

24Genetics



Jane, this is your  
sports test





# Table of Contents

---

1. Introduction .....	3
1.1. Frequently Asked Questions .....	6
2. Summary .....	8
3. Genetic Results .....	10
3.1. What do the results show? .....	10



# 1. Introduction

---

In the following pages, we offer you the sports report obtained from the analysis of your DNA. In addition, you will find information about your genetic predispositions to sports.

Here are some essential aspects to take into account before reading this report.

## The process by which we obtain your personalized report

The process we have followed to make your sports report consists of the following:

- **Extracting the DNA** from the saliva sample you sent us.
- Transforming the biological data contained in the DNA into computerized data. This process is called **sequencing**.
- Applying **the algorithms** developed exclusively by 24Genetics to this computer data, which allows us to obtain your personalized report.

As you can see, we combine purely biological processes with computer processes. Without losing an iota of scientific rigour, we can process vast amounts of information and offer you such detailed reports.

## What is our algorithm like?

24Genetics algorithms are based on **the analysis and study of thousands of reports** (called "papers" in the scientific environment), contrasted, validated and recognized by the scientific community at an international level and that add value to our reports. In addition, we only apply to each individual the studies related to the population analyzed in them, i.e., we do not use a survey that has been carried out only with an Asian population for a European person, for example.

The most straightforward case, as a differential value of the 24Genetics reports compared to others, is that the first filter applied by our algorithm is sex. We classify genotypes into males and females. In this way, we only use the appropriate studies for each sex, avoiding applying a survey that only analyzed a male population sample to females.

In this way, we gain **accuracy and reliability in our results**.

## Methodology

Our genetic reports are obtained based on three types of analysis methodology:

- **GWAS** (Genome-Wide Association Study). It is a study in which the DNA markers in the whole genome (the complete genetic material of a person) of people with a disease or trait are compared with those of people who do not have that disease or feature. It is a statistically based study, which considers a large number of genes associated with a predisposition in a less direct way but whose sum provides a relevant conclusion.
- **Multivariate analysis**. In this case, our algorithm analyzes several genetic variants or mutations of one or several genes, which have a more direct correlation with the predisposition.



- **Monovariate analysis.** In this type of methodology, it is a single variant of a single gene that determines predisposition because of its strong correlation with the genotype.

Each trait analyzed in this report is based on one of these three types of methodology.

The data and conclusions in this report, like the progress of scientific research in genetics, may evolve. New mutations are continually being discovered and we are learning more about the modifications we are analyzing today. At 24Genetics we make a great effort to apply new and consolidated scientific findings to our reports.

### What information do we offer you?

The information provided by our reports speaks of **predispositions**. And what do we mean by that? Let's take an example. The possibility of suffering a bone fracture due to stress is influenced by multiple factors, which we could include in 2 groups: **genetic and environmental**. Genetic factors indicate our innate propensity to suffer a bone stress fracture.

On the other hand, environmental factors include elements that also have an effect, such as diet, habits, age, weight, etc. So, whether we ultimately suffer a fracture depends on the combination of both factors. And, even if we have a genetic predisposition, we may never suffer a stress fracture if we eat a diet rich in calcium and vitamin D, maintain a healthy weight, and practice sports with caution and without risks. Or vice versa.

Therefore, what our reports tell you are always genetic predispositions. By controlling environmental factors, we can help prevent these predispositions from developing.

### What does this genetic test give me?

In this report, you have a lot of **scientifically validated information** about your **predispositions**. This lets you know **how your body works** naturally and what aspects you should pay attention to.

At 24Genetics, we recommend that you always consult a health or sports professional who can clarify your doubts, complement this report with your health history and available family history, supervise the follow-up of a personalized sports routine, or prescribe additional diagnostic tests if deemed necessary to confirm the risk of one or more specific predispositions.

### A fundamental concept: the genetic variant.

In terms of genetic concepts, we want to share a basic one, which appears in all the features of our reports and is essential for you to understand at least briefly, that of genetic **genetic variant** (also called **variation** or **mutation**). The variant is a permanent change in the DNA sequence that forms a gene and is what marks an individual predisposition. Therefore, in each of the traits in this report, you will see information on the gene or genes affected in that trait. A variant in that gene or genes determines the different predispositions of some people versus others.

## 1.1. Structure of this report

For ease of understanding, this report is organized into the following categories:



## Training and Abilities

Training defines your athletic performance, and choosing a sport based on personal preferences is more than understandable and reasonable. Still, genetics tells you what your natural predispositions are, allowing you to develop training plans to help you exploit your capabilities or improve your deficiencies. In this category, you will be able to check whether you are more likely to perform better in power or endurance sports or what your overall innate strength is according to your DNA.

## Risk of injury

Practising sports correctly, safely and with caution will help you avoid physical damage. Still, you can also find out if you have a certain genetic predisposition to suffer specific injuries and thus be able to design sports routines to strengthen those parts of your anatomy. In this category, we tell you about it.

## Biomarkers

Cholesterol levels, blood pressure or body mass index (BMI) and their relationship to the sport are influenced by your DNA, which determines your possible tendency to have additional advantages or risks than usual. Knowing yourself is the best tool to control your body. In this category, we inform you about your genetic predispositions so that you can use this information to your advantage.

## Heart

The heart is the physiological centre of our organism and deserves special attention. Sport is intrinsically related to this organ, and preventing sudden death due to marks remains a medical challenge. Most causes are related to congenital or acquired cardiovascular diseases with no symptoms observed before the fatal event.

In this category, we include, among other data, information on your genetic predisposition to various cardiac pathologies that could lead to sudden death. However, this study does not analyze many other diseases and potential causes of premature death.

