Weight Growth Charts from Birth to 6 Years of Age in Japanese Triplets

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We analyzed the characteristics of weight growth and present the weight growth charts from birth to 6 years of age in Japanese triplets. The study included 366 mothers and their 1098 triplet children, who were born between 1978 and 2006. Data were collected through a mailed questionnaire sent to the mothers asking for information recorded in medical records. For these births, data on triplets' weight growth, gestational age, sex, parity, and maternal age at delivery were obtained from records in the Maternal and Child Health Handbooks, which is provided by the authorities after a report of pregnancy. Birthweight proved to be the strongest contribution on weight of triplets from 1 to 6 years of age. In addition, gestational age was also a significant contributing factor to weight from birth to 6 years of age. Moreover, males had a higher weight from birth to 6 years of age than females. Compared to the 50th percentile of the growth standard for the general population of Japan, the weight deficit of the triplets was more than 40% at birth (male, –1.28 kg; female, –1.28 kg), decreased within the first 1 year of age, and fluctuated between 4% and 9% until 6 years of age (male, –1.82 kg; female, –1.78 kg). In conclusion, triplets have lower birth weight than singletons and in spite of the rapid catch-up growth during first year of life they are behind singletons even in mid-childhood. This study provides growth curves for use in triplets.

Keywords: triplet, weight, growth, gestational age, sex, birth order, maternal age

In Japan, as in other developed countries, the rate of multiple births has increased after the introduction of assisted reproductive technology. Especially the triplet rate has rapidly increased: 4.2-fold from the year 1974 to 2001 (Imaizumi, 2003). The perinatal mortality rate of triplets is much higher than that of twins or singletons (Imaizumi, 1994). Because birthweight is the strongest indicator of the risk of perinatal death, birth weight norms are important both for clinical practices and epidemiologic studies (Glinianaia et al., 2000).

Studies on the birthweight of twins or triplets have been conducted in many countries (Arbuckle et al., 1993; Buckler & Green 1994; Glinianaia et al., 2000; Kato, 2004; Min et al., 2000; Min et al., 2004). However, there are few previous studies on the physical growth of triplets after birth in the world, while a number of studies on the physical growth of twins after birth have been conducted (Akerman & Fischbein, 1992; Alfieri et al., 1987; Luke et al., 1995; Ooki & Yokoyama, 2004; Philip, 1981; Silventoinen et al., 2007a; Wilson, 1974; Wilson, 1976; Wilson, 1979). Most sets of triplets are born prematurely and have subsequently lower birth weight compared to singletons and twins (Glinianaia et al., 2000; Kato, 2004). Luke et al. (2006) reported the early childhood growth of twins compared to triplets though 18 months of age and demonstrated that triplets have slower postnatal growth and more residual stunting. The physical growth of triplets after 18 months of age may remain behind that of singletons, but this has not yet been demonstrated. As the number of triplets is increasing, there is an augmenting need to provide appropriate information to their parents on the characteristics of physical growth after birth. The purpose of this study was to analyze the characteristics of the weight growth of triplets from birth to 6 years of age and to present the weight growth charts of Japanese triplets.

Subjects and Methods

The subjects of this study were recruited from the Osaka City University Higher Order Multiple Births Registry (Yokoyama et al., 1995; Yokoyama, 2002; Yokoyama et al., 2005), which consisted of 578 mothers with triplets who were born between 1978 and 2006. Mothers and their triplets were enrolled also from several other sources, such as various Japanese Mother's Organization for Higher Order Multiple Births and referrals from public health nurses.

Received 24 March, 2008; accepted 27 August, 2008.

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Data were collected through a mailed questionnaire sent to the mothers asking for information recorded in medical records. For these births, data on triplets' weight growth, gestational age, sex, parity, and maternal age at delivery were obtained from records in the Maternal and Child Health Handbooks. This handbook was established by the Maternal and Child Health Law in Japan and is provided to the expecting mother by the authorities after a report of pregnancy. The purpose of this handbook is the maintenance of maternal and child health, and it includes information on health check-ups during pregnancy, the condition of the newborn, the progress of infant growth, and periodic medical check-ups for the infant and vaccinations recorded by obstetricians or pediatricians. In addition, information on infertility treatment was obtained.

