



# Constant multiple birth rates in the Czech Republic and the Slovak Republic until recently, 1972–1995

Yoko Imaizumi

National Institute of Population and Social Security Research, Ministry of Health and Welfare, Tokyo, Japan

Using vital statistics, yearly changes in the twinning and triplet rates by zygosity were investigated in the Czech Republic and the Slovak Republic during the period 1972–1995. Monozygotic (MZ) twinning rates in both countries had remained nearly constant (about 3 per 1000 total births) during that period. With a few exceptions, the dizygotic (DZ) twinning rates remained constant from 1972 to 1994, and increased in 1995 for both countries. MZ twinning rates for both countries were the lowest in Europe. As for triplet rates, overall rates increased significantly year by year in the Czech Republic, but not in the Slovak Republic. The triplet rate was significantly higher in 1995 than in the period 1972–1982 for both countries. The MZ triplet rate remained constant during that period in the Czech Republic. The trizygotic (TZ) triplet rates increased 3-fold for the Czech Republic and 4-fold for the Slovak Republic in 1972–1976 and 1992–1995. In the later period, the TZ rate was 1.5-fold higher in the Czech Republic than in the Slovak Republic. The quadruplet rate increased 2.3-fold from 2.9 per million births in 1982–1986 to 6.7 in 1992–1995 in the Czech Republic. The corresponding values were 2.7, 2.20 and 5.9-fold in the Slovak Republic. Both the Czech and the Slovak Republics were not affected by fertility drugs and assisted reproductive techniques until recently.

**Keywords:** twinning rate, triplet rate, quadruplets, zygosity

## Introduction

It is well known that the monozygotic (MZ) twinning rate has been almost constant throughout the world, whereas there were variations in the dizygotic (DZ) twinning rates among certain races.<sup>1</sup> On the other hand, ovulation-inducing hormones<sup>2</sup> and *in vitro* fertilisation (IVF)<sup>3</sup> give rise to a high rate of multiple births. In recent papers,<sup>4,5</sup> twinning rates were reported to have increased significantly after periconceptional multi-vitamin supplements.

Since 1972, rising twinning rates have been reported in Denmark,<sup>6,7</sup> Japan,<sup>8</sup> Taiwan,<sup>9</sup> the USA,<sup>10</sup> the UK,<sup>6,11,12</sup> the Netherlands,<sup>6</sup> Austria, Finland, Norway, Sweden, Canada, Australia, Hong Kong, Israel, and Singapore.<sup>13</sup> According to Imaizumi and Nonaka,<sup>14</sup> the MZ twinning rate remained constant during the period 1974–1994 in Japan, whereas the DZ twinning rate increased in 1987–1994. The higher DZ twinning rate since 1987 has been attributed to the higher proportion of mothers treated with ovulation-inducing hormones and partially attrib-

uted to IVF. The same tendency in the trizygotic triplet rate was also found in Japan.<sup>15</sup>

In the Czech and the Slovak Republics, multiple birth rates were not reported. Therefore the present study focuses attention on the trends in zygotic twinning and triplet rates for both countries during the period 1972–1995. It also deals with quadruplet rates.

## Materials and methods

Vital statistics data on multiple births was obtained by courtesy of the staff of the Statistics Section in the Czech Statistical Office and Statistical Office of the Slovak Republic. Twinning rates by zygosity were estimated using the Weinberg method.<sup>16</sup> Triplet rates by zygosity were estimated using the Allen method,<sup>17</sup> as follows:

$$\text{No. of MZ triplets} = L - (U + D)/3$$

$$\text{No. of DZ triplets} = D = 2n \times (\text{MZ twinning rate}) \times (\text{DZ twinning rate})$$

$$\text{No. of TZ triplets} = T = 4(U - D/2)/3$$

where  $L$  is the number of like-sexed triplets,  $U$  the number of unlike-sexed triplets and  $n$  the total number of live and stillbirths.

