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Evolution and Human Behavior 24 (2003) 376–390

Evolution and Human Behavior

Father absence, parental care, and female reproductive development

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Received 10 February 2003; received in revised form 19 June 2003

Abstract

This study examines female reproductive development from an evolutionary life history perspective. Retrospective data are for 10,847 U.S. women. Results indicate that timing of parental separation is associated with reproductive development and is not confounded with socioeconomic variables or phenotypic correlations with mothers' reproductive behavior. Divorce/separation between birth and 5 years predicted early menarche, first sexual intercourse, first pregnancy, and shorter duration of first marriage. Separation in adolescence was the strongest predictor of number of sex partners. Multiple changes in childhood caretaking environment were associated with early menarche, first sex, first pregnancy, greater number of sex partners, and shorter duration of marriage. Living with either the father or mother after separation had similar effect on reproductive development. Living with a stepfather showed a weak, but significant, association with reproductive development, however, duration of stepfather exposure was not a significant predictor of development. Difference in amount and quality of direct parental care (vs. indirect parental investment) in two- and single-parent households may be the primary factor linking family environment to reproductive development.

Keywords: Child development; Conjugal stability; Demography; Evolutionary ecology; Family environment; Father absence; Life history; Menarche; Parental investment; Puberty; Reproductive strategies; Sexual behavior

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doi:10.1016/S1090-5138(03)00039-4

1. Introduction

1.1. Background

In Western industrial populations, father absence is a risk factor for undesirable developmental outcomes: early sexual activity, teen pregnancy, and unstable marriages later in life (e.g., Bumpass, Martin, & Sweet, 1991; Ellis et al., 2003; Glenn & Kramer, 1987; Hogan & Kitagawa, 1985; Keith & Finlay, 1988; Kiernan & Hobcraft, 1997; Kinnaird & Gerrard, 1986; McLanahan & Bumpass, 1988; Newcomber & Udry, 1987). The mechanisms by which fathers affect offspring are unknown: Fathers may serve as a cue for canalization of reproductive strategies (Draper & Harpending, 1982; Ellis, 2002) or they may alter patterns of parental care influencing development (Barber, 2000, pp. 51–63; Ellis et al., 2003). Father absence may affect development through shared genes (e.g., Comings, Muhleman, Johnson, MacMurray, 2002), exposure to unrelated males (Ellis, 2002), and modeling of mothers' sexual behavior (Amato, 1999). Stress related to divorce and economic uncertainty may confound effects of father absence (Chisholm, 1999, pp. 161–168).

This study examines father absence, timing of parental separation and changes in caretaking environment, and their associations with female reproductive development in the United States. Multivariate analyses control for indicators of stressful environments, phenotypic correlations with mothers' reproductive strategy, and direct effects of fathers and stepfathers. Results suggest that quality of direct parental care during early childhood predicts differences in female reproductive development.

Human parental investment (PI) is complex, involving different types of resources. There is a tradeoff between investment in direct childcare and indirect investment (Quinlan, Quinlan, & Flinn, 2003). Some parents choose to emphasize investment in education, status symbols, etc. at a cost to direct care. Children may have different developmental responses to various facets of PI. Development may be insensitive to indirect PI because during human evolution there were few avenues for indirect investment (Kaplan & Lancaster, 2000). If human parenting behavior evolved to foster offspring social competency (Geary & Flinn, 2001), then children may be attuned to variations in direct care. Socioeconomics, hence, may have weak influence on development, except when parental economic activities affect patterns of direct care: when, for example, parents must work two jobs to make ends meet.

Here, two variables indicate limited direct parental care: (1) pair-bond dissolution, and (2) changes in caretaking arrangements. If all else is equal, two parents provide more direct care than a single parent. Behavioral studies found that children with two parents spent more time at home and with their mother than did father-absent children (Quinlan & Flinn, 2003), and girls in two-parent households were better supervised than were father-absent girls (Flinn, 1988a). Other studies found reduced parental supervision in single-mother households (Dornbusch et al., 1985; Newcomer & Udry, 1987), and many studies document shorter duration of breastfeeding among father-absent children (Bar-Yam & Darby, 1997; Kiehl, Anderson, Wilson, & Fosson, 1996; Pande, Unwin, & Haheim, 1997; Quinlan et al., 2003; Vega Lopez & Gonzalez, 1993). Other changes in caretaking

arrangements suggest inconsistency in direct care. After controlling for potential confounds, pair-bond dissolution and changes in caretaking arrangements serve as proxies of direct parental care.

