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Growth Characteristics in Twins and Higher Order Multiple Births

J.M.H. Buckler, J.B. Buckler
Department of Paediatrics and Child Health, University of Leeds, UK

Abstract. Measurements of height and weight have been undertaken on 201 pairs of twins and 46 sets of higher multiples once each at various ages through childhood. The heights of twins are comparable to the overall population of singletons, those of higher multiples are slightly undersized. However, the total group of twins were shorter than expected when compared with the heights of parents and siblings, but this was entirely accounted for by that component of the group who at birth had been very light for dates. The children in all groups of multiples were underweight for their height in comparison with standards of a comparable population and with their own siblings.

Key words: Twins, Higher multiples, Height, Weight, Size at birth

INTRODUCTION

Growth through childhood is dependent on many influences, some inherited and inherent and usually not amenable to therapeutic change, some acquired. The timing of the latter may be antenatal, perinatal or at any stage of subsequent development through childhood to maturity. The permanence or irreversibility of adverse effects on growth will depend on the cause, its timing, severity and duration. The size of a baby at birth will depend, in addition to the length of gestation, on the intrauterine environment and on inherited factors. Studies of the growth of twins and higher multiples in relation to birth size and zygosity offer an opportunity to evaluate the importance of these factors as influences on subsequent growth and ultimate adult size, and this was the purpose of this investigation.

SUBJECTS

A total of 201 pairs of twins from the neighbourhood of the City of Leeds have so far been seen over the last three years. These had mostly been identified through a survey undertaken by the University Department of Community Medicine, the families having indicated their willingness to participate in research. In addition, higher multiples have been visited at homes throughout England and Wales and 38 sets of triplets, 7 sets of quadruplets and one set of quintuplets have participated in the study. Most of the sets of children have been seen only once, the age range extending throughout childhood from the youngest at which they could cooperate (usually about three years of age) to the age at which they would have completed their education and left home. Thus, few were seen after the age of 18.

METHODS

Following initial explanation by letter or telephone, parents have completed a questionnaire and attended by appointment with their twins at the Department in Leeds, or those with higher multiples have been visited at their homes. Among the information provided through the written questionnaire and subsequent direct questioning are details of the pregnancy, its duration and the size of the babies at birth. In addition, heights and weights of parents and siblings have been obtained either by direct measurement at the visit, or by the parents themselves.

Zygosity

This has been evaluated mostly on clinical grounds and on the impressions of the parents themselves and of their acquaintances. (Judgement based on clinical appearance has been shown to be as reliable as many other methods in most cases [1,2,4].) In the minority where there was doubt, full blood grouping has usually been performed and sometimes HLA typing. Most of these families were themselves keen to know about zygosity. No reliance was placed on the reported observations about the placenta, which are known to be unreliable.

Measurements

Clinical examination and numerous physical measurements have been undertaken, but only height and weight are reported in this paper. Many other aspects will be analysed and presented subsequently. All measurements have been undertaken by the same observer (JMHB) by standard precise techniques.

The height and weight data are presented in terms of standard deviation scores (SDS). $SDS = (X-X_1)/S_x$, where X is the child's measurement, X_1 is the mean height or weight at the child's age, and S_x is the standard deviation at a given age [10]. These scores indicate how far from the mean of a standard comparable population the relevant measurement falls.

Table 1 gives an approximate indication of what SDS scores represent in terms of centile distribution, and values in cm and kg above or below the average for adults.

The use of SDS is a convenient way of combining data for individuals of different ages as this deviation from the mean will have a similar significance whatever the age.

