

Trends in Triplet Stillbirth Rates in Japan, 1975–1998

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Stillbirth rates of triplet births in the whole of Japan were analyzed using vital statistics from 1975 to 1998. Stillbirths were registered at 12 weeks gestation or later. The stillbirth rate was significantly higher in like- than in unlike-sex triplets for 1975–1998. During the 23-year period the stillbirth rate decreased from 342 to 49 per 1000 total births for like-sex and from 195 to 54 for unlike-sex triplets. The decrease in the stillbirth rate in the 23-year period was greater in both like- and unlike-sex triplets than in singleton and twin births. Risk factors for stillbirth in triplets were like-sex, youngest or oldest maternal age groups, shorter gestational age and lower birthweight. It is recommended that the optimum period to give birth for triplet pregnancies is 34–35 weeks of gestation for Japanese women.

Elevated triplet birth rates since 1974 have been attributed to the higher proportion of mothers treated with ovulation-inducing hormones and in-vitro fertilization (IVF) (Derom et al., 1995; Jonas & Lumley, 1993; Imaizumi, 1998). Stillbirth rates are higher in monozygotic twins than in singletons and dizygotic twins (Barr & Stevenson, 1961; Imaizumi & Nonaka, 1998; West et al., 1999). The stillbirth rate was significantly higher in like- than unlike-sex triplets in Japan from 1955 to 1967 and in 1974 (Imaizumi & Inouye, 1980). The stillbirth rate of triplets decreased from 640 per 1000 total births in 1961 to 380 in 1974.

The present study describes annual changes in stillbirth rates of triplets in Japan since 1974, as well as the effects of maternal age, sex composition of triplets, gestational age and birthweight on stillbirth rates of triplets.

Materials and Methods

Computerized vital statistics data on triplet births in Japan have been available since 1968. In this study, data for the period between 1975 and 1998 were analyzed. The stillbirth rate was calculated as the number of stillbirths per 1000 total births (live births plus stillbirths). Birth and “fetal death” certificate records included information on parental age, place of residence, sex of triplet births, date of live birth or

stillbirth, gestational age and occupation of the head of household. In Japan, a “fetal death” is registered as a stillbirth if the delivery occurs at 12 or more completed weeks of gestation. The gestational age at delivery is not necessarily the fetal age at death.

Registration of births (live births and stillbirths) is made on an individual basis, giving three separate records for each triplet maternity. To identify each set of triplets we used information on the date of birth, place of residence (codes for prefecture, health center, and city or town within the prefecture), and ages of both parents. There were 14,328 triplet births (11,942 live births and 2386 stillbirths) during that period. Firstly, we sorted the records using the above key fields, and then checked adjacent records for their identity. If three adjacent records were identical for every field, they were judged as the co-triplets from a set. With this criterion we identified 4560 sets (13,680 births, or 95.5 % of the total triplet births) with 648 births unmatched. To obtain more sets allowing for possible differences in birth dates and parental age, we repeated the above matching procedure for the remaining unmatched cases. At the second cycle, we allowed a maximum difference of 20 days between birth dates of co-triplets and 1 year difference in paternal and maternal ages for the adjacent three birth records. We further identified 120 sets, giving a total of 4680 sets of triplets (98.0% of all the triplet births). In the 4680 sets there were 201 sets with one or more sex-unknown co-triplet(s). Thus 4479 sets were used to estimate the stillbirth rates for like- and unlike-sex triplets in the present analysis.

In Japan, the gestational age before 1979 was recorded in months, and after 1979, in weeks. Analyses according to gestational age were carried out with data on triplets born in the period from 1979 to 1998.

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Results

Trends in Stillbirth Rates

Table 1 shows like- and unlike-sex triplet deliveries according to survival states of triplets and the stillbirth rate of triplets from 1975 to 1998. The stillbirth rate of like-sex triplets decreased from 342 per 1000 births in 1975 to 49 in 1998. The stillbirth rate thus decreased to be one-seventh of what it was in 1975. Similarly, the stillbirth rate of unlike-sex triplets gradually decreased from 195 in 1975 to 54 in 1998, a relative decrease of one-quarter. The linear regression of the stillbirth rate on the year gave coefficients (\pm standard error) of $-0.010 (\pm 0.001)$ for like-sex triplets and $-0.006 (\pm 0.001)$ for unlike-sex triplets during the entire period: the coefficients were significantly different from zero at the 1% level for both types of triplets. The stillbirth rate was significantly higher in like- than in unlike-sex triplets for the period 1975–1998.

