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Does a Triplet Birth Pose a Special Risk for Infant Development? Assessing Cognitive Development in Relation to Intrauterine Growth and Mother-Infant Interaction Across the First 2 Years

Ruth Feldman, PhD*, and Arthur I. Eidelman, MD‡

ABSTRACT. *Objective.* **To examine whether a triplet birth per se poses a risk to the development of infants' cognitive competencies and to the mother-infant relationship.**

Methods. **Twenty-three sets of triplets were matched with 23 sets of twins and 23 singleton infants ($n = 138$) with respect to gestational age, birth weight, and medical and demographic features. Infants with perinatal asphyxia, intraventricular hemorrhage of grade 3 or 4, periventricular leukomalacia, or central nervous system infection were excluded from the study. At 6, 12, and 24 months of age, mother-infant interaction was observed and infants' cognitive development was tested with the Bayley II test.**

Results. **Mothers of triplets displayed lower levels of sensitivity at 6, 12, and 24 months and infants were less socially involved at 6 and 24 months, compared with singletons and twins. Triplets scored lower than singletons and twins on the Bayley Mental Developmental Index at 6, 12, and 24 months. A weight discordance of >15% was found for 15 triplet sets (65.2%). The discordant triplets showed decreased cognitive skills at 12 and 24 months, compared with their siblings, and received the lowest scores for maternal sensitivity. Hierarchical multivariate regression analysis revealed that greater medical risk at birth, multiple-birth status, lower maternal sensitivity, and reduced infant social involvement in the first 2 years were each predictive of lower cognitive outcomes at 2 years ($R^2 = 0.33$).**

Conclusions. **Triplets appear to be at higher risk for cognitive delays in the first 2 years of life, and discordant infants are at especially high risk. This delay is related in part to the difficulty of providing sensitive mothering to 3 infants at the same time. The findings may assist practitioners in guiding prenatal and postpartum parental care and management.** ***Pediatrics*** **2005;115:443–452;** ***triplets, twins, multiple birth, parent-infant interaction, cognitive development, Bayley II, maternal sensitivity, infant social development.***

ABBREVIATIONS. IUGR, intrauterine growth retardation; MDI, Mental Developmental Index; MANOVA, multivariate analysis of variance; CRIB, Clinical Risk Index for Babies; PDI, Psychomotor Developmental Index.

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Triplets are a fast-growing birth population. In the United States, the rate of triplet births increased sevenfold, compared with that of singleton births, between 1973 and 1990, and the actual number of triplet births has multiplied 10-fold since 1980.[1–5] Similar increases have been noted in Australia, England, France, Belgium, Holland, and Israel,[6–12] and triplet births represent ~0.4% of deliveries.[13] Surprisingly, however, given this increase in the rates of triplet conception and improved chances of survival,[14] the long-term developmental course of triplets has not received sufficient empirical attention. To date, little research has examined triplets beyond the first 1 year of life, in relation to intrauterine growth and subsequent parenting patterns. Similarly, few studies have systematically compared the development of triplets with that of appropriately matched singletons and twins.

Information on mortality rates and short- and long-term developmental outcomes for triplets is important in facilitating appropriate prenatal counseling, because presumed outcome data frequently serve as a basis for recommendations regarding fetal reduction. In addition, such data provide a reference for psychosocial guidance for parents of triplets and for monitoring of the infants' development.[14] Because most published studies suffered from methodologic flaws or did not extend their observations beyond the first 1 year of life, they are not fully adequate to provide a proper database for such purposes.

Triplets are typically born prematurely (40–50% weigh <1500 g[15–17]), and prematurity is a risk condition for infant development. Premature infants, especially those born with very low birth weights, are at higher risk for morbidity and death, as well as for neurologic impairments, cognitive delay, and behavior problems in later childhood and adolescence.[18–24] Furthermore, triplet pregnancies come at great financial cost to society. In the United States, medical costs for triplet pregnancy care are estimated at $200 000.[25] Therefore, it is important to examine whether a triplet birth poses an independent risk for infant development, beyond that of prematurity and its associated medical complications.

An additional reason for concern in the development of triplets is the higher risk for intrauterine

growth retardation (IUGR) among infants born in a higher-order multiple birth. Although this concern regarding growth exists for all infants in the multiple birth set, not infrequently 1 of the fetuses is particularly affected, leading to a birth weight of <10th percentile for the estimated gestational age. In addition, a birth weight difference of ≥15% between the infant with the lowest weight and the infants with the highest weights defines a degree of weight discordance that is correlated with increased risks of abnormal neurologic, behavioral, and cognitive outcomes.[26–28] Such growth abnormalities are common with all multiple births but are particularly common with triplet births and higher-order multiple births. For example, Sasson et al[29] found IUGR in 53% of triplet pregnancies and discordance in 66% of triplet pregnancies, compared with only 6% IUGR and 13% discordance among twins. IUGR is considered a separate risk factor for cognitive delays, regardless of prematurity,[30–32] and has been correlated with higher reactivity, physiologic dysregulation, lower adaptability, and poor social skills.[33–35]

