
The Frequency of Recurrent Multiple Maternities Using Two Sets of Census Data in Japan: 1990 and 1995

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Frequencies of recurrent multiple maternities were estimated using two sets of census data in Japan in 1990 and 1995. The repeat frequency (RF) of the twinning rate is the frequency of 2 sets of twins among families or couples who have already had 1 set of twins and 2 more siblings. The overall RFs were 9.6 per 1000 couples in 1990 and 9.3 in 1995. The RFs of the monozygotic (MZ) twinning rates were 5.9 per 1000 couples in 1990 and 5.5 in 1995. The RFs of the dizygotic (DZ) twinning rates were 3.7 in 1990 and 3.8 in 1995. For unlike-sexed propositus twins, the RF of MZ twins were 5.0 per 1000 couples in 1990 and 5.5 in 1995. The RF of DZ twins were 5.3 in 1990 and 4.6 in 1995. As for like-sexed propositus twins, the corresponding RFs were 6.2 and 5.5 for MZ twins, and 3.4 and 3.6 for DZ twins, respectively. In mothers who have experienced a twin maternity, the overall RF of twinning was 1.5 to 2 times as high as the average mother's chance of having twins. There was no RF for triplets for both census years. As for geographic variations of the overall RF, the rates in Okinawa (16.2) and Hokkaido (15.3) were significantly higher than those in the Tohoku (8.7), Kanto (8.0) and Kyushu (7.4) districts.

Imaizumi (2001) estimated the number of twin pairs of less than 16 years of age using two sets of census data in Japan in 1990 and in 1995. The twinning rates from the census data are shown to be in good agreement with those obtained from vital statistics. The twinning rate in Japan has been increasing since 1987, where the dizygotic (DZ) twinning rate increased twice from 1975 to 1998 due to fertility drugs and in vitro fertilization (IVF; Imaizumi, 2003). Couples or families who have two sets of twin pairs need some support from society. Thus it is important to determine the number of such families in Japan. However, such repeat frequencies (RFs) of twinning were only reported in the European population (Bulmer, 1958; Bulmer, 1970; Dahlberg, 1952; Eriksson, 1973). The rate was also obtainable by using Mormon Church records in the United States (Wyshak & White, 1965).

In the present study, two sets of census data were used to estimate the RF of twin pairs in each family. It also addresses geographical variations of the RF of twinning.

Materials and Methods

Japanese census data include a code number for each household, individual codes within each household, family relationships to the head of the household, place of residence (codes for prefecture and city, town or village within the prefecture), sex, date of birth (year and month), and age. The month of birth was classified into four categories: January to March, April to June, July to September, and October to December. In the present study, census data were only used from private households whose members included a head of the household. If there were two or more persons of the same age and less than 16 years of age in the same household, these were regarded as multiples. Two individuals of the same age were regarded as twins, three as triplets, four as quadruplets, and five as quintuplets.

In the present data, the heads of the household consisted of the twins' fathers (or mothers) and twins' grandfathers (or grandmothers). The proportion of the former was 84% (122,444/146,169) in 1990 and 83% (117,323/140,627) in 1995 and the corresponding proportion of the latter was 16% and 17%, respectively. The proportion of males as the head of the household was 93.7% (137,029/146,169) in 1990 and 93.4% (131,243/140,627) in 1995.

Each set of twins in a household was taken in turn as a propositus. If there were two sets of twins in a household, the elder twin set was regarded as the propositus. The RF of twinning is the frequency of two sets of twins among families or couples who have already had one set of twins and two more siblings.

Received 6 June, 2006; accepted 29 March, 2007.