1.2. Life history approach to reproductive development

Life history strategies reflect two basic "decisions" (see Stearns, 1992): whether to reproduce now or later, and the amount of resources to invest in each offspring. "Choosing" a strategy depends on the costs and benefits of alternatives. Where fitness hinges on accumulation of resources and skills, delaying reproduction is appropriate (Geary & Bjorklund, 2000). Long delays, however, can reduce fitness through a shortened reproductive span, discounted reproduction, and mortality exposure.

Draper and Harpending (1982, 1988) suggest that humans evolved psychological mechanisms that use father presence during childhood as a cue for developing life history strategies. Father presence denotes an environment requiring two parents for child survival and cultural success and cues development of a *parenting* effort strategy (delayed maturation, stable relationships, low fertility). Conversely, father absence indicates that two parents are not necessary and cues a *mating* effort strategy (early maturation, short term partners, high fertility). The model posits a sensitive period: Family life from birth to 5–7 years shapes children's expectations of adult reproductive options (Belsky, Steinberg, & Draper, 1991, p.651). Developmental canalization is adaptive if conditions in childhood persist into adulthood.

Modifications of Draper and Harpending's (1982, 1988) model suggest that attachment mediates between early experience and adult behavior (Belsky et al., 1991). Father absence causes less responsive care, because mothers' time and attention are divided between making a living and caring for children. Unresponsiveness results in insecure attachment and an insecure "model" of social relationships. Insecure adults tend toward mating effort strategies. Conversely, secure attachment leads to a secure model of relationships and a parenting effort strategy. Attachment style is associated with conjugal behavior (e.g., Feeney, 2002; Gallo & Smith, 2001; Hill, Young, & Nord, 1994). Hence, parental separation early in life may predict conjugal instability and number of sex partners.

These evolutionary ideas suggest a "rule of thumb" for reproductive development. Quality of direct parental care received during childhood determines whether development continues or not and indicates appropriate adult strategies. If PI is forthcoming, then offspring should delay reproduction. High levels of PI indicate an environment in which offspring success is sensitive to parental care, and a long developmental period should improve offspring competency. If PI is not forthcoming, then offspring should accelerate reproductive development. Low levels of PI may indicate that success is not dependent on parental care, because "care-independent" risks are high (see Borgerhoff Mulder, 1992; Chisholm, 1999). If PI is not forthcoming, then delaying reproduction may not be beneficial and may reduce fitness. Therefore, limited PI should predict accelerated maturation.

The biological stress response may link direct parental care to reproductive development (Belsky et al.1991; Chisholm, 1999). Unresponsive parenting is positively associated with

children's stress (cortisol) (Gunnar, 2000; Gunnar & Donzella, 2002), and children of single mothers tend to have elevated cortisol levels (Flinn, Quinlan, Turner, Decker, & England, 1996). Stressful family environments are associated with accelerated reproductive development (Ellis & Graber, 2000; Ellis, McFadyen-Ketchum, Pettit, Dodge, & Bates, 1999; Hulanicka, 1999; Moffitt, Caspi, Belsky, & Silva, 1992), and parental "affectionate-positivity" and time fathers spent in childcare are associated with delayed puberty in girls (Ellis et al., 1999). In sum, the stress response may have "organizational" effects that adjust life history strategies in reaction to early experience (Worthman, 1999, pp. 87–88). [The stress response is also associated with attachment style (Spangler & Schieche, 1998).] Timing of parental separation may influence the strength of effects on development, because organizational influences are strongest in early childhood. Girls whose parents divorce or separate between birth and 6 years should be at higher risk of early menarche, first sexual intercourse, and first pregnancy. If, however, modeling of mother's mating behavior is the mechanism linking father absence to development (e.g., Amato, 1999), then separation during early or middle childhood (even adolescence) should have equal effects on girls reproductive development, and under the "modeling hypothesis" parental separation should not affect menarche.

