Brief Report: Birth Status, Medical Complications, and Social Environment: Individual Differences in Development of Preterm, Very Low Birth Weight Infants

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Objective: To assess whether medical complications mediate the relationship between birth status (i.e., birth weight and gestational age) and developmental outcome of preterm, very low birth weight (VLBW) infants, as well as the role of the early social environment (maternal distress and social support) in infant development.

Method: Birth status and medical complication information was collected during the child’s NICU stay. Maternal distress was assessed with the Beck Depression Inventory and the Parenting Stress Index at 4 months corrected infant age. Social support was measured with the Dunst Scales at 4 months corrected age. Child development measures were collected at 4 and 13 months corrected age (Bayley MDI and PDI), and at 36 months chronological age (PPVT-R and Achenbach CBCL).

Results: Medical complications mediated the birth status-outcome relationship at 4 and 13 months, but not at 36 months. The 36-month outcomes were predicted by 4-month maternal distress and social support.

Conclusions: Prematurity and VLBW are indirectly related to early developmental outcome through their association with medical complications. However, by 36 months, developmental outcomes are more closely related to aspects of the early social environment than to early physiological factors.

Key words: preterm infants; very low birth weight; medical complications; cognitive development; behavioral development; stress; depression; social support.

Clinicians and researchers alike have noted the wide variability in developmental outcome of preterm, low birth weight (LBW) infants. An increasingly common assumption is that medical complications, rather than degree of prematurity/LBW per se, drive developmental outcomes (Creasy, Jarvis, Myers, Markowitz, & Kerkering, 1993; Myers, 1992). However, the validity of this assumption has not been adequately tested in the literature and awaits explicit support with statistical mediation models.
In addition, researchers have increasingly emphasized the role of the social context on development after the child leaves the hospital environment (Beckwith & Parmelee, 1986; Beckwith & Rodning, 1996; Sigman, Cohen, Beckwith, & Parmelee, 1981). Giving birth prematurely can introduce a considerable amount of stress into the lives of the caregivers (Lowenthal, 1987), which may significantly impair the parents’ ability to provide an environment conducive to resiliency. To buffer the distress parents of high-risk infants may experience, adequate social support networks may be needed (Crnic, Greenberg, Ragozin, Robinson, & Basham, 1983).

In this study, we evaluated the importance of infant birth status, medical complications, and the social environment for developmental outcome in a sample of preterm, VLBW infants across the first 3 years of life. We hypothesized that (1) although poor infant birth status would be associated with more negative developmental outcomes, this relationship would be mediated by the severity of the child’s medical condition; and (2) early environments characterized by greater maternal distress and less social support would be associated with more adverse outcomes across development.

**Method**

**Participants**

Participants in the study included 30 infants and their mothers enrolled in a longitudinal study of preterm infant development conducted at a Level III neonatal intensive care unit (NICU). The participants were mostly Caucasian (93%), and mothers had a mean age of 27 years (range = 19–36). At the time of delivery, 61% of the mothers reported being married. Twenty-one percent of the mothers had not completed high school, 43% had a high school education, and 36% reported at least some post-secondary education (trade school, college, and/or postgraduate). The study initially included 60 participants, but due to attrition and/or missing data, the sample consists of 30 mother-infant pairs, with the exception of analyses regarding linguistic development, for which only 24 participants had data. The participants included here did not differ from those not included on birth status, medical complications, or demographic variables, with the exception that mothers not included in the report were slightly younger (mean age = 23 years, range = 15–36). Infants included in this report had an average birth weight of 1,000 grams (range = 490–1,510 grams), and an average gestational age of 27.9 weeks (range = 23.5–32 weeks).

**Measures**

To preserve power in the multiple regression analyses, we used several composite variables as predictors. In cases where a composite was formed, variables were first standardized using a z-transformation and then averaged. Correlations between the variables contained in any given composite were all statistically significant at the .05 level or better and are reported where appropriate.

*Infant Birth Status.* Each infant’s birth status (recorded during the NICU stay) was represented by a composite formed from his or her birth weight and gestational age \((r = .93, p < .001)\). A lower score on this composite indicates a younger, smaller infant.

*Infant Medical Complications.* The medical complications composite included the following variables taken from the infant’s medical record at discharge: 5-minute Apgar (Apgar, 1962) score (reverse scored); number of days the child received ventilator support; number of days the child received supplemental oxygen (separate from ventilator support); the number of days the infant received intravenous feedings, and the number of days the child received gavage feedings. The correlations among these variables ranged from .37 to .92 (average correlation = .66), and were all statistically significant. A lower score on this composite indicates an infant who experienced fewer medical complications during hospitalization.

