



Acta Genet Med Gemellol 41: 205-213 (1992)  
©1992 by The Mendel Institute, Rome

Seventh International Congress  
on Twin Studies

## Secular Trend and Associated Factors of Twinning in Taiwan

C.J. Chen<sup>1,2</sup>, T.K. Lee<sup>2</sup>, C.J. Wang<sup>3</sup>, M.W. Yu<sup>1</sup>

<sup>1</sup>Institute of Public Health, National Taiwan University College of Medicine, Taipei; <sup>2</sup>Institute of Biomedical Sciences, Academia Sinica, Taipei; <sup>3</sup>Department of Nursing, National Cheng-Kung University College of Medicine, Tainan, Taiwan

---

**Abstract.** Delivery records of public hospitals and local health centers were analyzed to investigate the secular trend of multiple births from 1955 to 1990 in Taiwan. Twinning rates decreased gradually from the late 1950s to 1973, slightly increased and remained stable from 1974 to 1980, and then increased strikingly from 1981 to 1990. During the study period, MZ rates were consistently higher than DZ rates except in 1986 when a higher DZ rate was observed. The highest MZ rate of 7.7 per 1,000 deliveries was observed in 1985, while the highest DZ rate of 4.6 per 1,000 deliveries was observed in 1986. The triplet incidence rate also declined from the early 1960s to 1973 and then increased markedly from 1974 to 1990. A case-control study including 482 MZ and 252 DZ twin pairs and 1,496 singletons was carried out in four teaching hospitals in Taipei City between October 1985 and June 1989 to examine factors related to twinning. The zygosity of twin pairs was determined by sex, placentation and red blood cell antigens. Multiple logistic regression analysis showed that the higher the maternal age, the lower the MZ and DZ rates, while the higher the parity, the higher the rates. There was no association of paternal age or of maternal educational level with twinning rates

**Key words:** Twinning, Epidemiology, Maternal age, Parity

---

## INTRODUCTION

The twinning phenomenon in humans has been of interest since ancient times [16]. However, the biology of twinning has only been intensively studied recently. Despite the efforts devoted to the identification of possible associated factors, the determinants and mechanisms of twinning are still not completely understood.

In recent decades, there has been a change in twinning rates in Taiwan, the USA, western European countries, Australia, New Zealand, Japan, Hungary, Poland, and in Canada [7,8,11,19,25]. In many countries, including Taiwan, a decline in twinning rates began in the 1950s and continued up to the late 1970s.

Many studies have reported on increased twinning rates associated with maternal age [1,3,5,12,14,22,24]. In Taiwan, both MZ and DZ rates increased with maternal age and parity in 1975-1984 [7]. In contrast, DZ twinning rates were found to increase with parity independent of maternal age in Nigeria [4] and Scotland [23]. The present study was carried out to examine the secular trend of twinning rates and to explore the possible factors associated with twinning including parity, paternal age, and maternal educational level.

## MATERIALS AND METHODS

In order to examine the secular trend of multiple births in Taiwan, delivery records of public hospitals and local health centers from 1955 to 1990 were obtained from national annual health statistics [10]. Annual deliveries reported from these hospitals and health centers ranged from 65,061 in 1955 to 22,343 in 1987. The number of twin deliveries in each year ranged from 371 in 1956 to 153 in 1973. The zygosity of twin deliveries was determined by Weinberg's method [6]. In other words, the number of DZ pairs was twice that of different-sexed twin pairs, while the number of MZ pairs was the difference between the number of DZ same-sexed and different-sexed twin pairs. MZ and DZ twinning rates were expressed as the number of MZ and DZ twin pairs per 1,000 deliveries, respectively.

To study multiple factors associated with the development of MZ and DZ twins, a matched case-control study was carried out. Twin subjects were recruited from 4 teaching hospitals in Taipei City including the National Taiwan University Hospital, MacKay Memorial Hospital, Taipei Municipal Maternal and Child Hospital, and the National Nursing School Hospital. All twins delivered in these hospitals from October 1985 to June 1989 were studied. In addition to placenta and cord blood collection for zygosity determination, the mothers of the twins were personally interviewed, according to a formulated questionnaire, by public health nurses well trained to standardize their interview technique.

