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Physical growth and cognitive abilities in concordant versus discordant birth weight twins at three years old

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ABSTRACT

Background: Discordant birth weight twins have been shown to have high rates of adverse perinatal outcomes, but little is known about their growth and development.
Aim: To determine whether smaller and larger birth weight premature twins in concordant and discordant birth weight groups differ on measures of physical growth and intelligence at 3 years.
Study design: Prospective cohort study. Eight-four children, 52 concordant and 32 discordant birth weight twin pairs, were measured for height, weight, and head circumference and on intelligence at 3 years. Perinatal and demographic variables, including birth weight, head circumference, small for gestational age, zygosity, in vitro fertilization, gender and social class were recorded.
Results: Smaller and larger birth weight twins did not differ significantly from each other on any growth parameters in either concordant or discordant birth weight groups at 3 years of age. Smaller birth weight twins in the discordant birth weight group performed significantly less well on Verbal, Performance, and Full Scale IQ scores (Verbal IQ for smaller twins was 8.6 points lower, $p<0.005$; Performance IQ, 11.9 points lower, $p<0.03$; Full Scale IQ, 12.4 points lower, $p<0.004$), but there were no significant intra-twin differences between larger and smaller birth weight concordant twins.
Conclusions: Smaller discordant birth weight twins performed significantly less well on intelligence, although they did not differ significantly from their larger twins on growth parameters at 3 years old. We conclude that smaller discordant birth weight twins had less optimal intra-uterine environments than their larger birth weight twin, which affected both their birth weights and brain development.

1. Introduction

Since 1980, the number of twin births has increased by 70%, in large part due to in vitro fertilization techniques [1]. The increased prevalence of multiple gestations also has been linked to greater mortality and higher numbers of premature births. Among twins, discordant birth weight is a well-documented phenomenon and occurs in 10–29% of twin gestations [2,3].

In most studies, discordance is defined as a difference of 15–25% in birth weight, whereas lesser differences are considered physiological and related to individual genetic or gender variation [2,4]. Discordant birth weight twins have a significantly higher rate of adverse perinatal outcomes than concordant birth weight pairs, including iatrogenic premature pregnancy, terminations, and prematurity-related problems [5]. A distinction also has been made between birth weight discordant pairs, with and without a small for gestational age (SGA) discordant twin [4–6]. Neonatal mortality has been found to be significantly increased among smaller twins in discordant pairs who were SGA, but not those who were appropriate for gestational age (AGA) [5].

Although the findings are not always in agreement, a broad literature has reported that both full-term and premature singleton infants born SGA show higher rates of morbidity, including poorer growth and lower intellectual functioning, than children who were AGA [7–11], although the effects on intellectual functioning are mostly subtle [12]. Both deficits in birth weight and in cognition among SGA children have been related to intra-uterine growth retardation (IUGR), resulting from less optimal intra-uterine conditions.

Nearly all studies examining the outcome of discordant birth weight twins have been limited to neonatal outcomes. One long-term study reported that premature, birth weight discordant twins/triplets who were SGA were more likely to have smaller growth in weight and height and to have more behavior disturbance and education delays than their AGA siblings; however, the findings were on twins/triplets ranging in age from 3 to 17 years old and born 10–20 years ago [13].

The aim of this study was to determine if birth weight discordance is associated with physical growth and intellectual abilities at 3 years old in prematurely born twins.

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2. Method

2.1. Subjects

Eighty-four consecutive children consisting of forty-two pairs of prematurely born twins, who attended a Neonatal Neurodevelopmental Clinic at a major metropolitan hospital participated in the study. The study was approved by the Institutional Review Board of the institution. All parents signed an informed consent for the study. Exclusion criteria included major congenital anomalies, known congenital syndromes, or significant ongoing medical illness, such as short bowel syndrome or bronchopulmonary dysplasia.

2.2. Procedure

Twins were classified as concordant or discordant in growth based on their birth weights (BWs). Twins whose BWs differed by 15% or more were classified as discordant twins; the others, as concordant [2]. Children with BWs <10 percentile of the expected weight for gestational age were considered SGA [14]. In addition to BW, head circumference at birth, gestational age (GA), gender and social class of the children were recorded. Social class was determined by parents' occupation and educational levels [15] and divided into upper, middle, and lower class. Method of conception (in vitro fertilization, use of clomid, or spontaneous) and zygosity (monochorionic or dichorionic) were recorded from the medical records.