SDS are also presented for heights and weights of siblings. The parents' heights are presented as "target height" values which are the mean of the adult SDS for the mother and

Table 1. Relationships between centiles and standard deviation scores

Centiles	Approximate SDS (for height)	Approximate difference of adult values from the mean			
		Height (cm)		Weight (kg)	
		M	F	M	F
3	-1.9	-12.5	-11.0	-13.0	-10.5
10	-1.3	- 8.5	- 8.0	- 9.5	- 8.0
25	-0.68	- 4.5	- 4.0	- 5.0	- 4.5
50	0	0	0	0	0
75	+0.66	+ 4.5	+ 4.0	+ 5.0	+ 5.0
90	+1.3	+ 8.5	+ 8.0	+11.5	+11.5
97	+1.9	+12.5	+11.0	+18.0	+18.5

father. This gives an approximate indication of where the SDS for height of (singleton) children might be expected to lie on the basis of parental heights.

RESULTS

Details of the Subjects and Their Characteristics at Birth

The zygosity and sex distribution of the twin pairs are shown in Table 2, and of the higher multiples in Tables 3 and 4. There is a somewhat atypical male predominance among the twins. The proportion of mothers of higher multiples who had been undergoing ovulation stimulating therapy prior to the pregnancy is also indicated.

The length of the pregnancies at the time of birth, where known, is shown in Table 5, which shows the typical tendency for shortened gestation averaging about 37 weeks for twins, 36 weeks for triplets, and 33 weeks for quadruplets [7,8].

Weight at birth has been evaluated according to centile standards for singletons [11,12] and categorised as "appropriate for gestational age" if above the 10th centile, "light for dates" if lying between the 5th and 10th centiles, and "very light for dates" if less than the 5th cen-

Table 2. Twin pairs

	Male	Female	Mixed	Total
Monozygotic	52	35		87
Dizygotic	34	27	53	114
Total	86	62	53	201

Male:Female = 225:177 (1.21:1)

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Table 3. Triplet sets

	All male	All female	2 male 1 female	1 male 2 female	Total	Ovulation stimulating therapy
Monozygotic	3	5			8	0 (0%)
Dizygotic	5	3	3	7	18	2 (11%)
Trizygotic	3	2	3	4	12	12 (100%)
Total	11	10	6	11	38	14 (37%)

Male:Female = 56:58 (0.97:1)

Table 4. Quadruplet sets

			Ovulation stimulating therapy
Trizygotic	3	1 all male 1 3 male 1 female 1 1 male 3 female	1/3
Quadrizygotic	4	2 2 male 2 female 2 1 male 3 female	4/4
Total	7		5/7 (71%)

Male:Female 14:14 (1:1)
1 set of quintuplets: 4 boys, 1 girl

Table 5. Gestational age of multiple births

	Twins		Triplets		Quads	
No. (weeks)	No.	%	No.	%	No.	%
>42	1	1/2	0	0	0	0
>40 < 42	8	4	0	0	0	0
>38 < 40	67	35	4	11	0	0
>36 < 38	62	32	12	32	0	0
>34 < 36	31	16	9	24	0	0
>32 < 34	12	6	7	19	4	57
>30 < 32	10	5	3	8	3	43
<30	2	1	2	5	0	0
Total	193	100	37	100	7	100

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tile. This distribution for all the multiple birth babies is shown in Table 6. This shows a higher proportion of birth weights which are low by singleton standards and increasingly so for higher multiples [6,8]. There is no difference in this distribution of weights between MZ and DZ twins. There was a high proportion of the multiple birth sets in which there had been a marked difference in birth weight between the individual members. In 26% of twin pairs, the smaller weighed over 15% less than the larger and in 11% the intrapair difference in birth weight was over 25%, with almost equal distribution between MZ and DZ sets.

These multiple birth babies are thus often small on two counts, being born at times of shorter gestation, and being inappropriately light for that length of gestation.

Table 6.

	MZ twins		DZ twins		Twins, total		Triplets		Quads	
	No.	%	No.	%	No.	%	No.	%	No.	%
Very light for dates (<5 centile)	40	24	51	23	91	24	64	58	6	22
Light for dates (5-10 centile)	33	20	36	17	69	18	15	13	13	46
Appropriate weight for gestational age	95	56	131	60	226	58	32	29	9	32
Total	168	100	218	100	386	100	111	100	28	100

Results of Measurements Taken During Survey

These are presented in histogram form in the Figures. The height of each column represents the mean value for the group, with a bar above for the standard error of the mean. The figure in brackets above the columns indicates the number of subjects in the group, but for "target heights" these represent the combined values for each of the pairs of parents.

