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# ACHIEVING BALANCE

## Understanding growth hormone for adults

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Each year there are approximately 6,000 new cases of adult growth hormone deficiency in the US alone.[1]

## INTRODUCTION

Being diagnosed with growth hormone deficiency (GHD) or having a compromised pituitary gland can be disruptive and upsetting. It is not something you can readily prepare for and you may find it difficult to describe what you're feeling in response.

This booklet addresses some of the challenges associated with AGHD and provides treatment options that you may want to explore. You might be surprised to learn that you are not alone. In fact, more than 50,000 adults in the US are treated for GHD.[1]

This booklet discusses a variety of issues surrounding AGHD. Having reliable, up-to-date information is important in understanding how to live with your condition. We hope this booklet provides you with the information you need to become an informed, active participant in your treatment. A glossary of the terms that appear in bold can be found in the back. Please consult your healthcare team to discuss any questions that may arise after reading the information provided. As always, your healthcare team is your primary source of information and care.

**The word endocrine comes from endo– (Greek endon: within) + crine– (Greek krinõ: to secrete).**



The **endocrine system** is one of two main control systems for the entire body (the other is the **nervous system**) and is responsible for making hormones. It includes the **pituitary** and **pineal glands**, the **hypothalamus**, the **thyroid**, **parathyroid,** and **adrenal glands**, the **pancreas**, the **testes** or **ovaries**, and **placenta**. The endocrine system makes hormones and these glands release the hormones directly into the bloodstream.

Hormones are chemicals that carry messages to different parts of the body. Many factors—such as your age, weight, and medications—affect how well your endocrine system works.

Some endocrine hormones work by turning something on and some work by turning something off. By controlling the amounts and kinds of hormones released into the bloodstream, the endocrine system keeps body functions in balance.[2]

**The human adult pituitary gland can double in size during puberty or pregnancy.[2]**

One of the glands of the endocrine system is the pituitary, which is located at the base of the brain and is only about the size of a pea. Because the pituitary gland makes several hormones that control other glands, it is often called the "master gland."[3]

The pituitary gland has two sections. Each section is responsible for producing different hormones. The **anterior pituitary gland** (front) produces six major hormones and the **posterior pituitary gland** (back) makes two hormones.

## FUNCTIONS OF THE PITUITARY GLAND

| Section of Pituitary | Hormone | Abbreviation | Organ(s) Affected | Function |
|---|---|---|---|---|
| **Anterior Pituitary Hormones** | Growth hormone | GH | Liver and adipose tissue (fatty tissue around the organs), muscle, and bone | • Stimulates growth<br>• Controls protein levels<br>• Controls cholesterol levels<br>• Affects cartilage directly<br>• Affects metabolism<br>• Affects spine bone mineral density |
| | Thyroid-stimulating hormone | TSH | Thyroid gland | • Stimulates thyroid hormones |
| | Adrenocorticotropic hormone | ACTH | Adrenal gland (cortex) | • Stimulates secretion of cortisol<br>• Stimulates metabolism with glucocorticoids |
| | Prolactin | PRL | Mammary glands | • Produces milk |
| | Luteinizing hormone | LH | Ovaries and testes | • Controls reproductive functions |
| | Follicle-stimulating hormone | FSH | Ovaries and testes | • Controls reproductive functions |
| **Posterior Pituitary Hormones** | Antidiuretic hormone/vasopressin | ADH/AVP | Kidneys | • Conserves water |
| | Oxytocin | None | Uterus | • Controls uterine contractions during childbirth |

Since the right balance of hormones helps the body to function at its best, too little or too much of a certain hormone can cause poor development and health.

## PROBLEMS ASSOCIATED WITH THE PITUITARY GLAND

Occasionally, a pituitary gland may become damaged or diseased, causing an imbalance in the amount of hormones it releases and sometimes causing hormones to not be released at all.

