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# Childhood Leukemia Causes, Risk Factors, and Prevention

## Risk Factors

A risk factor is anything that affects your chance of getting a disease such as cancer. Learn more about the risk factors for childhood leukemia.

- [Risk Factors for Childhood Leukemia](#)
- [What Causes Childhood Leukemia?](#)

## Prevention

There are very few known lifestyle-related or environmental causes of childhood leukemias, so it is important to know that in most cases there is nothing these children or their parents could have done to prevent these cancers.

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# Risk Factors for Childhood Leukemia

A risk factor is anything that affects a person's chance of getting a disease such as cancer. Different cancers have different risk factors.

Lifestyle-related risk factors such as tobacco use, diet, body weight, and physical activity play a major role in many adult cancers. But these factors usually take many years to influence cancer risk, and they are not thought to play much of a role in childhood cancers, including leukemias.

There are a few known risk factors for childhood leukemia.

## Genetic risk factors

Genetic risk factors are those that are part of our DNA (the substance that makes up our genes). They are often inherited from our parents. While some genetic factors increase the risk of childhood leukemia, most leukemias are not linked to any known genetic causes.

## Genetic syndromes

Some genetic disorders increase a child's risk of developing leukemia:

- **Down syndrome (trisomy 21):** Children with Down syndrome have an extra (third) copy of chromosome 21. They are many times more likely to develop either acute lymphocytic leukemia (ALL) or acute myeloid leukemia (AML) than are other children, with an overall risk of about 2% to 3%. Down syndrome has also been linked with transient leukemia (also known as transient myeloproliferative disorder) – a leukemia-like condition within the first month of life, which often resolves on its own without treatment.
- **Li-Fraumeni syndrome:** This is a rare inherited condition caused by a change in the *TP53* gene. People with this change have a higher risk of developing several kinds of cancer, including leukemia, bone or soft tissue sarcomas, breast cancer, adrenal gland cancer, and brain tumors.

Other genetic disorders (such as neurofibromatosis and Fanconi anemia) also carry an increased risk of leukemia, as well as some other types of cancers.

## Inherited immune system problems

Certain inherited conditions cause children to be born with immune system problems. These include:

- Ataxia-telangiectasia
- Wiskott-Aldrich syndrome
- Bloom syndrome
- Schwachman-Diamond syndrome

Along with an increased risk of getting serious infections from reduced immune defenses, these children might also have an increased risk of leukemia.

### **Having a brother or sister with leukemia**

Siblings (brothers and sisters) of children with leukemia have a slightly increased chance of developing leukemia, but the overall risk is still low. The risk is much higher among identical twins. If one twin develops childhood leukemia, the other twin has about a 1 in 5 chance of getting leukemia as well. This risk is much higher if the leukemia develops in the first year of life.

Having a parent who develops leukemia as an adult does not seem to raise a child's risk of leukemia.

### **Lifestyle-related risk factors**

Lifestyle-related risk factors for some adult cancers include smoking, being overweight, drinking too much alcohol, and getting too much sun exposure. These types of factors are important in many adult cancers, but they are unlikely to play a role in most childhood cancers.

Some studies have suggested that a woman drinking a lot of alcohol during pregnancy might increase the risk of leukemia in her child, but not all studies have found such a link.

### **Environmental risk factors**

Environmental risk factors are influences in our surroundings, such as radiation and certain chemicals, that increase the risk of getting diseases such as leukemias.

#### **Radiation exposure**

Exposure to high levels of radiation is a risk factor for childhood leukemia. Japanese atomic bomb survivors had a greatly increased risk of developing AML. If a fetus is exposed to radiation within the first months of development, there may also be an increased risk of childhood leukemia, but the extent of the risk is not clear.

The possible risks from fetal or childhood exposure to lower levels of radiation, such as from x-ray tests or CT scans, are not known for sure. Some studies have found a slight increase in risk, while others have found no increased risk. Any risk increase is likely to

be small, but to be safe, most doctors recommend that pregnant women and children not get these tests unless they are absolutely needed.

