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STRESS AND AGE AT MENARCHE OF MOTHERS AND DAUGHTERS

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Summary. The hypothesis that psychological stress during early childhood leads to advanced reproductive maturation was assessed using data from the California Childhood Health and Development Study. Regression analyses failed to indicate that bed wetting, nightmares or thumb-sucking at age 5 predict age at menarche, regardless of controls for mother's age at menarche. Among socioeconomic variables suggested as contextual stressors measured at age 9–11 only mother's education was a significant predictor of daughter's age at menarche, though its effect is trivial compared to mother's age at menarche. Path analysis on a subsample of the subjects failed to demonstrate the hypothesised indirect effect of mother's age at menarche on daughter's age at menarche acting through early marriage and marital dissolution. These results cast doubt on the theory that early childhood stress is the key to divergent reproductive strategies among females based on the timing of reproductive maturation.

Introduction

The finding that age at menarche is lower among girls from households where the father is absent has potential implications for biosocial influences on reproductive maturation (Jones *et al.*, 1972; Moffitt *et al.*, 1992; Surbey, 1990). Belsky, Steinberg & Draper (1991) proposed that early childhood stress resulting from non-intact families (and other contexts) is the critical influence in shaping divergent female reproductive strategies.

Belsky *et al.* (1991) include both psychological and biological processes in their conceptualisation of the development of female reproductive strategies but the association between childhood stress and advanced reproductive maturation is the unique aspect of their theory and provides a biological basis for the behavioural sequelae of early childhood experience as a reproductive strategy.

The empirical evidence for the hypothesis that childhood stress is related to advanced reproductive development is ambiguous. Some studies report lower age at menarche among girls from non-intact households (Jones *et al.*, 1972; Moffitt *et al.*,

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1992; Surbey, 1990) which are assumed to be more stressful. Surbey (1990) found that higher levels of stress among intact families were associated with earlier age at menarche. Moffitt *et al.* (1992) also found that family conflict predicted early age at menarche, even when parental divorce and the child's weight were taken into account.

However, there is also the possibility that lower age at menarche results from the strong relationship between age at menarche of mothers and their daughters. Women with an early age at menarche exhibit early onset of sexual behaviour and earlier age at first marriage which is more likely to end in divorce; they also have daughters who are early maturers. Thus the lower age at menarche among girls from father-absent families may simply reflect the greater likelihood that their mothers, who are likely to be early maturers, are divorced. While both stress and divorce are associated with mother's early reproductive maturation, it may be the relationship between mother's age at menarche and divorce that underlies the relationship with father's absence and daughter's age at menarche.

Belsky *et al.* hypothesise that early childhood stress leads to accelerated reproductive maturation through behavioural problems and lower levels of activity resulting in greater accumulation of fat. However, Moffitt *et al.*'s (1990) attempt to test this was negative. It is therefore now suggested that it is the effects of the mother's age at menarche on the likelihood of marital dissolution, not stress, that accounts for the association of father's absence with early age at menarche. This has not been included in previous studies so the analysis presented here attempts to determine if stressful situations in childhood are related to advanced reproductive maturation even when mother's age at menarche is taken into consideration. In addition, the hypothesis that the association between father's absence and age at menarche reflects the fact that both are related to mother's age at menarche is explicitly tested.

Materials and methods

Data from the California Child Health and Development Study (see van den Berg, Christianson & Oechsli, 1988, for a full description of the study) were used to test the effects of childhood stress on age at menarche. Subjects represent a cohort of girls born between 1960–63 in the Kaiser Hospital, Oakland, California. Racial composition was mixed: 65% of the sample were white, 24% black, 4% Asian-American, 3% Mexican American and 4% other. Follow-up interviews at age 5, 9–11, and in late adolescence (average age 17) provided measures appropriate to test the hypothesis. From the age 5 interview, mother's report of whether their daughters had nightmares, wet their bed or sucked their thumb, all of which are thought to be related to stress (Erman, 1987; Novello & Novello, 1987; Johnson & Johnson, 1975), as well as the absence or presence of the original father were used as measures of early childhood stress as shown in Table 1.

Comparable measures of stress were not available from the 9–11 interviews. Instead socioeconomic variables suggested by Belsky *et al.* (1991) as contextual stressors, including mother's education, mother's work and whether the mother's current husband was employed were used as predictors. These variables were coded dichotomously to reflect stress as shown in Table 1. Mother's age at menarche was

Table 1. Predictor variables used

Independent variable	Definition
Interview at age 5	
Father's status	Present/absent
Child's behaviour	
Nightmares	Scale of 1–4, from never to often
Sucks thumb	No/yes
Wets bed	Scale of 1–4, from never to often
Controls	
Race	All other/black
Interview at age 9–11	
Father's status	Present/absent
Work and education	
Mother's work status	None versus some to full
Husband works	Yes/no
Mother's education	Finished high school versus did not
Controls	
Age at examination	Months
Race	All other/black
Biiliac diameter	Centimetres

recorded on initial entry into the study; daughter's age at menarche as well as father's presence or absence at adolescence were taken from the late adolescent interview.

