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Short Report

Male Scarcity is Associated with Higher Prevalence of Premature Gestation and Low Birth Weight Births Across the United States

DANIEL J. KRUGER,[1]* JILLIAN CLARK,[2] AND SARAH VANAS[2]
[1]*Population Studies Center and School of Public Health, University of Michigan, Ann Arbor, Michigan 48109*
[2]*Literature, Science, and the Arts, University of Michigan, Ann Arbor, Michigan 48109*

Objectives: Modern adverse birth outcomes may partially result from mechanisms evolved to evaluate environmental conditions and regulate maternal investment trade-offs. Male scarcity in a population is associated with a cluster of characteristics related to higher mating effort and lower paternal investment. We predicted that modern populations with male scarcity would have shorter gestational times and lower birth weights on average.

Methods: We compared US Centers for Disease Control and Prevention county-aggregated year 2000 birth records with US Decennial Census data. We combined these data in a path model with the degree of male scarcity and known socio-economic predictors of birth outcomes as exogenous predictors of prematurity and low birth weight, with single mother households as a proportion of families with children as a mediator ($N = 450$).

Results: Male scarcity was directly associated with higher rates of low birth weight. Male scarcity made significant indirect predictions of rates of prematurity and low birth weight, as mediated by the proportion of families headed by single mothers. Aggregate socio-economic status also indirectly predicted birth outcomes, as mediated by the proportion of families headed by single mothers, whereas the proportion African American retained both direct and indirect predictions of adverse birth outcomes.

Conclusions: Male scarcity influences life history tradeoffs, with consequences for important social and public health issues such as adverse birth outcomes. Am. J. Hum. Biol. 25:225–227, 2013. © 2013 Wiley Periodicals, Inc.

The co-varying factors of prematurity and low birth weight are the primary causes of neonatal mortality in developed countries (Mathews and MacDorman, 2006). These birth outcomes reflect human life history trade-offs, and variation may be partially shaped by mechanisms evolved to evaluate local environmental conditions historically related to the offspring's prospects for survival (Haig, 1993). Mothers manipulate offspring's size, body composition, and metabolism based on a selective investment of energy stores (Laskey and Prentice, 1997). Eventual gestational age and birth weight will be a compromise between maternal and fetal strategies; each pursued by aggressive hormonal regulation (Haig, 1993). In good-quality environments, mothers will have more resources to invest and outcomes will tend toward the theoretical optimum for offspring fitness, but in more adverse environments maternal and offspring interests diverge (Wells, 2003). Maternal fitness is generally maximized at the expense of the fitness of each individual offspring (Smith and Fretwell, 1974; Trivers, 1974). Under adverse circumstances, maternal survival will be favored at the expense of investment in offspring (Hirschfield and Tinkle, 1975). In marginal environments, reduced somatic investment will lead to low birth weight infants, reducing maternal demands and preserving resources for future offspring (Haig, 1993). In the most severe environments, maternal reproductive investment will be constricted through an inability to conceive, miscarriage early in pregnancy, or stillbirth (for a review, see Haig, 1993).

In humans, paternal investments of resource provisioning, training in life skills, and defense from threats contributes to the prospects of offspring survival and reproduction (Geary, 2005). Among the foraging Ache, children who grew up without an investing father present suffered higher mortality rates (Hill and Hurtado, 1996). Thus, expectations for paternal investment may be an important factor in shaping maternal investment in a gestating fetus.

The relative proportions of men and women in a population influence the average level of paternal investment. In female biased populations, where men are scarce, males have higher returns from mating effort and lower incentives for long-term commitment and investment. Women marry later and are less likely to be married (Lichter et al., 1995). Where males are relatively scarce, there are higher divorce rates (Trent and South, 1989), more out-of-wedlock births and more single mother households (Barber, 2004), higher rates of teenage pregnancies (Barber, 2000), and lower expectations for paternal care of offspring (Guttentag and Secord, 1983).