It should be borne in mind that the 24Genetics tests do not sequence the entire genome but analyze just over 700,000 markers of the 3.2 million genetic links that mark variability between individuals (99.9% of the genome is common to the human species). Therefore, not finding any mutation does not mean we are not carriers since the modification can be found in genetic areas not analyzed in our study. Likewise, we did not examine all the genetic information related to each disease studied. Specifically, we explored, on average, slightly less than 50% of the pathogenic markers reported for the pathologies or syndromes analyzed and associated with sudden death in the databases consulted so that mutations could exist in the other half and not be seen in this report. The modifications we are looking for are those reported in some of the most critical genetic databases worldwide, mainly OMIM and ClinVar.

It is essential to consider that, if you need to deepen the study of a specific disease, there are genetic tests that analyze the entire gene or genes involved in that disease and that have clinical validity. If you have a family history, we recommend you consult a physician or geneticist to study the need for such a test.

**The information provided in this report is valid only for research, information and educational**



**purposes. It is not intended for clinical or diagnostic use.**

## 1.2. Frequently Asked Questions

### **Do my genes determine everything?**

Your genes are essential and determine the predisposition of your body's functioning, but many other factors influence it: lifestyle, exercise, and diet. In any case, knowing yourself well helps you to treat your body most appropriately. That is what genetics gives you: information and, consequently, knowledge.

### **Can there be more traits than those in my report?**

Every day, new research is published worldwide, allowing us to expand our knowledge in the genetics field. 24Genetics constantly analyzes this research to incorporate it into our algorithm and improve it, to obtain more relevant information from your DNA data. This means that your report may evolve and offer more data than you currently have, in which case we will contact you to notify you.

### **Are all sports genetic tests the same?**

Not all sports genetic testing is the same. There are not too many biotechnology companies with the capacity to perform these complex analyses, and most give very poor conclusions regarding the number of results. Thanks to our test, with some 700,000 genetic markers and our complex algorithms, we can offer what we believe is, to date, the most comprehensive sports genetic study on the market. The genetic information provided by 24Genetics is valid for research, information and educational uses. In no case is it suitable for clinical use.

### **What are 24Genetics tests based on?**

Our tests are developed based on countless genetic studies with the highest recognition and acceptance by the international scientific community. The scientific studies are published, through prestigious institutions and organizations, in specific databases as long as there is a certain level of consensus. These validated studies are used to create and update our algorithm, which is applied to our clients' genetic data.

### **If I have a low predisposition to injury, am I sure I won't get injured?**

Not having a higher genetic predisposition is not a guarantee of not being injured. Usually, these studies are carried out based on statistical data from a sufficiently large sample of people. The genetic differences between people with a specific pathology and those without are observed. The type of conclusion typically reached is that people with a genetic alteration have a greater predisposition to suffer a particular pathology. However, this does not mean that 100% of people with that alteration will have that pathology. Likewise, it does not mean that 100% of the people who do not have this alteration cannot suffer from this pathology.

### **Examples of some of the studies that support our sports genetics test**



- Collins M et al; The COL1A1 gene and acute soft tissue ruptures; Br J Sports Med; 2010 Jun 11.
- Posthumus M et al; Components of the transforming growth factor-beta family and the pathogenesis of human Achilles tendon pathology—a genetic association study; Rheumatology; 2010 Apr 1.
- Posthumus M et al; The COL5A1 gene is associated with increased risk of anterior cruciate ligament ruptures in female participants; Am J Sports Med; 2009 Nov;37(11):2234-40.
- Raleigh SM et al; Variants within the MMP3 gene are associated with Achilles tendinopathy: possible interaction with the COL5A1 gene; Br J Sports Med; 2009 Jul;43(7):514-20.
- September AV et al; Variants within the COL5A1 gene are associated with Achilles tendinopathy in two populations; Br J Sports Med; 2009 May;43(5):357-65.

## 2. Summary

### Training and capabilities

- General strength
- Predisposition to power sports
- Aerobic capacity
- Personal motivation
- Endurance swimming
- Flexibility
- Predisposition to endurance sports
- Muscle hypertrophy
- Frequency of sport practice
- Sprinting

### Risk of injury

- General risk of muscle injury due to sport
- Risk of an ankle injury
- Cramps
- Risk of a bone stress fracture
- Concussion

### Biomarkers

- Influence of sport on body mass index (BMI)
- Power of sport on glucose levels
- Sport and DHEA levels
- Sports effect on HDL cholesterol levels
- Influence of resistance training on blood pressure
- Oxidative stress

### Heart

- Resting heart rate
- Alteration of cardiac structures
- Familial hypertrophic cardiomyopathy type II
- Brugada syndrome
- Risk of myocardial infarction and sport
- Familial hypertrophic cardiomyopathy type I
- Arrhythmogenic right ventricular dysplasia
- Long QT syndrome

