FITNESS

DNA Wellness

Report

Bioneer

Report Summary for
Bioneer

Reported traits		Your SNP based summary
Endurance or Power?	Endurance (Aerobic Exercise)	Typical association with endurance sports
	Power (Anaerobic Exercise)	More likely to excel at power-based sports
Attitudes Towards Exercising	Desire to Exercise	Slightly more likely to want to exercise
	Exercise Frequency	Slightly less likely to frequently exercise
Maximizing the Benefits of Exercising	Weight Loss	Typical weight-loss benefits from exercising
	Boosting Oxygen Use	Typical exercise-induced breathing benefits
	Heart Health	Typical exercise-induced heart health
Exercise Related Injury Risk	Muscle Injuries	Slightly increased risk for exercise-induced muscle injuries
	Tendon Injuries	Slightly increased risk for exercise-induced tendon injuries

These risk estimates are solely based on the genetic variants used in this report and are not diagnostic or conclusively predictive. Any concerns or lifestyle changes should always be discussed with a healthcare professional first.

Top Suggestions

The following are the top suggestions made within this report. For a full list of your prioritized recommendations skip to the Conclusion section.

1. Try cold exposure to give your metabolism a boost
2. Ensure you get sufficient sleep
3. Eat more foods containing cinnamon

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Welcome to your Fitness DNA Wellness Report

Our goals with this report are to:

- Introduce you to **your genetic makeup**
- Explain how it **plays a role in your physical activity**
- Give you **suggestions on how to maximize your fitness**

This report is divided into four sections:

1. Endurance or Power?
2. Attitudes Towards Exercising
3. Maximizing the Benefits of Exercising
4. Injury Risk

For each section, we introduce a number of key genetic markers that the latest scientific studies have discovered. Then we take a look at your personal genotype file and create this report based on your unique genetic makeup.

Introduction

Fitness and Your Genetics

In order to live a long and healthy life it is extremely important to keep physically active and fit [1]. Frequent exercise provides great benefits:

- It ensures our bodies function at an optimal level.
- It allows us to safely participate in a wide range of activities.
- It promotes mental wellbeing.
- It boosts metabolism and reduces the risk for a wide range of diseases.

Maintaining a healthy level of fitness involves being frequently active. But what type of exercise should you do? How often should you exercise? How can you maximize the benefits of exercising? What kind of injuries should you be wary of? The answers to these questions differ for all of us. Clues to the answers can be found in your genetics. Your personal genetic makeup can predispose you to certain types of exercise and injury risk. With the use of genetics to help personalize our analysis we will help you discover your optimal approach to keeping fit and healthy.

The types of exercise you can choose from are extremely wide-ranging: walking, weight lifting, jazzercise, yoga, football, skydiving, the list goes on and on. **Essentially, exercise involves planned sessions of physical activity** [2]. In response, your body will improve itself and become better prepared for the next bout of exercising. Your muscles strengthen, your bone density increases, and you burn more fat. In short, **you get more fit**.

This is because when you increase your activity, your muscles have to use more energy. Muscles use a molecule called adenosine triphosphate (ATP) as the source of energy. ATP is produced from the **foods you eat** (especially sugars and fats) and the **air you breathe** (oxygen).

By improving your fitness, you enhance your fat-burning ability, helping you **store less fat and lose weight**. Your blood vessels expand, helping you **breathe deeper and lowering your blood pressure**.

Physical activity **supports and protects your body**. It **strengthens your muscles, bones, and connective tissue** such as tendons and ligaments. Muscles bulk up, bones take more calcium, and your connective tissue adds more collagen.

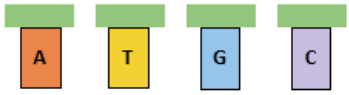
Exercise sends signals to your brain that reinforce these benefits. It boosts growth factors that **protect existing brain cells and increase the growth of new ones** [3, 4]. This **improves cognitive function and mood**, while the increased blood flow **helps your brain detox**.

Not only does exercise increase general wellbeing, but it also **reduces the risk of diseases such as diabetes, heart attack, and depression** [5, 6, 7, 8].

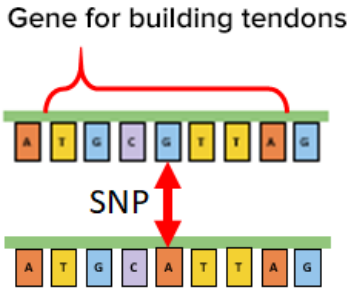
Your individual genetic makeup can have a strong influence on your physical activity. Studies have identified specific genetic markers linked to various fitness traits [9]. For example, genes encode the instructions for making muscles. Slight variations in the sequence of these genes can result in people with more explosive muscular strength [10]. Knowing your genetic makeup for these genes can help you identify your optimal fitness strategy.

How this Report Works

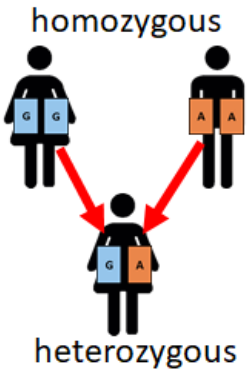
Your DNA is a like a long string packed into every cell in your body. Along this string are "**bases**", lined up like beads. There are four bases marked by the letters: **A**, **G**, **C**, and **T**. These align in very specific sequences to create genes. Your unique genetic makeup is stored in the sequence of these bases.



The sequence formed by these bases varies between people. For example, at a specific location in a sequence, 75% of the population might have a "G", while the other 25% may have an "A". The difference is only one base, so this type of genetic variation is called a **Single Nucleotide Polymorphism** or **SNP** (pronounced "snip"). In this example, the SNP has only two possible variations: "G" or "A".



