ABSTRACT. Low birth weight infants are at increased risk for behavioral and emotional problems. The Infant Health and Development Program was designed to evaluate the efficacy of intense pediatric and family support on reducing developmental and behavioral problems in low birth weight, premature infants. The major findings of this and other studies are presented in this article. Pediatrics 1998;102:1293–1297; behavior, low birth weight, infants, preterm infants, Infant Health and Development Program, development, intervention.

ABBREVIATIONS. LBW, low birth weight; IHDP, Infant Health and Development Program.

In the last decade, the survival rate for low birth weight (LBW) infants has increased markedly,3 raising questions about their subsequent health and development. A number of studies have found that LBW infants are at increased risk for developmental delay2 and for a variety of medical complications in infancy compared with their normal birth weight counterparts.3 At later ages, LBW children tend to have lower scores on tests of cognitive functioning4,5 and are at risk for having learning problems and poor academic achievement,6 even when cognitive test scores are normal.4,9 The risk of cognitive deficits is present for all birth weights ≥2500 g, although the risk increases as birth weight decreases.4,11,12 The likelihood of adverse developmental and scholastic outcomes also is greater with socioeconomic disadvantage13–15—itself a risk factor for LBW and prematurity—and this places many LBW premature infants at dual risk from both biologic and environmental factors.16,17

This article focuses on only one developmental aspect of LBW infants: behavior. The following are the primary issues explored.

• Are LBW infants at increased risk for the development of emotional and behavioral problems?
• What are the behavioral problems seen in LBW children?
• Is there a role for intervention?

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SECTION 4. EMOTIONAL CARE OF THE AT-RISK INFANT

Behavioral Outcomes in Low Birth Weight Infants

Cecelia McCarton, MD

REVIEW OF BEHAVIORAL OUTCOME STUDIES IN LBW INFANTS

Half a century ago, children born prematurely already were described as suffering from “...restlessness, nervousness, fatigability which resulted in distractibility and disturbed concentration ...”18 Research on this population has been rather unsystematic, limited, and atheoretic.19 Buka, Lipsitt, and Tsuang published an excellent review summarizing the recent world literature on the emotional and behavioral development of LBW infants born since 1960.20 After reviewing six studies of LBW infants as a group (without comparison subjects), they concluded that LBW infants have an increased risk for the subsequent development of behavioral difficulties.21–26 Behaviors such as inattention, impulsivity, and hyperactivity were described in some of the studies. No clear consensus could be drawn regarding the role of social class and “neurologic soft signs” in contributing to these behaviors.

Another series of longitudinal studies comparing LBW infants with a control population also supported the hypothesis that LBW infants had more emotional and behavioral problems and extreme aspects in temperament.27–34 Variables associated with poor behavioral outcomes included extreme prematurity (birth weight <1500 g), male gender, low social class, and the stage of pregnancy at which slow head growth began. Behavioral disturbances included hyperactivity, short attention span, less adaptability, more intensity, and higher thresholds to sensory stimuli. Only one study found the children less active, shyer with classmates, and maintaining more contact with adults.37

Six large cohort studies from prescribed geographic regions compared the behavioral development of an LBW subset of the cohort with that of the normal-weight members. Again, the consensus was that LBW infants displayed a higher risk of developing behavioral problems. The primary abnormal outcomes were described as hyperactivity and attention deficit. The associated factors included social class and intrauterine growth retardation.35–39

The only longitudinal report of behavioral outcomes extending to 29 years of age showed no significant differences in the rate of psychiatric disorders for normal and LBW infants (SL Buka, LP Tsuang, LP Lipsitt, 1990, unpublished data).
THE ROLE OF INTERVENTION: INFANT HEALTH AND DEVELOPMENT PROGRAM (IHDP)

Recognizing that LBW infants and perhaps certain subpopulations of LBW infants are at increased risk for emotional and behavioral problems provides opportunities for early detection and intervention. The following is a description of a family-based educational curriculum and family support program that can be effective in reducing behavioral problems in LBW children.