There are many reasons your pituitary gland might not work properly—pituitary disorders may run in your family or it could be the result of a head injury, intracranial bleeding, or brain surgery. But the most common cause of these pituitary problems is a benign tumor within the pituitary gland itself.[3,4]

### Pituitary Dysfunction

Pituitary disease is a general term that refers to the inability of the pituitary cells to function normally, resulting in a hormone imbalance. In **hypopituitarism**, the pituitary gland cannot secrete enough of one or more hormones necessary to support normal bodily functions. This can be caused by several conditions, ranging from the natural aging process to brain damage.[2,4] Any loss of these hormones can usually be treated with **hormone replacement therapy**.[4]

| Pituitary Gland Problems | |
|---|---|
| **Causes** | **Effects** |
| • Inherited disorders<br>• Pituitary tumors (adenomas)<br>• Disease of the hypothalamus<br>• Brain surgery<br>• Radiation therapy for tumors in the head<br>• Head injury[3,4] | • The pituitary gland does not release a sufficient amount of hormone, creating a hormone deficiency<br>• Tumors may overproduce hormones<br>• Pituitary tumors press on other structures close to the pituitary gland, causing vision problems and headaches[2,4] |

## PROBLEMS ASSOCIATED WITH THE PITUITARY GLAND

**Most adenoma tumors are benign and virtually all of them occur in the anterior pituitary gland (called adenohypophysis).**

### The Right Amount of Hormones

An upset in the balance of any hormone made by the pituitary gland can lead to severe health problems.

For example, when the pituitary gland makes too much **adrenocorticotropic hormone (ACTH)**, the adrenal gland makes too much of another hormone called cortisol. Over-production of cortisol results in **Cushing's syndrome**—a condition that causes many problems in **metabolism**, such as diabetes and muscle wasting.[2]

When not enough ACTH is released from the pituitary gland, the adrenal gland makes too little cortisol. As a result, the body is unable to efficiently make fuel available and to respond to stress. Symptoms include nausea, vomiting, weakness, collapse during illness or other stress, and lack of hunger.[2]

Other common causes of hypopituitarism include:

- Hypothalamic disease
- Congenital hypopituitarism
- Head injury/intracranial bleeding



Although growth hormone helps promote growth in children, adults need it for other reasons.

## UNDERSTANDING GROWTH HORMONE

One of the hormones produced by the anterior section of the pituitary gland is growth hormone (GH). In childhood, GH plays a key role in stimulating body growth. It helps bones accumulate calcium and phosphorus, two minerals that make bones strong and hard.[5] It is involved in the breakdown of fats and helps increase muscle strength by adding protein to your muscles.

In adulthood, GH continues to play an important role. It promotes maintenance of lean tissue such as muscle and bone (including increasing bone density) and promotes breakdown of fat.[5,6]

The body's ability to regulate hormones is a complex process, influenced by a variety of factors that we are only beginning to understand. Although GH helps promote growth during childhood, adults need it for other reasons. It is important for good health throughout life.

**At the completion of normal puberty, growth is completed.[7] However, bones continue to grow thicker and harder until they stop growing completely by the mid-20s.**

## UNDERSTANDING ADULT GROWTH HORMONE DEFICIENCY

Growth hormone deficiency (GHD) occurs when the pituitary gland cannot produce enough GH for proper health. If this occurs in adulthood, it is called adult growth hormone deficiency (AGHD).

Generally, adults with GHD can be divided into two groups: those who were growth hormone-deficient as children and continue to be as adults (**childhood-onset GHD**) and adults who became growth hormone-deficient as adults (**adult-onset GHD**).

Some adults are diagnosed with GHD as children and the condition persists into adulthood. Most of the time, however, AGHD involves damage to the pituitary gland or the hypothalamus, a specialized part of the brain that controls the pituitary.[8] Many adults with GHD have a history of pituitary tumors that may have been treated with surgery or radiation.[3]

AGHD can cause you to lose muscle tone and strength, and make you feel tired. It may also make your skin feel dry and thin. An adult who does not produce enough GH may also feel depressed or anxious and some people experience sleep disturbances.[6]

AGHD can cause an increase in fat and a decrease in muscle. It may lead to a greater risk of cardiovascular (heart) disease and impairment of cardiovascular function. The heart muscle can become weak, just like skeletal muscle, which can make it difficult for the heart to function properly.[6]



## TESTING FOR ADULT GROWTH HORMONE DEFICIENCY

Before you begin GH treatment, your healthcare professional may confirm or measure the effects of GHD with one or more of the following tests:

- **GH stimulation test (stim test)** to measure your pituitary gland's ability to make GH
- Cholesterol and triglyceride (or lipids) screening tests for high lipid levels
- Dual Energy X-Ray Absorptiometry (DXA) scan to evaluate bone mineral density (BMD) and **osteoporosis**

If you've already been diagnosed with pituitary disease or have had surgery for the removal of pituitary tumors, you may have also been diagnosed with AGHD. There are also some adults who appear to have GHD, but the cause is unknown. These cases require additional testing to determine whether it is GHD.