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Table 1

Relationship Between the Propositus Twin Sex Compositions and Other Twin Sex Compositions in 1990 and 1995

	Propositus	Other twin pairs				The number of couples ¹
		MF	MM	FF	Total	
1990	MF	12	14	21	47	4568
	MM	22	46	36	104	10,828
	FF	15	55	34	104	11,051
	Total	49	115	91	255	26,447
1995	MF	10	19	15	44	4351
	MM	22	38	32	92	9935
	FF	14	41	34	89	9976
	Total	46	98	81	225	24,262

Note: ¹The number of couples who had four or more children, including one or two sets of twin pairs

MF = male–female, MM = male–male, FF = female–female

To compute the RF of twinning, the denominator is the total number of couples who had four or more children, including one or two sets of twin pairs. The first step is to extract propositus twin families who have only one set of twins. If the number of a propositus twin's sibship size was four or more, then the number of families was added up according to the sex-composition of the twin propositus. These numbers plus the number of two sets of twin pairs were used as the denominator.

Twinning rates by zygosity were estimated using Weinberg's method (Weinberg, 1901).

Data on the total fertility rate (TFR) in Japan was obtained from the National Institute of Population and Social Security Research, Tokyo (1997). Twinning rates in each prefecture were obtained from Imaizumi (1996).

Results

The RF of Twinning

Table 1 shows the relationship between the propositus twin sex-compositions and the other twin sex-compositions. The number of two sets of twins per couple was 255 in 1990 and 225 in 1995. The highest frequency was obtained as a set of female–female (FF) and male–male (MM) for both sets of census data, whereas the lowest was MF and MF in both datasets. There was no RF for triplets for both census years.

Table 2 shows the total number of two sets of twins, the number of couples (or families), and the RFs of twinning according to zygosity in 1990 and in 1995. Table 2 also shows odds ratios (OR) for the RF of twinning in unlike-sex versus like-sex propositus twins. The RF of twinning for unlike-sexed propositus twins was higher than for like-sexed twins for both census years, but the differences were not statistically significant at the 5% level. For unlike-sexed propositus twins, the monozygotic (MZ) twinning rates were 5.0 per 1000 couples in 1990 and 5.5 in 1995. The

dizygotic (DZ) twinning rates were 5.3 in 1990 and 4.6 in 1995. Thus the twinning rates were almost the same for both zygositys in 1990. As for like-sexed propositus twins, the MZ twinning rates (6.2 in 1990 and 5.5 in 1995) were higher than the DZ twinning rates (3.4 and 3.6, respectively).

Geographical Variations

Table 3 shows the number of two sets of twin pairs and the RF of twinning in each prefecture in 1990 and in 1995. The number of two sets of twin pairs in each prefecture was small, so that the average of the RFs of the twinning rate for two census years was used for comparison of the prefectures. The rate was the highest in Okinawa (16.1 per 1000 couples), followed by Nagano (15.9), Nara Prefecture (15.7), and Hokkaido (15.3), whereas the lowest value was obtained in Oita Prefecture (1.9), followed by Akita and Shimane (2.7), and Fukuoka prefectures (6.3). The rate was 8.5 times higher in Okinawa than in Oita Prefecture.

To look at geographical variations of the RF of the twinning rate, correlation coefficients between the RF of twinning rate and geographical, economic and demographic characteristics of the prefectures were computed. Correlation coefficients between the RF on the one hand, and latitude and the TFR (the average from 1975 to 1995) on the other were $-.06$ and $.10$, respectively, being not significant at the 5% level.

Forty-seven prefectures are divided into nine districts due to the small number of recurrent twin sets in each prefecture (see Table 3 and Figure 1). The RF of twinning was the highest in Okinawa (15. per 1000), followed by Hokkaido (15.2). On the other hand, the rate was the lowest in Kyushu (7.4), followed by Shikoku (7.9) and Tohoku District (8.0). Table 4 shows odds ratios for the RFs of the twinning rate between two districts. The rates in Okinawa and Hokkaido were significantly higher than those in the Tohoku, Kanto and Kyushu districts. Correlation coefficients between the RF of the twinning rate on the one hand, and the total twinning rate (the average from 1975 to 1995) and the TFR (the average from 1975 to 1995) on the other, were $.35$ for both rates, being not significant at the 5% level.