Table 1 also shows overall stillbirth rates of triplets and singletons. The overall stillbirth rate of triplets was 308 per 1000 births in 1975 and 75 in

1998, whereas the corresponding rates of sex-known triplet sets were 292 (106/363) and 52 (51/987), respectively. Thus, stillbirth rates of sex-known triplet sets were underestimated. The risk of stillbirth was 6-fold higher in triplets than in singletons in 1975, and the relative risk decreased to 2.4-fold in 1998.

There has been an almost complete reversal of the ratio. In 1975, there were 80 like- and 41 unlike-sex triplet deliveries, a ratio of almost 2:1 (see Table 1). In 1998, however, there were 116 like- and 211 unlike-sex triplet deliveries, a ratio of almost 1:2.

Stillbirth Rates According to Sex Composition and Maternal Age

Table 2 shows stillbirth rates of like- and unlike-sex triplets according to maternal age during the period 1975–1998. The stillbirth rate of like-sex triplets decreased significantly along the six 4-year periods in each maternal age group except the age group less than 25 years. However, the only significant decrease for unlike-sex triplets was in the maternal age group between 25 and 29 years. With two exceptions, the stillbirth rate was higher in the like- than in the unlike-sex triplets in each maternal age group.

Table 1

Like- and Unlike-sex Triplet Deliveries According to Survival States of Triplets and Stillbirth Rates Among Triplet Deliveries and Singleton Births, 1975–1998

Year	Like-sex Triplet Deliveries					SR	Unlike-sex Triplet Deliveries					Overall Triplets ^a		Singletons
	3LB	2LB, 1SB	1LB, 2SB	3SB	Total		3LB	2LB, 1SB	1LB, 2SB	3SB	Total	SR	SR	
1975	46	9	2	23	80	342	29	5	2	5	41	195**	308	50
1976	50	7	2	20	79	300	24	4	0	6	34	216	299	52
1977	53	4	4	20	81	296	31	5	0	5	41	163**	281	51
1978	59	5	2	12	78	192	37	1	0	4	42	103*	179	48
1979	47	4	2	18	71	291	36	5	1	7	49	190*	264	47
1980	52	7	1	15	75	240	36	1	2	5	44	152	235	46
1981	62	7	4	19	92	261	45	3	1	3	52	90**	220	48
1982	53	5	4	20	82	297	54	8	1	10	73	183**	268	48
1983	60	5	4	12	81	202	36	3	0	7	46	174	251	45
1984	58	6	1	16	81	230	40	4	0	6	50	147	221	45
1985	53	6	1	15	75	236	40	2	0	4	46	101**	221	45
1986	52	2	1	14	69	222	43	4	1	6	54	148	216	45
1987	52	11	2	18	83	277	55	4	0	4	63	85**	221	44
1988	62	4	1	7	74	122	59	3	0	5	67	90	144	43
1989	50	4	1	8	63	159	73	2	2	9	86	128	186	42
1990	65	6	2	14	87	199	101	4	0	7	112	74**	162	41
1991	64	5	1	10	80	154	123	5	2	4	134	52**	126	39
1992	98	2	1	7	108	77	138	10	1	8	157	76	141	38
1993	79	3	1	10	93	125	152	13	3	9	177	87	132	36
1994	103	4	0	8	115	81	194	6	3	11	214	70	111	33
1995	94	6	0	7	107	84	183	8	2	11	204	74	122	31
1996	107	5	0	8	120	81	179	4	0	5	188	34**	75	31
1997	86	4	4	13	107	159	181	10	0	5	196	43**	112	31
1998	109	2	0	5	116	49	195	6	2	8	211	54	75	31

Note: LB: Live births; SB: Stillbirths; SR: Stillbirth rate per 1000 births, * Comparison of like-sexed and unlike-sexed triplets, $p < 0.05$, ** $p < 0.01$; a: Individual triplet births including unknown sexes.