The cognitive development of triplets has not been studied in depth, and most studies did not distinguish triplets from twins. Gutbrod et al[36] found that singletons showed better cognitive functioning at 5 months but not at 20 months, compared with a group of twins and triplets. The school readiness of singletons was not found to differ from that of children born in a multiple birth.[37] Eleven French triplet sets examined at 7 years of age showed poorer cognitive skills, compared with singletons, but the differences did not reach statistical significance.[38] Similarly, the cognitive functioning of 17 Swedish triplet sets, 4 to 8 years of age, was lower than the average for the Swedish population; however, when triplets were compared with singletons born prematurely at <2500 g, only a slight cognitive delay was detected.[39] In addition, triplet infants with IUGR demonstrated significantly poorer performance than did their appropriate-for-gestational age siblings with most cognitive subsets. Krall and Feinstein,[40] who monitored 1 quintuplet set, 2 quadruplet sets, and 2 triplet sets, found that the multiple-birth infants functioned at the low end of the normative spectrum and that the infants' birth weights were related to the attainment of cognitive milestones. In a French study of 77 sets of school-aged triplets, parents, teachers, and social workers reported whether the children's general functioning was good, average, or poor, and more triplets were found to perform poorly, compared with singletons and twins.[41] However, no standard testing or direct observations were used in that study, and the researchers did not control for neurologic conditions such as cerebral palsy or brain damage.

Authors of triplet studies have underscored the potential negative impact of a triplet birth on the development of cognitive skills, as a result of the mother's limited capacity to provide adequate attention and stimulation to each child.[42–44] Parents of triplets often respond with shock to the discovery of a triplet pregnancy and report tremendous physical, emotional, and financial burdens once the infants are born.[45] Parents admit to a situation they have long desired but have difficulty managing competently once the infants are born.[42] Because triplet pregnancies are associated with increased medical complications for mothers, life at home begins with maternal physical and emotional exhaustion.[46] Interviews with parents indicate not only that parenting of triplets is more difficult than parenting of twins but also that the 1 additional child makes the difference between a manageable parenting situation and an unmanageable situation.[42–44] Mothers of triplets report high levels of stress, anxiety, social isolation, and fatigue and a significant decline in the marital relationship.[47] Most importantly, mothers of triplets complain of having no energy to develop a unique bond with each child and of emotional detachment from the children.[48]

Our recent report noted that triplets showed a degree of cognitive delay at 1 year of age,[49] although the effects of intrauterine growth were not analyzed. Furthermore, that report did not examine the link between parenting and cognitive development among triplets beyond the first 1 year of life. Such data are particularly important in light of the increasing concerns mothers raise during the second year with respect to the toddlers' growing need for individual attention.[45] Similarly, a group of 12 French mothers evaluated at 2 and 4 years reported high levels of stress and depression at this stage and complained of difficulties in managing aggression and competition among the children.[50,51] These studies clearly suggest that parenting stress and the mother's inability to focus on the relationship with each child are likely to increase in the second year and may interfere with the children's development at this stage.

The high level of stress and the decrease in the parents' sense of competence may result in lower maternal sensitivity to the needs of each child. Because cognitive development in infancy is based in part on the mother's provision of sensitive, age-appropriate parenting and adequate stimulation of the infant's growing cognitive skills,[52–54] the enormous parenting stress and lower sense of competence caused by the triplet situation is likely to interfere with the infants' cognitive development. Moreover, the effects of the mother's lower sensitivity on the infant's cognitive development are likely to be more pronounced during the second year, a period when infants become more mobile and verbal but are still highly dependent on the mother to make sense of their environment, especially because their access to care-giving adults outside the family setting is still limited. Therefore, it may be postulated that, within the limited-resources ecology created by the triplet situation, triplet infants are likely to receive lower levels of maternal sensitivity. Furthermore, a child with IUGR, who is less socially competent and more difficult and dysregulated,[33–35] is likely to receive even lower levels of sensitive mothering than the siblings, which places such triplet children at especially high risk for less-than-optimal growth and development.

In light of the aforementioned factors, the goal of

the present study was to extend our previous reports[49,55] on the development of triplets beyond infancy and to more fully assess the relationships between mothering, infant social involvement, and cognitive development. We hypothesized that triplets would demonstrate lower cognitive development at 6, 12, and 24 months, compared with singletons and twins. In this study, we expanded our observations and analyses as we hypothesized that the level of maternal sensitivity at 6, 12, and 24 months among mothers raising triplets would be lower and would be related to a lesser sense of maternal competence in the parental role. As a result of this decrease in maternal sensitivity, it was expected that the levels of children's social involvement, reciprocity, and competent use of play material during interactions with their mothers would be lower in the triplet group. Furthermore, we hypothesized that discordant infants would display poorer cognitive outcomes at 2 years of age, in comparison with their siblings with normal intrauterine growth. Finally, we hypothesized that better mothering and greater child social involvement and competence in the first 2 years would predict better cognitive skills among infants at the toddler stage.

