Estimated Number of Siblings in Japanese Families with Multiple Birth Children using Two Sets of Census Data: 1990 and 1995

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The purpose of this study was to estimate the number of siblings in each Japanese family with multiple birth children using two sets of census data, from 1990 and 1995. The mean number of siblings for singletons was 2.3 in 1990 (2.4 in 1995), 2.9 (2.9) for one set of twins, 4.6 (4.5) for two sets of twins, and 3.5 (3.3) for one set of triplets. For birth order of multiples, the highest mean sibling number was 4.4 for one set of twins (the middle), 7.5 for two sets of twins (the middle-middle), and 4.3 for one set of triplets (the last). The mean sibling number was slightly higher for like-sexed twins and triplets than in unlike-sexed twins and triplets. The mean sibling number was highest in the Okinawa District, among nine districts (0.4 for singletons, 0.6 for one set of twins, 1.0 for two sets of twins and 0.6 for triplets). The current study of the number of siblings in each family with multiple birth children will help provide data for designing programs to help support multiple-birth families. The method of using census data on multiple births might result in a system to analyze nationwide data on multiple birth children if there is no national registry of multiple births after live births in any country.

■ **Keywords:** multiple births, sibling size, geographical variations, census data

The number of multiple births worldwide has increased markedly since 1972 due to the introduction and use of fertility drugs and in-vitro fertilization in developed and some developing countries (Imaizumi, 2003, 2005; Macfarlane & Blondel, 2005). This statement is particularly relevant in Japan, which possesses what is arguably the best demographic data system in Asia. Indeed, Japan has led other countries in recognition of the fact that couples and families who have multiple birth children require economic and medical support from society (Yokoyama et al., 1995, 1997, 2004). Under such circumstances, it is important to know the mean number of siblings in each Japanese family with multiple birth children. To date, however, no such data is available. Imaizumi (2001) estimated the number of Japanese twin pairs less than 16 years of age using two sets of census data in 1990 and in 1995, as well as the frequency of repeated twinning using these same census data sets (Imaizumi & Nishida, 2007).

The purpose of this study is to estimate the number of siblings in each Japanese family with multiple birth children using the same two sets of census data (1990 and 1995).

Materials and Methods

Census data includes a code number for each household, individual codes in each household, family relationships with the head of a household, place of residence (codes for prefecture and city, town or village within the prefecture), sex, date of birth (year and month), and age. Month of birth was classified into four groups: January–March, April–June, July–September, and October–December. Census data in the present study was only used for private households that consisted of members of the household, including a head of household. These records contain at least one living child under the age of 16 in each household. The total number of private households was 9,752,423 in 1990 and 8,275,730 in 1995. If there were two persons or more of the same age under 16 years in the

same household, they were regarded as multiplets. Two residents of the same age were regarded as twins, each of which was in turn treated as a propositus. In the present study, the majority of household heads were fathers of twins (84% in 1990 and 83% in 1995) and the others were grandfathers of twins (16% and 17%, respectively). The next stage was to extract two or more pairs of twins from propositus twin families.

A concept of birth order for twin pairs or triplets is the position of one or two sets of twin pairs or one set of triplets among siblings. The definition of birth order of one set of twin pairs among siblings is as follows — the first (only one set of twins), the first with other singletons, the middle, and the last. The definition of birth order of two sets of twin pairs is as follows; first–middle, first–last (only two sets of twins), first–last with singletons, middle–middle, and middle–last. The definition of birth order of a triplet set is as follows; the first (only one set of triplets), the first with singletons, the middle, and the last.