A biosocial hypothesis, contrary to the parental investment model, suggests that father absence/presence may influence girls' reproductive development regardless of intermediate effects on quality of parental care. Mechanisms for this direct effect are not clear: Pheromones of unrelated adult males may accelerate maturation or paternal pheromones may delay puberty to avoid father–daughter incest (Ellis, 2002). If fathers directly influence development, regardless of their effect on parental care, or if exposure to unrelated males accelerates development, then girls living with their father postseparation should show similar development to girls in intact families, and girls living with stepfathers should be at risk of early menarche, first sex, and first pregnancy.

2. Methods

2.1. Data

The National Survey of Family Growth (NSFG) is a study of reproduction in a sample of 10,847 U.S. women aged 15–44 years conducted between 1973 and 1995 (Amba, Chandra, Mosher, Peterson, & Piccinino, 1997). Analyses are for the 1995 survey. The NSFG is not ideal for identifying causal mechanisms; however, multivariate analyses and tests of multiple hypotheses are suggestive.

The survey design includes "over-sampling" of some subpopulations. Assuming simple random sampling (SRS), the design yields biased parameter estimates (Potter & Iannocchione, 1998). Sampling weights correct biased point estimates (Brogan, 1998). Normed weights are used here. Sampling weights do not correct biased variance estimates. Assuming SRS, sample standard errors (S.E.'s) are lower than direct or replication estimates (ibid), increasing the likelihood of Type I errors. Published differences between direct and SRS estimates of S.E.'s

for the NSFG (Potter & Iannocchione, 1998, p. 29) suggest that 99% confidence intervals (used here) compensate sufficiently for increased probability of Type I errors.

2.2. Variables and analysis

Three variables indicate pace of reproductive development: age at menarche, age at first voluntary sexual intercourse, and age at first pregnancy outcome. Two variables indicate pair-bond stability: number of sex partners and duration of first marriage. The first analyses have three predictors: (1) timing of parental separation (age 0–5, 6–11, and 12–17 years) versus intact family environment; (2) number of changes in the caretaking situation (see Appendix); and (3) whether a girl lived with a stepfather/mothers' boyfriend postseparation (1 = lived with stepdad). A categorical caretaking environment variable—(1) lived with both parents until age 18; (2) lived with mother only postseparation; (3) lived with father only—was the predictor in analyses of fathers' direct effects.

Other variables control for possible confounds (see Table 1). Father absence may be confounded by socioeconomic status (Chisholm, 1999, pp. 161–168). Socioeconomic controls (mother and father's education levels, and African American ethnicity) adjust associations between family environment and reproductive development. Mother's age at first birth controls for heritability of reproductive strategies in the analysis of time to first pregnancy; for other analyses better controls are desirable, but unavailable. Age at first marriage is included in the analysis of duration of first marriage. Whether the daughter lived with her father postseparation entered the appropriate models to isolate associations between father absence and reproductive variables.

Hazard analysis modeled associations between predictors and menarche, first sex, first pregnancy, and duration of first marriage. Cox regression allows for inclusion of censored cases and does not assume normal distribution. The proportional hazards assumption was tested with "time-dependent" covariates (i.e., product terms for Time × Time-Independent

Table 1
Descriptive statistics

Variable	*N*	Median	Mean	S.D.	Min	Max
Lived with stepdad	10847	0	0.11[a]	0.32	0	1
African American ethnicity	10847	0	0.14[a]	0.35	0	1
Mom's years of education	10776	12	11.62	3.49	0	19
Dad's years of education	10291	12	11.87	3.94	0	19
Mom's age at 1st birth	10776	21	21.52	4.42	9	54
Lived with dad after divorce	10847	0	0.08[a]	0.27	0	1
Age at 1st marriage	6760	21	21.74	4.26	13	43
Duration of 1st marriage (if divorced)	4333	10	10.54	7.06	0	29
Age at menarche	10839	13	12.61	1.61	5	28
Age at 1st sexual intercourse	9660	17	17.57	3.10	6	41
Age at 1st pregnancy	7103	21	21.49	4.73	11	41
Lifetime number male sex partners	10847	3	6.49	21.43	0	900

[a] Indicates proportion.

