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Brief Communication

Birth Weight and Placental Proximity in Like-Sexed Twins

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SUMMARY

In addition to zygosity, the type of placentation has proven to be an important variable in twin studies. A number of quantitative traits in human twins have been found to be influenced by chorion type. Our study confirms an earlier finding that there is larger within-pair birth weight variability in dichorionic twins with fused placentas than in those with separate placentas. This finding emphasizes the importance of detailed twin placental examinations to help identify traits that may be influenced by prenatal environmental influences.

INTRODUCTION

In 1961, Kempthorne and Osborne [1] postulated intrauterine competition between two members of a twin pair as a source of within twin-pair variability. One of the first examples of such competition was the transfusion syndrome in which monochorionic monozygotic (MC-MZ) twins have an arterial venous anastomosis that results in one twin transfusing the other and marked discrepancies in red cell volume [2]. An even more striking example of competition between monochorionic human twins is when one twin's heart prevents the cotwin's heart from developing and the result is an acardiac monster [3]. These relatively rare situations raised the possibility of a spectrum of prenatal competitive effects and have led to searches for associations between placental type and a variety of quantitative traits. Cord

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blood cholesterol, for example, was found to be five times more variable within dichorionic monozygotic (DC-MZ) twins than within MC-MZ twin pairs [4]. Comparisons of dermatoglyphic variables revealed some pattern areas (thumb patterns, for example) to be more variable in DC-MZ twins than in MC-MZ twins, but for other variables (e.g., axial triradius), the reverse is true [5]. Other studies detected associations between placental type and IgG levels [6] and intelligence [7].

Birth weight has long been known to be influenced markedly by the mother. The classic studies of Walton and Hammond in 1938 [8] revealed that when the large Shire horse was crossed with the diminutive Shetland, foal weights from the Shire dam and Shetland sire were about the same at birth as that of the pure Shire. In contrast, the offspring of the reverse cross were similar in weight at birth to pure Shetland foals. Morton, in 1955 [9], published human data from a Japanese population that found a similar correlation between birth weights of maternal half-sibs (.58) and full siblings (.45), but an insignificant correlation between paternal half-sibs (.10). Nance et al. [10] estimated that 40% of the variation in human birth weight could be accounted for by maternal factors using the offspring of identical twins as genetic half-siblings.

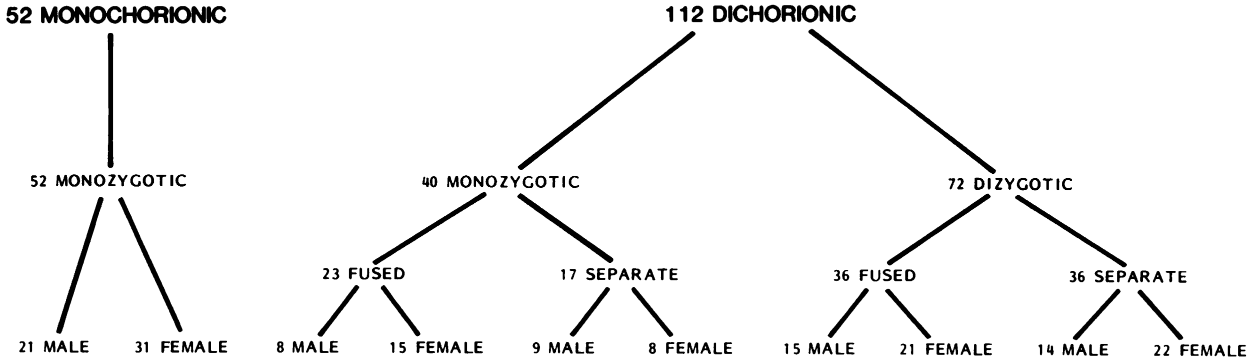
Corey et al. [11] analyzed the within-pair variability of birth weight in a series of MZ and DZ twins of known placental type and found that whether the placentas were fused or separate was more important than chorion type or zygosity. Our study was designed to test, on a separate data set, this finding of Corey et al.

MATERIALS AND METHODS

In 1936, Norma Ford Walker initiated a study of twin births in Toronto hospitals. This study was continued by one of the authors (I. A. U.), and by 1959, a sample of 1,783 twin births was studied. Sex, birth order, birth weights, presence of congenital anomalies, maternal age, and reproductive history were recorded for each birth. Placentas were examined and injected with colored latex. In the 1970s, a sample of these twins was ascertained for a study of heart disease risk factors [12], which included extensive genotyping for zygosity determination. When ascertained for zygosity testing, the twins ranged in age from 20 to 41 years. For our study, birth weights were compared to placental data in 165 pairs of like-sexed twins. There were no monoamniotic pairs in this sample. Accurate gestational age data were not available, but the individual birth weights ranged from 1,595 to 3,653 g, with a mean of 2,549 g and a standard deviation of 496 g.

RESULTS

The 10 groups of twins determined by chorion type, zygosity, whether the placentas were fused or separate, and sex are summarized in figure 1. There was no significant difference among the mean birth weights for the groups, so that it was not necessary to adjust for birth weight when making comparisons of within-pair birth-weight differences among the groups. The means and standard deviations of the absolute within-pair birth-weight differences for the 10 groups and a total of 164 twin pairs are shown in figure 1. Originally, data were collected on 165 twin pairs, but one pair of male monozygotic twins with dichorionic separate placentation was found to have a within-pair difference of 1,410 g, over 12 times the mean within-pair difference for this type of twin. Dixon's test of significance of outliers [13] for this pair was highly significant ($P < .005$), and the pair was therefore excluded from subsequent analyses.



