Acta Genet Med Gemellol 42: 275-287 (1993)

Received 9 March 1993
Final 25 May 1993

Physical Growth of Japanese Twins*

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Abstract. The present study aimed at clarifying the characteristics of twins' physical growth. First, 557 pairs oı normal Japanese twins were analyzed according to the following three life stages: (1) intrauterine growth, (2) body weight and height from birth to 6 years, and (3) body weight and height at school age (from 6 to 11 years). The following results were obtained. 1. Intrauterine growth of twins was very different from that of singletons, especially as regards weight, so twins should be estimated by twin standards. 2. Size deficit at birth was appropriately recovered over the first 6 years. 3. No size deficit was observed by school age. Second, the similarity of bodyweight and height according to zygosity was analyzed using 605 pairs of normal Japanese twins, 427 monozygotic (MZ), 113 same-sexed dizygotic (DZ) and 65 opposite-sexed DZ pairs. The similarity between MZ and DZ pairs was almost the same at birth. However, MZ pairs became ~~increasingly more similar with age,~~ whereas DZ pairs became more dissimilar. This tendency was very clearly seen through early infancy, thus suggesting that genetic factors became more apparent during this life stage.

Key words: Intrauterine growth, Body weight and height, Intraclass correlation coefficient, Japanese twins

INTRODUCTION

Very little basic data is available concerning the general physical growth of twins in Japan, and the estimation of twins' growth has been based on singleton standards. In fact, in Japan few reports on this subject exist. The present study aimed at clarifying the characteristics of growth, if any, in Japanese twins.

* This paper was originally presented as four separate papers on "Growth and Development of Japanese Twins" at the 7th International Congress on Twin Studies in Tokyo, held between 22-25 June 1992.

Our study consists of four parts. First, intrauterine growth was analyzed, because the intrauterine growth of twins is claimed to be very different from that of singletons. There are many reports [4,5,7,8,14] on the birthweight of twins according to gestational week, but very few as regards other items such as height, head circumference and chest circumference at birth. In fact, weight at birth is one of the most important body measurements when growth estimation for newborns is considered. For the purpose of understanding total body balance or neurological development, it is important to estimate the total development of newborn babies by taking into account such measurements as body weight and height, head or chest circumference, and so on.

Second, bodyweight and height from birth to 6 years were analyzed. Physical development in infancy is most dramatic and diverse. For this reason, it is essential to know the process of normal development in this period in order to predict growth in later life. Very little basic data is available on this point at present and our study aimed at analyzing the normal process of twins' physical development in infancy, compared with those of Japanese singletons.

Third, body weight and height at school age were analyzed, and also compared with that of general Japanese school children. It is often said that school-age children are in relatively good condition, mentally as well as physically, and the death rate is the lowest of all age groups. According to Wilson [13], twin's size deficit at birth was fully offset in this period, so our study aimed to consider this point. Fourthly, similarity of body weight and height was analyzed to disclose the genetic background to physical growth.

SUBJECTS AND METHODS

The first subjects were 557 pairs of twins, who were the applicants, from 1982 to 1991, to the High School affiliated with Tokyo University, Japan. They consisted of 221 male-male, 276 female-female and 60 opposite-sexed twins. First, their weight, height, head circumference and chest circumference at birth were analyzed according to gestational week and zygosity. These four values were compared with those of Japanese singleton norms.

Then, body weight or height from birth to 6 years was analyzed, according to sex, and compared with Japanese standards supplied by the Ministry of Health and Welfare of Japan. Next, body weight and height at school age (6-11 years) was analyzed. The twins were measured in April, May or June at each grade to compare with standards supplied by the Ministry of Education, Science and Culture of Japan.

The second set of subjects were 605 pairs of twins, who had been applicants between 1982 and 1992 to the High School affiliated with Tokyo University, Japan. They consisted of 427 MZ twins, 113 same-sexed DZ twins and 65 opposite-sexed DZ twins. Their similarity in body weight and height from birth to 11 years was analyzed, and a zygosity diagnosis was made by many genetic markers or a questionnaire designed by us [9]. The genetic markers used were as follows: ABO, MN, Rh, Duffy, Kell, Hp, Gm, HLA, ACP, ESD, ADA, Se, P. Tf, and, partly, DNA fingerprinting.

RESULTS AND DISCUSSION

1. Intrauterine growth of twins

Body size according to sex, zygosity, birth order (first-and second-born) and presentation at birth were shown in Table 1. Male twins were significantly larger than female twins regarding head circumference. This result has previously been reported by Wilson [11]. DZ twins were significantly larger than MZ twins in all four measurements.