#### Caption:

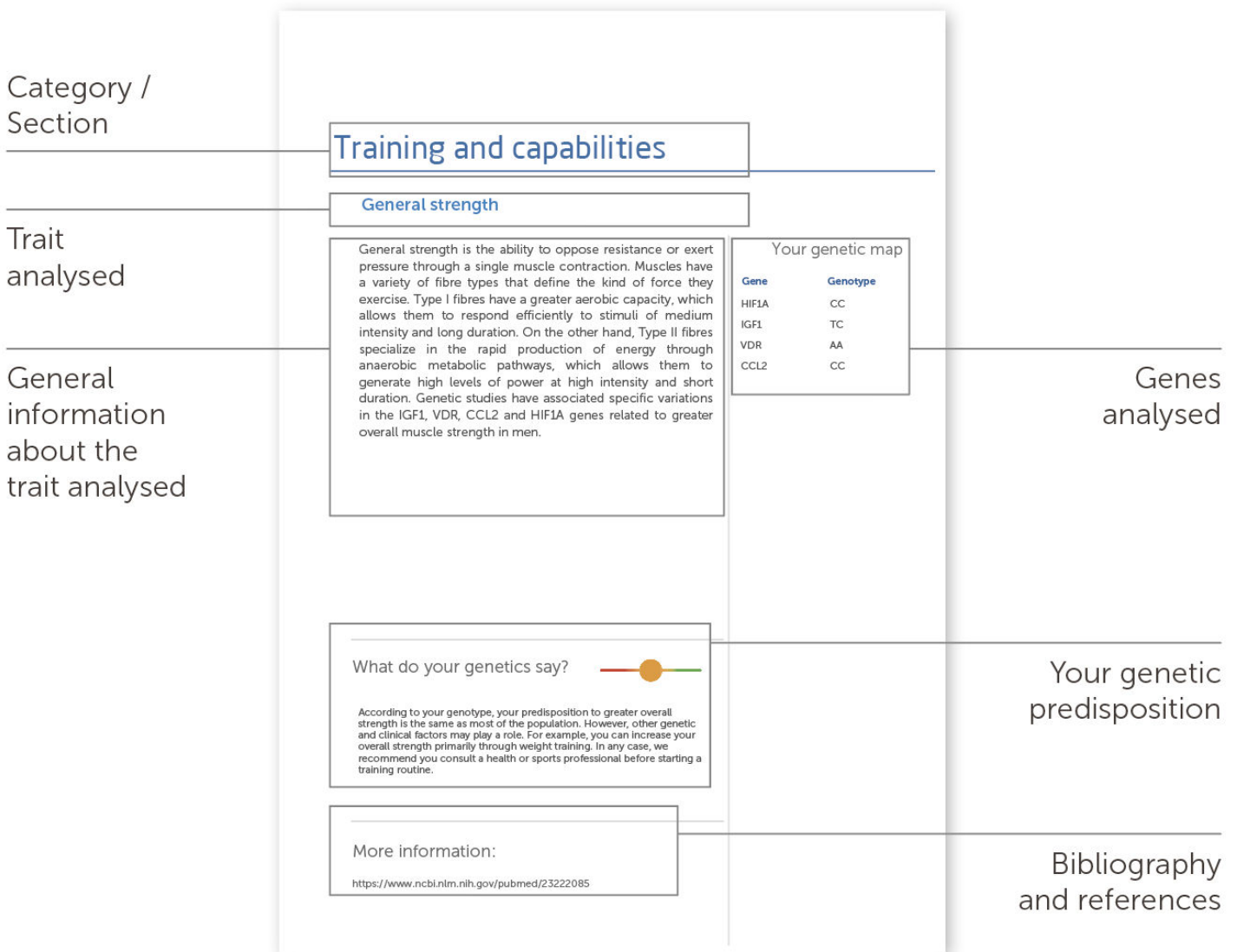
- Your analyzed genotype is favorable.
- Your analyzed genotype is a little favorable.
- Your analyzed genotype doesn't particularly affect you.
- Your analyzed genotype is a little unfavorable.
- Your analyzed genotype is unfavorable.





# 3. Genetic Results

## 3.1. What do the results show?





# Training and capabilities

## General strength

General strength is the ability to oppose resistance or exert pressure through a single muscular contraction. Muscles have a variety of fibre types that define the kind of force they exercise. Type I fibres have a greater aerobic capacity, which allows them to respond efficiently to stimuli of medium intensity and long duration. On the other hand, Type II fibres specialize in the rapid production of energy through anaerobic metabolic pathways, which allows them to generate high levels of power at high intensity and short duration. Genetic studies have associated specific variations in the VDR, CCL2 and HIF1A genes related to greater overall muscle strength in women.

## Your genetic map

Gene	Genotype
HIF1A	CC
VDR	GG
CCL2	AA

## What do your genetics say?



According to your genotype, your predisposition to greater overall strength is normal. However, other genetic and clinical factors may play a role. You can increase your overall strength mainly by weight training. In any case, we recommend that you consult a health or sports professional before starting a training routine.

## More information:

<https://www.ncbi.nlm.nih.gov/pubmed/23222085>



# Training and capabilities

## Flexibility

Flexibility is the ability of a muscle to passively lengthen through a range of motion and mobility. It could be defined as the ability to actively move a joint through its range of motion. Programs to improve joint mobility and flexibility are standard in clinical and physical sports settings. They generate multiple benefits, such as improved physical performance, reduced risk of injury or joint discomfort, improved posture and lower back pain. In addition, it helps to increase blood and nutrient flow to the tissues and, above all, improves muscle coordination and increases the range of mobility available in the joints.

At the genetic level, several studies show that people with mutations in the COL5A1 and ACTN3 genes tend to have less flexibility than individuals without those mutations.

## Your genetic map

Gene	Genotype
COL5A1	TT
ACTN3	TT

## What do your genetics say?



According to your genotype, your flexibility tends to be expected. However, other genetic and clinical factors may play a role. Therefore, the flexibility program design should be customized whenever possible, so we recommend you seek the advice of a specialized personal trainer or physiotherapist.

## More information:

<https://pubmed.ncbi.nlm.nih.gov/21362053/>

# Training and capabilities

## Predisposition to power sports

Power measures the speed at which force is applied. That is, it is an athlete's ability to exert pressure quickly. Fast twitch fibres generate a relatively high amount of power in a short period but fatigue faster. This is because they have a lower capacity to obtain aerobic energy, lower oxygen, and higher glycogen levels, so, for muscle contraction, they get points through anaerobic respiration. It is estimated that 80% of power is inherited, depending on the specific muscle type. Several studies have analyzed genetic markers associated with power sports. They show that mutations in the genes AGT, IL6, AMPD1, ACE, VEGFA, ACVR1B and NOS3, among others, correlate with a greater or lesser predisposition to achieve a good performance in power sports in women.

## Your genetic map

Gene	Genotype
ACE	GG
ACVR1B	GG
AGT	AG
AMPD1	GG
IL6	GC
NOS3	TC
VEGFA	GG

## What do your genetics say?



According to your genotype, your predisposition to perform well in power sports is normal. However, other genetic and clinical factors may play a role. Regardless of your genetic predisposition, power can be trained with different types of exercise. We recommend you consult a health or sports professional before starting a training routine.