### **Exposure to chemotherapy and certain other chemicals**

Children and adults treated for other cancers with certain chemotherapy drugs have a higher risk of getting a [second cancer](#)<sup>1</sup>, usually AML, later in life. Drugs such as cyclophosphamide, doxorubicin, etoposide, and teniposide have been linked to a higher risk of leukemia. These leukemias usually develop within 5 to 10 years of treatment, and they tend to be hard to treat.

Exposure to chemicals such as benzene (a solvent used in the cleaning industry and to manufacture some drugs, plastics, and dyes) may cause acute leukemia in adults and, rarely, in children. Chemical exposure is more strongly linked to an increased risk of AML than to ALL.

Several studies have found a possible link between childhood leukemia and household exposure to pesticides, either during pregnancy or early childhood. Some studies have also found a possible increased risk among mothers with workplace exposure to pesticides before their child is born. However, most of these studies had serious limitations in the way they were done. More research is needed to try to confirm these findings and to provide more specific information about the possible risks.

### **Immune system suppression**

Children who are getting intensive treatment to suppress their immune system (mainly children who have had organ transplants) have an increased risk of certain cancers, such as lymphoma and ALL.

### **Uncertain, unproven, or controversial risk factors**

Other factors that have been studied for a possible link to childhood leukemia include:

- Exposure to electromagnetic fields (such as living near power lines)
- Living near a nuclear power plant
- [Infections \(especially from viruses\) early in life](#)<sup>2</sup>
- Mother's age when child is born
- Parent's smoking history
- Fetal exposure to hormones such as diethylstilbestrol (DES) or birth control pills
- Father's workplace exposure to chemicals and solvents

- Chemical contamination of ground water

So far, most studies have not found strong links between any of these factors and childhood leukemia, but researchers continue to study these exposures.

## Hyperlinks

1. [www.cancer.org/treatment/treatments-and-side-effects/physical-side-effects/second-cancers-in-adults/chemotherapy.html](http://www.cancer.org/treatment/treatments-and-side-effects/physical-side-effects/second-cancers-in-adults/chemotherapy.html)
2. [www.cancer.org/cancer/leukemia-in-children/about/new-research.html](http://www.cancer.org/cancer/leukemia-in-children/about/new-research.html)

## References

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# What Causes Childhood Leukemia?

The exact cause of most childhood leukemias is not known. Most children with leukemia do not have any known risk factors.

Still, scientists have learned that certain changes in the DNA inside normal bone marrow cells can cause them to grow out of control and become leukemia cells. DNA is the chemical in our cells that makes up our **genes**, which control how our cells function. We usually look like our parents because they are the source of our DNA. But our genes affect more than how we look.

Some genes control when our cells grow, divide into new cells, and die at the right time:

- Genes that help cells grow, divide, or stay alive are called **oncogenes**.
- Genes that help keep cell division under control or cause cells to die at the right time are called **tumor suppressor genes**.

Cancers can be caused by DNA mutations (or other types of changes) that keep oncogenes turned on, or that turn off tumor suppressor genes. These gene changes can be inherited from a parent (as is sometimes the case with childhood leukemias), or they may happen randomly during a person's lifetime if cells in the body make mistakes as they divide to make new cells.

A common type of DNA change that can lead to leukemia is known as a **chromosome translocation**. Human DNA is packed into 23 pairs of chromosomes. In a translocation, DNA from one chromosome breaks off and becomes attached to a different chromosome. The point on the chromosome where the break occurs can affect oncogenes or tumor suppressor genes. For example, a translocation seen in nearly all cases of childhood chronic myeloid leukemia (CML) and in some cases of childhood acute lymphocytic leukemia (ALL) is a swap of DNA between chromosomes 9 and 22, which leads to what is known as the **Philadelphia chromosome**. This creates an oncogene known as *BCR-ABL*, which helps the leukemia cells grow. Many other changes in chromosomes or in specific genes have been found in childhood leukemias as well.