During the study period, a total of 73,264 deliveries, including 844 twin births, took place in the four study hospitals. Zygosity of the twin pairs was determined by sex, placentation and red blood cell antigens including A, B, C, D, E, c, e, M, N, Le<sup>a</sup> Le<sup>b</sup>, and P<sub>1</sub>. Monochorionic twin pairs and dichorionic same-sexed twin pairs with concordant red blood cell antigens were regarded as MZ. Different-sexed twin pairs and dichorionic same-sexed twin pairs with one or more discordant blood types were classified as DZ. Among the 844 twin pairs, there were 482 MZ pairs, 252 DZ pairs, and 110 pairs whose zygosity was indeterminable due to lack of information on placentation, red blood types, or both.

In order to elucidate on factors associated with twinning, two singletons matching each twin pair for delivery hospital and date of birth were selected. Information on associated factors was extracted from the medical charts of these singleton deliveries. Only 1,496 (88.6%) of the 1,688 matched singletons had complete data for analysis. The fre-

**Table 1 - Parity of MZ and DZ twins and singletons**

Parity	Singleton		MZ		DZ		Odds ratio	
	No.	(%)	No.	(%)	No.	(%)	MZ vs. singl.	DZ vs. singl.
1	1304	(87.2)	334	(69.3)	181	(71.8)	1.0	1.0
2	159	(10.6)	89	(18.5)	46	(18.3)	2.2	2.1
3	29	( 1.9)	33	( 6.8)	15	( 6.0)	4.5	3.8
4+	4	( 0.3)	26	( 5.4)	10	( 4.0)	24.7	17.1

**Table 2 - Maternal age of MZ and DZ twins and singletons**

Maternal age	Singleton		MZ		DZ		Odds ratio	
	No.	(%)	No.	(%)	No.	(%)	MZ vs. singl.	DZ vs. singl.
<25	326	(21.8)	147	(30.5)	51	(20.2)	1.0	1.0
25-29	760	(50.8)	414	(44.4)	137	(54.4)	0.6	1.2
30-34	348	(23.3)	105	(21.8)	58	(23.0)	0.7	1.1
35+	62	( 4.1)	16	( 3.3)	6	( 2.4)	0.6	0.6

quency distribution of parity, paternal age and maternal educational level of MZ and DZ twin pairs was compared with that of singletons. The statistical significance of associations between factors and twinning were assessed by chi-square tests. The multiple logistic regression analysis was used to estimate the multivariate-adjusted odds ratio of twinning for each factor. The statistical significance of multivariate-adjusted odds ratios was assessed by the t-test of regression coefficients.

**RESULTS**

The secular trend of twinning rates from 1955 to 1990 in Taiwan is shown in Fig. 1. The rates decreased gradually from the late 1950s to 1973, slightly increased and remained stable from 1974 to 1980, and then increased strikingly from 1981 to 1990. During the study period, MZ rates were consistently higher than DZ rates except in 1986 when a higher DZ rate was observed. Generally speaking, MZ rates declined gradually from the late 1950s to the early 1970s and have been on the increase again since the late 1970s. There were four MZ peak rates in 1957, 1966, 1975 and 1985, respectively. The highest MZ rate of 7.7 per 1,000 was recorded in 1985. A decline also took place in the DZ rates from the late 1950s to the early 1970s, with an increase only occurring again after 1975. The highest DZ rate of 4.6 per 1,000 was observed in 1986.