METHODS

Participants

Participants included 138 newborn infants and their parents. The sample included 23 consecutive sets of triplets born at the Shaare Zedek Medical Center, a tertiary-care medical hospital in Jerusalem, Israel. Each set of triplets was matched with a set of twins and a singleton child born in the same hospital during the same period. Infants were matched with respect to birth weight, gestational age, medical risk, and family demographic features (maternal and paternal ages and education levels). Birth weights were matched to the average of the triplet set, with maintenance of comparable ratios of small-for-gestational age (birth weight of <10th percentile)/appropriate-for-gestational age (birth weight of 10th to 90th percentile) and male/female infants in the 3 groups. None of the mothers who gave birth to triplets during the study period refused participation. Three families that experienced triplet births during the recruitment period were not included. In the first family, 2 of the children died shortly after birth. In the second family, 1 child died shortly after birth. In the third family, 1 child became seriously ill and did not meet the inclusion criteria. Three mothers of singletons and 2 mothers of twins who were approached to participate in the study declined, citing time limitations or father refusal as reasons.

All children in the study came from 2-parent families in which at least 1 parent was employed and the mothers were >20 years of age. Exclusion criteria included grade 3 or 4 intraventricular hemorrhage, periventricular leukomalacia, perinatal asphyxia (defined as a 5-minute Apgar score of ≥7 and an absence of signs of clinical encephalopathy), metabolic or genetic disease, central nervous system infection, and abnormal neurologic examination results before discharge. All families were middle-class, representing the majority of young families in the Israeli population.[56] Demographic and medical information for the 3 groups is presented in Table 1 and indicates no differences between the 3 groups. No differences were found in the level of the parents' self-reported social support or in the mother's employment status (full, part-time, or none). The study was approved by the institutional review board, and all participating families signed an informed consent form.

One twin set and 1 singleton missed the 6-month follow-up assessment, 1 triplet set and 1 twin set missed the 12-month follow-up assessment, and 24-month data were not available for 1 triplet set, 1 twin set, and 2 singletons. In 1 triplet set, 1 of the infants died after his first birthday, and data were available for the complete set only up to 1 year. The surviving 2 infants from the set were studied at 2 years of age. All missed appointments were missed because of scheduling difficulties.

Procedure

Infants and their mothers visited a hospital-based developmental laboratory at 6, 12, and 24 months (corrected age). Infants were tested with the Bayley Scales of Infant Development,[57] and 10 minutes of free mother-infant interaction were videotaped. At each age, each mother received a set of age-appropriate toys to play with the infant and was asked to interact with the child as she typically does. Neurologic evaluation was performed at 24 months.

Measures

Infant Medical Risk

Infant medical risk was measured with the Clinical Risk Index for Babies (CRIB).[58]

Mother-Infant Interaction

Ten minutes of mother-infant interaction were videotaped at each age. Coding of all tapes was conducted at a central university laboratory, by trained observers. Interactions were coded with the Coding Interactive Behavior system.[59] The Coding Interactive Behavior system is a global rating system of parent-infant interaction that includes 42 codes rated from 1 (low) to 5 (high). The system has been validated in numerous studies of healthy and at-risk infants and has shown sensitivity to infant age, interacting partner, cultural background, and developmental risk conditions.[52,60–63] Two factors were calculated. (1) Maternal sensitivity was based on 10 items, i.e., acknowledgment of the infant's interactive signals, elaboration of the child's vocalizations and movements, warm and positive affect, affectionate tone of voice, fluency of the interaction, consistency and predictability of style, resourcefulness in dealing with the infant's negative states, appropriate range of affect, and adaptation to the

TABLE 1. Demographic and Medical Factors

	Singletons (n = 23)		Twin Sets (n = 23 Sets, 46 Infants)		Triplet Sets (n = 23 Sets, 69 Infants)	
	Mean	SD	Mean	SD	Mean	SD
Birth weight, g	1638.26	445.48	1658.22	495.5	1660.14	417.33
Gestational age, wk	32.10	2.76	32.57	2.97	32.22	2.52
Medical risk, CRIB score	1.63	2.45	1.30	1.90	1.43	2.19
Maternal age, y	27.84	5.46	28.55	6.03	29.25	4.68
Maternal education, y	14.56	2.42	14.21	1.47	14.01	2.33
Paternal age, y	30.08	5.95	31.93	7.59	32.06	5.01
Paternal education, y	13.50	3.01	13.93	2.56	14.15	2.95
Male gender, %	53.8		57.4		55.1	
No. of siblings	1.53	1.20	1.65	1.32	1.0	.86
SGA, %	8.7		9.0		8.6	
Abnormal neurologic examination results at 24 mo	0/21		2/44		3/63	

SGA indicates small for gestational age. No significant differences between groups were noted for any factor.

infant's state and signals (Cronbach's α = .92, .94, and .90 at 6, 12, and 24 months, respectively). (2) Child social involvement was calculated from 5 items at 6 months and from 7 items at 12 and 24 months. These included child initiation of interactive bids, child positive affect, child vocalization, child alertness, and child-led interactions. At 12 and 24 months, 2 additional codes were included, ie, child symbolic-creative play and child competent use of the environment (Cronbach's α = .86, .88, and .82 at 6, 12, and 24 months, respectively). Interactions at each age were transferred to continuous tapes, siblings were not placed successively, and tapes were randomly assigned to the 2 coders, to ensure unbiased coding. Two coders, who did not participate in the testing and were not aware of the infant multiple-birth status, were trained to 90% agreement. Reliability was measured on 15 assessments at each stage and averaged 94% (κ = .82).

