

Personal report

Test ID:

GA-HR-009485

Date of sampling:

09 Jul 2023

Date of birth:

18 Sep 1962

This report does not constitute medical advice. Results should be interpreted by a medical professional in context of medical history, clinical signs and symptoms.

Result breakdown

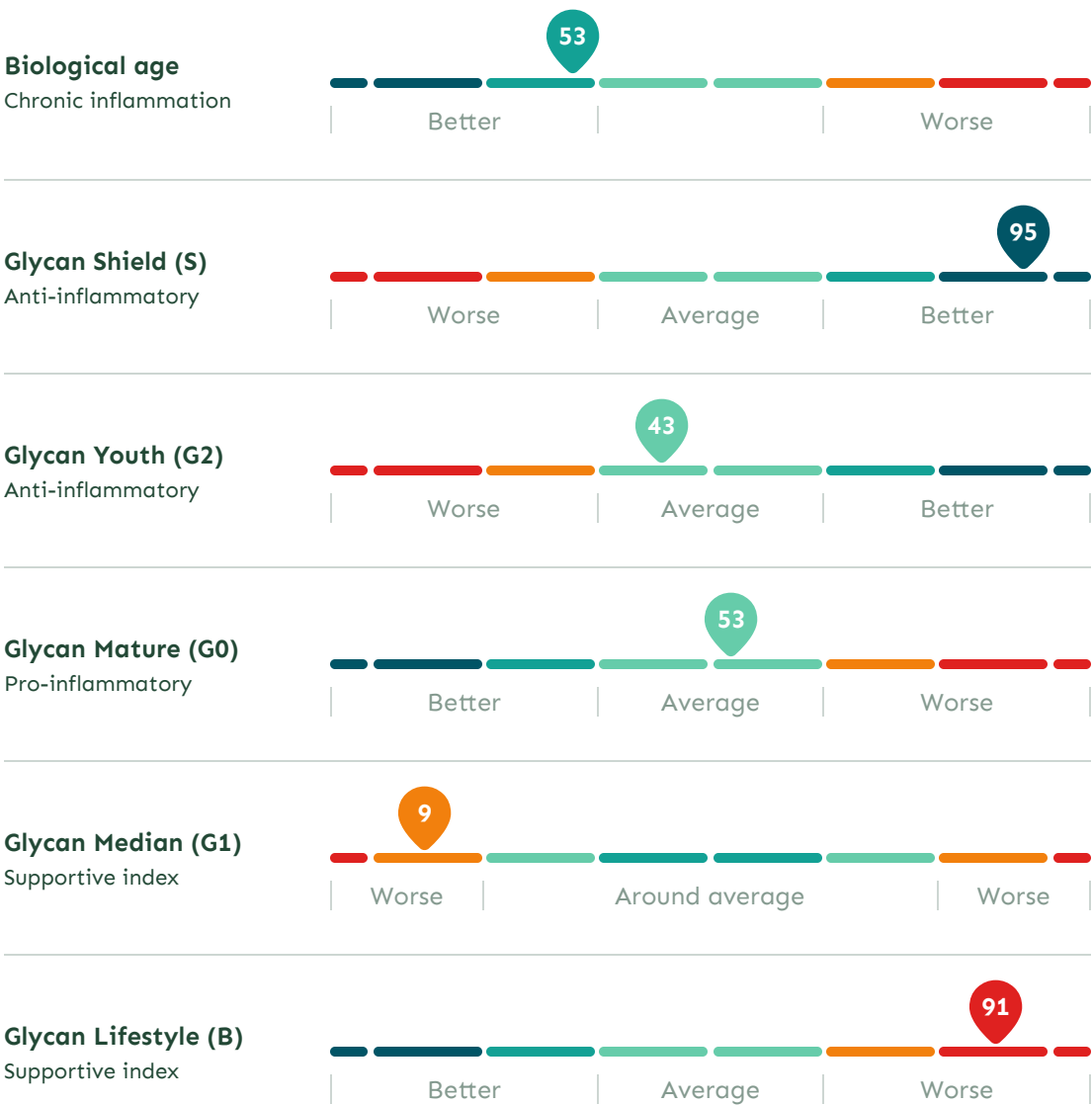
GlycanAge measures **inflammaging**, which indicates the levels of chronic inflammation driven by the immune system as it ages.

Result summary

We analyse 29 different glycan structures gathered from the blood sample. We group related structures into 5 different indexes.

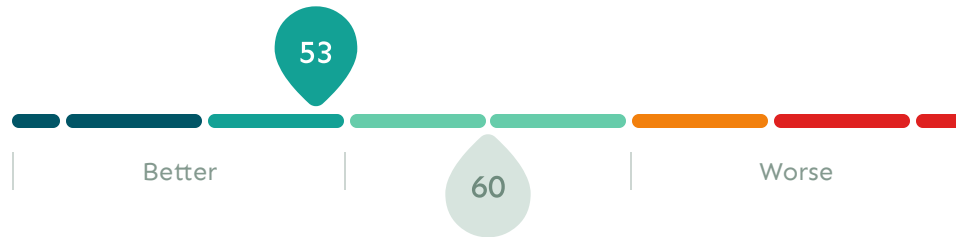
Primary indexes (Shield, Youth, Mature) have either a pro- or anti- inflammatory function. By looking at the ratio between these indexes, we're able to determine biological age of a person.

Supportive indexes (Median, Lifestyle) can help narrow down associations with specific disease types, genetic traits, and/or some lifestyle habits. **They don't influence the overall biological age.**



Your GlycanAge result is

53



7 years younger than
chronological age

What does this mean?

GlycanAge measures **inflammaging**, which indicates the levels of chronic inflammation driven by the immune system as it ages. It is not a diagnostic tool but can provide valuable insights into potential health risks and areas for intervention.

A lower biological age compared to chronological age may indicate a reduced risk of age-related diseases and a healthier aging trajectory. Conversely, a higher biological age may suggest accelerated aging and increased susceptibility to chronic conditions.

Understanding a patient's biological age can help identify potential areas for targeted interventions and assist in developing personalized treatment plans to optimize health and well-being.

GlycanAge reflects chronic inflammation



Lower biological age Lower chronic inflammation

Optimised lifestyle

Optimised lifestyle is one of several domains which reduces chronic inflammation. This could include:

- Personalised diet
- Better quality sleep
- Suitable exercise routine
- Better stress management

Genetic advantage

Some individuals have a favourable genetic make-up when it comes to glycans and/or may have a family history of (super)centenarians.

