Your genetic results were analyzed on a previous version of our genotyping platform. Click here for more information. [https://permalinks.23andme.com/pdf/PN-20-0312.pdf]

23andMe

Leonard Glassner
Late-Onset Alzheimer's Disease

Late-Onset Alzheimer's Disease

Alzheimer's disease is characterized by memory loss, cognitive decline, and personality changes. Late-onset Alzheimer's disease is the most common form of Alzheimer's disease, developing after age 65. Many factors, including genetics, can influence a person's chances of developing the condition. This test includes the most common genetic variant associated with late-onset Alzheimer's disease.

Leonard, you have **one copy** of the ε4 variant we tested.

People with this variant have a slightly increased risk of developing late-onset Alzheimer's disease. Lifestyle, environment, and other factors can also affect your risk.

1 variant detected
in the APOE gene

How To Use This Test

This test does not diagnose Alzheimer's disease or any other health conditions.

Please talk to a healthcare professional if this condition runs in your family, you think you might have this condition, or you have any concerns about your results.

Intended Uses

- Tests for the **ε4** variant in the APOE gene associated with an increased risk of developing late-onset Alzheimer's disease.

Limitations

- Does **not** include all possible variants or genes associated with late-onset Alzheimer's disease.
- Does **not** include any variants or genes linked to early-onset Alzheimer's disease.
- Does **not** determine a person's full APOE genotype.

Ethnicity Considerations

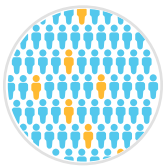
- The ε4 variant included in this test is found and has been studied in many ethnicities. Detailed risk estimates have been studied the most in people of **European** descent.

You may have a slightly increased risk of developing late-onset Alzheimer's disease based on your genetic result.

However, most people with this result do not develop late-onset Alzheimer's disease. Consider discussing your risk with a healthcare professional, especially if you have a family history or other risk factors for this condition.

We detected one copy of the ε4 variant in the APOE gene.

See Scientific Details



Although your risk may be slightly increased, most people with this variant do not develop late-onset Alzheimer's disease.

Studies estimate that, on average, a male of **European** descent with this variant has a 4-7% chance of developing late-onset Alzheimer's disease by age 75 and a 20-23% chance by age 85. There is not enough data to estimate the chances in males of other ethnicities.

See Scientific Details

Non-genetic factors may also influence your risk of developing late-onset Alzheimer's disease.

Even though nothing has been proven to prevent Alzheimer's disease, some studies suggest that eating a healthy diet and staying physically and mentally active is linked to a reduced risk of developing late-onset Alzheimer's disease.

Research is ongoing to understand what causes Alzheimer's disease and to find effective treatments. See Resources for more information.

Lifestyle and other factors can also influence the chances of developing late-onset Alzheimer's disease.

Consult with a healthcare professional before making any major lifestyle changes.

Age

The risk of developing Alzheimer's disease increases greatly as a person ages. This condition is most often diagnosed in people over the age of 65.

Sex

More females than males have late-onset Alzheimer's disease, perhaps due to both biological and lifestyle factors.

Family history

Parents, siblings, and children of an individual with late-onset Alzheimer's disease have a higher chance of developing the disease themselves.

Heart health

Research shows that high blood pressure, high cholesterol, and type 2 diabetes are associated with an increased risk for late-onset Alzheimer's disease.

Maintaining normal blood pressure, keeping a healthy weight, eating a healthy diet, and exercising regularly are a few things you can do to promote and maintain your heart health.

Lifestyle

Lifestyle may impact Alzheimer's risk. Exercise and a heart-healthy diet have both been associated with a decreased risk for Alzheimer's disease.

Intellectual activity

Fewer years of education has been associated with a greater risk of developing Alzheimer's disease later in life.

While the reason for this is still unclear, researchers suggest that exercising the brain through activities like reading, writing, and doing puzzles may help promote brain health.