Discussion

Puech (1877) found a higher rate of unlike-sex twins among women with several twin maternities. Rumpe (1891) found that the tendency to repeat twinning was found only among mothers of DZ twins, and Weinberg (1901) was of the same opinion. Bulmer (1970) indicates that the DZ twinning rate is under hereditary control, but not the MZ twinning rate.

According to Imaizumi (2001), the estimated twinning rates, as well as the triplet, quadruplet and quintuplet rates from the census data, were in good agreement with those obtained from vital statistics.

Table 2
The Repeat Frequency of Twinning in Japan for 1990 and 1995

Propositus	Younger twin pairs		Total number of couples ¹	Twinning rate per 1000		
	Unlike-sexed	Like-sexed		Monozygotic	Dizygotic	Total
Japanese census (1990)						
Unlike-sexed twins	12	35	4568	5.0 (23)	5.3 (24)	10.3 (47)
Like-sexed twins	37	171	21,879	6.2 (134)	3.4(74)	9.6 (208)
Total	49	206	26,447	5.9 (157)	3.7 (98)	9.6(255)
Odds ratios [95%CI]						0.529 [0.279, 1.002]
Japanese census (1995)						
Unlike-sexed twins	10	34	4351	5.5 (24)	4.6 (20)	10.1 (44)
Like-sexed twins	36	145	19,911	5.5 (109)	3.6 (72)	9.1 (181)
Total	46	179	24,262	5.5(133)	3.8 (92)	9.3 (225)
Odds ratios[95%CI]						0.793 [0.408, 1.540]

Note: CI = confidence interval
 The figures in parentheses are the number of twin pairs
¹The number of couples who had four or more children, including one or two sets of twin pairs

Accordingly, the census data provided good information about multiples of less than 16 years of age.

In Japan, compulsory education is from elementary school to junior high school (between the ages of 6 and 15 years). After graduation from junior high school, the population is divided into those who gain employment and those who proceed to senior high school. In isolated

regions and the distant islands, some children live apart from their parents in order to attend senior high school or gain employment. For those reasons, the estimation of the number of multiples was limited to those of 15 years or less in order to obtain accurate estimates.

In Japan, the proportion of families adopting children is very low compared with a number of foreign