The IHDP is the first multisite, randomized clinical trial designed to evaluate the efficacy of combining early child development and family support services with infant follow-up in reducing developmental, behavioral, and other health problems in LBW premature infants (birth weight, <2500 g; gestational age, ≤37 weeks). The intervention protocol and the specific curricula used were adapted for LBW infants from two longitudinal studies of successful early intervention with socially disadvantaged children of normal birth weight.

PATIENTS AND METHODS

Eight medical institutions serving diverse demographic populations in different geographic locations were selected through a national competitive review.

Sample

All infants born in participating hospitals who weighed <2500 g at birth and who weighed ≤37 weeks’ gestation were eligible for the entire study. In addition, the families of the children had to live within a specified distance from the intervention site and be able to speak English. Children with major anomalies or other specified conditions who were better assisted in other programs were excluded. The primary analysis group comprised 985 infants.

The research design included stratification by eight sites and two birth weight groups (infants weighing 2001 to 2500 g, and infants weighing <2000 g). One third of the sample came from the heavier group and two thirds from the lighter group. Subjects within each weight group were randomly allocated: one third to the intervention group and two thirds to the follow-up (or control) group.

Program Description

The program was initiated after the infant’s discharge from the neonatal nursery and continued until 36 months of age, corrected for prematurity. Infants in the intervention and control groups participated in the same pediatric follow-up, which comprised medical, developmental, and social services, with referral for pediatric care and other services as indicated. The services exclusively for the intervention group consisted of home visits, attendance at a child-development center, and parent group meetings. All services were provided free to the families.

Home Visits

The protocol specified weekly home visits for the first year and biweekly visits thereafter. The home visitor provided health and developmental information and family support and implemented two specific curricula. One curriculum emphasized cognitive, linguistic, and social development via a program of games and activities for the parent to use with the child. The second curriculum involved a systematic approach to help parents manage self-identified problems.

Child Development Centers

Beginning at age 12 months and continuing until corrected age 36 months, the intervention children attended the center 5 days per week. The teaching staff continued to implement the curriculum of learning activities used by the home visitors and tailored the program to each child’s needs and developmental level. Teacher–child ratios were 1:3 for children 12 to 23 months of age and 1:4 for those 24 to 36 months of age; class sizes were 6 and 8 children, respectively. Each site provided transportation in IHDP-operated vans to any child who needed it.

Parent Groups

Beginning at age 12 months, bimonthly parent-group meetings provided information on child-rearing, health and safety, and other parenting concerns, as well as some degree of social support.

Assessment of Behavioral Competence

Behavior competence was assessed using a battery of two behavior problems. At the 24- and 36-month visits, the parents completed the Behavior Checklist, an adaptation of the 60-item Behavior Screening Questionnaire, which consists of 21 questions used to produce a 12-item score. The items are scored using a 3-point Likert scale. The total score was used. At the 36-month visit, mothers also completed the Child Behavior Checklist for Ages 2–3. A 3-point Likert scale is used for 99 items. Mothers were read the items by the interviewers to control for possible differences in reading ability. A total problem raw score was used. Higher scores indicate more behavior problems in both scales.

Videotaping Procedure

For the mother–child interaction study, three types of interactions were videotaped at 30 months using a standardized protocol: an 8-minute free-play period, a clean-up period, and three different problem-solving tasks based on previous research by Matas and associates. On each of the three tasks, the child works to obtain a toy contained in a collection of toys. The videotaping continues for each task until the child solves the problem or until 16 minutes have elapsed, whichever occurs first. The first task (the fixed lever) was relatively easy and was used as a warm-up task. Data are reported here for the second task (the rake box), which was expected to be more difficult for the child and to require the mother’s assistance for solution. In the rake task, the child must connect two sticks to make one long stick, insert it into a narrow opening at one end of a flat box, and take a small toy from the box.