Heights and Weights of Twins

The pooled SDS values for heights of the twins in this series are very closely comparable to those of the overall population. However, when compared with expectancy based on parental height, there is a slight shortfall, more evident with the DZ than the MZ group. Compared with the height of the twins, the mean height of the parents of the twins is above average (0.310 ± 0.071, $P < 0.1$). This difference is only significant for the DZ component, the mean height for MZ twins being fractionally greater than for the DZ group ($0.118 \pm 0.085 : 0.002 \pm 0.082$, NS) (Fig.1). Comparison of the height SDS with that of the weight shows a striking difference ($P < 0.01$) as all the twin groups are below average weight (to a similar degree in MZ and DZ groups). This effect is made more evident when comparison is made with siblings (Fig.2). In this comparison an attempt has been made to match up numbers of siblings and twins. Only those twins who have siblings have been considered in this respect (276 out of 402) and

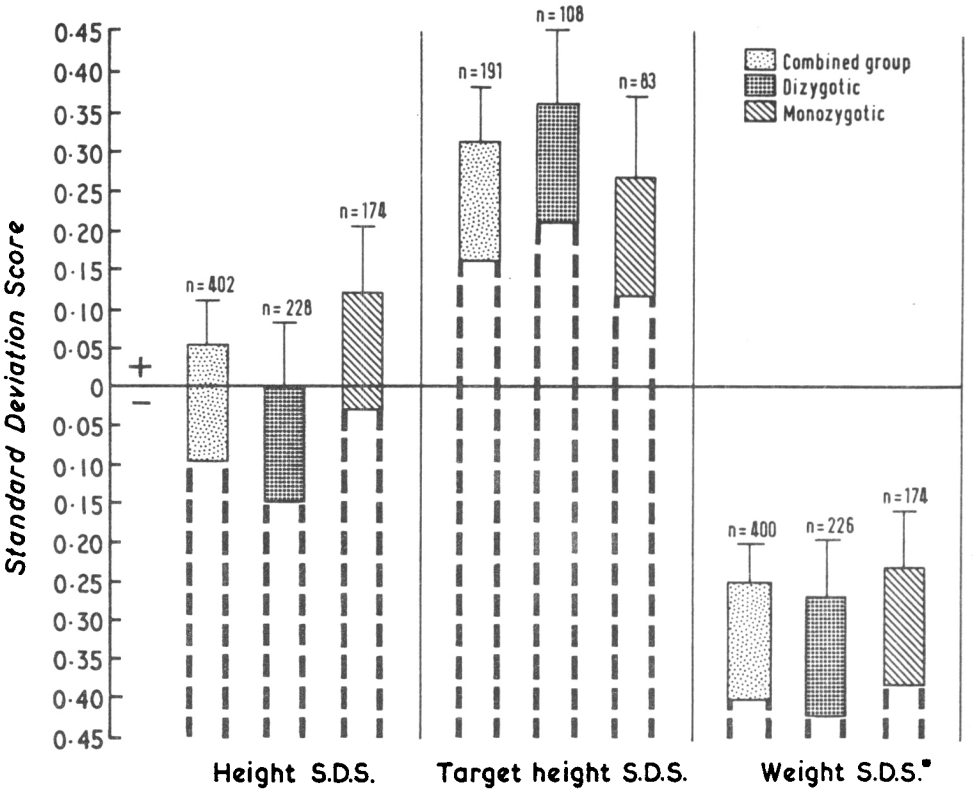

Fig. 1. Height, target height and weight, standard deviation scores for twins.