In Japan, the health check-up system after birth differs according to life stage. Until 6 years of age, children participate in health check-ups administered by the Ministry of Health, Labor and Welfare based on age, which is counted as actual weeks, months, or years after birth. The weight data of children based on health check-ups are routinely recorded in the handbook. Mothers participating in this study were advised to refer to these records when completing the questionnaire. Weight growth data were assigned to the appropriate age groups on the basis of time (in days) since birth, which was calculated as the date at the check-up minus the child's birthday. The response rate was 65.9 %. We had 1143 triplet individuals providing information on growth, but 45 triplets with unknown sex were excluded from the analyses. Ultimately, the subjects of this study were 366 mothers and their 1098 triplet children. The mothers gave written informed consent to participate in the present study.

The means and standard deviation of weight from birth to 6 years of age for triplets were calculated according to gestational age, very low birthweight, extremely low birthweight, sex, parity, birth order, infertility treatment, and maternal age at triplet delivery. The significance of differences between mean values was tested using mix-model ANOVA where the comparison was between two or more groups in order to adjust for familial clustering (i.e. sets of triplets) as a random effects factor. The SPSS statistical package, version 16.0 for Windows (2007) was used for statistical analysis.

The factors affecting birth weight and weight at 1, 3 or 6 years of age were confirmed by stepwise regression analysis, with a threshold significance level of 0.05. The independent variables were gestational age, sex, parity, birth order of triplets, infertility treatment and maternal age at triplet delivery. Moreover, in order to account for the starting point for postnatal growth, the regression analysis on factors associated with body weight at 1, 3, and 6 years of age was done two ways: with and without adjusting for birth weight.

The selected percentiles (3rd, 10th, 25th, 50th, 75th, 90th, and 97th) of weight were calculated according to age and sex. Smoothing of growth curves was performed by cubic polynominal functions. The weight deficit of the triplets was calculated as the percentage difference between the value of the general population and that of the triplets divided by the value of the general population. The weight deficits were calculated using the 50th percentile values of the growth standards presented by the Ministry of Health, Labor and Welfare (Kato et al., 2001).

Results

Table 1 presents the number of subjects according to sex and age for which weight data were available. Table 2 summarizes the characteristics of the subjects. Gestational age at birth did not differ by maternal age at triplet delivery and was 32.6 ± 3.66 weeks (mean ± standard deviation) in women aged less than 25 years, 33.3 ± 2.72 weeks in women aged 25–29 years, 33.2 ± 2.57 weeks in women aged 30–34 years and 32.9 ± 2.56 weeks in women aged 35 years or more.

Table 3 shows the mean weight at birth and at 1, 3 and 6 years of age analyzed according to gestational age, very low birthweight, extremely low birthweight, sex, parity, birth order, infertility treatment and maternal age at triplet delivery. Females and triplets whose gestational age was earlier had a lower birth weight and lower weight at 1, 3 and 6 years of age. These differences were statistically significant. Extremely low birthweight infants had a lower weight at 1, 3 and 6

Table 1

Number of Triplet Individuals According to Sex and Age of Assessment of Weight Data

		Male	Female
Birth		558	540
0 year	1–2 months	103	122
	2–3	53	46
	3–4	204	191
	4–5	133	148
	5–6	108	112
	6–7	169	142
	7–8	91	92
	8–9	93	93
	9–10	148	124
	10–11	104	101
	11–12	56	66
1 year	0–1	186	172
	1–2	99	71
	6–7	158	151
	7–8	157	143
2 years	0–6	248	243
	6–12	30	32
3 years	0–6	273	269
	6–12	79	71
4 years	0–6	194	185
	6–12	27	33
5 years	0–6	185	192
	6–12	36	47
6years	0–6	147	131

https://doi.org/10.1375/twin.11.6.641 Published online by Cambridge University Press