See Scientific Details for more information

About Late-Onset Alzheimer's Disease

When it develops

Late-onset Alzheimer's disease develops after 65 years of age.

Typical signs and symptoms

- Memory loss that worsens over time
- Mood and personality changes
- Trouble planning or solving problems
- Confusion with place or time
- Difficulty performing daily life activities

How common is the condition?

Late-onset Alzheimer's disease affects people of all ethnicities. About 1 in 10 Americans age 65 and older is affected by Alzheimer's disease. Elderly African Americans and Hispanics are more likely to develop the condition than people of other ethnicities.

How it's treated

There is currently no known prevention or cure for Alzheimer's disease. Medication may be used to delay or ease symptoms.

Read more at:
Alzheimers.gov [https://www.alzheimers.gov/]
National Institute on Aging [https://www.nia.nih.gov/health/alzheimers]
GeneReviews [https://www.ncbi.nlm.nih.gov/books/NBK1161/]
MedlinePlus [https://medlineplus.gov/genetics/condition/alzheimer-disease/]

Consider sharing this result with a healthcare professional, especially if you have other risk factors.

- If you have a family history of this condition or think you have symptoms, consult with a healthcare professional.
- If you have questions about your results or how they might affect you or your family, a genetic counselor may be able to help.
- See our Frequently Asked Questions for more information.

Scientific Details

The ε4 variant in the APOE gene is the most common genetic factor associated with late-onset Alzheimer's disease.

- The APOE gene contains instructions for making a protein called apolipoprotein E. This protein helps control the levels of cholesterol and fats in the blood. It is not known exactly how the ε4 variant increases the risk of late-onset Alzheimer's disease.

  Read more at MedlinePlus [https://medlineplus.gov/genetics/gene/apoe/]

You have one copy of the ε4 variant we tested.

1 marker was tested.

Marker Tested	Gene	Marker ID (SNP)	Your Genotype*	Variant Genotype	Percent of 23andMe customers with variant	
ε4	APOE	rs429358	C | T	C	European	**26.51%**
					African American	**35.77%**
					Ashkenazi Jewish	**22.07%**
					East Asian	**17.89%**
					Hispanic or Latino	**22.71%**
					South Asian	**17.85%**
					Middle Eastern	**12.78%**

Explanation: The variant tested is a change from a T to a C in the DNA sequence of the APOE gene. Two genetic markers (rs429358 and rs7412) in the APOE gene are often used together to define three variants of the APOE gene called ε2, ε3, and ε4. However, the rs429358 marker by itself can be used to identify the ε4 variant.

References: [1, 2, 4, 11, 13, 14, 15, 17, 18, 22] | ClinVar [https://www.ncbi.nlm.nih.gov/clinvar/variation/17864/]

*This test cannot distinguish which copy you received from which parent. This test also cannot determine whether multiple variants, if detected, were inherited from only one parent or from both parents. This may impact how these variants are passed down.

23andMe always reports genotypes based on the 'positive' strand of the human genome reference sequence (build 37). Other sources sometimes report genotypes using the opposite strand.

Test Interpretation

This report provides risk estimates for people of European, African American, East Asian, and South Asian descent. Estimates for other ethnicities are not currently available.

Lifetime risk

The lifetime risk estimates shown below represent the proportion of people expected to develop Alzheimer's disease by age 65, 75, and 85. These values are based on people of European descent. Lifetime risk estimates are not available for people of other ethnicities.

Genotype	Sex	Age 65	Age 75	Age 85
General population	Male	<1%	3%	11%
General population	Female	<1%	3%	14%
No ε4 variants	Male	<1%	1-2%	5-8%
No ε4 variants	Female	<1%	1-2%	6-10%

One copy of ε4 variant	Male	1%	4-7%	20-23%
One copy of ε4 variant	Female	<1%	5-7%	27-30%
Two copies of ε4 variant	Male	4%	28%	51%
Two copies of ε4 variant	Female	2%	28%	60%

Likelihood ratios

A "likelihood ratio" estimates how the test result affects the chances of a condition, compared to the chances of the condition prior to testing. In the table below, values greater than 1 mean that the chances of developing the condition are higher based on the test result. Values less than 1 mean that the chances are lower based on the test result. Values close to 1 mean that the chances of developing the condition have not changed significantly.