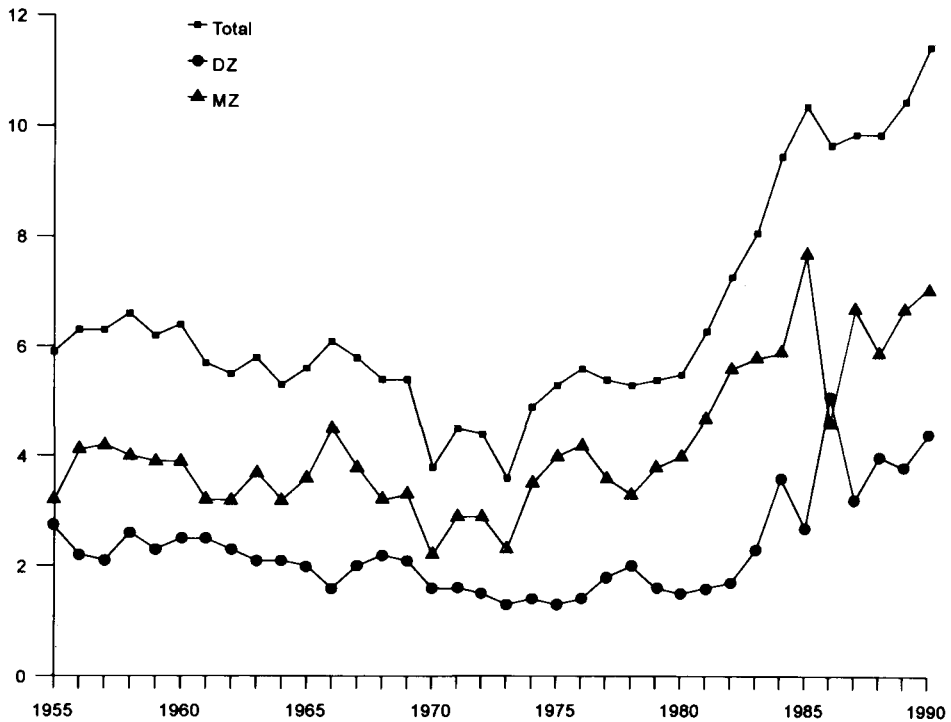


Fig. 1 - Secular trend of twinning rate in Taiwan from 1955 to 1990.

Triplet incidence rates from 1955 to 1990 are shown in Fig. 2. There was a greater variation in the triplet incidence rate than in the twinning rate due to the much lower incidence of triplets and the small number of deliveries under observation. However, it too showed a decline from the early 1960s up to 1973, and then increased strikingly between 1974 and 1990. The annual incidence rates of same-sexed triplets were consistently higher than those of different-sexed triplets for the years 1955 to 1973. No consistent difference was observed between different-sexed and same-sexed triplet rates after that date.

The twinning rate in the four study hospitals in Taipei City between October 1985 and June 1989 was 11.5 per 1,000 deliveries (844/73,264). Based on Weinberg's rule, MZ and DZ rates were estimated as 7.5 and 4.0 per 1,000 deliveries, respectively. Table 1 shows the parity of MZ and DZ twins and singletons. Both MZ and DZ twinning rates were significantly associated with parity in a dose-response relationship. The higher the parity, the greater the odds ratio of giving birth to MZ and DZ twins. The maternal age of MZ twins was younger than that of singletons. The older the maternal age, the lesser the chance of giving birth to MZ twins. The distribution of maternal age for DZ twins was similar to that for MZ twins. The odds ratio of giving birth to DZ twins was 0.6 for the maternal age group of 35 years or more.