## Inherited versus acquired gene mutations

Some children **inherit** DNA mutations from a parent that increase their risk for cancer (see [Risk Factors for Childhood Leukemia](#)<sup>1</sup>). For instance, a condition called Li-

Fraumeni syndrome, which results from an inherited mutation of the *TP53* tumor suppressor gene, increases a person's risk of developing leukemia, as well as some other cancers.

Certain inherited conditions can increase the risk of developing leukemia, but most childhood leukemias do not seem to be caused by inherited mutations. Usually, DNA mutations related to leukemia develop after conception rather than having been inherited. Some of these **acquired** mutations might occur early, even before birth. In rare cases, acquired mutations can result from exposure to radiation or cancer-causing chemicals, but most often they occur for no apparent reason.

## Combinations of genetic and environmental factors

Some studies have suggested that many childhood leukemias may be caused by a combination of genetic and environmental factors. For example:

Certain genes normally control how our bodies break down and get rid of harmful chemicals. Some people have different versions of these genes that make them less effective. Children who inherit one of these gene changes may not be as able to break down harmful chemicals if they are exposed to them. The combination of genetics and exposure might increase their risk for leukemia.

Some research suggests that some childhood leukemias might be caused by a combination of certain gene changes that happen very early in life, along with being exposed to certain viruses later than normal. This “delayed infection” (after the first year or so of life) might affect the immune system in a way that leads to leukemia. For more on this, see [What's New in Childhood Leukemia Research?](#)<sup>2</sup>

Research on these and other possible causes of childhood leukemias is ongoing. But at this time the cause of most childhood leukemias is not known for sure. What's more, the different types of childhood leukemia might each have different causes.

## Hyperlinks

1. [www.cancer.org/cancer/leukemia-in-children/causes-risks-prevention/risk-factors.html](http://www.cancer.org/cancer/leukemia-in-children/causes-risks-prevention/risk-factors.html)
2. [www.cancer.org/cancer/leukemia-in-children/about/new-research.html](http://www.cancer.org/cancer/leukemia-in-children/about/new-research.html)

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## Can Childhood Leukemia Be Prevented?

Although the risk of many adult cancers can be reduced by lifestyle changes (such as quitting smoking), there is no known way to prevent most childhood cancers at this time. Most children with leukemia have no known [risk factors](#)<sup>1</sup>, so there is no sure way to prevent these leukemias from developing.

Some leukemias result from treating cancers with radiation and chemotherapy, or the use of immune-suppressing drugs to avoid rejection of transplanted organs. Doctors are looking for ways to treat patients with cancer and organ transplants without raising the risk of leukemia. But for now, the obvious benefits of treating life-threatening diseases with [chemotherapy](#)<sup>2</sup>, [radiation therapy](#)<sup>3</sup>, or organ transplants must be balanced against the small chance of developing leukemia several years later.

X-rays or CT scans done before birth or during childhood use much lower levels of radiation than those used for treatment. If there is any increase in risk from these tests, it is likely to be very small, but to be safe, most doctors recommend that pregnant women and children not get these tests unless they are absolutely needed.

There are very few known lifestyle-related or environmental causes of childhood leukemias, so it is important to know that in most cases there is nothing these children or their parents could have done to prevent these cancers.



## Hyperlinks

1. [www.cancer.org/cancer/leukemia-in-children/causes-risks-prevention/risk-factors.html](http://www.cancer.org/cancer/leukemia-in-children/causes-risks-prevention/risk-factors.html)
2. [www.cancer.org/treatment/treatments-and-side-effects/treatment-types/chemotherapy.html](http://www.cancer.org/treatment/treatments-and-side-effects/treatment-types/chemotherapy.html)
3. [www.cancer.org/treatment/treatments-and-side-effects/treatment-types/radiation.html](http://www.cancer.org/treatment/treatments-and-side-effects/treatment-types/radiation.html)

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Pearce MS, Salotti JA, Little MP, et al. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: A retrospective cohort study. *Lancet*. 2012;380(9840):499-505.

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