Table 2
Multivariate hazard analysis

	Menarche[a] (*N* = 10,135)			1st Sexual Intercourse[b] (*N* = 10,141)			1st Pregnancy[c] (*N* = 10,141)			Duration of 1st Marriage[d] (*N* = 6,375)		
Variables	HR	CI		HR	CI		HR	CI		HR	CI	
Parents separated[e]												
0–5 years old	1.802	1.012	3.208	4.027	2.155	7.523	2.459	1.431	4.228	1.507	1.118	2.031
6–11 years old	1.485	1.000	2.206	2.672	1.730	4.129	1.780	1.208	2.621	1.278	0.986	1.658
12–17 years old	1.177	0.940	1.474	1.999	1.563	2.558	1.521	1.205	1.921	1.092	0.870	1.371
Changes in caretaking situation[f]												
1	1.058	0.971	1.154	1.683	1.306	2.170	1.701	1.342	2.156	1.120	0.938	1.338
2	1.136	0.994	1.297	2.755	1.696	4.473	3.133	2.008	4.890	1.487	1.110	1.993
3 or more	1.184	1.019	1.375	4.555	2.261	9.175	5.731	3.045	10.786	1.841	1.2671	2.675
Lived w/ stepdad	0.962	0.853	1.083	1.254	1.107	1.420	1.192	1.032	1.376	0.935	0.757	1.156
Control variables												
African American	1.016	0.952	1.084	3.918	2.563	5.988	8.463	5.820	12.306	0.962	0.769	1.203
Mom's education level	1.004	0.994	1.013	1.016	1.007	1.026	0.972	0.962	0.983	1.042	1.013	1.072
Dad's education level	0.924	0.880	0.970	0.935	0.901	0.970	0.869	0.840	0.900	1.055	1.030	1.081
Mom's Age at first birth	1.001	0.995	1.008	0.964	0.957	0.971	0.955	0.947	0.962	0.957	0.938	0.977
Lived w/ dad	0.950	0.847	1.067	1.046	0.927	1.181	1.040	0.907	1.193	0.831	0.674	1.024
Age at marriage	–	–	–	–	–	–	–	–	–	1.126	1.115	1.136

Time dependent covariates for each analysis are listed below.

HR = adjusted hazard ratio. CI = 99% confidence interval.

[a] Time dependent covariates: age at parental separation, dad's education level.

[b] Time dependent covariates: age at parental separation, dad's education level, changes in family environment, African American.

[c] Time dependent covariates: age at parental separation, dad's education level, changes in family environment, African American.

[d] Time dependent covariates: age at parental separation, dad's education level, mom's education level, changes in family environment, African American.

Women who never married were excluded from the analysis. Women who had not divorced were included as censored cases.

[e] Reference group = women from intact family environments.

[f] Reference group = no changes in family environment.

variables; see Kleinbaum, 1996, 214–239). Significant ($P \leq .05$) time-dependent variables were retained in the models and appear in the note to Table 2. A hazard ratio (HR) >1 indicates that an event (e.g., menarche) tended to occur earlier for one group (e.g., father-absent girls) compared with a reference group (e.g., girls from intact families); a HR < 1 indicates delays in one group relative to the reference. For continuous predictors (e.g., dad's education) an HR indicates timing of events relative to next lower level of the predictor.

Logistic regression modeled associations between the predictors and odds of being above the median number of sex partners. Logistic regression models number of sex partners as a dichotomous variable (above the median) because the distribution of number of sex partners is skewed (Table 1). An odds ratio (OR) >1 indicates that an outcome (e.g., above median for sex partners) is more likely for one group compared with a reference group; OR < 1 indicates a less likely outcome.

3. Results

Ninety percent of the women in the sample were born into a two-parent family. More than 74% stayed with two parents from birth through 18 years; about 12% of women's parents divorce/separated between birth and 6 years; 8% separated between 6 and 12 years and 6% between 12 and 18 years. Of the women whose parents separated or divorced, 76% lived with their mother postseparation; 11% lived with their father; about 9% lived with grandparents without parents; and about 3% lived with other relatives, in foster care, or in an institutional setting. Eighteen percent of the sample women experienced two or more changes in caretaking arrangements, and only 8% experienced three or more changes. See Table 1 for descriptive statistics.

