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The Importance of Plasma Volume Expansion and Nutrition in Twin Pregnancy

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Abstract. Physiological adaptation including expansion in plasma volume is exaggerated in women with twin pregnancies. In singleton pregnancy and multiparous twin pregnancies there is an association between plasma volume expansion and birth weight, but this is not so in primigravid twin pregnancies. Women with twin pregnancies have a similar dietary intake to singleton pregnancies, but it is not known whether there are differences with parity or zygosity. Absorption and utilisation of nutrients may be increased to meet demands for extra fetal growth. Nutrient supply and plasma volume expansion will be further discussed and their association with birth weight presented.

Key words: Twin pregnancy, Nutrition, Plasma volume

INTRODUCTION

The exaggerated physiological adaptation to pregnancy in women having twins is exemplified by the increased plasma volume in both primigravidas and multiparas compared to singleton pregnancies [2, 7]. There is a significant relationship between birthweight and plasma volume in both primigravid [4, 5, 10] and multiparous singleton pregnancies [1] and in multiparous twin pregnancies [2], but not previously in primigravid twin pregnancies.

Our previous work has also shown that dietary intake is not different in twin compared with singleton pregnancies. This is true for both energy and protein intake and for the intake of metals, for example, zinc, copper and iron [3]. It was concluded, then, that the absorption, transport and utilisation of dietary nutrient must be adequate for the increased fetal demands for twin pregnancy. Zinc is an example of a nutrient whose concentration in the blood changes in pregnancy. Plasma zinc concentration falls in normal singleton pregnancy [11]. The reason for the drop in plasma zinc has been attributed to plasma volume expansion and also to changes in albumin metabolism [12]. Zinc in the plasma is 70% bound to albumin in the nonpregnant and there is usually a good correlation between the plasma zinc and albumin levels. Both plasma zinc [3] and serum albumin [2] have previously been shown to be lower in twins than singletons.

This paper considers the relative importance of plasma volume expansion, maternal nutrition, particularly zinc, and birthweight in twin pregnancies.

METHODS

One hundred and seventeen primigravid twin pregnancies were studied. The plasma volume was measured by Evan's blue dye between 30 and 34 week gestation [5]. Serum albumin was measured by the Biuret method on the autoanalyser. Zinc was measured by atomic absorption spectrometry [9].

RESULTS

Firstly, only those twins delivered after 37 weeks gestation are included. They are divided into those who were normotensive, those who had mild preeclampsia and those who developed proteinuric preeclampsia by Nelson's classification. The relationship between plasma volume and birthweight in primigravidas, as compared with our previously published relationship in multiparous twin pregnancies, is shown (Fig. 1). There is a significant relationship in those primigravid twins with mild preeclampsia. In those primigravid twins who were normotensive, the association is almost identical to that of multiparous twin pregnancies, but on account of the greater scatter of values the correlation coefficient is not significant at 0.29. Clearly, there was no relationship between plasma volume and birthweight in those with proteinuric preeclampsia.

As it has been shown in the past that in mild preeclampsia there is no difference either in plasma volume [8] or birthweight [6] from normal pregnancy, it was felt justified to combine the results from normotensive twins and those with mild preeclampsia (Fig. 2). There is a significant relationship between the plasma volume and the combined birthweight of twins born after 37 weeks in primigravidas, which is very similar to the previous one for multiparous twin pregnancies. This approach, however, excludes all twins born preterm.

Centile birthweight tables for twins were determined from the weights of twins delivered over a 20-year period (1950-69) in Aberdeen Maternity Hospital. This standardises for gestation length, sex of twins and parity and enables twins delivered after 32 weeks gestation to be included. The present group of 117 primigravid twin pregnancies were divided according to presence or absence of preeclampsia and allocated to the appropriate birthweight centile categories (Table 1). In the total group, there is an over-representation of those under the 25th centile, with fewer in the intermediate categories. In those who were normotensive, 40% are under the 25th centile, but in those with mild preeclampsia there is over-representation in the intermediate category, 50th-< 75th centile (36%). In proteinuric preeclampsia, as expected, nearly 47% were under the 25th centile birthweight. When primigravid twins who were normotensive and those with mild preeclampsia were grouped together, there was still a greater than expected proportion over the 25th centile (35%).

Mean plasma volume according to the combined centile birthweight (Table 2) in the normotensive group tends to increase slightly as the birthweight increases. In those with mild preeclampsia this is more marked and there is a statistically significant difference