Correspondence: Dr Y Imaizumi, National Institute of Population and Social Security Research, Ministry of Health and Welfare, 1-2-3 Kasumigaseki, Chiyoda-ku, Tokyo, 100-0013 Japan.  
Tel: +81 3 3595 2992; Fax: +81 3 3591 4817;  
E-mail: [imaizumi@so.ipss.go.jp](mailto:imaizumi@so.ipss.go.jp)  
Received 16 August 1998; accepted 10 November 1998

**Table 1** Number of total births and twin pairs, and twinning rate according to zygosity in the Czech Republic and the Slovak Republic, 1972–1995

Year	Number of total births		Number of twin pairs						Twinning rate per 1000 births					
	Czech	Slovak	Czech Republic			Slovak Republic			Czech Republic			Slovak Republic		
			MZ	DZ	Total	MZ	DZ	Total	MZ	DZ	Total	MZ	DZ	Total
1972	16 4744	8 8461	519	1006	1525	311	592	903	3.15	6.11	9.26	3.52	6.69	10.21
1973	18 2953	9 3636	552	1172	1724	325	594	919	3.02	6.41	9.42	3.47	6.34	9.81
1974	19 5427	9 8292	709	1158	1867	262	692	954	3.63	5.93	9.55	2.67	7.04	9.71
1975	19 2869	9 8372	704	1070	1774	297	656	953	3.65	5.55	9.20	3.02	6.67	9.69
1976	18 8522	10 0528	602	1124	1726	358	560	918	3.19	5.96	9.16	3.56	5.57	9.13
1977	18 2865	10 0257	503	1174	1677	333	634	967	2.75	6.42	9.17	3.32	6.32	9.65
1978	18 0018	10 0892	544	1116	1660	291	660	951	3.02	6.20	9.22	2.88	6.54	9.43
1979	17 3084	10 0889	484	1028	1512	337	636	973	2.80	5.94	8.74	3.34	6.30	9.64
1980	15 4665	9 5720	445	996	1441	246	642	888	2.88	6.44	9.32	2.57	6.71	9.28
1981	14 5186	9 3862	439	850	1289	239	580	819	3.02	5.85	8.88	2.55	6.18	8.73
1982	14 2518	9 3192	442	866	1308	262	600	862	3.10	6.08	9.18	2.81	6.44	9.25
1983	13 8132	9 2528	437	884	1321	272	556	828	3.16	6.40	9.56	2.94	6.01	8.95
1984	13 7587	9 1345	456	764	1220	257	590	847	3.31	5.55	8.87	2.81	6.46	9.27
1985	13 6488	9 0645	428	852	1280	261	546	807	3.14	6.24	9.38	2.88	6.02	8.90
1986	13 3942	8 7641	436	712	1174	251	538	789	3.26	5.32	8.76	2.86	6.14	9.00
1987	13 1469	8 4422	453	802	1255	210	480	690	3.45	6.10	9.55	2.49	5.69	8.17
1988	13 3238	8 3659	405	782	1187	225	490	715	3.04	5.87	8.91	2.69	5.80	8.55
1989	12 8881	8 0482	394	722	1116	246	464	710	3.06	5.60	8.66	3.06	5.77	8.82
1990	13 1094	8 0390	422	730	1152	245	492	737	3.22	5.57	8.79	3.05	6.12	9.17
1991	12 9850	7 8948	371	784	1155	233	420	653	2.86	6.04	8.89	2.95	5.32	8.27
1992	12 2142	7 4997	385	766	1151	259	508	767	3.15	6.27	9.42	3.45	6.77	10.23
1993	12 1470	7 3583	372	708	1080	177	512	689	3.06	5.83	8.89	2.41	6.96	9.36
1994	10 6915	6 6644	338	660	998	192	434	626	3.16	6.17	9.33	2.88	6.51	9.39
1995	9 6397	6 1668	306	704	1010	190	388	578	3.17	7.30	10.48	3.08	6.29	9.37