- Centenarian genes
- Good glycan genes

Effect of therapies

Certain therapies and medications may on their own contribute to a reduction in chronic inflammation. Examples include:

- Hormone replacement therapy
- Prolonged use of steroids
- Biologics

Other factors

Other less common causes include:

- Current pregnancy
- Bariatric surgery followed by extensive weight loss
- IVIG



Higher biological age Higher chronic inflammation

Unoptimised lifestyle

Unoptimised lifestyle often associates with higher levels of chronic inflammation. It could include one or several of the following factors:

- Poor diet
- Sleep deprivation
- Over/under exercising
- Poor stress management

Poor health

Most chronic disease are precipitated or lead to raised chronic inflammation levels. Other factors and conditions that may lead to raised inflammation:

- Existing chronic condition(s)
- Hormone imbalance (post-pregnancy, menopause, testosterone deficiency)

Future health

Individuals at risk of a disease, particularly those with strong family history of certain diseases, may present with raised chronic inflammation levels:

- Family history of chronic diseases



Future investigation

You may investigate further for signs of chronic inflammation:

- Check for lack of nutrition
- Check hormone levels
- Assess cardiovascular risk
- Blood tests
- Check of unusual symptoms

Biological age over time

Tracking biological age over time provides valuable insights into a patient's aging trajectory. Monitoring changes in biological age can help to:

- **Assess the effectiveness of interventions:** Evaluate the impact of lifestyle modifications, treatments, or medications on aging biomarkers.
- **Identify early warning signs:** Detect potential health issues before they become symptomatic.
- **Personalize care plans:** Tailor treatment and prevention strategies based on individual aging patterns.

We currently have only one data point for this patient. Additional data points over time are required to create a graph of biological age over time.



Glycan Shield (S)

This index represents glycans with **sialic acid (S)**.

Sialylated glycans help reduce inflammation and are more abundant in younger people, so having a **higher score in this index is better**.

How to improve this index

1 Check your diet

Are you meeting your micro and macronutrient needs? Do you follow a particular approach to diet (e.g. vegan, carnivore, keto, etc.)? How do you time your meals and are you practicing fasting? All these factors can have varying effects on chronic inflammation and while some things benefit some people, they can fuel inflammation in others.

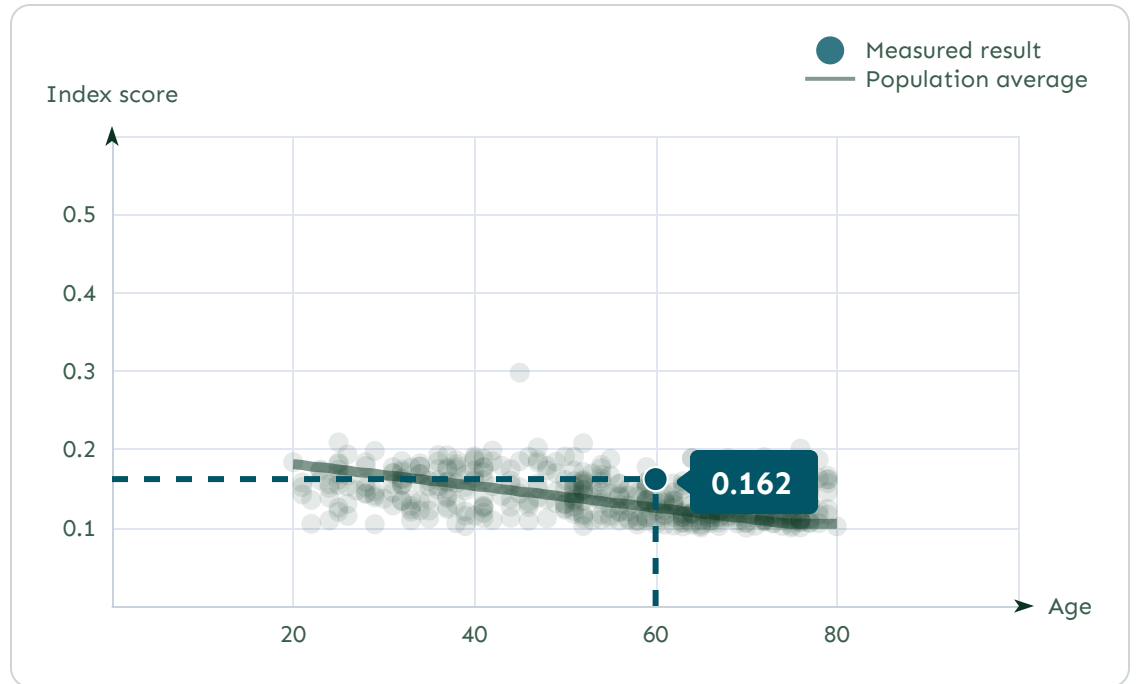
2 Check for basic nutrient deficiencies

Consider doing some basic blood tests to identify potential **vitamin** and **mineral** deficiencies.

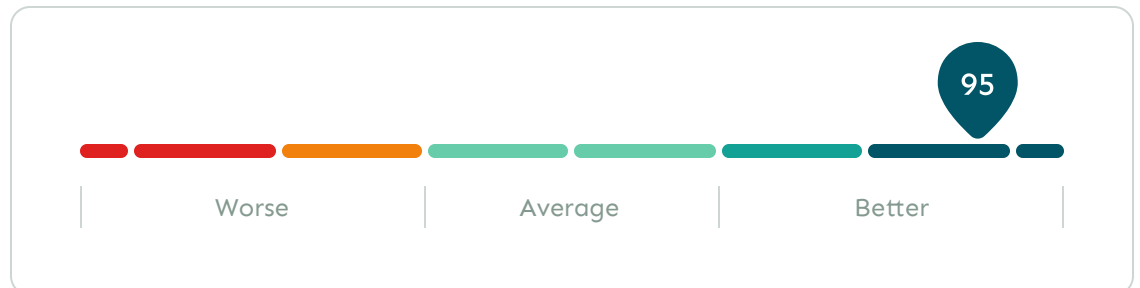
3 Consider supplements

Supplements can support your nutritional needs, but it's crucial to first determine what requires supplementation. Begin by addressing common deficiencies (e.g., vitamin D, magnesium, omega-3s). After optimizing these basics, you can consider additional supplements, but always consult a medical professional (experimental data shows NAD+ can have positive effects on GlycanAge).