RESULTS

Child Behavioral Competence—Primary Analysis

The average score on the Child Behavior Checklist was significantly lower for the intervention group than for the follow-up group, with higher scores indicating more reported behavior problems (Table 1). Although the difference between study groups was small, the adjusted odds for having a score >63, the cut point above which scores are correlated with clinically evident behavior problems, were 1.8 times greater in the follow-up group (95% confidence interval: 1.2 to 2.9). The actual percentages were 18.8% for the follow-up group and 13.9% for the intervention group.

Secondary Analysis

The multiple regression analysis indicated significant main effects of several initial status variables. Higher scores (suggestive of more behavior problems) for the intervention group were associated with a higher birth weight group and a higher age at enrollment.

| TABLE 1. Behavioral Competence—Infant Health and Development Program |
|------------------|------------------|------------------|
|                  | Control Group (n = 347) | Intervention Group (n = 338) | Effect Size (P) |
| Child behavior checklist | 47.2 (20.5) | 43.7 (19.1) | −18 (.006) |

Child behavior checklist (age 2–3 y)
lems) were associated with being African-American or Latino, with being male, and with lower maternal age and education level. Controlling for these variables, there was a significant effect of the intervention (adjusted Effect Size = –.20; \( P = .003 \)). The only variable that had a significant interaction with the intervention was maternal education (\( P = .009 \)). With college-educated mothers, there seemed to be little difference between the control and intervention groups, whereas with mothers with less education, those in the intervention group reported fewer behavior problems.

Thus, the intervention may have helped these mothers become better informed about age-appropriate behaviors and consequently report fewer behavior problems; it may have taught them more effective techniques for behavior management; or it may have altered the children’s behavior.

Brooks-Gunn and colleagues further analyzed these data and found that in terms of behavioral competence the intervention was most efficacious in African-American children whose mothers had not graduated from high school.51

### SPECIFIC MATERNAL CHARACTERISTICS INFLUENCED BY INTERVENTION

Recent studies suggest that intervention programs can be effective in teaching mothers to interact and communicate better with their children. For example, interventions have influenced parental involvement, acceptance, and stimulation.52–54 Others have found increased maternal involvement and vocalizations and improvements in expressiveness, contingent responsiveness, game-playing, and quality of assistance.55–57 Numerous studies also have demonstrated that intervention programs can be effective at teaching mothers to be more responsive and less directive in their interactions with their children.58–60 Research also has found that intervention improves turning-taking behaviors.58–60 Mahoney and Powell reported that other maternal affective characteristics (warmth and enjoyment) were less responsive to intervention coaching.61

The importance of mother–child interaction for child development is substantiated in numerous studies. These early interactions appear to be especially important for LBW premature infants. Researchers have turned to intervention programs in hope of facilitating infants’ early interaction and developmental outcomes. Although intervention programs have proven effective in improving the developmental consequences of LBW premature infants, few studies actually have measured the effects of intervention on the quality of mother–child interaction and, thus, little is known about their influence on dyadic exchanges.

Spiker and colleagues focused on enhancing maternal interactive behavior and child social competence in LBW premature infants. They rated multiple maternal variables, child variables, and dyadic variables based on an 8-minute videotape that had free play and a structured learning task at the 30-month IHDP visit.55

Significant effects were seen on six of eight ratings (Table 2). Intervention mothers had higher ratings on quality of assistance; intervention children had higher ratings on persistence and enthusiasm and on overall competence and involvement, as well as lower ratings on percentage of time off task; intervention dyads were rated as more synchronous.57

Additional research was pursued in determining the effects of IHDP on the quality of maternal interactive behavior. It is important to remember that the IHDP aimed at having an impact on both the parent and the child. The IHDP curriculum included activities to assist parents in teaching their children. It provided information to parents on child management, child development, appropriate expectations for children, and the importance of providing a rich array of experiences to children. Parents also were provided general social support and were assisted in developing problem-solving skills, both of which are factors that seemed likely to make the parents more accepting, effective, and thoughtful managers of their children. IHDP also included a highly enriched day care experience for children that was aimed at enhancing the child’s intellectual language and social competence.

