

FREQUENCY OF PARENTAL REPORT OF PROBLEM BEHAVIOR IN CHILDREN DECREASES WITH INCREASING MATERNAL AGE AT DELIVERY¹

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Summary.—Child behavior problems were assessed in 1377 3-yr.-old twin pairs with the Child Behavior Check List from Achenbach (translated into Dutch language by Verhulst). The association between problem scores and maternal age at delivery of the twins was analyzed with statistical control for several potential confounding variables: birth weight of twins, maternal smoking during pregnancy, being breast or bottle fed and socioeconomic status. After controlling for all available confounding covariates, a significant linear effect for maternal age was left. Especially Externalizing behavior problems as well as the separate categories that constitute Externalizing, i.e., Aggressive, Oppositional, and Overactive, appeared to decrease continuously with increasing maternal age. This was true for both boys and girls as well as for first and secondborn twins. Evidence in support of a biological explanation of the association between maternal age and child behavior problems, is presented.

That maternal age is somehow related to behavioral characteristics of their offspring, is obvious from the many (predominantly) American studies on teenage mothers and their children. Several adverse behavioral and health symptoms in those children have been reported: reduced birth weight, increased morbidity and mortality rate, and retarded intellectual and emotional development (Lee, Ferguson, Corpuz, & Gartner, 1988; Roosa, Fitzgerald, & Nancy, 1982; Hofferth, 1987; Fraser, Brockert, & Ward, 1995; Camp, 1996). One important question is whether this reflects an effect that is specific to that particular group of children or whether it is just a special case of a more general association between maternal age and offspring behavior. There might be a tendency among investigators to accentuate all the social and behavioral features of very young mothers that might explain the effects on their children's behavior. And, this in turn may disguise the theoretical possibility that maternal age as such—mediated by some biological and social age-related condition—affects in a *continuous* fashion health and devel-

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opment of children rather than in a discrete (teenage versus nonteenage) way. If the latter option is true, then it is likely that in a nonteenage population maternal age is associated with problem behavior in offspring, too.

To test this hypothesis, we have studied problem behavior in a sample of 3-yr.-old twins from nonteenage mothers varying over a wide maternal age range. The analyses were controlled for socioeconomic status, maternal smoking during pregnancy, birth weight, and early feeding habits (breast versus bottle). The investigation was performed in a sample of twins which was studied for several reasons, the present study being one of them.

METHOD

Subjects

About 45% of all multiple births (mostly twins) born in The Netherlands since the end of 1986 are registered in The Netherlands Twin Register, kept by the department of Physiological psychology at the Vrije Universiteit of Amsterdam. More than 13,000 twin pairs, varying in age between 2 mo. and 10 yr., have been registered, for which parents of the children gave their written permission. Parents fill out several questionnaires about their twins. The first one, shortly after birth, asks about birth weight, gestational age, health problems, smoking and drinking habits of mothers during pregnancy, etc. A second questionnaire is mailed to the parents when the children are between 1½ and 2 years of age, asking predominantly about health and motor development. When the children are 3 years of age the Child Behavior Checklist for 2- to 3-yr.-olds (CBCL/2-3; see below) from Achenbach, Edelbrock, and Howell (1987) and translated into the Dutch language by Verhulst (Achenbach, 1991) is filled out by both parents (Achenbach, *et al.*, 1987; Achenbach, 1991; Koot, 1993). This checklist was mailed to 1792 twin families and completed and returned for 1377 twin pairs. This corresponds roughly with 35% of all Dutch twins in the 2- to 3-year age category. Although zygosity is not relevant for the present study, for the sake of completeness we give the numbers of each category of zygosity. The total sample of 1377 pairs consisted of 242 MZ female, 214 MZ male, 235 DZ female, 263 DZ male, 409 male-female pairs, and 14 pairs of unknown zygosity. The procedure for determination of zygosity has been described elsewhere (Van den Oord, Koot, Boomsma, Verhulst, & Orlebeke, 1995).