Compared to people in the same age group and biological sex:



This result ranks in the **95th** percentile:



Glycan Youth (G2)

This index groups glycans that contain two galactoses.

Glycans with galactoses help reduce inflammation and are more abundant in younger people, so having a **higher score in this index is better**.

How to improve this index

1 Weight management

This index is negatively affected by excess body weight, more specifically excess body fat. Fat loss, whether through diet or exercise, has a positive impact on this index.

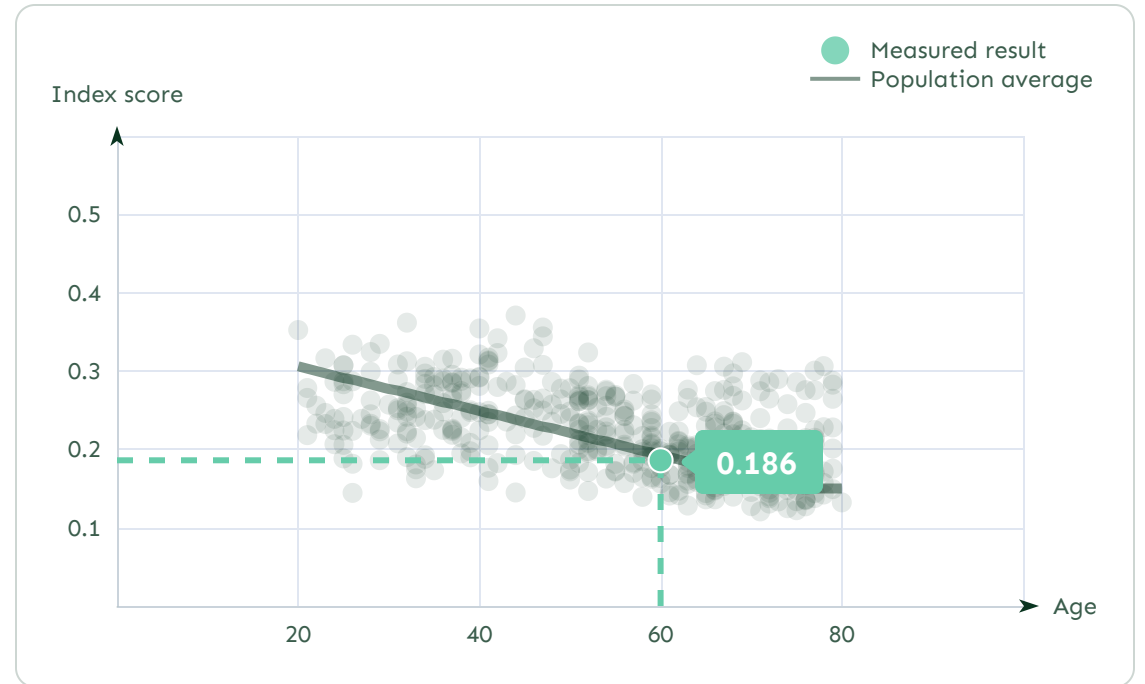
2 Consider checking your hormones

This index is associated with hormonal balance. Consider a check of sex hormones (estrogen and progesterone), as suboptimal amounts of them could be a driver of higher GlycanAge results.

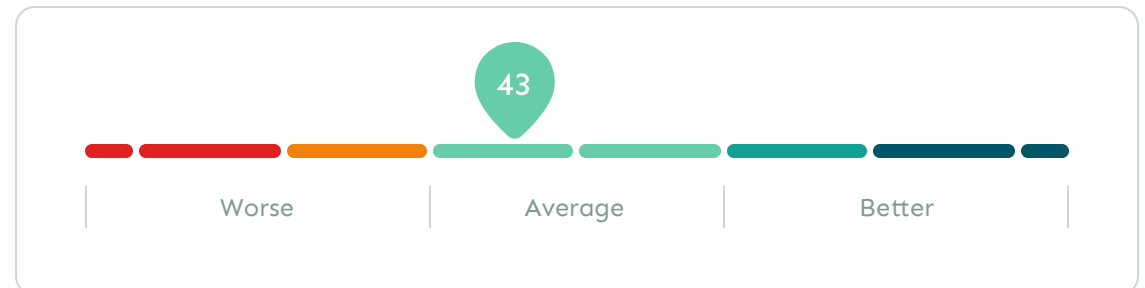
3 Autoimmune conditions management

The inflammatory nature of many autoimmune conditions is a driver of higher GlycanAge results and management of those conditions through lifestyle and/or medical interventions can help to improve the results.

Compared to people in the same age group and biological sex:



This result ranks in the **43rd** percentile:



Glycan Mature (G0)

This index groups glycans that are missing both of their galactoses.

Glycans without galactoses promote inflammation and are more abundant in older people, so having a **lower score in this index is better**.

How to improve this index

1

Consider checking your hormones

This index is associated with hormonal balance. Consider a check of sex hormones (estrogen and progesterone), as suboptimal amounts of them could be a driver of higher GlycanAge results.