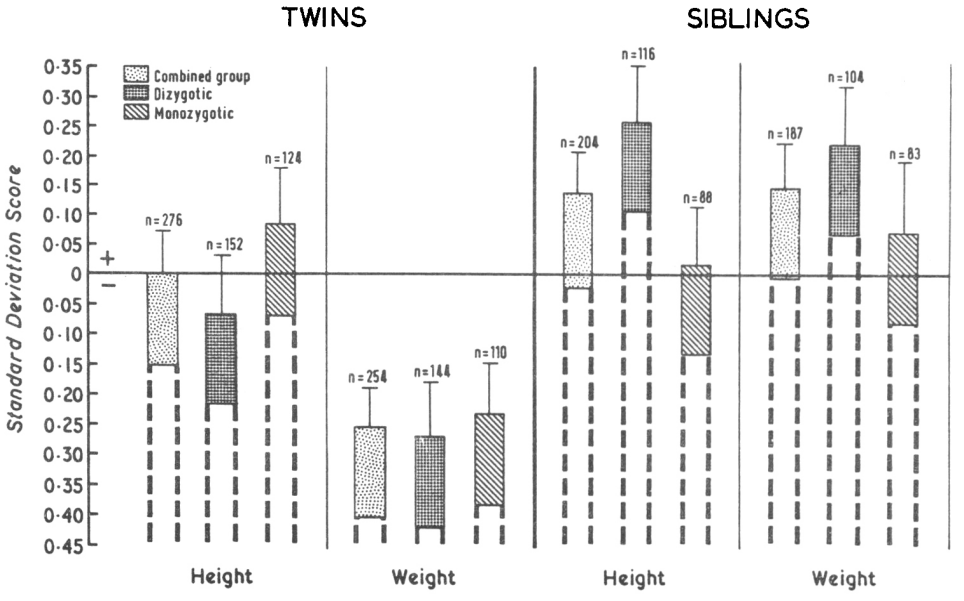

Fig. 2. Height and weight, standard deviation scores for twins and their siblings.

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in fact these twins are slightly shorter in stature than the overall group. The number of siblings in families with twins clearly varies and in order to avoid bias the numbers of values for the twins and their siblings have been artificially made equal for each individual family.

The heights and weights of siblings in families with DZ twins are slightly greater than those with MZ twins (height 0.254 $\pm$ 0.096 : 0.014 $\pm$ 0.098). Overall, the siblings heights are greater than those of the twins (0.144 $\pm$ 0.069 : 0.000 $\pm$ 0.071, NS), but this is evident with the DZ component only ($P < 0.2$). As would be expected, the weights of the siblings correlate well with their heights, which emphasises therefore the significance of the weight deficit of the twins themselves.

Growth Characteristics of Twins in Relation to the Appropriateness of Their Birth Weight

Fig.3 shows the differing outcome in terms of height for the twins in relation to the appropriateness of their weight at birth, and Table 7 shows the statistical significance between the various groups. It is apparent that those twins whose weight at birth was above the 10th centile for the appropriate duration of gestation (and many of these would have been well