Another test your doctor may order will measure **insulin-like growth factor 1 (IGF-I) levels**. IGF-I is a protein produced by the liver and other tissues in response to GH. Since your IGF-I levels are more stable than GH and they reflect GH activity, they can provide an indirect measure of the amount of GH in your body.[9]

In AGHD patients, a diagnosis may be confirmed by low levels of IGF-I. Although this step is helpful in determining whether you have GHD, it is usually not sufficient for diagnosing it.

**What you need to know about STIM testing**

Normally, GH is secreted in several brief bursts throughout the day. But the measurement of GH levels at one moment may not reflect the total amount that is being produced over time, so a random blood test might miss the burst. To more accurately measure your body's ability to make GH, your healthcare team will give you medication to stimulate your pituitary to see how much GH it produces.

Some of the medications used for GH testing are insulin, arginine, glucagon, GHRH, and L-DOPA. The medication is administered and blood samples are drawn to measure for GH. Some physicians may choose to prescribe a combination of medications. The result of this test is very important, because it can help your healthcare professional determine if treatment is appropriate for you.

One of the most reliable stim tests is the insulin tolerance test (ITT)—in which insulin is injected and blood taken to compare with normal individuals—because it can measure GH secretion.[9] This stim test is sometimes associated with side effects. Therefore, healthcare providers sometimes prefer other tests for particular patients. A very good alternative is the arginine GHRH test.[9]

## ADDITIONAL INFORMATION ABOUT GHD



**Your treatment options**

If test results indicate that your pituitary gland is not producing enough GH, your doctor will let you know what types of treatment are available. The goal of therapy for AGHD is to replace growth hormone that your body is missing.

There are several GH products available and a number of ways to administer GH; however, all require injections. Your HCP will work with you to determine which product is right for you.

**What you can expect from Growth Hormone Therapy**

Although there is no cure for GHD, treatments are available and early diagnosis and intervention provide a better opportunity for treatment success.

In recent clinical studies, it has been shown that GH therapy helps you stay leaner by reducing body fat and increasing lean body mass. In certain studies in adults who have adult-onset GHD, GH therapy has been shown to reduce LDL (or "bad") cholesterol levels. In adults who have childhood-onset GHD, GH therapy may reduce their total cholesterol and LDL cholesterol levels and increase spine BMD. However, not all patients will experience all of these changes. Additionally, GH at higher doses may not be tolerated by all patients and may increase IGF-1 levels higher than normal. Finally, many of the studies are for short time periods (1 to 2 years) and we don't completely understand the long-term benefits and risks in adults.

**Life After Diagnosis**

You may have read this booklet from start to finish or you may have chosen to focus only on the sections that were relevant to you at a certain time. Your journey through GH therapy may be much the same—you may find it a continuous process where you are making many decisions at once or you may need to stop, reflect, and reevaluate your treatment plan from time to time.

Regardless of the path you're on, knowing more about your condition can help you feel more in control and comfortable about treating it. Another way to achieve this is to have open, honest discussions with your healthcare team.

**What is growth hormone deficiency (GHD)?**

GHD can be caused by a number of diseases, all of which result in low levels of GH and can occur at any age. When GHD occurs in childhood, it can affect bone length and final height. In adults, GH is needed to maintain the proper amounts of body fat, muscle, and bone, even after final adult height has been reached.[1]

**What causes AGHD?**

GHD is caused by the inability of the pituitary gland to produce adequate amounts of GH. This condition may be present at birth, or it may develop later in life due to trauma, infections, tumors, or even radiation therapy.

Many adults with GHD have a history of pituitary tumors that may have been treated with surgery or radiation. In rare cases, no cause can be identified.[3]

**What are the symptoms of AGHD?**

The symptoms of AGHD are common to many adults with GHD. It is important to remember that a GHD diagnosis is made only after specific testing to determine your body's ability to secrete GH. Adults with GHD may have the following symptoms or signs:

- Increased fat mass, especially in the abdomen
- Decreased muscle mass
- Low energy, fatigue, sleep disturbance
- Decreased strength and exercise tolerance
- Weight gain
- Anxiety, depression, low self-esteem, social isolation
- Thin, dry skin

## FREQUENTLY ASKED QUESTIONS



**How is GHD diagnosed?**

GHD is often diagnosed with a test called a "stim test." (To learn about a GH stim test, turn to page 9.)