The comparison between twins and the general Japanese population is shown in Table 2. Weight deficit was the largest among the four measurements in both males and females, and chest circumference showed the greatest deficit after weight.

Birthweight according to gestational week is shown in Figure 1. Mean birthweight increased until 42 weeks gestation. 50 percentile birthweight increased until 41 weeks gestation. Weight growth of twins was nearly the same as that of singletons, up to 33 weeks, but from 33 weeks on, twins progressively lagged behind, approaching -1.5SD for singletons at 38 weeks. These results showed high concordance with previous reports [4,5,7,8,14]. 28.5% (310/1086) of infants were light-for-dates by singleton standards (-1.5SD below singleton norms). This seemed an overestimation. Appropriate-for-dates (between -1.5 SD and +1.5 SD) and heavy-for-dates (over +1.5 SD) amounted to 70.8% (769/1086) and 0.6% (7/1086) of infants respectively.

Birth length according to gestational week is shown in Figure 2, where it can be seen

Table 1 - Body size according to sex, zygosity, birth order and presentation

	weight (g)	height (cm)	chest circumference (cm)	head circumference (cm)
males	2,453 (N=502)	46.8 (N=471)	29.7 (N=458)	32.3⁺ (N=458)
females	2,457 (N=608)	46.6 (N=569)	29.8 (N=549)	32.0 (N=549)
first-born	2,480 (N=557)	46.8 (N=519)	29.9 (N=503)	32.1 (N=501)
second-born	2,430 (N=553)	46.6 (N=521)	29.7 (N=504)	32.2 (N=505)
MZ	2,426 (N=785)	46.6 (N=738)	29.7 (N=708)	32.0 (N=708)
DZ	2,526*** (N=325)	47.0* (N=302)	30.0* (N=299)	32.3** (N=298)
vertex	2,479 (N=701)	46.8 (N=654)	29.9 (N=637)	32.2 (N=638)
breech	2,426 (N=198)	46.7 (N=188)	29.6 (N=184)	32.2 (N=184)

males > females: + $p<0.05$
DZ > MZ: * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table 2 - Average size deficit for twins at birth in relation to the general population

	Male				Female			
	twins	general population 1970	general population 1980	difference (%)	twins	general population 1970	general population 1980	difference (%)
weight	2.45	3.2	3.23	23.44 ~ 24.15	2.46	3.1	3.16	20.65 ~ 22.15
(g)	2.46	–	3.23	23.84	2.48	–	3.14	21.02
height	46.8	50.2	49.7	5.84 ~ 6.77	46.7	49.7	49.3	5.48 ~ 6.24
(cm)	47.0	–	50.0	6.00	47.0	–	49.2	5.27
chest. c	29.7	32.8	32.5	8.61 ~ 9.45	29.8	32.6	32.4	8.02 ~ 8.59
(cm)	30.0	–	33.0	9.09	30.0	–	32.5	8.02
head. c	32.3	33.5	33.6	3.58 ~ 3.87	32.0	33.1	33.2	3.32 ~ 3.61
(cm)	32.5	–	33.5	2.99	32.0	~	33.1	3.32

[The general population norms were supplied by the Ministry of Health and Welfare of Japan. In each measurement, the values on the first line are means, and those on the line below, medians].

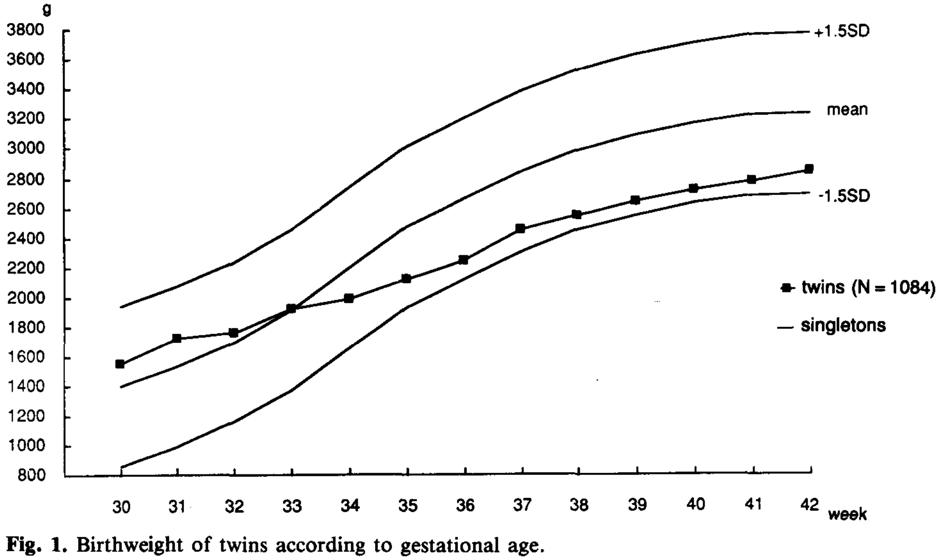

Fig. 1. Birthweight of twins according to gestational age.

