ANALYSIS OF MULTIPLE BIRTHS IN JAPAN

I. WEIGHT AT BIRTH AMONG 12,392 PAIRS OF TWINS

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Summary Birth weight among 12,392 twin pairs were analysed in relation to survival state, sex and zygosity. Mean birth weights were higher in live birth than in stillbirth twins, and among the former the heaviest mean birth weight was seen in first-born males followed by second-born males, first-born females and second-born females in this order. Coefficient of variation was smaller in live birth than in stillbirth twins. Distribution of weight was negatively skewed in live birth twins, whereas it was positively skewed in stillbirth twins. Frequency of low-birth-weight (LBW) was higher in stillbirth than in live birth twins. It was indicated that estimated frequency of LBW was higher in MZ than in DZ twins in each category by birth order, sex and survival state.

INTRODUCTION

Previous studies on the birth weight in multiple pregnancies dealt with such factors as sex, survival state, gestational period, maternal age, parity, placentation, presentation of fetuses, zygosity and racial difference. The purpose of the present study is to examine the effect of survival states, sex composition and zygosity on the birth weight in a large sample of Japanese twins consisting of 12,392 pairs.

SUBJECTS AND METHODS

Source of data is similar to the reports of the previous series (Imaizumi and Inouye, 1979; Imaizumi, Asaka and Inouye, 1979): "Survey A" of "Survey on Socio-economic Aspects of Vital Events-Plural Births in 1975" (Health and Welfare Statistics and Information Department, Ministry of Health and Welfare), which includes data on 12,524 sets of multiple births in Japan in 1974, number of twin pairs being 12,392. As to the survival states at births there are four categories: 1) both live birth (Live-Live), 2) first-born is live birth and second-born is stillbirth (Live-Still), 3)

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Table 1. Survival states and sex compositions of 12,392 pairs of twins.

	MM	MF	FM	FF	U*	Total
Live-Live	4,339	912	819	4,348	0	10,418
Live-Still	219	34	40	209	13	515
Still-Live	81	14	5	43	5	148
Still-Still	580	92	57	458	124	1,311
Total	5,219	1,052	921	5,058	142	12,392

* Sex of one or both twins is unknown.

first-born is stillbirth and second-born is live birth (Still-Live) and 4) both stillbirth (Still-Still). As to sex compositions there are five categories: 1) both male (MM), 2) first-born is male and second-born is female (MF), 3) first-born is female and second-born is male (FM), 4) both female (FF) and 5) sex of one or both twins is unknown (U). Table 1 shows the number of twin pairs according to the survival states and sex compositions.

RESULTS

As is seen in Table 2, mean birth weight is higher in live birth than in stillbirth twins. Among live birth twin individuals, the heaviest mean birth weight is seen in first-born males followed by second-born males, first-born females and second-born females in this order. In stillbirths males are heavier than females, but unlike in live births, second-borns are heavier than first-borns in both sexes. Standard deviation of birth weight is smaller in four groups of live births than those of stillbirths. The coefficients of variation in live births are 20.57 (first-born males), 20.50 (second-born males), 20.71 (first-born females) and 20.85 (second-born females), while in stillbirths they are 41.96 (first-born males), 43.28 (second-born males), 43.27 (first-born females) and 42.18 (second-born females). Among live births a positive kurtosis is seen in all four groups, but among stillbirths a negative kurtosis is seen except in second-born females. It may be interesting to note that in live births all four groups indicate a negative skewness, whereas in stillbirths it is positively skewed.

Table 3 shows the frequency of low-birth-weight (LBW) children. LBW is defined as the birth weight less than or equal to 2,500 g, and non-low-birth-weight (NLBW) more than 2,500 g. The frequency of LBW is lower in live birth than in stillbirth twin individuals in each group by sex and birth order. Among live births the frequency of LBW is increased in the order of first-born males, second-born males, first-born females and second-born females, whereas such tendency is not seen in stillbirths.

As to low-birth-weight (LBW) and non-low-birth-weight (NLBW) there are four groups: 1) both twins are LBW (LBW-LBW), 2) first-born LBW and second-born NLBW (LBW-NLBW), 3) first-born NLBW and second-born LBW (NLBW-LBW) and 4) both NLBW (NLBW-NLBW). There are 10,404 pairs of live-live

Table 2. Weight (g) at birth in 24,784 twin individuals.

		Live birth		Stillbirth	
		First-born	Second-born	First-born	Second-born
Male	Number of cases	5,505	5,236	233	372
	Number of missing observations	7	10	543	526
	Mean	2,447.0	2,396.1	1,686.3	1,694.9
	Standard deviation	503.3	491.2	707.6	733.6
	Kurtosis	0.625	0.243	-0.576	0.461
	Skewness	-0.394	-0.281	0.385	0.664
Female	Number of cases	5,416	5,311	172	365
	Number of missing observations	5	9	402	431
	Mean	2,366.3	2,315.4	1,532.6	1,605.8
	Standard deviation	490.0	482.8	663.1	677.3
	Kurtosis	0.454	0.324	-0.852	-0.848
	Skewness	-0.423	-0.361	0.419	0.260
Total	Number of cases	10,921	10,547	411*	749*
	Number of missing observations	12	19	1,048*	1,077*
	Mean	2,407.0	2,355.5	1,612.7	1,643.5
	Standard deviations	498.3	488.6	693.9	707.9
	Kurtosis	0.540	0.290	-0.633	0.001
	Skewness	-0.397	-0.313	0.413	0.500

* including sex unknown.