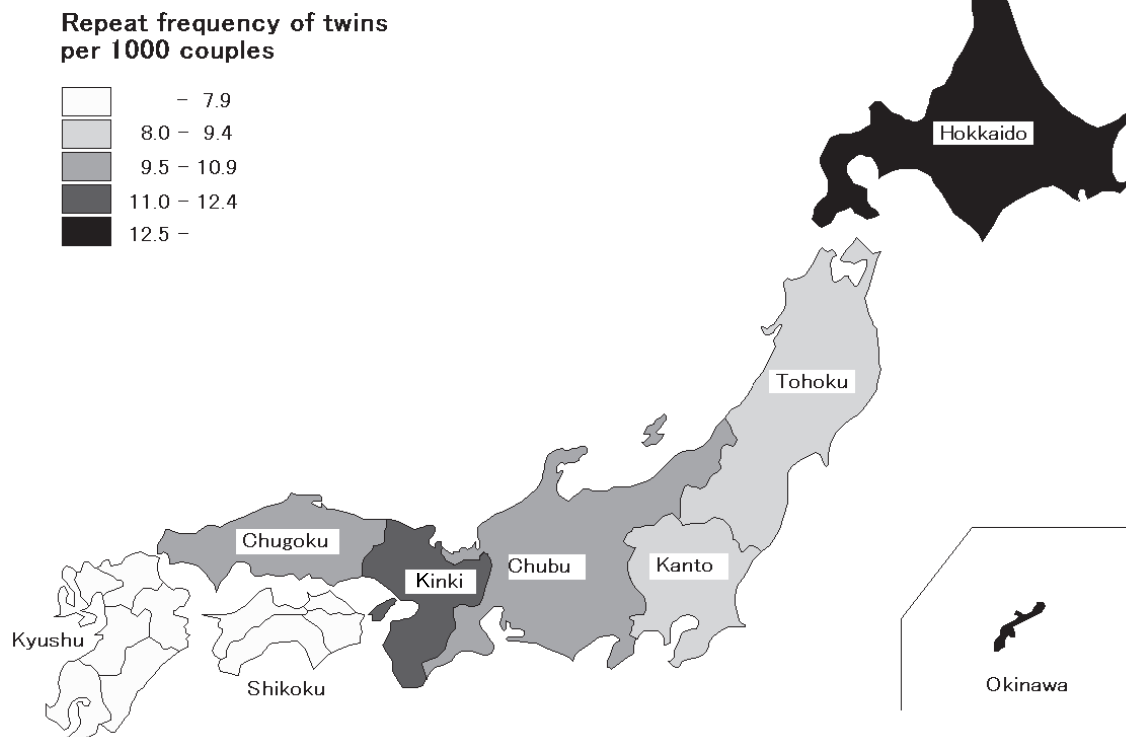


Figure 1
Geographical distribution of twinning rate repeat frequency.

Table 3

The Repeat Frequency (RF) of Twins for Each Prefecture in 1990 and in 1995

Prefecture	1990		1995		Mean	District	RF per rate 1000	Twinning Rate per 1000	TFR
	Number	RF per 1000	Number	RF per 1000					
Hokkaido	22	16.5	17	14.1	15.3	Hokkaido	15.4	6.92	1.53
Aomori	3	9.1	4	13.4	11.2	Tohoku	8.7	5.98	1.77
Iwate	4	9.8	3	8.4	9.1				
Miyagi	6	10.0	3	5.4	7.7				
Akita	1	5.3	0	0.0	2.7				
Yamagata	2	7.5	2	7.7	7.6				
Fukushima	4	6.0	7	11.1	8.5				
Ibaraki	3	4.8	3	5.1	5.0	Kanto	8.0	6.96	1.63
Tochigi	6	12.8	5	12.3	12.6				
Gunma	2	4.8	3	7.7	6.2				
Saitama	7	5.6	10	8.6	7.1				
Chiba	7	6.7	6	6.1	6.4				
Tokyo	17	10.0	13	8.7	9.4				
Kanagawa	9	6.8	13	10.7	8.7				
Niigata	8	15.2	4	7.8	11.5	Chubu	10.5	6.98	1.74
Toyama	2	10.8	2	12.0	11.4				
Ishikawa	1	3.8	3	12.0	7.9				
Fukui	2	12.3	0	0.0	6.2				
Yamanashi	2	10.5	2	11.8	11.2				
Nagano	7	14.5	8	17.3	15.9				
Gifu	4	9.3	2	5.2	7.2				
Shizuoka	10	12.4	7	9.4	10.9				
Aichi	13	10.0	13	10.7	10.3				
Mie	1	3.2	2	7.1	5.1				
Shiga	4	13.2	3	9.9	11.5	Kinki	11.0	6.52	1.64
Kyoto	7	13.7	4	8.1	10.9				
Osaka	10	6.4	13	9.3	7.9				
Hyogo	15	12.6	10	9.6	11.1				
Nara	5	19.4	3	12.0	15.7				
Wakayama	4	21.5	1	5.9	13.7				
Tottori	2	11.9	1	6.1	9.0	Chugoku	10.0	6.86	1.80
Shimane	0	0.0	1	5.5	2.7				
Okayama	6	14.2	4	9.8	12.0				
Hiroshima	7	11.7	8	14.9	13.3				
Yamaguchi	4	13.5	1	3.2	8.3				
Tokushima	1	6.8	2	15.4	11.1	Shikoku	7.9	6.79	1.70
Kagawa	2	10.1	1	5.8	8.0				
Ehime	2	5.4	2	6.1	5.8				
Kochi	2	12.7	1	7.2	10.0				
Fukuoka	4	3.4	7	6.3	4.8	Kyushu	7.4	6.78	1.77
Saga	3	10.6	4	16.1	13.3				
Nagasaki	4	7.5	3	6.6	7.1				
Kumamoto	4	8.3	3	6.6	7.5				
Oita	0	0.0	1	3.7	1.9				
Miyazaki	2	5.6	2	6.1	5.9				
Kagoshima	8	14.2	6	11.7	12.9				
Okinawa	16	17.5	12	14.7	16.2	Okinawa	16.2	7.04	2.19
Total	255	9.6	255	9.3	9.5				

