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A Comparative Study of Twinning and Triplet Rates in 17 Countries, 1972-1996

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Abstract. Secular changes in twinning and triplet rates were analyzed using vital statistics in Austria, the Czech Republic, the Slovak Republic, England and Wales, Germany, the Netherlands, Switzerland, Denmark, Finland, Norway, Sweden, Canada, Australia, Hong Kong, Israel, Japan, and Singapore during the period from 1972 to 1996. Among those 17 countries, the twinning and triplet rates in the Czech Republic and in the Slovak Republic remained constant from 1972 to 1994, whereas these rates increased significantly year by year in the other 15 countries during the examined period in each country. Twinning rates increased from 1.2-fold in Austria to 2-fold in Denmark from 1972 to 1996. As for triplets, the rate increased from 3-fold in Denmark to 9-fold in Norway during that period. With one exception, that being the Slovak Republic, the triplet rate was highest in the Scandinavian countries, followed by the other European and Asian countries. The rising twinning and triplet rates have been attributed to the higher proportion of mothers treated with ovulation-inducing hormones and partially attributed to IVF.

Key words: Twinning rate, Triplet rate, Epidemiology, Worldwide

INTRODUCTION

It is well-known that the monozygotic twinning rate was about 3.5 per 1000 births throughout the world, whereas there were variations in the dizygotic twinning rates among races [1]. On the other hand, ovulation inducing hormones [2] and in-vitro fertilization (*IVF*) [3] bring a high rate of multiple births. In the recent papers [4-5], twinning rates increased significantly after periconceptional multivitamin supplementation.

Since the 1970s, rising twinning and triplet rates have been reported in Japan [6-8], Taiwan [9], Denmark [10], the USA [11], the UK [12-13], Austria, Finland, Norway, Sweden, Canada, Australia, Hong Kong, Israel, and Singapore [14].

The present study focuses attention on trends in the overall twinning rate and triplet rate on a world-wide scale during the period from 1972 to 1996.

MATERIALS AND METHODS

In this analysis, data on multiple births was obtained by the courtesy of the staff of the Statistics Section in 17 countries: the Austrian Central Statistical Office, Czech Statistical Office, Statistical Office of the Slovak Republic, Federal Statistics Office in The Federal Republic of Germany (Germany), Swiss Federal Statistical Office, Central Bureau of Statistics in The Netherlands, Office for National Statistics in England and Wales Statistics, Statistics Denmark, the Health and Welfare Statistics and Information Department in the National Board of Health and Welfare in Sweden, Population Statistics in Finland, Population Statistics in Norway, Division of Health Statistics in Canada, the Australian Bureau of Statistics, the Health and Welfare Statistics and Information Department in Japan, Demographic Statistics Section in Hong Kong, National Registration Department in Singapore, and the Ministry of Health in Israel.

There was no available data on the number of triplet births in Sweden, Australia, and Israel. However, the number of triplet and higher order multiple births was available in these countries. To compute the rate of triplet and higher order multiple births, the numerator used was one third of the number of these multiple births.

RESULTS

The number of twin pairs and twin individuals was obtained in 12 countries after Imaizumi [14-15]. Table 1 shows the number of twin pairs in the remaining five out of 17 countries during the period from 1972 to 1996. Table 2 shows the number of triplet sets and triplet individuals in 14 countries during that period. Table 3 shows the number of triplet and higher order multiple births in Sweden, Australia, and Israel during the period from 1972 to 1996. The twinning and triplet rates were computed by using data on multiple births mentioned as above. Figure 1 shows secular changes in the twinning rate per 1000 births and the triplet rate per million births in 16 countries during the period from 1972 to 1996. Table 4 shows regression coefficients of the twinning rate and the triplet rate on the year in each country. With two exceptions, the linear regression coefficients for the twinning rate and the triplet rate on the year showed positive values in each country, being statistically significant at the 1% level. The exceptions were the Czech Republic and the Slovak Republic, where the twinning and triplet rates remained constant during that period.

1. *Denmark*

The twinning rate slowly increased from 9.0 in 1972 to 11.2 in 1990, and rapidly increased to 17.8 by 1996. The rate was 2-fold higher in 1996 than in 1972. The triplet rate slowly increased from 1972 to 1986 and rapidly increased from 203 in 1988 to 559 in 1996. The rate was 3-fold higher in 1996 than in 1972.

