

Chronic Maternal Depression and Children's Injury Risk

David C. Schwebel,¹ PhD and Carl M. Brezausek,² MS

¹Department of Psychology and ²Center for Educational Accountability, University of Alabama at Birmingham

Objective A substantial number of mothers of young children suffer from depression. One understudied consequence of maternal depression is how it affects toddlers' injury risk. This study examined links between chronic maternal depression and child injury. **Methods** A national sample of 1,364 American children was studied. **Results** Chronic levels of severe maternal depression placed children at increased risk of concurrent injury from birth to age 3. The relation between chronic, severe maternal depression and child injury risk held even after controlling for variance from family SES, child sex, child temperament and externalizing behavior, and parenting. Chronic maternal depression during infancy and toddlerhood did not influence children's subsequent risk for injury, between age 3 and first grade. Less severe symptoms of chronic maternal depression were unrelated to concurrent or future child injury. **Conclusions** Chronic, severe levels of maternal depression are linked to concurrent child injury risk during infancy and toddlerhood.

Key words chronic depression; injury; mothers; parents; safety; toddlers.

Epidemiological data suggest roughly 15% of women are depressed at any one time (Elgar, McGrath, Waschbusch, Stewart, & Curtis, 2004), and some research suggests that mothers of young children may have rates of depression even higher than the general population of women. In one study of over 800 disadvantaged British mothers of young children, about a third of mothers reported high levels of depressive symptoms (Mulvaney & Kendrick, 2005).

One consequence of maternal depression is its effect on children. There is considerable evidence that maternal depression is linked to children's behavior, with children of depressed mothers demonstrating higher levels of behavior problems and psychopathology; academic problems; social problems and negative peer relationships; and internalizing pathology such as depression, low self-esteem, and poor self-regulation (see Elgar et al., 2004; Lovejoy, Graczyk, O'Hare, & Neuman, 2000; for reviews). The mechanism behind these links is likely bidirectional and via multifaceted mediated pathways, including genetic/biological lines, psychosocial influences, and presence of tangible resources and social capital.

One area that is less well understood is the influence of maternal depression on children's health. In particular, potential links between maternal depression and children's risk of unintentional injury are poorly

understood. Injury is the leading cause of pediatric mortality in the US (National Center for Injury Prevention and Control [NCIPPC], 2008), and obtaining an accurate picture of behavioral risk factors—including parental traits—that might increase or decrease risk of injury is critical to development of empirically supported prevention programs.

Two previous studies have directly examined links between maternal depression and child injury risk. The first, conducted by O'Connor and colleagues (O'Connor, Davies, Dunn, Golding, & the ALSPAC Study Team, 2000), used a prospective design with over 10,000 English families. The researchers discovered that mother's self-reported symptoms indicative of potential clinical depression, assessed when children were 21 months of age, were related to risk of two or more significant injuries over the subsequent 3 months. The second, by Phelan and colleagues (Phelan, Khoury, Atherton, & Kahn, 2007), studied about 1,100 children and their parents in the US over 2 years. Severe levels of chronic depression, as measured at the start and end of the 2-year period, were related to child injury risk during the second year of the study. This finding was particularly strong among the boys in the sample. Phelan and colleagues (2007) tested child externalizing behavior as a possible mediating variable between

All correspondence concerning this article should be addressed to David C. Schwebel, PhD, Department of Psychology, University of Alabama at Birmingham, 1300 University Blvd, CH 415, Birmingham AL 35294, USA.
E-mail: schwebel@uab.edu

Journal of Pediatric Psychology 33(10) pp. 1108–1116, 2008

doi:10.1093/jpepsy/jsn046

Advance Access publication May 12, 2008

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maternal depression and child injury risk, but results did not support externalizing behavior as a mediator.