Results

Mean Number of Sibling Size of Single and Multiple Births

Table 1 shows the distribution of the number of siblings according to four types of families: singletons, one set of twins, two sets of twins, and one set of triplets, in 1990 and in 1995. To compare with mean sibling sizes for singletons and multiple maternities, couples who have only one singleton were eliminated from the present analysis as shown in Table 1. The total number of couples in 1990 and in 1995, respectively, was 9,472,037 and 8,035,168 for singletons, 145,900 and 140,389 for one set of twins, 256 and 223 for two sets of twins, and 1,336 and 2,123 for one set

of triplets. As for the mode of the sibling size in each type of families, the value is two for singletons (70% in 1990 and 68% in 1995), three for one set of twin pairs (51% and 47%), four for two sets of twin pairs (61% and 66%), and three for triplets (59% and 73%). Corresponding mean numbers of siblings were 2.3 in 1990 (2.4 in 1995), 2.9 (2.9), 4.6 (4.5), and 3.5 (3.3), respectively. These results show that couples with one or two multiple maternities are expected to have on average more children than couples with only singletons.

Birth Order of Multiples

Table 2 shows the proportion of birth order of multiples and the mean number of siblings according to one and two sets of twins, and one set of triplets for both census years. For one set of twins, the highest proportion of birth order of the twin pair was the last (50.9% in 1990 and 46.8% in 1995) followed by the first (only one set of twins) (31.6% in 1990 and 35.6% in 1995). Proportions of the other two types of birth orders are lower (3.3–14.2%) for both census years. For two sets of twin pairs, the highest value was the first–last (only two sets of twins) (60.5% in 1990 and 65.9% in 1995) followed by the middle–last (23.4% in 1990 and 21.5 in 1995%). The lowest proportion was the middle–middle (2.3% in 1990 and 3.1% in 1995). For one set of triplets, the highest proportion was the first (only one set of triplets) both in 1990 (59.1%) and in 1995 (72.6%). The second was the last in 1990 (40.7%) and in 1995 (27.3%). For both census years, the mean numbers of siblings are in ranges of 2 (the first; only one twin set) and 4.4 (the middle) for one set of twins, 4 (the first–last; only two twin sets) and 7.5 (the middle–middle) for two sets of twin pairs, and 3 (the first; only one set of triplets) and 4.3 (the last) for one set of triplets.

TABLE 1

Distribution of the Number of Siblings According to Four Types of Families in 1990 and in 1995

Number of siblings	Single	One set of twins	Two sets of twins	Triplets
1990				
2	6,600,064 (69.7)	46,077 (31.6)	0	0
3	2,556,830 (27.0)	73,635 (50.5)	0	791 (59.2)
4	264,923 (2.8)	22,436 (15.4)	155 (60.6)	412 (30.8)
5	37,360 (0.4)	2,889 (2.0)	69 (27.0)	117 (8.8)
Over 6	12,860 (0.1)	863 (0.6)	32 (12.5)	16 (1.2)
Total	9,472,037	145,900	256	1,336
Mean number of siblings	2.34	2.90	4.61	3.53
	(SD = 0.57)	(SD = 0.79)	(SD = 1.02)	(SD = 0.73)
1995				
2	5,459,724 (68.0)	50,029 (35.6)	0	0
3	2,275,233 (28.3)	66,324 (47.2)	0	1,542 (72.6)
4	256,764 (3.2)	20,559 (14.6)	147 (65.9)	461 (21.7)
5	33,240 (0.4)	2,711 (1.9)	55 (24.7)	103 (4.9)
Over 6	10,207 (0.1)	766 (0.6)	21 (9.4)	17 (0.8)
Total	8,035,168	140,389	223	2,123
Mean number of siblings	2.37	2.85	4.49	3.34
	(SD = 0.58)	(SD = 0.79)	(SD = 0.86)	(SD = 0.62)

Note: Figures in parentheses indicate the percentage. SD is standard deviation.