You inherit two copies of each gene: one from your mother, and one from your father. In the case of the example SNP above, if you were to carry one of each variant (e.g. "AG"), you would be considered **heterozygous** for this SNP. If you carried two of the same copies ("GG" or "AA"), you would be **homozygous** for this SNP. If the majority of the population had the "G" allele, the combination "GG" would be called homozygous **major**; the less common "AA" would be called homozygous **minor**.

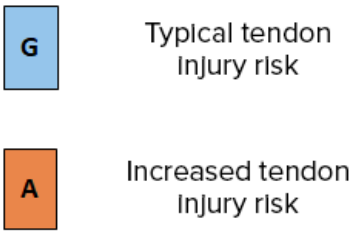


These two-letter designations are your ***genotype*** for a specific SNP. Genotypes indicate what ***trait***, or "**phenotype**", you are most likely to have.

We can extend our example by pretending that the gene in the above example is involved in strengthening tendons. People with the "G" variant might be more likely to have stronger tendons, while people with the "A" variant might be predisposed to weaker tendons. People with this "A" version would be more likely to experience tendon injuries, increasing their risk for conditions such as Tennis Elbow.

You can see how having access to this knowledge can **empower people to take proactive steps to keep themselves healthy**. In our example, someone who knows they have the "AA" genotype -- as well as what this genotype means for their health -- could use this information to consciously make lifestyle adjustments that reduce tendon injury risk. They could reduce their genetic risk-- or maybe even "cancel it out" altogether!

In this report we discuss SNPs that have been associated with fitness-related traits. However, it is in no way a definitive list of all the SNPs or genes that are related to fitness, and there are many more genetic variations yet to be discovered. As scientists continue to discover more about the genetics of exercising, we will update our reports to take these new findings into account -- so be sure to check back for future updates to learn even more!



Some Caveats to Consider

Before we get started, there are four important points to keep in mind as you read through your results:

1. Your environment plays a major role in determining if you develop a trait or not.

While your genetic information is very valuable, it is only one piece of the puzzle. The way you interact with your environment can have a profound impact on your health. Many different factors -- such as diet, exercise, smoking, alcohol, pollution, and even the amount of social interaction you get -- all have the potential to override any genetic risk factors you might have! Nonetheless, knowing your genetic makeup is one of the best ways to educate yourself about what lifestyle choices can help you maximize your long-term health and well-being.

2. Risk factors are a sum of averages.

Because of how scientific studies are conducted, the degree of risk associated with any specific SNP has to be determined by averaging together data from many different study participants. The exact amount of risk for any single individual, however, is unknown. There are also many individual SNPs that may contribute to a single trait or function -- and some of these SNPs might increase risk for a trait, while others may decrease it.

In our gene reports, we take into consideration as many SNPs as possible when determining your risk of a particular trait, and give you detailed breakdowns of each SNP in the tables in each section below. This gives you the most accurate picture of how your genetic profile relates to specific traits.

3. Results from some studies may apply only to specific ethnic groups.

A study of fitness levels in Korean male children is not necessarily going to identify the same SNPs as a study of fitness levels in Irish elderly females. Some SNPs may confer risk regardless of the specific population being studied, while others may only be relevant to particular groups.

4. The data we have is only a small part of your entire genetic makeup.

It is important to remember that the genotype file you provide us with only covers a very small proportion of your entire genome (about 0.05% for a typical 23andMe file). You will carry many more genetic variations than just the ones we report on here, and these can potentially have a strong impact on your predisposition towards certain traits. As the field of genetics progresses, more and more of your genome will become accessible and able to be analyzed.

That being said, we analyze the most widely-studied and well-understood genetic variants currently known to science. Our databases are constantly being updated and expanded. We will continue to update this report to ensure the most accurate information available is used to help you make informed decisions about your health.

With these points in mind, you are now ready to read on and learn all about your genetic makeup, the impact it may have on your fitness, and how you can take advantage of all this information!

Endurance or Power?

What type of exercise do your genetics suggest you are best suited for?

The two main types of exercise are **power and endurance**. Power exercise requires short bursts of maximum muscle exertion, while endurance exercise involves much longer periods of medium muscle exertion. Examples of these are sprinting (power) and jogging (endurance).

Endurance (Aerobic Exercise)

Typical endurance activities include long-distance running, cycling, rowing, and cross-country skiing. They require muscles to spread out energy use over long periods of time. To accomplish this, the body engages in aerobic exercise -- it uses oxygen as a fuel to produce energy. Activity can be sustained for many hours, as long as there is enough oxygen to support the muscle requirements. This type of exercise is often called ‘cardio’ exercise because it requires the use of the cardiovascular system.

Variations in genes essential to aerobic exercise can affect how well-suited someone is for endurance activities. For example, the SNP rs1799722 in the gene *BDKRB2* is involved in the response to sustained physical activity [11]. It expands blood vessels, increasing cardiovascular capacity and maintaining aerobic energy production [12].

See below for a list of all the SNPs involved, your genetic makeup for each, and their relationship with endurance exercise.

Endurance SNPs

SNP	Your Genotype	Associations	Reference
rs12722	TT	Increased capacity for endurance-based activities	13
rs1572312	GG	Slightly increased capacity for endurance-based activities	14
rs1799722	CT	Typical capacity for endurance-based activities	15
rs1799945	CC	Typical capacity for endurance-based activities	16
rs1815739	CC	Typical capacity for endurance-based activities	17
rs2267668	AA	Typical capacity for endurance-based activities	18
rs4343	AG	Slightly increased capacity for endurance-based activities	19
rs4994	AA	Typical capacity for endurance-based activities	20
rs5443	CC	Very slightly reduced capacity for endurance-based activities	21
rs7181866	AA	Typical capacity for endurance-based activities	22
rs8192678	TT	Slightly reduced capacity for endurance-based activities	23

On average, your genetic makeup for the above SNPs shows a mixed association with endurance sports. This means it is uncertain as to whether you find it easier than the average person to perform aerobic activities. If you do not already participate in aerobic activities it may be a good idea to begin as they provide many health benefits.