Table 3. Low-birth-weight (LBW) and non-low-birth-weight (NLBW) deliveries.

		Live birth				Stillbirth			
		First-born		Second-born		First-born		Second-born	
		N	%	N	%	N	%	N	%
Male	LBW	3,095	56.2	3,188	60.9	202	86.7	326	87.6
	NLBW	2,410	43.8	2,048	39.1	31	13.3	46	12.4
		5,505		5,236		233		372	
Female	LBW	3,425	63.2	3,611	68.0	160	93.0	326	89.3
	NLBW	1,991	36.8	1,700	32.0	12	7.0	39	10.7
		5,416		5,311		172		365	
Total	LBW	6,520	59.7	6,799	64.5	368	89.5	664	88.7
	NLBW	4,401	40.3	3,748	35.5	43	10.5	85	11.3
		10,921		10,547		411*		749*	

* including sex unknown.

birth (Live-Live), 471 pairs of live-still birth (Live-Still), 132 pairs of still-live birth (Still-Live) and 264 pairs of still-still birth (Still-Still), excepting either or both of which missed sex and/or birth weight (Table 4).

As expected the frequency of type LBW-LBW is the lowest in Live-Live (48.5%, 5,048/10,404), intermediate in Live-Still and Still-Live (63.1%, 297/471 and 62.1%,

Table 4. Number of twin pairs according to weight type and sex compositions.

Weight type	Sex compositions				Total
	MM	MF	FM	FF	
<u>Live-Live</u>					
LBW-LBW	2,028	367	305	2,348	5,048
LBW-NLBW	435	86	138	450	1,109
NLBW-LBW	685	204	114	648	1,651
NLBW-NLBW	1,183	255	262	896	2,596
Total	4,331	912	819	4,342	10,404
<u>Live-Still</u>					
LBW-LBW	129	17	18	133	297
LBW-NLBW	12	5	3	8	28
NLBW-LBW	48	7	9	44	108
NLBW-NLBW	19	3	5	11	38
Total	208	32	35	196	471
<u>Still-Live</u>					
LBW-LBW	46	7	1	28	82
LBW-NLBW	18	2	3	9	32
NLBW-LBW	3	3	1	2	9
NLBW-NLBW	7	1	0	1	9
Total	74	13	5	40	132
<u>Still-Still</u>					
LBW-LBW	111	13	5	104	233
LBW-NLBW	0	0	1	7	8
NLBW-LBW	6	1	0	6	13
NLBW-NLBW	6	2	0	2	10
Total	123	16	6	119	264

82/132, respectively), and the highest in Still-Still (88.3%, 233/264). Similarly the frequency of LBW-NLBW is the highest in Still-Live (24.2%, 32/132) and that of NLBW-LBW is the highest in Live-Still (22.9%, 108/471). NLBW-NLBW indicated the highest (25.0%, 2,596/10,404) frequency in Live-Live and the lowest (3.8%, 10/264) one in Still-Still. LBW is clearly associated with stillbirth.

Among live-live twins, the frequency of LBW-LBW is the highest, followed by NLBW-NLBW, NLBW-LBW and LBW-NLBW in this order in all sex compositions, except in FM, in which LBW-NLBW is more frequent than NLBW-LBW, suggesting the frequency of second-born male with NLBW is increased or that with LBW is decreased.

From Table 4, by applying Weinberg's differential method, frequencies of monozygotic (MZ) and dizygotic (DZ) twins with LBW can be estimated according to birth order, survival state and sex. In this estimation numbers of MZ and DZ twin pairs were estimated first separately for males and females and for survival states. Frequencies of LBW were then computed for twin individuals by counting the number

Table 5. Estimated frequencies of low-birth-weight (LBW) at birth in monozygotic (MZ) and dizygotic (DZ) twins.[†]

		First-born male	Second-born male	First-born female	Second-born female
Live-Live	MZ	0.57	0.64	0.67	0.71
	DZ	0.50	0.54	0.52	0.59
Live-Still	MZ	0.68	0.87	0.74	0.93
	DZ	0.66	0.77	0.62	0.76
Still-Live	MZ	0.88	0.66	0.98	0.77
	DZ	0.71	0.53	0.76	0.72
Still-Still	MZ	0.91	0.96	0.94	0.93
	DZ	0.84	0.85	0.93	0.87

of individuals separately for first- and second-born twins. The results in four survival states of twins are shown in Table 5. It is indicated that frequencies of birth weight with LBW are higher in MZ than in DZ twins in all categories.

