Social Science & Medicine 108 (2014) 237–242

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Very low birthweight: Dysregulated gestation versus evolutionary adaptation

Ralph Catalano [a], Deborah Karasek [a,*], Alison Gemmill [b], April Falconi [a], Julia Goodman [a], Aristotle Magganas [a], Terry Hartig [c]

[a] School of Public Health, 50 University Hall #7360, University of California, Berkeley, CA 94720, USA
[b] Department of Demography, 2232 Piedmont Ave., University of California, Berkeley, CA 94720, USA
[c] Institute for Housing and Urban Research, Uppsala University, Box 514, SE-75120 Uppsala, Sweden

ARTICLE INFO

Article history:
Received 1 November 2013
Received in revised form
19 December 2013
Accepted 30 January 2014
Available online 10 February 2014

Keywords:
Very low birthweight
Perinatal health
Risk aversion
Selection *in utero*
Decision-making
Economy
Sweden

ABSTRACT

Much medical literature attributes persistently high rates of very low birthweight (VLBW) to "dysregulated" gestation. We offer the alternative view that natural selection conserved well-regulated, though nonconscious, decisional biology that protects the reproductive fitness of women by spontaneously aborting gestations that would otherwise yield frail infants, particularly small males. Modern obstetric practice, however, converts some fraction of these erstwhile spontaneous abortions into live births of very small infants. We further propose that the nonconscious decisional biology of gestation exhibits preferences also seen in consciously made decisions. We hypothesize that the incidence of VLBW among male infants should vary with the population's self-reported intentions to assume financial risk. We apply time-series modeling to monthly birth counts by sex and weight from the Swedish Medical Birth Registry between January 1993 and December 2010. We gauge risk aversion with monthly data from the Micro Index of the Swedish Consumer Tendency Survey (MISCT). Consistent with our argument that nonconscious decisional biology shares risk aversion with conscious decisions, we find that the incidence of VLBW among male infants in Sweden varies with the population's self-reported intentions to assume financial risk. We find increases above expected odds of a very low weight infant among males born 1 month after increases above expected levels of self-reported risk aversion in the Swedish population. We offer this finding as support for the argument that persistently high rates of VLBW arise, at least in part, from a combination of medical interventions and mechanisms conserved by natural selection to protect reproductive fitness.

Males weighing less than 1500 g at birth suffer greater mortality and morbidity as neonates than larger male infants and females of equal or greater weight (Stevenson et al., 2000). Even in Sweden, a high-income country with accessible, high-quality medical care and progressive social policies, adult men born at very low weight (i.e., <1500 g) more likely exhibit health and behavioral deficits than men larger at birth or women born at equal or greater weight (Gaddlin et al., 2008).

The literature concerned with very low birthweight (VLBW) typically views the phenomenon as the product of dysregulated biology (Brou et al., 2012). We draw on economics, psychology, and evolutionary theory to offer the alternative view that natural selection conserved well-regulated decisional biology that protects the reproductive fitness of women by spontaneously aborting gestations that would otherwise yield infants unlikely to thrive in prevailing environments. Modern medical practice has, however, converted a fraction of these erstwhile spontaneous abortions into very low weight births. We further speculate that this selection *in utero*, which operates outside a woman's awareness, shares risk aversion with the decisions that she could report making in everyday life. As evidence of this shared risk aversion we show that the incidence of VLBW among male infants in Sweden varies with the population's self-reported intentions to assume financial risk. We conclude by arguing that obstetric medicine has helped introduce conscious decisional biases, which characterize many of our economic decisions, into reproductive choices previously made by less biased, though non-cognitive, decisional biology.

* Corresponding author.
E-mail addresses: rayc@berkeley.edu (R. Catalano), dkarasek@berkeley.edu (D. Karasek), alisong@demog.berkeley.edu (A. Gemmill), April.falconi@berkeley.edu (A. Falconi), juliagoodman@berkeley.edu (J. Goodman), aristotlem@earthlink.net (A. Magganas), terry.hartig@ibf.uu.se (T. Hartig).

http://dx.doi.org/10.1016/j.socscimed.2014.01.050
0277-9536/

1. Selection *in utero*

A long line of literature draws from evolutionary theory to shed light on commonalities and differences in the ways that humans develop over the life course (Stearns, 1976). A subset of that work focuses on gestation because it provides not only the earliest environment for human maturation but also a site of selection against potentially less fit individuals (Møller, 1997). This literature includes the argument that pregnant women estimate, without awareness, the likelihood that a fetus, if born, will survive early life environments with sufficient vigor to reproduce as an adult (Catalano et al., 2012a, 2012b). The argument assumes that a population of gestations begun at the same time in the same environment exhibits a normal distribution of hardiness. Small males disproportionately occupy the left (i.e., low value tail) of this distribution due to their relatively high likelihood of death and morbidity, despite receiving greater maternal investment (Clutton-Brock, 1991; Powe et al., 2010; Stevenson et al., 2000). This relatively great frailty explains why pregnancies of small males yield relatively few grandchildren for mothers (Lummaa, 2001).