Because women in populations with male scarcity face lower prospects for paternal investment, which is historically associated with higher infant and child mortality, they may reduce somatic investment in gestating offspring to conserve maternal resources for investment in potential future offspring. Truncated maternal investment may result in shorter pregnancies and lighter offspring, increasing the rates of premature gestation births and low-birth weight births. Thus, modern populations with male scarcity or female bias may have shorter gestational times and lower birth weights on average, even when controlling for relevant socio-economic factors. The proportion of families with children that are single mother households reflects the ambient level of paternal

*Correspondence to: Daniel J. Kruger, School of Public Health, University of Michigan, 1420 Washington Heights, Ann Arbor, MI 48109-2029, USA. E-mail: kruger@umich.edu

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TABLE 1. County level variable descriptives

Variable	Proportion or *M*	SD
Male:Female ratio (ages 18–64)	98.23	6.47
Proportion African American	11.31	12.49
Median household income	44385	1024
Below poverty	11.25	5.04
High school graduates	81.35	6.53
College graduates	26.46	9.43
Single mothers	22.42	6.83

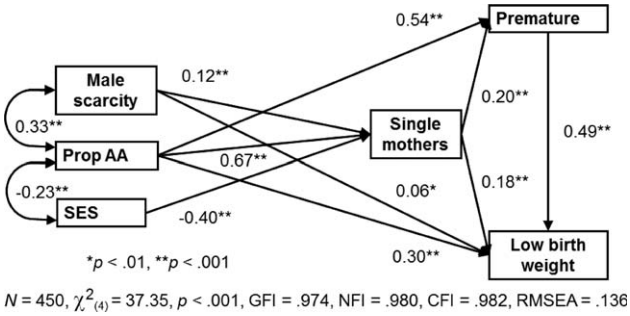

Fig. 1. Standardized regression coefficients in path model prediction of premature (< 37 weeks) and low birth weight (<2,500 g) births.

investment, and this factor likely mediates the effects of the sex ratio.

MATERIALS AND METHODS

We combined year 2000 birth records aggregated by County ($N = 450$) from the US Centers for Disease Control and Prevention with 2000 US Decennial Census data. We calculated the proportions of births that were premature (less than 37 weeks gestation) and low birth weight (under 2,500 g), the ratio of men to women for ages 18–64, single mother households as a proportion of families with children, and combined four indicators of socio-economic status (SES). These were median household income and the proportions of households with income below poverty level, and the proportions of High School and College graduates among those 25 years old and older (see Table 1). We combined these data in a path model with the degree of male scarcity, SES, and proportion African American as exogenous predictors of prematurity and low birth weight, with single mother households as a proportion of families with children as a mediator. We trimmed non-significant paths in iterative models by descending order of *P*-values to yield the most parsimonious model.

RESULTS

Male scarcity was directly associated with higher rates of low birth weight across countries in the USA (see Fig. 1). Male scarcity made significant indirect predictions of rates of prematurity, Sobel test's $z = 3.61$, $P < 0.001$, and low birth weight, Sobel test's $z = 3.02$, $P = 0.003$, as mediated by the proportion of families headed by single mothers. Aggregate SES also indirectly predicted rates of prematurity, Sobel test's $z = 3.63$, $P < 0.001$, and low birth weight, Sobel test's $z = 4.95$, $P < 0.001$, as mediated by the proportion of families headed by single mothers. The African American proportion of the population predicted and both prematurity low birth weight directly and indirectly, Sobel's $z = 3.68$, $P < 0.001$ and $z = 5.07$, $P < 0.001$, respectively.

DISCUSSION

Population conditions consistent with a lower prevalence of paternal investment predicted a higher prevalence of adverse birth outcomes, controlling for other socio-demographic factors. The prevalence of paternal investment was lower in female biased populations, where males are scarce. These results indicate that modern adverse birth outcomes may partially result from maternal mechanisms evaluating environmental conditions and regulating investment trade-offs. We are not proposing that regulating maternal somatic investment is a conscious and intentional reproductive strategy. Such mechanisms facilitated reproductive success in ancestral environments; they are a legacy from times when mortality rates were considerably higher than in the contemporary USA. Although adaptive through much of recent human evolution, these mechanisms may not promote reproductive success in modern environments. In fact, there is a growing literature on the adverse impacts of prematurity and low birth weight on the risk for obesity and many of the most prevalent non-communicable diseases later in life (e.g., Gluckman et al., 2009).

Our study provides additional evidence for the power of evolutionary theory and a Life History framework to promote an understanding of critical health issues in modern populations. Given the tremendous health consequences of prematurity and low birth weight, it is not surprising that considerable efforts to ameliorate adverse birth outcomes and infant mortality exist. Yet, despite decades of clinical, scientific, and legislative efforts, adverse birth outcomes and infant mortality persist, and demographic disparities are substantial. Interventions promoting desirable birth outcomes in modern societies may be more effective if they attend to risk factors outside of the standard medical model. Our research suggests a practical and feasible strategy for intervention. Increasing the level of paternal involvement and support during pregnancy, especially from unmarried and non-residential fathers, may generate considerable returns on investment across a broad range of health and social outcomes.

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