## More information:

<https://www.ncbi.nlm.nih.gov/pubmed/28666769>



# Training and capabilities

## Predisposition to endurance sports

Endurance measures the ability to repeat an activity without feeling fatigued. Therefore, endurance training is defined as a high or low-intensity activity performed for a prolonged period, as opposed to power training, where the action is very high intensity for a short period. Endurance is greatly influenced by the proportion of slow twitch fibres in skeletal muscle, known as red fibres because they contain more myoglobin. This protein stores oxygen, obtaining its own energy source, allowing it to maintain its strength for longer. In addition, studies have associated specific variations in the PPARGC1A and FTO genes with the predisposition to better or worse performance in endurance sports in women.

### Your genetic map

Gene	Genotype
FTO	AT
PPARGC1A	TT
PPARGC1A	TC

### What do your genetics say?



According to your genotype, you are predisposed to perform well in endurance sports. In addition, other genetic and clinical factors may play a role. For example, training such as long-distance running at a slow pace, cycling or swimming, yoga, sit-ups, squats, or push-ups will improve your endurance. However, we recommend you consult a health or sports professional before starting a training routine.

### More information:

<https://www.ncbi.nlm.nih.gov/pubmed/23222085>

# Training and capabilities

## Aerobic capacity

Maximal aerobic capacity (or maximal volume of oxygen - VO2 max) is the maximum amount of oxygen that the body can absorb, transport and use per unit of time and, consequently, determines a person's aerobic fitness and power during prolonged exercise. Aerobic capacity can be improved through sports training to achieve a higher maximal oxygen volume, leading to low blood pressure, low cholesterol levels, and lower risk of obesity, type 2 diabetes and cardiovascular disease. Conversely, a low flow of oxygen to our cells explains possible shortness of breath, decreased endurance and increased susceptibility to respiratory infections with age. In addition, studies show that mutations in the ACSL1 gene correlate with poorer trainability of aerobic capacity.

## Your genetic map

Gene	Genotype
ACSL1	AA

## What do your genetics say?



According to your genotype, you have a low predisposition to improve your aerobic capacity through sport. Other genetic and clinical factors may play a role. Cross-training, combining several sports, is an excellent way to train aerobic capacity.

## More information:

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3098655/>

# Training and capabilities

## Muscle hypertrophy

Muscle hypertrophy is the scientific name given to the growth of muscle cell size, which implies an increase in fibre size and thus muscle development. Almost any type of sports training usually involves muscle development to a greater or lesser extent. Still, sometimes hypertrophy is a goal in itself for some athletes, in which case specific routines are designed for that purpose, based mainly on strength training. Some benefits of muscle hypertrophy are increased strength and endurance, joint strengthening, and injury prevention.

One study shows that individuals with mutations in the PPARG gene tend to obtain more significant muscle hypertrophy, i.e., increased muscle development, due to sports training.

## Your genetic map

Gene	Genotype
PPARG	CC

## What do your genetics say?



According to your genotype, your predisposition to obtain muscular hypertrophy due to the practice of sport is normal. However, other genetic and clinical factors may have an influence. For example, training is usually based on weight lifting to achieve muscle hypertrophy. The so-called "training to failure" system is standard among other routines, combining repetitions and weight until the last repetition cannot be performed entirely.

## More information:

<https://pubmed.ncbi.nlm.nih.gov/19526109/>



# Training and capabilities

## Personal motivation

When we undertake any task or project, there can be two motivations. Rational motivation is the set of objective reasons why it is positive to carry out such a project. On the other hand, personal or intrinsic motivation is the set of psychological forces that lead us to undertake such action. It arises from within the individual and is usually a reliable indicator of our possibilities to carry it out. In sports, both types of motivations have an influence. For example, we can exercise because we are overweight or have high blood pressure, and we can do it because our body asks us to, without any apparent objective reasons.

In the case of personal motivation, genetics has a lot to say. For example, several studies show that variations in the BDNF and VDR genes can influence our motivation to practice sport.

## Your genetic map

Gene	Genotype
BDNF	CC
VDR	GG

## What do your genetics say?



According to your genotype, you are predisposed to have a greater personal motivation to practice sports. Other genetic and clinical factors may also play a role. Sport is an objectively healthy practice that helps prevent diseases, and taking into account the objective factors that advise us to exercise is a sound reinforcement. In addition, the advice of a personal trainer can provide reinforcement and technical and motivational support.

## More information:

<https://pubmed.ncbi.nlm.nih.gov/24805993/>

# Training and capabilities

## Frequency of sport practice

By training frequency, we mean the number of sports sessions performed, or the number of times a specific muscle group is exercised, during a given period of time, (usually, a whole week). But, leaving aside technical definitions, we can say that frequency in sport is the periodicity with which we carry out this activity and is directly related to the achievement of the objectives set, together with other factors, such as the type of training, the intensity, the duration of the sessions, etc.

Genetics can influence our predisposition to exercise more frequently. In this regard, a study shows that a mutation in the GCKR gene is directly related to a greater tendency to practice sports more assiduously.

## Your genetic map

Gene	Genotype
GCKR	TC

## What do your genetics say?



According to your genotype, you are predisposed to practice sports frequently. However, other genetic and clinical factors may play a role. Regardless of your genetic predisposition, we recommend you consult a personal trainer, who can define your personalized routine with the optimal training, intensity, frequency and rest times according to your goals and physical condition.