If every fetus "presented" with the same hardiness, prospective mothers could still vary in their non-conscious willingness to assume the risk of a live birth because women vary in their ability to provide offspring with the resources needed to survive childhood. Women vary, for example, in age, health, parity and socio-economic status, each of which may affect the time, energy, and other resources available to invest in prospective offspring. Each pregnant woman, therefore, may have her own critical value of fetal hardiness below which a gestation spontaneously aborts. The distribution of these critical values in a population of pregnant women will exhibit an expected value, such as a mean or median, below which the incidence of spontaneous abortion occurs significantly more frequently than above. Increased environmental threats to infant survival or to maternal resources will shift this population-level criterion to the right as individual mothers protect their fitness and that of their children by non-consciously raising the level of fetal hardiness needed to avoid spontaneous abortion. This right shift should, based on the assumptions listed above, lead to more spontaneous abortions of smaller males than of other fetuses.

Even in well-educated, high-income societies with accessible medical care, fewer than 50 percent of conceptions yield a live birth (Wilcox et al., 1999). Most of these losses occur before the 10th week of gestation and affect fetuses with chromosomal or other abnormalities that make survival, if born, unlikely in any environment. At least 16, and perhaps as many as 20, percent of post 10th week gestations, however, spontaneously abort (Buss et al., 2006). Fetuses lost after the 10th week exhibit relatively few detectable abnormalities but include a higher frequency of small for gestational age males than fetuses that survive to birth (Catalano et al., 2012a).

Best estimates suggest that post 10th week spontaneous abortions decline from a peak at the end of the first trimester (12th week) to a 16th week plateau that remains steady until approximately the 22nd week. At that point clinical interventions begin to yield very low weight infants, virtually all of whom gestate fewer than 36 weeks (Ammon Avalos et al., 2012; Goldhaber and Fireman, 1991). As predicted by our theory, males predominate among these births (Brettell et al., 2008). We assume that many of these births would have been, through nearly all of human history, spontaneous abortions that spared mothers from risky investment in frail offspring.

Women cannot report making the "decision" to spontaneously abort a gestation or describe the estimation of costs and benefits that informed such a choice. Psychologists have alluded to estimations and decisions that individuals cannot report making, but which can be brought into their consciousness using psychological techniques, as manifestations of "deep activation" (Dijksterhuis and Aarts, 2010; Sheeran et al., 2013; Wegner and Smart, 1997). Extending this notion, and consistent with modern rejection of the Cartesian separation of cognition from biology (Damasio, 1994; Jeannerod, 1997; Koestler, 1967; Ryle, 1949), we speculate that still deeper activation, out of awareness, not accessible to individual consciousness, and yet manifest in gestational outcomes, shares at least some of the preferences and biases that women and men exhibit in their conscious decisions (Sklar et al., 2012). Natural selection presumably conserved different levels of awareness in decision making for some purpose. We speculate that in the case of gestation, complete lack of awareness has protected maternal fitness by disallowing or mitigating biases now known to affect consciously made decisions (Haidt, 2012; Strough et al., 2011). These biases include the "sunk cost fallacy" that allows the decision to invest in option o at time t to increase the likelihood of investing in option o at time $t + n$ (Ellingsen and Robles, 2012). If allowed to affect the decisional biology of gestation as much as it affects cognitive choice, the sunk cost fallacy would lead mothers to continue gestations regardless of emergent frailties of fetuses. Natural selection would, therefore, conserve any emergent capability, such as deep activation, that protected the decisional biology of gestation against biases such as the sunk cost fallacy.

Our speculation suggests that variation over time in conscious risk aversion will coincide with non-conscious risk aversion revealed by a clinically important phenomenon – the incidence of very low weight male births. More specifically, we hypothesize that self-reported reluctance of Swedish households to assume financial risks will predict reluctance, outside of awareness, to extend the gestation of small male fetuses and thereby increase the incidence of very low weight male births.

Although self-reported risk aversion does not respond to changes within the typical range of macroeconomic conditions (Barsky and Sims, 2009), we recognize that a macroeconomic shock to the orderly functioning of markets could induce cognitively realized risk aversion and, separately, "dysregulate" gestation. This circumstance would require modern medicine to rescue more very low weight infants when the population coincidently reports less willingness to purchase durable goods. Indeed, the literature includes a report that the incidence of very low weight births in Sweden increases with rising unemployment (Catalano et al., 1999). We, therefore, included the unemployment rate in our tests. If unusually high unemployment predicts increased odds of very low birthweight but unexpectedly high risk aversion does not, we would infer that negative shocks to the macro-economy coincidentally dysregulate gestation and make the population risk averse. If unexpectedly high risk aversion predicts increased odds of very low birthweight but unusually high unemployment does not, we would infer that the previously reported association between unemployment and very low birthweight may arise from risk aversion induced, at least in part, by negative economic shocks. If both unexpectedly high risk aversion and unusually high unemployment predict increased odds of very low birthweight, we would infer that both risk aversion and "dysregulation" may independently affect gestation.

2. Methods

2.1. Data

The Micro Index of the Swedish Consumer Tendency Survey (MISCT) gauges risk aversion in monthly samples of 1500 Swedish consumers aged 16–84 (National Institute of Economic Research, 2012). The MISCT combines responses to questions on present