J. of Obst. & Gyn. of India Vol. 52, No. 1 : January/February 2002 Pg 71-75

A Reapprisal of Factors Affecting Fetal Growth & Body Composition

Rita Mhaskar, Arun Mhaskar

Dept. of Obstetrics & Gynaecology, St. John's Medical College, Bangalore

Summary

The study comprised of 200 normal singleton pregnant women who were certain of their dates or had a ultrasonography examination before 20 weeks gestation and had no risk factors. A detailed information on age; height; pregravid weight, present weight and level of education was collected. Paternal data on height, weight and age was also obtained. All neonates were subjected to detailed anthropometric measurements. Body composition was estimated according to method of Dauncey et al (1977). Total body fat, fat free mass and ponderal index were also calculated. The data were analysed with respect to neonatal sex and correlated with maternal and paternal parameters. Male neonates showed higher body weight, body length, head circumference and trunk circumference. Female neonates showed a higher total body fat as well as uniform increase in fat throughout the body. Birth weight had a positive correlation with prepregnancy weight, maternal weight (R^2=0.22) and weight gain during pregnancy (R^2=0.25). Total body fat strongly correlated to neonatal sex (R^2=0.25) and maternal weight (R^2=0.15).

Introduction

Human foetal growth is not uniform and its control is complicated. The first level of control is genetic, the second resides in foeto- placental homeostatic mechanisms and the third in maternal environment acting through the placenta.

This study was undertaken to identify the various factors affecting fetal growth and body composition.

Materials and Methods

The study group comprised 200 women who were randomly recruited from a general population of women, who were screened carefully to exclude women with any known obstetric or medical problems. Parturients were eligible for the study only if they were certain of the last menstrual period or had an ultrasonographic examination before 20 wks gestation. All were singleton pregnancies and not using tobacco/ alcohol. The obstetric record was reviewed and each mother was interviewed. Information obtained from each included maternal age, height, pre-gravid weight (if known), present weight and level of education. All mothers underwent basic antenatal investigations. Age, height and weight of fathers were obtained.

From the maternal data, the weight gain during pregnancy was calculated wherever the pre-pregnancy weight was available. The body mass index (BMI) was calculated for both parents. All the neonates were examined by the Paediatrician within 24 hours and declared to be normal.

The following anthropometric measurements were obtained:
(1) Birth weight (2) Body length (3) Head circumference (4) Upper limb length (length of forearm + length of the

arm) (5) Upper limb circumference (6) Upper limb skin fold thickness (7) Lower limb circumference (9) Lower limb skin fold thickness (10) Trunk skin fold thickness (11) Trunk length (12) Trunk circumference.

Skin fold thickness was measured using a spring loaded caliper called the "fat-O-Meter".

Body composition was established according to the method of Dauncey et al. (1977) Total body fat and fat free mass was estimated. Ponderal index was also calculated for each neonate.

All the neonatal parameters were analysed in relation to neonatal sex and the significance of the variation noted. Similarly, all the maternal and the paternal data were analysed in relation to neonatal sex and the significance of the variation noted. Also the correlation between the neonatal parameters and the maternal parameters were identified.

Results

The data were analysed as follows. First the descriptive statistics were computed. These included the range, mean and standard deviation (SD) for quantitative variables, and category frequency counts for qualitative variables. Next, inferential statistical analysis was undertaken. The inferential processes used in the analysis were univariate and multivariate. All tests of hypothesis were two tailed.

The results are depicted in Table 1-4.

- Male neonates showed a higher body weight ($P<0.006$), body length ($P<0.001$), lower limb length ($P<0.02$), head circumference ($P<0.02$) and trunk circumference ($P<0.004$) as compared to female neonates.
- Female neonates showed a higher upper limb skin fold thickness ($P<0.007$), lower limb skin fold

Table I: Maternal & Paternal Anthropometric Data

Variable	Mean	SD	Minimum	Maximum	Number
Age (Yrs)	23.77	3.99	18.00	37.00	200
Maternal Ht (cm)	153.55	6.25	135.00	174.00	200
Maternal Wt (kg)	57.71	8.83	40.00	83.00	200
Pregravid Wt (kg)	47.59	7.22	32.00	70.00	145
Weight gain (kg)	10.58	3.28	6.00	25.00	145
Maternal BMI	20.32	2.94	14.53	30.18	145
Parity	1.61	0.80	1.00	5.00	200
Paternal Ht (cm)	165.52	7.45	147.00	187.00	200
Paternal Wt (kg)	63.40	10.10	40.00	98.00	200
Paternal BMI	23.28	3.60	14.38	36.02	200