Measures

The CBCL/2-3 is a checklist for parental ratings of problem behaviors in 2- to 3-yr.-old children. The list contains 90 items describing many different behavioral problems. Each item can be endorsed with 0 (not true), 1 or 2 (true). For 1113 twin pairs both parents completed one CBCL/2-3 form for each child. Analyses were carried out on midparent scores. When mater-

nal scores were missing (247 pairs) or when paternal score were missing (12 pairs), the missing values were replaced by the rating of the other parent.

The answers to the 99 items give scores in seven behavioral problem categories, *viz.*, Oppositional, Aggressive, Overactive, Withdrawn, Anxious, Sleep problems, and Somatic problems. The first three categories contribute to the higher-order category of Externalizing behavior problems whereas Withdrawn and Anxious form the higher-order category of Internalizing behavior problems.

The sum of all problem categories gives one Total score. Two to three years earlier, *i.e.*, in the first mailed questionnaire, shortly after birth, pre- and perinatal information were collected; amongst others was the ages of the mothers at the time the twins were born. For the present analyses maternal age was categorized into three groups: ≤ 26 yr. ($n=484$), >26 yr. but ≤ 33 yr. ($n=1762$), and >33 yr ($n=492$).

Further, information on the following potential confounding factor was collected: birth weight, socioeconomic status (the mean of scores on education of father (6 levels), education of mother (6 levels), and vocation of father (6 levels) with Cronbach α of .76, feeding during the first three weeks (bottle or breast), and smoking habits of the mother during pregnancy. The question, Did you smoke during pregnancy?, could be answered by choosing one of three possible options of Never, Sometimes, or Regular.

Selection of Model

Preliminary data analysis showed that the distributions of scores on the dependent variables (CBCL-total, Externalizing, Internalizing and all the separate problem dimensions) were highly positively skewed. To obtain a more symmetric and nearly normal distribution, it was decided to perform a square root transformation of scores on each of the dependent variables.

For each of the dependent variables and for each child (first or second born) separately, a covariance analysis has been carried out, using a model fitting approach (Aitkin, Anderson, Francis, & Hinde, 1989). The starting point in each case was the standard covariance model with maternal age and sex of the child as factors, and maternal smoking, birth weight, socioeconomic status, and (amount of) breast feeding versus bottle feeding as covariates.

We first investigated in a stepwise fashion whether quadratic terms of the covariates and interactions of covariate \times covariate significantly improved the fit of the model. All tests were carried out at $\alpha=.05$. It turned out that in four out of the 12 cases, an interaction of maternal smoking \times socioeconomic status had to be added to the model. In only one case this interaction could be described (more) parsimoniously by a linear maternal smoking \times socioeconomic status term only. Hence, in the remaining three cases the interaction was quite complex.

Secondly, we investigated for each covariate separately whether a cell-specific term improved the model fit significantly. This yielded in one case (Internalizing, secondborn child) a significant interaction between maternal age, sex, and socioeconomic status, which could be described after simplification by a *linear* term, maternal age \times sex \times socioeconomic status.

After these two steps, it was investigated whether the interaction of maternal age \times sex could be simplified or removed entirely. In all but two cases this interaction could be removed from the model. In one case (Aggression, firstborn child) this interaction could be described by a linear maternal age \times sex term only. In the other case (Internalizing, second-born child), the term had to be kept in the model due to the hierarchy principle (McCullagh & Nelder, 1989) which says that a term should be kept in the model when it is part of a higher-order interaction. Finally, in all cases, all effects involving maternal age could again be effectively described by a linear maternal-age term only. Since breast/bottle feeding never produced a significant effect, we decided to remove this covariate from all models.

To present the estimated regression coefficients of the fitted models, the dependent variables and the continuous covariates (birth weight and socioeconomic status) have been standardized. The fitted regression models are shown in Table 1 below, together with R as well as the standardized regression coefficients for both factors and covariates. The regression coefficient of sex of the child and the linear terms of maternal age and maternal smoking indicate an estimated difference in the dependent variable when one switches from one category level to another. The regression coefficients should be interpreted cautiously and are only valid for a "typical" case, here defined as a nonsmoking mother of middle socioeconomic status with a child with a birth weight of 2500 grams.