Infant Cognitive Development

Infant cognitive development was assessed by trained psychologists, with the Bayley Scales of Infant Development.[57] The Bayley II assessment yields 2 developmental indices, ie, the Mental Development Index (MDI) and the Psychomotor Developmental Index (PDI). Different psychologists performed cognitive testing at each observation point, to ensure unbiased evaluation.

Maternal Competence and Satisfaction

Maternal competence and satisfaction were measured at 6 months with the Parental Competence and Satisfaction Scale.[64] The Parental Competence and Satisfaction Scale is a 17-item instrument assessing the levels of parental anxiety, frustration, motivation, competence, and problem-solving. Two factors are extracted, ie, parental competence and parental satisfaction in the parenting role, and the instrument has shown good reliability and validity.

Statistical Analyses

The 2 indices of cognitive development (MDI and PDI) and the 2 mother-infant interaction factors (maternal sensitivity and child social involvement) at each age were examined with a separate multivariate analysis of variance (MANOVA), with multiple-birth group (singletons, twins, or triplets) and infant gender as the between-subject factors. Univariate analyses with posthoc Scheffe's tests followed significant main effect findings with the MANOVA. Pearson correlations examined associations between cognitive development and mother-infant interaction variables at each age and across ages. A hierarchical multivariate regression model was computed, predicting infants' MDI scores at 24 months according to maternal and infant variables in the first 2 years. The sample size provides sufficient power (d = 0.85) to detect a medium effect size (effect size = 0.5).[65]

RESULTS

Six Months

Mother-Infant Interaction

A MANOVA conducted for the mother-infant interaction variables (maternal sensitivity and infant social involvement) showed an overall effect for multiple birth [Wilks' F (df = 4, 256) = 4.32, $P < .01$], ie, more positive interactions in the singleton and twin groups, compared with the triplet group. Univariate tests with posthoc Scheffe's tests indicated that both maternal sensitivity and infant social involvement were greater in the singleton and twin groups, compared with the triplet group (Table 2). No differences were found between singletons and twins (Figs 1 and 2).

Infant Cognitive Development

A MANOVA conducted for the 2 Bayley scores (MDI and PDI) revealed an overall effect for multiple birth [Wilks' F (df = 4, 256) = 2.95, $P < .05$]. Univariate tests with posthoc Scheffe's tests indicated that triplets scored lower on the MDI, compared with singletons and twins; no differences were found in PDI scores (Table 3; Fig 3). Higher MDI scores at 6 months were correlated with greater maternal sensitivity (r = 0.20, $P < .05$) and greater infant social involvement (r = 0.26, $P < .01$) at the same age.

Twelve Months

Mother-Infant Interaction

A MANOVA conducted for the mother-infant interaction variables at 12 months revealed an overall effect for multiple birth [Wilks' F (df = 4, 246) = 2.95, $P < .05$]. Univariate tests with posthoc Scheffe's tests showed that mothers of triplets were less sensitive during interactions, compared with mothers of singletons and twins. No differences were found in infant social involvement (Table 2; Figs 1 and 2).

Infant Cognitive Development

A MANOVA conducted for the 2 Bayley scores (MDI and PDI) showed an overall main effect for multiple birth [Wilks' F (df = 4, 256) = 2.36, $P < .05$]. Univariate tests with posthoc Scheffe's tests demonstrated that triplets showed lower MDI scores, compared with singletons and twins (Table 3). No differences were found in the PDI scores (Table 3; Fig 3). Correlations between MDI scores at 12 months and mother-infant interactions were found. Higher MDI scores were related to greater maternal sensitivity (r = 0.28, $P < .01$) and greater infant social involvement (r = 0.19, $P < .05$).

TABLE 2. Maternal Sensitivity and Infant Social Involvement at 6, 12, and 24 Months of Age for Singletons, Twins, and Triplets

	Singletons (A)		Twins (B)		Triplets (C)		Univariate F	P
	Mean	SD	Mean	SD	Mean	SD		
6 mo								
Maternal sensitivity	4.38	0.75	4.25	0.89	3.95	0.93	4.66* (A, B > C)	.021*
Infant social involvement	2.48	0.88	2.43	0.89	2.03	0.78	5.61† (A, B > C)	.007†
12 mo								
Maternal sensitivity	4.17	0.95	4.03	0.89	3.88	0.93	4.21* (A, B > C)	.036*
Infant social involvement	2.67	0.91	2.55	0.89	2.43	0.78	1.56	
24 mo								
Maternal sensitivity	3.79	0.89	3.75	1.89	3.25	0.82	2.96* (A, B > C)	.041*
Infant social involvement	3.75	1.12	3.36	1.09	2.87	0.95	4.78* (A > B > C)	.013*

A, B > C indicates that means in the singletons and twins groups are significantly higher than means in the triplets group, as shown by posthoc Scheffe's tests; A > B > C, means in the singletons group are significantly higher than means in the twins group, and means in the twins group are significantly higher than means in the triplets group, as shown by posthoc Scheffe's tests.
* $P < .05$.
† $P < .01$.