Table 2

Stillbirth Rates of Like- and Unlike-sex Triplets According to Maternal Age, 1975–1998

Period		Maternal age							
		Less than 25		25–29		30–34		35 or more	
		Like-sexed	Unlike-sexed	Like-sexed	Unlike-sexed	Like-sexed	Unlike-sexed	Like-sexed	Unlike-sexed
1975–1978	No. of triplet sets	59	27	175	90	71	36	15	5
	Stillbirth rate	232	160	278	178	300	139	487	200
1979–1982	No. of triplet sets	60	24	156	114	81	72	23	8
	Stillbirth rate	333	139	235	155	272	125	362	500
1983–1986	No. of triplet sets	45	18	144	99	97	63	20	16
	Stillbirth rate	385	19	178	118	216	185	200	271
1987–1990	No. of triplet sets	42	31	150	150	87	123	28	24
	Stillbirth rate	246	129	213	69	126	114	214	97
1991–1994	No. of triplet sets	35	44	186	250	145	308	30	81
	Stillbirth rate	257	205	86	71	99	63	78	41
1995–1998	No. of triplet sets	34	34	161	264	172	376	83	125
	Stillbirth rate	186	69	101	62	45	49	133	32
Regression coefficient		-0.0042	-0.0011	-0.0093*	-0.0063**	-0.0135**	-0.0051	-0.0187*	-0.0171
(Standard error)		(0.0044)	(0.0044)	(0.0021)	(0.0010)	(0.0010)	(0.0022)	(0.0041)	(0.0083)

Note: * Significant at the 5% level, ** Significant at the 1% level.

Effect of Gestational Age

Table 3 shows 4-yearly changes in stillbirth rates of triplets according to the sex composition of each triplet set and gestational age during that 4-year period. With one exception, the stillbirth rate was higher in like- than in unlike-sex triplets in each gestational age group. Differences in stillbirth rates between like- and unlike-sex triplets were statistically significant in six combinations of year-periods and gestational ages (Table 3). The stillbirth rate decreased from 1979–1982 to 1995–1998 for both like- and unlike-sex triplets, except for in the 23

weeks or less gestation group. In this group the stillbirth rate slowly, though not significantly, decreased from 964 to 870 for like-sex, and from 867 to 824 for unlike-sex triplets. For the gestational groups of 24 weeks or more, the stillbirth rate significantly decreased along the years for both like- and unlike-sex triplets.

Table 4 shows the relationship between stillbirth rates of triplets and gestational ages in the period 1979–1998. The rate was the lowest at 34 weeks (17), followed by 35 weeks (18). When the year of birth was divided into two periods, 1979–1988 and

Table 3

Trends in Stillbirth Rates for Like- and Unlike-sex Triplets According to Gestational Ages, 1979–1998

Year	Gestational Age (weeks)				
	-23	24–27	28–31	32–35	36+
Like-sex Triplets					
1979–1982	964* (56)	706 (17)	190* (49)	56 (89)	61 (109)
1983–1986	981 (53)	438* (16)	75 (40)	39 (86)	24 (111)
1987–1990	976* (42)	354* (16)	98 (41)	37 (108)	47* (100)
1991–1994	854 (41)	111 (18)	33 (71)	11 (179)	4 (87)
1995–1998	870 (36)	138 (29)	26 (91)	10 (238)	24 (56)
Unlike-sex Triplets					
1979–1982	867 (20)	561 (19)	63 (16)	24 (69)	35 (94)
1983–1986	944 (24)	125 (8)	67 (25)	32 (62)	9 (77)
1987–1990	800 (30)	51 (13)	47 (50)	19 (124)	12 (111)
1991–1994	778 (45)	59 (45)	18 (114)	17 (320)	27 (158)
1995–1998	824 (34)	87 (50)	25 (144)	8 (445)	11 (126)

Note: (): The figures in parentheses indicate the number of triplet sets.

* Comparison of SRs in triplets for two types, $p < .05$.

Table 4
Stillbirth Rates of Each Triplet Birth According to Gestational Ages, 1979–1998

Gestational age (weeks)	1979–1988			1989–1998			Total LB	SB	SR	Ratio of SR 1979–88/1989–98
	LB	SB	SR	LB	SB	SR				
–23	31	670	956	101	772	884	132	1442	916	1.08
24	42	36	462	73	15	170	115	51	307	2.71
25	15	35	700	90	24	211	105	59	360	3.33
26	16	11	407	95	14	128	111	25	184	3.17
27	49	26	347	181	12	62	230	38	142	5.58
28	89	26	226	211	16	70	300	42	123	3.21
29	79	13	141	277	11	38	356	24	63	3.70
30	140	14	91	391	8	20	531	22	40	4.53
31	150	14	85	523	14	26	673	28	40	3.27
32	239	16	63	661	17	25	900	33	35	2.50
33	249	18	67	976	19	19	1225	37	29	3.53
34	309	8	25	1212	18	15	1521	26	17	1.72
35	394	14	34	1094	14	13	1488	28	18	2.72
36	464	21	43	927	18	19	1391	39	27	2.27
37	494	17	33	511	26	48	1005	43	41	0.69
38	317	15	45	145	5	33	462	20	41	1.36
39	151	7	44	24	1	40	175	8	44	1.11
40	61	1	16	4	2	333	65	3	44	0.05
41	2	1	333	0	0	—	2	1	333	—
42	3	0	0	0	0	—	3	0	0	—
35+	1886	76	39	2705	66	24	4591	142	30	1.63