Table 2
Major Characteristics of the Triplet Individuals

Gestational age (weeks)	≤28	69 (6.2%)
	29–32	303 (27.4%)
	33–36	624 (56.4%)
	37 ≤	96 (8.7%)
	Unknown	15 (1.4%)
	Mean ± standard deviation	33.1 ± 2.65
	Range	25–38
Sex	Male	563 (49.3%)
	Female	544 (47.6%)
Parity	0	855 (77.2%)
	≥1	246 (22.2%)
	Unknown	6 (0.5%)
Infertility treatment	Not used	201 (18.2%)
	Used	882 (79.7%)
	Unknown	24 (2.2%)
Maternal age of delivery	< 25	24 (2.2%)
	25–29	373 (33.7%)
	30–34	528 (47.7%)
	35 ≤	182 (16.4%)
	Mean ± standard deviation	31.0 ± 3.58
	Range	20–42

years of age. Neonates born to multiparous women had a higher birth weight, but neonates born to primiparous women had a higher weight at 1, 3 and 6 years of age. Third-born neonates had a lower birth weight and lower weight at 1, 3 and 6 years of age. Triplets born to women using infertility treatment had lower birthweight. Triplets born to women aged less than 25 years had a lower birthweight and lower weight at 1, 3 and 6 years of age than triplet children born to women aged 25 years or older.

Table 4 shows the results of stepwise regression analysis on birthweight and weight at 1, 3, or 6 years of age with associated factors as independent variables. Without adjusting birthweight, gestational age has the strongest contribution on weight from birth to 6 years of age, but also sex affected weight from birth to 6 years of age. Moreover, birth order in triplets affected only birthweight. Meanwhile, in order to account for the starting point for postnatal growth, with adjusting for birthweight as the independent variable, birthweight has the strongest contribution on weight from 1 to 6 years of age, but also gestational age and sex affected weight from 1 to 6 years of age.

The percentiles of weight are presented in Figure 1 and Figure 2. The weight deficit of the triplets in the 50th percentile was more than 40% at birth relative to the growth standards of the general population (male, –1.28 kg; female, –1.28 kg). The deficit decreased rapidly within the first year of age, but fluctuated between 4% and 9% until 6 years of age (male, –1.82 kg; female, –1.78 kg; see Figure 3).

Discussion

Despite the rapid increase in multiple births including triplets and subsequently the augmenting need to

Table 3
Birthweight and Body Weight at 1, 3 and 6 Years of Age by Maternal and Child Characteristics

		Birthweight (g)			Weight at 1 year of age (kg)			Weight at 3 years of age (kg)			Weight at 6 years of age (kg)		
		N	Mean	*SD*	*N*	Mean	*SD*	*N*	Mean	*SD*	*N*	Mean	*SD*
Gestational age (weeks)	≤ 28	69	916.7	129.5***	31	7.49	1.08***	28	12.22	1.37***	13	16.77	2.08***
	29–32	300	1389.4	261.8	90	8.20	1.21	167	12.73	1.62	83	17.64	2.20
	33–36	621	1850.6	302.3	192	8.70	1.00	292	13.21	1.63	146	18.67	2.49
	37 ≤	93	2201.6	361.9	42	8.55	0.86	52	13.34	1.55	36	18.29	2.31
Sex	Male	558	1715.2	440.7***	186	8.64	1.15***	273	13.31	1.70***	147	18.58	2.51***
	Female	540	1673.8	417.8	172	8.23	1.03	269	12.75	1.52	131	17.83	2.26
Parity	Multipara	243	1801.5	447.3***	82	8.05	1.24***	107	12.82	1.63***	64	18.07	2.47***
	Primipara	849	1665.3	421.4	276	8.56	1.04	432	13.08	1.64	211	18.29	2.41
Birth order	First-born	366	1757.8	421.9***	118	8.52	1.08***	181	13.05	1.54***	93	18.26	2.45***
	Second-born	366	1695.7	436.0	120	8.50	1.15	181	13.19	1.72	92	18.55	2.44
	Third-born	366	1631.0	423.5	120	8.31	1.09	180	12.84	1.64	93	17.87	2.34
Infertility treatment	Not used	201	1729.7	425.0***	74	8.32	1.00	100	13.11	1.30	43	18.16	1.90
	Used	873	1687.2	432.7	275	8.46	1.14	436	13.00	1.71	229	18.19	2.51
Maternal age at triplet	< 25	24	1418.9	373.0***	9	6.96	1.41***	15	12.10	1.81***	3	16.07	0.81***
Delivery (years)	25–29	370	1726.0	431.0	116	8.49	1.11	170	13.24	2.00	81	18.59	2.42
	30–34	525	1695.0	431.4	172	8.54	1.07	282	13.05	1.40	151	18.23	2.51
	35 ≤	179	1667.3	418.0	61	8.32	1.00	75	12.66	1.39	43	17.67	2.00