that mean birth length increased until 40 weeks gestation. Length increase was also delayed after 33 weeks, and birth length gradually approached -1.5SD of singletons, but the length difference between twins and singletons was not so great as that of weight, as has already been reported [5,14].

Chest circumference at birth according to gestational week is shown in Figure 3. No data on Japanese singletons were available, but the value in twins may be nearly the same as the -1.5SD for singletons. As has already been noted, after birthweight, chest circumference shawed the greatest size deficit (when gestational week was not taken into

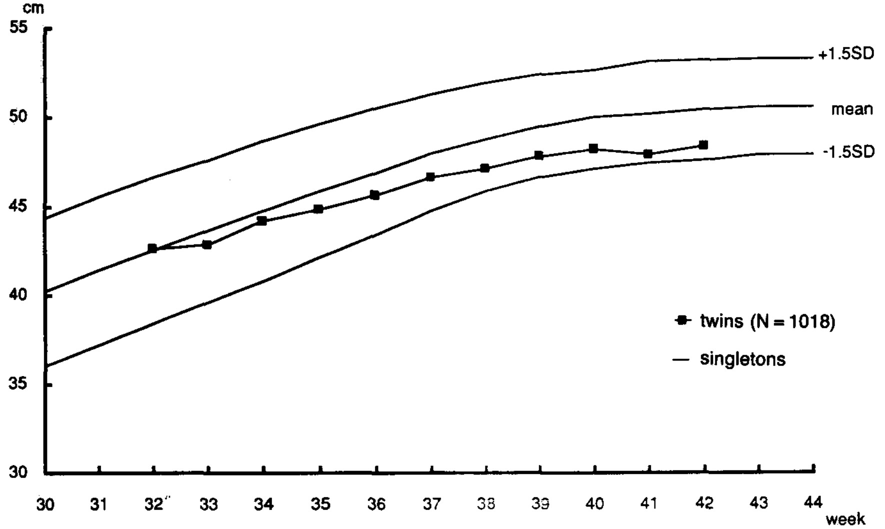

Fig. 2. Birth length of twins according to gestational age.

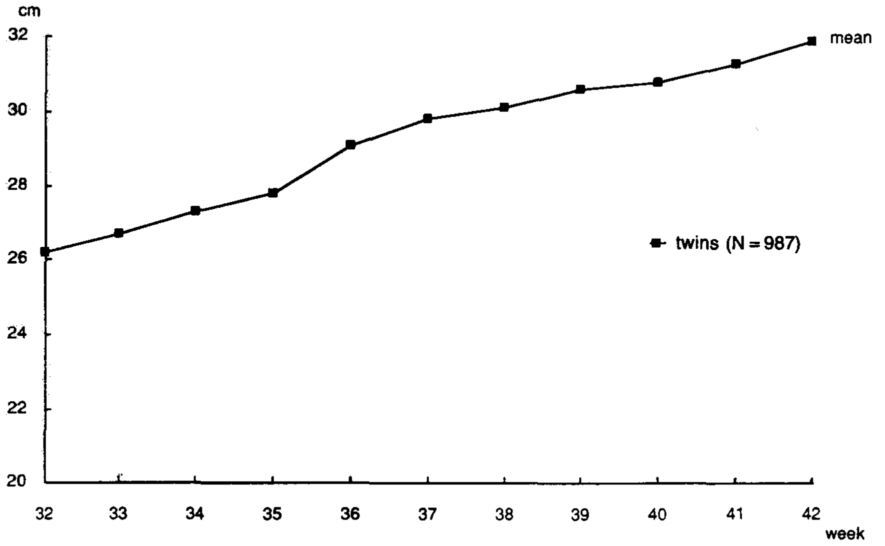

Fig. 3. Chest circumference of twins at birth according to gestational age.

account – see Table 2). Both the mean and the 50 percentile value increased until 42 weeks gestation. Head circumference at birth according to gestational week is shown in Figure 4. Both the mean and the 50 percentile value increased from 34 to 42 weeks gestation.

