seen (visuoperceptual deficit) and where objects are seen in relation to other objects (visuospatial deficit). It is also common to have trouble with executive functioning skills, which include planning, management, attention, and organization.

8 of every 10 people with NF1 have a moderate to severe impairment in learning.

6 out of every 10 people with NF1 have attention deficit hyperactivity disorder (ADHD) of some type.

5 of every 10 have poor reading, spelling, and mathematic skills.

The most common subtypes of ADHD in people with NF1 are the primarily inattentive or combined subtypes.

glossary

Lisch nodules—well-defined, dome-shaped elevations on the surface of the eye. They range in color from clear yellow to brown.

Neurofibroma—small bumps or growths on or under the skin that are usually not harmful.

Neurofibromin—a protein that keeps cells from growing too quickly.

Macrocephaly—a condition in which the head is abnormally large.

Optic glioma—a brain tumor that forms in or around the optic nerve, which connects the eye to the brain. As the tumor grows, it presses on the optic nerve, affecting vision.

Pectus excavatum—a condition in which the rib cage forms abnormally and the breastbone (sternum) caves in. The condition is also known as sunken chest or funnel chest.

Plexiform neurofibroma—a tumor that tends to involve large nerves. Sometimes, they form under the skin or deeper, but they can also involve small nerves and form on the surface of the skin (superficial). Though they are usually not cancerous, these tumors may grow and affect the structure of nearby bone, skin, and muscle. There are two main types of plexiform neurofibromas: diffuse and nodular.

- **Diffuse:** If these tumors are described as diffuse, it means there is usually no clear point, or edges, of where the tumors begin or end. These tumors also appear to spread out like fingers
- **Nodular:** If these tumors are described as nodular, it means they look like small clusters, or nodules, along the nerve

Pseudoarthrosis—a break in a bone that does not heal on its own.

Scoliosis—a condition in which the spine curves abnormally.

Tibial dysplasia—a condition in which the shin bone (tibia) curves or bows excessively.