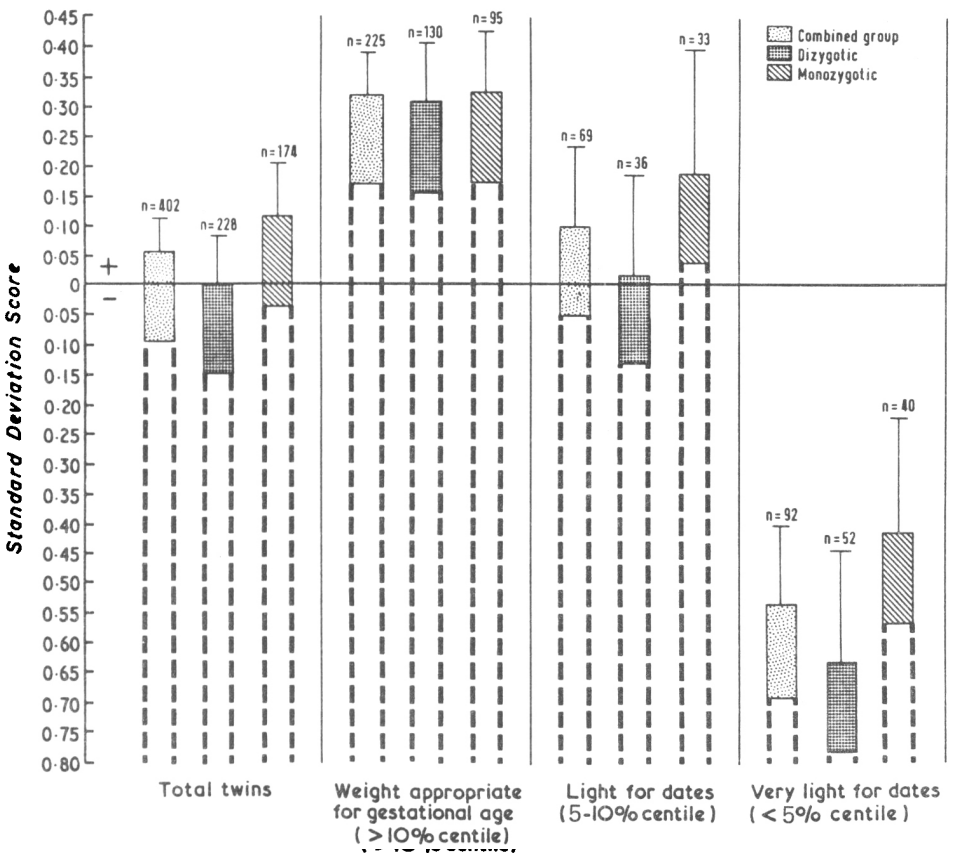

Fig. 3. Height of twins in relation to the appropriateness of their weight at birth.

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Table 7.

		Total	AGA	Total LFD	Very LFD
Total twin group					
Total	(N = 402)	X	<0.05	<0.1	<0.01
AGA	(N = 225)	<0.05	X		
Total LFD	(N = 161)	<0.1		X	
Very LFD	(N = 92)	<0.01			X
Monozygotic Twins					
Total	(N = 174)	X	NS	NS	<0.1
AGA	(N = 95)	NS	X	<0.1	<0.02
Total LFD	(N = 73)	NS	<0.1	X	
Very LFD	(N = 40)	<0.1	<0.02		X
Dizygotic Twins					
Total	(N = 228)	X	<0.1	<0.2	<0.05
AGA	(N = 130)	<0.1	X	<0.01	<0.01
Total LFD	(N = 88)	<0.2	<0.01	X	
Very LFD	(N = 52)	<0.05	<0.01		X

P values for significance of differences. NS = not significant
Birth criteria
AGA = appropriate birth weight for duration of gestation (> 10 centile);
Total LFD = all those with birth weight < 10th centile for duration of gestion;
Very LFD = Those with birth weight < 5th for duration of gestation.

below the average) were above the average height of the overall twin group. These twins showed little difference in size as a result of zygosity, and had heights that were closely comparable to those of their parents and siblings. However, light for dates babies (< 10th centile), and in particular those very light for dates (less than 5th centile weight for gestational age), had markedly reduced stature subsequently compared with the overall population of twins, but the adverse effect was a little more evident with DZ than with MZ twins.

Growth Characteristics of Triplets and Higher Multiples

Fig. 4 shows the height of triplets, and illustrates the similarity to the growth pattern of the twins. Thus, the overall group was of slightly sub-average height compared with the standard singleton population, but considerably so when compared with the height SDS of their parents ($P < 0.05$). (Too few of the triplet sets had siblings for a worthwhile comparison to be made with them). This adverse effect on growth was mainly due to those who were inappropriately lightweight at birth (less than 10th centile), who formed the majority. The smaller proportion who were above the 10th centile weight for gestational age at birth subsequently grew to be above average height and not much below expectancy on the basis of parental height.