Δ BW	340 ± 274	311 ± 287	316 ± 182	320 ± 188	114 ± 105	242 ± 120	240 ± 201	373 ± 297	125 ± 90	279 ± 216
$LOG_{10}(\Delta BW + .5)$	2.59 ± 1.35	2.54 ± 1.13	2.80 ± 0.87	2.79 ± 0.91	1.36 ± 1.30	2.57 ± 0.67	2.30 ± 1.08	2.69 ± 1.39	1.57 ± 1.21	2.51 ± 1.04

FIG. 1.—Subdivision of the 164 twin pairs into the 10 zygosity, chorion, placental-type, and sex groups. Group means for within-pair absolute birth-weight differences (ΔBW) and log transformations are shown ± standard deviations.

TABLE 1

LINEAR CONTRASTS OF MAIN EFFECTS FOR RAW AND TRANSFORMED VALUES OF INTRAPAIR BIRTH-WEIGHT DIFFERENCES

		RAW DATA*				TRANSFORMED DATA†		
FACTOR	CONTRAST	Contrasted means	t'-value	df	P	t-value	df	P
Chorion type	MC vs. DC	325.5 vs. 251.0	1.73	61.5	.089	1.18	154	.239
Zygosity	MZ vs. DZ	273.6 vs. 254.2	0.60	109.9	.548	0.88	154	.379
Placental type	Fused vs. Separate	312.1 vs. 189.9	3.54	71.2	.001	2.73	154	.007
Sex	Female vs. Male	304.8 vs. 226.9	2.45	107.0	.016	2.51	154	.013

* Using t'-tests with separate variance estimates because of significant heterogeneity.
† Using a pooled variance estimate of LOG_{10} (ΔBW + .5).

Significant heterogeneity of variance in intrapair birth-weight differences among the groups was indicated by the Bartlett-Box test [14] ($P < .001$). The apparent reason for this heterogeneity was revealed when the group mean absolute birth-weight differences were plotted against the standard deviations of the absolute birth-weight differences, revealing a linear relationship. A logarithmic transformation of the absolute birth-weight differences, after 0.5 was added to remove zero values, eliminated the linear relationship between means and standard deviations. The Bartlett-Box test was not significant ($P = .48$) for the transformed data.

Analysis of variance of the transformed within-pair birth-weight differences revealed a significant difference among the groups ($P = .02$). To determine the source of this heterogeneity among the groups, linear contrasts for the main effects of chorion type, zygosity, placental type, and sex were examined in both the raw and transformed within-pair differences (table 1). For the raw data, t' tests with separate variance estimates were used because of the significant heterogeneity of within-group variances. A pooled variance estimate was used for testing contrasts in the transformed data. A significant effect of sex reflected the greater average within-pair differences for female twins, and a significant effect of placental type was due to greater average within-pair differences of twins with fused as compared with those with separate placentas. In addition to these main effects, the interactions between sex and placental type as well as between sex and chorion type approached significance ($.10 > P > .05$) for both the raw and transformed data.

DISCUSSION

These independent data confirm the report of Corey et al. [11] that there are significantly greater within-pair birth-weight differences for twins with fused dichorionic placentas than for twins with separate dichorionic placentas. In addition, this data set revealed significantly greater variability within female twin pairs than within male twin pairs.

This confirmation of an association of placental proximity with a trait known to be influenced by prenatal maternal influences indicates that one possible way of searching for prenatal maternal influences on other traits could be the comparison of twins of known placental types.

REFERENCES

1. Kempthorne O, Osborne RH: The interpretation of twin data. *Am J Hum Genet* 13:320–339, 1961
2. Strong SJ, Corney G: The placenta in twin pregnancy. Oxford, England, Pergamon Press, 1967
3. Kaplan C, Benirschke K: The acardiac anomaly new case reports and current status. *Acta Genet Med Gemellol (Roma)* 28:51–59, 1979
4. Corey LA, Kang KW, Christian JC, Norton JA Jr, Harris RE, Nance WE: Effects of chorion type on variation in cord blood cholesterol of monozygotic twins. *Am J Hum Genet* 28:433–441, 1976
5. Reed T, Uchida IA, Norton JA Jr, Christian JC: Comparisons of dermatoglyphic patterns in monochorionic and dichorionic monozygotic twins. *Am J Hum Genet* 30:383–391, 1978
6. Byron E, Slavin B: Serum IgG levels in feto-fetal transfusion syndrome. *Arch Dis Child* 49:908–910, 1974

7. Melnick M, Myrianthopoulos NC, Christian JC: The effects of chorion type on variation in IQ in the NCPP twin population. *Am J Hum Genet* 30:425–433, 1978
8. Walton A, Hammond J: The maternal effects on growth and conformation in Shire horse-Shetland pony crosses. *Proc R Soc Lond [B]* 125:311–335, 1938
9. Morton NE: The inheritance of human birth weight. *Ann Hum Genet* 20:125–134, 1955
10. Nance WE, Corey LA, Boughman JA: Monozygotic twin kinships: a new design for genetic and epidemiologic research, in *Genetic Epidemiology*, edited by Morton NE, Chang CS, New York, Academic Press, 1978, pp 87–132
11. Corey LA, Nance WE, Kang KW, Christian JC: Effects of type of placentation on birthweight and its variability in monozygotic and dizygotic twins. *Acta Genet Med Gemellol (Roma)* 28:35-40, 1979
12. Feinleib M, Christian JC, Ingster-Moore L, Garrison RJ, Breckenridge WC, Uchida I: The Hamilton twin study: comparison of serum lipid levels in monozygotic and dizygotic twins by chorion type. *Prog Clin Biol Res* 69C:149-161, 1981
13. Dixon WJ: Processing data for outliers. *Biometrics* 9:74–89, 1953
14. Winer BJ: *Statistical Principles in Experimental Design*, 2nd ed. New York, McGraw-Hill, 1971