If you are training for aerobic-based activities, the following suggestions may be beneficial for you:

When considering potential endurance activities it is useful to separate them into high-impact and low-impact. High-impact activities include running and step aerobics while low-impact activities include cycling, swimming, and rowing. If you are concerned with exercise-related injuries then low-impact exercise may be better suited for you.

Try mixing some high-intensity interval training (HIIT) into your training regime. Short bouts of high-intensity exercise can help boost your ability to burn fuel. This can contribute to increasing your aerobic fitness.

Use a sauna following your training sessions. Saunas help with recovery after endurance training [24]. This is especially so for infrared saunas as they are able to penetrate deeper into your body, helping muscles relax and joints recover [25]. If you do not have access to a nearby sauna you could consider buying one.

Several natural substances may also help increase endurance. For example, green tea extracts and curcumin (found in the spice turmeric) are reported to improve endurance capacity [26, 27, 28].

PPARGC1A : Turning Up Your Energy Production

The SNP rs8192678 is linked to the gene *PPARG coactivator 1 alpha* (*PPARGC1A*) which is involved in energy metabolism, especially mitochondria function [29]. Studies have reported the 'T' allele of rs8192678 reduces levels of *PPARGC1A* in muscles [30]. Your genotype (TT) has been associated with a reduced capacity for endurance activities [23].

As *PPARGC1A* plays a central role in increasing fat burning and energy production in response to exercise, lower levels may reduce your potential for endurance sports. To account for this information you could try increasing *PPARGC1A*.

PPARGC1A responds to temperature changes and increases in concentration with exposure to cold [31]. This is because it is trying to help warm your body up by increasing energy production (thermogenesis). You could use this knowledge and try boosting *PPARGC1A* activity with cold exposure. It is best to build up cold exposure gradually. Start by turning your central heating down, and going for minimally (but legally) clothed walks. Then move on to cold showers. When comfortable with these you might be ready for cold baths and, finally, ice baths.

Additionally, supplementing with the vitamin-like compound pyrroloquinoline quinone (PQQ) may also help increase *PPARGC1A* [32]. PQQ exposure to mouse cells produced increases in protein levels of *PPARGC1A* and stimulated mitochondrial biogenesis. If you are looking to supplement with PQQ, a suitable dose for enhancing mitochondria is 0.075 to 0.3mg/kg daily [33]. For more information on dosages and any potential side-effects read this post.

Power (Anaerobic Exercise)

Typical power-based activities include sprinting and weight lifting. It's basically any exercise that requires maximum intensity over a short period of time. The body engages in anaerobic exercise to achieve this when muscles rapidly burn any available fuel. This can rapidly deplete the available oxygen and lead to lactate buildup, which can trigger muscle pain and soreness.

Variation in genes related to muscle strength can result in differing power performance. For example, the gene *ACTN3* is responsible for making a special type of muscle used in anaerobic exercise (fast twitch fibers). A SNP (rs1815739) creates two versions of this gene. One version works much better and is significantly overrepresented in power athletes [34].

See below for a full list of the SNPs associated with power-based exercise. View your genetic makeup for each and the relationship with anaerobic activities.

Power SNPs

SNP	Your Genotype	Associations	Reference
rs1137101	GG	Slightly increased capacity for power-based exercise	35
rs11549465	CC	Typical capacity for power-based exercise	36
rs17602729	GG	Slightly increased capacity for power-based exercise	37
rs1800795	CC	Typical capacity for power-based exercise	38
rs1801131	TT	Typical capacity for power-based exercise	39
rs1801282	CC	Very slightly reduced capacity for power-based exercise	40
rs1805086	TT	Typical capacity for power-based exercise	41
rs1815739	CC	Slightly increased capacity for power-based exercise	17
rs1867785	AG	Typical capacity for power-based exercise	42
rs2854464	AA	Slightly increased capacity for power-based exercise	43
rs2887	AG	Very slightly increased capacity for power-based exercise	44
rs4880	AA	Slightly reduced capacity for power-based exercise	45
rs699	AA	Very slightly reduced capacity for power-based exercise	46
rs7136446	CC	Increased capacity for power-based exercise	47
rs8192678	TT	Slightly increased capacity for power-based exercise	48

On average, your genetic makeup for the above SNPs is slightly associated with power-based sports. This means you may find it easier than the average person to perform anaerobic activities. To make the most of this information, ensure power-based sports are part of your training regime.

If you are training to increase power, the following suggestions may be beneficial for you:

Schedule a session with a personal trainer to learn how to correctly perform power-based exercises. As many power-building exercises involve added weight, it is essential that you understand how to execute them safely. A personal trainer can also help you develop a comprehensive training regime.

Whey protein improved resistance training activities in several studies [49, 50]. Those who supplemented with whey protein shortly before and after their training had larger gains in mass and strength [51, 52]. Creatine boosts the benefits of whey protein [53, 54] and by itself also increases body mass and improves performance in high-intensity interval training (HIIT) [55, 56, 57, 58, 59].

Additionally, the non-essential amino acid citrulline increases the number of repetitions performed during upper and lower body strength training [60, 61]. Foods naturally high in citrulline include watermelon (highest amount), squash, melons, cucumber, and pumpkin. With citrulline supplements, 2.4 g/day

effectively reduces fatigue and increases workout capacity [62].