Wheeden used the free-play portion of the 30-month mother–child videotaped IHDP sessions to explore maternal characteristics.62 The means and standard deviation units for each of the 12 maternal behaviors examined are presented in Table 3.57 Mothers in the intervention group showed more expression and enjoyment toward their children than did

**TABLE 2.** Maternal and Child Behaviors—Infant Health and Development Program

<table>
<thead>
<tr>
<th>Maternal ratings</th>
<th>Control Mean (SD)</th>
<th>Intervention Mean (SD)</th>
<th>( P ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supportive presence</strong></td>
<td>4.0 (1.5)</td>
<td>4.2 (1.5)</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Quality of assistance</strong></td>
<td>3.3 (1.5)</td>
<td>3.6 (1.5)</td>
<td>.05</td>
</tr>
<tr>
<td><strong>Child ratings</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Persistence</strong></td>
<td>3.2 (1.0)</td>
<td>3.5 (1.0)</td>
<td>.01</td>
</tr>
<tr>
<td>% Time off task</td>
<td>0.19 (.2)</td>
<td>0.14 (.2)</td>
<td>.01</td>
</tr>
<tr>
<td><strong>Enthusiasm</strong></td>
<td>4.2 (1.4)</td>
<td>4.5 (1.3)</td>
<td>.05</td>
</tr>
<tr>
<td>Overall child</td>
<td>3.2 (.9)</td>
<td>3.4 (1.0)</td>
<td>.01</td>
</tr>
<tr>
<td><strong>Dyadic ratings</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall experience</td>
<td>3.2 (1.0)</td>
<td>3.3 (1.0)</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Mutuality</strong></td>
<td>2.7 (1.0)</td>
<td>3.0 (.95)</td>
<td>.01</td>
</tr>
</tbody>
</table>

**TABLE 3.** Maternal Interactive Ratings (Mean)

<table>
<thead>
<tr>
<th>Maternal behavior</th>
<th>Total Sample Mean (SD)</th>
<th>Intervention Mean (SD)</th>
<th>Control Mean (SD)</th>
<th>( P ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expressiveness</td>
<td>2.83 (.76)</td>
<td>3.08 (.75)</td>
<td>2.67 (.73)</td>
<td>&gt;.001</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>2.88 (.77)</td>
<td>3.05 (.74)</td>
<td>2.78 (.77)</td>
<td>.002</td>
</tr>
<tr>
<td>Warmth</td>
<td>2.33 (.84)</td>
<td>2.35 (.86)</td>
<td>2.18 (.80)</td>
<td>&gt;.001</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>3.22 (.98)</td>
<td>3.49 (.92)</td>
<td>3.05 (.98)</td>
<td>&gt;.001</td>
</tr>
<tr>
<td>Responsivity</td>
<td>2.98 (.95)</td>
<td>3.22 (.99)</td>
<td>2.83 (.98)</td>
<td>&gt;.001</td>
</tr>
<tr>
<td>Achievement</td>
<td>3.38 (.86)</td>
<td>2.73 (.87)</td>
<td>2.16 (.78)</td>
<td>&gt;.001</td>
</tr>
<tr>
<td>Inventiveness</td>
<td>2.26 (.64)</td>
<td>2.38 (.63)</td>
<td>2.18 (.64)</td>
<td>.008</td>
</tr>
<tr>
<td>Praise</td>
<td>1.75 (.90)</td>
<td>1.85 (.90)</td>
<td>1.68 (.89)</td>
<td>NS</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>3.11 (.82)</td>
<td>3.28 (.74)</td>
<td>2.00 (.85)</td>
<td>.004</td>
</tr>
<tr>
<td>Pace</td>
<td>3.03 (.70)</td>
<td>3.01 (.61)</td>
<td>3.04 (.75)</td>
<td>NS</td>
</tr>
<tr>
<td>Acceptance</td>
<td>2.83 (.78)</td>
<td>3.00 (.73)</td>
<td>2.73 (.79)</td>
<td>.003</td>
</tr>
<tr>
<td>Directiveness</td>
<td>3.32 (.86)</td>
<td>3.23 (.77)</td>
<td>3.37 (.90)</td>
<td>NS</td>
</tr>
</tbody>
</table>
mothers in the follow-up group. They demonstrated more positive affect and fondness toward their children. Intervention mothers seemed more aware of their children's activities and interests and responded more consistently and appropriately to their children's behavior. Furthermore, they showed more encouragement of their children's sensorimotor and cognitive development, and they provided their children with a larger repertoire of types and approaches toward toys. Also, intervention mothers were more successful in engaging their children in play interactions and displayed more acceptance and approval of their children during interactions.