These values are calculated by 23andMe using data from Farrer et al. (1997), Murrell et al. (2006), Liu et al. (2014), and Agarwal et al. (2014).

Genotype	European	African American	East Asian	South Asian
No ε4 variants	0.56	0.67	0.68	0.60
One copy of ε4 variant	1.83	1.46	2.44	3.29
Two copies of ε4 variant	8.24	3.75	25.63	5.72

European

Genotype	Likelihood ratio	95% confidence interval
No ε4 variants	0.56	0.54 - 0.58
One copy of ε4 variant	1.83	1.74 - 1.93
Two copies of ε4 variant	8.24	6.78 - 10.01

African American

Genotype	Likelihood ratio	95% confidence interval
No ε4 variants	0.67	0.56 - 0.80

One copy of ε4 variant	1.46	1.13 - 1.88
Two copies of ε4 variant	3.75	1.85 - 7.58

East Asian

Genotype	Likelihood ratio	95% confidence interval
No ε4 variants	0.68	0.65 - 0.71
One copy of ε4 variant	2.44	2.13 - 2.80
Two copies of ε4 variant	25.63	10.50 - 62.56

South Asian

Genotype	Likelihood ratio	95% confidence interval
No ε4 variants	0.60	0.54 - 0.66
One copy of ε4 variant	3.29	2.62 - 4.12
Two copies of ε4 variant	5.72	2.34 - 14.00

Odds ratios

An "odds ratio" estimates how strongly a genetic variant is associated with a condition. An odds ratio greater than 1 means that people with that genotype are more likely to develop the condition, while an odds ratio less than 1 means that people with that genotype are less likely to develop the condition, compared to the reference group.

Genotype	European	African American	East Asian	South Asian
Reference genotype	1	1	1	1
One copy of ε4 variant	2.64 - 3.63	2.32	2.10 - 3.08	3.93 - 4.18
Two copies of ε4 variant	14.49	7.19	11.71	4.81

Health Risk Estimates

Risk estimates are based on clinical studies that identify an association between a genotype and a health condition.

Consider talking to a healthcare professional if you have any concerns about your results.

References [1, 10, 11, 18, 22]

Other Factors

Other factors besides the ε4 variant can influence your chances of developing late-onset Alzheimer's disease.

This is not a complete list of other factors.

People with multiple risk factors may have a higher risk of developing late-onset Alzheimer's disease.

Consult with a healthcare professional before making any major lifestyle changes.

Other Factors	References
Age Alzheimer's disease is most often diagnosed in people over the age of 65. About 1-4% of people have Alzheimer's disease at age 65. The risk increases dramatically every decade thereafter.	[4]
Sex More females than males have late-onset Alzheimer's disease. This may be partly due to the fact that females tend to live longer than males, but biological and lifestyle differences likely also play a role. Studies also suggest that the APOE ε4 variant is associated with a greater risk for late-onset Alzheimer's disease in females than in males.	[3, 4, 20]
Family history First-degree relatives of a person with late-onset Alzheimer's disease have a higher chance of developing late-onset Alzheimer's disease themselves. This may in part be explained by genetic factors, but it may also be related to family members sharing a similar lifestyle and environment.	[4, 9]
Heart health Many studies have investigated the relationship between cardiovascular risk factors and Alzheimer's disease. Evidence suggests that factors which increase the risk of cardiovascular disease (obesity, high cholesterol, and high blood pressure) also increase the risk of Alzheimer's disease in older age. Having type 2 diabetes and smoking have also both been linked to an increased risk of developing cardiovascular disease and Alzheimer's disease.	[4, 16, 24, 25, 27]

Diet

[4, 5, 21, 30]

Understanding the effects of diet on Alzheimer's risk is an active area of research. Studies suggest that eating a heart-healthy diet is associated with a reduced risk of developing Alzheimer's disease. This can include eating plenty of green leafy vegetables, fruits, whole grains, and healthy fats (such as those found in fish, nuts, and olive oil), and limiting saturated fat, red meat, and added sugar.