**Maternal Distress.** Maternal stress at 4 months corrected infant age was measured by self-report using the Parenting Stress Index-Short Form (PSI-SF; Abidin, 1990). Test-retest reliability for the PSI-SF is .84 (Abidin, 1990). Mother-reported depression was measured at this same time using the Beck Depression Inventory (BDI; Beck & Steer, 1993). Internal consistency for the Beck ranges from .73 to .92, and test-retest reliability has been found to range from .48 to .86 (Beck, Steer, & Garbin, 1988). These measures were significantly correlated \((r = .81, p < .001)\) and were used to form a maternal distress composite for each mother. A higher score on this composite indicates higher maternal distress.
Results

Interrelationships of Infant Birth Status, Medical Complications, and Developmental Outcomes

We assessed the question of whether medical complications mediated birth status-outcome relations using Baron and Kenny's (1986) approach. For illustration purposes, here we describe in detail the results of this procedure for the 4-month mental development outcome. As expected, birth status and medical complications were significantly related, such that younger, smaller infants experienced more medical complications ($\beta = -.76, p < .001$). When alone in the model, better initial birth status (i.e., older gestational ages and heavier birth weights) was associated with higher Bayley Mental Development Index scores ($\beta = .43, p < .05$), and this model explained 16% of the variance in mental development scores. When both medical complications and birth status were entered into the model, however, the relationship between birth status and Bayley MDI was nonsignificant ($\beta = .13, p < .05$), indicating that medical complications mediated the relationship between birth status and mental development. With medical complications added to the model, 37% of the variance in mental development scores was explained. These results, along with those of similar models predicting 4-month motor and 13-month mental and motor development, are summarized in Table I. As shown, the same pattern of results emerged for all 4- and 13-month outcomes. In contrast, there was no relationship between infant birth status or medical complications and 36-month outcomes.

Relationship of Early Social Environment and Developmental Outcome

Neither maternal distress nor social support was related to child performance on the Bayley at 4 or 13 months. At 36 months, maternal distress was related to child behavioral outcome such that children of mothers reporting greater distress (stress and depression) at 4 months were rated as showing more internalizing ($r = .42, p < .05$) and externalizing ($r = .63, p < .01$) behaviors at 36 months. Maternal distress was not related, however, to child linguistic functioning as measured by the PPVT-R. In contrast, maternal social support was signifi-
Table I. Summary of Multiple Regression Mediation Models at 4 and 13 Months

<table>
<thead>
<tr>
<th>Step/predictor(s)</th>
<th>Model F (df)</th>
<th>Adj. R²</th>
<th>β</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DV: MDI 4 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Birth status</td>
<td>6.41* (1, 28)</td>
<td>.16</td>
<td>.43*</td>
<td>3.87</td>
</tr>
<tr>
<td>2. Birth status</td>
<td>9.62*** (2, 27)</td>
<td>.37</td>
<td>-1.13</td>
<td>5.16</td>
</tr>
<tr>
<td>Medical complications</td>
<td></td>
<td></td>
<td>-7.44</td>
<td>5.87</td>
</tr>
<tr>
<td>DV: MDI 13 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Birth status</td>
<td>3.71 (1, 28)</td>
<td>.09</td>
<td>.34</td>
<td>4.07</td>
</tr>
<tr>
<td>2. Birth status</td>
<td>5.19** (2, 27)</td>
<td>.22</td>
<td>-1.13</td>
<td>5.79</td>
</tr>
<tr>
<td>Medical complications</td>
<td></td>
<td></td>
<td>-6.26</td>
<td>6.59</td>
</tr>
<tr>
<td>DV: PDI 4 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Birth status</td>
<td>4.04* (1, 28)</td>
<td>.10</td>
<td>.36*</td>
<td>4.06</td>
</tr>
<tr>
<td>2. Birth status</td>
<td>5.89** (2, 27)</td>
<td>.25</td>
<td>-1.14</td>
<td>5.70</td>
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<tr>
<td>Medical complications</td>
<td></td>
<td></td>
<td>-6.54</td>
<td>6.48</td>
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<tr>
<td>DV: PDI 13 months</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1. Birth status</td>
<td>11.89** (1, 28)</td>
<td>.27</td>
<td>.55**</td>
<td>3.13</td>
</tr>
<tr>
<td>2. Birth status</td>
<td>8.02** (2, 27)</td>
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<td>.22</td>
<td>4.66</td>
</tr>
<tr>
<td>Medical complications</td>
<td></td>
<td></td>
<td>-4.20</td>
<td>5.23</td>
</tr>
</tbody>
</table>

