

Influence of Pre-Natal Environment on Correlation between Birth Weight and Parental Height

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IT HAS BEEN SHOWN that birth weight is more closely related to height of mother than to height of father (Cawley, McKeown & Record, 1954). Since this result was independent of duration of gestation, it was attributed to the influence of the maternal environment on rate of foetal growth. This influence might be expected to be most conspicuous in circumstances in which foetal growth is most seriously retarded, for example in multiple pregnancies and in first pregnancies. In the present communication we examine correlation between birth weight and parental height according to litter size¹ and birth rank. We also enquire to what extent association between maternal size and rate of foetal growth is related to the size of the placenta.

LITTER SIZE

In man, as in most experimental animals, birth weight is inversely related to size of litter. The low weight of multiple births is due partly to early onset of labour, and partly to retardation of foetal growth during the last weeks of gestation. The time at which retardation appears varies with size of litter, being approximately 26 weeks for quadruplets, 27 weeks for triplets and 30 weeks for twins (McKeown & Record, 1952). In each case retardation is marked (as indicated by comparison with the rate of growth of singletons) and there is therefore good reason to believe that in multiple pregnancy foetal development is seriously restricted by the maternal environment.

Since the provision which the maternal environment makes for foetal growth is determined to some extent by size of mother (as indicated by height) it was thought of interest to compare correlations between birth weight and parental height in single and twin pregnancy. For this purpose we make use of data for 1,028 and 506 singletons previously described (Cawley, McKeown & Record, 1954), and of an independent series of twin births of which an account has also been given (McKeown & Record, 1954). Data included birth weight, parity, sex, duration of gestation, height of both parents and (except in the case of the 1,028 single births) placental weight.

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¹ It is appreciated that the term "litter size" may be considered undesirable when used in reference to the number of human births, but we found no satisfactory alternative.

TABLE 1. MEAN LITTER WEIGHT (LB.) OF TWINS ACCORDING TO HEIGHT OF PARENTS

Height of Mother (Inches)	Under 60	60-	62-	64-	66-	68 and Over
Mean litter weight	10.33 (23)	10.83 (73)	11.07 (133)	11.29 (90)	11.54 (38)	13.59 (18)
Mean litter weight standardized for height of father	10.01	10.94	11.03	11.24	11.65	13.91
Height of Father (Inches)	Under 64	64-	66-	68-	70-	72 and over
Mean litter weight	10.91 (23)	11.26 (54)	11.14 (96)	11.31 (88)	11.08 (84)	11.53 (30)
Mean litter weight standardized for height of mother	10.95	11.23	11.31	11.25	11.01	11.34

In examination of birth weight it is of course necessary to use the combined weight of the twin pair. Table 1 gives mean litter weight according to parental height, and shows that as in single pregnancy weight increases sharply with mother's height, but is apparently unrelated to father's height. In view of the correlation between parents' heights, it has been thought desirable to correct for height of other parent. This adjustment has been made by standardisation, and has no substantial effect on the result.

That association between birth weight and parental height is sharper in twin pregnancy than in single pregnancy is suggested by the correlations given in Table 2. After correction for height of other parent, correlation in twin pregnancy between birth weight and mother's height (0.24) is higher, and correlation between birth weight and father's height (-0.02) is lower, than in single pregnancy. Indeed father's height appears to have no influence on birth weight of twins.

It was shown previously that in single pregnancy association between birth weight and mother's height is independent of length of gestation. This is also the case in twin pregnancy (although there is a substantial positive correla-

TABLE 2. CORRELATIONS BETWEEN BIRTH WEIGHT AND PARENTAL HEIGHT ACCORDING TO LITTER SIZE

	Number of Pregnancies	Correlation Between Foetal Weight and:				Standard Error
		Mother's height	Father's height	Mother's height (Corrected for height of other parent)	(Father's height (Corrected for height of other parent))	
Twins.....	375	0.25	0.05	0.24	-0.02	0.05
Singletons						
Smethwick data.....	1,028	0.20	0.13	0.18	0.09	0.03
Birmingham data.....	506	0.19	0.11	0.16	0.05	0.04

tion between length of gestation of twins and mother's height, McKeown & Record, 1954). The relevant correlations are as follows:

	Birth Weight and Mother's Height	Birth Weight and Father's Height
Corrected for gestation.....	0.25	0.06
Corrected for gestation and height of other parent.....	0.24	-0.01

It is concluded that in twin, as in single pregnancy, association between birth weight and mother's height is determined by the influence of maternal size on rate of foetal growth.