Finally, the quadratic term of maternal smoking has simply been defined as the square of the linear maternal-smoking term, with nonsmoking as baseline.

RESULTS AND DISCUSSION

Results are summarized in Table 1, together with R and the standardized regression coefficient (b) for main factors and covariates. In case of the effects maternal age, sex, and maternal smoking, b represents the expected increase in the standardized square-root-transformed dependent variable when the independent factor increases by one category. In case of the (continuous) covariates, b represents the expected increase in the transformed standardized dependent variable per 1 SD increase in the independent variable. Analysis shows in the first place more behavioral problems in boys than in girls, in children of smoking mothers compared to those of nonsmoking mothers, in children with low birth weight, and in children from

TABLE 1
EFFECTS OF MATERNAL AGE ON BEHAVIORAL PROBLEMS FROM CHILD BEHAVIOR CHECK LIST WITH
SEX, BIRTH WEIGHT, MATERNAL SMOKING, AND SOCIOECONOMIC STATUS AS COVARIATES

Effect	CBCL-Total		Externalizing		Internalizing		Aggressive		Oppositional		Overactive	
	<i>b</i>	<i>t/F</i>	<i>b</i>	<i>t/F</i>	<i>b</i>	<i>t/F</i>	<i>b</i>	<i>t/F</i>	<i>b</i>	<i>t/F</i>	<i>b</i>	<i>t/F</i>
Maternal Age												
First Linear	-.14	-2.89†	-.16	-3.40‡	-.06	-1.13	-.20	-4.35‡	-.11	-2.33	-.16	-3.23†
Second Linear	-.20	-4.06‡	-.21	-4.45‡	-.12	-2.27*	-.19	-4.08‡	-.16	-3.32	-.23	-4.78‡
Maternal Age × Sex												
First Linear							.19	2.10*				
Second Linear					.12	1.15						
Maternal Age × Socioeconomic Status												
First Linear									.19	1.98*		
Second Linear					-.03	-0.53						
Maternal Age × Sex × Socioeconomic Status												
Second Linear					.07	2.34*						
Sex												
First Linear	.24	4.28‡	.27	4.85‡	.09	1.59	.49	8.96‡	.13	2.27*	.25	4.52‡
Second Linear	.19	3.42‡	.21	3.84‡	.03	.47	.46	8.47‡	.05	0.89	.22	3.90‡
Sex × Socioeconomic Status												
Second Linear					-.02	-0.77						
Maternal Smoking												
First		4.57†				3.30*						2.38
Linear	.02	.12	.09	2.47†	-.33	-1.84	.08	2.23*	.08	2.31*	-.17	-1.00
Quadratic	.06	.60			.21	2.21*					.13	1.43
Second Linear	.13	3.52‡	.13	3.58‡	.04	1.14	.13	3.52†	.13	3.48‡	.10	2.40*

(continued on next page)

**p* < .05. †*p* < .01. ‡*p* < .001.

TABLE 1 (CONT'D)
EFFECTS OF MATERNAL AGE ON BEHAVIORAL PROBLEMS FROM CHILD BEHAVIOR CHECK LIST WITH
SEX, BIRTH WEIGHT, MATERNAL SMOKING, AND SOCIOECONOMIC STATUS AS COVARIATES

