Birth weight for gestational age of infants, by year of mothers' age;

A Life History study

Jane M. Rees, MS, PhD, RD. Maternal Child Health Program and Adolescent Medicine Section, Departments of Health Services and Pediatrics, University of Washington, Seattle, WA.

Introduction

- Life History Theory (1) predicts offspring of youngest maternal organisms will be small and in poor condition, as result of a physiological trade-off between final maternal and initial offspring development, as demonstrated in all species tested up to now, including fish, barnacles, sheep, rats, trees, and grasses.

- In humans the uterus develops (Fig 1) to age 20 (2) and at least one dimension of growth (knee height) continues through adolescent pregnancy and post partum (3).

- However, some (4,5,6) have denied infant outcome is affected by developmental characteristics of adolescent gravidas, agreeing that "a biological explanation seems unwarranted" (5).

- Biological characteristics of African-American (AA) pregnancies are especially suited to an investigation of a developmental trade-off. They:
  > share a relatively common ethnic heritage and socio-demographic ecology (7),
  > may achieve menarche (8), and have first intercourse (9), early, and conceive before completing physical development (3),
  > experience an abnormal biochemical gestational milieu (10), preterm birth (11) and/or depressed birth weight (12).

Figure 1.   Uterine volume (ml) by Tanner Stage (2)

N = 163, girls ≥ 19 y = Adults
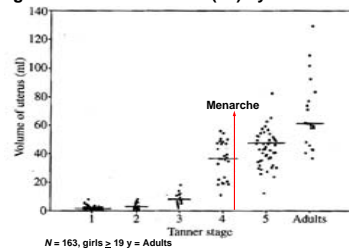
Hypotheses

- Maternal biological maturity and birth weight for gestational age are related.
- The hypothesized relationship is suggestive of a trade-off between growth of the mother and growth of the offspring.

Methods

Design: retrospective cross-sectional analysis of a population cohort.
Population: from the 1999 NCHS Perinatal Mortality Data File (13) all (169,600) live singleton 1st born infants of 15-29 y old AA delivering from the 34 to 41 wk in the US.
*Analysis:*

- calculation of mean birth wt at gestational wk by y of maternal age, (y of maternal age a proxy for maturation; birth wt and gestational age for offspring size and condition).
- mean wt of births at each gestational wk stratified by mothers' y of age.
- relationships were tested by Linear Regression and ANCOVA, adjusted for prenatal care initiation, marital status, and appropriateness of educational attainment.
- differences found were significant for this finite population, there was almost no sampling error in the File and inferential analyses were not required.
- confidence intervals were developed, for comparison of results with populations in other years.

Table 1. Mean birth weight by gestational week, and age of mother.

Gest. Wk.	34		35		36		37		38		39		40		41	
	Mean BW (g)	N	Mean BW (g)	N	Mean BW (g)	N	Mean BW (g)	N	Mean BW (g)	N	Mean BW (g)	N	Mean BW (g)	N	Mean BW (g)	N
AGE (y)																
15	2650	227	2783	282	2857	462	2919	627	3045	1031	3153	1487	3240	1358	3281	677
16	2649	303	2719 *	467	2828	712	2948 *	1188	3049	1954	3157	2619	3250	2483	3318	1267
17	2621	398	2739	612	2822	893	2935	1622	3052	2740	3166	3954	3263	3647	3332	1948
18	2574	489	2734	689	2812	1145	2940	1964	3072	3477	3183	4972	3284	4676	3353	2474
19	2575	456	2716	766	2793	1176	2936 *	2082	3064 *	3819	3201	5607	3287	5326	3361	2904
20	2542	387	2678	546	2798 *	911	2946	1649	3089	3299	3203	4795	3303	4538	3369	2474
21	2543	251	2696 *	422	2785	707	2949	1389	3104	2553	3224	3638	3319	3553	3410	1905

* Deviation

Figure 2. Mean birth weight by gestational age, and age of mother: U.S. AA 1999, singleton live births (N=107,997)
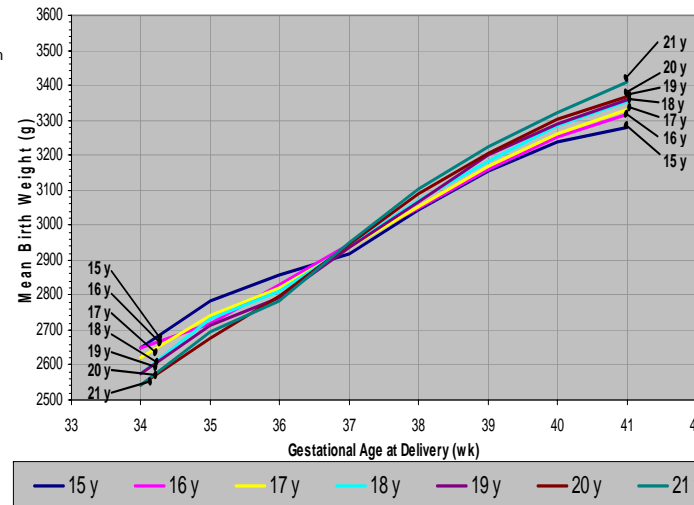
Results