Exercise

[4, 5, 8, 12]

Understanding the effects of exercise on Alzheimer's risk is an active area of research. Evidence suggests that exercise benefits the brain and decreases the risk of developing Alzheimer's disease. This may result from many factors, including improvements in blood flow and a lower risk of developing metabolic and cardiovascular diseases. In some studies, even a low-impact physical activity like walking was shown to be beneficial.

Intellectual activity

[4, 5, 26, 27]

Fewer years of education has been associated with a greater risk of developing Alzheimer's disease later in life. The risk appears to be highest in people who did not complete high school. The cause of this association is unclear. Some researchers hypothesize that more years of education may help people build stronger brain connections that can protect the brain against conditions like Alzheimer's disease. It could also be that lower education levels reflect lower socioeconomic status, which may limit a person's access to affordable health care and nutritious foods. All these factors as well as others may contribute to a higher risk of developing Alzheimer's disease.

Ethnicity

[4, 19, 28, 29]

African Americans and Hispanics develop late-onset Alzheimer's disease at higher rates than people of European and Asian descent. This may be due to differences in rates of other health conditions such as heart disease and diabetes, as well as differences in lifestyle and socioeconomic factors. The frequency of the APOE ε4 variant also differs between these groups.

Other genes

[6, 23]

Many studies have identified additional genes and variants that influence risk for late-onset Alzheimer's disease. However, these variants have only a small effect on risk compared to the APOE ε4 variant.

Test Details

Indications for Use

The 23andMe PGS Genetic Health Risk Report for Late-Onset Alzheimer's Disease is indicated for reporting of the ε4 variant in the APOE gene. This report describes if a person's genetic result is associated with an increased risk of developing late-onset Alzheimer's disease, but it does not describe a person's overall risk of developing Alzheimer's disease. The ε4 variant included in this report is found and has been studied in many ethnicities. Detailed risk estimates have been studied the most in people of European descent.

Special Considerations

- This test does not identify or report on the ε2 and ε3 variants of the APOE gene. These variants are not associated with an increased risk of developing Alzheimer's disease.
- Genetic testing for late-onset Alzheimer's disease is not currently recommended by any healthcare professional organizations.

Test Performance Summary

Clinical Performance [4]

- Approximately 65% of Alzheimer's patients have one or two copies of the APOE ε4 variant.
- However, many people with the APOE ε4 variant will not develop late-onset Alzheimer's disease.

Warnings and Limitations

- This test does not cover all variants that could cause this condition.*
- This test does not diagnose any health conditions.
- Share results with your healthcare professional for any medical purposes.
- If you are concerned about your results, consult with a healthcare professional.

See the Package Insert [https://permalinks.23andme.com/pdf/package_insert_legacy.pdf] for more details on use and performance of this test.

* Variants not included in this test may be very rare, may not be available on our genotyping platform, or may not pass our testing standards.

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Frequently Asked Questions

Late-Onset Alzheimer's Disease

What does this test do?

This test looks for the ε4 variant in the APOE gene associated with late-onset Alzheimer's disease.

People with the ε4 variant are more likely to develop late-onset Alzheimer's disease. However, not everyone with this variant will develop the condition.

This test does not include all possible genetic variants or genes associated with late-onset Alzheimer's disease.

This test does not include any genetic variants or genes linked to early-onset Alzheimer's disease.

What does this test **not** do?

This test does not diagnose late-onset Alzheimer's disease. Only a healthcare professional can do that.

This test does not tell you if you have Alzheimer's disease or if you will definitely develop the condition in the future.