Other research supports the possibility that maternal depression is associated with increased child injury risk. These findings include correlational links between maternal neuroticism and child injury (Davidson, Hughes, & Richards, 1987; Morrongiello, Corbett, McCourt, & Johnston, 2006), between maternal use of antidepressants or tranquilizers and toddler poisoning incidents (Beautrais, Fergusson, & Shannon, 1981), and between maternal anxiety and child injury (Bradbury, Janicke, Riley, & Finney, 1999). Three other reports have investigated how maternal depression might influence mother's behaviors to protect children from injury. Two publications based on data from the National Maternal and Infant Health Survey (NMIHS) indicate mothers who are depressed are less likely to use injury prevention strategies such as installing car seats, covering electrical outlets in the home, and storing syrup of ipecac (Leiferman, 2002; McLennan & Kotelchuck, 2000). Data from a British sample of over 1,700 families contradict this finding, however. Mulvaney and Kendrick (2006) found similar rates of child safety practice (safe storage of medicine, use of smoke alarms, use of fireguards, and safe storage of sharp objects) among depressed and nondepressed mothers.

In summary, previous evidence suggests that there may be links between maternal depression and child injury risk. The present study sought to extend these results by investigating three hypotheses. First, we expected to replicate previous reports by showing chronic levels of severe, clinically relevant, maternal depression are related to young children's risk for injury. Second, we extended previous research by examining moderate levels of subclinical depressive symptomatology. We predicted chronic levels of moderate, subclinical, maternal depression symptoms would also be related to young children's risk for injury. Third, we examined longitudinal influences. We hypothesized that maternal depression during the infancy and toddler years would be related to increased risk of child injury as children begin to make their own decisions about engaging in potentially dangerous situations, from ages 3 through first grade.

Beyond these three primary hypotheses, a secondary objective of this investigation was to conduct initial inquiries into the mechanisms through which chronic maternal depression might influence child injury risk. To do so, we controlled for the variance of possible moderators—child gender, family income, child temperament and externalizing behavior, and parenting characteristics—to determine if the relation between chronic maternal depression and

child injury would hold after controlling for those covariates. These covariates were selected because they have been shown to correlate closely to child injury risk (Schwebel & Gaines, 2007) and/or maternal depression (Elgar et al., 2004; Lovejoy et al., 2000) in previous work.

Methods

Data Source

Data came from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care, a longitudinal investigation of the effects of early child care on children's development. Participants were recruited at birth from 31 hospitals located in or near 10 US cities (Little Rock, AR; Irvine, CA; Lawrence, KS; Boston, MA; Morganton, NC; Philadelphia, PA; Pittsburgh, PA; Charlottesville, VA; Seattle, WA; Madison, WI). During selected 24-hr sampling periods, 8,986 women giving birth were visited in the hospital. Of these, 5,416 met the study's eligibility criteria (briefly, English-speaking mothers age 18 or over who planned not to put children up for adoption, not to relocate in the next year, and who lived in safe and accessible neighborhoods for research; for details, see NICHD Early Child Care Research Network, 2000). A subset of this group was selected in accordance with a conditional-random sampling plan designed to ensure recruited families reflected the economic, educational, and ethnic diversity of the catchment area at each site. When the infants were 1 month old, 1,364 families (58% of those contacted) enrolled in the longitudinal study (see NICHD Early Child Care Research Network, 1994, 2001, for details of study design and recruitment, including informed consent procedures). The sample included 705 boys (52%) and 659 girls (48%) and was 80% Caucasian, 13% African American, and 7% of other ethnicities. Average education for mothers in the sample was 14.23 years ($SD = 2.51$).

Measures

Several measures were chosen from the NICHD Early Child Care Study data for the present analysis, as detailed below. Unless otherwise indicated below, the measures were taken when children were 6, 15, 24, and 36 months old, and aggregates were created by averaging those four scores. If constructs were assessed using different scales at different ages, scores were standardized before they were averaged.

Injury

Mothers reported their children's history of injuries requiring professional medical attention on a quarterly

basis from birth to first grade (biannually during the kindergarten and first grade years), either through telephone interviews or during scheduled home visits by experimenters. A large body of empirical research indicates that parental reports of child injury history are reliable (Pless & Pless, 1995), particularly when reports are collected at relatively short intervals to reduce recall biases (Cummings, Rivara, Thompson, & Reid, 2005; Harel et al., 1994; Peterson, Harbeck, & Moreno, 1993).

Two measures were computed from the mothers' reports: number of injuries children incurred from birth through their third birthday, and number of injuries from their third birthday through the end of first grade (approximately age 6).