Effect	CBCL-Total		Externalizing		Internalizing		Aggressive		Oppositional		Overactive	
	<i>b</i>	<i>t/F</i>	<i>b</i>	<i>t/F</i>	<i>b</i>	<i>t/F</i>	<i>b</i>	<i>t/F</i>	<i>b</i>	<i>t/F</i>	<i>b</i>	<i>t/F</i>
Birth Weight												
First Linear	-.09	-3.07†	-.10	-3.58‡	-.04	-1.27	-.06	-2.33*	-.11	-3.71‡	-.08	-2.90†
Second Linear	-.07	-2.44†	-.07	-2.31*	-.01	-0.29	-.05	-1.69	-.05	-1.58	-.08	-2.72†
Socioeconomic Status												
First Linear	-.08	-2.31*	-.09	-3.10†	-.00	-0.08	-.09	-3.17†	-.07	-2.57†	-.11	-3.38‡
Second Linear	-.08	-2.94†	-.07	-2.53†	-.10	-3.50‡	-.05	-1.76	-.05	-1.69	-.13	-3.83‡
Maternal Smoking × Socioeconomic Status												
First												
Linear		3.48*				8.85‡						5.21†
Quadratic	-.34	-2.06*			-.68	-4.08‡					-.25	-1.51
Second Linear	.39	2.38*			.70	4.21‡					.34	2.12*
											.08	2.11*

* $p < .05$. † $p < .01$. ‡ $p < .001$.

low socioeconomic status families. After correction for these significant covariate effects, maternal age appears to be associated significantly with higher prevalence of child behavior problems (CBCL-Total score): the older the mother the fewer parental-reported behavioral problems in their children. This holds for both first- and the second-born children.

A closer look at the outcomes shows that this total-CBCL effect can predominantly be attributed to externalizing behavioral problems because the before mentioned relationships are especially true for Externalizing and not or hardly so for internalizing behavioral problems, the exception being socioeconomic status. The covariate corrected association between externalizing behavior problems and maternal age is presented in Fig. 1. The factors that constitute Externalizing: Aggressive, Oppositional, and Overactive, problems, all show a more or less comparable association with maternal age as the higher-order factor Externalizing itself does, in both first- and second-born twin children.

In all cases, the main effect of maternal age could be simplified by a linear component, i.e., the quadratic term was not significant. Two weak but significant interactions suggest, first, that the decreasing influence of higher maternal age on aggressive is more pronounced in girls than in boys and, second, that children from lower socioeconomic status categories seem to benefit a little bit more from the older ages of their mothers with regard to oppositional behavior compared to higher socioeconomic children.

Maternal smoking is more prevalent in families of lower socioeconomic status. There are some interactions between socioeconomic status and maternal smoking for scores on Internalizing and for Overactive. The nature of these interactions indicate that the effect of smoking on problem behavior is smaller in families of higher socioeconomic status than in families of lower status.

The present paper has furnished evidence that ages of mothers are negatively associated with problem behavior of their children. Especially externalizing problem behavior, Aggressive, Oppositional and Overactive, is stronger when mothers' ages are (relatively) low. And this is so even after elimination of the potential confounding influences of several covarying factors of smoking, socioeconomic status, birth weight, sex of child, and method of feeding (breast versus bottle).

It should be emphasized that it is rather unlikely that the maternal age effect has much to do with the teenage versus nonteenage mothers difference. Our data show a significant linear trend from youngest mothers (average: about 25 years) to mothers of about 33 years and continuing to the oldest mothers (aged about 35 and over). It has been suggested (Van Balen, 1995) that a high proportion of children of older mothers are the result of *in vitro* fertilization (IVF) and are therefore in the first place very often only

