Early life environment, fertility and age of menarche: A test of life history predictions using a longitudinal assessment of adversity perception and economic status

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Early life environment, fertility, and age of menarche: A test of life history predictions in a human population

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Introduction:

1. Life history theory (LHT)

- An organism has access to finite resources and energy that must be allocated in an optimal way to maximize fitness.
- Developmental trajectories are optimized according to environmental context, resulting in phenotypic plasticity.
- LHT predicts that organisms exposed to high extrinsic mortality and fluctuations in population density will have an earlier age of sexual maturity, larger broods, and higher reproductive effort [2].

2. Extrinsic mortality

- *Extrinsic mortality*: death due to unavoidable causes [1], not sensitive to changes in reproductive decisions [2].
  - Differs from *intrinsic mortality*, which originates within an organism and may be influenced by tradeoffs in energetic allocations to reproduction, maintenance, and growth [2]
- Changes in extrinsic mortality risk have been shown to influence the timing of life history events such as age of reproductive maturation [3].

3. Access to resources

- Environmental stability is dependent on availability of resources, a significant factor in life history strategies [4].
- Ancestral humans may have relied upon somatic capital; contemporary Western humans tend to invest in and rely upon extra-somatic resources (e.g., money, land, social capital) [5].

4. Early life environment

- Early life environment has significant effects on later life outcomes.
- Adjustments in reproductive effort as reflected by age at reproductive maturation and fertility in response to experimentally induced variation in mortality has been documented in a number of species under various conditions [6,7].

Methods:

- We used data from the National Longitudinal Study of Adolescent Health (Add Health) to test our hypotheses [8].
- The database is a nationally-representative sample of Americans, with data collected in four waves across 14 years (1994-2008).
- The initial wave targeted students in grades 7-12, and the following waves continued assessing the same individuals until they were 24-32 years old.

Add Health

Results:

1. Number of live births in early adulthood:

An individual's perceived likelihood of living to the age of 35 (β=-0.046, p<0.0001), whether or not they reported their neighborhood as safe (β=-0.467, p<0.0001), and family income as a child (β=-0.004, p<0.0001; see Figure 1) were all independently predictive in the hypothesized direction (fewer resources and less early life safety lead to more children).

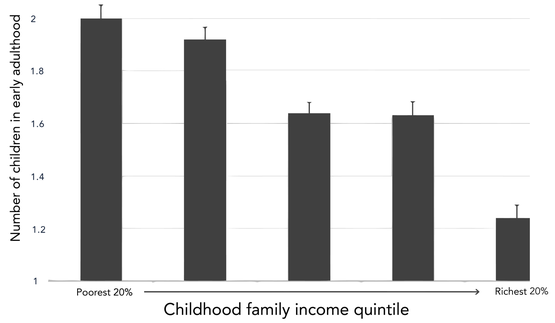

Figure 1:
Number of children in early adulthood by childhood family income quintile, N=2,859.

2. Age at menarche:

An individual's perceived likelihood of living to the age of 35 (β=0.049, p<0.001), whether or not they reported their neighborhood as safe (β=0.234, p<0.001), and household income as a child (β=0.0015, p<0.01) were all independently predictive in the hypothesized direction (fewer resources and less early life safety lead to an earlier age of menarche).

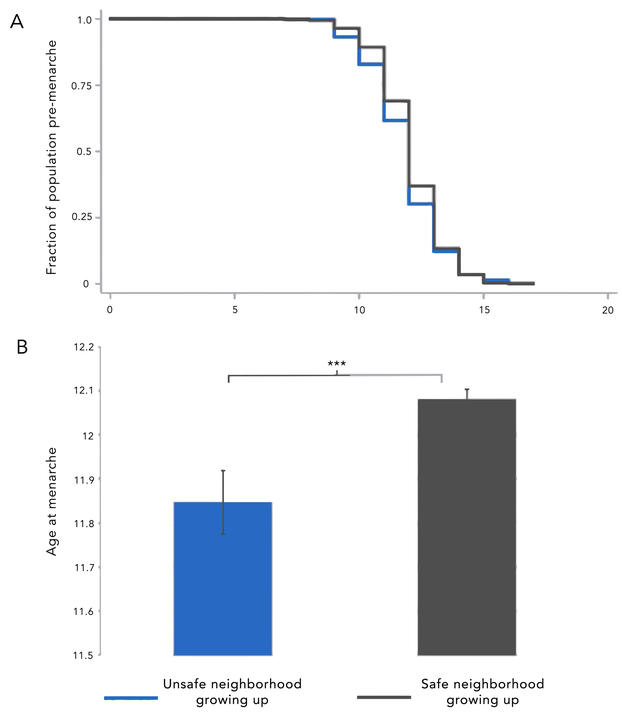

Figure 2A:
Kaplan-Meyer survival estimation of percent of population who have not reached menarche by perceived safety of childhood neighborhood.
N=425 in unsafe neighborhood, N=3,181 in safe neighborhood.

Figure 2B:
Comparison of mean age at menarche by perceived safety of childhood neighborhood, t(3,604)=3.304, p=.0005. N=425 in unsafe neighborhood, N=3,181 in safe neighborhood.

Methods (cont.):

- We used family income as a proxy for early extra-somatic resource access.
- Perceived environmental safety was estimated with two Wave I variables: answers to the questions:
  - "Do you feel safe in your neighborhood?"
  - "On a scale of 'No chance' to 'It will happen', what do you think are the chances you will live to age 35?".
- Although we have no way of determining or accounting for objective extrinsic mortality rates, our predicting variables track individuals' perceptions of adversity in their environments.
- The perceived risk metrics were used to predict:
  - (1) number of live births up to age 34
  - (2) Age at menarche
- The variables of interest reflect how cues in the environment have been aggregated and internalized.

Discussion:

- Our results support the hypothesis that perceptions of environmental adversity are associated with variation in reproductive effort in a contemporary human population in a manner that is consistent with predictions made by LHT in regards to presence and perception of available resources and extrinsic hazards.
- It is possible that stress endocrine responses may influence skeletal growth patterns that contribute to earlier onset of menarche.
  - Along with other factors, lower adrenal androgen levels were associated with delayed onset of menarche in otherwise healthy girls [11].
- Positive associations between perceptions of environmental adversity and early adult fertility may involve decreases in inter-birth intervals which may include increases in ovarian function (higher estrogen levels) [9], shorter periods of lactational amenorrhea [10], increased coital activity, or shorter gestational periods.
- Biodemographic methods are fruitful for assessing human evolutionary biology and elucidating our evolutionary trajectory.

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