## More information:

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6722860/pdf/genes-10-00570.pdf>

# Training and capabilities

## Endurance swimming

Swimming is a sport that mainly exercises the latissimus dorsi, pectoralis, deltoid, triceps, biceps, teres major and trapezius muscles, and, secondarily, the abdominals, gluteus, intercostals, and quadriceps. On a cardiorespiratory level, it improves oxygen consumption by up to 10%. In addition, it allows the heart to pump up to 18% more blood, resulting in better circulation and reducing the heart rate. It is also one of the sports that helps to improve coordination. There are four basic swimming styles (crawl, breaststroke, backstroke, and butterfly), each with its specific technique and level of difficulty, as well as its muscular and skeletal indications so that it is a sport that can be adapted to the particular needs of each person.

In genetics, a specific mutation in the NOS3 gene has been correlated with a predisposition to a better performance in endurance swimming.

## Your genetic map

Gene	Genotype
NOS3	TC

## What do your genetics say?



Depending on your genotype, you are predisposed to perform well in endurance swimming. Other genetic and clinical factors may play a role. We can say that swimming is a sport recommended for almost any type of person, as it generates a little impact on bones and joints, improves flexibility and elasticity, and burns fat. It can also help to manage stress and anxiety.

## More information:

<https://pubmed.ncbi.nlm.nih.gov/30765915/>

# Training and capabilities

## Sprinting

Sport sprinting is the increase in exercise speed over a period of time, usually short. It is also known as doubling, because it is estimated to consist of doubling the energy level during that time interval. It should be noted that, like any form of exercise, it requires prior preparation in which the body becomes accustomed to these changes in intensity. Sprinting has many benefits: it improves reaction capacity and increases bone density and sports performance in general. Studies have associated specific variations in the AMPD1 and ACVR1B genes with the level of sprinting performance.

### Your genetic map

Gene	Genotype
AMPD1	GG
ACVR1B	GG

### What do your genetics say?



According to your genotype, your predisposition to correct sprint performance is average. However, other genetic and clinical factors may have an influence. Therefore, before you start sprinting, it is advisable to seek the advice of a doctor and a sports specialist to help you define your goals and burst times in a personalized and controlled manner.

### More information:

<https://www.ncbi.nlm.nih.gov/pubmed/24885427>



# Risk of injury

## General risk of muscle injury due to sport

Sport has numerous health benefits, but any physical activity carries a risk of injury from the activity itself and the possibility of performing the exercises incorrectly. To avoid the latter, having a sports or health professional supervise the correct development of the sports routine is essential. When a muscle is injured, proteins are released into the blood, the concentration of which is evidence of more significant damage to the muscle fibres and a greater likelihood of muscle fatigue. However, some people have a greater predisposition to injury than others, and this, in part, is due to their genetics. Scientific evidence has shown that specific variation in the IL6 gene correlates with the risk of injury.

## Your genetic map

Gene	Genotype
IL6	GC

## What do your genetics say?



You are predisposed to suffer muscular injuries due to sports according to your genotype. In addition, other genetic and clinical factors may play a role. Therefore, in addition to avoiding falls or using protective equipment, if you do certain activities, such as risky or contact sports, it is advisable to do physical exercise to strengthen and maintain the flexibility of your joints and muscles.

## More information:

<https://pubmed.ncbi.nlm.nih.gov/18758806/>

# Risk of injury

## Risk of a bone stress fracture

Bone mineral density (BMD), also called bone density or bone mass, is the most widely used indicator to assess the risk of a stress fracture. Stress fractures are small cracks in the bone caused by repetitive application of force, repetitive motion or regular use of a weakened bone. Some people have a greater predisposition to stress fractures associated with lower bone density, with a genetic component of up to 85%. The most advanced case of low bone density is osteoporosis, a disease that affects more in older age and especially women after menopause. In addition, studies have associated specific variations in the FAM210A and C18orf19 genes, among many others, with the risk of bone stress fractures.

## Your genetic map

Gene	Genotype
FABP3P2	CC
ARHGAP1	TC
AXIN1	TC
TMEM263	TC
RPS3AP2	AG
C17orf53	AC
FAM210A	AG
CCDC170	TC
CPED1	AA
LOC10013328	CC
CPN1	CC
LOC10537704	TC
LOC10798396	AG
DCDC5	TC
RHEBL1 DHH	CC
DNM3	GG
LOC10798450	AA
FOXL1	AA
FUBP3	CC
CSRNP3	GG
GPATCH1	TC
HOXC6	CG
IDUA	AG
LOC10537357	GG
JAG1	CC
KCNMA1	TT
KIAA2018	TG
LOC10536970	TT
LEKR1	TT
RPL37AP7	TC
LRP5	CC

## What do your genetics say?



According to this study, your propensity is to have normal levels, in line with the average person.

## More information:

[www.ncbi.nlm.nih.gov/pubmed/22504420](http://www.ncbi.nlm.nih.gov/pubmed/22504420)



# Risk of injury

## Risk of an ankle injury

The ankle bone (talus) and the lower ends of the tibia and fibula form the ankle joint. Ligaments stabilize and support the joint, and muscles and tendons move it. The most common ankle injuries are sprains, followed by fractures. A strain, or sprain, is also a fairly common sports injury, occurring when ligaments are strained beyond their normal range of motion, causing the ankle to bend, twist or turn oddly. It can take a few weeks to several months to heal completely, which is essential to decrease the possibility of a recurrent injury (an injury that recurs after a period of recovery).

On a genetic level, a study confirms the increased predisposition to ankle injuries in women with an ACTN3 gene mutation.

## Your genetic map

Gene	Genotype
ACTN3	TT

## What do your genetics say?



Based on your genotype, you are not particularly predisposed to ankle injuries. However, other genetic and clinical factors may play a role. To avoid ankle injury, it is advisable to warm up before physical activity and maintain strong muscles to protect the ligaments. And whenever possible, consult your health advisor or athletic trainer to customize your training.

## More information:

<https://pubmed.ncbi.nlm.nih.gov/25566457/>



# Risk of injury

## Concussion

A concussion, also called a traumatic brain injury, can occur when the head hits an object or when a moving object strikes the head. This type of injury can cause headaches, changes in alertness, loss of consciousness (rare), or memory loss. It can also affect how the brain functions, and depending on the severity of the trauma, the extent of the injury and its duration, the consequences can be more or less significant. Sports activities are a common cause of concussion, which a physician should diagnose.