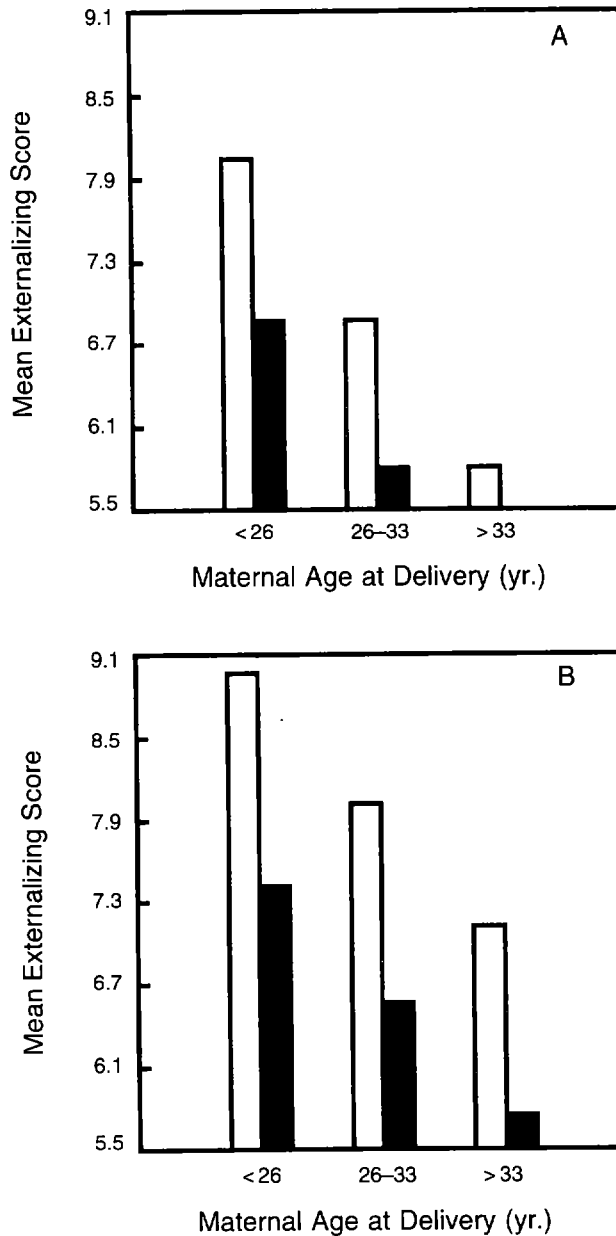


FIG. 1. Mean score on Externalizing behavior for first born (A) on the Child Behavior Check List and second born (B) twin boys (□) and girls (■) as a function of maternal age at delivery. Scores were corrected for covarying influences of some confounding factors and so reflect values for a "typical" (average) case with regard to the covariates.

children and in the second place extremely wanted, i.e., such children have more than average caring and motivated parents. We think that such an explanation is not very likely because in a separate study (J.B. Deijen, personal communication) the maternal age effect remained unchanged after controlling for parity, i.e., the maternal age effect exists within each parity category. Other authors (Fergusson & Lynsky, 1993) ascribe the effect to a combination of low social class (more characteristic for young than for older mothers) and a less nurturant and more changeable home environment. Our data do not point in that direction since we controlled for the confounding influence of social class and since we found that the association between maternal age and externalizing child behavior is linear, i.e., also between the two highest maternal age categories (about 30 and 35 years).

There seems thus to be some continuous condition, either prenatal or (social) postnatal or a mix of these two, that has to be adopted for the understanding of the maternal age effect. One explanation could be found in the possibility that fetuses of young mothers are exposed to different amounts of gender-related hormones compared to children of older mothers. Converging evidence in favour of this hypothesis comes from a *post hoc* test within the same dataset. We could compare the average maternal age of mothers of lefthanded twin children with that of righthanded children. Separate *t* tests for first- and second-born twins showed a significant higher average age for mothers of righthanded children (Welch $t_{92} = 2.55$, $p < .02$ and $t_{772} = 2.92$, $p < .004$ for first- and second-born twins, respectively). Some authors consider lefthandedness—or at least some cases—as a developmental disorder that might be ascribed to enhanced exposure to the androgen testosterone (Coren, 1992).

A recent study, Zumoff, Strain, Miller, and Rosner (1995) indicated that total 24-hr. testosterone levels are significantly higher in young than in older premenopausal women: at age 40 years the level is about half what it is at age 21. Although these facts are no unequivocal proof for a “testosterone-explanation” of the association between maternal age and child behavioral problems, they can be considered as compatible with a biological basis for this phenomenon, which needs to be tested independently. On the other hand, one should realize that other different factors can play a role. For instance, it is possible that educational style changes with parental age and that this in turn affects the child’s behavior.

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Accepted January 16, 1998.