Maternal depression

Maternal depression was measured using the Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977), a self-report scale designed to assess depression in nonclinical populations. The measure was assessed at all four time points; the average intercorrelation across time was $r = .52$. The CES-D includes a rating of the frequency of 20 depressive symptoms over the past week using a 4-point scale; higher scores represent higher levels of depression. Psychometrics are good (Cronbach's $\alpha = .89, .90, .91, \text{ and } .90$ at the four assessment points, respectively; Billbrey, Batten, Appelbaum, & Wendell, 1994b; Coleman, Batten, Appelbaum, & Wendell, 1995a, 1995b; Little, Appelbaum, Batten, & Wendell, 1993b). Two measures were taken from the CES-D based on standard cutoffs in the literature (McCaffery, Niaura, Swan, & Carmelli, 2003; Santor, Zuroff, Ramsay, Cervantes, & Palacios, 1995): (a) a rating of severe depression with scores on the CES-D above 16 at all four measurement points, and (b) a rating of moderate depression with scores on the CES-D above 8 at all four measurement points. Those mothers with severe depression were excluded from the moderate depression group for analyses. The severe depression score is consistent with chronic levels of clinical depression; the moderate depression score is consistent with chronic levels of subclinical depression.

Family SES

The SES aggregate was created by averaging the family's income-to-needs ratio when the child was 6, 15, 24, and 36 months old (average inter-correlation = .80). The income-to-needs ratio calculated income based on the entire income of all members of the family living in the same household and estimated needs based on the poverty threshold during the year of measurement, the number of

people in the household, and the number of children in the household (see Billbrey, Batten, Appelbaum, & Wendell, 1994a, for details). An income-to-needs ratio that is less than 1 reflects significant poverty; the mean (3.56) and standard deviation (2.97) of this sample reflect a group of families that is generally middle and upper class, but includes some impoverished families.

Child positive affect

Positive affect was assessed via a semi-structured mother-child play interaction adapted from Egeland and Heister (1993). Positive affect (6, 15, and 24 months) and enthusiasm (36 months) were rated on a Likert-style rating scale by two raters (4-point scale used at 6, 15, and 24 months; 7-point scale used at 36 months). Adequate inter-rater reliability was obtained between independent coders at all four ages (Appelbaum, Batten, & Wendell, 1994; Batten & Wendell, 1994; Bland, Batten, Appelbaum, & Wendell, 1995, 1996a). The four scores were standardized and then aggregated; the average inter-correlation was $r = .10$.

Child negative affect

Negative affect was assessed via the same semi-structured mother-child play interaction as positive affect. Negative affect (6, 15, and 24 months) and negativity (36 months) were rated on a Likert-style rating scale by two raters (4-point scale used at 6, 15, and 24 months; 7-point scale used at 36 months). Adequate inter-rater reliability was obtained between independent coders at all four ages (Appelbaum et al., 1994; Batten & Wendell, 1994; Bland et al., 1995, 1996a). The four scores were standardized and then aggregated; the average inter-correlation was $r = .12$.

Child externalizing behavior

Externalizing behavior was measured by summing the aggressive and destructive behavior scales of mother-reported Achenbach's Child Behavior Checklist (CBCL; Achenbach, 1992) at 24 and 36 months. The two scores correlated, $r = .71$. No assessment of externalizing behavior was made at 6 or 15 months. The CBCL is a widely used measure with excellent psychometric properties (test-retest reliability and Cronbach's α for internal reliability of both scales $> .70$; Achenbach, 1992).

Parenting

The total score of the Home Observation for Measurement of the Environment (HOME; Caldwell & Bradley, 1984) was used as a measure of quality and style of caregiving. The infant/toddler version (45 items) was used at 6 and 15 months and the early childhood version (55 items)

at 36 months; the three measures had an average inter-correlation of $r = .55$. No assessment was made at 24 months. Items in both versions address a wide range of topics related to the home environment, including language and academic stimulation available in the home, responsiveness, acceptance, enrichment, and modeling by the caregiver, and variety and safety of the physical environment. Items are scored in a binary fashion, and the total number of "yes" responses in the environment is summed to create a score. Psychometric qualities of the measure are good (Cronbach's $\alpha = .76$ at 6 months, $.77$ at 15 months and $.87$ at 36 months; Bland, Batten, Appelbaum, & Wendell, 1996b; Little, Appelbaum, Batten, & Wendell, 1993a, 1994).