BIRTH RANK

It is well known that birth weight increases with birth rank. This association must be attributed to variation in rate of foetal growth, for there is a small negative correlation between length of gestation and birth order (Karn & Penrose, 1951). There is no evidence of a difference between growth rates of first and later born until about 36-37 weeks, but from this time later born are heavier than first born (McKeown & Record, 1953 b).

In view of this result it was anticipated that correlation between birth weight and maternal height would be sharper in first than in later pregnancies, although the difference might be less conspicuous than that associated with litter size, since retardation of foetal growth is much less marked in first pregnancies than in multiple pregnancies. Table 3 gives data based on the two series of single births. In both, after correction for height of other parent, the difference between correlations of birth weight with height of mother and height of father is greater in first born than in later born; but the errors of the correlations are substantial, and the evidence is suggestive rather than conclusive. Two sets of data have therefore been combined, and mean weights calculated according to parental height; adjustments have again been introduced for height of other parent. The results are illustrated in Fig. 1, in which the points represent mean standardized birth weights, and the straight lines represent partial regression of weight on parental height. The data suggest that mean birth weight is more

TABLE 3. CORRELATION BETWEEN BIRTH WEIGHT AND PARENTAL HEIGHT ACCORDING TO BIRTH RANK

Birth Rank	Smethwick Data				Birmingham Data			
	Number	Correlations, corrected for height of other parent, between foetal weight and:		Standard error	Number	Correlations, corrected for height of other parent, between foetal weight and:		Standard error
		Mother's height	Father's height			Mother's height	Father's height	
First born.....	416	0.22	0.13	0.05	222	0.31	-0.03	0.07
Later born.....	612	0.14	0.09	0.04	284	0.09	0.10	0.06

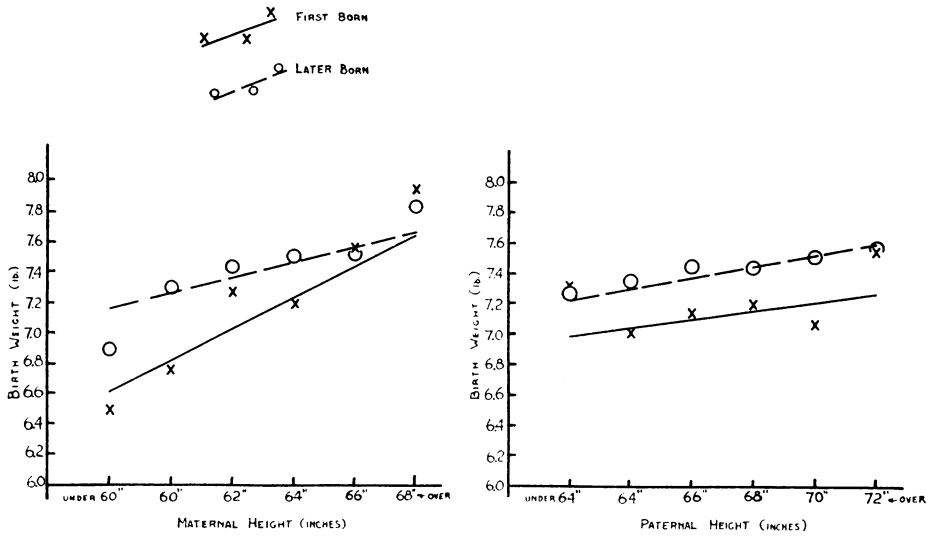


FIG. 1. Regression of birth weight on parental weight

sharply related to height of mother in first than in later pregnancies. Since there is only a trivial correlation between length of gestation and maternal height in single pregnancy, this result must be attributed to the fact that the influence of maternal size on rate of foetal growth is more marked in first born than in later born.

There is also a difference between growth rates of male and female foetuses (from 30–31 weeks gestation: McKeown & Record, 1953 b) and it was thought of interest to examine correlation between birth weight and parental height according to sex. Results (Table 4) based on the two series of single births are inconclusive, which is scarcely surprising in view of the small difference between growth rates of male and female foetuses.

THE INFLUENCE OF PLACENTAL SIZE ON CORRELATION BETWEEN BIRTH WEIGHT AND PARENTAL HEIGHT

In the Shire-Shetland cross reported by Walton & Hammond (1938) weight of placenta was closely related to weight of foetus, and indeed the proportion

TABLE 4. CORRELATION BETWEEN BIRTH WEIGHT AND PARENTAL HEIGHT ACCORDING TO SEX

Sex	Smethwick Data				Birmingham Data			
	Number	Correlations, corrected for height of other parent, between foetal weight and:		Standard error	Number	Correlations, corrected for height of other parent, between foetal weight and:		Standard error
		Mother's height	Father's height			Mother's height	Father's height	
Males.....	545	0.18	0.07	0.04	248	0.18	0.05	0.06
Females.....	483	0.18	0.12	0.05	258	0.15	0.05	0.06

of combined foetal and placental weight represented by placental weight was approximately the same for hybrids and pure breeds. This suggested that variation in foetal weight according to maternal size might be accounted for by variation in placental size, in which case it would be necessary to enquire in what way the maternal environment limits growth of the placenta.