Table II-Neonatal Parameters

Parameters	Mean	SD	Minimum	Maximum	Number
Gest. Age (wk)	39.01	1.06	37.00	42.00	200
Head Cir (cm)	32.84	1.35	29.50	36.50	200
Birth Wt (gm)	2909.0	374.62	21.00	3800.0	200
Birth Length (cm)	48.83	1.60	45.00	53.00	200
UL Cir (cm)	9.97	0.79	8.20	12.00	200
UL SKF (cm)	0.25	0.10	0.10	0.60	200
UL fat Vol (ml)	41.41	20.50	11.90	127.44	200
LL length (cm)	22.07	1.07	18.00	25.00	200
LL Cir (cm)	13.13	1.15	10.70	16.70	200
LL SKF (cm)	0.52	0.16	0.10	1.00	200
LL Fat Vol (ml)	152.74	61.60	24.75	345.00	200
TR length (cm)	18.78	1.41	15.00	24.00	200
TR Cir (cm)	31.61	1.54	27.00	36.00	200
TR SKF (cm)	00.25	0.11	0.10	0.60	200
TR Fat Vol (ml)	148.62	72.49	42.75	412.02	200
TBF (gms)	483.23	195.27	105.90	1196.37	200
FFM (gms)	2425.77	200.63	1820.26	3062.44	200
PI	2.49	0.21	2.01	2.99	200

Table III: Analysis of Maternal and Paternal Anthropometric Data with Respect to Neonatal Sex

Anthropometric Data	Male (N=104)	Female (N=96)	Significance (P)
Maternal Data			
Age (Yrs)	24.2 ± 4	23.3 ± 3.9	ns
Height (cms)	153.3 ± 6.0	152.9 ± 6.5	ns
Weight (kgs)	58.3 ± 8.2	57.1 ± 9	ns
Pregravid Wt (kg)	47.8 ± 7	47.3 ± 7.5	ns
Weight gain (kg)	10.4 ± 3.3	10.7 ± 3.3	ns
BMI (kg/m^2)	20.3 ± 2.9	20.4 ± 3.0	ns
Parity	1.7 ± 0.9	1.5 ± 0.6	ns
Paternal data			
Height (cms)	165.7 ± 6.7	165.4 ± 6.2	ns
Weight (kg)	62.9 ± 10.3	63.9 ± 9.9	ns
BMI (kg/m^2)	23.0 ± 3.8	23.6 ± 3.4	ns

Table IV- Neonatal Morphometric & Estimates of Body Composition

Neonatal Data	Male (N=104)	Female (N=96)	Significance (P)
Gest. Age (wks)	38.9 ± 1.1	39.0 ± 1.0	Ns
Birth Wt (gms)	2978.1 ±280.5	2834.2 ± 355.2	P<0.006 t=2.76, df =198
Length (cms)	49.3 ± 1.6	48.4 ± 1.5	P<0.001 t=4.25, df=198
P.I. ($gm \times 100/cm^3$)	2.48 ± 0.2	2.5 ± 0.2	ns
U.L. length (cms)	16.07 ± 1.0	16.09 ± 1.1	ns
L. Length (cms)	22.2 ± 1.0	21.9 ± 1.1	P<0.02, t=3.2 df=198
Trunk length	18.8 ± 1.1	18.8 ± 1.4	ns
Head Circum (cms)	33.1 ± 1.3	32.5 ± 1.4	P<.002, t=2.14 df=198
U.L. Circum (cms)	9.9 ± 0.8	9.9 ± 0.8	ns
L.L. Circum (cms)	13.1 ± 1.1	13.2 ± 1.2	ns
Trunk Circum (cms)	31.8 ± 1.6	31.4 ± 1.5	P<0.04, t=2.14 df=198
U.L. skin fold (cms)	0.2 ± 0.1	0.3 ± 0.1	p<0.007, t=2.74 df=198
L.L. skin fold (cms)	0.5 ± 0.1	0.6 ± 0.2	P<0.001, t=3.57
Trunk skin fold (cms)	0.2 ± 0.1	0.3 ± 0.1	P<0.001, t=4.18
U.L. fat (ml)	38.3 ± 20.2	44.8 ± 20.4	P<0.03, t=2.29
L.L. fat (ml)	132.3 ± 65.4	166.3 ± 75.9	P<0.001, t=3.4
Total body fat (gm)	442.7 ±178.1	527.1 ± 204.3	P<0.002, t=3.12
Fat free mass (gms)	2535.4 ±270.4	2307 ± 241.3	P<0.001, t=6.28

thickness (P<0.001), upper limb fat volume (P<0.03), lower limb fat volume (P<0.007), trunk fat volume (P<0.001) and total body fat (P<0.002) as compared to male neonates.