2

Revise your exercise regimen

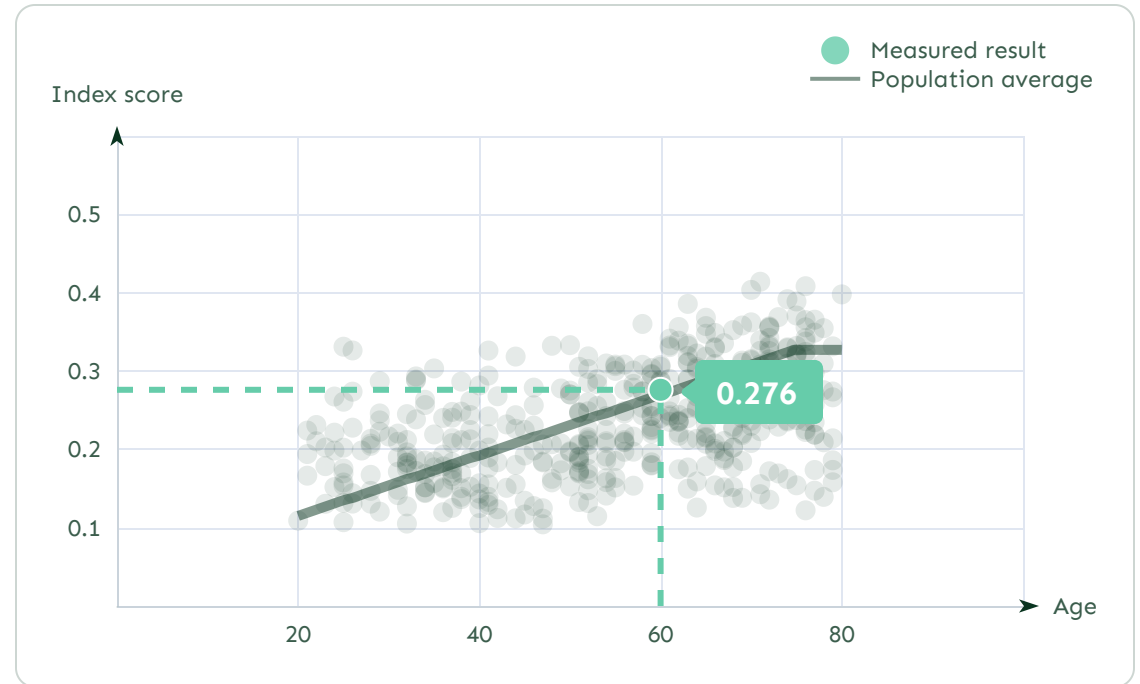
Lack of physical activity and a sedentary lifestyle can fuel chronic inflammation. Regular physical activity and exercise can positively effects on GlycanAge results. However, overexercising without proper recovery can fuel inflammation and have negative impacts on the results.

3

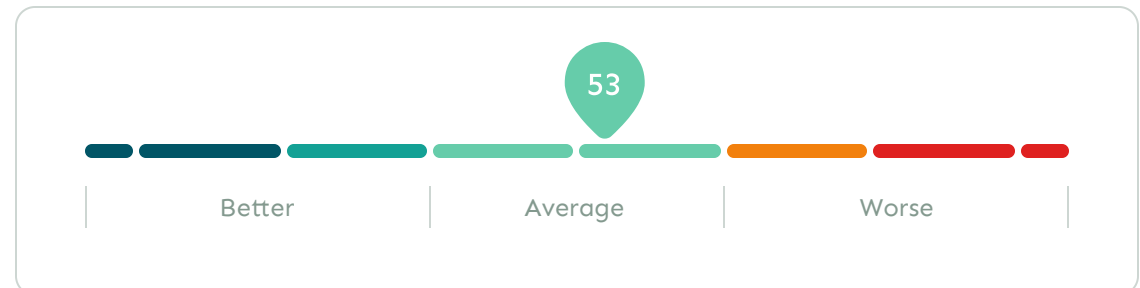
Menopause management

During entering peri-menopause, when estrogen levels drop, this index tends to rise abruptly. Menopause management with interventions such as hormone replacement therapy (HRT) has shown to have positive effects on this index.

Compared to people in the same age group and biological sex:



This result ranks in the 53rd percentile:



Glycan Median (G1)

This index groups glycans that contain one galactose making them more protective compared to those without one but not more than those containing two of them.

These glycans have a prominent genetic component and **neither too much or too little of them is optimal**.

How to improve this index

1 Consider checking your heart health

This index is associated with heart health. If you have a family history of cardiovascular disease, consider doing some check-ups to assess your risk of future cardiac events (e.g. blood pressure, lipid profile)

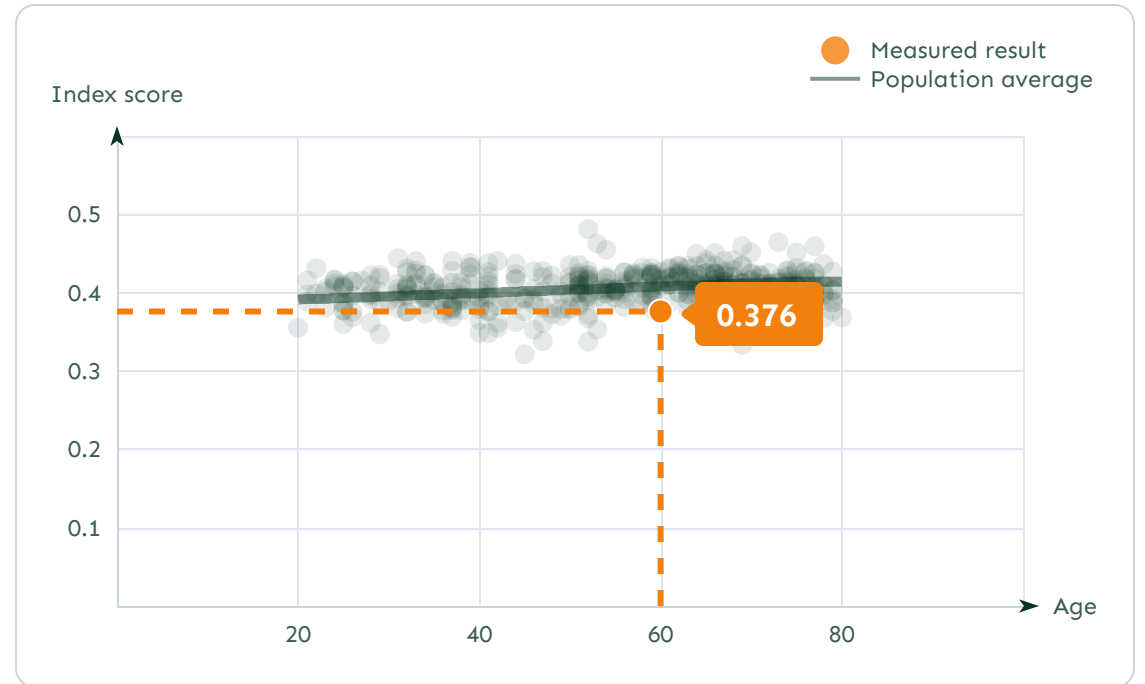
2 Work on your metabolic health

A lower score in this index is associated with poor metabolic health. Try to avoid food that causes digestive system issues. For some it's gluten, dairy, or even certain plants. There is no one size-fits-all diet, and what might be generally considered healthy could be causing inflammation for you.