Other blood tests may also tell the doctor about the condition of the kidneys, bone, and thyroid gland. The amount of insulin-like growth factor 1 (IGF-I) in the blood may be checked. This is a substance that provides an indirect measure of the amount or activity of GH in the body.[8]

Other tests include scans of the brain and/or bones. These images may reveal tumors or reduced bone density, indicating a cause for the GHD.

**Is there a cure for GHD?**

Although there is no cure for GHD, treatments are available. Talk to your healthcare professional about your options.

# The following resources provide reliable information regarding GHD.

## EDUCATION AND SUPPORT



The following resources provide information regarding GHD. GH is available by prescription only and should be prescribed by a physician—preferably an endocrinologist—who will determine the appropriate product, dosing, and injection instructions.

**The Hormone Foundation**
800-HORMONE
www.hormone.org

**Human Growth Foundation**
800-451-6434
www.hgfound.org

**The MAGIC Foundation**
800-3-MAGIC3
www.magicfoundation.org

**NIH/National Institute of Child Health and Human Development**
301-496-5133
www.nichd.nih.gov/

**Nutropin.com**
This site provides information related to the use of hormone replacement therapy for adults. Or, call 1-866-NUTROPIN (1-866-688-7674)

# GLOSSARY

**Adrenocorticotropic hormone (ACTH)**–A chemical messenger made by the pituitary that targets the adrenal gland, causing it to make and release corticosteroids.

**Addison's Disease**–When the adrenal glands do not produce enough cortisol or aldosterone, Addison's disease, known as adrenal insufficiency or hypocortisolism, occurs. Some of the effects of Addison's disease include weight loss, muscle weakness, fatigue, low blood pressure, and skin darkening.

**Adenoma**–A tumor within a gland.

**Adrenal glands**–Located above each kidney, and secrete cortisol and other hormones.

**Adult-onset growth hormone deficiency**–A condition where patients develop growth hormone deficiency as adults due to pituitary or hypothalamic disease.

**Anabolic hormone**–Hormones that help cells take substances from the blood to repair, build, and develop the body.

**Anterior pituitary gland**–The front portion of the pituitary gland. Hormones secreted by the anterior pituitary influence growth, sexual development, skin pigmentation, thyroid function, and adrenocortical function. This can affect fertility, lactation, and adrenal function.

**Apnea**–A temporary pause in breathing.

**Atherosclerosis**–Also known as "hardening of the arteries." This is when fats, cholesterol, blood products, fibrous tissue, and calcium accumulate on the inside surface of the arteries over time.

**Benign**–A term used to describe an illness that is mild or in the case of a tumor, noncancerous.

**Blood lipids**–Fatty substances in the blood such as HDL cholesterol, LDL cholesterol, and triglycerides.

**Bone age**–The stage of development or maturity of the bones. Although bone age in most children corresponds to actual age, some children may have advanced or delayed bone growth. Bone age is measured by taking an x-ray, usually of the hand and wrist, to compare with standards for boys and girls of various ages.

**BMD**–See spine bone mineral density.

**Carpal tunnel syndrome**–Swollen tissue compressing the nerves of the wrist, causing painful numbness and weakness of the hand.

**Carotid intima-media thickness (IMT)**–A measure of the thickness of the carotid artery. Located in the neck, this artery provides blood flow to the brain. IMT can be a signal of early atherosclerosis and can predict cardiovascular events including heart attack, stroke, and heart muscle scarring and damage.

**Centile or percentile**–A number based on dividing something into 100 parts. In the case of a group of children the same age, the centile number represents the percent of children of the same age and sex who are taller or shorter than the child being measured.

**Childhood-onset adult growth hormone deficiency**–Childhood growth hormone deficiency that continues into adulthood.

**Computed tomography (CT**)–Also called a CAT scan, a detailed image used to diagnose the cause of pituitary gland and hormone abnormalities.