Missing Data

There are missing data points in the NICHD Study of Early Child Care data set. In many cases, data are missing due to attrition; in other cases, data are missing due to failure of parents to complete particular measures used in this investigation. Of the 1,364 families who took part in the NICHD Study of Early Child Care, 1,215 had full data available for the analyses conducted. Missing data for the remaining 149 were imputed using Markov Chain Monte Carlo multiple imputation strategies for arbitrary missing data, assuming the data were missing at random (Cameron & Trivedi, 2005).

Analytic Plan

Following consideration of descriptive data, data were analyzed in three steps. First, univariate Poisson regression models were computed to predict concurrent injuries, from birth through 36 months, based on presence or absence of chronic maternal depression during that concurrent time period. One model used severe levels of chronic depression as a predictor variable (with CES-D scores >16 , or in the clinical range) and the other used moderate levels of chronic depression as a predictor variable (with CES-D scores >8 , or in the subclinical range). Second, potential confounds to the relation between maternal depression and child injury were considered individually as covariates in multivariate Poisson regression models that also included maternal depression. These covariates included demographics (sex, income), child characteristics (positive affect, negative affect, and externalizing behavior), and parenting. Again, separate models were constructed with severe and moderate levels of depression included. Models were also constructed with all covariates entered simultaneously to determine if depression remained a predictor of child injury even after

controlling for all other covariates. Third, the same set of univariate and multivariate Poisson regression models were constructed predicting future injuries, from age 3 to when the child was in first grade, based on parent and child characteristics during the toddler years.

Results

Table I presents descriptive data from the sample. As is commonly found in the injury literature, injury events were relatively infrequent. Children experienced a mean of 0.20 injuries ($SD = 0.53$; range = 0–4) over the 3-year period of birth to age 3 and a mean of 0.56 ($SD = 0.80$; range = 0–5) injuries over the 3-year period of age 3 to grade 1. Chronic maternal depression was also rare in the sample, with 2.49% of mothers reporting severe, clinical-level depressive symptoms at all four data points and 15.51% of mothers reporting moderate, subclinical depressive symptoms at all four data points.

We also examined descriptive injury data within the groups of mothers with and without depression. There were 34 mothers with severe levels of chronic depression and 178 with moderate levels of chronic depression. While children developed from birth to age 3, the sample of mothers with severe depression had children with an injury rate ($M = 0.56$, $SD = 0.85$, range = 0–3) almost three times that of the sample whose mothers were not chronically depressed ($M = 0.19$, $SD = 0.52$, range = 0–4) and that whose mothers had moderate levels of chronic depression ($M = 0.20$, $SD = 0.51$, range = 0–3). Injury rates while children developed from age 3 to first grade were more similar across groups: children of mothers without chronic depression had a mean of 0.56 injuries

Table I. Descriptive Data ($N = 1364$)

Variable	Mean (SD)
Demographic variables	
Sex	51.69% male
Income: needs ratio	3.56 (2.97)
Mother variables	
Parenting	-0.03 (0.87)
Chronic severe depression	2.49% of sample
Chronic moderate depression	15.51% of sample
Child variables	
Positive affect	-0.01 (0.62)
Negative affect	-0.00 (0.61)
Externalizing behavior	14.10 (6.69)
Injuries, birth to age 3	0.20 (0.53)
Injuries, age 3 to grade 1	0.56 (0.80)

The parenting and affect scores reflect aggregates of standardized values.

($SD = 0.80$, range = 0–4); children of mothers with moderate levels of chronic depression had a mean of 0.58 ($SD = 0.78$, range = 0–5); and children of mothers with severe levels of chronic depression had a mean of 0.68 ($SD = 0.72$, range = 0–2).

Table II presents data concerning the effect of chronic maternal depression on child injury. The first line illustrates univariate models; as shown, severe maternal depression was a strong predictor of concurrent child injury risk ($t = 4.52$, $p < .01$; .95 CI = 0.61, 1.54). After including various covariates in the model, the effect of severe levels of depression remained statistically significant and strong (lines 2–5, columns 1–4). The effect also remained strong and statistically significant after all covariates were included in the model ($t = 4.31$, $p < .01$; .95 CI = 0.58, 1.54). Thus, chronic maternal depression appears to be a robust predictor of child injury risk, even after controlling for potential covarying effects.