This test does not take into account other risk factors for late-onset Alzheimer's disease, such as personal and family health history. Thus, this test cannot provide a complete assessment of your risk of developing late-onset Alzheimer's disease.

This test does not include all possible genetic variants or genes associated with late-onset Alzheimer's disease.

This test does not include any genetic variants or genes linked to early-onset Alzheimer's disease.

The report says that detailed risk estimates for the ε4 variant included in this test are best studied in people of **European** descent. What if I'm not of European descent?

The effect of the ε4 variant on a person's lifetime risk of developing late-onset Alzheimer's disease is well understood in people of European descent. If a person who is not of European descent has the ε4 variant, he or she is still expected to have a higher risk for late-onset Alzheimer's disease, but the exact risk may vary depending on his or her ethnicity. See Scientific Details for more information about risk in people of non-European descent.

Where can I learn more about Alzheimer's disease, support groups, and other resources?

You can learn more about Alzheimer's disease from the following resources:

- Alzheimer's Association
- Alzheimer's Society
- AlzForum
- Alzheimer's Association Facts and Figures

If you have questions about your results or how they might affect you or your family, a genetic counselor may be able to help. Learn more about genetic counseling.

My report says I have **one copy of the ε4 variant** associated with late-onset Alzheimer's disease. What does this mean?

This means you have one copy of the ε4 variant we tested.

People with this result have a slightly increased risk of developing late-onset Alzheimer's disease. However, this does not mean you have developed or will definitely develop the condition. Other factors can also affect your chances of developing late-onset Alzheimer's disease. Learn more about other factors.

What does **slightly increased risk** mean?

A "slightly increased risk" means that, based on your genetic result for this test, your chances of developing late-onset Alzheimer's disease are slightly higher than average. Studies estimate that, on average, a male of European descent with your genetic result has a 4-7% chance of developing Alzheimer's disease by age 75, compared to a 3% chance for the general population. By age 85, that risk is 20-23% for people with your genetic result, compared to 11-14% for the general population. See Scientific Details for more information.

Non-genetic factors may also influence your risk of developing late-onset Alzheimer's disease. Learn more about other factors.

My report says I have **one copy of the ε4 variant** associated with late-onset Alzheimer's disease. What are some things I could do?

This result is associated with a slightly increased risk of developing late-onset Alzheimer's disease. Consider sharing this result with a healthcare professional, especially if you have other family members who have had Alzheimer's disease or if you have other risk factors that may increase your chances of developing late-onset Alzheimer's disease.

Even though nothing has been proven to prevent Alzheimer's disease, some studies have linked eating a healthy diet and staying physically and mentally active to a decreased risk of developing late-onset Alzheimer's disease.

Research is ongoing to understand what causes Alzheimer's disease and to find effective treatments. You can learn more about Alzheimer's disease from the following resources:

- Alzheimer's Association
- Alzheimer's Society
- AlzForum
- Alzheimer's Association Facts and Figures

If you have questions about your results or how they might affect you or your family, a genetic counselor may be able to help. Learn more about genetic counseling.

How could my result affect my family?

Since you share DNA with your family members, they may also be interested in your result. If you are thinking about talking to family members about your results, see this article for a discussion of things to consider before having the conversation.

Because you have one copy of the ε4 variant, it is expected that:

- Each of your children has a 50% chance of inheriting this variant from you.
- At least one of your parents has this variant.
- Each of your full siblings has at least a 50% chance of having this variant.

Change Log

Your report may occasionally be updated based on new information. This Change Log describes updates and revisions to this report.

Date	Change
Nov. 5, 2020	Odds ratios for different APOE genotype combinations were updated for people of East Asian descent.
Nov. 14, 2019	An explainer video was added to the report for customers with the following results: 0 variants detected, 1 variant detected, and variant detected.
April 17, 2017	Late-onset Alzheimer's Disease report created.

Leonard Glassner's Report, printed on 2024-04-13 UTC