The evolutionary cost of fertility explains why disease-related genetic variants persist

- **A study published in *Nature Ecology & Evolution* shows that natural selection has favoured genetic variants that increase fertility, although they also increase the risk of disease and reduce longevity.**
- **The research, led in Catalonia, provides some of the strongest genomic evidence to date supporting the antagonistic pleiotropy theory, which suggests ageing is caused in part by prioritizing fertility during youth.**
- **The results offer a new evolutionary perspective on human health and help explain why many genetic variants associated with common diseases have been maintained throughout evolution.**

Research team leaders: Dr. Arcadi Navarro, director of the BBRC and researcher at the IBE (CSIC-UPF) and ICREA at the UPF, and Dr. Gerard Muntané, researcher at IRBCatSud and the UPF. Credit: FPM

Barcelona, 21 July 2026.- Genetic variants that favour higher fertility may have been maintained throughout human evolution even though they also increase the risk of disease and are linked to a shorter life expectancy. This is the main conclusion of a study that helps explain why natural selection has not eliminated many genetic variants linked to common diseases.

The work, led by the Institute of Evolutionary Biology (IBE, CSIC-Pompeu Fabra University) with the participation of the Barcelonaβeta Brain Research Center (BBRC), has been published in the scientific journal *Nature Ecology & Evolution*. The research analysed large-scale genomic data to study the relationship between fertility, longevity and genetic predisposition to 62 diseases.

The results indicate that **natural selection tends to maximise fertility during reproductive age**. For this reason, it can favour genetic variants that increase reproductive success, even if these same variants carry a higher risk of developing diseases or reduced longevity in later stages of life.

"The results help us understand why natural selection has not eliminated many variants associated with common diseases that have a major impact on health", explains **Dr Arcadi Navarro**, director of the BarcelonaBeta Brain Research Center, group leader of the Genomics Research Group and principal investigator at the IBE (CSIC-UPF). "*Some of these variants may have been favoured because they increased our ancestors' reproductive success, even if this entailed a cost to health or lower life expectancy later on"*, also adds the professor and ICREA researcher at the UPF, and corresponding co-author of the study.

Researchers have observed that genetic variants simultaneously associated with higher fertility and a higher risk of disease show clear signs of having been favoured by natural selection. This pattern is observed both in recent periods and on evolutionary scales spanning the last 50,000 years.

The data therefore suggest that, from an evolutionary point of view, the reproductive advantages associated with some genetic variants may have offset their detrimental effects on future health. On average, alleles—the different variants of a gene—linked to a higher risk of disease are also associated with greater fertility and reduced longevity.

Analysis at the individual level shows that, among people with a higher genetic risk of developing diseases, there are differences depending on whether the disease appears in childhood (such as autism) or in adulthood (such as glaucoma).

During the childbearing years, those with a high genetic risk who do not go on to develop the disease tend to have more children. In contrast, when the disease appears in adulthood, the opposite is true: the people who end up developing the disease are also the ones who have had the most children. "*This is because falling ill at a young age, during the childbearing years, carries a high reproductive cost; in contrast, when the disease appears in adulthood, this cost is lower, because by that time most people have already had children*," explains **Eva Brigos Barril**, a predoctoral researcher at the IBE (CSIC-UPF) and the study's first author.

This does not mean that late-onset diseases increase fertility, but rather that some of the genetic variants that increase the risk could also have aided reproductive success during youth.

A new evolutionary perspective on human health

The research falls within the life-history theory, which studies how organisms distribute limited resources between functions such as growth, reproduction and maintenance of the organism.

"One of the major questions in genetics is why variants that increase the risk of developing a disease continue to exist. Our work provides evidence that, in some cases, these variants also confer reproductive advantages", highlights **Dr Gerard Muntané**, a researcher at the Pere Mata Institute (IRBCatSud) and a collaborating researcher and professor at Pompeu Fabra University.

In this context, the antagonistic pleiotropy theory suggests that **the same genetic variant can have beneficial effects at one stage of life and detrimental effects at another**. For example, a variant can aid reproduction during youth and, at the same time, increase the risk of developing a disease during old age.

The new study provides the largest genomic analysis to test this hypothesis in humans to date. The results reinforce the idea that **natural selection prioritizes effects that occur before or during the reproductive age** but has a lesser capacity to eliminate variants that cause harmful consequences at later stages.

This perspective helps answer one of the big questions in human evolutionary genetics: why genetic variants that increase the risk of suffering from common diseases and have a significant cost to health continue to exist on such a massive scale.

According to the results, the answer lies, at least in part, in the fact that some of these variants also provided reproductive advantages. Therefore, their persistence would not be an evolutionary anomaly, but the result of a balance between the benefits during the reproductive age and the costs that appear later.

Reference article: Brigos-Barril E, Vasallo C, Farré X, et al. Genetic trade-offs in fertility and longevity explain the maintenance of disease-associated alleles in humans. Nature Ecology & Evolution (2026).DOI: 10.1038/s41559-026-03140-z.

About the Barcelonaβeta Brain Research Center and the Pasqual Maragall Foundation

The Barcelonaβeta Brain Research Center (BBRC) is the research center of the Pasqual Maragall Foundation dedicated to the prevention of Alzheimer's disease and the study of cognitive functions affected in healthy and pathological aging. BBRC's research focuses on the preclinical stage of Alzheimer's, a period prior to the appearance of the first symptoms, when changes in the brain associated with the disease are already occurring. The BBRC, supported by the "la Caixa" Foundation since its creation, has more than 150 professionals dedicated to contributing to the forefront of research on Alzheimer's and other neurodegenerative diseases.

The Pasqual Maragall Foundation is a non-profit organization founded in April 2008 as a response to the commitment made by Pasqual Maragall, former mayor of Barcelona and former president of the Government of Catalonia, when he publicly announced that he had been diagnosed with Alzheimer's disease. The Foundation's mission is to promote research to prevent Alzheimer's and contribute to social transformation by improving the quality of life of affected individuals and their families, as well as raising public awareness about the disease.

The Pasqual Maragall Foundation has the support of more than 115,000 members and:

About the Faculty of Medicine and Life Sciences (MELIS) at UPF

MELIS is an intensive research department at Pompeu Fabra University (UPF), distinguished with three María de Maeztu awards for excellence (2014, 2018, 2024). Located at the Barcelona Biomedical Research Park (PRBB), one of the city's leading biomedical centers, MELIS is home to more than 340 researchers across 40 groups, covering a wide range of research lines in biology. You can find more information about the department on the website.

About the Institute of Evolutionary Biology (IBE: CSIC-Universitat Pompeu Fabra)

The IBE is a joint center of the Spanish National Research Council (CSIC) and Pompeu Fabra University (UPF), established in Barcelona in 2008. The IBE is dedicated to understanding the evolutionary mechanisms that generate and maintain biodiversity, with the potential to drive strategies for species conservation. It boasts a collaborative and multidisciplinary scientific team at the forefront of scientific and technical advances. To fulfill its mission, the IBE conducts innovative research spanning genomics, ancient DNA analysis, population dynamics, complex networks, and artificial intelligence. The IBE serves society with the ultimate goal of promoting planetary well-being through cutting-edge research and informing citizens about its scientific progress towards this global objective.

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