Note: *SD* = standard deviation; *** $p < .001$.

https://doi.org/10.1375/twin.11.6.641 Published online by Cambridge University Press

Table 4

Result of Multiple Regression Analysis of Factors Associated with Body Weight

Dependent variable	Independent variable	Beta	*p*	Adjusted R^2
Birthweight	Gestational age	0.801	$p < .001$	0.667
	Birth order in Triplets	–0.117	$p < .001$	
	Sex	–0.078	$p < .001$	
	Parity	0.056	$p = .002$	
Weight at 1 year	Gestational age	0.311	$p < .001$	0.156
	Parity	–0.184	$p = .001$	
	Sex	–0.170	$p = .001$	
Weight at 3 years	Gestational age	0.214	$p < .001$	0.073
	Sex	–0.171	$p < .001$	
Weight at 6 years	Gestational age	0.206	$p = .001$	0.058
	Sex	–0.129	$p = .031$	

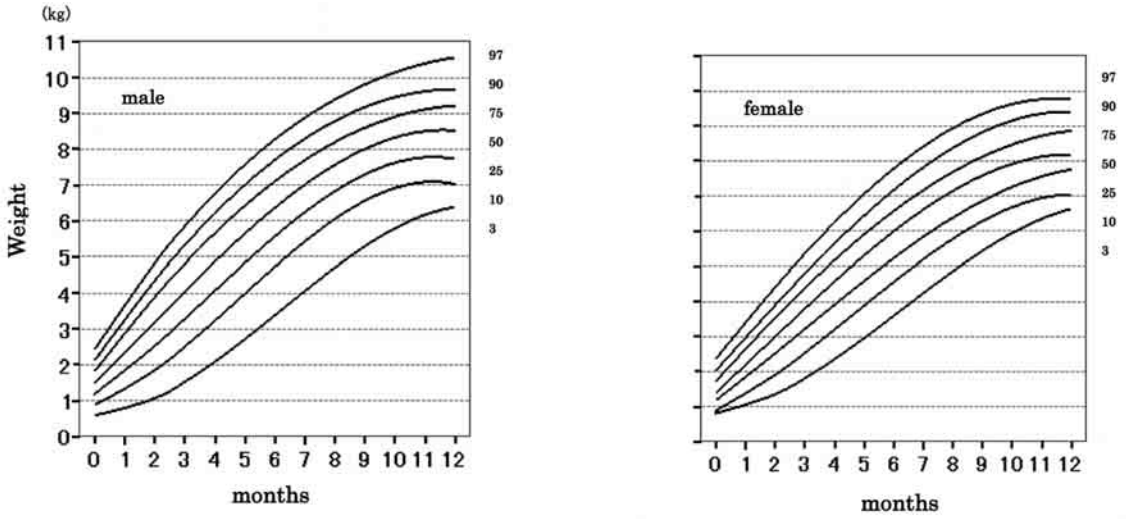

Figure 1

Body weight of triplets according to age percentiles from birth to 1 year of age.