Corresponding data concerning moderate levels of maternal depression are presented on the latter columns of Table II (children whose mothers had severe levels of maternal depression were omitted from this analysis). As shown, moderate levels of depression did not predict child injury risk in univariate or multivariate models.

Table III replicates Table II, but uses longitudinal modeling to predict injuries children experienced between

age 3 and first grade based on child and parent traits from birth to age 3. None of the models emerged as statistically significant.

Discussion

Replicating previous work (O'Connor et al., 2000; Phelan et al., 2007), results from this study suggest chronic levels of severe maternal depression are related to increased risk of injury among infants and toddlers. This relation remained true even after controlling for variance based on family SES, child sex, child temperament and externalizing behavior, and parenting strategies.

Contrary to our second hypothesis, more moderate, subclinical levels of maternal depression were not related to increased child injury risk. It appears that only chronic and fairly severe maternal depression causes significant increased risk of child injury. And contrary to our third hypothesis, chronic severe maternal depression during the children's infancy and toddler years was not related to increased injury risk as children developed subsequently (from age 3 through grade 1).

As is the case in many novel areas of inquiry, these findings raise as many questions as they answer. In particular, they fail to address what mechanism or mechanisms may be behind a link between maternal depression and child injury risk. The facts that severe but not moderate

Table II. Descriptive Data and Poisson Models, Maternal Depression Predicting Concurrent Injuries

	Chronic severe depression				Chronic moderate depression			
	<i>B</i>	<i>SE</i>	<i>t</i>	95% CI	<i>B</i>	<i>SE</i>	<i>t</i>	95% CI
Depressed, univariate model	1.08	0.24	4.52**	0.61, 1.54	0.07	0.19	0.38	−0.30, 0.45
Model controlling for demographics ^a	1.04	0.24	4.31**	0.57, 1.50	0.04	0.19	0.20	−0.34, 0.41
Model controlling for child variables ^b	1.09	0.24	4.47**	0.61, 1.57	0.06	0.20	0.28	−0.34, 0.46
Model controlling for parenting	1.10	0.24	4.62**	0.64, 1.57	0.13	0.19	0.65	−0.26, 0.52
Model controlling for all covariates	1.06	0.25	4.31**	0.58, 1.54	0.07	0.20	0.36	−0.33, 0.47

^aDemographic covariates: child sex and family income.

^bChild covariates: positive affect, negative affect and externalizing behavior.

* $p < .05$; ** $p < .01$.

Table III. Descriptive Data and Poisson Models, Maternal Depression Predicting Future Injuries

	Chronic severe depression				Chronic moderate depression			
	<i>B</i>	<i>SE</i>	<i>t</i>	95% CI	<i>B</i>	<i>SE</i>	<i>t</i>	95% CI
Depressed, univariate model	0.19	0.21	0.91	−0.22, 0.61	0.04	0.11	0.36	−0.18, 0.26
Model controlling for demographics ^a	0.19	0.21	0.90	−0.23, 0.61	0.03	0.12	0.28	−0.19, 0.26
Model controlling for child variables ^b	0.21	0.22	0.98	−0.21, 0.63	0.04	0.12	0.32	−0.19, 0.27
Model controlling for parenting	0.20	0.21	0.94	−0.22, 0.62	0.05	0.12	0.44	−0.18, 0.28
Model controlling for all covariates	0.22	0.22	1.01	−0.21, 0.65	0.05	0.12	0.40	−0.19, 0.29

^aDemographic covariates: child sex and family income.

^bChild covariates: positive affect, negative affect and externalizing behavior.

levels of maternal depression predicted concurrent risk of child injury (ages 0–3) but not future risk of injury (ages 3 to grade 1) are highly consistent with the possibility that parent-related characteristics are particularly important to child safety during the infancy and toddlerhood years, but less so as children develop (Morrongiello, 2005).

Thus, one likely mechanism for the link between maternal depression and young children's injury risk is that chronically depressed mothers do not appropriately safeguard the physical environments children engage in. Results from two studies, both using the same dataset, support this possibility (Leiferman, 2002; McLennan & Kotelchuck, 2000; but see Mulvaney & Kendrick, 2006, for contradicting results). Less severely depressed mothers may have time periods when they are healthy enough to provide basic safeguards in the home environment (e.g., stair gates, outlet covers), and thus it is only chronic and severe maternal depression that increases child injury risk. Similarly, as children mature to the age when they are not supervised 100% of the time, and therefore make some independent decisions about engaging in risky activities, they may be less affected by the influence of parents who have or have not safeguarded the physical environments they engage within.