Several studies have shown that mutations in the IL6R and APOE genes are correlated with a greater or lesser likelihood of concussion.

### Your genetic map

Gene	Genotype
IL6R	AC
APOE	GG

### What do your genetics say?



According to your genotype, you have a low predisposition to concussion. Other genetic and clinical factors may play a role. Since a concussion is caused by trauma, it is a complex injury to prevent. Helmets, mouthguards and other safety items can reduce the risk of head injury, especially in high-risk sports where the trauma may be more severe.

### More information:

<https://bjsm.bmj.com/content/bjsports/52/3/192.full.pdf?ijkey=ZKH90hYIAcypOJa&keytype=ref>





# Risk of injury

## Cramps

Muscle cramps are sudden involuntary contractions or spasms in one or more muscles. They are relatively frequent and usually occur after exercise. The most typical case is muscle cramps in the legs at night. They can be very painful and last from a few seconds to several minutes. Dehydration; low levels of electrolytes, such as magnesium, potassium or calcium; muscles with poor blood supply; pregnancy; or certain medications are some of the causes, although the main reason is usually excessive tension of a specific muscle. If you have a cramp, it is essential to stop exercising, gently stretch the muscle, drink water, walk a little and relieve the pain with ice, if necessary.

On a genetic level, a study shows that people with a particular mutation in the COL5A1 gene are more prone to muscle cramps than people without the modification.

## Your genetic map

Gene	Genotype
COL5A1	TT

## What do your genetics say?



According to your genotype, you are not particularly predisposed to muscle cramps. However, other genetic and clinical factors may play a role. To avoid cramps, it is recommended to stretch your muscles before exercising and drink plenty of fluids to stay hydrated. If cramps occur at night, it is advisable to stretch before going to bed. If you have frequent cramps, we recommend you visit your doctor or physiotherapist.

## More information:

<https://pubmed.ncbi.nlm.nih.gov/22894972/>



# Biomarkers

## Influence of sport on body mass index (BMI)

Body mass index (BMI) is a number that is calculated based on a person's weight and height and is used to identify weight ranges that can lead to health problems. A healthy weight is considered between 18.5 and 24.9 BMI; overweight corresponds to the range between 25 and 29.9; and over 30 is considered obese, from moderate to severe. Physical activity is beneficial for all people, regardless of their genetics. Still, studies show that a specific variant of the FTO gene has a direct relationship with a more significant benefit of the practice of sport in reducing BMI.

### Your genetic map

Gene	Genotype
FTO	AA
FTO	CC

### What do your genetics say?



According to your genotype, you are highly predisposed to reduce your BMI by practising sports. However, other genetic and clinical factors may have an influence. In addition to a correct sports routine, a balanced diet can help you reduce your weight and improve your health and well-being, always under the supervision of a health professional. You can also see your predisposition to the greater or lesser effectiveness of different types of diet in our nutrigenetic report.

### More information:

<https://www.ncbi.nlm.nih.gov/pubmed/19553294>



# Biomarkers

## Sports effect on HDL cholesterol levels

HDL cholesterol is a lipoprotein (lipids need to bind to proteins to move in the blood), commonly referred to as "good" cholesterol because it transports cholesterol from other organs to the liver, which is responsible for removing it from the body. Therefore, having high levels of HDL is healthy. Research has shown that many people can increase their HDL levels by exercising. Specific variants in the CETP gene have been correlated with increased HDL levels through sports training in women.

### Your genetic map

Gene	Genotype
CETP	CC
LPL	CC

### What do your genetics say?



According to your genotype, your predisposition to increase your HDL levels through sport is normal. However, other genetic and clinical factors may play a role. In addition to sport, to increase "good cholesterol", it is essential to increase the consumption of monounsaturated fats (olives, nuts...) and polyunsaturated fats (tuna, mackerel, salmon or sardines; olive, soybean and canola oils; or flax and chia seeds).

### More information:

<https://www.ncbi.nlm.nih.gov/pubmed/21252145>



# Biomarkers

## Power of sport on glucose levels

Insulin is a hormone generated by the pancreas, which controls glucose levels in two ways: by using it as a source of energy, mainly by the muscle and by regulating its production by the liver. This function is "insulin sensitivity". When insulin does not perform this function well, it is called "insulin resistance", and glucose accumulates in the blood, producing hyperglycemia, which can lead to obesity and type II diabetes. Sport involves increased energy expenditure, which positively influences glucose levels. According to genetics, specific variants of the HNF4A and LIPC genes show a predisposition to obtain adequate insulin and glucose levels, thanks to the practice of sports regularly.

## Your genetic map

Gene	Genotype
HNF4A	GG
LIPC	TC

## What do your genetics say?



According to your genotype, your predisposition to obtain adequate insulin and glucose levels through regular sports practice is expected. Other genetic and clinical factors may play a role. A decrease in weight, under the supervision of a physician or nutritionist, with particular emphasis on reducing the consumption of sweets, bread, pasta and other carbohydrates, may help to achieve better insulin control.

## More information:

<https://www.ncbi.nlm.nih.gov/pubmed/19406499>

# Biomarkers

## Influence of resistance training on blood pressure

Blood pressure is the force exerted by the blood against the walls of the blood vessels throughout the circulatory system. Arterial hypertension is a chronic condition in which the blood vessels have persistently high blood pressure, which can damage them. It is estimated that most of the population will have hypertension at some point. The practice of endurance sports (running, swimming, cycling, prolonged sessions on the elliptical bike or rowing machine, among others) can help reduce blood pressure. Still, this influence depends very much on the individual, and genetics plays an important role. Several studies have associated specific variations in the NOS3 gene with an antihypertensive effect in particular genotypes.