3.1. Pace of reproductive development

Timing of parental separation and number of changes in caretaking environment predicted all three measures of reproductive development. Age at menarche, first pregnancy, and first voluntary sexual intercourse showed consistent dose–response relationships to timing of separation and changes in caretaking. After controlling for all the variables in model, women whose parents separated between birth and 6 years of age experienced nearly twice the risk (hazard) of early menarche, were at more than four times greater risk of early sexual intercourse, and were at two and a half times greater risk of early pregnancy when compared with women from intact families (see Table 2 for adjusted hazard ratios and 99% confidence intervals). Risk of early reproductive development decreased the longer women had lived with both parents. Number of changes in caretaking environment showed a similar pattern. Compared with women who had no change in their family environment, women who experienced three or more changes were at slightly higher risk of early menarche, had more than four times the risk of early sexual intercourse, and more than five times the risk of early pregnancy. Again, the risk of accelerated reproductive development decreased as the number of changes decreased. Women who experienced only one or two changes,

however, did not have significantly greater risk of early menarche compared with women who experienced no changes.

3.2. Pair-bond stability

Compared to the pace of reproduction, indicators of women's own pair-bond stability did not show a consistent pattern of associations with the predictors. Early parental separation (0–5 years) was associated with shorter duration of first marriage (Table 2). Women whose parents separated between 6 and 17 years of age, however, did not have significantly shorter marriages than did women from intact families. Women who experienced two or more changes in caretaking situation also tended to divorce sooner than women who experienced no changes. Women who experienced three or more changes were more likely to be above the median for number of sex partners than were women who experienced no changes in family environment (see Table 3 for adjusted odds ratios and 99% confidence intervals). Women who experienced one or two changes were not significantly more likely to be above the median compared with no change. Compared with women who grew up in intact families, women whose parents separated were more likely to be above the median number of sex partners (Table 3). Parental separation in adolescence (12–17 years) was the strongest predictor of number of sex partners. Odds of being above the median decreased for women whose parents separated before age 12. (Mean number sex partners, adjusted for covariates and controls using ordinary least squares method, was 5.3 for women from intact families, 7.1

Table 3
Logistic regression: above median for number of sex partners

(N = 10,097)	OR	CI	
Parents separated [a]			
0–5 years old	1.221	0.990	1.505
6–11 years old	1.361	1.083	1.711
12–17 years old	1.631	1.277	2.085
Changes in caretaking situation [b]			
1	1.111	0.927	1.331
2	1.039	0.789	1.368
3 or more	1.567	1.154	2.128
Lived w/ stepdad	1.299	1.017	1.661
Control variables			
Mom's education level	1.062	1.017	1.084
Dad's education level	1.018	1.000	1.035
African American	1.742	1.483	2.046
Age	1.060	1.053	1.067
Mom's Age at first birth	0.982	0.970	0.995
Lived w/ dad	1.183	0.925	1.513

OR = adjusted odds ratio, CI = 99% confidence interval.

[a] Reference group = women from intact family environments.

[b] Reference group = no changes in family environment.

for women whose parents separated between 12 and 17 years, 6.2 for 6–11 years, and 6.6 for 0–5 years. A Winsorized criterion showed a similar pattern.) It is possible that the censored cases result in biased estimates: Some younger women below the median may eventually be above the median. Additional logistic regression analyses with subsamples of women >30 and >40 years of age, however, yielded similar results.

3.3. Direct effect of biological fathers

Fathers may have direct effect on daughters' development, rather than indirectly through parental care. These analyses examine associations with living with father (without a stepmother) after parental separation. Women who lived with their father only postseparation were the reference category. Variables in previous analyses (including timing of separation and changes in caretaking situation) entered the models as covariates. The "lived with father" indicator was excluded.

Woman from two-parent and mother-only households did not show increased risk of early menarche compared with women who lived with their father only (see Table 4). However, when the analysis is limited to women whose parents separated between 0 to 6 years compared with women from intact families, then women who lived with their mother only or *father only* tended to have earlier menarche than did women from intact families (one-tail $P = .02$ for father only and one-tail $P < .001$ for mother only by Mann–Whitney tests). Women whose parents separated before age 6 and who had lived with their father postseparation had the lowest mean age at menarche in the sample.

Other results are not consistent with predictions of the "biosocial" hypothesis. Women from two-parent families showed decreased risk of early sexual intercourse compared with women who had lived with their father only (Table 4), but there was no significant difference in hazards of first sex between women from mother- and father-only households. Women from either two-parent or mother-only households were *less* likely to experience early pregnancy compared with women who lived with their father postseparation.