The height, weight, and head circumference of each child were measured at 3 years of age. All measurements were made by an experienced follow-up nurse. Heel-to-crown length was measured to the nearest 1.0 cm and occipital-frontal head circumference, to the nearest 0.5 cm. BW and head circumference at birth were abstracted from the children's medical records.

A psychologist administered the Wechsler Preschool and Primary Scale of Intelligence-Third Edition (WPPSI-III) [16]. The WPPSI-III provides a summary Verbal, Performance (visual/visual–motor), and Full Scale IQ (VIQ, PIQ, and FSIQ, respectively). There is a significant correlation between IQ scores attained at 3 years old and IQ at school age [16].

All children also received a neurologic examination. Cerebral palsy was classified as mild (does not limit activities, child may be clumsy), moderate (between mild and severe), and severe (significant limitations of physical activity, child may require wheel chair) [17].

2.3. Statistical analysis

All twins were determined to be the larger or smaller BW member of each twin dyad. Using data from the CDC/National Center for Health Statistics [18], a z-score was calculated for height, weight, and head circumference for each child at 3 years old. The mean z-score and standard deviations for smaller concordant, larger concordant, smaller discordant, and larger discordant BW groups, respectively, were calculated for each growth parameter. Skewness and kurtosis tests were used to test the assumption of normality of the data obtained. Analyses of variance (ANOVAs) were performed on the intra-twin differences in z-scores for the growth parameters (heights, weight, and head circumference) at 3 years old with concordance (concordant BW v discordant BW) as the independent variable. Similar ANOVAs were performed with concordance and size for gestational age (AGA/AGA v AGA/SGA pairs) as the independent variables and intra-twin differences on each of the summary IQ scores as the dependent variables. Post-hoc analyses (paired t-tests) were conducted. All data were presented as mean ± standard deviation unless stated otherwise.

3. Results

3.1. Characteristics of the patient population

Table 1 presents the perinatal and demographic variables obtained for the concordant and discordant BW twins. Twenty-six pairs (52 children) were concordant, and 16 pairs (32 children) were discordant in BW. The BW of concordant twins was 1388 ± 441 g, and GA was 30 ± 2.5 weeks. The BW of discordant twins was 1418 ± 421 g and GA was 31 ± 2.4 weeks. The percent difference in BW for concordant twins was 7 ± 4 (range of 1–15%), while discordant twins differed from each other by 29 ± 10%, (range of 18–64%). The head circumference at birth for concordant twins was 29.1 ± 3.0 cm and for discordant twins, 29.4 ± 2.7 cm.

Fourteen twins were SGA: 3 in the concordant group and 11 in the discordant group ($p<0.001$). There were no twin pairs in which both were SGA. In 18 pairs, both twins were male and in 11, both were females. Thirty-four twin pairs (of whom 20 were concordant) were conceived through in vitro procedures; 1 pair, using clomid; and 7 pairs, spontaneously. Thirty-nine dyads were dichorionic (23 concordant sets); 1 was monochorionic; and 2, monochorionic/dichorionic.

Nearly all the children were from middle class homes, and there was no significant difference between the concordant and discordant BW groups on social class category. Correlations between social class and gender composition, respectively, of the twin pairs with growth parameters or IQ measures were not significant. Therefore, social class and gender were not used as covariates in the analyses. One child in the discordant twin group had moderate cerebral palsy.

3.2. Weight and head circumference at birth

BW and head circumference at birth for the four twin groups are shown in Table 2. Concordant and discordant groups differed significantly on intra-twin differences in BW ($p<0.002$); concordant twins had a difference of 105 ± 64 g and discordant twins, a difference of

Table 1
Perinatal and demographic data of the participants.

Variable	Concordant twins	Discordant twins
Number of children	52	32
Mean birth weight (g)	1388 ± 441	1418 ± 421
Range	662–2565	718–2550
Mean gestational age (weeks)	30 ± 2.5	31 ± 2.4
Range	25–36	26–36
Mean head circumference	29.1 ± 3.0	29.4 ± 2.7
Range	22.5–37.0	22.5–36.0
SGA (number)*	3	11
Gender (male)	30	19
Gender combination		
Male–male	11	7
Female–female	7	4
Male–female	8	5
Method of conception (twin sets)		
IVF	20	14
Clomid	1	0
Spontaneous	5	2
Chorionicity (twin sets)		
Dichorionic	23	16
Monochorionic	1	0
Mono/dichorionic	2	0
Gender (male)	30	19
Social class (twin sets)		
Low	2	1
Middle/upper	24	15

* $p<0.001$.