Head growth was also delayed after 33 weeks, but the difference was not so apparent, and was almost equal to singleton means. As as been indicated above, head circum-

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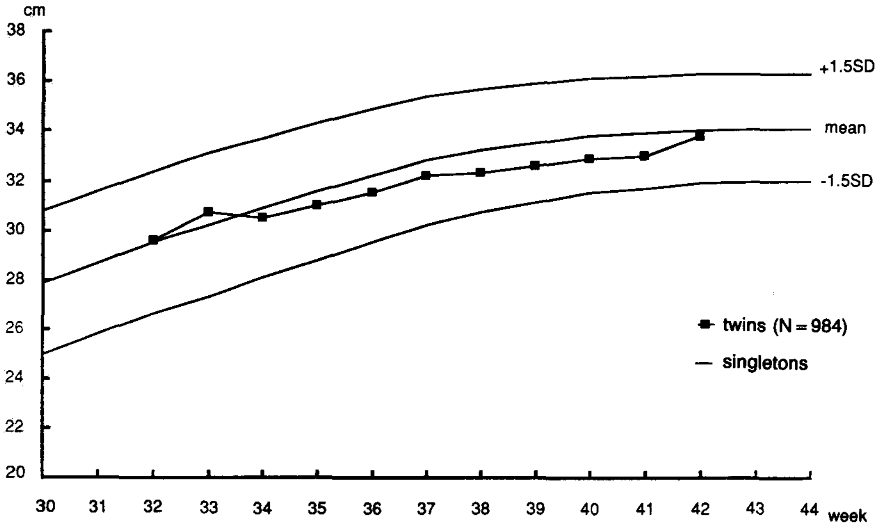

Fig. 4. Head circumference of twins at birth according to gestational age.

ference was not as delayed as chest circumference, suggesting that neurological growth is not as disturbed as other aspects of physical development.

Body size according to gestational week and zygosity we shown in Table 3. As to weight, DZ twins were larger than MZ twins through 33-41 weeks gestation. This tendency was first pointed out by Naeye et al [8], though their data consisted of placental records. And many other researchers noted birthweight differences between MZ and DZ twins. DZ twins were, in general, observed to be larger than MZ twins, also in the other measurements. These results strongly suggested that DZ twins were larger than MZ twins, irrespective of gestational week, especially with respect to birthweight. Grennert [3] also reported the same tendency. The difference in intrauterine growth between twins and singletons is clear, therefore, twins', intrauterine growth should be estimated by twin standards per se.

2. Body weight and height from birth to 6 years

Mean body weight and height according to sex is shown in Table 4. No difference between the sexes was observed at birth in either weight or length (given as height in Table 4), but after a few months, male twins became heavier or taller than female twins and these differences increased until the age of 2 years or 2 years and 6 months. But by the age of 6 years, these differences disappeared.

The speed of weight or height gain between ages is shown in Table 5. The greatest increase in weight occurred during the first 3 months in both males and females, after which, the rate of weight gain decreased. Male twins gained significantly ($p<0.01$) more weight than female twins from birth to 3 months. And female twins gained significantly ($p<0.01$) more weight than male twins from 2 to 3 years. The greatest height increase

Table 3 - Birth size of twins according to gestational week and zygosity

gestational week	weight (g)		height (cm)		chest circumference (cm)		chest circumference (cm)	
	MZ	DZ	MZ	DZ	MZ	DZ	MZ	DZ
33	1910 (N=16)	1989 (N=10)	42.6 (N=14)	43.1 (N=10)	26.6 (N=10)	26.8 (N=10)	30.4 (N=10)	31.0 (N=10)
34	1977 (N=34)	2021 (N=6)	44.2 (N=30)	44.4 (N=6)	27.4 (N=24)	26.8 (N=6)	30.5 (N=24)	30.8 (N=6)
35	2103 (N=81)	2130 (N=40)	44.9 (N=75)	44.5 (N=30)	28.3 (N=71)	26.8 (N=32)	31.1 (N=71)	30.8 (N=32)
36	2245 (N=74)	2278 (N=28)	45.4 (N=70)	45.8 (N=24)	28.8 (N=69)	29.8 (N=24)	31.4 (N=69)	31.8 (N=24)
37	2460 (N=118)	2463 (N=27)	46.6 (N=78)	46.9 (N=22)	29.8 (N=78)	29.7 (N=22)	31.9 (N=107)	32.6 (N=22)
38	2507 (N=160)	2604 (N=60)	47.0 (N=160)	47.3 (N=58)	30.0 (N=155)	30.4 (N=56)	32.3 (N=154)	32.4 (N=56)
39	2635 (N=140)	2690 (N=66)	47.6 (N=135)	48.1 (N=65)	30.5 (N=130)	30.8 (N=62)	32.6 (N=132)	32.6 (N=62)
40	2677 (N=84)	2794 (N=66)	48.2 (N=81)	48.2 (N=65)	30.5 (N=81)	31.3 (N=65)	32.7 (N=81)	33.1 (N=64)
41	2795 (N=28)	2795 (N=12)	47.8 (N=28)	48.3 (N=12)	31.2 (N=26)	31.5 (N=12)	32.8 (N=26)	33.3 (N=12)