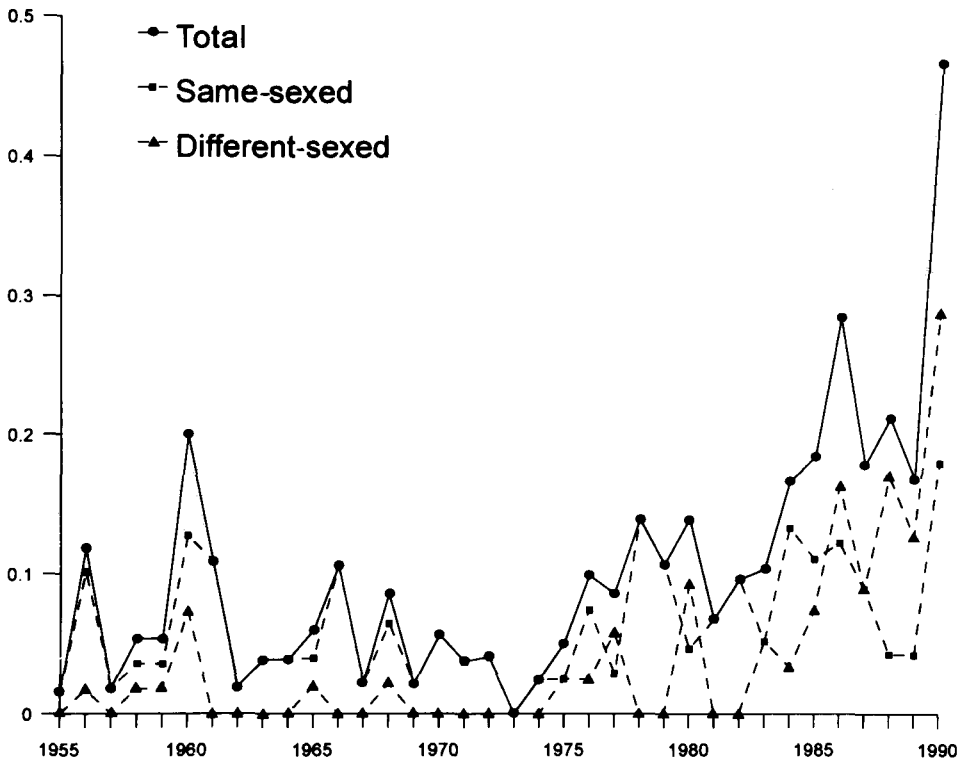


Fig. 2 - Secular trend of triplet incidence rate in Taiwan from 1955 to 1990.

Because of the significant association between parity and maternal age, the odds ratios of giving birth to MZ twins by parity and maternal age are shown in Table 3. There was a consistent increase in the odds ratios for parity in all maternal age groups, and a consistent decrease in the odds ratios for maternal age in most parity groups. Parity and maternal age-specific odds ratios of giving birth to DZ twins are shown in Table

Table 3 - Odds ratios of MZ twinning by parity and maternal age

Maternal age	Parity			
	1	2	3	4+
<25	1.0*	3.8	7.3	14.6
25-29	0.6	1.6	5.9	14.6
30-34	0.5	1.1	3.6	17.6
35+	0.7	0.5	0.2	5.9

\* First parity with maternal age less than 25 years selected as the reference group.

4. Here also an increasing trend of odds ratios for parity in all maternal age groups and a decreasing trend of odds ratios for maternal age in most parity groups was observed. Results of the multiple logistic regression analyses of MZ and DZ twinning rates on parity and maternal age are shown in Table 5. The odds ratios for both MZ and DZ twinning were found to increase with parity and decrease with maternal age. There was no significant interaction to be found between parity and maternal age. Neither was there any significant difference in paternal age between the twins, both MZ and DZ, and singletons as shown in Table 6. The MZ and DZ twins and singletons all had a similar maternal educational level as shown in Table 7.

**Table 4 - Odds ratios of DZ twinning by parity and maternal age**

Maternal age	Parity			
	1	2	3	4+
<25	1.0*	3.3	4.1	—
25-29	1.0	2.1	9.6	32.9
30-34	0.8	1.8	4.6	12.4
35+	0.2	1.9	—	8.2

\* First parity with maternal age less than 25 years selected as the reference group.