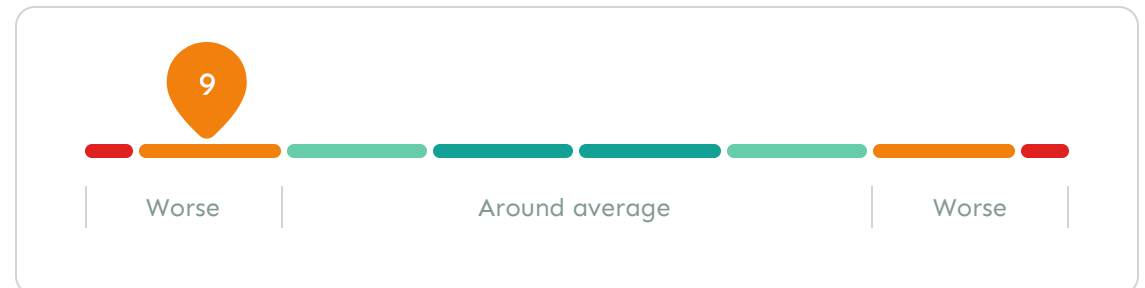
3 Weight management

This index shows improvement when introducing a low-calorie diet and upon general weight loss (in individuals struggling with excess body weight).

Compared to people in the same age group and biological sex:



This result ranks in the 9th percentile:



Glycan Lifestyle (B)

This index groups glycans that have a bisecting GlcNAc.

Glycans with this modification promote inflammation, so having a **lower score in this index is better**.

How to improve this index

1 Stop smoking

Smokers tend to have a high score in this index so reducing, or ideally stopping smoking, can have a positive impact on this index. This includes classic tobacco and vaping products.

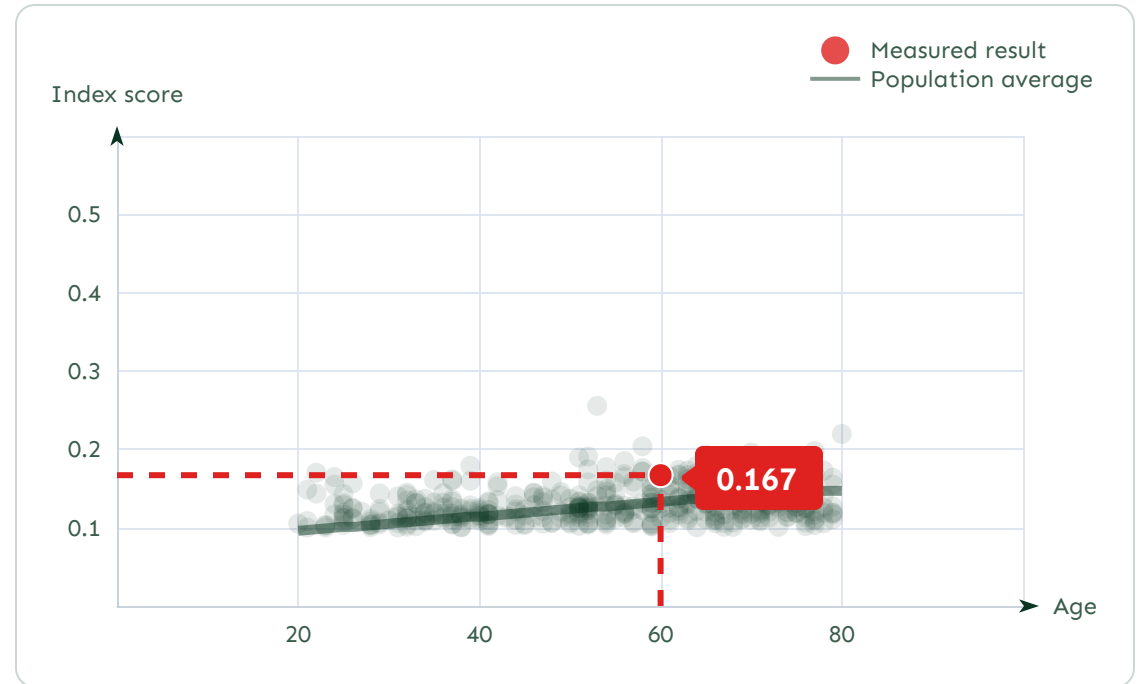
2 Improve your sleep quality

Quality sleep is very important for good health. Even one night of poor sleep can elevate inflammatory markers, so a continuous pattern of poor sleep can have more permanent consequences and elevate the levels of chronic inflammation.

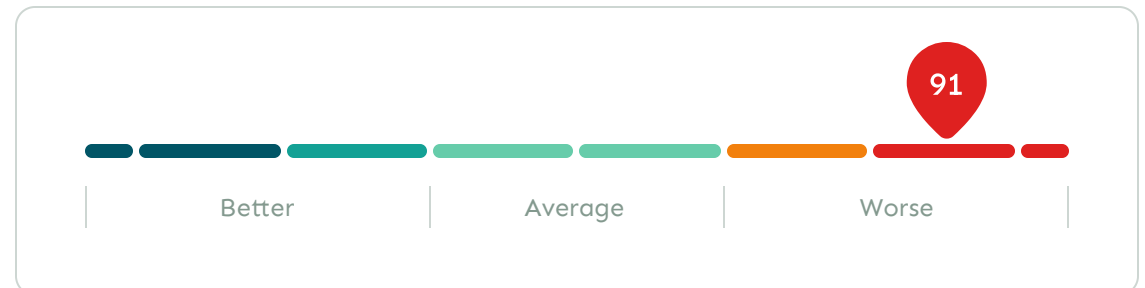
3 Reduce your stress levels

Stress significantly impacts GlycanAge results. Chronic stress can increase your biological age by several years, so it's important to manage and reduce stress whenever possible.

Compared to people in the same age group and biological sex:



This result ranks in the **91st** percentile:



Influencing factors

Lifestyle, life stages, as well as pharmacological interventions can have a significant impact on chronic inflammation, which will likely reflect on GlycanAge results.

Diet

Dietary habits shape inflammation levels and affect the GlycanAge score. While short-term lapses in diet, such as an occasional indulgence, won't impact the GlycanAge score, long term changes in diet will most likely affect the results.