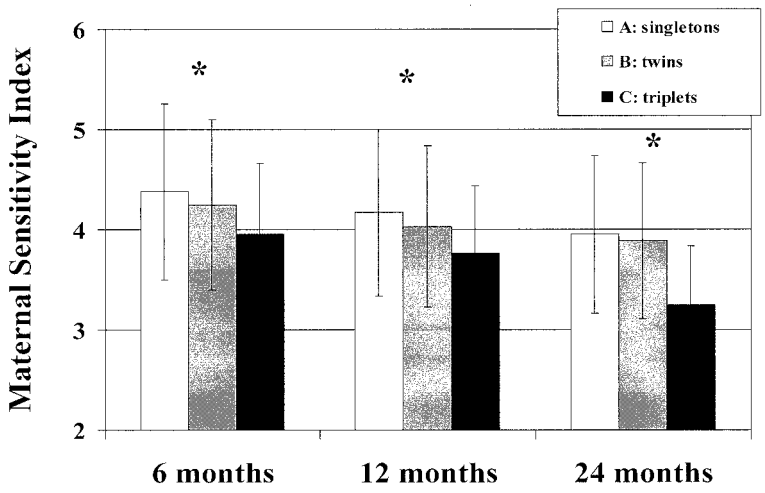

Fig 1. Maternal sensitivity for singletons, twins, and triplets at 6, 12, and 24 months of age. *$P < .05$, A and B > C.

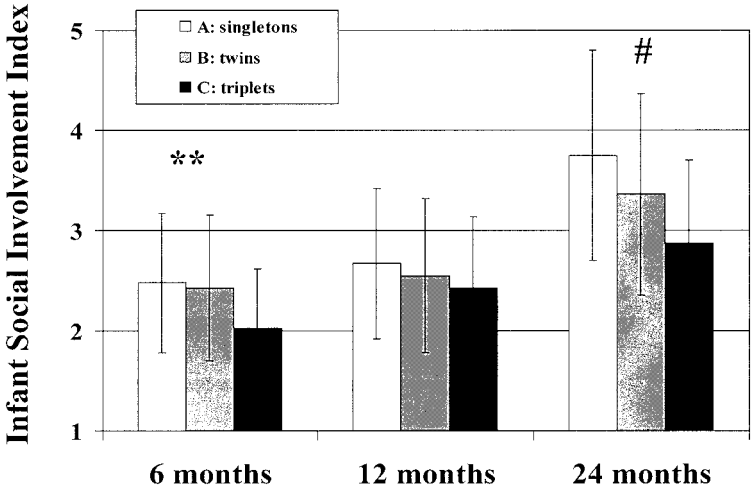

Fig 2. Infant social involvement of singletons, twins, and triplets at 6, 12, and 24 months of age. **$P < .01$, A and B > C; #$P < .05$, A > B > C.

TABLE 3. Infant Cognitive Development at 6, 12, and 24 Months of Age Among Singletons, Twins, and Triplets

	Singletons (A)		Twins (B)		Triplets (C)		Univariate *F*	*P*
	Mean	SD	Mean	SD	Mean	SD		
6 mo								
MDI	96.86	5.01	95.23	5.70	92.73	6.64	4.72* (A, B > C)	.018*
PDI	84.47	7.11	85.50	9.65	83.08	10.37	0.98	
12 mo								
MDI	91.21	8.64	88.96	9.43	83.14	10.51	4.76* (A, B > C)	.015*
PDI	87.91	10.90	88.80	11.57	89.93	11.85	0.42	
24 mo								
MDI	99.00	14.66	97.65	15.72	91.70	14.51	3.75* (A, B > C)	.046*
PDI	87.91	10.90	88.80	11.52	90.93	11.85	0.76	

A, B > C indicates that means in the singletons and twins groups are significantly higher than means in the triplets group, as shown by posthoc Scheffe's tests.
* $P < .05$.

Twenty-Four Months

Neurologic Status

Twenty-one of the 23 singleton infants, 44 of the 46 twin infants, and 63 of the 66 triplet infants were evaluated. All infants were fully ambulatory, and none suffered from any hearing disorder. Neurologic examination results were normal for all of the singleton infants. Mild spastic hemiparesis was noted for 2 of the twin infants and 3 of the triplet infants. The neurologic abnormalities did not interfere with motor functioning or gait for any of the infants. No statistically significant differences were found among the 3 groups in the incidence of abnormal neurologic findings at 24 months of age.

Mother-Infant Interaction

A MANOVA conducted for the mother-infant interaction variables at 12 months showed an overall effect for multiple birth [Wilks' F ($df = 4, 246$) = 2.75, $P < .05$]. Univariate tests with posthoc Scheffe's tests

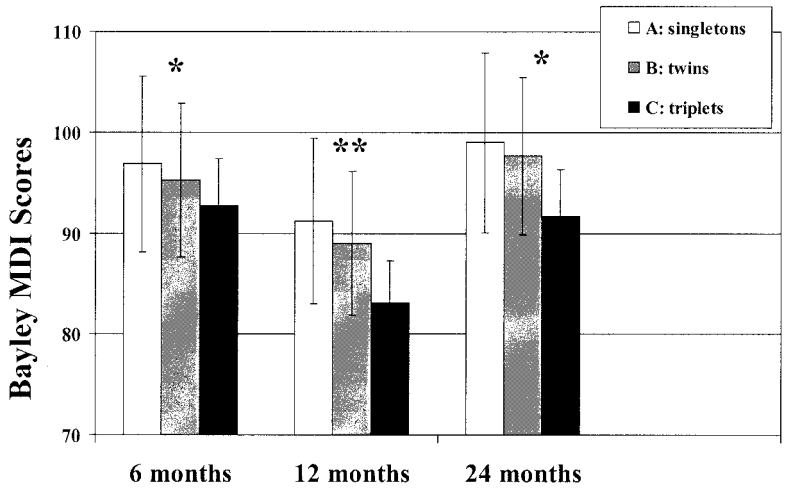

Fig 3. MDI scores for singletons, twins, and triplets at 6, 12, and 24 months of age. *$P < .05$, A and B > C; **$P < .01$, A and B > C.

indicated that maternal sensitivity was greater in the singleton and twin groups, compared with the triplet group (Table 2). In infant social involvement, a dose-response pattern was found, with singletons scoring higher than twins, who scored higher than triplets (Figs 1 and 2).