Table 4 - Body weight and height of twins from birth to 6 years according to sex

Age	Weight		Height	
	males	females	males	females
birth	2453 (N=502)	2457 (N=608)	46.8 (N=471)	46.6 (N=569)
2 mo.~3mo.	5594 (N=108)**	5231 (N=127)	57.5 (N=98)	56.7 (N=114)
3 mo.~4 mo.	6080 (N=255)**	5777 (N=291)	59.9 (N=242)**	58.8 (N=285)
4 mo.~5 mo.	6908 (N=97)**	6469 (N=129)	62.8 (N=92)**	61.4 (N=126)
5 mo.~6 mo.	7160 (N=106)	7070 (N=147)	63.7 (N=99)	63.6 (N=144)
6 mo.~7 mo.	7808 (N=132)**	7339 (N=149)	67.1 (N=123)**	65.2 (N=148)
9 mo.~10 mo.	8669 (N=64)*	8357 (N=101)	70.5 (N=62)*	69.6 (N=97)
1 yr.~1 yr. 1 mo.	9395 (N=141)**	9021 (N=172)	74.3 (N=141)**	73.3 (N=168)
2 yr.~2 yr. 6 mo.	11897 (N=101)**	11351 (N=108)	85.0 (N=101)*	83.7 (N=107)
3 yr.~3 yr. 6 mo.	13.68 (N=313)*	13.44 (N=360)	93.1 (N=313)	92.7 (N=359)
4 yr.~4 yr. 6 mo.	15.60 (N=110)	15.86 (N=124)	100.7 (N=112)	101.5 (N=126)
5 yr.~5 yr. 6 mo.	17.26 (N=118)	17.90 (N=117)+	106.3 (N=118)	107.6 (N=117)+
6 yr.~6 yr. 6 mo.	19.42 (N=175)	19.57 (N=205)	113.2 (N=176)	113.3 (N=210)

[From birth to 2 years and 6 months, weight is shown in grammes (g), and above the age of 3 years, is shown in kilogrammes (kg); height is shown in centimetres (cm).]
males > females: *$p<0.05$, **$p<0.01$
females > males: +$p<0.05$

Table 5 - Velocity of weight gain (g) and height increase (cm)

Age	Weight gain (g/yr)		Height increase (cm/yr)	
	males	females	males	females
birth ~ 3 mo.	14499 (N=255)*	13337 (N=290)	51.9 (N=229)*	49.7 (N=267)
3 mo. ~ 6 mo.	6753 (N=86)	6429 (N=97)	27.7 (N=79)	25.9 (N=96)
6 mo. ~ 9 mo.	3909 (N=30)	3669 (N=58)	14.3 (N=28)	17.0 (N=56)
9 mo. ~ 1 yr.	3482 (N=23)	3051 (N=43)	14.4 (N=23)	14.8 (N=41)
1 yr. ~ 2 yr.	2090 (N=51)	2237 (N=57)	9.6 (N=51)	10.4 (N=54)
2 yr. ~ 3 yr.	1824 (N=84)	2175 (N=93)*	8.2 (N=84)	9.3 (N=93)**
3 yr. ~ 4 yr.	2008 (N=96)	2282 (N=108)	7.7 (N=98)	8.8 (N=108)
4 yr. ~ 5 yr.	1922 (N=77)	2251 (N=77)	6.1 (N=79)	6.8 (N=79)*
5 yr. ~ 6 yr.	1915 (N=114)	2098 (N=123)	6.0 (N=114)	5.8 (N=123)

*$p<0.05$, **$p<0.01$

was observed from birth to 3 months in both males and females, whereupon the rate of gain began to decrease. Male twins increased significantly ($p<0.05$) more in height than females from birth to 3 months. However, female twins gained significantly ($p<0.01$) more height than males from 2 to 3 years.