## Results

### *Changes in the twinning rate by zygosity*

Table 1 shows the estimated number of MZ and DZ twin pairs and the twinning rates by zygosity in the Czech Republic and the Slovak Republic during the period 1972–1995. The MZ twinning rate was about 3/1000 births for both countries, whereas the DZ rate remained nearly constant (5.2–7.3 per 1000 births) during the same period (Figure 1). Zygotic twinning rates were similar for both countries except for the latest years in the Czech Republic, where the DZ twinning rates increased. The linear regression coefficients ( $\pm$  SE) of the DZ twinning rate on the year were  $0.005 \pm 0.012$  in the Czech Republic and  $-0.014 \pm 0.013$  in the Slovak Republic, therefore not significant. Similarly, the linear regression coefficients ( $\pm$  SE) of the MZ twinning rate on the year were  $-0.003 \pm 0.007$  and  $-0.015 \pm 0.010$ , respectively, also not significant.

### *Changes in the overall triplet and zygotic triplet rates*

Table 2 shows the number of triplet sets by sex combination and total triplet rates per million births in the Czech and the Slovak Republics during the period 1972–1995. The linear regression coefficients ( $\pm$  SE) of the triplet rate on the year were  $2.140 \pm 1.0134$  in the Czech Republic, being sig-

nificant at the 5% level, and  $1.3026 \pm 0.9081$  in the Slovak Republic, being not significant. For both countries, the triplet rate was the highest in 1995. In the Czech Republic, the triplet rate was significantly higher in 1995 (207.5 per million births) than that (97.2) during the period 1972–1982 (OR 2.13; 95% CI 1.34–3.38) and in 1995 than that (116.3) during the period 1983–1993 (OR 1.78; 95% CI 1.12–2.83). In the Slovak Republic, the triplet rate was significantly higher in 1995 (162.2) than that (81.8) during the period 1972–1982 (OR 1.98; 95% CI 1.03–3.81) and higher in 1995 than (97.2) during the period 1983–1993 (OR 1.86; 95% CI 0.96–3.59). With one exception, the triplet rate was similar for both countries in each year. The exception was in 1978, where the rate was 4.9 times higher in the Czech Republic than the Slovak Republic, being significant at the 5% level.

Table 3 shows the zygotic triplet rates for the 5 periods in the Czech and Slovak Republics. With one exception, the triplet rate was the lowest in the MZ triplets, followed by the DZ, and the TZ triplets in each period for both countries. The exception was in the earliest period (1972–1976), where the DZ triplet rate was highest. In the latest period (1992–1995), the DZ rate was 3-fold and the TZ rate was about 6.5-fold higher than the MZ rate in the Czech Republic. The corresponding values in the Slovak Republic were 1.6 and 2.3-fold, respectively. The TZ triplet rate was higher in the Czech Republic than in the Slovak Republic in each period. The TZ