3.4. Effect of stepfathers

Stepfather presence was associated with age of first sexual intercourse and first pregnancy, but it did not "dislodge" associations between parental separation and those variables. For all

Table 4
Adjusted hazards of living with a single father

	Menarche			1st sexual intercourse			1st Pregnancy		
Caretaking environment	HR	CI		HR	CI		HR	CI	
Two parents[a]	1.024	0.845	1.234	0.746	0.618	0.920	0.193	0.068	0.553
Single mother[a]	1.013	0.875	1.179	0.933	0.796	1.093	0.456	0.267	0.767

HR = hazard ratios adjusted for covariates in Table 2 except the "lived w/ dad" variable. An additional time dependent covariate for care-taking environment was included in the model for "Age at 1st Pregnancy Outcome."

[a] Reference group = single father.

Table 5
Adjusted hazards of stepfather exposure

	Menarche			1st sexual intercourse			1st pregnancy		
Stepfather exposure	HR	CI		HR	CI		HR	CI	
0–5 years old[a]	0.935	0.809	1.08	1.278	1.1	1.484	1.338	1.136	1.575
6–11 years old[a]	0.998	0.849	1.173	1.207	1.019	1.429	1.094	0.898	1.333
12–17 years old[a]	0.946	0.783	1.143	1.148	0.942	1.398	1.151	0.913	1.451
Duration of stepfather exposure (stepdaughters only, N = 1,211)									
0–5 years old[b]	0.934	0.713	1.224	1.077	0.813	1.428	1.057	0.758	1.474
6–11 years old[b]	1.057	0.833	1.34	1.075	0.84	1.375	0.941	0.702	1.263

HR = hazard ratios adjusted for covariates in Table 2.
[a] No stepfather exposure was the reference group.
[b] Stepfather exposure beginning at age 12 years or later was the reference group.

criterion variables, adjusted hazards of parental separation from birth through 5 years were greater than adjusted hazards of stepfather exposure (see Table 2). Hazards of first sex and first pregnancy were increased for girls living with stepfathers (1.25 and 1.19, respectively). Living with a stepfather was not associated with age at menarche. Analyses of the timing/duration of stepfather relationships indicate that compared with no exposure, living with a stepfather from birth through 5 years had the strongest effect on age at first sex and first pregnancy (see Table 5). Analyses limited to girls who had lived with a stepfather during childhood ($N = 1{,}211$), which replicate Ellis and Garber (2000, p. 495), found no significant association between duration/timing of stepfather exposure and reproductive development (Table 5).

4. Discussion

Parental separation in early childhood and changes in caretaking situation are associated with timing of menarche, first sexual intercourse, first pregnancy, and duration of first marriage. Significant associations remain after adjustment for covariates, suggesting that predictors are not confounded with other indicators of disadvantaged environments. These results are similar to a recent prospective study of the effects of timing of father absence on teen pregnancy and early sexual activity (Ellis et al., 2003). Ellis et al. (2003) conclude that their results are consistent with three hypotheses: (1) Single- and two-parent families have different patterns of parental care resulting in differences in reproductive development, (2) social learning may account for developmental differences as father-absent girls model their mothers' sexual behavior, and (3) reproductive strategies may be heritable. The NSFG data cannot conclusively distinguish between these hypotheses; however, results for menarche suggest that social learning is unlikely. There also may be multiple effects on reproductive development.

Other results suggest that father presence does not merely cue development: Girls who lived with their father postseparation showed similar development to girls who lived with a

single mother. Furthermore, associations between early parental separation and reproductive development were independent of stepfather exposure.

One finding not predicted deserves mention. African American ethnicity showed substantially increased hazards of first sex and first pregnancy, but was not associated with menarche, suggesting that cultural forces influence reproductive timing.

4.1. Limitations of the study

Retrospective data may suffer from recall bias. A recent study, however, compared individual recall to archive material and found that simple sociodemographic information was accurate after 50 years (Berney & Blane, 1997). The life-event and sociodemographic data used here are not likely to be biased, nor do they appear "noisy."

Low resolution is a trade-off for convenience of retrospective data. There are two proxies of direct PI in the NSFG: parental separation and changes in caretaking arrangements. Better measures could isolate mechanisms for fathers' effect on reproductive development. There is ample evidence, however, that direct care is enhanced in two-parent households (Bar-Yam & Darby, 1997; Dornbusch et al., 1985; Flinn, 1988a; Kiehl et al., 1996; Newcomer & Udry, 1987; Pande et al., 1997; Quinlan & Flinn, 2003; Quinlan et al., 2003; Vega Lopez & Gonzalez, 1993). Multivariate analyses, multiple tests, and findings from similar studies narrow the field of plausible explanations.