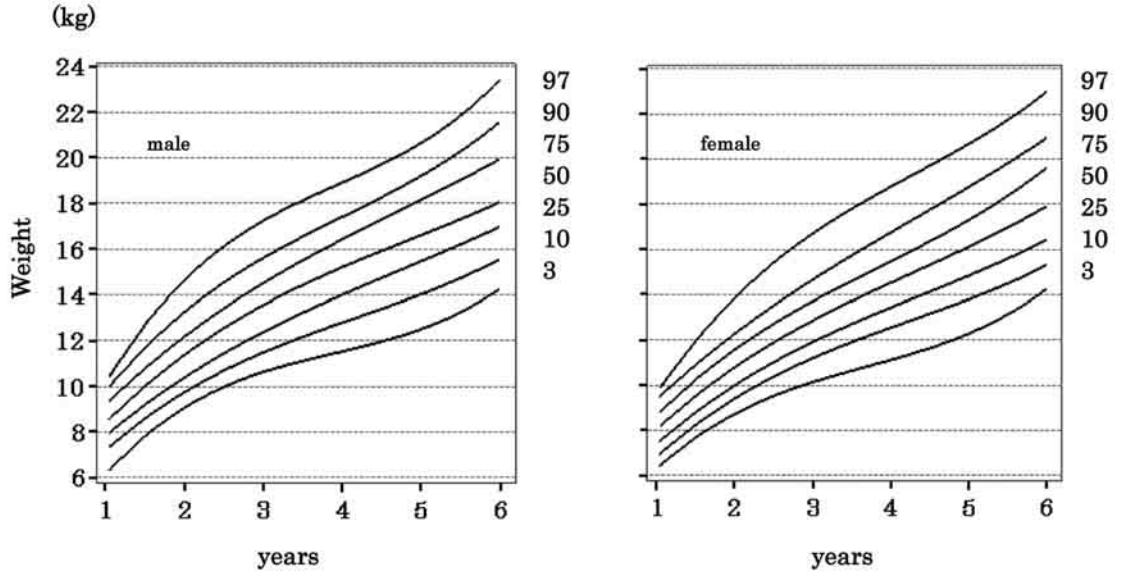

Figure 2

Body weight of triplets according to age percentiles from 1 to 6 years of age.

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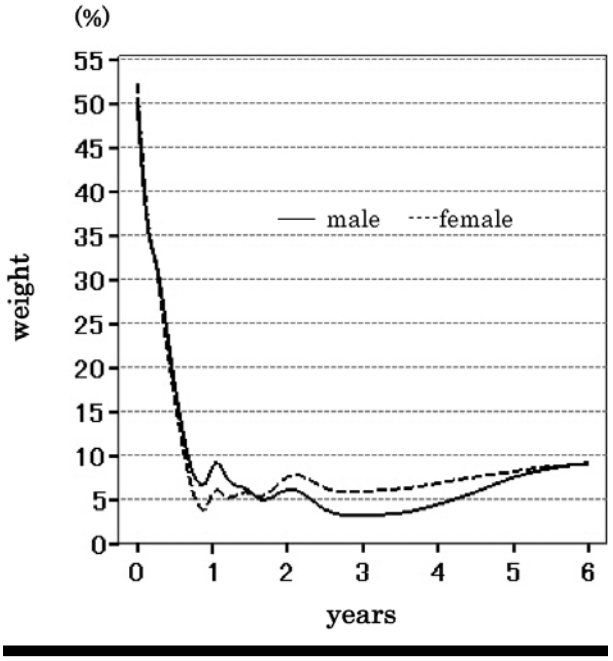

Figure 3

Weight deficit of triplets as to the 50th percentiles compared with general population from birth to 6 years of age.

provide appropriate information to their parents, there are no growth charts after birth for triplet children in the world. The present data are the largest triplet sample in the world to provide accurate age after birth.

Birthweight proved to be the strongest contribution on weight of triplets until 6 years of age. In addition, gestational age was also a significant contributing factor to weight from birth to 6 years of age. Our data show that triplets with extremely low birthweight (< 1000 g) and a gestational age of 28 weeks or less had lower weight from birth to 6 years of age. Mohsin et al. (2006) indicated that low birthweight and short gestation was the most common cause of neonatal death. Besides, earlier gestational age was found to be related to a greater risk of cerebral palsy (Yokoyama et al., 1995). It is probable that extremely low birthweight and extreme earlier gestational age affects growth and development after birth in triplets. Extremely low birthweight and extreme preterm infants may need longitudinal follow-up.