**Table 5 - Multiple logistic regression analysis of MZ and DZ twinning by parity and maternal age**

Variable	Group	Multivariate-adjusted odds ratio	
		MZ	DZ
Maternal age	<25	1.0	1.0
	25-29	0.6	1.0
	30-34	0.5	0.8
	35+	0.3	0.3
Parity	1	1.0	1.0
	2	2.6	2.3
	3	6.0	5.3
	4+	31.9	22.6

**Table 6 - Paternal age of MZ and DZ twins and singletons**

Paternal age	Singleton		MZ		DZ		Odds ratio	
	No.	(%)	No.	(%)	No.	(%)	MZ vs. singl.	DZ vs. singl.
<25	93	( 6.6)	39	( 8.1)	17	( 6.7)	1.0	1.0
25-29	617	(43.6)	205	(42.5)	104	(41.3)	0.8	0.9
30-34	523	(37.0)	173	(35.9)	101	(40.1)	0.8	1.1
35+	181	(12.8)	65	(13.5)	30	(11.9)	0.9	0.9

**Table 7 - Maternal educational level of MZ and DZ twins and singletons**

Maternal educational level	Singleton		MZ		DZ		Odds ratio	
	No.	(%)	No.	(%)	No.	(%)	MZ vs. singl.	DZ vs. singl.
Elementary	120	( 8.0)	55	(11.4)	24	( 9.5)	1.0	1.0
Junior high	258	(17.2)	88	(18.3)	42	(16.7)	0.7	0.8
Senior high	712	(47.6)	219	(45.4)	112	(44.4)	0.7	0.8
College	406	(27.1)	120	(24.9)	74	(29.4)	0.6	0.9

## DISCUSSION

The reason for the consistent decline in twinning rates in many countries between the 1950s and 1970s remains to be clarified. Several possible factors such as the change in parity and maternal age [17], the use of oral contraception, of pesticides and the effects of environmental pollution [15] together with reduced sperm activity [18] have all been proposed as explanations of this phenomenon. However, the decline in both the twinning and triplet incidence rates in Taiwan between the 1950s and early 1970s may be attributable to the decrease in parity as a result of socioeconomic developments and the introduction of intensive family planning and birth control programs. On the other hand, the striking increase in multiple birth rates from then onwards may be due to the use of ovulation-stimulating drugs and other forms of infertility treatment.

The increase in DZ rates with maternal age has been consistently observed in many studies [1,3,5,12,14,22,24]. Our previous study also reported a slight increase of DZ rates with maternal age during the period 1975 to 1984 in Taiwan [7]. In this study however, the DZ rates on adjustment for the effect of parity, were negatively associated with maternal age. It is suspected that women with infertility problems from the late 1970s onwards may have undergone treatment at an earlier age. Thus younger mothers may have higher DZ rates than older mothers in recent years. The increase in DZ twinning rates with parity is self-explanatory in that DZ twinning and large families are both indicative of high fertility.

Slight increases in MZ rates with maternal age were observed in Taiwan [7], the USA [4], and Hungary [9]. Some researchers believe that MZ twinning is a special form of congenital malformation resulting from an arrest early in the development of embryonic life [26]. Defective nutritional intake and teratogen exposures have also been hypothesized to play a role in the formation of MZ twins [2,20]. It has been suggested that the increase in MZ twinning rates in the UK could be related to the use of oral contraceptives [13], while a large-scale Australian study showed an increased MZ twinning rate in pregnancies that had taken place following termination of oral contraception [21]. In the past, in Taiwan, oral contraceptives were less frequently used than intrauterine devices as birth control methods. However, there has been an increasing trend in the use of oral contraceptives in recent years. The younger women in Taiwan prefer oral contraception,

while the older women still tend to use intrauterine devices. Whether the use of oral contraceptives contributed to the higher MZ rates in the younger rather than older mothers in Taiwan necessitates further elucidation.

**Acknowledgements:** This study was supported by grants (75-0412-B002-23, 76-0412-B002-42, 77-0412-B002-18, 78-0412-B002-17) from the National Science Council, Executive Yuan, Republic of China.