NSFG data cannot test the hypothesis that reproductive strategies are inherited genetically. Heritable life history might confound associations between family environment and development. Human heritability estimates range from .00 to .40 for fertility, from .15 to .72 for age at first sex, and .19 for first birth (Hughes & Burlson, 2000). Other estimates are .42 for pair-bond, .28 for number of mates (Trumbetta & Gottesman, 2000), .44 for menarche and .40 for pubertal timing (Rowe, 2000). The meaning and accuracy of heritability estimates for humans are controversial (Collins, Maccoby, Steinber, Hetherington, & Bornstein, 2000; Dickens & Flynn, 2001; Ehrlich & Feldman, 2003; Falconer & Mackay, 1996, 171–174; Feldman & Otto, 1997; Kamin & Goldberger, 2002; Maccoby, 2000). With these estimates, there is still a potentially large reaction range (e.g., Belsky, 2000): After adjusting for mother's age at first birth, hazard of first pregnancy for girls whose parents separated between birth and 6 years was more than twice that for girls from intact families (Table 2). Although not ideal, mother's age at first birth provides control for heritability of life history traits. NSFG data, however, do not include controls for paternal transmission (e.g., Comings et al., 2002).

4.2. Contradictory findings

Similar studies show contradictory results. McLanahan and Bumpass (1988), using the 1982 NSFG, obtained null results based on 12% to 17% of the sample. Whether they used sampling weights is unclear: The unweighted, reduced sample may yield biased estimates. Two studies found no effect of presence of an adult male on menarche (Graber, Brooks-Gunn, & Warren, 1995; Kim & Smith, 1998), but both lack statistical power ($N = 75$ and 226,

respectively). Finally, analyses of stepfather exposure here failed to replicate Ellis and Garber (2000, p. 495), which may be due to their small sample of stepdaughters ($N = 31$).

One result contrary to prediction requires attention. Parental divorce during adolescence was associated with increased risk of multiple sexual partners. Parental control may be weakened during and after a break up, exposing girls to sex with several partners in adolescence. Adolescents also may model parental dating behavior following divorce (e.g., Amato, 1999). NSFG data cannot distinguish between these possibilities.

4.3. Conclusions

These results are consistent with life history theory. Timing of parental separation and changes in caretaking arrangements are independently associated with reproductive development. Direct care and indirect investment are separate avenues of PI and quality of parental care may not be linked to general "life-course adversity" (see Ellis et al., 2003). Intermediate mechanisms by which family environments influence reproductive development are unclear. Attachment may mediate between early family environment and subsequent pair-bonds; and the stress response may play an important role in sexual maturation. Both attachment and stress are associated with direct parental care. Direct effects of the biological father or stepfather through pheromones (Ellis, 2002) on girls' reproductive development seem unlikely given similar risks associated living with either mother or father postseparation. Living with a stepfather showed weak, but significant, associations with development; but duration of exposure did not. The "stepfather effect" may be due to reduced care as mothers shift their attention to mating effort or due to conflicts of reproductive interests that produce stressful environments (Daly & Wilson, 1998; Flinn, 1988b).

In sum, reproductive development may be sensitive to direct parental care, and ability to provide direct care is enhanced in two-parent households. Variation in direct parental care may be the causal link between types of environmental risks (mortality, inequality, etc.) and human life history (see Wilson & Daly, 1997). Conclusive results await tests of behavior genetic models incorporating direct environmental measures (Collins et al., 2000; Dickens & Flynn, 2001). Investigations should also examine links among environmental risks, parental care, physiological mechanisms (e.g., cortisol), and development, research requiring a complex longitudinal design.

Appendix. Types of family environment/caretaking arrangements

1. two biological parents
2. two adoptive parents
3. biological mother only
4. biological father only
5. biological mother and stepfather or adoptive father
6. biological father and stepmother or adoptive mother
7. single biological parent and grandparent

8. single biological parent and other opposite sex relative
9. single biological parent and boyfriend/girlfriend
10. grandparent(s) without parents
11. other relative(s) without parents
12. group home or institution without parents
13. other situation/place without parents

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