Finally, a more chilling approach is whole body cryostimulation. It consists of exposure to very cold temperatures for short periods of time, which increases anaerobic capacity and stimulates recovery [63, 64].

PPARG: Making More Fuel

The SNP rs1801282 impacts a gene called *peroxisome proliferator-activated receptor gamma* (*PPARG*). The major allele, 'C', is reported to be relatively less associated with athletic performance [40]. As your genotype is CC, it may be of benefit to investigate ways to ameliorate this genetic link.

PPARG is involved in the ability to process fat [65]. It helps the body detect fats and then instructs it to create little fat-burning factories (peroxisomes). This contributes to how your body stores fat (adipocyte differentiation) and produces fuel for energetic activities. Increasing *PPARG* levels may help with performing power-based exercises.

The spice cinnamon is reported to increase *PPARG* [66]. Cinnamon extracts caused mouse fat tissue to increase *PPARG* and it's target genes. Fortunately, cinnamon is a very versatile spice and can be found in many different foods. Alternatively, you may wish to look into cinnamon extract supplements.

Attitudes Towards Exercising

Do you have a predisposition to be more physically active or are you likely to struggle motivating yourself to exercise?

The key ingredient to increasing fitness is a desire to do so. The mind plays an important role in our quest to become fitter. Sometimes the hardest thing can be just getting out the door.

People largely vary in the in the amount of time they spend exercising. Some work out daily while others can spend years avoiding any physical activity. While many factors are at play, having a positive or negative outlook on exercise is a crucial factor. Attitude toward physical activity affects the likelihood of **developing and maintaining a consistent, healthy exercise regime**.

Desire to Exercise

How you feel about exercising strongly influences whether you will lead an active lifestyle. People with positive attitudes towards exercise are much more likely to engage in frequent physical activity. Motivation, positive exercise experiences, and the post-exercise sensations of reward can all play a part in molding attitudes towards maintaining a healthy physical activity regime.

Genetic variations in genes related to how your brain responds to physical activity can impact your desire to exercise. The *BDNF gene*, which is involved in enhancing mood and brain health, increases in response to exercise [67]. The SNP rs6265 impacts the function of *BDNF*, and those with one or more copies of the minor allele ('T'; also known as the "met" allele) have been reported to show a greater desire to continuously engage in physical activity [68].

See below for a full list of the SNPs associated with the desire to exercise. In this table you can view your genetic makeup for each variant, and their reported associations with a person's overall desire to exercise:

Desire to Exercise SNPs

SNP	Your Genotype	Associations	Reference
rs12405556	TT	Slightly increased desire to exercise	69
rs1800497	GG	Very slightly reduced desire to exercise	70
rs3751812	GT	Slightly increased desire to exercise	71
rs6265	CC	Relatively reduced motivation to exercise	68
rs8044769	CT	Slightly increased desire to exercise	71

On average, your genetic makeup for the above SNPs is associated with a slightly increased positive disposition towards physical activity. This means you may find it easier than the typical person to start and maintain a beneficial exercise regime. However, if you are struggling to find the motivation to exercise then consider the following:

Find a sport you like playing or have always wanted to give a go. Sign up for a team in your local league.

If it is sunny outside, then head out and soak up some rays (not too much of course!). Exposure to sunlight increases dopamine receptors that are involved in motivation for exercise [72, 73, 74].

Some plants can also improve mental functioning and help boost the motivation needed to start exercising. Antioxidant flavonoids from blueberries increase positive mood [75]. One study reported that groups of children and young adults who were given a blueberry drink showed an increased positive mood. This is proposed to be due to the beneficial effect blueberry molecules have on the brain, especially the decision making (executive function) centre.

If mood imbalances and fatigue are affecting your motivation, you may wish to try Rhodiola. This adaptogen improves focus and endurance in both body and mind. It enhances mood by increasing beta-endorphin, your natural feel-good opioid [76]. It also protects neurons and helps them recover and grow after injury [77].

DRD2: Turning On Brain Circuits For Exercise Motivation

The SNP rs1800497 (also known as Taq1A) is linked to the gene *dopamine receptor D2* (*DRD2*) which plays a role in reward and locomotion [78, 79]. This SNP has been linked to reduced numbers of *DRD2* and an increased risk for obesity, possibly due to less physical activity [80, 81]. Your genotype for this SNP (GG) was associated with a relatively lower frequency of exercise in Japanese men and women during childhood to adolescence [70].

Dopamine is a neurotransmitter that the brain uses to communicate between neurons. *DRD2* forms receptors that are found in reward pathways in the brain. Some of these reward pathways are involved in motivation for exercise [73]. Increasing your levels of *DRD2* may boost these reward pathways and help

get you exercising more frequently.

One lifestyle hack you can use to increase your *DRD2* levels is caloric restriction, or fasting [82]. In a study investigating *DRD2* in rat brains, higher levels were associated with food restrictions. To apply this information, try intermittent fasting by restricting your eating to an 8-10 hour window every day [83].

Additionally, curcumin has been reported to increase *DRD2* levels in the brains of diabetic rats [84]. The best natural source for curcumin is the spice turmeric. You could try eating foods rich in turmeric, such as Indian or South-East Asian dishes. Although you can use turmeric as a spice, you'll only absorb a small amount. A more efficient way to boost your *DRD2* would be to use curcumin supplements such as theracumin. Curcumin supplements can provide you with more bioavailable curcumin, especially in liposomal form or in combination with piperine (found in back pepper) [85]. A good strategy is to ingest 30-60mg in the morning, upon awakening. For more information on dosage and potential risks go here.

Exercise Frequency

Spending more time engaged in physical activity has powerful benefits for mental and physical wellbeing. The amount of time people spend exercising ranges from the highly active to the excessively sedentary. Those in the active groups are reported to have a more positive attitude towards exercising [4].