These results showed considerable concordance with the weight and height increases reported above. The same results were also reported by Wilson [11]. The order of twins' birth did not appear to be of relevance, with no significant differences observed between the weight and height of the first and second born between the ages of 0 and 6. Pettersson [10] also reported no correlation between twins' birth order and their length at birth. Though, in both sexes, DZ twins were significantly ($p<0.01$) heavier than MZ twins at birth, zygosity differences disappeared after 3 months. This result showed a high degree of concordance with those reported by Wilson [11,12]. In several age groups, height was observed to vary significantly with zygosity, but these differences disappeared by the age of 6.

The comparison between twins and the general Japanese population is shown in Table 6. Differences in weight between the two groups were greatest at birth, but became less than 5% after 6 months for males, and after 5 months for females. And this tendency continued until 6 years of age. Differences in height were greatest at birth, but decreased after 2 months, and the twins' height deficit became less than 5% after 2 months. The weight deficit was greater than the height deficit, and this tendency is also reported by Wilson [13].

3. Body weight and height at school age

Mean body weight and height of twins according to sex is shown in Table 7. From 6 to 9 years of age, male twins were heavier than female twins, but thereafter female twins became heavier. With regard to height, male twins were taller than female twins from

Table 6 - Average size deficit for twins from birth to 6 years in relation to the general population

Age	Weight		Height	
	males	females	males	females
birth	23.44~24.15	20.65~22.15	5.84~6.77	5.48~6.24
2 mo.~3 mo.	8.21~8.36	5.77~6.61	3.85~4.33	2.91~3.08
3 mo.~4 mo.	11.11~11.88	7.37~9.69	4.47~4.92	3.76~4.08
4 mo.~5 mo.	6.50~6.62	5.27~6.23	3.24~3.53	3.00~3.31
5 mo.~6 mo.	8.21	3.15~3.55	4.35~4.50	2.45~2.60
6 mo.~7 mo.	4.17~4.76	4.68~4.80	1.47~1.61	2.10~2.40
9 mo.~10 mo.	3.67~4.09	1.30~1.65	1.95~2.08	1.14~1.42
1 yr.~1 yr. 1 mo.	1.05~3.19	0.77~0.88	1.46~1.59	1.08~1.21
2 yr.~2 yr. 6 mo.	2.30~3.25	2.99~4.54	2.41~2.52	2.79~3.01
3 yr.~3 yr. 6 mo.	2.98~4.20	0~3.03	1.38~1.79	0.32~1.28
4 yr.~4 yr. 6 mo.	1.27~3.23	0	0.49~0.79	0
5 yr.~5 yr. 6 mo.	0.80~3.63	0	0.75~1.21	0
6 yr.~6 yr. 6 mo.	2.31	0	0.35	0

The general population norms were supplied by the Ministry of Health of Health and Welfare of Japan

Table 7 - Body weight and height of twins at school age according to sex

Age	Weight (kg)		Height (cm)	
	males	females	males	females
6 years	20.59 (N=326)	20.22 (N=389)	115.9 (N=326)*	115.2 (N=394)
7 years	23.00 (N=321)	22.71 (N=378)	121.8 (N=321)*	120.8 (N=383)
8 years	25.80 (N=321)	25.45 (N=397)	127.1 (N=321)*	126.3 (N=401)
9 years	28.88 (N=323)	28.63 (N=382)	132.3 (N=323)	132.1 (N=386)
10 years	32.24 (N=322)	32.39 (N=373)	137.8 (N=322)	138.7 (N=373)+
11 years	36.41 (N=248)	37.21 (N=324)	143.3 (N=248)	145.3 (N=324)++

males > females: $^{*}p<0.05$
females > males: $^{+}p<0.05$, $^{++}p<0.01$

6 to 9 years, but from then onwards, female twins became taller. This tendency has been observed in singletons too.

No significant birth order or zygosity difference was observed through all years, as has been reported elsewere [1,2,6,12], One exception was observed with respect to height in 10 year old females, however, which was thought to be an unusual result. The zygosity and birth order differences which exist at birth seemed to disappear during early infancy and not to appear again after this period, as Wilson reported [12].

