Down syndrome

Down syndrome is a chromosomal condition that is associated with intellectual disability, a characteristic facial appearance, and weak muscle tone (hypotonia) in infancy. All affected individuals experience cognitive delays, but the intellectual disability is usually mild to moderate.

People with Down syndrome may have a variety of birth defects. About half of all affected children are born with a heart defect. Digestive abnormalities, such as a blockage of the intestine, are less common.

Individuals with Down syndrome have an increased risk of developing several medical conditions. These include gastroesophageal reflux, which is a backflow of acidic stomach contents into the esophagus, and celiac disease, which is an intolerance of a wheat protein called gluten. About 15 percent of people with Down syndrome have an underactive thyroid gland (hypothyroidism). The thyroid gland is a butterfly-shaped organ in the lower neck that produces hormones. Individuals with Down syndrome also have an increased risk of hearing and vision problems. Additionally, a small percentage of children with Down syndrome develop cancer of blood-forming cells (leukemia).

Delayed development and behavioral problems are often reported in children with Down syndrome. Affected individuals' speech and language develop later and more slowly than in children without Down syndrome, and affected individuals' speech may be more difficult to understand. Behavioral issues can include attention problems, obsessive/compulsive behavior, and stubbornness or tantrums. A small percentage of people with Down syndrome are also diagnosed with developmental conditions called autism spectrum disorders, which affect communication and social interaction.

People with Down syndrome often experience a gradual decline in thinking ability (cognition) as they age, usually starting around age 50. Down syndrome is also associated with an increased risk of developing Alzheimer disease, a brain disorder that results in a gradual loss of memory, judgment, and ability to function. Approximately half of adults with Down syndrome develop Alzheimer disease. Although Alzheimer disease is usually a disorder that occurs in older adults, people with Down syndrome usually develop this condition in their fifties or sixties.

Frequency

Down syndrome occurs in about 1 in 800 newborns. About 5,300 babies with Down syndrome are born in the United States each year, and approximately 200,000 people in this country have the condition. Although women of any age can have a child with Down syndrome, the chance of having a child with this condition increases as a woman gets older.

Causes

Most cases of Down syndrome result from trisomy 21, which means each cell in the body has three copies of chromosome 21 instead of the usual two copies.

Less commonly, Down syndrome occurs when part of chromosome 21 becomes attached (translocated) to another chromosome during the formation of reproductive cells (eggs and sperm) in a parent or very early in fetal development. Affected people have two normal copies of chromosome 21 plus extra material from chromosome 21 attached to another chromosome, resulting in three copies of genetic material from chromosome 21. Affected individuals with this genetic change are said to have translocation Down syndrome.

A very small percentage of people with Down syndrome have an extra copy of chromosome 21 in only some of the body's cells. In these people, the condition is called mosaic Down syndrome.

Researchers believe that having extra copies of genes on chromosome 21 disrupts the course of normal development, causing the characteristic features of Down syndrome and the increased risk of health problems associated with this condition.

Inheritance Pattern

Most cases of Down syndrome are not inherited. When the condition is caused by trisomy 21, the chromosomal abnormality occurs as a random event during the formation of reproductive cells in a parent. The abnormality usually occurs in egg cells, but it occasionally occurs in sperm cells. An error in cell division called nondisjunction results in a reproductive cell with an abnormal number of chromosomes. For example, an egg or sperm cell may gain an extra copy of chromosome 21. If one of these atypical reproductive cells contributes to the genetic makeup of a child, the child will have an extra chromosome 21 in each of the body's cells.

People with translocation Down syndrome can inherit the condition from an unaffected parent. The parent carries a rearrangement of genetic material between chromosome 21 and another chromosome. This rearrangement is called a balanced translocation. No genetic material is gained or lost in a balanced translocation, so these chromosomal changes usually do not cause any health problems. However, as this translocation is passed to the next generation, it can become unbalanced. People who inherit an unbalanced translocation involving chromosome 21 may have extra genetic material from chromosome 21, which causes Down syndrome.

Like trisomy 21, mosaic Down syndrome is not inherited. It occurs as a random event during cell division early in fetal development. As a result, some of the body's cells have the usual two copies of chromosome 21, and other cells have three copies of this chromosome.