A second plausible mechanism behind the link between maternal depression and child injury risk has to do with parental supervision rather than environmental safeguarding. Symptoms of depression include inattention, poor concentration, distractibility, and irritability. These symptoms, which are generally more pronounced and serious in mothers with chronic and severe depression, might lead to poor or inconsistent supervision and enforcement of safety-related rules. Again, as children develop greater independence and require less intensive supervision in the late preschool and early school years, inadequate maternal supervision may be less critical for child safety.

Chronic maternal depression could also lead to increased child injury risk through less proximal mechanisms. These mechanisms might include reduced financial or social resources; the passing of genetic or biological traits that influence child behavior, risk-taking, or decision-making when confronted with dangers; and reduced tendency to model safe behavior from peers or other adults. All of these symptoms will be more salient in mothers with more serious and chronic depression. Finally, the issue of causality must not be overlooked. It is possible that repeated child injuries might play a role in development or maintenance of maternal depression rather than vice versa.

Limitations and Implications

This study contributes to an understudied area of public health concern, but its limitations should be considered along with its contributions. The most significant limitations are related to use of archival data. Measures of potential mediating variables of interest—for example, parental supervision strategies and safeguarding practices—were unavailable. Also limiting was the sample size. Although large, it did not permit sufficient power and frequency of injury to consider adequately the effect of possible moderating or mediating effects.

Despite these limitations, the study has both applied and scientific implications. From an applied perspective, the findings highlight the importance of treatment for chronic severe maternal depression. Only a small portion of mothers in the sample met the strict criteria for chronic, severe mental illness (2.49%); this is a set of women with severe and chronic mental illness. There have been multiple cries for improved treatment of chronic and severe mental illness in our society (Arnow & Constantino, 2003; Smith, Schwebel, Dunn, & McIver, 1993). In particular, researchers have called for increased awareness and treatment of postpartum depression, which sometimes leads to more chronic and severe maternal depression (Fawcett, 2005; Logsdon, Wisner, Billings, & Shanahan, 2006). There is ample evidence that chronic depression is a treatable condition; the present findings suggest that proper treatment will improve not only the mothers' health, but also could address health risks in their children as well.

The results also have multiple implications for future empirical investigation. First, more fine-grained longitudinal issues should be considered. Are there ages when young children are at particular risk for injury if parented by a mother with depression? How does "typical" postpartum depression, which usually wanes as the child approaches the 1-year mark (Wisner, Parry, & Piontek, 2002), affect children's risk for injury, both over the first year and subsequently? Research should also address different stages of development. Does maternal depression influence children's risk for injury during the later years of childhood, or during adolescence? Children make more independent risk-taking decisions at these stages, and suffer more injuries in locations outside the home, but maternal depression might still influence their behavior in as-yet-undiscovered ways.

Future work should also consider the environment children are injured within. As toddlers enter day-care centers and other nonhome environments, does maternal depression influence their risk of injury outside the home,

or is the finding reported in this article driven only by increased risk of injury in the home? Another area in need of further inquiry is the role of moderating and mediating factors. Our results suggest several of the more "obvious" covariates were not related to the link between maternal depression and child injury. Phelan and colleagues (2007) reported null results from a test of child externalizing as a mediator. Future work should try to uncover what mechanism or mechanisms might be responsible for the link between maternal depression and child injury.

Finally, more careful consideration of maternal depression should be made. Some individuals with depression have excessive irritability and anger. One might imagine these symptoms would influence child injury risk in a way far different than maternal depression marked by symptoms of fatigue and a vegetative state.

Acknowledgments

This study was conducted by the NICHD Early Child Care Research Network supported by NICHD through a cooperative agreement that calls for scientific collaboration between the grantees and the NICHD staff. We thank the NICHD team for sharing their data. The secondary analyses were supported by funds from the UAB School of Social and Behavioral Sciences and Department of Psychology (D.C.S.) and from the Cecil J. Picard Center for Child Development at the University of Louisiana at Lafayette (C.M.B.).

Conflicts of interest: None declared.

Received November 19, 2007; revisions received April 18, 2008; accepted April 20, 2008

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