The adverse effect on subsequent growth of being a member of a higher multiple set is even more apparent with quadruplets and quintuplets, as shown in Fig. 5. The relationship between height and weight of each subset of multiples was similar, all being underweight, but the overall reduction in size became increasingly apparent with the higher multiples.

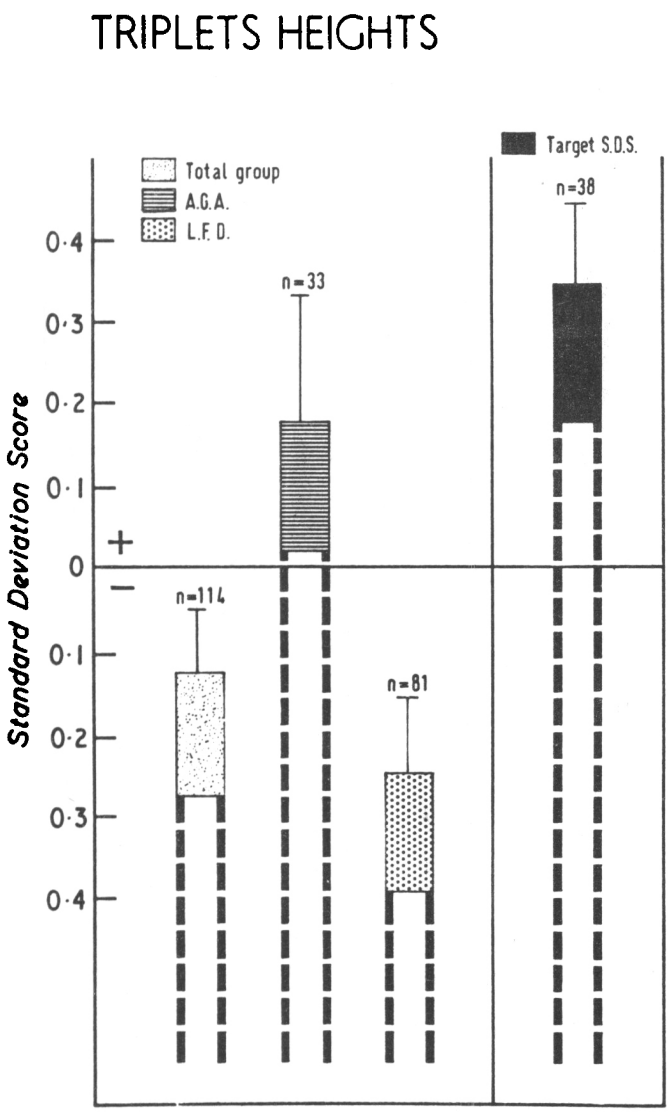

Fig. 4. Height, standard deviation score for triplets compared with target height and subdivided according to appropriateness of weight at birth.

DISCUSSION

The range of values for height and weight SDS of these children is very great and only some of the implied differences achieve a level of statistical significance. The study group may not be truly representative of the overall population of British multiple births, being somewhat self-selected. The apparently average size of the overall group of twins could therefore be

