Does maternal size shape the duration of pregnancy? Implications for evolutionary trends in growth

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The impact of human evolution on childbirth attracted attention from anthropologists from early in the 20th century. The consequences of bipedal locomotion for pelvic shape and structure were discussed by Krogman, while Portmann emphasised that human offspring maintained rapid growth in infancy, as if prolonging fetal growth after birth. These insights led eventually to the classic 'obstetric dilemma' (OD) hypothesis of Washburn, which assumed a trade-off between the dimensions of the pelvis and the fetal head, driven by antagonistic selective pressures on bipedal locomotion and fetal encephalisation. This

The emphasis was on the 'clash' of two skeletal traits, each of which was assumed to be constrained by

Much recent critique, with several themes:
(1) that constraint on size at birth as actually maternal energetics
(2) that OD varies by ecology and life-course exposures
(3) that OD may have favoured lactase persistence to relax such selective pressures

Proponents of theme 1 have argued that essentially there is no OD, however this fits poorly with high levels of obstructed labour in many populations, better explained by theme 2

An emerging theme has been that the OD connects with broader components of life history, reflected in variable timings of maturation and size

Here we address this more specifically, by framing and evaluating the hypothesis that **maternal size should shape the duration of pregnancy as well as size at birth**

That maternal size correlates with offspring size is well established. Widespread correlations of maternal height and BMI with offspring birth dimensions. The role of the maternal pelvis in this has been little explored, however in Brazilian cohort study, when pelvic dimensions were included in models, associations of maternal BMI with birth weight vanished. The pelvis therefore may shape birth size, though this effect may fail if the mother is obese or diabetic.

On average, therefore, larger mothers produce larger babies, and this holds both within populations, and also between them. This logic has been used for example to model long-term secular trends in size at birth in hominins and humans. Larger size at birth promotes infant survival and hence maternal fitness.

A little explored hypothesis is that this might also impact the duration of pregnancy, which is under a different set of selective pressures compared to size at birth. Cross-species studies show that primates achieve between 30-60% of adult brain size by birth, with humans at the lower end of this range. This suggests a minimum level of 'brain viability' must be achieved by birth. Consistent with that, compared to birth at 41 weeks, every week less in gestation is associated with a steadily increasing risk of children requiring special needs education.

The notion that maternal size might influence the duration of pregnancy as well as size at birth can be related to more than one underlying mechanism

- That maternal size shapes pelvic dimensions, hence a smaller mother may need to deliver her fetus earlier
- That maternal size shapes metabolic turnover and nutritional supply to the fetus, hence a smaller mother inherently grows a smaller fetus

In other words, there may be common ground between the 'metabolic ceiling' hypothesis and the 'pelvic constraints hypothesis.

This leads to two complementary hypotheses:

- That within a population, on average, smaller mothers may have shorter pregnancy
- That between populations, those with smaller average size may have shorter average pregnancies

The basic evidence

Potential mechanisms

The potential mechanism through which maternal size might impact pregnancy duration required careful consideration, for several reasons. First, birth dynamics are potentially impacted by three different genotypes – those of the mother, father and fetus – and their respective contributions require elucidation. Second, preterm delivery is associated with a range of risk factors, some of which may relate to maternal health. Since maternal height is a marker of developmental experience as well as genotype. Short maternal stature may index health status as well as pelvic dimensions.

For example, alleles raising birth weight in the fetus are associated with shorter gestational duration and higher maternal BP, indicating that birth weight is promoted through a 'high risk' strategy for both parties. Hence, pre-eclampsia plays an important role in mediating the association of short stature with preterm delivery. This indicates that selection could have favoured larger maternal size to reduce these costs.

However, we also need to consider the average duration of pregnancy, as well as the proportion of neonates delivered preterm.