We can uncover the genetic basis of exercise frequency by comparing the genetic makeup between the more and less active groups in exercise studies (based on self-reported measures and fitness trackers).

For example, variations in genes related to the musculoskeletal system can affect how frequently someone might exercise. The SNP rs1801725 affects the function of the gene *CASR*, which is involved in transporting calcium and healthy bones [86]. Having a healthy skeleton is a key ingredient for exercising. As such this SNP has also been reported to be associated with varying levels of physical activity [87].

See below for a list of all the SNPs involved, your genetic makeup for each, and their relationship with the frequency of exercise.

Exercise Frequency SNPs

SNP	Your Genotype	Associations	Reference
rs1043595	GG	Slightly increased levels of physical activity	88
rs10946808	AG	Very slightly reduced levels of physical activity	88
rs1137101	GG	Slightly reduced levels of physical activity	89
rs17782313	CT	Very slightly reduced levels of physical activity	90
rs1801725	GG	Typical levels of physical activity	87
rs3094622	AA	Slightly increased levels of physical activity	88
rs328902	CC	Slightly reduced levels of physical activity	88
rs6275	GG	Typical levels of physical activity	91
rs6548238	CT	Very slightly reduced levels of physical activity	90
rs696217	GG	Typical levels of physical activity	92

On average, your genetic makeup for the above SNPs is weakly associated with reduced physical activity. This means you may spend a little less time exercising than the average person. If so, then this could contribute to increased risk for a variety of health complications. Ensuring adequate physical activity is strongly recommended.

If you **struggle to find the time to exercise** on a frequent basis then consider the following suggestions:

A great way to avoid skipping out on exercising is to build an element of commitment into your training. This can be something like arranging to meet a friend and train with them, scheduling sessions with a personal trainer, or signing up for a competition.

Several studies suggest that caffeine helps with motivation [93]. One study showed directly that caffeine can help motivate sedentary people to exercise [94]. If using caffeine then we suggest combining it with theanine as this is reported to increase cognition and mood [95, 96, 97, 98].

Coffee fruit extracts may be a better option than coffee, especially if you are sensitive to caffeine. Compared to coffee, they are richer in antioxidant polyphenols (such as chlorogenic acid) and lower in caffeine. By boosting GABA and acetylcholine in the brain, they may sharpen your focus, increase your motivation, and lower your anxiety [99, 100].

Asian ginseng is a time-tested and safe stimulant herb that may help get you exercising more frequently. It can combat physical and mental fatigue, raise your stress resilience, and improve your mood. This herb may even improve chronic fatigue by increasing antioxidant defence, making it especially beneficial for people who frequently feel tired and drained [101, 102, 103].

LEPR: Increasing Energy Expenditure

The SNP rs1137101 is linked to the gene *leptin receptor* (*LEPR*) which plays a role in regulating appetite and energy expenditure [89]. Your genotype for this SNP (GG) is associated with relatively lower levels of physical activity and energy expenditure [69]. This is potentially because the rs1137101 'G' risk allele reduces the function of *LEPR* [104].

Leptin is a hormone that acts upon a region of the brain called the hypothalamus. An interaction between leptin and *LEPR* (the leptin receptor) in the hypothalamus causes reduced hunger and increases energetic behavior [105]. Finding ways to increase *LEPR* levels may help to boost physical activity levels.

It is very important to ensure you get adequate sleep as this is central to regulating *LEPR* [106]. If you struggle to sleep then go here for 53 effective ways to fall, and stay, asleep.

Green tea may help to increase the levels of *LEPR* [107]. The polyphenols in green tea are reported to promote gene expression of *LEPR* in obese rats. If you are susceptible to caffeine then make sure to get a decaffeinated variety. Alternatively, you could try taking green tea supplements.

Maximizing the Benefits of Exercising

Does your genetic makeup support bigger gains from physical activity or do you need to put in some extra time at the gym to reap the benefits?

While we all gain benefits from exercising, some of us have a genetic predisposition to make more significant gains. Some people can put in the same amount of effort as others, but receive an increased level of benefit.

Exercise boosts fat-burning, stimulates the breathing rate and the heart rate. Research has shown that people with particular genotypes may experience greater improvements than others.

Weight Loss

Physical activity increases the body's energy demands. It makes the body burn fat stores as a source of fuel for the muscles. Burning fat helps with weight loss. But have in mind that this is not the entire story of weight loss. It is also very important to pair exercise with a suitable diet. The simple mantra of weight loss is 'eat well, move more'.

Body Mass Index (BMI) is one way of measuring weight changes. To calculate your BMI, weight and height are taken into account. You can use a calculator here to find out your BMI. BMI is used as a proxy for detecting obesity (BMI greater than 30), which puts people at a significantly increased risk for diseases such as diabetes and heart attacks [108, 109, 110].

Studies investigating the impact of exercise on BMI measurement have identified genetic variations

linked to the breakdown of fat that can affect the risk of obesity. The gene *PPARGC1A* plays a role in regulating muscle energy use [30]. The SNP rs6548238 can impact *PPARGC1A* function and post-exercise fat burning [111].

See below for a full list of the SNPs involved, your genetic makeup for each, and the relationship with BMI and exercise.

Weight Loss SNPs

SNP	Your Genotype	Associations	Reference
rs1800795	CC	Typical weight-loss benefits from exercising	112
rs1861868	CT	Very slightly increased weight-loss benefits from exercising	113
rs696217	GG	Very slightly reduced weight-loss benefits from exercising	92
rs8050136	AC	Very slightly increased weight-loss benefits from exercising	114

On average, your genetic makeup for the SNPs above is associated with a typical ability to lose weight by exercising.