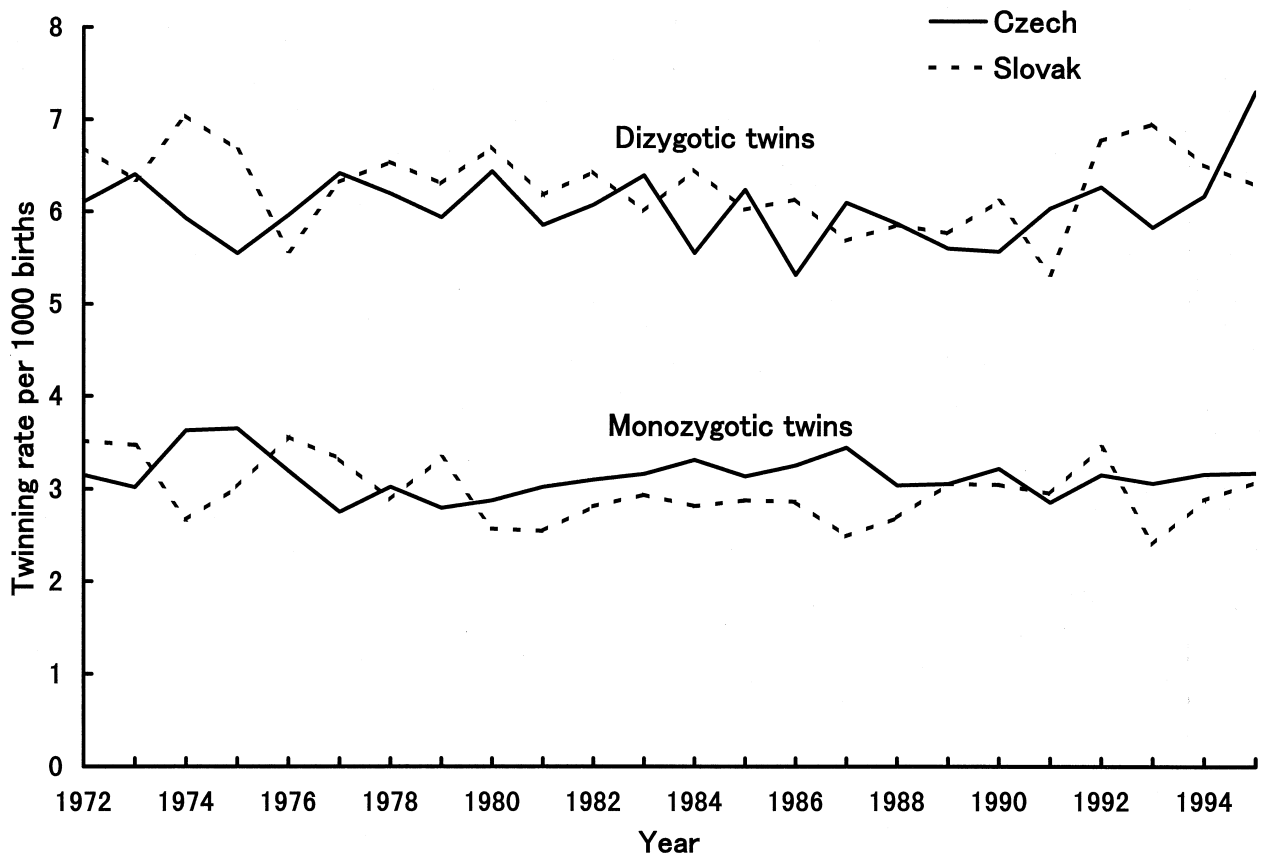


Figure 1 Changes in monozygotic and dizygotic twinning rates in the Czech and the Slovak Republics, 1972–1995

Table 2 Number of triplet sets by sex composition and total triplet rate per million births in the Czech and the Slovak Republics, 1972–1995

