Researchers argue that long human lifespan is due in part to the contributions of elders

July 7 2022, by Sonia Fernandez

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According to long-standing canon in evolutionary biology, natural selection is cruelly selfish, favoring traits that help promote reproductive success. This usually means that the so-called "force" of selection is well equipped to remove harmful mutations that appear during early life and throughout the reproductive years. However, by the age fertility ceases, the story goes that selection becomes blind to what happens to our bodies. After the age of menopause, our cells are more vulnerable to harmful mutations. In the vast majority of animals, this usually means that death follows shortly after fertility ends.

Which puts humans (and some species of whale) in a unique club: animals that continue to live long after their reproductive lives end. How is it that we can live decades in selection's shadow?

"From the perspective of natural selection, long post-menopausal life is a puzzle," said UC Santa Barbara anthropology professor Michael Gurven. In most animals, including chimpanzees—our closest primate brethren—this link between fertility and longevity is very pronounced, where survival drops in sync with the ability to reproduce. Meanwhile in humans, women can live for decades after their ability to have children ends. "We don't just gain a few extra years—we have a true post-reproductive life stage," Gurven said.

In a paper published in the *Proceedings of the National Academy of Sciences*, senior author Gurven, with former UCSB postdoctoral fellow and population ecologist Raziel Davison, challenge the longstanding view that the force of natural selection in humans must decline to zero once reproduction is complete.

They assert that a long post-reproductive lifespan is not just due to recent advancements in health and medicine. "The potential for long life is part of who we are as humans, an evolved feature of the life course," Gurven said.

The secret to our success? Our grandparents.

"Ideas about the potential value of older adults have been floating around for awhile," Gurven said. "Our paper formalizes those ideas, and asks what the force of selection might be once you take into account the contributions of older adults."

For example, one of the leading ideas for human longevity is called the Grandmother Hypothesis—the idea that, through their efforts, maternal grandmothers can increase their fitness by helping improve the survival of their grandchildren, thereby enabling their daughters to have more children. Such fitness effects help ensure that the grandmother's DNA is passed down.

"And so that's not reproduction, but it's sort of an indirect reproduction. The ability to pool resources, and not just rely on your own efforts, is a game changer for highly social animals like humans," Davison said.

In their paper, the researchers take the kernel of that idea—intergenerational transfers, or resource sharing between old and young—and show that it, too, has played a fundamental role in the force of selection at different ages. Food sharing in non-industrial societies is perhaps the most obvious example.

"It takes up to two decades from birth before people produce more food than they're consuming," said Gurven, who has studied the economy and demography of the Tsimané and other indigenous groups of South America. A lot of food has to be procured and shared to get kids to the point where they can fend for themselves and be productive group members. Adults fill most of this need with their ability to obtain more food than they need for themselves, a provisioning strategy that has sustained pre-industrial societies for ages and also carries over into industrialized societies.

"In our model, the large surplus that adults produce helps improve the survival and fertility of close kin, and of other group members who reliably share their food, too," Davison said. "Viewed through the lens of food production and its effects, it turns out that the indirect fitness value of adults is also highest among reproductive-aged adults. But using demographic and economic data from multiple hunter-gatherers and horticulturalists, we find that the surplus provided by older adults also generates positive selection for their survival. We calculate all this extra fitness in late adulthood to be worth up to a few extra kids!"

"We show that elders are valuable, but only up to a point," contends Gurven. "Not all grandmothers are worth their weight. By about their mid-seventies, hunter-gatherers and farmers end up soaking up more resources than they provide. Plus, by their mid-seventies, most of their grandkids won't be dependents anymore, and so the circle of close kin who stand to benefit from their help is small."

But food isn't everything. Beyond getting fed, children are also taught and socialized, trained in relevant skills and worldviews. This is where older adults can make their biggest contributions: While they don't contribute as much to the food surplus, they have the accumulation of a lifetime of skills they can deploy to ease the burden of childcare on parents, as well as knowledge and training that they can pass on to their grandchildren.

"Once you take into account that elders are also actively involved in helping others forage, then it adds even more fitness value to their activity and to them being alive," Gurven said. "Not only do elders contribute to the group, but their usefulness helps ensure that they also receive from the surpluses, protections and care from their group. In other words, interdependence runs both ways, from old to young, and young to old."

"If you're part of my social world, there might be some kickback," Davison explained. "So to the extent that we're interdependent, I'm vested in your interest, beyond just simple kinship. I'm interested in getting you to be as skilled as possible because some of your productivity could help me down the road."

Gurven and Davison found that rather than our long lifespans opening up opportunities that led to a human-like foraging economy and social behavior, the reverse is more likely—our skills-intensive strategies and long-term investments in the health of the group preceded and evolved with our shift to our particular human life history, with its extended childhood and unusually long post-reproductive stage.

In contrast, chimpanzees—who represent our best guess as to what humans' last common ancestor may have been like—are able to forage for themselves by age 5. However, their foraging activities require less skill, and they produce minimal surplus. Even so, the authors show that if a chimpanzee-like ancestor would share their food more widely, they could still generate enough indirect fitness contributions to increase the force of selection in later adulthood.

"What this suggests is that human longevity is really a story about cooperation," said Gurven. "Chimpanzee grandmothers are rarely observed doing anything for their grandkids."

Though the authors say their work is more about how the capacity for long life came to first exist in the Homo lineage, the implication that we owe it to elders everywhere is an important reminder looking forward.

"Despite elders being far more numerous today than ever before in the past, there's still much ageism and underappreciation of older adults," Gurven said. "When COVID seemed to be most deadly just for older adults, many shrugged their shoulders about the urgency of lockdown or other major precautions.

"Much of the huge value of our elders goes untapped," he added. "It's time to think seriously about how to reconnect the generations, and harness some of that elder wisdom and expertise."

More information: Raziel Davison et al, The importance of elders: Extending Hamilton's force of selection to include intergenerational transfers, *Proceedings of the National Academy of Sciences* (2022). DOI: 10.1073/pnas.2200073119

Provided by University of California - Santa Barbara