Although significant differences were found in many components of maternal interactive behavior, achievement orientation was the factor that most differentiated mothers in the intervention group from those in the follow-up group. This finding is meaningful in that the IHDP was designed to improve the developmental outcomes of LBW premature infants. Although improving mother–child interaction was a component of the curriculum, the primary focus was on the child. It is possible that mothers whose children received the IHDP intervention program, compared with those whose children did not receive the intervention, were aware of this focus on improving children's developmental outcomes. Accordingly, mothers in the intervention group might have attempted to encourage their children's learning and development to a greater extent than did mothers in the follow-up group who were not aware of the focus of IHDP.

Finally, these findings suggest that an intervention program designed primarily to improve the developmental consequences of LBW premature infants also was effective in influencing specific aspects of maternal interactive behavior. Qualitative differences were seen in domains not targeted directly by the IHDP curriculum, suggesting that the intervention had many avenues of influence on the children and families. It is likely, for example, that topics and issues discussed during the home visits and parent-group meetings, such as children's developmental milestones and child-rearing guidance, served to enhance maternal awareness and contribute to the higher ratings of maternal interactive behaviors.

Alternatively, it is possible that the effects of the IHDP intervention were mediated by the impact on and improvements in the children. Because a major focus of the IHDP was on the child, it is possible that the intervention children may have been more cooperative and involved social partners and more advanced cognitively, which may have affected their synchrony with their mothers.

**SUMMARY**

This study demonstrates that LBW infants, as a group, are at increased risk for emotional and behavioral problems. A comprehensive educational and developmental intervention program such as the IHDP was successful not only in improving the behavioral competence of LBW infants at 3 years of age but also in influencing maternal characteristics and mother–child interactions.

Once the intervention ended, however, the differences in behavioral performance disappeared. Follow-up studies of the IHDP cohort through 5 and 8 years of age showed no difference in behavioral competence between the follow-up and intervention groups.

In the 1960s, a number of theorists suggested that the first years of life were of extraordinary importance in remediating the academic disadvantages often observed among poor and ethnic-minority children. Moreover, in some cases, a more radical suggestion was made: that disadvantaged children could possibly be "inoculated" against their disadvantages by providing them with enrichment experiences in the first years of life. It was implied that, as with inoculations against infectious diseases, these enrichment inoculations might provide long-lasting protection.

The results of the IHDP call into question the notion that providing enriching experiences in the first few years of life can protect children against biological disadvantages for extended periods of time. As Zigler has stated, it is unrealistic to expect 1 year of center-based intervention, in the case of Head Start, or even several years of such intervention, to offset totally the experiences of children living in difficult and impoverished family circumstances or receiving low-quality care. It seems likely that interventions to improve the long-term behavioral performance of biologically vulnerable children will have to extend beyond age 3 years to attain maximum effectiveness during the school years. Additional research is required to determine the most effective type, timing, and intensity of intervention services for biologically vulnerable children.

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13.
Behavioral Outcomes in Low Birth Weight Infants

Cecelia McCarton

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