The total number of daughters for which information at all three rounds was available was 1001. However, missing data resulted in sample sizes of 310 for analyses at age 5, 456 at age 9–11 and 518 (430 whites) at late adolescence. Independent variables thought to indicate stress or stressful contexts were entered into ordinary least squares regression models. Analysis revealed that age at menarche was significantly earlier for blacks compared to all other groups and therefore a dummy variable indicating black or non-black was included as a control. Next biiliac diameter, as a control for the developmental trajectory underlying reproductive development, was added to the model. Finally mother's age at menarche was added.

Previous analyses have included weight as a control for the biological processes of reproductive maturation (Moffitt *et al.*, 1992). However, weight, or even percentage of body fat as suggested by Frisch (1976), is not as good a predictor of age at menarche as pelvic dimensions which are thought to represent a mechanical constraint on reproductive ability (Ellison, 1982). Furthermore, biiliac diameter, as an aspect of cumulative skeletal growth, should reflect changes in developmental trajectory caused by childhood stress better than weight which is subject to short term fluctuations.

Models using discrete time hazards were also estimated and show essentially the same results; results of the ordinary least squares analyses are reported here because

Table 2. Measures of early childhood stress as predictors of daughter's age at menarche (N=310)

Variable	Regression coefficients†		
	Model 1	Model 2	Model 3
Race	−3·6	−3·6	3·2
Father absent	−2·2	−1·5	−0·6
Sucks thumb	−0·6	−0·3	−0·2
Wets bed	−0·1	−0·03	0·1
Has nightmares	−1·7	−1·7	−1·3
Biiliac diameter		−0·22****	−0·19***
Mother's menarche			2·2****
Adjusted R^2	0·003	0·82	0·10

***p<0·001; ****p<0·0001.

†Effect of variable on age at menarche in months. For biiliac diameter this represents the change per cm while for mother's menarche it is the change per year change in mother's age at menarche.

of the greater ease of interpretation. The regression coefficients presented represent the effect of the independent variables on daughter's age at menarche in months.

Results

Table 2 shows the results of the analyses including both stress measures and contextual variables at age 5 hypothesised to affect reproductive maturation. None of the stress measures is a significant predictor of age at menarche even without controls for biiliac diameter or mother's age at menarche.

Table 3 shows the results for measures of contextual stress at age 9–11. Here two socioeconomic indicators of contextual stress, mother's education and whether the mother's current husband works, are significant predictors of age at menarche, but only mother's education is in the direction predicted by the theory. Only a small amount of variance is explained by sociological variables alone (R^2=0·01). The models including biiliac diameter and mother's age at menarche explain much more of the variance (R^2=0·06; R^2=0·13). The addition of mother's age at menarche and biiliac diameter does not diminish the impact of the socioeconomic variables but strengthens them slightly, suggesting that they have independent effects on age at menarche.

Table 4 shows the effects of father's absence at the late adolescent interview. Here, unlike at age 5 or 9–11, father's absence is a significant predictor of age at menarche, though it can not be considered a causal predictor since father's absence may have occurred after the girl reached menarche. In addition, there is an interaction of father's absence with race. Analysis (not shown) indicates that the interaction represents a significant effect of father's absence on daughter's age at menarche among whites but not blacks.

Table 3. Contextual stressors at age 9–11 as predictors of daughter's age at menarche (N=456)

Variable	Regression coefficients†		
	Model 1	Model 2	Model 3
Race	11·0	10·0	10·7
Age at examination	0·02	0·1	0·1
Father absent	−0·3	−0·8	−1·6
Mother's education	−3·7‡	−3·0	−4·3*
Mother's work	−2·3	−2·5	−1·9
Husband works	12·1‡	12·3*	13·3*
Race × husband works	−13·8	−13·0	−13·5
Biiliac diameter		−0·2****	−0·14****
Mother's menarche			2·9****
Adjusted R^2	0·01	0·06	0·13

*p<0·05; ****p<0·0001; ‡p<0·1.
†See Table 2.

Table 4. Effect of father's absence at adolescence on daughter's age at menarche (N=518)

Variable	Regression coefficient†	Beta
Race	2·7	−0·07
Father absent	−5·1**	0·13
Mother's menarche	3·1****	0·29
Race × father absent	−8·8*	−0·19
Adjusted R^2	0·10	

*p<0·05; **p<0·01; ****p<0·0001.
†Effect of variable on age at menarche in months.