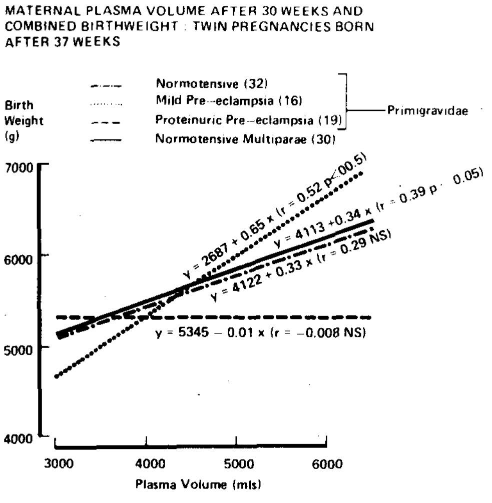

Fig. 1

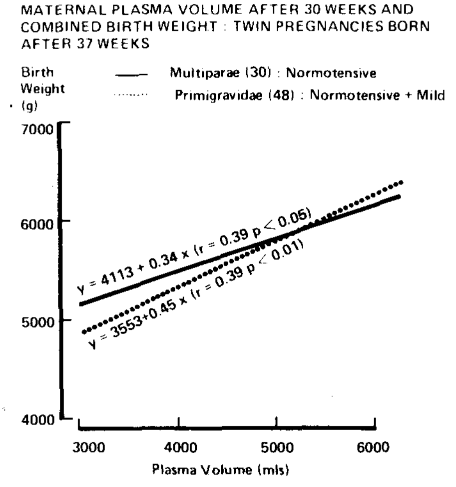

Fig. 2

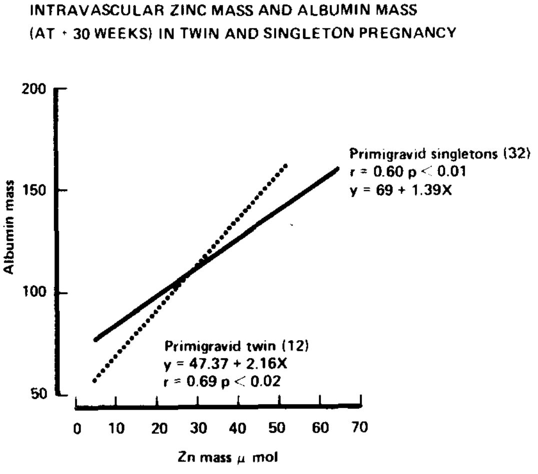

Fig. 3

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TABLE 1 - **Distribution of Combined Birthweight Centiles of Primigravid Twins**
(% values; nos. in parenthesis are nos. in each group)

	Birthweight centiles			
	< 25	25 –< 50	50 –< 75	⩾ 75
All (117)	38.5 (45)	17.1 (20)	19.7 (23)	24.8 (29)
Normotensive (60)	40.0 (24)	18.3 (11)	15.0 (9)	26.6 (16)
Mild preeclampsia (25)	24.0 (6)	16.0 (4)	36.0 (9)	24.0 (6)
Proteinuric preeclampsia (32)	46.9 (15)	15.6 (5)	15.6 (5)	21.9 (7)
Normotensive and mild preeclampsia (85)	35.3 (30)	17.7 (15)	21.2 (18)	25.9 (22)

TABLE 2 - **Mean (±SD) Plasma Volume (ml) by Combined Birthweight Centiles in Primigravid Twin Pregnancies** (nos. in parenthesis are nos. in each group)

	Birthweight centiles			
	< 25	25 –< 50	50 –< 75	⩾ 75
Normotensive (55)	3902 ± 489 (22)	4182 ± 610 (8)	4266 ± 457 (9)	4138 ± 690 (16)
Mild preeclampsia (23)	3281* ± 450 (6)	3783 ± 705 (4)	3729 ± 418 (8)	4294* ± 427 (5)
Proteinuric preeclampsia (30)	3952 ± 661 (14)	4092 ± 278 (4)	4240 ± 468 (5)	4112 ± 307 (7)

* Statistically significant.

TABLE 3 - **Mean (±SD) Plasma Volume (ml) by Combined Birthweight Centiles in Primigravid Twin Pregnancies** (nos. in parenthesis are nos. in each group)

	Birthweight centiles			
	< 25	25 –< 50	50 –< 75	⩾ 75
Normotensive and mild preeclampsia (78)	3769* ± 481 (28)	4049 ± 643 (12)	4013 ± 439 (17)	4175* ± 566 (21)
Proteinuric preeclampsia (30)	3952 ± 661 (14)	4092 ± 278 (4)	4240 ± 468 (5)	4112 ± 307 (7)
All (108)	3830* ± 547 (42)	4060 ± 574 (16)	4065 ± 446 (22)	4159* ± 573 (28)

* Statistically significant.

in the mean plasma volume in those women whose twins were under the 25th centile birthweight and those who were over the 75th centile ($t = 3.44, P < 0.01$). Rather surprisingly, in those with proteinuric preeclampsia, there was also a slight increase in the plasma volume as birthweight increase. When the plasma volumes of normotensive women and those with mild

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preeclampsia were grouped together according to the centile birthweight categories (Table 3) there was a significant difference between the mean plasma volume of the twins in the lowest category of birthweight and the highest ($t = 2.66$, $P < 0.05$). This is not found in the proteinuric preeclamptics. When all categories are combined together, again there is a significant difference between those women whose twins are less than 25th centile and those over 75th centile ($t = 2.39$, $P < 0.05$).

In 12 of the primigravid normotensive twin pregnancies, plasma zinc and plasma albumin are measured in conjunction with plasma volume. As has been shown for singleton pregnancy [12] there was no relationship between serum albumin and plasma zinc levels in twin pregnancies ($r = 0.24$, $n = 12$, NS). Intravascular albumin mass was calculated by multiplying serum albumin concentration by the plasma volume. Intravascular zinc mass was calculated in the same manner. In twin pregnancies there was a significant relationship (Fig. 3) between intravascular albumin mass and intravascular zinc mass. This relationship was very similar to that for singleton pregnancies. Thus, there is a significant association between zinc and albumin in twin pregnancy only after adjustment for plasma volume expansion.

CONCLUSION

In primigravid twin pregnancy as in singleton pregnancy, the expansion of plasma volume is an important determinant of birthweight. Food intake and the levels of nutrient in the blood can be perfectly adequate for fetal growth even though the concentrations in the blood are lower than in singleton pregnancy. Adaptations of pregnancy with respect to transport of nutrient to the fetal-placental unit depend on plasma protein changes and an expansion of plasma volume, and the generally lowered levels of nutrient may favour transfer across the placenta to the fetus. It is likely that such changes in plasma volume and plasma proteins are more important with respect to fetal growth than maternal nutrition, except when this may be extremely low.

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