Year	Czech Republic					Triplet rate	Slovak Republic					Triplet rate	Odds Ratio
	Total	MMM	MMF	MFF	FFF		Total	MMM	MMF	MFF	FFF		
1972	19	3	5	5	6	115.3	11	3	0	3	5	124.4	0.93
1973	18	5	4	1	8	98.4	8	2	1	2	3	85.4	1.15
1974	15	3	4	4	4	76.8	8	2	1	2	3	81.4	0.94
1975	19	3	1	8	7	98.5	8	2	2	1	3	81.3	1.21
1976	10	2	2	3	3	53.0	7	1	2	1	3	69.6	0.76
1977	10	2	1	3	4	54.7	4	1	0	1	2	39.9	1.37
1978	26	6	8	7	5	144.4	3	0	3	0	0	29.7	4.86 <sup>a</sup>
1979	17	2	5	6	4	98.2	11	1	4	5	1	109.0	0.90
1980	15	4	3	4	4	97.0	9	2	2	4	1	94.0	1.03
1981	16	3	2	5	6	110.2	10	2	1	5	2	106.5	1.03
1982	20	5	4	7	4	140.3	8	0	1	2	5	85.8	1.63
1983	25	11	2	9	3	181.0	8	1	2	3	2	86.5	2.09
1984	9	4	2	1	2	65.4	8	2	3	2	1	87.6	0.75
1985	18	1	7	5	5	131.9	6	1	2	2	1	66.2	1.99
1986	20	5	8	4	3	149.3	11	1	4	2	4	125.5	1.01
1987	18	3	3	8	4	136.9	4	0	0	2	2	47.4	2.89
1988	10	2	1	1	6	75.1	9	3	2	1	3	107.6	0.70
1989	13	1	3	4	5	100.9	9	1	3	3	2	111.8	0.90
1990	17	5	4	5	3	129.7	7	2	3	2	0	87.1	1.49
1991	13	4	4	2	3	100.1	3	0	0	2	1	38.0	2.63
1992	15	4	7	3	1	122.8	9	2	0	5	2	120.0	1.02
1993	13	3	3	6	1	107.0	6	2	3	1	0	81.5	1.31
1994	13	1	6	2	4	121.6	8	3	0	3	2	120.0	1.01
1995	20	6	3	7	4	207.5	10	3	3	2	2	162.2	1.28

<sup>a</sup>Significant at the 5% level

**Table 3** Change of triplet rates by zygosity in the Czech and the Slovak Republics, 1972–1995

Year	Triplet deliveries			Triplet rate per million births		
	Monozygotic	Dizygotic	Trizygotic	Monozygotic	Dizygotic	Trizygotic
<b>Czech Republic</b>						
1972–1976	19	37	25	20.94	39.93	26.74
1977–1981	15	30	39	18.41	35.70	46.39
1982–1986	18	26	48	26.12	37.82	69.66
1987–1991	16	24	31	25.02	36.47	46.99
1992–1995	6	18	37	12.83	39.81	83.84
<b>Slovak Republic</b>						
1972–1976	15	20	7	31.96	41.83	13.84
1977–1981	–3	19	21	–5.11	37.72	42.66
1982–1986	5	16	20	10.84	35.57	43.63
1987–1991	4	13	15	8.72	32.68	37.05
1992–1995	7	11	15	24.22	39.31	55.66

**Table 4** Number of quadruplet sets and quadruplet rate per million births in the Czech Republic and the Slovak Republic, 1972–1995

Year	Number of sets	Rate	Number of sets	Rate	OR (95% Confidence interval)
<b>Czech Republic</b>					
1972–1976	4	4.33	6	2.45	2.59 [0.87–7.72]
1977–1981	0	0			
1982–1986	2	2.90			
1987–1991	4	6.11	7	6.36	
1992–1995	3	6.71			
<b>Slovak Republic</b>					
1972–1976	1	2.09	2	1.40	4.17 [0.76–22.74]
1977–1981	0	0			
1982–1986	1	2.20			
1987–1991	2	4.90	4	5.84	
1992–1995	2	7.22			

triplet rate was about 3–4 times higher in the latest period than in the earliest period for both countries. On the other hand, the DZ triplet rate remained nearly constant throughout all periods. Similarly, the MZ triplet rate remained nearly constant during the whole period in the Czech Republic.

#### Changes in quadruplet rates

Table 4 shows the number of quadruplet sets and quadruplet rates per million births in the Czech and the Slovak Republics during the period from 1972 to 1995. Quadruplet rates were similar for both countries for the entire period. The quadruplet rate increased after 1986, but were not significant for either country.