## REFERENCES

1. Anderson WJR (1956): Stillbirth and neonatal mortality in twin pregnancy. *J Obstet Gynaecol Br Emp* 63:205-215.
2. Arey LB (1923): The cause of tubal pregnancy and tubal twinning. *Am J Obstet Gynecol* 5:163-167.
3. Bonnelykke B (1990): Social class and human twinning. *J Biosoc Sci* 22:381-386.
4. Bulmer MG (1958): The repeat frequency of twinning. *Ann Hum Genet* 23:31-35.
5. Bulmer MG (1959): The effect of parental age, parity and duration of marriage on the twinning rate. *Ann Hum Genet* 23:454-458.
6. Bulmer MG (1976): Is Weinberg's method valid? *Acta Genet Med Gemellol* 25:25-28.
7. Chen CJ, Lin TM, Chang C, Cheng YJ (1987): Epidemiological characteristics of twinning rates in Taiwan. *Acta Genet Med Gemellol* 36:335-342.
8. Czeizel A, Acsadi G (1971): Demographic characteristics of multiple births in Hungary. *Acta Genet Med Gemellol* 20:301-313.
9. Czeizel A (1973): Unexplained demographic phenomena of multiple births in Hungary. *Acta Genet Med Gemellol* 22:214-218.
10. Department of Health, Executive Yuan, Republic of China (1990): Health Statistics. Taipei: Department of Health.
11. Elwood JM (1973): Changes in the twinning rate in Canada 1926-1970. *Br J Prev Soc Med* 27:236-241.
12. Elwood JM (1978): Maternal and environmental factors affecting twin births in Canadian cities. *Br J Obstet Gynaecol* 85:351-358.
13. Emery AEH (1986): Identical twinning and oral contraception. *Eugen Soc Symp* 3:23-27.
14. Eriksson AW, Fellman J (1967): Twinning in relation to the marital status of the mother. *Acta Genet (Basel)* 17:385-398.
15. Eriksson AW, Eskola MR, Fellman JO (1976): Retrospective studies on the twinning rate of Scandinavia. *Acta Genet Med Gemellol* 25:29-35.
16. Gedda L (1961): *Twins in history and science*. Springfield, Illinois: Charles Thomas.
17. James WH (1975): The secular decline in dizygotic twinning rates in Italy. *Acta Genet Med Gemellol* 24:9-14.
18. James WH (1978): A hypothesis on the declining dizygotic twinning rates in developed countries. *Prog Clinic Biol Res* 24:81-88.
19. James WH (1986): Recent secular trends in dizygotic twinning. *J Biosoc Sci* 18:497-504.
20. Kaufman MH, O'Shea KS (1978): Induction of monozygotic twinning in the mouse. *Nature (Lond)* 276:707-708.
21. Macourt DC, Stewart P, Zaki M (1982): Multiple pregnancy and fetal abnormalities in association with oral contraceptive usage. *Aust NZ J Obstet Gynaecol* 22:25-28.
22. Millis J (1959): The frequency of twinning in poor Chinese in the maternity hospital Singapore. *Ann Hum Genet* 23:171-174.



23. Nylander PPS (1975): Factors which influence twinning rates. In MacGillivray I, Nylander PPS, Corney G (eds): *Human Multiple Reproduction*. London: WB Saunders, pp. 98-106.
24. Nylander PPS (1981): The factors that influence twinning rates. *Acta Genet Med Gemellol* 30:189-202.
25. Rola-Janiki A (1974): Multiple births in Poland 1949-71. In Parisi P. (ed): *Multiple births and twin care Acta Genet Med Gemellol Suppl* 22.
26. Stockard CR (1921): Developmental rate and structural expression: an experimental study of twins "double monsters" and single deformities and the interaction among embryonic organs during their origin and development. *Am J Anat* 28:115-277.

**Correspondence:** Prof. Chien-Jen Chen, Institute of Public Health, National Taiwan University College of Medicine, 1, Jen-Ai Road Section 1, Taipei 10018, Taiwan.