Infant Cognitive Development

A MANOVA conducted for the 2 Bayley scores (MDI and PDI) showed an overall main effect for multiple birth [Wilks' F ($df = 4, 246$) = 2.36, $P < .05$]. Univariate tests with posthoc Scheffe's tests indicated that triplets showed lower MDI scores, compared with singletons and twins. No differences were found in the PDI scores (Table 3; Fig 3). Higher MDI scores at 24 months were correlated with greater maternal sensitivity ($r = 0.18$, $P < .05$) and greater infant social involvement ($r = 0.29$, $P < .01$).

Stability in Maternal Sensitivity and Infant Social Involvement

Both mother sensitivity and infant social involvement showed individual stability from 6 to 24 months. Correlations were calculated for mother sensitivity at 6 and 12 months ($r = 0.38$, $P < .001$), at 12 and 24 months ($r = 0.36$, $P < .001$), and at 6 and 24 months ($r = 0.35$, $P < .001$). Correlations were calculated for infant social involvement at 6 and 12 months ($r = 0.44$, $P < .001$), at 12 and 24 months ($r = 0.38$, $P < .001$), and at 6 and 24 months ($r = 0.32$, $P < .001$). Mother sensitivity and infant social involvement were inter-related at 6 months ($r = 0.32$, $P < .001$), 12 months ($r = 0.30$, $P < .01$), and 24 months ($r = 0.33$, $P < .001$).

Triplet Discordance

Discordance in birth weight of >15% between the triplet with the highest birth weight and the triplet with the lowest birth weight was found in 15 triplet sets (65.2%). Among twins, discordance was found in 5 sets (21%). To examine whether the discordant infant fared worse than the siblings, we computed differences in MDI scores between the discordant triplet and the 2 siblings, only among the 15 sets of triplets with a discordant infant, at 6, 12, and 24 months (Table 4). At 6 months, no significant differences were found in the MDI scores of the healthier triplets and the discordant child. At both 12 and 24 months, however, the higher birth weight triplets scored higher, compared with the discordant infant, which indicates that the gap between the siblings and the discordant child increases, rather than decreases, with age (Fig 4).

To examine whether mothers showed greater sensitivity to the healthier infants, compared with the sickest triplets, maternal sensitivity at 6, 12, and 24 months was averaged into a single maternal sensitivity construct ($\alpha = .78$). Maternal sensitivity toward the healthier triplets was greater (mean: 3.92; SD: 0.88) than maternal sensitivity toward the discordant child (mean: 3.25; SD: 0.83) [F ($df = 2, 64$) = 3.93, $P < .05$]. Finally, to examine whether the reported findings were caused by the worse outcomes of the discordant triplets, we examined differences in MDI scores at 6, 12, and 24 months between singletons, twins, and the 2 healthier triplets. All findings remained significant when the discordant infants were not included in the analysis, confirming that triplets

TABLE 4. MDI Scores at 6, 12, and 24 Months of Age for Triplet Sets With a Discordant Infant

	MDI				Univariate F	P
	Nondiscordant Triplets		Discordant Triplet			
	Mean	SD	Mean	SD		
6 mo	92.45	6.80	93.05	6.49	0.77	
12 mo	85.27	8.87	79.42	7.24	3.86*	.043*
24 mo	93.98	8.25	88.03	6.54	3.75*	.045*

* $P < .05$.

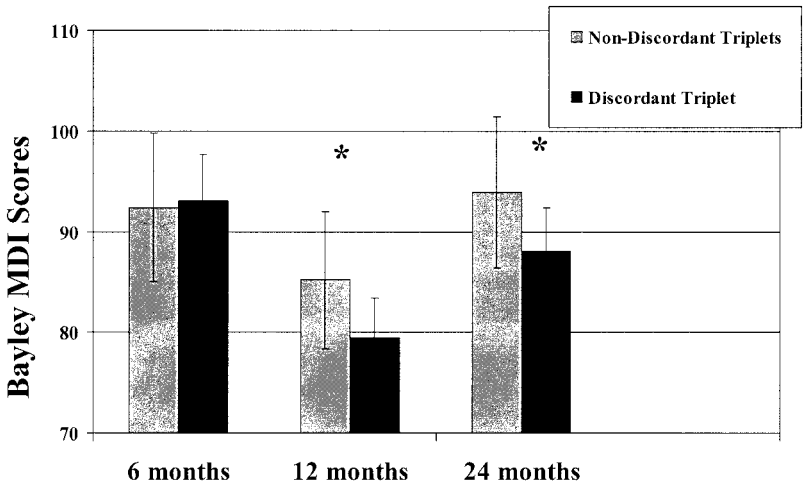

Fig 4. MDI scores for nondiscordant triplets and discordant triplets at 6, 12, and 24 months of age. *$P < .05$.

as a group were at higher risk for cognitive delays and the discordant infants were at increased risk in comparison with their siblings.