### Your genetic map

Gene	Genotype
NOS3	GG

### What do your genetics say?



According to your genotype, endurance training predisposes you to lower blood pressure. Other genetic and clinical factors may play a role. Apart from sports, healthy lifestyle habits to prevent hypertension are well known to the population: maintaining an appropriate BMI, reducing sodium in our diet, limiting alcohol, tobacco and caffeine consumption, and reducing stress levels.

### More information:

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2714087/>



# Biomarkers

## Sport and DHEA levels

Dehydroepiandrosterone (DHEA) is an endogenous prohormone naturally secreted by the adrenal glands, which helps produce other hormones, including androgens and estrogens. DHEA strengthens muscles and positively affects bones and joints; stimulates neurological and immune function; helps reduce body fat and preserve muscle mass; increases daily energy and improves sexual appetite. Natural levels of DHEA peak in early adulthood and slowly decline as one ages. This hormone can also be produced artificially (anabolic steroids), and some athletes use it to obtain better results, although its consumption is prohibited within the world of sports competition.

A study shows that people with mutations in the intergenic zone LOC146253 and other genes tend to have abnormal DHEA levels.

## Your genetic map

Gene	Genotype
ZNF789	CC
LOC146253	AA
LOC10537660	TT
ANO2	CC
ZKSCAN5	GG
SLC22A24	CC
SULT2A1	GG
LOC10272340	CC

### What do your genetics say?



According to this study, you are more prone than the average person to having normal levels.

### More information:

[www.ncbi.nlm.nih.gov/pubmed/26014426](http://www.ncbi.nlm.nih.gov/pubmed/26014426)

# Biomarkers

## Oxidative stress

Oxidative stress is the process by which our body's cells become oxidized, resulting in damage that affects their functions. It occurs due to an excess of free radicals and oxygen and a lack of antioxidants to counteract it. Environmental pollution, active and passive smoking, excessive sunbathing, and consuming drugs or too much alcohol are some leading causes. But during the practice of sport, free radicals and the consequent oxidative stress are also increased, which can be damaging in the case of a weakened antioxidant defence system. Its consequences are usually excessive muscle pain and fatigue after training.

Genetics is an influential factor in this regard, and a study shows that a particular variant of the SOD2 gene reduces the efficiency of the organism in its defence against oxidative stress caused by sport, which could be unfavourable in the practice of sports, especially high-intensity sports.

## Your genetic map

Gene	Genotype
SOD2	AA

## What do your genetics say?



According to your genotype, you are predisposed to oxidative stress due to sports. Other genetic and clinical factors may also play a role. Broccoli, blueberries, carrots, tomatoes, cocoa, peppers, almonds, green tea, red wine in moderation, and some vegetable oils, such as olive oil, are antioxidant foods. Other micronutrients, such as selenium, beta-carotene, and vitamins C and D, also have this effect.

## More information:

<https://www.ncbi.nlm.nih.gov/pubmed/24865797?dopt=Abstract>



# Heart

## Resting heart rate

The adult heart usually beats between 60 and 100 times per minute at rest. When the heart beats below 60 times per minute, it is bradycardia, which can be a severe problem if the heart rate is too slow and the heart cannot pump enough oxygen-rich blood to the body. A heart rate above 100 beats/min at rest is called tachycardia and is associated with an increased risk of cardiovascular disease. In terms of sports practice, cardiovascular or aerobic exercises such as running, swimming or cycling increase heart rate to a greater extent. In contrast, isometric activities, such as weight lifting, induce a minor increase in heart rate. Several studies have associated specific variations in the FADS1 and CD46 genes, among many others, with abnormal heart rates in particular genotypes.

## Your genetic map

Gene	Genotype
TFPI	GG
LOC10537540	AA
RNU3P3	TC
SYT10	CC
LOC10536969	AG
CD46	TT
MYH6	AA
LOC10537797	TT
ACHE	AA
FADS1	GG
SLC35F1	TC
KIAA1755	TC
CCDC141	GG
GNB4	GG
CHRM2	TT
NKX2 5	GG
LOC10537392	AC
FNDC3B	CG
RFX4	AT
CPNE8	TT
RBFOX1	GG
SLC10A7	GG
RNU4 35P	TC
LOC10798525	AA
HMG2P29	GG
LOC10192800	AA

### What do your genetics say?



According to this study, you are more prone than the average person to having normal levels.

### More information:

[www.ncbi.nlm.nih.gov/pubmed/23583979](http://www.ncbi.nlm.nih.gov/pubmed/23583979)





# Heart

## Risk of myocardial infarction and sport

A heart attack is the necrosis or death of the cells of an organ, or part of it, due to a lack of blood supply. Although a heart attack can occur in any organ, we commonly call acute myocardial infarction, which is the heart muscle, a heart attack. The lack of irrigation that causes a heart attack is caused by the narrowing of the arteries (stenosis) that prevents oxygen from reaching the myocardium, mainly due to a blood clot or atherosclerosis, among other reasons. The consequence is tissue necrosis. Some risk factors that can obstruct the coronary arteries are hypertension, high cholesterol, smoking, obesity, a sedentary lifestyle or advanced age. As for genetics, it has been observed that physically active women with a particular variant in the LPL gene enjoy a protective effect against myocardial infarction.

### Your genetic map

Gene	Genotype
LPL	CC

### What do your genetics say?



According to your genotype, your predisposition to myocardial infarction due to sport is regular. However, other genetic and clinical factors may play a role. Our tests do not sequence the entire genome, so there may be mutations in genetic regions that we are not analyzing. Also, we do not study all the pathogenic markers involved in this disease, but slightly less than 50%.