Other Names for This Condition

- 47,XX,+21
- 47,XY,+21
- Down's syndrome
- trisomy 21
- trisomy G

Diagnosis & Management

Genetic Testing Information

- What is genetic testing?
  /primer/testing/genetictesting
- Genetic Testing Registry: Complete trisomy 21 syndrome
  https://www.ncbi.nlm.nih.gov/gtr/conditions/C0013080/

Research Studies from ClinicalTrials.gov

- ClinicalTrials.gov
  https://clinicaltrials.gov/ct2/results?cond=%22down+syndrome%22

Other Diagnosis and Management Resources

- National Down Syndrome Congress: Health Care & Medical Resources
  https://www.ndsccenter.org/programs-resources/health-care/
- National Down Syndrome Congress: Speech and Language
  https://www.ndsccenter.org/programs-resources/speech-and-language/
- National Down Syndrome Society: Health Care & Research
  https://www.ndss.org/rescat_lifespan/tax/health-care-research/
- National Down Syndrome Society: Therapies & Development
  https://www.ndss.org/resources/therapies-development/

Additional Information & Resources

Health Information from MedlinePlus

- Encyclopedia: Down Syndrome
  https://medlineplus.gov/ency/article/000997.htm
- Health Topic: Congenital Heart Defects
  https://medlineplus.gov/congenitalheartdefects.html
- Health Topic: Down Syndrome
  https://medlineplus.gov/downsyndrome.html

Genetic and Rare Diseases Information Center

- Down syndrome
  https://rarediseases.info.nih.gov/diseases/10247/down-syndrome

Additional NIH Resources

- Eunice Kennedy Shriver National Institute of Child Health and Human Development
  https://www.nichd.nih.gov/health/topics/downsyndrome
- GeneEd
  https://geneed.nlm.nih.gov/topic_subtopic.php?tid=142&sid=147
- National Human Genome Research Institute
  https://www.genome.gov/19517824/
- National Institute of Diabetes and Digestive and Kidney Diseases: Hypothyroidism
  https://www.niddk.nih.gov/health-information/endocrine-diseases/hypothyroidism

Educational Resources

- Boston Children's Hospital
  http://www.childrenshospital.org/conditions-and-treatments/conditions/d/down-syndrome
- Centre for Genetics Education (Australia)
  http://www.genetics.edu.au/publications-and-resources/facts-sheets/fact-sheet-36-trisomy-21-down-syndrome
- cK-12: Nondisjunction (Trisomy 21)
  https://www.ck12.org/biology/Gametogenesis/enrichment/Nondisjunction/?referrer=concept_details
- Down Syndrome: Health Issues (Len Leshin, M.D., F.A.A.P.)
  http://www.ds-health.com/
- Genetic Science Learning Center, University of Utah
  https://learn.genetics.utah.edu/content/disorders/extraormissing/
- Kennedy Krieger Institute
  https://www.kennedykrieger.org/patient-care/diagnoses-disorders/down-syndrome
- KidsHealth from the Nemours Foundation
  https://kidshealth.org/en/kids/down-syndrome.html
- MalaCards: down syndrome
  http://www.malacards.org/card/down_syndrome
- Merck Manual Consumer Version
  https://www.merckmanuals.com/home/children-s-health-issues/chromosome-and-gene-abnormalities/down-syndrome-trisomy-21

- Orphanet: Down syndrome
  https://www.orpha.net/consor/cgi-bin/OC_Exp.php?Lng=EN&Expert=870
- Your Genes Your Health from Cold Spring Harbor Laboratory
  http://www.ygyh.org/ds/whatisit.htm
- Your Genome from Wellcome Genome Campus
  https://www.yourgenome.org/facts/what-is-downs-syndrome

Patient Support and Advocacy Resources

- Chromosome Disorder Outreach
  https://chromodisorder.org/
- LuMind Research Down Syndrome Foundation
  https://www.lumindrds.org/
- LuMind Research Down Syndrome Foundation
  https://www.lumindrds.org/
- National Down Syndrome Congress
  https://www.ndsccenter.org/
- National Down Syndrome Society
  https://www.ndss.org/
- Resource list from the University of Kansas Medical Center
  http://www.kumc.edu/gec/support/down_syn.html

Scientific Articles on PubMed

- PubMed
  https://www.ncbi.nlm.nih.gov/pubmed?term=%28Down+Syndrome%5BMAJR%5D%29+AND+%28Down+syndrome%5BTI%5D%29+AND+review%5Bpt%5D+AND+english%5Bla%5D+AND+human%5Bmh%5D+AND+%22last+1080+days%22%5Bdp%5D

Catalog of Genes and Diseases from OMIM

- DOWN SYNDROME
  http://omim.org/entry/190685

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Reviewed: June 2012
Published: August 14, 2018

Lister Hill National Center for Biomedical Communications
U.S. National Library of Medicine
National Institutes of Health
Department of Health & Human Services