Moreover, sex was a significant factor affecting weight from birth to 6 years of age. Male triplets had a higher weight from birth to 6 years of age than females. These results are in accordance with previous reports on twins (Blickstein et al., 1995; Buckler & Green, 1994; Ooki & Yokoyama, 2004) and singletons (Arbuckle et al., 1993). The effects of parity, birth order, infertility treatment and maternal age at triplet delivery were mostly disappeared at early age. In the present study, lasting effects of gestational periods and sex on weight from birth to 6 years of age were observed. However, the growth standards of the general population did not correct the effects of gestational age to reflect the actual condition of physical growth. The present data should be treated in the same way in order to estimate the difference between the general population and triplets. Therefore in the present study, the growth charts for the triplets were differentiated only according to sex.

Compared to the 50th percentile of growth standard for the general population of Japan, the weight deficit of Japanese twins is more than 20% at birth but recovers rapidly in the first 6 to 12 months and is as low as 0 to 2% from 4 to 6 years of age (Ooki & Yokoyama, 2004). These trends were consistent with those reported by Buckler and Green (1994). However in the present study, the weight deficit of the triplets, which was more than 40% at birth, decreased within the first year but remained between 4% and 9% until 6 years of age. This suggests that a triplet pregnancy has a greater effect on future growth than a twin pregnancy. However, the sample size of this study was not as large as the aforementioned sample (Ooki & Yokoyama, 2004). Further follow-up is needed to investigate whether triplets achieve normal weight later in life. We intend to investigate next the physical growth of triplets after 6 years of age, including more subjects.

Regarding other factors associated with weight of triplets, birth order in triplets had significant effects on weight: third-born neonates had a lower weight. Our result is consistent with that reported by Orlebeke et al. (1993) who also found that later-born triplets were lighter than first-born triplets. Silventoinen et al. (2007b) found in Dutch data that the second-born twin was lighter until 12 years of age than the first-born twin. However, in the present study, regression analysis showed that the effect of birth order in triplets disappeared at an early age. The sample size of this study was, however, not as large as the twin study reported by Silventoinen et al. (2007b), which may explain this discrepancy. Differences between triplets and twins in this respect need to be investigated.

Meanwhile, Salihu et al. (2005) indicated that triplets born to older women tended to show lower likelihood to fetal growth inhibition as compared to those of younger mothers. In the present study, the effect of maternal age at delivery on weight of triplets was very small. However, mean weights from birth to 6 years of age in triplets born to women aged less than 25 years seem to be smaller than those in triplets born to women aged 25 years of age or older. The effect of maternal age at delivery on weight growth of triplets may need more detailed analyses, including the background maternal and socioeconomic factors. Data on zygosity, maternal smoking, maternal pregravid height/weight, previous obstetric outcome, and maternal weight gain during pregnancy are lacking in this study, and it has been suggested that these factors are associated with weight development (Luke et al., 2002; Ooki & Yokoyama, 2003; Vogazianos et al., 2005).

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A limitation of the present study was that these data were semi-longitudinal. Specifically, data on the same individual were used according to the recorded times. Some of our subjects provided most of longitudinal data. On the other hand, others provided data from birth to 1 year of age. Additionally, the number of subjects in each age group varied considerably. Consequently, the range of measurements in each group becomes small. The clinical use of 3rd percentiles and 97th percentiles of this growth charts as indicators of growth retardation might not be necessarily appropriate.

In conclusion, triplets have lower birthweight than singletons and in spite of the rapid catch-up growth during first year of life they are behind singletons even in mid-childhood. This study provides growth curves for use in triplets. Further follow-up of the triplets should reveal whether and when their growth catches up with singletons.

Acknowledgement

This research was supported by Ministry of Education, Science, Sports and Culture, Grant-in-Aid for Scientific Research (B), 2004–2007.

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