If you are looking to lose weight, the following suggestions may be helpful:

If you are not already frequently exercising, get moving! In order to lose weight you need to increase your fitness levels. Increasing physical activity promotes long-term weight loss [115].

Optimal diets vary from person to person but some general rules apply to everyone. Ensure caloric intake matches, or is less, than energy use. Making and eating soup can help with reducing the amount of calories you eat [116]. Reduce the amount of highly-purified carbohydrates (e.g. foods high in flour and/or sugar) in your meals and replace them with more fresh produce (vegetables, fruit, and lean meat) and healthy fats (olive oil, fish oil, nut oils). Ensure you are adequately hydrated at all times.

Additionally, green tea increased weight loss in numerous clinical trials [117, 118]. If you are sensitive to caffeine then consider decaffeinated green tea, which has similar weight-loss benefits [119].

Consider supplementing with forskolin, which helps fight obesity and weight gain [120]. If you choose to use forskolin, dose it gradually and cautiously as some people are sensitive and experience side effects [121].

Boosting Oxygen Use

With increased exercise, your body requires more oxygen to help burn the fuel for your muscles. As you spend more time exercising, your body becomes more efficient at this process. Your breath can deepen allowing you to use your lungs at full capacity. Additionally, you may start producing more red blood cells, which can carry more oxygen from the lungs into your bloodstream. Increasing oxygen levels helps you to sustain aerobic exercise, enhancing your performance at endurance-type workouts.

To test how much oxygen someone can inhale scientists use a measurement called the ‘maximal oxygen

uptake', or '$V0_2$ max'. People with a higher $V0_2$ max score are able to absorb higher levels of oxygen and have increased aerobic capacity.

$V0_2$ max is calculated using a device that measures the difference in oxygen levels for the inhale and exhale of a person engaged in aerobic exercise. The more oxygen you can absorb with each breath, the more you have to fuel your exercise. You can estimate your $V0_2$ max at home using your age, resting and maximum heart rate, and BMI score [122, 123].

Studies using this measurement have identified SNPs in genes linked to the development of the cardiovascular system. For example, the gene *HIF1A* controls the expression of genes for making new red blood cells and blood vessels [124]. The SNP rs11549465, linked to *HIF1A*, can influence $V0_2$ max in response to exercise [125].

See below for a full list of the SNPs involved, your genetic makeup for each, and the relationship between your genotype and $V0_2$ max gains from exercise.

Boosting Oxygen Use SNPs

SNP	Your Genotype	Associations	Reference
rs11549465	CC	Typical respiratory gains in response to exercising	125
rs11715829	TT	Slightly less respiratory gains in response to exercising	126
rs12115454	GG	Slightly increased respiratory gains in response to exercising	127
rs1695	GG	Slightly increased respiratory gains in response to exercising	128
rs17602729	GG	Typical respiratory gains in response to exercising	129
rs1800169	GG	Typical respiratory gains in response to exercising	130
rs1800795	CC	Typical respiratory gains in response to exercising	112
rs6190	CC	Typical respiratory gains in response to exercising	130
rs6552828	GG	Typical respiratory gains in response to exercising	127

On average, your genetic makeup for the SNPs above is associated with typical increases in $V0_2$ max when training.

If you are looking for ways to increase your $V0_2$ max then hopefully one, or more, of the following suggestions suits you:

Exercises that will improve your breathing capacity include; longer cardio sessions, yoga, and high-intensity interval training [131].

You could consider taking the plant-based antioxidant, quercetin. Studies report increased $V0_2$ max for endurance activities following quercetin supplementation [132]. Foods high in quercetin include capers, onions, berries, nuts, and tea [133].

Additionally, amino acid supplements (beta-alanine and branch chain amino acids) improve $V0_2$ max scores in people who exercise [134, 135]. Protein-rich foods (such as fish, meat, and legumes) are good sources of amino acids. If you are considering supplementation then correct dosage is key. Beta-alanine dosages of 4-6 g per day for at least a month are recommended [136, 137]. Branch chain amino acid dosages provide benefits when used at 0.087g/kg at a 2:1:1 ratio (leucine:isoleucine:valine) [138].

Heart Health

One of the most obvious responses to exercising is an increase in heart rate. This is because the heart is working hard to distribute all the necessary fuel to the muscles while removing waste products. The more you train, the more efficient your heart gets [139, 140]. Your resting heart rate becomes lower and you become more responsive to exercise. Heart rate before, during, and following exercise can be used as an indicator of increased risk of cardiovascular disease [141, 142, 143].

Genetic studies have identified genes involved in the heart rate response to exercise. For example, the gene *CREB1* helps the heart adapt its rate to exercise in the long term [144]. Variations in this gene cause people to have different heart rate responses to training regimes [145].

See below for a list of the SNPs involved, your genetic makeup for each, and the relationship with heart rate in response to exercise.

Healthier Heart SNPs

SNP	Your Genotype	Associations	Reference
rs1343676	CT	Very slightly increased exercise-induced heart health benefits	146
rs1372876	AC	Very slightly increased exercise-induced heart health benefits	146
rs151283	AA	Typical exercise-induced heart health benefits	147
rs2218650	AA	Slightly reduced exercise-induced heart health benefits	146
rs2224202	GG	Slightly reduced exercise-induced heart health benefits	147
rs2242446	CT	Very slightly reduced exercise-induced heart health benefits	148
rs2253206	AG	Very slightly increased exercise-induced heart health benefits	145
rs2360969	CT	Very slightly increased exercise-induced heart health benefits	145
rs272564	AA	Slightly reduced exercise-induced heart health benefits	146
rs6795970	GG	Very slightly reduced exercise-induced heart health benefits	146

On average, your genetic makeup for the SNPs above is associated with typical heart health improvements from training.