#### Discussion

The overall twinning rate increased from 1972 to 1996 for ten countries.<sup>13</sup> In Japan, the MZ rate remained nearly constant during the period 1975–1994,<sup>14</sup> whereas the DZ twinning rate

increased year by year during that period. In England and Wales, the MZ and DZ twinning rates increased from 1975 to 1995.<sup>11</sup> On the other hand, in the Czech and the Slovak Republics, the MZ and the DZ twinning rates remained fairly constant during the period 1972–1994, and only increased thereafter for the DZ twinning rate. In the Czech Republic, with three exceptions, unlike-sexed twinning rates were significantly higher in 1995 than in each previous year. The exceptions were in 1973, 1980, and 1983. In the Slovak Republic, unlike-sexed twinning rates were significantly higher in 1995 than in 1976, 1981, 1983, and 1985–1991. Therefore the fertility drugs and the assisted reproductive techniques such as IVF may have been introduced into those countries recently.

The overall triplet rate increased significantly year by year during the period 1972–1995 in the Czech Republic, but not in the Slovak Republic. However, in the latter country the rate was significantly higher in 1995 than in the period 1972–1982. MZ and DZ triplet rates remained nearly constant during that period for both countries, whereas the TZ triplet rate increased 3-fold for the Czech and 4-fold for the Slovak Republics between 1972–1976 and 1992–1995. A native Czech obstetrician confirmed

that IVF procedures had been available in that country since 1993 or 1994. A similar situation may have occurred in the Slovak Republic recently. In Japan,<sup>15</sup> the MZ triplet rate remained constant from 1974 to 1994, whereas the TZ triplet rate increased 11-fold during that period. The higher TZ triplet rate since 1987 in Japan has been attributed to the higher proportion of mothers treated with ovulation-inducing hormones and partially IVF. Westergaard *et al*<sup>7</sup> mentioned that the triplet rate increased in Denmark after 1989 due to the result of IVF and hormonal induction of ovulation. In England and Wales,<sup>11</sup> the TZ triplet rate increased after 1971–1975 and rapidly after 1982–1984 up to 1991–1994.

The MZ triplet rate remained relatively constant in the Czech Republic during the period from 1972 to 1995, whereas the MZ rate in the Slovak Republic was not constant during that period (Table 3). In the latter country, the number of triplet sets was 44% of that of the former country. The small number of triplets may not have resulted in consistent rates of the MZ triplet rate with the period. In the Slovak Republic, the estimated number of MZ triplet sets was in negative values in the period 1977–1981. The number of estimated negative MZ triplet sets was also reported in another paper.<sup>18</sup> It seems that these negative values may be related to estimation errors.

The multiple birth rate in the present study was not affected by the assisted reproductive techniques before 1981. Then the zygotic twinning and triplet rates were estimated during the period 1972–1981. The monozygotic twinning rate for both countries was the lowest (3.1 per 1000 births) in Europe.<sup>19</sup> According to Imaizumi,<sup>18</sup> the MZ triplet rates in the Caucasian population ranged from 13 per million births in England and Wales to 24 in Australia, the DZ triplet rates from 52 in Australia to 75 in Italy, and the TZ triplet rates from 24 in Australia to 52 in Italy. Therefore, the MZ and the TZ triplet rates in the present study belong in the Caucasian population, whereas the DZ triplet rate (38–40) was under the range of these populations. The lowest DZ triplet rate attributed to the lowest MZ twinning rate in the present study compared with that of other countries.<sup>13,19</sup> However, the lowest triplet rate was obtained in the MZ triplet and followed by the TZ and the DZ triplet rate in each country. After the introduction of assisted reproduction techniques, the highest rate was obtained among TZ triplets.

The quadruplet rate increased 2.3-fold from 2.9 in 1982–1986 to 6.7 in 1992–1995 in the Czech Republic. The corresponding values were 2.7-fold, 2.20 and 5.9 in the Slovak Republic, respectively. Quadruplet rates for both countries increased recently, which may be attributed to ovulation-inducing hormones. Among developed countries, the Czech and the Slovak Republics were not affected until recently

by the fertility drugs and the assisted reproductive techniques such as IVF.