Note: LB: Live births; SB: Stillbirths; SR: Stillbirth rate per 1000 births.

1989–1998, the stillbirth rate was the lowest at 34 or 35 weeks for both periods. Although the stillbirth rate decreased at every gestational age in the latter period (1989–98), it decreased to less than a third at shorter gestational ages: 25–31 and 33 weeks.

Effect of Birthweight on Stillbirth Rates

Table 5 shows stillbirth rates of like- and unlike-sex triplets according to birthweight for a triplet set during the period from 1979 to 1998. Stillbirth rates of both types of triplets decreased with birthweight of triplets. The lowest stillbirth rate was observed at birthweight 6001–6500g in like-sex triplets (9 per 1000 births) and 7000g or more in unlike-sex triplets (7). With one exception, the stillbirth rate was higher in like- than in unlike-sex triplets. However, stillbirth rates were significantly higher only at 3000g or less and 4501–5000g.

Effect of Gestational Age and Birthweight on Stillbirth Rates

Table 6 shows stillbirth rates of triplets according to gestational age and birthweight for a triplet set during the period from 1979 to 1998. When the categories with less than eight sets were neglected, the stillbirth rate of triplets was the lowest (21) at 24–27 weeks of gestation and birthweight 3500g or less. At 3501–5000g, the stillbirth rate was always the lowest at 28–31 weeks; at birthweight 5001g or more, the

stillbirth rate was lower at 32–35 weeks than at 36 weeks or more. The lowest stillbirth rate of triplets was 0 at 4501–5000g and 28–31 weeks and at 7001g or more and 32–35 weeks. The second and third lowest rates were five at 6001–6500g and 32–35

Table 5
Stillbirth Rate of Like-sexed and Unlike-sexed Triplets According to Birthweight of Triplet Sets, 1979–1998

Weight at Birth (g)	Like-sex Triplets		Unlike-sex Triplets	
	Sets (n)	SR	Sets (n)	SR
–2000	263	869	193	715*
2001–2500	47	397	51	150*
2501–3000	64	162	82	53*
3001–3500	69	53	92	72
3501–4000	106	72	139	41
4001–4500	167	36	180	22
4501–5000	159	29	253	12*
5001–5500	216	25	312	15
5501–6000	230	17	309	10
6001–6500	190	9	277	8
6501–7000	135	12	195	9
7001–	128	13	137	7

Note: SR: Stillbirth rate per 1000 births.

* Comparison of SRs in triplets for two types, *p* < .05.

Table 6

Stillbirth Rate of Triplets According to Gestational Age and Birthweight of Triplets Sets, 1979–1998

Weight at Birth (g)	Gestational age (weeks)				
	–23	24–27	28–31	32–35	36+
–2000	915 (491)	368 (78)	690 (14)	1000 (1)	—
2001–2500	800 (5)	225 (74)	300 (20)	333 (1)	—
2501–3000	1000 (1)	92 (65)	78 (77)	533 (5)	467 (5)
3001–3500	—	21 (16)	50 (126)	197 (22)	556 (6)
3501–4000	333 (1)	222 (3)	30 (178)	126 (66)	278 (6)
4001–4500	—	—	13 (157)	30 (179)	271 (16)
4501–5000	—	—	0 (64)	15 (329)	187 (25)
5001–5500	—	—	0 (7)	13 (448)	69 (77)
5501–6000	—	—	0 (2)	8 (369)	24 (168)
6001–6500	—	—	0 (2)	5 (221)	14 (245)
6501–7000	—	—	—	9 (76)	10 (254)
7001–	—	—	—	0 (19)	11 (246)

Note: () : The figures in parentheses indicate the number of triplet sets.

weeks and eight at 5501–6000g and 32–35 weeks, respectively.