There are many ways to improve your cardiovascular response to exercising:

The most common way is simply to exercise more and eat well [1]. But, if you are already exercising frequently and have a good diet, or your health impairs your ability to exercise or absorb nutrients, then you will need something more.

The antioxidant molecule α-lipoic acid provides protection from heart disease and reduces inflammation following exercise [149, 150]. Combining α-lipoic acid supplementation with exercise helps to reduce cardiovascular disease risk in obese people with impaired glucose tolerance [151]. Recommended oral dosages of lipoic acid range from 600-1800 mg daily [152].

Additionally, the amino acid citrulline has been shown to enhance physical activity performance and provide benefits to patients with heart conditions [60, 153, 154, 155, 156]. Foods naturally high in citrulline include watermelon (highest amount), squash, melons, cucumber, and pumpkin. Citrulline at 2.4 g/day enhances exercise performance, while 3 g/day protects the heart [62, 154].

SCN10A : Fine-Tuning Your Heart

The SNP rs6795970 is linked to the gene *sodium voltage-gated channel alpha subunit 10* (*SCN10A*) and heartbeat regulation [157, 158]. In a study looking at over 40,000 people from the United Kingdom, the major allele, 'G', was associated with relatively higher heart beats per minute following exercise [146]. Having a higher heart rate after exercise can be an indication of a less efficient heart. As you are homozygous (GG) for this allele it may be beneficial to look for ways to mitigate this genetic link.

SCN10A is involved in signaling between neurons, an essential component of keeping the heart beating efficiently [159, 160]. If *SCN10A* is not present in sufficient levels it may result in a higher heart rate following exercise. Looking for ways to increase *SCN10A* might help alleviate any complications.

Forskolin, found in high concentrations in mint plants, increases *SCN10A* [161]. It activates protein kinase A, which in turn increases the density of *SCN10A* on the outside of neurons. Eating more meals containing mint might help boost levels, or you could consider supplementing with forskolin. For more information on the health benefits of forskolin read this post.

Exercise Related Injury Risk

Do your genetics place you at an increased risk for exercise-related injuries?

Increasing physical activity will improve your fitness but it also increases your risk of exercise-related injuries.

Common exercise injuries affect either the muscles or the tendons.

Muscle Injuries

Increased physical activity places strong demands on our muscles to keep us moving. Muscle overexertion can cause fatigue and cramps. In extreme cases, the increased strain can injure and break down muscles, causing a serious condition called rhabdomyolysis.

Scientific studies have associated detox genes with increased muscle injury risk. For example, the gene *SOD2* helps to protect the body from oxidative stress by detoxifying free radicals [162]. The SNP rs4880 is linked to reduced *SOD2* activity and an increased risk for muscle damage [45].

See below for a list of the SNPs involved, your genetic makeup for each, and the relationship between muscle injury and physical exercise.

Muscle Injuries SNPs

SNP	Your Genotype	Associations	Reference
rs12722	TT	Very slightly increased risk for exercise-related muscle injuries	163
rs13266634	CT	Very slightly increased risk for exercise-related muscle injuries	164
rs1800012	AC	Very slightly increased risk for exercise-related muscle injuries	165
rs1800629	AG	Very slightly increased risk for exercise-related muscle injuries	166
rs1800795	CC	Increased risk for exercise-related muscle injuries	166
rs1815739	CC	Slightly decreased risk for exercise-related muscle injuries	167
rs2070739	CT	Average risk for exercise-related muscle injuries	165
rs28497577	GG	Average risk for exercise-related muscle injuries	168
rs4880	AA	Increased risk for exercise-related muscle injuries	45

On average, your genetic makeup for the SNPs above is weakly associated with an increased risk of exercise-related muscle injuries. This does not mean you will definitely get injured, just that you have a very slightly increased chance.

If you are concerned about muscle injuries then please read through the following suggestions to see which are best suited for you:

Warm up slowly as you start exercising. Allow your body to get used to increased activity in a controlled manner. Most importantly, listen to your body.

The amino acid taurine is important for healthy muscles [169, 170]. Physical activity reduces its levels in the muscles, this can be corrected with supplements [171, 172]. More specifically, supplementation at a dosage of 0.1 g per kg of body weight, twice daily for 3 days, improves muscle recovery and performance following exercise [173].

Higher vitamin D levels have been associated with faster muscle recovery [174, 175, 176]. If you have low vitamin D levels then you should ensure you get adequate sunshine and eat some foods high in vitamin D (e.g. fatty fish, beef liver, egg yolks, and mushrooms). If you are unable to meet these requirements you might consider taking a vitamin D supplement. Learn more about your lab test results at labtestanalyzer.com.

SOD2: Protecting Muscles From Oxidation

The SNP rs4880 is linked to the gene *superoxide dismutase 2* (*SOD2*) and protecting the body from the oxidative effects of exercising [45]. The major allele, 'A', is associated with increased muscle inflammation markers (creatinine and creatine kinase) and reduced likelihood of being a power athlete. As you are homozygous (AA) for this risk allele, it may be beneficial to learn of ways to mitigate this genetic factor.

SOD2 plays a role in protecting your body from the increased oxidative load that exercising places on the body [177]. It can catalyze oxygen-based free radicals into safe products, helping to reduce oxidative stress on your cells. Increasing this gene could help with muscle protection and exercise recovery.

Hydrogen water has been reported to increase *SOD2* levels [178]. Subjects who drank 1.5-2 litres of 70% hydrogen water per day, for 8 weeks, showed a 39% increase. Additional health benefits for hydrogen water include protection against neurodegenerative disorders [179]. You can buy bottles of hydrogen water or make your own by dissolving hydrogen tablets in water or using a machine that can produce it for you.