There is no one-size-fits-all diet, as each person's metabolism is unique and finding the optimal diet for an individual is a difficult task. This makes GlycanAge a valuable tool that can help you understand whether your patient's diet is good for them or if it fuels inflammation.

Our research found that in overweight individuals, only caloric restriction has an overall anti-inflammatory effect in most people whereas other types of diets show different effects depending on a individual.



Indeterminate effect

No clear outcome from the study

Related research papers

Effects of low-calorie and different weight-maintenance diets on IgG glycome composition

The study investigated the effects of different diets on IgG glycans, analyzing 1,850 samples from the Diogenes study, one of the largest dietary intervention studies. A total of 938 participants who were overweight underwent an 8-week low-calorie diet (800 kcal/day), followed by one of the weight maintenance diets for 6 months:

- Low protein / low glycemic index
- Low protein / high glycemic index
- High protein / low glycemic index
- High protein / high glycemic index

Only caloric restriction (CR) resulting in weight loss showed anti-inflammatory effects. After 8 weeks of CR, a decrease was observed in the pro-inflammatory Glycan Mature index and an increase in the anti-inflammatory Glycan Shield index. These changes returned to baseline after some of the weight was gained back on maintenance diets.

While no statistically significant changes in IgG glycans were observed on the maintenance diets, individual responses varied—some participants showed improvement, while others experienced worsening results. This variability underscores the importance of a personalized approach to nutrition showing there is no one-size-fits-all diet.

Stress

When the body experiences stress, it activates the fight-or-flight response, which is beneficial in short-term situations. However, chronic stress disrupts the hormonal balance, keeping hormones like adrenaline and cortisol high, which leads to disruption of the immune system and fuels inflammation.

Therefore, individuals who are under a lot of stress can have higher GlycanAge scores. Both individuals under constant stress, such as work-related pressure, and those who encounter sudden, intense stress, like major life events, may experience an increase in their GlycanAge due to the body's sustained inflammatory response.



Biological age
Chronic inflammation

Related research papers

[N-glycosylation profiling of plasma provides evidence for accelerated physiological aging in post-traumatic stress disorder](#)

The study aimed to explore whether traumatic stress accelerates the aging process by analyzing glycan profiles in individuals experiencing varying levels of stress. A total of 32 participants were included: 13 individuals with post-traumatic stress disorder (PTSD), 9 trauma-exposed individuals without PTSD, and 10 low-stress control subjects. The researchers used the GlycoAge test, a biomarker for physiological aging, and found that, on average, individuals with PTSD and those exposed to trauma showed signs of accelerated aging by 15 years compared to the low-stress controls./day), followed by one of the weight maintenance diets for 6 months:

Insufficient sleep

Insufficient sleep has been shown to raise inflammatory markers in the body. Both acute sleep deprivation (e.g., being awake for 24 hours) and chronic insufficient sleep can increase inflammation.

While short-term sleep deprivation does not affect the GlycanAge score, long-term insufficient sleep can cause elevated GlycanAge score.

Additionally, individuals with sleep disorders such as sleep apnea, which disrupts normal breathing during sleep, may also have higher scores due to the inflammatory nature of this condition. Our research indicates that people with severe obstructive sleep apnea (OSA) are, on average, 6.9 years older biologically than their chronological age.



Biological age
Chronic inflammation

Related research papers

[Not-So-Sweet Dreams: Plasma and IgG N-Glycome in the Severe Form of the Obstructive Sleep Apnea](#)

The aim of the study was to explore whether IgG glycans can be used as biomarkers for severe obstructive sleep apnea (OSA). IgG and total plasma glycans were analyzed in 70 subjects with severe OSA and 23 controls. Significant changes were observed in both IgG and total plasma glycans. Furthermore, patients with severe OSA exhibited accelerated biological aging, with GlycanAge score on average being 6.9 years higher than their chronological age. This study suggests that both IgG and total plasma glycans might be considered biomarkers for severe OSA. (day), followed by one of the weight maintenance diets for 6 months:

Exercise

Regular physical activity and exercise have positive effects on biological age and glycan indexes.

However, individuals who engage in exercise after a long period of inactivity and sedentary lifestyle may initially experience an increase in chronic inflammation and their biological age, especially if they are overweight.

Exercise is also crucial for cardiovascular health and studies in women show that exercise has positive effects on a specific glycan that has a cardio protective role.



Cardio health

Cardio protective glycan

Related research papers

[Physical Exercise Induces Significant Changes in Immunoglobulin G N-Glycan Composition in a Previously Inactive, Overweight Population](#)

The study investigated the impact of regular exercise on IgG glycans in previously inactive, middle-aged, overweight population. 397 participants were subjected to one of the following exercise programs for 12 weeks:

- circular exercise program
- cardio exercise program
- Nordic walking program

After completing the program, the participants showed an increase in some pro-inflammatory glycans, which was somewhat expected as they were previously inactive.

The main result of the study was an increase in a specific glycan structure (GP9) which is reported to have a protective role in cardiovascular health in women.

Overexercising

Although exercise and regular physical activity are crucial for good health, overexercising can have negative impacts on levels of inflammation.

The acute inflammation caused by a workout is beneficial. However, constant overexercise without proper recovery period can cause an increase in low-grade systemic inflammation and may increase the GlycanAge score.

Professional athletes and individuals with extreme exercise regimens generally have a higher GlycanAge score compared to those who engage in moderate and balanced exercise.



Biological age
Chronic inflammation

Related research papers

[Regular moderate physical exercise decreases Glycan Age index of biological age and reduces inflammatory potential of Immunoglobulin G](#)

The study included 276 healthy participants divided into 4 groups based on their activity level:

- inactive group
- newly involved recreational group
- regularly moderate active group
- professionally competing athlete group

On average, those who exercise regularly had the lowest GlycanAge score when compared to other groups. It was found that those who exercise regularly had on average a lower GlycanAge score by 7.4 years when compared to inactive individuals (around 10 years for women and 6 for men). Professional athletes showed an increased GlycanAge score by 7.6 years on average compared to those who exercise regularly, however, this trend was observed in women only.

Additional notes

Some forms of intense exercise, such as repeated sprint training (RST), show positive effects on glycans and lead to a reduction in biological age.

Weight loss

Excess body weight significantly influences IgG glycans and is associated with a higher GlycanAge score and poor index scores.