### More information:

<https://www.ncbi.nlm.nih.gov/pubmed/21252145>



# Heart

## Alteration of cardiac structures

The left ventricle's morphological structure and the aortic root's size are inherited traits that, if altered, can cause cardiovascular disease. The practice of endurance sports entails an overload of pressure and volume on all cardiac structures. During exercise, the left ventricle increases its contractile capacity in proportion to the demand for cardiac output, increasing cardiovascular risk in the case of altered structures. It is, therefore, essential to take echocardiographic measurements into account. Possible complications may include heart failure, heart attack, stroke, or aneurysm. Studies show that mutations in the SMG6 and LOXL1 genes, among many others, correlate with a greater predisposition to suffer alterations in cardiac structures.

### Your genetic map

Gene	Genotype
SLC35F1	GG
TMEM232	CC
SMG6	TG
PRDM6	AG
HMGA2	TT
LOC1005063	AA
LOXL1	AG

### What do your genetics say?



According to this study, your propensity is to have normal levels, in line with the average person.

### More information:

[www.ncbi.nlm.nih.gov/pubmed/19584346](http://www.ncbi.nlm.nih.gov/pubmed/19584346)



# Heart

## Familial hypertrophic cardiomyopathy type I

Familial hypertrophic cardiomyopathy type I is an inherited coronary artery disease characterized by a thickening of the heart muscle, which typically occurs in the anterior part of the wall separating the left and right ventricle (interventricular septum). This thickening is called left ventricular hypertrophy (LVH). The clinical manifestations of this disease range from asymptomatic LVH to sudden cardiac death, including arrhythmias or atrial fibrillation, and it develops mainly during adolescence or adulthood. However, it can also occur in childhood and senescence. Studies show that mutations in the MYH7 and MYBPC3 genes correlate with an increased predisposition to familial hypertrophic type I heart disease.

### Your genetic map

Gene	Genotype
MYBPC3	DD
MYBPC3	CC
MYH7	CC
MYH7	GG
MYH7	II
MYH7	TT
MYH7	AA
MYBPC3	GG

### What do your genetics say?



We have not detected any pathogenic mutations, but you might have some in non-analysed genetic regions.

### More information:

<https://www.omim.org/entry/192600>

# Heart

## Familial hypertrophic cardiomyopathy type II

Type II familial hypertrophic heart disease is an inherited coronary artery disease characterized by a thickening of the heart muscle, which typically occurs in the wall that separates the left and right ventricle (interventricular septum). The difference with type I is morphological since type II affects the entire interventricular septum and not only the anterior part. This thickening is called left ventricular hypertrophy (LVH). The clinical manifestations of this disease range from asymptomatic LVH to sudden cardiac death, including arrhythmias or atrial fibrillation, and it develops mainly during adolescence or adulthood. However, it can also occur in childhood and senescence. Studies show that mutations in the TNNT2 gene correlate with an increased predisposition to type I familial hypertrophic heart disease.

### Your genetic map

Gene	Genotype
TNNT2	GG
TNNT2	CC
TNNT2	II

### What do your genetics say?



We have not detected any pathogenic mutations, but you might have some in non-analysed genetic regions.

### More information:

<https://www.omim.org/entry/115195>



# Heart

## Arrhythmogenic right ventricular dysplasia

Arrhythmogenic right ventricular dysplasia or cardiomyopathy is a disease of the heart muscle of genetic origin. There is a progressive dystrophy mainly of the ventricular myocardium, which is replaced by fibro adipose tissue. Clinically it is characterized by ventricular arrhythmias and is one of the most common causes of sudden death in young adults. Studies show that mutations in the DSG2 gene correlate with an increased predisposition to arrhythmogenic right ventricular dysplasia.

### Your genetic map

Gene	Genotype
SCN5A	GG
SCN5A	CC

### What do your genetics say?



We have not detected any pathogenic mutations, but you might have some in non-analysed genetic regions.

### More information:

<https://www.omim.org/entry/601144>



# Heart

## Brugada syndrome

Brugada syndrome is a disease of the heart muscle characterized by ventricular arrhythmias. It is caused by right ventricular myocardial dystrophy and can lead to palpitations, ventricular tachycardia or syncope, and even sudden death. It is a rare but potentially fatal pathology and is sometimes inheritable. Studies show that mutations in the SCN5A gene correlate with a greater predisposition to Brugada syndrome.

## Your genetic map

Gene	Genotype
DSG2	GG
DSG2	TT
DSG2	AA

## What do your genetics say?



We have not detected any pathogenic mutations, but you might have some in non-analysed genetic regions.

## More information:

<https://www.omim.org/entry/610193>



# Heart

## Long QT syndrome

Cardiac waves are the different upward or downward curvatures that form the tracing of an electrocardiogram. They are the product of the force produced by the heart's activity and are repeated from beat to beat unless altered. The different parts of the wave are represented by the letters P, Q, R, S and T. By observing the wave's shape, it is possible to determine how long it takes for the ventricles to activate and deactivate, and this is called the QT interval. Prolonged QT syndrome (LQTS) is a condition that can cause the heart to beat rapidly and chaotically, and, as a result, fainting, seizures, arrhythmias or even sudden death can occur. Studies show that mutations in the *KCNQ1* gene correlate with an increased predisposition to long QT syndrome.

## Your genetic map

Gene	Genotype
<i>KCNQ1</i>	CC
<i>KCNQ1</i>	GG

## What do your genetics say?



We have not detected any pathogenic mutations, but you might have some in non-analysed genetic regions.

## More information:

<https://www.omim.org/entry/192500>

# 24Genetics



24Genetics Europe HQ  
Paseo de la Castellana, 95  
Planta 28  
Madrid 28046  
Spain  
+34 910 059 099

24Genetics USA HQ  
100 Cambridge St.  
14th Floor  
Boston MA 02114  
Massachusetts - US  
+1 (617) 861-2586

UK Cambridge  
+44 1223 931143

24Genetics México  
Torre Magenta  
Paseo de la Reforma, 284  
Planta 17  
Colonia Juárez  
Ciudad de México 06600  
México  
+52 (55) 9171 2060

[24Genetics.com](https://www.24Genetics.com)