The comparison between twins and the general Japanese population is shown in Table 8. The difference in weight between the two groups was about 2% in favour of the

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Table 8 - Average size deficit for twins at school age in relation to the general population

Age	Weight (kg)		Height (cm)	
	males	females	males	females
6 years	1.29	0.83	0	0
7 years	1.41	0.48	0	0
8 years	1.56	0.97	0.1	0.2
9 years	1.60	1.28	0.1	0.2
10 years	1.95	2.09	0	0.1
11 years	1.30	2.21	0.1	0.2

The general population norms were supplied by the Ministry of Education, Science and Culture of Japan.

general population, through all years. For male twins, the deficit was 0.27-0.64 kg, and for female twins, 0.11-0.84 kg.

Regarding height, a size deficit was not observed in twins throughout this period. The deficit was within 0.2 cm for male twins, and within 0.3 cm for female twins.

As was mentioned above, a size deficit was not observed in twins compared to singletons through 6-11 years of age. One of the reasons was that these subjects were regarded as a group which developed normally. But, according to Wilson [13] both the weight and height deficit in twins was fully offset by 8 years of age.

Moreover, no difference from singletons was observed with respect to Rohrer's Index (weight/height), suggesting that the physique of twins does not differ from that of singletons. It was concluded that twins who lived through infancy without any particular problems had no size deficit compared to singletons, at least in body weight or height. Thus, school-age twins are generally the same size as other youngsters, and no special considerations are necessary in estimating their development.

4. Body weight and height similarities in terms of zygosity

The intraclass correlation coefficient and percent deviation according to zygosity are shown in Tables 9 and 10. Percentage deviation (PD) was calculated by the following formula:

$$PD = A\text{-}B/(A+B) \times 100 \text{ (A: A's value, B:B's value)}$$

The similarity between MZ twins increased with age, while that between DZ twins seemed to decrease. The same tendency was reported by Wilson [12,14].

As was shown, MZ twins were nearly as similar between-pair as DZ twins at birth, suggesting that the similarity may be more influenced by non-genetic factors, such as gestational age, mother's body weight or height, and so on.

The intraclass MZ correlation coefficient became constant after a certain age, which suggests that not only the physical measurements at a particular age, but also total growth pattern, was strongly affected by genetic factors. For this reason, a longitudinal twin study is needed to analyze physical growth in more detail.

Table 9 - Intraclass correlation coefficient of weight and height from birth to 11 years, according to zygosity and combination of sex

Age	Weight			Height		
	MZ	same-sexed DZ	opposite-sexed DZ	MZ	same-sexed DZ	opposite-sexed DZ
birth	0.65871 (N=424)	0.62186 (N=112)	0.55714 (N=65)	0.72319 (N=392)	0.71037 (N=102)	0.51195 (N=60)
3 mo.~4 mo.	0.80840 (N=191)	0.48229 (N=48)	0.44361 N=25)	0.75006 (N=182)	0.61750 (N=47)	0.22798 (N=24)
6 mo.~7 mo.	0.78127 (N=109)	0.50599 (N=40)	0.27169 (N=9)	0.79637 (N=105)	0.55783 (N=38)	0.04429 (N=9)
9 mo.~10 mo.	0.85740 (N=60)	0.66505 (N=27)	0.21601 (N=9)	0.83593 (N=59)	0.70602 (N=26)	0.44703 (N=9)
1 yr.~1 yr. 1 mo.	0.88272 (N=112)	0.45315 (N=36)	0.28429 (N=19)	0.84571 (N=110)	0.64363 (N=36)	0.38554 (N=19)
3 yr.~3 yr. 6 mo.	0.87087 (N=259)	0.49476 (N=73)	0.29853 (N=37)	0.92199 (N=258)	0.67392 (N=73)	0.44670 (N=37)
6 yr.~6 yr. 6 mo.	0.88627 (N=136)	0.56844 (N=52)	0.28589 (N=16)	0.89714 (N=138)	0.64648 (N=52)	0.58698 (N=17)
6 years	0.89532 (N=267)	0.54626 (N=72)	0.26229 (N=46)	0.92841 (N=268)	0.70436 (N=72)	0.54872 (N=47)
7 years	0.89756 (N=265)	0.52054 (N=69)	0.08947 (N=42)	0.93637 (N=266)	0.65879 (N=69)	0.47805 (N=43)
8 years	0.91224 (N=269)	0.58959 (N=70)	0.32968 (N=48)	0.93995 (N=271)	0.62378 (N=70)	0.46097 (N=48)
9 years	0.91409 (N=267)	0.57543 (N=69)	0.28565 (N=47)	0.94509 (N=269)	0.61453 (N=69)	0.44305 (N=47)
10 years	0.90958 (N=263)	0.49616 (N=66)	0.29346 (N=48)	0.93427 (N=263)	0.57745 (N=66)	0.45379 (N=48)
11 years	0.91574 (N=220)	0.42466 (N=57)	0.41489 (N=34)	0.93638 (N=220)	0.51650 (N=57)	0.36929 (N=34)