Discussion

Stillbirth rates of triplets in Japan were 49 for like-sex and 54 for unlike-sex triplets in 1998. The corresponding figures in 1955 were 498 and 453, respectively (Imaizumi & Inouye, 1980). The stillbirth rate in 1998 decreased to one-tenth for like-sex and to one-eighth for unlike-sex triplets during the 43-year period from 1955.

The stillbirth rates for singleton pregnancies in Japan from vital statistics were 94 in 1955 and 31 in 1998, where the rate decreased to one-third during the 43-year period. The stillbirth rate for twins was 257 in 1955 (Imaizumi et al., 1980) and 66 (1493/22555) in 1998 (from vital statistics in Japan), where the rate decreased to be one quarter of what it was at the beginning of the 43-year period. Therefore, the most drastic decline in the stillbirth rate was seen in like-sex triplets, followed by unlike-sex triplets, twins and singletons.

As shown in Table 1, stillbirth rates were generally greater in like- than in unlike-sex triplets. Although the rate decreased during the 23 years for both sex compositions, the overall stillbirth rate may have been confounded by the proportion of like-sex triplet sets. The ratio of like- to unlike-sex triplet sets was about 2:1 in 1975 and about 1:2 in 1998. The decline in the rate for the overall triplet sets was considered to be due to the increased proportion of unlike-sex sets, which generally had a lower stillbirth rate. If we assume that the ratio of the like- to the unlike-sex sets had been that for the year 1975 (namely, 80 and 41), then the values for the overall stillbirth rate for the rest of the years would be expected to be higher than the observed.

The distinct increase in the proportion of unlike-sex triplets is probably explained by the concurrent increase in trizygotic triplets. According to Imaizumi (2003), trizygotic triplet rates increased rapidly after 1987 in Japan. This implies that like-sex triplets included more trizygotic triplets after 1987. If we assume a random distribution of sex among trizygotic triplets, two out of eight sets would be like-sex (the ratio of the unlike- and the like-sex was 3:1). As in 1998, if the number of like-sex sets was half that of the unlike-sex sets, two thirds of the like-sex triplets would be trizygotic. This may be one of the reasons for stillbirth rates in like-sex triplets decreasing more rapidly than in unlike-sex triplets during the period from 1975 to 1998 (see Table 1).

The proportion of shorter gestational age, 12–23 weeks of gestation, decreased from 17.5% (56/320) in 1979–1982 to 8.0% (36/450) in 1995–1998 for like-sex triplets; the corresponding figures were 9.2% (20/218) and 6.5% (50/765) for unlike-sex triplets, respectively, (Table 3). As for birthweights of a triplet set, the proportion under 2000g decreased from 19.6% (154/786) in 1979–1988 to 11.2% (112/1001) in 1989–1998 for like-sex triplets; the corresponding figures were 11.5% (63/546) and 7.7% (131/1695) for unlike-sex triplets, respectively. Because shorter gestational age and lower birthweight are risk factors for stillbirths, these trends would have contributed to the decrease in the stillbirth rates during the period studied. However, the declining stillbirth rate of triplets may be attributed more directly to improvements in antenatal and perinatal medical care, which may have been more effective even for triplet deliveries at shorter gestational ages (Table 4).

According to Luke (1996), the lowest stillbirth rate of triplets was 0.33% at 2500–2800g and 36–37 weeks during the period from 1983 to 1988 in the United States. However, in the present study, the lowest stillbirth rate of triplets was 0 at 4501–5000g for a triplet set and 28–31 weeks, followed by 6001–6500g (0.45%), 5501–6000g (0.81%), and 6501–7000g (0.88%) at 32–35 weeks during the period from 1979 to 1998. It should be noted that the birthweight was calculated as a set in the present study, while the data in the United States was shown on an individual basis (Luke, 1996). Moreover, American women are generally taller than Japanese women, and birthweight is also higher on average in American than Japanese babies. Therefore, it is difficult to compare the present results directly with Luke's (Luke, 1996). However, lower stillbirth rates are seen in similar conditions in both studies. Considering a comparison of gestational age with relatively lower stillbirth rates (Table 4), it is recommended that the optimum time for Japanese women carrying triplets to give birth is at 32–35 weeks of gestation.

From this study, it is suggested that risk factors for stillbirth among triplets were the like-sex composition

(Table 1), maternal age groups less than 20 years and 35 years or more (Table 2), shorter gestational age (Table 3) and lower birthweight (Table 5).

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