Weight loss, whether through dieting, exercise, or bariatric surgery, generally leads to a reduction in the GlycanAge score and improvements in nearly all indexes.

However, extreme weight loss can temporarily increase the GlycanAge score. Upon fat tissue reduction, inflammatory molecules stored in the fat are released into the bloodstream, causing increased inflammation.



Biological age
Chronic inflammation



Glycan Shield
Anti-inflammatory



Glycan Youth
Anti-inflammatory



Glycan Mature
Pro-inflammatory

Related research papers

[Extensive weight loss reduces glycan age by altering IgG N-glycosylation](#)

Individuals scheduled for bariatric surgery (n=37) were subjected to 3 weeks of low-calorie diet (900 kcal/daily). In the short period while under caloric restriction, an improvement in the Glycan Lifestyle index was observed, indicating a reduced pro-inflammatory potential of IgG glycans.

Following the bariatric surgery, additional improvements such as a decrease in the pro-inflammatory Glycan Mature index and an increase in anti-inflammatory indexes Glycan Youth and Glycan Mature were observed.

The results were further validated on 1680 individuals from the TwinsUK cohort followed for 20 years where it was observed that reduction of BMI through weight loss was associated with a reduced GlycanAge score and improvements in the Glycan Mature and Glycan Youth indexes.

Additional notes

In another [study](#), we investigated the effects of different diet types on IgG glycans and found that caloric restriction, rather than a specific type of diet, is the main driver of positive changes.

Supplements

Supplements can affect the GlycanAge score both positively and negatively, as individuals have different responses to them.

Our studies looking at the effects of omega-3s and NAD+ precursor supplements, show positive effects on the GlycanAge score and indexes.

Experimentally we know various other supplements affect the GlycanAge score, especially if the supplements target common deficiencies (e.g. vitamin D) or have anti-inflammatory properties.

However, not all supplements are suitable for everyone and GlycanAge can help you understand how your patient is responding to them.



Indeterminate effect

No clear outcome from the study

Related research papers

[The effect of n-3 polyunsaturated fatty acids-enriched hen eggs consumption on IgG and total plasma protein N-glycosylation in healthy individuals and cardiovascular patients](#)

The study investigated the effects of omega-3 PUFAs-enriched hen eggs consumption on IgG glycans and other inflammatory biomarkers in healthy people and in cardiovascular (CV) patients. In healthy individuals who consumed omega-3 enriched eggs, we saw a decrease in the Glycan Lifestyle index and in those consuming normal eggs we saw an increase in the Glycan Mature index. In CV patients, we saw a switch towards a less-inflammatory profile of the total blood plasma glycans.

[The use of a systems approach to increase NAD+ in human participants](#)

This double-blinded, placebo-controlled crossover trial investigated the efficacy of the NAD+ supplement Nuchido TIME+. Healthy participants (n=26) aged 21-72 were randomized to receive either the supplement or a placebo for 28 days, followed by a one-week washout period, after which the groups switched treatments. Participants taking the NAD+ supplement experienced an average decrease in their GlycanAge score by 1.26 years after only 28 days, a change not observed in those receiving the placebo.

Metformin

Metformin is a prescription drug commonly used for treating type 2 diabetes and insulin resistance. Due to its supposed benefits, it is also being used in non-diabetics.

The effects of metformin are still being researched, especially for non-diabetics. Our studies show that metformin generally does not significantly influence GlycanAge in non-diabetics. However, some individuals do experience changes in their GlycanAge scores while on metformin, reflecting their unique response to the treatment.



Indeterminate effect

No clear outcome from the study

Related research papers

[Effects of testosterone and metformin on the GlycanAge index of biological age and the composition of the IgG glycome](#)

This clinical trial investigated the effects of metformin and testosterone replacement therapy (TRT) in 82 male participants dealing with obesity and low testosterone levels. They were randomized into receiving:

- metformin
- TRT
- metformin+TRT
- placebo

Samples were taken at 3 timepoints - before starting the treatment, at the 6-month mark, and again one year into the treatment. Significant changes in IgG glycans were observed only in the groups receiving TRT, whether alone or combined with metformin, indicating that these changes were attributed to TRT rather than metformin. In the metformin group, there was no consistent trend in GlycanAge scores - some individuals experienced a minor increase, while others experienced a minor decrease. The exception was one participant who showed a significant decrease in their GlycanAge score after taking metformin.

Additional notes

Preliminary data shows that metformin has some positive effects on IgG glycans in diabetics.

Irregular cycles

During a woman's menstrual cycle, hormones fluctuate cyclically, and IgG glycans also change in a cyclic pattern. However, these changes are typically not significant enough to affect the overall GlycanAge score, so the menstrual cycle phase generally does not influence the results.

However, for women with irregular menstrual cycles or conditions like polycystic ovary syndrome (PCOS) or endometriosis, which are characterized by hormonal imbalances and increased inflammation, the GlycanAge score may be higher.



Biological age
Chronic inflammation

Related research papers

[Periodic Changes in the N-Glycosylation of Immunoglobulin G During the Menstrual Cycle](#)

The study examined longitudinal changes in IgG glycans during the menstrual cycle in a cohort of healthy premenopausal women with regular cycles (n=70). The women were sampled at 12 time points during their cycle—every 7 days for 3 months. Although the average variation in Glycan indexes was only up to 1.1%, the changes exhibited a cyclic pattern.

The follicular phase was characterized by the highest abundance of Glycan Mature, Glycan Median, and Glycan Lifestyle indexes, which are known to have pro-inflammatory properties. After ovulation, we saw an increase in anti-inflammatory Glycan Youth and Glycan Shield indexes.

These variations were associated with female sex hormones and menstrual cycle phases, however, the changes in Glycan indexes didn't overlap with the highest concentrations of sex hormones but appeared as menstrual cycle phase-specific events. Despite the observed changes in IgG glycans, they weren't significant enough to affect the overall GlycanAge score.

Additional notes

If the patient has irregular cycles due to entering peri-menopause, you can refer to the [perimenopause](#) page for more information.

Pregnancy

During pregnancy, estrogen levels increase significantly, with a specific form of estrogen being predominantly produced by the placenta (estradiol E2).

Estrogen has known anti-inflammatory properties, similar to the effects seen with IgG glycans. During pregnancy, women can experience a reduction in their GlycanAge score, along with improvements in anti-inflammatory indexes (Glycan Youth, Glycan Shield).