Mean infant birth wt by gestational wk (Fig 2 and Table 1) was:

- inversely related to mothers' y of age15-21 at each gestational wk <37, 34 th wk mean wt of births to mothers, for example:
  - 15 y - 2650 g
  - 21 y - 2543 g

- positively related to mothers' y of age 15-21 at each gestational wk ≥37, 41st wk mean wt of births to mothers, for example:
  - 15 y - 3281 g
  - 21 y - 3410 g

- unrelated to adult (≥22) mothers' y of age

Relationships were confirmed by Linear Regression and ANCOVA, adjusting for: prenatal care initiation, marital status, appropriateness of educational attainment.

Conclusion

As predicted by life history theory (1) gravidas delivered infants whose birth weight for gestational age was related to the maternal state of biological maturity:

- in negative association with mothers' y of age 15-21 y, preterm,
- in positive association with mothers' y of age 15-21 y, term births.
- unrelated to adult mothers' y of age

Consistency of interrelationships across adolescence when adjusted for available socioeconomic factors indicates the stage of physical development was partially responsible for birth wt for gestational age of adolescents' infants.

A potential explanation for the pattern of relationships is:

- least mature gravidas were likely to expel infants which reached a relatively large size in early gestation,
- more mature adolescent gravidas could carry infants of that size to a longer gestation,
- an immature uterus (among other body components) contributes to preterm birth of infants who would have had the opportunity to develop more fully in the womb of more mature adolescent gravidas.

Implications

This trade-off leading to small, less fit infants is one of the biological processes in gestation with ill effects that are predictive of adult diseases (14) and poor outcome in intergenerational reproduction patterns (15), and thus is important though it does not give rise to a large overall number of preterm or small infants in a particular year.

Child bearing among mothers 15 – 21y producing infants affected by a trade-off between their mother's final development and their initial development should be a focus of biological as well as socio-economic concern.

The trade-off likely affects adolescent child bearing in other US ethnicities, though perhaps to a lesser degree because of dissimilar growth and reproductive patterns (later menarche, greater contraception and later childbearing among the dominant European American population).

References:
1. Stearns SC. *The evolution of life histories.* New York, Oxford University Press 1992.
2. Holm K, Laursen EM, Brocks V, Muller J. Pubertal maturation of the internal genitalia: an ultrasound evaluation of 166 healthy girls. Ultrasound Obstet Gynecol. 1995 Sep;**6**(3):175-81.
3. Hediger ML, School TO and Schall JI: Implications of the Camden study of adolescent pregnancy: Interactions among maternal growth, nutritional status, and body composition. Ann NY Acad Sci 1997;**817**:281-291.
4. Garn SM and Petzold AS. Characteristics of the mother and child in teenage pregnancy. Am J Dis Child 1983; **137**: 365-8.
5. Geronimus AT. The effects of race, residence, and prenatal care on the relationship of maternal age to neonatal mortality. AJ Pub Health 1986; **76**: 1416-1421.
6. Stevens-Simon C, and McAnarney ER. Adolescent maternal weight gain and low birth weight: a multifactorial model. Am J Clin Nutr 1988; **48**: 948-53.
7. American Academy of Pediatrics, Committee on Adolescence: Adolescent pregnancy current trends and issues: 1998. Pediatrics 1999; **103**: 516-20.
8. Herman-Giddens M, Slora E, Wasserman R, et al. Secondary sexual characteristics and menses in young girls seen in office practice: A study from the Pediatric Research in Office Settings Network. Pediatrics 1997; **4**: 505-12.
9. Rosenthal SL, et al.. Sexual initiation: predictors and developmental trends. Sexually Transmitted Diseases 2001; **28**: 527-32.
10. Scholl TO, Hediger ML, and Schall JI: Maternal growth and fetal growth:Pregnancy course and outcome in the Camden study. Ann NY Acad Sci 1997;**817**:292-30.
11. Akinbami LJ, et al. 2000. Risk of preterm birth in multiparous teenagers. Arch Pediatr Adolesc Med. **154**(11):1101-7.
12. Rees JM, Lederman SA, and Keily J: Birth weight associated with lowest neonatal mortality: Infants of adolescent and adult mothers. Pediatrics 1996;**98**:1161-1166.
13. Center for Disease Control (CDC), National Center for Health Statistics. 1999 Perinatal Mortality Data File. CD-ROM Series 20 Number 20. 2002.
14. Kuzawa CW. Fetal origins of developmental plasticity: Are fetal cues reliable predictors of future nutritional environments? Am J Hum Biol **17**:5-21, 2005.
15. Emanuel I, Leisenring W, Williams MA, et al.. The Washington State intergenerational study of birth outcomes: methodology and some comparisons of maternal birthweight and infant birthweight and gestation in four ethnic groups. Paediatr Perinat Epidemiol 1999; **13**: 352-69.