Do patterns of covariation between human pelvis shape, stature, and head size alleviate the obstetric dilemma?

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Fischer and Mitteroecker claim to have resolved the obstetric dilemma by establishing a previously unrecognized, ameliorating pattern of selective covariation between pelvis shape, stature, and head size (1). We feel that, although their results are intriguing, the authors do not fully consider the interconnecting web of factors that play important roles in complexity and the evolutionary trade-off between bipedalism and the pattern of increasing brain size in the genus *Homo*.

The suite of adaptations that defines the Hominin subfamily started around 7 million y ago. By comparison, obstetrically compromising rapid encephalization started in tall *Homo* populations around 2 million y ago with *Homo erectus* (*sensu lato*). From this point onwards, the obstetric dilemma is best thought of as how to integrate brain expansion with a pre-existing bipedal architecture. The relationship between brain size and pelvis morphology is a question of bioplasticity versus genetic evolution. To properly address this question, one must explicitly consider whether the suggested relationship is an evolutionary-selective phenomenon or an analytic artifact produced by combining multiple anatomically related variables (each of which potentially underwent differential patterns of selection) or plasticity in the individual (with or without epigenetic shifts between the mother and offspring).

Fischer and Mitteroecker (1) do highlight an increase in cranial volume between 600 and 100,000 y ago within the genus *Homo*, but this was followed by an opposite evolutionary trajectory. Using the same cited Ruff et al. data, we find that brain expansion peaked in both Neanderthals and *Homo sapiens* around 100,000 y ago, plateaued, then decreased markedly within *Homo sapiens* after 35–21,000 y ago, along with stature and mass (2). If, however, we use the encephalization quotient (EQ) as a diachronic measure, then we see a flat-line over the last 100,000 y, although body size actually decreases. It should be noted that this was a period of massive cultural expansion by *Homo sapiens*. So, although EQ was maintained, some other benefit presumably ameliorated and balanced the economy of brain size. This finding must suggest a very strong stabilizing selective pressure on an appropriately safe brain size, maintaining EQ while body size was reducing, possibly with obstetric risk, balanced against continuing sexual selective pressure for relatively larger brains (3, 4). This pattern of reduction of adult height while EQ is maintained only makes obstetric sense if smaller populations allow easier delivery. Although such a relationship is obstetrically counter-intuitive, Kurki (4) has found evidence consistent with it by comparing modern era regional populations, including the San.

A distinct but complementary test of these scenarios would be to examine and compare changes in brain and body sizes and coefficients of phenotypic variation and obstetric outcome among regional populations over the past 100 y, when high rates of obstetric intervention could have reduced natural selection and "allowed" the dramatic secular trends in size of elite populations, usually put down solely to nutrition and health. This would provide a broad based framework to try and understand the on-going interaction between selective pressures operating on female pelvic morphology and fetal development patterns.

1 Fischer B, Mitteroecker P (2015) Covariation between human pelvis shape, stature, and head size alleviates the obstetric dilemma. *Proc Natl Acad Sci USA* 112(18):5655–5660.
2 Ruff CB, Trinkaus E, Holliday TW (1997) Body mass and encephalization in Pleistocene *Homo*. *Nature* 387(6629):173–176.
3 Miller GF, Penke L (2007) The evolution of human intelligence and the coefficient of additive genetic variance in human brain size. *Intelligence* 35(2):97–114.
4 Kurki HK (2011) Pelvic dimorphism in relation to body size and body size dimorphism in humans. *J Hum Evol* 61(6):631–643.

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