- Fat free mass of the male neonates was significantly more than that of female neonates (P<0.001).
- The total body fat of the female neonates was significantly more than that of the male neonates (P<0.002).
- There was no significant differences in ponderal index, upper limb and trunk length, and upper and lower limb circumferences between male and female neonates.

The dependent variables birth weight, fat free mass and total body fat were analysed with independent variables.

In this model, birth weight had a positive correlation with pre pregnancy weight (R^2=0.13) (Fig I)

maternal weight at term (R^2=0.22) (Fig. II)

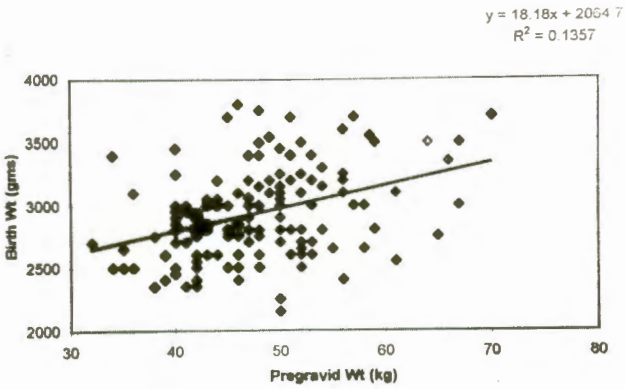

Fig I: Correlation of Birth Weight with Pre Pregnancy Weight

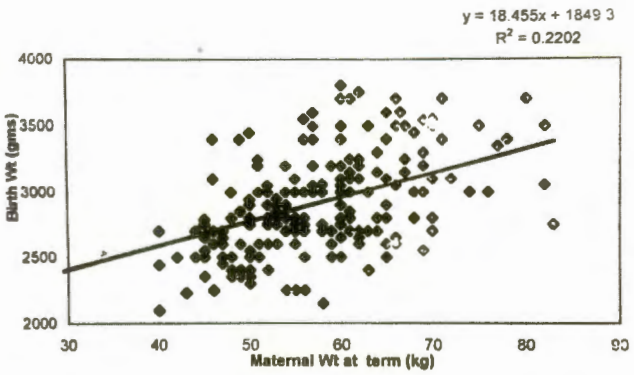

Fig. II: Correlation of Birth Weight with Maternal Weight at term

Male fat free mass was strongly correlated with neonatal sex (R^2=0.17) followed by maternal weight (R^2=0.1178) (Fig. III) and pregnancy weight (R^2=0.0588) (Fig. IV). Total body fat strongly correlated with neonatal sex (R^2=0.21) and neonatal weight (R^2=0.15). A positive correlation was also found between paternal height and length of the baby (R^2=0.023) (Fig. V).