TABLE 2

Proportion of Birth Order of Multiple Births and Mean Number of Siblings of Twins According to One Set of Twins and Two Sets of Twins, and Triplet Families in 1990 and 1995

Birth order of multiple births	1990		1995	
	No. of couples	Mean no. of siblings	No. of couples	Mean no. of siblings
One set of twin pairs				
First (only one set of twins)	46,077 (31.6)	2.00	50,029 (35.6)	2.00
First (one set of twins and other singletons)	20,693 (14.2)	3.11	19,805 (14.1)	3.11
Middle	4,870 (3.3)	4.43	4,789 (3.4)	4.40
Last	74,260 (50.9)	3.30	65,768 (46.8)	3.30
Total	145,900 (100)	2.90	140,389 (99.9)	2.85
Two sets of twin pairs				
First–Middle	13 (4.7)	5.46	6 (2.7)	5.16
First–Last (only 2 sets of twins)	155 (60.5)	4.00	147 (65.9)	4.00
First–Last (2 sets of twins and other singletons)	22 (8.6)	5.18	15 (6.7)	5.13
Middle–Middle	6 (2.3)	7.50	7 (3.1)	7.43
Middle–Last	60 (23.4)	5.48	48 (21.5)	5.29
Total	256 (99.5)	4.61	223 (99.9)	4.49
Triplets				
First (only one set of triplets)	791 (59.21)	3.00	1,542 (72.63)	3.00
First (one set of triplets and other singleton)	0 (—)	—	1 (0.05)	4.00
Middle	1 (0.07)	7.00	0 (—)	—
Last	544 (40.72)	4.28	580 (27.32)	4.24
Total	1,336 (100)	3.53	2,123 (100)	3.34

Note: Figures in parentheses indicate the percentage.

Sex Compositions of Multiples

Figure 1 shows the mean sibling number for one set of twins and triplets according to sex compositions. With one set of twin pairs, the mean size of the like-sexed twins was 2.9 for both census years, whereas the mean size was 2.8 for unlike-sexed in both census years. With triplets, the highest value was 3.8 in 1990 (3.6 in 1995) for three females, follows by 3.6 in 1990 (3.5) for three males, 3.5 in 1990 (3.3) for one male and two females, and 3.4 in 1990 (3.3) for two males and one female.

Table 3 shows proportions of couples and the mean number of siblings according to sex combination and birth order of one set of twin pairs. For each type of birth order, the proportions are higher in the like-sexed twins than in the unlike-sexed twins for both census years. The mean number of siblings was nearly the same among sex combinations in each birth order for both census years.

Geographical Variations

Table 4 shows the mean sibling size according to singleton, one and two sets of twin pairs, and one set of triplets in each district for both census years. The highest value was 2.8 for singletons, 3.4 for one set of twins, 5.2 for two sets of twins, and 3.9 for triplets in the Okinawa District. The lowest values are 2.3 for singletons and 2.8 for one set of twins in the Kanto District, 4.2 for two sets of twin pairs in the Hokkaido District, and 3.4 for triplets in the Kyushu District. In addition, the mean sibling number for each type of family was higher in the Okinawa District than in other districts (0.4 for singletons, 0.6 for one set of twins, 1.0 for two sets of twins and 0.6 for triplets).

Table 5 shows the mean sibling number according to the sex composition of twins and triplets for both census years. With twins, the mean sibling number was higher in like-sexed twins than unlike-sexed twins in each district.

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TABLE 3

Proportions of Couples and the Mean Size of Siblings According to Sex Combinations and Birth Order of One Set of Twins