Differences between the discordant twins and their siblings in cognitive development and mother-infant interaction were similarly examined. Although the discordant twins showed lower MDI scores at 6, 12, and 24 months, the differences did not reach statistical significance, possibly because of the small number of discordant twins in the sample ($N = 5$). No differences were found for the discordant twins in maternal sensitivity or infant social involvement.

Maternal Competence and Satisfaction in the Parenting Role

A univariate analysis of variance with posthoc Scheffe's test was conducted to examine differences in the maternal sense of competence and satisfaction in the parenting role. The maternal sense of competence was highest in the singleton group, lower in the twins group, and lowest in the triplet group [F ($df = 2, 67$) $= 4.07$, $P < .05$]. No group differences were found for maternal satisfaction.

The maternal sense of competence was related to maternal sensitivity at 6 months ($r = 0.34$, $P < .001$), 12 months ($r = 0.30$, $P < .01$), and 24 months ($r = 0.26$, $P < .05$). Infant cognitive development was related to the maternal sense of competence at 6 months ($r = 0.28$, $P < .05$). The maternal sense of satisfaction at 6 months was associated with maternal sensitivity at 6 months ($r = 0.26$, $P < .05$).

Prediction of Cognitive Outcomes at 2 Years

A regression model was used to predict infants' cognitive outcomes at 2 years from maternal and child interactive behavior and infant medical risk and multiple-birth status. Predictors were entered in 4 blocks. In the first block, the infant medical risk was indexed with the CRIB. In the second, the infant's multiple-birth status was entered. These variables controlled for variance related to the infants' medical conditions. In the third block, mother sensitivity at 6, 12, and 24 months was entered. In the fourth block, the infant's social involvement at each stage was entered. The regression model is presented in Table 5.

TABLE 5. Prediction of Cognitive Development at 24 Months

	β	R^2 Change	F Change	df
Medical risk	−.20*	0.03	2.79*	1, 122
Multiple birth	−.22*	0.06	3.98*	2, 121
Maternal sensitivity				
6 mo	.12			
12 mo	.21*			
24 mo	.36†	0.13	10.43‡	5, 118
Infant social involvement				
6 mo	.13			
12 mo	.19*			
24 mo	.31*	0.11	8.74‡	8, 115

R^2 total = 0.33, $F(8,115) = 6.83$, $P < .001$.
* $P < .05$.
† $P < .01$.
‡ $P < .001$.

As indicated in Table 5, infant medical risk at birth, multiple-birth status (ie, being part of a triplet set), maternal sensitivity, and infant social involvement each predicted unique variance in infants' cognitive competence at 24 months. Neurologic status was unrelated to infant cognitive development or mother-infant interaction variables. In combination, the predictor variables explained 33% of the variance in infants' cognitive outcomes at 24 months.

Finally, we examined whether any of the findings for the triplet group were related to the mode of conception. Of the 23 triplet sets, 1 was a spontaneous pregnancy, 12 were conceived after medically induced ovulation, and 10 were conceived through in vitro fertilization. No differences were found in any of the maternal measures, mother-child interaction variables, or infant cognitive development measures between triplets born after in vitro fertilization and the other triplet children, consistent with previous research.[66,67]

DISCUSSION

The results of this study are among the first to chart the cognitive development of triplets beyond the first 1 year of life and to examine cognitive competencies of triplets in relation to the mother-infant relationship and the long-term effects of intrauterine growth. Triplets as a group showed lower cognitive skills, compared with singletons and twins matched

for gestational age and fetal growth parameters, at 6, 12, and 24 months of age, which suggests that the triplet situation itself constitutes a separate risk condition for infants' cognitive growth, independent of the effects of other known medical risks to infant development. In addition, although triplets as a group demonstrated slower cognitive development, triplets with a birth weight discordance of ≥15% showed significantly poorer cognitive outcomes, compared with their siblings, at 1 and 2 years of age. These findings are consistent with previous research on the higher morbidity and mortality rates and impaired cognitive development among discordant twins[68] and are the first to demonstrate such risks among discordant triplets. In general, our findings emphasize the special professional attention that must be paid to the development of triplets, especially infants who are born with IUGR and are discordantly smaller than their siblings. The exclusion criteria for the study population (ie, perinatal asphyxia, grade 3 or 4 intraventricular hemorrhage, periventricular leukomalacia, congenital abnormalities, or central nervous system infection) and the fact that there was no significant difference in the neurologic status of the 3 groups of infants support the conclusion that the triplet state itself is a major factor in the poorer developmental outcomes of these children.