**Congenital**–A condition present at birth.

**Corticosteroids**–Hormonal substances from the adrenal gland.

**Craniopharyngioma**–A congenital tumor of the brain, often affecting the pituitary.

**Cushing's syndrome**–Also known as hyperadrenocorticism. Occurs when a pituitary tumor causes the product of too much ACTH. The adrenal gland then produces too many corticosteroids, leading to severe fatigue, weak muscles, high blood pressure, high blood sugar, irritability, anxiety, and depression.

**Endocrine system**–A system of glands in the body that secrete hormones. These include the pituitary, the adrenals, the thyroid, the gonads (testes and ovaries), the pancreas, and the parathyroids.

**Epiphyseal closure**–The end of a long bone; initially separated from the main bone by a layer of cartilage that eventually ossifies (see ossification) so the parts become fused. When this happens, linear growth ceases.

**Fetus**–The product of conception from the end of the eighth week to the moment of birth.

**Genes**–Chromosomal units inherited from parents. Genes determine the specific characteristics of offspring.



**Gestation**–The amount of time from conception to birth.

**Gonads**–A word that is used to describe the sex glands—testes in men and ovaries in women.

**Growth hormone (GH)**–A hormone secreted by the pituitary gland that causes physical growth and helps maintain health in adulthood.

**Growth hormone deficiency (GHD)**–A condition where the level of growth hormone released from the pituitary gland is too low or is not present at all.

**Hormone replacement therapy**–Used to increase or replace a deficient hormone level in the body.

**Hormones**–Chemicals secreted into the bloodstream in small amounts by glands throughout the body. Hormones set many life processes in motion, including growth, puberty, reproduction, metabolism, and self-preservation.

**Hyperadrenocorticism**–Deficient production of growth hormone and other hormones by the pituitary gland.

**Hyperglycemia**–Excessive sugar in the blood.

**Hypopituitarism**–Deficient production of hormones by the pituitary gland.

**Hypoglycemia**–Insufficient sugar in the blood.

**Hypothalamus**–A region in the brain that secretes hormones for the control of water balance, sugar and fat metabolism, regulation of body temperature, and secretion of other hormones by the pituitary.

**Idiopathic**–A condition or disease occurring without a known cause.

**Insulin-like growth factor I (IGF-I/ somatomedin C)**–A chemical produced by the liver and other tissues in response to growth hormone. It is the "middleman" between growth hormone and the changes in cells that lead to growth.

**Insulin sensitivity**–A measure of how sensitive cells in the body are to the effects of insulin. High blood sugar results when cells don't respond to the insulin signal to take in sugar from the blood stream.

**Insulin resistance**–Cells are insensitive to insulin and do not adequately process blood sugar.

**Magnetic resonance imaging**–Also called an MRI scan; a detailed scan used to diagnose many things, including the cause of pituitary gland and hormone abnormalities.

**Metabolic disease**–Any disease that affects metabolism, and in turn, affects growth, maturity, and the way the body uses chemicals, food, mechanical energy, or heat.

**Metabolism**–The sum of all energy and material transformations that occur within living cells.

**Nervous system**–The brain, spinal cord, nerve endings, and various ganglia that receive and respond to stimulation.

**Ossification**–The formation of bone substance, or the conversion of other tissue into bone.

**Osteoporosis**–A condition in which bones become weak and brittle and are more likely to fracture.

**Pancreas**–A gland behind the stomach that produces juices that aids in digestion. In addition, there is an area (the Islets of Langerhans) that secretes insulin to aid in the metabolism of sugar and other carbohydrates.

**Parathyroid**–Glands located behind the thyroid gland that secrete a hormone that regulates calcium and phosphorus metabolism.

**Pituitary gland**–A small gland attached by a stalk to the base of the brain; it secretes hormones that control other glands and regulates growth. It is sometimes called the "master gland."

**Posterior pituitary gland**–The back portion of the pituitary gland. It secretes hormones into the bloodstream that control water balance.

**Secretion**–The substance released by glandular organs.

**Spine Bone Mineral Density**–Bones get their rigidity from mineral deposits such as calcium and phosphate. The term bone mineral density is used to describe the thickness and composition of the bones of the spine. The diagnostic tool is sometimes referred to as *bone densitometry*. It measures the density of the bones of the spine and hips, and can give an estimate of the risk of fracture.

**Thyroid gland**–A butterfly-shaped gland located at the base of the neck just below the Adam's apple, which produces hormones that are essential for proper metabolism.

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