## Acknowledgements

This study was supported in part by the Grant from the Ministry of Health and Welfare of Japan for Handicapped Children, 1996–1997. I am grateful to the staff of the Czech Statistical Office and Statistical Office of the Slovak Republic for providing data on multiple births.

## References

- 1 Bulmer MG. *The Biology of Twinning in Man*. Clarendon Press: Oxford, 1970.
- 2 Wyshak G. Statistical findings on the effects of fertility drugs on plural births. In: Nance WE, Allen G, Parisi P (eds). *Twin Research: Part B, Biology and Epidemiology*. Alan R Liss: New York, 1978, pp 17–33.
- 3 Elsner CW, Tucker MJ, Sweitzer CL *et al*. Multiple pregnancy rate and embryo number transferred during *in vitro* fertilization. *Am J Obstet Gynecol* 1997; **177**: 350–357.
- 4 Werler MM, Cragan JD, Wasserman CR, Shaw GM, Erickson JD, Mitchell AA. Multivitamin supplementation and multiple births. *Am J Med Genet* 1997; **71**: 93–96.
- 5 Ceizel AE. Periconceptional folic acid containing multivitamin supplementation. *Eur J Obstet Gynecol Reprod Biol* 1998; **78**: 151–161.
- 6 Derom R, Orlebeke J, Eriksson A, Thierry M. The epidemiology of multiple births in Europe. In: Keith LG *et al* (eds). *Multiple Pregnancy, Epidemiology, Gestation and Perinatal Outcome*. Parthenon Publ Group: New York/London, 1995, pp 145–162.
- 7 Westergaard T, Wohlfahrt J, Aaby P, Melbye M. Population based study of rates of multiple pregnancies in Denmark, 1980–91. *Br Med J* 1997; **314**: 775–779.
- 8 Imaizumi Y. Recent and long term trends of multiple birth rates and influencing factors in Japan. *J Epidemiol* 1994; **4**: 103–109.
- 9 Chen CJ, Lee TK, Wang CJ, Yu MW. Secular trend and associated factors of twinning in Taiwan. *Acta Genet Med Gemellol (Roma)* 1992; **41**: 205–213.
- 10 Taffel SM. Health and demographic characteristics of twin births: United States, 1988. Vital and Health Statistics, Series 21, No. 50, 1992; 1–17.
- 11 Wood R. Trends in multiple births, 1938–1995. *Pop Trends* 1997; **87** (Spring): 29–35.
- 12 Murphy M, Hey K, Brown J, Willis B, Ellis JD, Barlow D. Infertility treatment and multiple birth rates in Britain, 1938–94. *J Biosoc Sci* 1997; **29**: 235–243.
- 13 Imaizumi Y. Trends of twinning rates in ten countries, 1972–1996. *Acta Genet Med Gemellol (Roma)* 1997; **46**: 209–218.
- 14 Imaizumi Y, Nonaka K. The twinning rates by zygosity in Japan, 1975–1994. *Acta Genet Med Gemellol* 1997; **46**: 9–22.
- 15 Imaizumi Y, Nonaka K. Rising trizygotic triplet rates in Japan, 1975–1994. *Acta Genet Med Gemellol (Roma)* 1997; **46**: 87–98.
- 16 Weinberg W. Beiträge zur Physiologie und Pathologie der Mehrlingsgeburten beim Menschen. *Arch Ges Physiol* 1901; **88**: 346–430.

- 17 Allen G. A differential method for estimation of type frequencies in triplets and quadruplets. *Am J Hum Genet* 1960; **12**: 210–224.
- 18 Imaizumi Y, Inouye E. Analysis of multiple birth rates in Japan, III. Secular trend, maternal age effect and geographical variation in triplet rates. *Jpn J Hum Genet* 1980; **25**: 73–81.
- 19 Bulmer MG. The twinning rate in Europe and Africa. *Ann Hum Genet* 1960; **24**: 121–125.