Note: TFR = total fertility rate

Table 4

Odds Ratios for the Repeat Frequencies of Twinning (95% Confidence Intervals) Between Districts

District	Hokkaido	Tohoku	Kanto	Chubu	Kinki	Chugoku	Shikoku	Kyushu	Okinawa
Hokkanido	—	1.78(1.08–2.91)	1.95(1.30–2.91)	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	2.11(1.31–3.39)	<i>ns</i>
Tohoku	1.78(1.08–2.91)	—	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	1.87(1.10–3.18)
Kanto	1.95(1.30–2.91)	<i>ns</i>	—	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	2.05(1.31–3.20)
Chubu	<i>ns</i>	<i>ns</i>	<i>ns</i>	—	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>
Kinki	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	—	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>
Chugoku	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	—	<i>ns</i>	<i>ns</i>	<i>ns</i>
Shikoku	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	—	<i>ns</i>	<i>ns</i>
Kyushu	2.11(1.31–3.39)	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	—	2.22(1.32–3.70)
Okinawa	<i>ns</i>	1.87(1.10–3.18)	2.05(1.31–3.20)	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	2.22(1.32–3.70)	—

Note: *ns* = not significant as the 5% level

countries. Married couples to whom a child is already born do not tend to adopt another child. Therefore, unrelated children of the same age are unlikely to be living together in a household.

The divorce rate in Japan is average for developed countries. It was 2 per 1000 population in 1980 and 1990. Proportions of remarriage for both husbands and wives were 3.9% in 1975, 5.1% in 1980, 6.3% in 1985, 6.8% in 1990, and 6.5% in 1995. Proportions of childless divorce increased from 32% to 38% during the period from 1975 to 1995. Numbers of children per divorced couples increased from 1.02 to 1.22 for the same period. Therefore, for a small proportion of remarried couples who have half-siblings, unrelated children of the same age are unlikely to be living together in a household.

Using Table 1 from Imaizumi and Nonaka (1998), the zygotic twinning rates among live-births were computed between 1975 and 1994 in Japan. The MZ twinning rate was 3.7 and the DZ rate was 2.4 per 1000 live-births. It is of interest to compare this finding with the RF of twins and twinning rates among live-births in the general population. From Table 2, the RFs of MZ twins were 5.0 for the census year in 1990 and 5.5 in 1995 for unlike-sexed twins. The corresponding RFs of DZ twins were 5.3 and 4.6, respectively. The RFs of DZ twins were 1.9- to 2.2-fold higher than the twinning rates among live-births in the general population. Similarly, the value was 1.4- to 1.5-fold higher for MZ twins. On the other hand, for like-sexed twins, the values were 1.4- to 1.5-fold for DZ twins and 1.5- to 1.7-fold for MZ twins. The increased MZ and DZ twinning rates were obtained among propositus twin families for both like-sexed and unlike-sexed twins. According to Wyshak and White (1965), the RFs of twins were 33.2 per 1000 maternities for total twins and 44.3 for DZ twins in Salt Lake City, United States. In Sweden, the RF was 36.8%; the RF of male-female twin pairs (46%) was higher than it was for like-sexed twin pairs (31%; Dahlberg, 1952). Eriksson (1973) also reported that the RF was about 48% in Åland in the years 1750 to