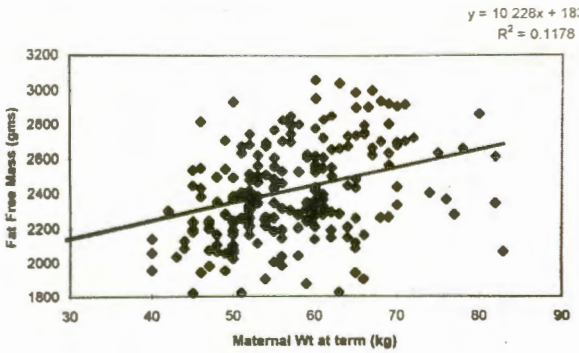

Fig. III: Correlation of Male fat Free Mass with Maternal Weight at term

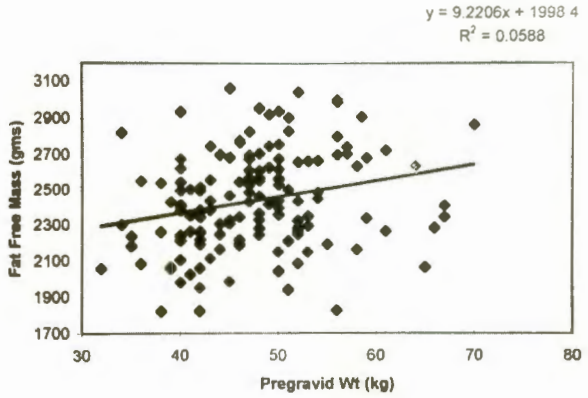

Fig. IV: Correlation of Male Fat Free Mass with Prepregnancy Weight

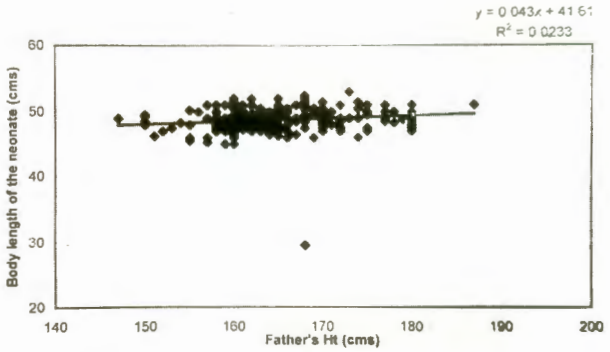

Fig. V: Correlation of paternal Height with Neonatal Length

Discussion

In our study male neonates were heavier than female neonates by 144 gms. This is in agreement with other reports describing greater neonatal birth weight, in males compared to female ranging from 150-176 gms (Catalino et al, 1995; Hytten & Leitch, 1964).

In our study population there was increased triceps, subscapular and quadriceps-skin fold measurement in female compared to male neonates. Mc Gowan et al (1975) described an increase in flank and quadriceps skin fold measurement but not triceps or subscapular skin fold measurement. Gampel (1965) in England and Wagner et al (1967) in the U.S., however, did not find any sex difference in skin fold measures between male and female neonates.

We speculate that the racial homogeneity, average nutritional status, lack of significant differences in parental anthropometrics and absence of obstetric or medical problems in this study population contributed to our being able to demonstrate significant differences in estimates of body composition between male and

female neonates. But, though these findings may apply to our study population but need to be examined in different populations.

The neonates have a significantly higher body fat than male neonates. This has been corroborated by our study as well as Catalano et al (1995a) study. However, our study showed a uniform increase in fat distribution in female neonates as against Catalano et al (1995a) study where there was no difference in fat distribution in the two sexes.

A positive correlation between birth weight and prepregnancy weight and weight gain in pregnancy has also been observed by other authors (Catalano et al, 1995b; Eastman & Jackson, 1968; Kerr 1943; Niswander et al, 1969; Patrik et al, 1992; Simpson et al, 1976; Singer et al, 1968).

Of interest, is the correlation of paternal height with neonatal body length of the male neonates (Fig. V). This was the only instance in which a paternal factor was included in the regression model. We believe that the inclusion of neonatal sex and paternal height in the model support the hypothesis that genetic factors primarily affect neonatal body composition. This has also been shown in Polani's (1974) study regarding body length and birth weight.

References

1. Catalano PM, Thomas AJ, Arallone DA, Amini SB., Am. J. Obst Gyn, 173. 1176, 1995.
2. Catalano PM, Drago NM, Amini SB. Am J Obstet Gynecol 172: 1464, 1995
3. Dauncey MJ, Grandy G, Gairdner D Arch Dis Child 52: 223, 1977.
4. Eastman NJ, Jackson E. Weight relationships in pregnancy. Obstet Gynecol Sur 23: 1003, 1968.
5. Gampel B. Hum Biol 37: 29, 1965.
6. Hytten FE and Leitch I. The Physiology of human pregnancy. Blackwell, Oxford. 1964. p. 230.
7. Kerrr A. Amer J. Obst Gyn 45: 950; 1943.
8. McGowan A, Jordan M, MacGregor J Biol Neonate 25: 66, 1975.
9. Niswander KR, Singer J, Westphal M, Weiss W. Obstet Gynecol, 33: 482, 1969.
10. Patrick M. Catalano MD, Elaine D. Ezbur MS, Scott R. Allen MD, Judith H. Mc Bean MD and Timothy J McAuliffe PhD: Obstet Gynecol 79: 46, 1992.
11. Polani PE. Chromosomal and other genetic influences on birth weight variation. In Size at birth Eds" K Elliot, Knight. Ciba foundation symposium 27. Amsterdam: Elsevier, 1974: pp 127 164.
12. Simpson JN, Lawlwss RW, Mitchell C A. Obstet Gynec 31: 417; 1968.
13. Singer JE, Westphal M and Niswander KR. Obstet Gynec 31: 417; 1968.
14. Wagner M, Wagner G, Mathis R. Biol Neonate 11 106, 1967.