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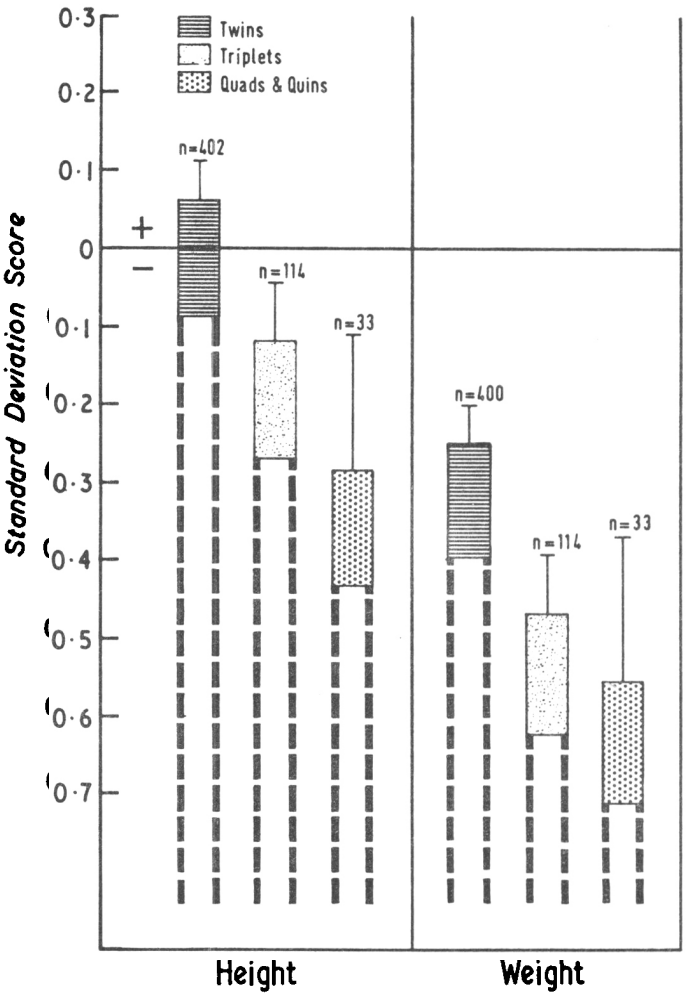

Fig. 5. Height and weight standard deviation scores for twins, triplets and higher multiples.

somewhat misleading. However, by comparing these children with their parents and siblings, the effect of possible bias in the study population can be evaluated. The heights of the parents of these twins and triplets are above average. That mothers of twins tend to be tall has been documented [3] and this may be relevant here, as well as the effect of social bias. We have not attempted, as yet, to see whether the height of mothers is more or less significant than that of fathers in producing the high "target height". Siblings probably form the best control group and DZ twins do show a shortfall in height compared with their siblings, but this is not evident with the MZ group. The parents and siblings of the families of DZ twins do tend to be above average size, whereas siblings in families of MZ twins are not, and the MZ twins grow as well or better than their siblings.

The most significant factor in the growth outcome of these children demonstrated by this study depends on the appropriateness of the size at birth in relation to gestational age. Twins

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and triplets whose weight at birth exceeds the 10th centile for gestational age subsequently grow up to singleton expectation and this applies whether they are MZ or DZ. It is only those children who are inappropriately very small at birth that end up below expected height, and so lower the mean for the total group. This adverse effect seems to be more marked with low birthweight DZ than with MZ twins. These effects of zygosity are not dependent on a difference in the percentage of babies who are light for dates as these are the same in MZ and DZ groups. It is intended, in the future, to examine the outcome of twin pairs with a large disparity in birth size and to determine whether this shows a relationship to zygosity.

The other striking finding from this report is that all these groups of higher multiple birth children are relatively underweight for their height according to singleton standards and by comparison with their own singleton siblings. Previous studies have demonstrated a catch up in height and weight of twins, bringing them to normal levels by the age of 9 [5,14], although Silva and Crosado [9] have reported that twins remain lighter and shorter than singletons at 9 and 11 years. However, we are not aware of any report of persisting lower weight:height relationships in twins as compared with singletons. Wilson [13] did suggest that weight was more affected by growth suppression than height in 4 year old twins, and it may be that our data will need more detailed analysis in relation to age groups. As yet, we have not determined in which component of body mass this deficit is to be found, but the data are available to do so. If, as seems probable, they are merely less fat, this is probably no disadvantage to them, as such a high proportion of the standard so-called "normal" population is overweight. It will be of interest to determine whether the smaller size at birth, with possible lower fat proportions then, predisposes to the subsequent development of less fat during the growing years.

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Correspondence. Dr. J.M.H. Buckler, Department of Paediatrics and Child Health, D Floor, Clarendon Wing, The General Infirmary, Leeds LS2 9NS, UK.