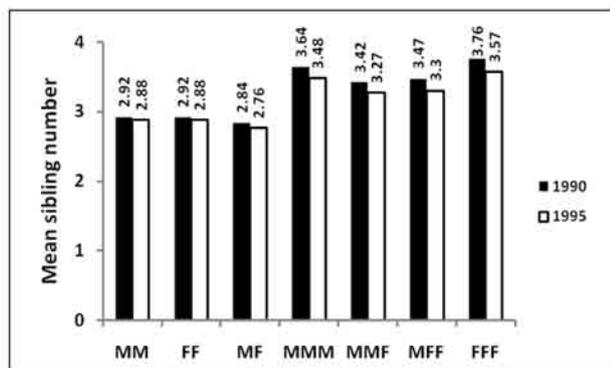| Sex composition		Number of couples according to birth order				
		Total	First (only one set of twins)	First with singletons	Middle	Last
1990						
MM	No. of couples	58,035 (39.8)	17,788 (38.6)	8,118 (39.2)	1,966 (40.4)	30,163 (40.6)
	Mean sibling size	2.91	2	3.11	4.44	3.30
MF	No. of couples	28,530 (19.6)	10,166 (22.1)	3,692 (17.8)	798 (16.4)	13,874 (18.7)
	Mean sibling size	2.84	2	3.09	4.44	3.28
FF	No. of couples	59,335 (40.7)	18,123 (39.3)	8,883 (42.9)	2,106 (43.2)	30,223 (40.7)
	Mean sibling size	2.92	2	3.12	4.49	3.30
1995 \						
MM	No. of couples	54,738 (39.0)	18,618 (37.2)	7,846 (39.6)	2,028 (42.3)	26,246 (39.9)
	Mean sibling size	2.87	2	3.11	4.38	3.31
MF	No. of couples	30,006 (21.4)	12,549 (25.1)	3,705 (18.7)	810 (16.9)	12,942 (19.7)
	Mean sibling size	2.76	2	3.12	4.44	3.28
FF	No. of couples	55,645 (39.6)	18,862 (37.7)	8,254 (41.7)	1,949 (40.7)	26,580 (40.4)
	Mean sibling size	2.87	2	3.12	4.41	3.30

Note: Figures in parentheses indicate the percentage.

FIGURE 1

Mean number of siblings for twins and triplets according to sex compositions.

TABLE 4

Mean Number of Siblings for Singletons, One and Two Sets of Twins, Triplets, and Total Fertility Rate (TFR) in 1990 and 1995

District	Single	One set of twins	Two sets of twins	Triplets	TFR
Hokkaido	2.36	2.89	4.22	3.53	1.53
Tohoku	2.37	2.87	4.29	3.43	1.77
Kanto	2.32	2.83	4.33	3.42	1.63
Chubu	2.35	2.86	4.23	3.38	1.74
Kinki	2.34	2.85	4.34	3.45	1.64
Chugoku	2.39	2.92	4.34	3.41	1.80
Shikoku	2.35	2.86	4.50	3.46	1.70
Kyushu	2.44	2.98	4.25	3.37	1.77
Okinawa	2.75	3.39	5.23	3.94	2.19
Total	2.35	2.87	4.55	3.43	—

The highest value was obtained in the Okinawa District (3.4 for MM, 3.5 for FF and 3.3 for MF), whereas the lowest was in the Kanto District (2.8 for like-sexed) and in the Shikoku District (2.7 for MF). With triplets, the mean sibling number was higher in like-sexed than unlike-sexed triplets in each district. The highest value was obtained in the Okinawa District (4.3 for like-sexed, 3.8 for unlike-sexed), whereas the lowest was obtained in the Shikoku District (3.5 for like-sexed) and in the Chugoku District (3.3 for unlike-sexed).

Discussion

In the present study, the mean number of siblings for couples with only singletons was obtained from computing census data. However, the number of siblings in families with multiple maternities were estimated under some assumptions as described in the Materials and Methods section. Therefore, the size of siblings for multiple maternities has a positive bias compared to couples with only singletons.

Owing to fertility drugs and in-vitro fertilization in Japan, the twinning rate has increased, especially in the period between 1987 and 2005, and decreased thereafter (Imaizumi, 2005; and the recent vital statistics from 2004 to 2009). The triplet rate also increased between 1974 and 1999 and decreased thereafter (Imaizumi, 2005). These infertility treatments might be slightly influenced by the mean number of siblings for both only singletons and multiple maternities.