The association of father's absence and age at menarche at the adolescent interview among whites provides an opportunity to test whether the two are linked indirectly through mother's age at menarche using a path model as shown in Fig. 1. The results indicate that mother's age at menarche has a strong direct effect on her daughter's age at menarche (beta=0·29, p<0·001) which can be interpreted as due to genetic transmission. In comparison, the effect of the hypothesised indirect path through mother's age at first marriage and father's absence is trivial. While age at menarche has a significant effect on age at first marriage (beta=0·09, p<0·05), age at first marriage has a significant effect on father's absence at the adolescent interview (beta=0·16, p<0·01), and father's absence has a significant effect on daughter's age at menarche (beta= −0·13, p<0·01); the overall effect of this path (−0·002 versus 0·29

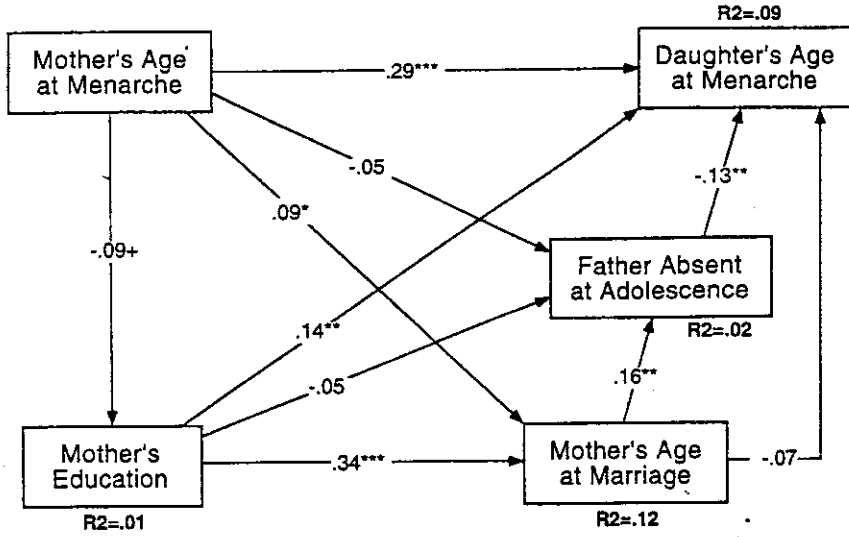

Fig. 1. Path model showing direct and indirect effects of mother's age at menarche on daughter's age at menarche: *$p<0{\cdot}05$; **$p<0{\cdot}01$; ***$p<0{\cdot}001$.

for the direct path) accounts for a trivial amount of the relationship between mother's and daughter's age at menarche.

Mother's education has a direct effect on daughter's age at menarche (beta=0·14, $p<0{\cdot}01$), a relationship for which no interpretation can be offered.

Discussion

These results do not provide support for Belsky *et al.*'s (1991) hypothesis that early childhood stress acts to decrease age at menarche. Measures of stress during early childhood, including father's absence, do not predict age at menarche. While analysis of socioeconomic variables considered by Belsky *et al.* to represent contextual stressors, at age 9–11, was unable to rule out a role for contextual stressors in determining age at menarche, the fact that their effects do not appear to be related to reproductive development, as measured by biiliac diameter, suggests that these contextual stressors do not act by altering the developmental path towards reproductive maturity. These results are consistent with Moffitt *et al.*'s (1992) study which also failed to substantiate Belsky *et al.*'s hypothesised mechanism that stress leads to internalising problems which in turn lead to a lower metabolic rate and the storage of fat, thus stimulating earlier onset of menarche.

Furthermore, the current study found father's absence to be a significant predictor only after age 9–11 unlike earlier studies that not only reported a significant effect of father's absence before that age, but found a significant correlation between the duration of father's absence and age at menarche (Moffitt *et al.*, 1992; Surbey, 1990). Thus among this sample the effects of father's absence are not consistent with its duration as a reflection of stress. Instead they suggest that patterns of marital dissolution may account for differences in the age of menarche between girls whose

fathers were absent or present, though the possibility that marriages that eventually dissolve, even after the daughter's menarche, are more stressful than those that do not cannot be ruled out.

However, a path model was not able to demonstrate that the association of father's absence and early age at menarche is due to selective effects of mother's age at menarche. While mother's age at menarche has a strong direct effect on daughter's age at menarche, it was not an important predictor through an indirect pathway linking mother's age at menarche to age at first marriage and the presence of the original father. However, the path model tested here, while representing the proposed hypothesis, is only one of many possible. For instance while mother's education shows a direct effect on daughter's age at menarche, this path may represent the effects of eating habits or lifestyle characteristics related to education. Other variables, such as family conflict, which have been implicated in age at menarche need to be tested to determine if they provide an indirect link between mother's and daughter's ages at menarche.

In conclusion, while the role of stress in the timing of reproductive maturation is an interesting area for exploration, the findings of this study suggest that previous results must be kept in perspective. Mother's age at menarche and measures of reproductive development, such as biiliac diameter, are more important predictors of age at menarche than any of the measures of stress employed in this study. The relatively small influence of social variables on age at menarche indicates that social processes, by whatever mechanism, are not capable of producing divergent reproductive strategies based on the timing of reproductive maturation. While early childhood experience among females may be related to subsequent patterns of sexual behaviour through psychological mechanisms, they do not appear to be related to the timing of reproductive maturation.

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