The differences in weight and height tendencies between MZ and DZ twins both became apparent during the first three months. With regard to weight, the tendency became more marked by the age of one year, and by the age three, regarding height. This suggests that genetic influences became clearer by early childhood. Genetic activity during this period of life should be studied in more detail to gain a better understanding of the mechanism of human growth.

CONCLUSIONS

In order to increase understanding of the physical growth of twins, 557 or 605 pairs of normal Japanese twins were analyzed, and the following findings were obtained:

Table 10 - Percent deviation of weight and height from birth to 11 years, according to zygosity

Age	Weight			Height		
	MZ	same-sexed DZ	opposite-sexed DZ	MZ	same-sexed DZ	opposite-sexed DZ
birth	5.77468 (N=424)	6.73635 (N=112)	6.82208 (N=65)	1.51667 (N=392)	1.63561 (N=102)	1.79541 (N=60)
3 mo.~4 mo.	3.05394 (N=191)	5.49541 (N=48)	5.67644 N=25)	1.17399 (N=182)	1.52658 (N=47)	2.74389 (N=24)
6 mo.~7 mo.	2.56878 (N=109)	4.55726 (N=40)	4.56097 (N=9)	0.90528 (N=105)	1.40636 (N=38)	1.50997 (N=9)
9 mo.~10 mo.	2.11694 (N=60)	3.79173 (N=27)	6.34185 (N=9)	0.79925 (N=59)	1.14893 (N=26)	1.87263 (N=9)
1 yr.~1 yr. 1 mo.	1.89750 (N=112)	4.21396 (N=36)	6.36787 (N=19)	0.69121 (N=110)	1.08246 (N=36)	2.11360 (N=19)
3 yr.~3 yr. 6 mo.	1.71674 (N=259)	4.40931 (N=73)	4.96651 (N=37)	0.48565 (N=258)	1.24415 (N=73)	1.41286 (N=37)
6 yr.~6 yr. 6 mo.	2.27004 (N=136)	4.39605 (N=52)	6.13999 (N=16)	0.59100 (N=138)	1.31377 (N=52)	1.79185 (N=17)
6 years	2.20464 (N=267)	4.37103 (N=72)	5.89891 (N=46)	0.54220 (N=268)	1.22264 (N=72)	1.37386 (N=47)
7 years	2.29985 (N=265)	4.89850 (N=69)	5.92125 (N=42)	0.52407 (N=266)	1.31679 (N=69)	1.38635 (N=43)
8 years	2.23858 (N=269)	5.00445 (N=70)	5.73287 (N=48)	0.50019 (N=271)	1.36496 (N=70)	1.50730 (N=48)
9 years	2.26344 (N=267)	5.59821 (N=69)	6.51688 (N=47)	0.50110 (N=269)	1.41164 (N=69)	1.63295 (N=47)
10 years	2.52818 (N=263)	6.41840 (N=66)	7.31701 (N=48)	0.56477 (N=263)	1.60146 (N=66)	1.71297 (N=48)
11 years	2.48078 (N=220)	6.65753 (N=57)	6.51504 (N=34)	0.56738 (N=220)	1.65167 (N=57)	1.57319 (N=34)

1. The intrauterine growth of twins was very different from that of singletons: for this reason, twins' growth should be estimated by twins' standards.
2. DZ twins were larger than MZ twins, irrespective of gestational week, especially regarding birthweight.
3. After birthweight, twins showed the greatest size deficit in chest circumference, and height and head circumference, respectively.
4. Twins' size deficit in body weight or length at birth no longer existed by the age of 6 years.
5. By Junior school age (from 6 to 11 years), twins who went through infancy without any particular problems, had no size deficit compared to singletons, and do not require any special consideration.
6. MZ twins were nearly as similar between pairs as DZ twins at birth, suggesting that this similarity was more influenced by non-genetic factors.

7. The differences in both weight and height between MZ and DZ twins became apparent during the first three months. By one year, this tendency became clear with regard to weight, and by three years, with regard to height, suggesting that genetic influences became evident by this stage of life.

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