DISCUSSIONS

It was revealed that birth weight was heavier in male than in female twins for both first-born and second-born twin individuals (Table 2). Corney *et al.* (1972) summarized the data ever reported, concerning sex influence on birth weight, and showed that birth weight was heavier in male than in female twins among unlike-sex as well as like-sex twin pairs with a few exceptions, though they did not separate first- or second-borns. If our data are rearranged, the similar findings are seen as is shown in Table 6. Standard deviation and coefficient of variation of birth weight are larger in stillbirth than in live birth twins among our subjects, which is in agreement with the data by Corney *et al.* (1972). These results indicate that birth weight in stillbirth twins is more heterogeneous than in live birth twins, suggesting that factors other than birth weight may also contribute to the etiology of stillbirth. In the present study the skewness was negative for live birth and positive for stillbirth twins (Table 2). McKeown and Record (1952) reported almost normal distribution of birth weight for 650 twins (kurtosis=0.08 and skewness=0.19), though the materials were not divided according to survival state. If live births and stillbirths were pooled for our data, kurtosis is 0.659 and skewness is -0.530 for 11,332 first-born twins, and 0.525 and -0.495 for 11,296 second-born twins, respectively, indicating non-normal distribution. The difference between the two reports may be due to the criterion for selection of subjects. Data by McKeown and Record (1952) included stillbirths only after 7 months' gestation, but ours after 3 months of gestational age.

Karn (1952a, 1952b, 1953) mentioned that among a total of 583 twin pairs mean birth weight was higher in survivors than in non-survivors, and that the group of "both survivor" had the highest mean, after which means were ranged in the order

Table 6. Mean birth weight (g) of twin individuals classified by sex.

Authors	Unlike sex				Like sex				Total number of pairs
	Male		Female		Male		Female		
	N	Weight	N	Weight	N	Weight	N	Weight	
McKeown and Record (1952)	—	2, 563	—	2, 390	—	2, 368	—	2, 322	325*
Karn (1952a)	103	2, 468	103	2, 300	210	2, 232	192	2, 218	304*
Karn (1953)	92	2, 604	92	2, 486	176	2, 508	150	2, 468	255*
Fraccaro (1957)	78	2, 385	78	2, 204	164	2, 381	146	2, 335	466*
Parsons (1964)	233	2, 622	233	2, 531	—	—	—	—	233**
Butler and Albermar (1969)	57	2, 617	57	2, 395	154	2, 513	140	2, 332	204*
Howard and Brown (1970)	84	2, 549	84	2, 477	216	2, 277	172	2, 354	278**
Corney <i>et al.</i> (1972)	202	2, 719	202	2, 622	304	2, 659	268	2, 547	488**
Present study	1, 770	2, 523	1, 784	2, 418	8, 962	2, 402	8, 935	2, 326	10, 418**

* all births. ** survivors.

from "survivor and non-survivor" group to the "both non-survivor" group. The results are in accordance with the present result. Parsons (1964) also reported that in pairs in which one or both individuals did not survive, birth weights were lower and more variable than pairs both survived. Among 272 pairs of opposite-sexed twins, he found that the difference between members of a pair was greater in the former category than in the latter (0.100 vs. 0.067), by calculating the value A, the mean of absolute difference divided by the sum of $\bar{M}$ (mean weight of males) and $\bar{F}$ (mean weight of females). Values A from the present sample are 0.065 (both survived, $n=8763$) and 0.155 (one or both not survived, $n=760$) for same-sexed twins, and 0.069 (both survived, $n=1731$) and 0.120 (one or both not survived, $n=107$) for opposite-sexed twins. Our result is compatible with that of Parsons (1964). Hendricks (1966) reported that perinatal mortality rate among 379 sets of twins was 32% for 30–35 weeks of gestation and 12% for 36–40 weeks of gestation in the group consisting of twin individuals with birth weight more than one standard deviation below the mean. The rate was diminished in other groups. Pettersson *et al.* (1976) reported that among 818 twin deliveries perinatal mortality for twin babies was 63.6 per 1,000 born on the whole, and the most heavy losses occurred among the low-weight premature twins, where both twins often perinatally died. The present study also indicated that low-birth-weight (LBW) or type LBW-LBW were in close relationship to stillbirth.

Estimated frequencies of birth with low-birth-weight (LBW) were higher in MZ than in DZ twins among each group classified by survival states, sex and birth order (Table 5). Corney *et al.* (1972) examined mean birth weights of individuals from like-sexed twin pairs (survivors only), according to sex, placentation and zygosity. Mean birth weights of DZ twin individuals were 2,728 g ($n=160$), those of MZ twin individuals were 2,595 g (dichorionic, $n=36$) or 2,579 g (monochorionic, $n=108$) among male twins. For females corresponding figures were 2,601 g (DZ,

n=144), 2,385 g (dichorionic MZ, n=18) or 2,500 g (monochorionic MZ, n=106). These results are in good agreement with ours with respect to the effect of zygosity. In the majority of previous studies the unlike-sex twins have higher mean birth weights than the like-sex twins in both sexes (Table 6). This also supports the above findings that mean birth weight is heavier in DZ than in MZ twins. The result of analysis on the factors other than those dealt with in the present study will be published elsewhere.

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