Step 1 shows model results with birth status as the only predictor. Step 2 shows model results with both birth status and medical complications as predictors.
MDI = Mental Development Index, PDI = Psychomotor Development Index.
*p ≤ .05.
**p ≤ .01.
***p ≤ .001.

significantly related to linguistic functioning, such that children of mothers reporting greater support showed better receptive language functioning at 36 months (r = .46, p < .05). In addition, maternal social support was related to child internalizing behaviors; thus, children of mothers reporting greater support were rated as showing fewer internalizing behavior problems at 36 months (r = −.42, p < .05). Maternal social support at 4 months was not related to child externalizing behaviors.

Discussion

As expected, the birth status of younger, smaller infants was associated with less optimal developmental outcomes at 4 and 13 months corrected age on the Bayley mental and psychomotor scales. However, results showed that the effect of infant birth status on developmental outcome is indirect, mediated by the medical condition of the child. The amount of variance accounted for with medical complications in the model was substantial, ranging from 22% to 37%, and in all cases an improvement over models with only infant birth status.

These data suggest that prematurity or low birth weight per se does not place this population at risk; rather, the medical complications that infants experience in the weeks and months following birth heighten risk. However, neither birth status nor medical complications were related to developmental measures taken at 36 months, suggesting that the role of such factors lessens with time.

In contrast, the importance of the early social environment became more evident over time in this study. Maternal distress (stress and depression) and social support, although unrelated to infant functioning at 4 and 13 months, were related to 36-month outcomes. Mothers reporting greater distress in response to the preterm birth at 4 months had children who displayed more behavioral difficulties, both of the internalizing and externalizing variety, at 3 years of age. Moreover, children of mothers reporting greater support at 4 months also demonstrated lower levels of internalizing behavior problems, as well as more advanced receptive language skills at 3 years, than children of mothers with less support.

Overall, the pattern of results shown in this study suggests that whereas biological factors are a dominant influence on early outcomes of preterm infants, the importance of the early social environment becomes evident in later development. This latter finding is consistent with the work of Weisglas-Kuperus, Baerts, Smrkovsky, and Sauer (1993), who found that relatively static social factors such as socioeconomic status, family composition, and ethnic background became significant predictors of cognitive scores after 2 years of age, but not before. This study is different in that it examined more psychologically oriented characteristics of the environment (e.g., maternal distress and social support), which varied considerably for the mothers of this sample. Some mothers reported stress levels within the clinical range, and depression scores at the upper end of the moderate range.

There are several limitations of this study. First, because maternal distress and child behavioral ratings were both evaluated by the mother, the relationship may be due to shared method variance. Relatedly, we acknowledge that the relationship between maternal distress and child behavior may be genetically driven, rather than environmentally. Second, the relatively small sample size may have resulted in low power for some analyses. With the current sample (n = 30), the estimated power for
detecting moderate correlations (in the .4 range) was 80% (Cohen & Cohen, 1983). Thus, other more subtle relationships between the constructs of interest may have gone undetected due to sample size limitations. Third, the higher attrition rate for younger mothers of the sample may have resulted in underestimation of the importance of some constructs, particularly maternal distress and social support, which may have a more pronounced impact for those mothers.

This study has important clinical implications. Specifically, these results suggest that efforts to enhance the development of preterm infants must take into consideration the multiple influences operating in the lives of these children and their families, in addition to attending to the child's early medical needs. An understanding of the timing of importance of physical versus social factors may help parents form appropriate expectations regarding the future course of their child's development. Although biological factors may inhibit the preterm child's development early in life, the role of such factors will likely diminish over time. In addition, intervention efforts targeting the potentially malleable psychological responses of the mother to the preterm birth, as well as her support network, may be particularly valuable for enhancing child development.

Acknowledgments

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mance of preterm infants with bronchopulmonary dysplasia (BPD), Respiratory Distress Syndrome (RDS), or no respiratory illness. Infant Behavior and Development, 15, 27–41.