Tendon Injuries

Tendons help connect the muscles to the bones. Made of collagen fibers, tendons are tough, and able to withstand high tension. Increased physical activity means more movement and higher demands on these fibers, which can begin to tear. This can result in an injury to the tendon (tendinopathy), such as in tennis/golfers elbow and Achilles tendinitis.

Variations in genes essential to tendon development and maintenance can influence the risk of tendon injuries. For example, the SNP rs12722 in *COL5A1* affects collagen production, which impacts tendon strength and recovery. Weaker tendons increase the risk of injury [180].

See below for a list of the SNPs involved, your genetic makeup for each, and the relationship with tendon injury and physical exercise.

Tendon Injuries SNPs

SNP	Your Genotype	Associations	Reference
rs12722	TT	Very slightly increased risk of exercise-related tendon injury	181
rs1800012	AC	Very slightly reduced risk of exercise-related tendon injury	182
rs679620	CC	Very slightly increased risk of exercise-related tendon injury	183

On average, your genetic makeup for the SNPs above is weakly associated with an increased risk for exercise-related tendon injuries. This does not mean you will definitely get injured, just that you have a very slightly increased chance.

If you have concerns about tendon injuries then the following suggestions may work for you:

Begin your workout with slow, controlled exercises. Allow your body to get used to moving before increasing the load. If you do progress to exercising at a high level be wary of your limits. Braces or tape

can support the movement of limbs affected by tendon injuries.

Curcumin and vitamin C are natural products that help with tendon injuries [184]. Both compounds improved tendon healing in rat studies [185, 186, 187, 188].

A berry called sea buckthorn improved the recovery of tendon injuries in rats by promoting better fiber alignment and protein growth [189].

Glucosamine is a naturally occurring substance commonly used to promote supple joints and healthy cartilage. It reduced biomarkers of collagen breakdown in 2 studies with bicycle racers [190, 191]. If considering taking glucosamine then please read a brief warning and some information about dosage here first.

COL5A1: Strengthening Connective Tissue

The SNP rs12722 is linked to the gene *collagen type V alpha 1 chain* (*COL5A1*) and tendon injuries [181]. In a study looking at professional soccer players, the minor allele, 'T', was associated with more severe injuries [163]. Your genotype is homozygous (TT) for this risk allele, it might be beneficial to look for ways to help ameliorate this genetic factor.

The *COL5A1* gene provides instructions for making a component of type V collagen. Collagens are a family of proteins that strengthen and support bones, tendons, and muscles. If your *COL5A1* is not functioning correctly it may result in weaker tendons. Looking for ways to increase collagen production may be of benefit.

The succulent plant *Aloe vera* is reported to increase collagen production [192]. Volunteers given an *Aloe vera* gel supplement for 90 days showed increased collagen production in the skin.
Additionally, supplementing with collagen hydrolysate has been demonstrated to help reduce activity-related joint pain [193, 194].

Conclusion

This ends your SelfDecode Fitness DNA Wellness Report -- we hope you found it informative and enlightening! The goals of this report were:

- To introduce you to the basic science of what your genes are, and how they work.
- To show how your genotype for different SNPs can be associated with different fitness traits.
- To illustrate how individual SNPs may impact the types of exercise you are best suited for, your desire to exercise, your injury risk, and the benefits you reap.
- To demonstrate how this information can help you adapt your fitness regime and make more educated decisions about your lifestyle, diet, and supplements to support healthy exercise.

The following is a prioritized list of all the suggestions made throughout your report. We use your SNP data to help us identify which might be most relevant to you. Please keep in mind that we do not have information on the majority of genetic variations you carry, the environment you live in, and your lifestyle choices. As such, this list is not guaranteed to be 100% accurate.

1. Try cold exposure to give your metabolism a boost
2. Ensure you get sufficient sleep
3. Eat more foods containing cinnamon
4. Consider caloric restriction
5. Consider increasing your curcumin intake
6. Drink more hydrogen water
7. Consider using *Aloe vera* supplements
8. Try supplementing with the vitamin-like compound PQQ
9. Include power-based activities in your training regime
10. Try supplementing with ginseng
11. Consider supplementing with forskolin
12. Try combining caffeine with theanine
13. Try drinking more green tea
14. Try using glucosamine for healthy joints
15. Ensure you have adequate vitamin C
16. Use creatine to help improve physical performance
17. Try supplementing with taurine
18. Try taking a berry called sea buckthorn

If you'd like to learn more, we encourage you to:

- Use SelfDecode to explore your genetics further.
- Check out our DNA Wellness Reports page to learn more about all the specialized reports we offer.
- Check back in with us to receive updated versions of the reports you have already purchased.
- Get in touch! We'd love it if you let us know how this report helped you improve your health, as well as what new information or features you would like to see in future versions.

In closing, please keep in mind that this report is not an official medical document, and should not be used to replace traditional medical approaches for diagnosis or treatment. Any health concerns you have should always be discussed with a licensed professional in the appropriate medical field (doctor, psychologist, nutritionist, etc.) before making any major medical decisions.

The science behind personalized genetics is rapidly growing and making new discoveries every day. **At SelfDecode, we are committed to staying on the cutting edge of all of the latest science**. This exciting field is constantly producing new findings and challenging existing ideas -- and for this reason we encourage all our readers to check back regularly as we continue to incorporate the latest findings into our Gene Reports! No report on the market will have 100% of all the existing scientific information, but we strive to provide the most comprehensive reports available. Email alerts regarding new versions of this report will be sent so you can continue to access the latest scientific information about your genetics and your health.

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