1939. Eriksson (1973) concluded that the overall RF of multiple maternities was about two to three times as high as the average mother's chance of having twins. These proportions were higher in the European population and in the United States than in Japan. However, the former values were obtained 50 years or more ago. Therefore, the reason for the lower RF value of twinning in Japan is likely to be related to the small numbers of sibships in the present Japanese society compared with the American and European populations 50 years or more ago. Another reason is the lower twinning rates in Japanese compared with the American and European populations. It is also related to limitations of the census data, in which information was only obtained for the current residence situation.

From Table 3, the highest RF was obtained in the Okinawa Prefecture. According to Komai and Fukuoka (1936), the highest DZ twinning rate was obtained in the Okinawa Prefecture during the period 1926 to 1931. The TFR in Okinawa was the highest during the period 1975 to 1995 (see Table 3). Recently, factors affecting twinning rates have included fertility drugs and IVF in developed countries (Imaizumi, 2003). Geographical variations of the twinning rates in Japan are thus, to a certain extent, dependent on the number of reproductive clinics in each prefecture. The current study of the RF in each prefecture will help provide data for designing programs to help support twin families.

Acknowledgments

I am grateful to the staff of the Statistics Bureau and Statistics Center in Japan.

References

- Bulmer, M. G. (1958). The RF of twinning. *Annals of Human Genetics*, 23, 31–35.
- Bulmer, M. G. (1970). *The biology of twinning in man*. Oxford: Clarendon Press.

- Dahlberg, G. (1952). Die Tendenz zu Zwillingeburten. *Acta Geneticae Medicae et Gemellologiae*, 1, 80–88.
- Eriksson, A. (1973). Human twinning in and around the Åland Islands. *Commentationes Biologicae*, 64, 1–154.
- Imaizumi, Y. (1996). Epidemiology of multiple births in Japan: Twinning rates and geographical variations. In T. Terao (Ed.), *Study on management of multiple pregnancy in Japan* (pp. 5–30). Tokyo: Ministry of Health and Welfare of Japan.
- Imaizumi, Y. (2001). Estimated number of multiplets under 16 years using two sets of census data in Japan: 1990 and 1995. *Twin Research*, 4, 232–237.
- Imaizumi, Y. (2003). A comparative study of zygotic twinning and triplet rates in eight countries, 1972–1999. *Journal of Biosocial Science*, 35, 287–302.
- Imaizumi, Y., & Nonaka, K. (1998). Yearly changes in stillbirth rates of zygotic twins in Japan, 1975–1994. *Acta Gegeticae Medicae et Gemellologiae*, 47, 19–30.
- Komai, T., & Fukuoka, G. (1936). Frequency of multiple births among the Japanese and related peoples. *American Journal of Physical Anthropology*, 21, 433–447.
- National Institute of Population and Social Security Research, Tokyo, Japan. (1997). *Latest demographic statistics 1997*. Research Series, No. 292, p. 212.
- Puech, A. (1877). De la repetition des accouchements multiples. *Annales de Gynécologie et Obstétrique*, 2, 264–282.
- Rumpe, (1891). Ueber einige Unterschiede zwischen eineiigen und Zweieiigen. *Zeitschrift für Geburtshilfe und Gynäkologie*, 22, 344–358.
- Weinberg, W. (1901). Beitrage zur Physiologie und Pathologie der Mehrlingsgeburten beim Menschen. *Pflugers Archive fur die Gesamte Physiologie des Menschen und der Tiere*, 88, 346–430.
- Wyshak, G., & White, C. (1965). Genealogical study of human twinning. *American Journal of Public Health*, 55, 1586–1593.
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