According to the census data, the percentage of private households with one child under the age of 18 years was 23% in 1990 (3,281,006 out of 14,141,116) and 25.9% in 1995 (3,254,895 out of 12,545,721). Most of these values belong to couples with only singletons. Then, in the present study, the mean number of siblings for couples with only singletons was an overestimation because of the elimination of couples who had only one singleton. Therefore, the difference between mean numbers of siblings for couples with only singletons and with multiple maternity is larger than the estimated values in the present study.

TABLE 5

Number of Mean Sibling Size According to Sex Compositions of Twins and of Triplets, 1990–1995

District	MM	FF	MF	MMM	FFF	MMF	MFF
Hokkaido	2.91 (2,690)	2.92 (2,693)	2.81 (1,275)	3.65 (21)	3.94 (17)	3.29 (18)	3.39 (21)
Tohoku	2.94 (4,763)	2.96 (4,835)	2.85 (2,456)	3.61 (35)	3.70 (33)	3.32 (36)	3.44 (34)
Kanto	2.84 (16,726)	2.82 (17,144)	2.75 (8,657)	3.49 (104)	3.68 (144)	3.29 (124)	3.34 (133)
Chubu	2.88 (10,741)	2.89 (10,795)	2.78 (5,679)	3.54 (80)	3.54 (82)	3.33 (115)	3.27 (98)
Kinki	2.88 (9,066)	2.88 (9,288)	2.76 (4,597)	3.65 (63)	3.61 (83)	3.40 (78)	3.69 (75)
Chugoku	2.94 (3,511)	2.91 (3,629)	2.84 (1,921)	3.52 (37)	3.67 (30)	3.39 (44)	3.20 (35)
Shikoku	2.90 (1,818)	2.91 (1,920)	2.73 (944)	3.58 (16)	3.40 (12)	3.45 (17)	3.23 (21)
Kyushu	2.98 (6,430)	3.01 (6,457)	2.89 (3,264)	3.45 (40)	3.79 (45)	3.27 (49)	3.38 (43)
Okinawa	3.43 (751)	3.48 (832)	3.27 (527)	4.32 (6)	4.26 (8)	3.95 (6)	3.63 (8)

As seen in Table 1, couples or families with multiple birth children had more children compared with couples who had only singletons. Often multiple birth children have additional burdens compared with singletons. Greenberg et al. (2001) found a remarkably high proportion of affected twin pairs with autism and that the prevalence of cerebral palsy is higher in multiple births than in singletons (Grether et al., 1992; Petterson et al., 1993; Yokoyama et al., 1995) as is the proportion of child abuse (Groothuis et al., 1982; Nelson & Martin, 1985; Tanimura et al., 1990). According to Japanese vital statistics, proportions of low birthweight (LBW) infants in singletons were 5.6% in 1990 and 6.5% in 1995. For multiple births, proportions were 56.5% and 62.5%, respectively, in the same years. Due to the increasing number of multiple births in Japan (Imaizumi, 2003), proportions of LBW infants increased since 1979 (data from Japanese Vital Statistics). According to Fujimura et al. (2007), the estimated proportion of necessary number of neonatal intensive care unit (NICU) is 3 per 1,000 live births in 2005. However, to satisfy this ratio, 700–1,000 NICU beds are more necessary than a present number of beds. Therefore, the proportion of the number of NICU beds in Japan is insufficient. Given these circumstances, the need for social support systems for families with multiple births is obvious, and such support should come both from society itself as well as the government. The method of the present study might result in a system to analyze nationwide data on multiple birth children if there is no national registry of multiple births after live births.

The fact that the sibling number in each family with multiple birth children slightly higher in 1990 than in 1995 is reflective of the fact that the total fertility rate (TFR) in Japan is declining, as well as the fact that an increasing proportion of mothers are treated with fertility drugs and in-vitro fertilization (Imaizumi, 2005).