Infant cognitive development is based on 2 central factors, ie, the infant's disposition and neurologic intactness and the mother's sensitive support of emerging skills and timely introduction of new and appropriate stimulation.[67,68] The development of maternal sensitivity requires the mother's full investment in the well-being, communicative signals, and growing capacities of an individual child.[69] Mothers of triplets were found previously to report higher levels of parenting stress and lower investment in the formation of a unique emotional relationship with each child,[49–51] and the present findings underscore the role of lower maternal competence in the parenting role as an important factor in the slower cognitive development of triplets. The data demonstrate that, when mothers need to attend to the specific interaction rhythms and growth needs of 3 infants simultaneously, the level of sensitive parenting available to each child is significantly reduced. These findings were persistent at 6, 12, and 24 months of age, across the period when infants move from initial manipulation of objects in their environment to interactions that involve symbols, words, gestures, social participation, and initiation. We observed that the decrease in maternal sensitivity among mothers raising triplets was not a transient phenomenon but rather a stable maternal interactive style. This maternal trait was related to the mothers' decreased sense of self-efficacy and was predictive of the infants' cognitive outcomes at the toddler stage, beyond the infants' medical risk and multiple-birth status, which points to the strength of the association between maternal parenting style and infant developmental outcomes.

Similar to the mother's reduced sensitivity, the infant's social involvement during mother-child interaction was lower in the triplet group. The present findings, consistent with previous reports[60,61] and theoretical formulations,[69–70] indicate that the degree of infant social participation, including child alertness, communicative initiation, vocalization, competent use of toys, and creative-symbolic output, is closely linked to the mother's sensitive handling of the interactive flow and the timely presentation of new stimuli. The findings demonstrated that infant social skills predicted cognitive outcomes, beyond neurologic intactness and maternal behavior, which highlights the associations between child curiosity, social competence, and creative dyadic play and the ultimate cognitive development of the infant.

Among the triplet sets, the infants with the greatest degree of IUGR, especially if the weight difference between siblings was >15%, received lower levels of sensitive mothering, displayed the least social involvement, and showed the poorest cognitive outcomes. These observations are consistent with the analyses of triplet birth weights by Jones et al[71] and Blickstein et al,[72] who noted that the patterns of growth for all triplets diverge from the patterns for singletons beginning with the 30th week of gestation and become significantly different after 33 weeks, as a result of presumed suboptimal nutrient transfer. Not surprisingly, a greater degree of growth restriction and discordance reflects such a potential intrauterine pathologic process and increased risk to the infants. The findings are also consistent with those of Minde et al,[73] who studied twins and found that mothers developed preferences for 1 child (typically the healthier twin) immediately after birth, that the maternal behavior was better toward the preferred child, and that the preferred child showed fewer behavior problems at 4 years. Similarly, the degree of discordance between the birth weights of twins was found to be correlated with the difference in the twins' behavior problem scores in later childhood,[74] emphasizing the greater risk for the discordant twin in the cognitive and social-emotional domains. Belsky's[75] theory on "differential susceptibilities to rearing environment" suggests that, the greater the infant's medical risk and dysregulation, the more he or she must depend on sensitive handling by the mother for optimal development. A triplet birth creates a paradoxical situation in which the discordant child, who is a priori at greater medical risk, is less able to self-regulate, and requires much higher levels of sensitive mothering, unfortunately receives lower levels of maternal sensitivity and attention, which increases the long-term developmental risks.

CONCLUSIONS

The fact that triplet births were associated with poorer cognitive outcomes at 2 years of age, even when the infants were matched with respect to medical risk, birth weight, gestational age, maternal and paternal ages and education levels, maternal employment, and family social support, indicates that being born and raised as part of a triplet set places infants at special risk for later development. We suggest that this risk is related to a combination of intrauterine factors, especially as they affect growth

at critical periods in gestation, and to the stressful postnatal parenting situation created by the triplet birth and the inevitably lower levels of maternal sensitivity and exclusive parenting available for each infant. These findings have clear implication for social policy. Because the numbers of triplets are increasing, the need for financial and social support for parents during the first months of infant life is clear. Without such organized assistance, it cannot be expected that the mother will form the unique, sensitive, individualized relationship that is necessary for these high-risk infants. In addition, parents and physicians should be informed of the inherent risks to infant development posed by the triplet situation, and this information should be used to plan modes of intervention. Additional study is necessary to ascertain the critical postnatal environmental and parenting factors that are most important for infant development in this unique high-risk situation.

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BLOGS PROVIDE RAW DETAILS FROM SCENE OF THE DISASTER

"For vivid reporting from the enormous zone of tsunami disaster, it was hard to beat the blogs. The so-called blogosphere, with its personal journals published on the Web, has become best known as a forum for bruising political discussions and media criticism. But the technology proved a ready medium for instant news of the tsunami disaster and for collaboration over ways to help. . . . Bloggers at worldchanging.com, some of them living in the affected nations, began chattering immediately after the waves hit and began discussions of ways to help. South Asian bloggers created tsunamihelp.blogspot.com to direct people to aid organizations. . . . Howard Rheingold, the author of *Smart Mobs: The Next Social Revolution*, about the use of interactive technologies like text-messaging to build ad hoc coalitions, said that using blogs to muster support for aid was a natural next step. 'If you can smart mob a political demonstration, an election, or urban performance art, you can smart mob disaster relief,' he said."

Schwartz J. *New York Times*. December 28, 2004

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Does a Triplet Birth Pose a Special Risk for Infant Development? Assessing Cognitive Development in Relation to Intrauterine Growth and Mother-Infant Interaction Across the First 2 Years

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