Biological age

Chronic inflammation



Glycan Shield

Anti-inflammatory



Glycan Youth

Anti-inflammatory

Related research papers

[Immunoglobulin G galactosylation and sialylation are associated with pregnancy-induced improvement of rheumatoid arthritis and the postpartum flare: results from a large prospective cohort study](#)

We investigated changes in IgG glycans in Caucasian women diagnosed with rheumatoid arthritis (RA) from pre-pregnancy until six months postpartum. The study included 148 RA patients and 32 healthy controls. We observed an increase in the anti-inflammatory Glycan Youth and Glycan Shield indexes from preconception until the end of pregnancy, which was associated with remission of RA symptoms during pregnancy. After pregnancy, we observed a significant decrease in both Glycan Youth and Glycan Shield indexes, reaching their lowest levels at six months postpartum. This decrease was associated with a flare-up in RA severity.

Additional notes

Pregnancy has been observed to improve chronic conditions like rheumatoid arthritis, which often flare up again postpartum. These changes are likely due to the pregnancy-induced increase in estrogen and are also reflected in glycan levels and indexes.

Post-pregnancy

After giving birth, woman's body undergoes significant changes as hormone levels gradually return to their pre-pregnancy state.

The marked increase in estrogen observed during pregnancy diminishes, often leading to an increase in the GlycanAge score. This is often reflected by a reduction in anti-inflammatory indexes (Glycan Shield, Glycan Youth).



Biological age

Chronic inflammation



Glycan Shield

Anti-inflammatory



Glycan Youth

Anti-inflammatory

Related research papers

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Perimenopause

Perimenopause is a phase preceding menopause in which estrogen levels start to drop.

Before perimenopause, women exhibit a similar aging pace to men. However, upon entering perimenopause, their GlycanAge score rises abruptly, reflecting the increase in inflammation due to a large drop in estrogen levels.

Perimenopause is predominantly characterized by an increase in the pro-inflammatory Glycan Mature index and a decrease in the anti-inflammatory Glycan Youth index. Studies also observe an increase in Glycan Lifestyle index.



Biological age
Chronic inflammation



Glycan Mature
Pro-inflammatory



Glycan Shield
Anti-inflammatory



Glycan Lifestyle
Supportive index



Glycan Youth
Anti-inflammatory

Related research papers

[Immunoglobulin G glycome composition in transition from premenopause to postmenopause](#)

The study analyzed the IgG glycome in 5080 samples from 1940 females multiple times during their transition from pre-menopause to menopause. The most prominent changes associated with entering menopause were an increase in the Glycan Mature and Glycan Lifestyle indexes and a subsequent decrease in Glycan Youth and Glycan Shield. These changes are known to occur with aging in general, however, they were more pronounced in peri-menopausal women compared to women of other age groups and to men.

Additional notes

During their transition from pre- to peri-menopause, women can experience an increase in their GlycanAge score by over a decade.

Hormone replacement therapy

Hormone replacement therapy (HRT) is often used in managing symptoms of peri- and menopausal women to restore hormonal balance, especially estrogen.

Estrogen is a known modulator of IgG glycans that has anti-inflammatory properties.

Women who undergo HRT often experience a reduction in their GlycanAge score and a reduction in the pro-inflammatory Glycan Mature index.



Biological age

Chronic inflammation



Glycan Mature

Pro-inflammatory

Related research papers

[Effects of estradiol on biological age measured using the glycan age index](#)

Postmenopausal women (n=58) with low estrogen levels were randomized to receive estrogen, raloxifene (medication used to relieve some symptoms of menopause) or placebo. Those on estrogen and raloxifene showed positive changes such as a reduction in the pro-inflammatory Glycan Mature index.

To confirm the effects of estrogen even further, pre-menopausal healthy women (n=21) were treated with leuprolide, which lowered estrogen production, mimicking symptoms of menopause. Some women received transdermal estrogen and others were on placebo.

The placebo group experienced an increase in the pro-inflammatory Glycan Mature index and showed an average increase in their GlycanAge score by 9,1 years. This effect was prevented by transdermal estrogen therapy. After recovery, GlycanAge scores of women returned to baseline.

Additional notes

HRT in women isn't just about optimizing estrogen - it's about finding the right balance between all female sex hormones, including progesterone.

Research papers

Biological age

[Glycans Are a Novel Biomarker of Chronological and Biological Ages](#)

[Immunoglobulin G glycans – Biomarkers and molecular effectors of aging](#)

[Heritability of the glycan clock of biological age](#)

[Immunoglobulin G glycosylation in aging and diseases](#)

[IgG glycans in health and disease: Prediction, intervention, prognosis, and therapy](#)

Influencing factors

[Immunoglobulin G galactosylation and sialylation are associated with pregnancy-induced improvement of rheumatoid arthritis and the postpartum flare: results from a large prospective cohort study](#)

[Periodic Changes in the N-Glycosylation of Immunoglobulin G During the Menstrual Cycle](#)

[Immunoglobulin G glycome composition in transition from premenopause to postmenopause](#)

[Effects of estradiol on biological age measured using the glycan age index](#)

[Estrogens regulate glycosylation of IgG in women and men](#)

[The effect of n-3 polyunsaturated fatty acids-enriched hen eggs consumption on IgG and total plasma protein N-glycosylation in healthy individuals and cardiovascular patients](#)

[The use of a systems approach to increase NAD⁺ in human participants](#)

[Extensive weight loss reduces glycan age by altering IgG N-glycosylation](#)

[Effects of testosterone and metformin on the GlycanAge index of biological age and the composition of the IgG glycome](#)

[Regular moderate physical exercise decreases Glycan Age index of biological age and reduces inflammatory potential of Immunoglobulin G](#)

[N-glycosylation profiling of plasma provides evidence for accelerated physiological aging in post-traumatic stress disorder](#)

[Not-So-Sweet Dreams: Plasma and IgG N-Glycome in the Severe Form of the Obstructive Sleep Apnea](#)

[Intense Physical Exercise Induces an Anti-inflammatory Change in IgG N-Glycosylation Profile](#)

[Physical Exercise Induces Significant Changes in Immunoglobulin G N-Glycan Composition in a Previously Inactive, Overweight Population](#)