But in man although foetal and placental weights are fairly highly correlated (Calkins, 1937, gives an estimate of 0.56) the influence of the maternal environment on rate of foetal growth is not wholly determined by placental size. For example a substantial difference between growth rates of singletons and twins remains when allowance is made for the difference in placental weight (McKeown & Record, 1953 a), and the difference in weights of first and later born is not entirely explained by the fact that the placenta is larger for later born than for first born (McKeown & Record, 1953 b).

Placental weights were available for 506 Birmingham single births, and for 375 pairs of twins; correlations between foetal and placental weights for the two series were 0.65 and 0.56 respectively. Table 5 shows the effect of correction for placental weight on correlations between birth weight and parental heights. For both singletons and twins, placental weight is correlated with parental height, and is more highly correlated with height of mother than with height of father. But fixing placental weight has little effect on correlation between foetal weight and parental height, whereas fixing foetal weight almost eliminates correlation between placental weight and parental height.

It is concluded that the influence of the maternal environment on rate of foetal growth according to size of mother is not determined mainly by an influence on the size of the placenta. The data given in Table 6 are consistent with the same conclusion in respect of the differences noted in Table 3 in relation to birth order. Placental weights were available for 222 first born and 284 later

TABLE 5. THE INFLUENCE OF PLACENTAL WEIGHT ON CORRELATION BETWEEN FOETAL WEIGHT AND PARENTAL HEIGHT

	Correlation Between:			
	Foetal weight and		Placental weight and	
	Mother's height	Father's height	Mother's height	Father's height
Singletons (506).....	0.19	0.11	0.13	0.10
Corrected for:				
Height of other parent.....	0.16	0.05	0.10	0.06
Height of other parent and placental weight.....	0.13	0.02	—	—
Height of other parent and foetal weight.....	—	—	0.00	0.03
Twins (375).....	0.25	0.05	0.18	0.07
Corrected for:				
Height of other parent.....	0.24	-0.02	0.16	0.02
Height of other parent and placental weight.....	0.19	-0.04	—	—
Height of other parent and foetal weight.....	—	—	0.03	0.04

TABLE 6. THE INFLUENCE OF PLACENTAL WEIGHT ON CORRELATION BETWEEN FOETAL WEIGHT AND PARENTAL HEIGHT. (SINGLETONS ONLY)

Birth Rank	Correlation Between:			
	Foetal weight and		Placental weight and	
	Mother's height	Father's height	Mother's height	Father's height
First born (222).....	0.32	0.07	0.22	0.04
Corrected for:				
Height of other parent.....	0.31	-0.03	0.22	-0.04
Height of other parent and placental weight.....	0.23	-0.01	—	—
Height of other parent and foetal weight.....	—	—	0.05	-0.02
Later born (284).....	0.13	0.14	0.09	0.15
Corrected for:				
Height of other parent.....	0.09	0.10	0.05	0.13
Height of other parent and placental weight.....	0.08	0.03	—	—
Height of other parent and foetal weight.....	—	—	-0.02	0.07

born, for which correlations between foetus and placenta were respectively 0.60 and 0.68. Correlations between foetal weight and parental height are again not much affected by fixing placental weight, but correlations between placental weight and parental height are substantially reduced by fixing foetal weight. Numbers are of course small, and the results are no more than suggestive.

SUMMARY

Data recorded for two series of 1,028 and 506 singletons, and for 375 pairs of twins, are used to explore the influence of litter size and birth rank on association between birth weight and parental height. In twin pregnancy, after correction for height of other parent, correlation between birth weight and mother's height (0.24) is higher, and correlation between birth weight and father's height (-0.02) is lower, than in single pregnancy. Similarly, in single pregnancy, association between birth weight and parental height is more marked for first than for later born. These results are independent of duration of gestation, and are attributed to the influence of the maternal environment on rate of foetal growth.

For both singletons and twins, placental weight is more highly correlated with height of mother than with height of father. But correction for placental weight has little effect on correlation between foetal weight and parental height, whereas correction for foetal weight almost eliminates correlation between placental weight and parental height. It is concluded that the influence of the maternal environment on rate of foetal growth according to size of mother is not determined mainly by an influence on the size of the placenta.

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