New research provides insight into menopause

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Insight into why females of some species undergo menopause while others do not has proven elusive despite an understanding of the biological mechanisms behind the change.

However, new research by scientists at the Universities of Cambridge and Exeter suggests that menopause is an adaptation to minimize reproductive competition between generations of females in the same family unit.

Even in 'natural fertility' human societies (i.e., those without access to modern medicine or technology) women typically survive for many years after they have ceased to reproduce. Menopause represents an evolutionary puzzle because theory suggests that there should be no selection for genes which promote survival past the end of reproduction. The current explanation was proposed 50 years ago and is known as the 'grandmother hypothesis': Natural selection can favour post-reproductive survival if older non-breeding women can help their children survive and reproduce.

The problem is that data from natural fertility societies suggests that grandmothering benefits are too small to favour switching off reproduction by age fifty in order to help. So while the grandmother hypothesis can explain why women continue to survive after they have stopped breeding, it can't explain why they stop breeding in the first place.

In this paper, published this week in the journal *PNAS*, the researchers propose that the timing of reproductive cessation in humans is best understood as an evolutionary adaptation to reduce reproductive competition between generations of females in the same family unit.

Reproductive competition is ubiquitous in other cooperative vertebrates, but up to now its potential role in human life history evolution has been overlooked. The research demonstrates that humans are unique among primates because there is almost no overlap of reproductive generations. In natural fertility populations, women on average have their first baby at 19 years and their last baby at 38 years; in other words, women stop breeding when the next generation starts to breed.

Moreover, the scientists go on to demonstrate that this pattern is expected given the female-dispersal system thought to characterize ancestral humans. Female dispersal means that reproductive competition in ancestral human families would have involved 'mothers-in-law' competing with 'daughters-in-law'. In these circumstances younger females have a decisive advantage in competition because a mother-in-law is related to her daughter-in-law's offspring (and therefore share's an interest in her reproductive success), but not vice versa.

The researchers developed a simple mathematical model of this competition which predicts that older women should cease breeding when younger women in the same social unit start to breed. This hypothesis and model can thus explain the observed timing of reproductive cessation in humans, and so contributes to a much better understanding of how menopause evolved.

Despite vast differences in wealth, resources, and access to medicine, women in all societies experience menopause. This suggests that the human fertility schedule is hard-wired into our genetic makeup as a consequence of our evolutionary history, prior to more recent cultural

and technological advances.

Dr Michael Cant at the University of Exeter explains, “Women everywhere experience a rapid decline in fertility after the age of forty, culminating in menopause around ten years later. Our study helps to explain why this phase of rapid 'senescence' of the reproductive system starts when it does, and why women, on average, stop having children a full ten years before the onset of menopause.”

It also helps to explain why in some societies (particularly in Africa and Asia), women are required by social law to stop having children when their first grandchild is born. A better understanding of the selective forces that have shaped the genetically programmed human fertility schedule may in future provide medical insights into the genetic causes of premature ovarian failure and other diseases of low fertility.

“The grandmother hypothesis was proposed 50 years ago by the American evolutionary biologist George Williams,”says Dr Cant. “However, data on grandmother effects indicate that something key is missing from Williams’ argument. Our study suggests the missing part of the puzzle, and generates a raft of new testable predictions.”

Dr Rufus Johnstone at the University of Cambridge adds, “It should open up new avenues for research on menopause and fertility in humans, and provide new insights into the evolution of menopause in the two other species in which it occurs under natural conditions - killer whales and pilot whales."

Source: University of Cambridge