According to Imaizumi and Nishida (2007), the repeat frequency of twins in the Okinawa District was higher than in eight other districts. From Table 4, the TFR indicated the highest value in the Okinawa District among the nine districts. Similarly, in Table 4, the mean sibling size is higher in the Okinawa District than in the other eight districts for singletons (0.4 person per couple), one set of twins (0.6), for two sets of twins (1.0), and for triplets (0.6). It is clear that economical and medical support from society is more vital for families in the Okinawa District compared with the other eight districts. The present study of the sibling number in each family with twins or triplets will help provide data for designing programs to help support multiple birth families.

Acknowledgments

References

Fujimura, M., Kusuda, S., Sugiura, M., Tada, H., Tunazuka, T., Uchiyama, A., Ooki, S., & Wada, K. (2007). Study on estimated number of necessary NICU beds in Japan in 2005. In M. Fujimura (Ed.), *Evaluation of the quality of medical care by the 'Mother and child health center network of neonatal period', and study on its follow-up and improvement by intervention* (pp. 1–6). Tokyo, Japan: Ministry of Health, Labour and Welfare of Japan.

Greenberg, D. A., Hodge, S. E, Sowinski, J., & Nicoll, D. (2001). Excess of twins among affected sibling pairs with

autism: Implications for the etiology of autism. *American Journal of Human Genetics*, 69, 1062–1067.

Grether, J. K., Cumminis, S. K., & Nelson, K. B. (1992). The California cerebral palsy project. *Pediatric and Perinatal Epidemiology*, 6, 339–351.

Groothuis, J. R., Altemeier, W. A., Robarge, J. P., O'Connor, S., Sandler, H., Vietze, P., & Lustig, J. V. (1982). Increased child abuse in families with twins. *Pediatrics*, 70, 769–773.

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. (2005). Demographic Trends of Multiple Birth: Japan and Asia. In I. Blickstein & L. Keith (Eds.), *Multiple pregnancy* (pp. 33–38). London: Parthenon Publishing Group.

Imaizumi, Y., & Nishida, E. (2007). The frequency of recurrent multiple maternities using two sets of census data in Japan: 1990 and 1995. *Twin Research and Human Genetics*, 10, 638–643.

Macfarlane, A., & Blondel, B. (2005). Demographic trends in Western European countries. In I. Blickstein & L. Keith (Eds.), *Multiple pregnancy* (pp. 11–21). London: Parthenon Publishing Group.

Nelson, H. B ., & Martin, C. A. (1985). Increased child abuse in twins. *Child Abuse and Neglect*, 9, 501–505.

Petterson, B., Nelson, K. B., Watson, L., & Stanley, F. (1993). Twins, triplets, and cerebral palsy in births in Western Australia in the 1980s. *BMJ*, 307, 1239–1243.

Tanimura, M., Matsui, I., & Kobayashi, N. (1990). Child abuse in one of a pair of twin in Japan. *Lancet*, 336, 1298–1299.

Yokoyama, Y., Shimizu, T., & Hayakawa, K. (1995). Incidence of handicaps in multiple births and associated factors. *Acta Genetice Medicae et Gemelollogiae, 44*, 81–91.

Yokoyama, Y., Shimizu, T., & Hayakawa, K. (1995). l. Prevalence of cerebral palsy in twins, triplets and quadruplets. *International Journal of Epidemiology*, 24, 943–948.

Yokoyama, Y., Shimizu, T., Yura, A., & Hayakawa, K. (1997). Actual conditions of help and support of childcare in families with multiple birth children (Summary in English). *Japanese Journal of Public Health, 44,* 81–88.

Yokoyama, Y., Nakahara, Y., Matsubara, S., Sugimoto, M., Koyama, H., & Mitsutsuji, R. (2004). Comparison of child-rearing problems and necessary community welfare and health services between mothers with twins or triplets of mothers with singleton children (Summary in English). *Japanese Journal of Public Health, 51,* 94–102.