2. *Finland*

The twinning rate had remained nearly constant between 1975 and 1989 (10.4-11.3), and rapidly increased to 15.6 by 1996. The twinning rate increased by 38% from 1975 to

Table 1 - Number of twin pairs in 5 countries, 1972-1996

Year	Denmark	Germany	Netherlands	Swizerland	England and Wales
1972	684	8558	2218	769	–
1973	702	7699	2006	789	–
1974	700	7554	1802	755	6151
1975	691	7186	1715	754	5909
1976	623	7488	1827	706	5538
1977	593	7141	1796	694	5449
1978	622	7243	1744	710	5859
1979	626	7371	1832	675	6099
1980	582	7967	1927	747	6308
1981	519	7781	1932	726	–
1982	532	7867	1854	709	6201
1983	518	7792	1830	714	6293
1984	567	7909	1991	716	6321
1985	587	8249	2058	765	6700
1986	577	8792	2194	800	6969
1987	617	9186	2250	806	7186
1988	662	9483	2346	859	7452
1989	690	9544	2480	962	7579
1990	712	10024	2690	949	7934
1991	840	9620	2794	973	8160
1992	923	9564	2789	1003	8314
1993	1022	9826	2825	956	8302
1994	1137	9744	2818	994	8451
1995	1123	10095	3070	975	8749
1996	1207	11063	3197	1063	8615

1996. As for triplets, the rate had remained nearly constant between 1975 and 1987 (122-229) and increased thereafter up to 545 in 1992 and decreased thereafter. The rate was 3.1-fold higher in 1996 than in 1975.

3. *Norway*

The twinning rate increased by 60% from 8.9 in 1974 to 14.5 in 1996. As for triplets, the rate was 50 in 1974 and increased to 133 in 1986, where the average was 105, and rapidly increased up to 507 in 1991 and decreased thereafter. The rate was 9-fold higher in 1996 than in 1974.

Table 2 - Number of triplet sets and number of triplets in 14 countries, 1972-1996

Year	Number of triplet sets											Number of triplet individuals		
	Denmark	Finland	Norway	Austria	Czech	Slovak	Germany	Netherlands	Switzerland	England & Wales	Canada	Japan	Singapore	Hong Kong*
1972	15	-	-	4	19	11	64	17	5	-	28	-	13	21
1973	4	-	-	5	18	8	81	24	4	-	40	-	12	6
1974	6	-	3	12	15	8	78	24	3	60	28	372	7	12
1975	15	8	3	8	19	8	72	26	10	72	34	396	9	4
1976	6	11	4	15	10	7	74	26	7	76	43	388	15	12
1977	7	14	7	4	10	4	75	27	10	68	23	392	5	9
1978	9	8	1	9	26	3	80	28	16	62	30	386	9	5
1979	4	9	5	8	17	11	60	21	12	76	43	386	6	12
1980	6	8	4	8	15	9	94	21	14	91	49	378	5	20
1981	7	9	8	5	16	10	103	32	17	-	42	463	8	29
1982	6	15	9	11	20	8	95	31	17	70	46	496	9	24
1983	7	12	3	8	25	8	76	21	11	89	40	430	10	11
1984	7	10	9	14	9	8	124	32	10	80	63	408	0	29
1985	7	12	8	19	18	6	137	31	13	93	49	394	13	15
1986	8	10	7	11	17	11	138	26	18	123	50	393	12	12
1987	8	9	11	15	18	4	158	53	25	125	64	462	12	30
1988	12	15	19	12	10	9	217	45	22	157	63	451	17	36
1989	18	15	18	6	13	9	215	75	20	183	66	474	20	41
1990	17	25	23	17	17	7	204	113	29	201	75	643	29	36
1991	21	24	31	19	13	3	234	120	22	208	84	674	23	19
1992	30	36	15	17	15	9	240	109	29	202	97	863	33	32
1993	27	21	20	21	13	6	276	91	16	234	107	858	25	48
1994	36	33	29	21	13	8	262	114	24	260	117	1057	30	48
1995	39	27	15	16	20	10	280	63	20	282	100	1006	60	44
1996	38	23	27	27	29	9	386	97	32	259	118	960	62	49

* Number of live twins.

Table 3 - Number of triplet and higher order multiple births, 1972-1996

Year	Sweden	Australia*	Israel#
1972	39		
1973	34		
1974	38		
1975	24		
1976	31		
1977	24		
1978	33		
1979	45		
1980	30		
1981	27		
1982	33	–	117
1983	28	–	123
1984	39	–	150
1985	24	49	258
1986	50	49	219
1987	60	63	240
1988	54	88	228
1989	101	103	210
1990	100	87	252
1991	136	85	246
1992	192	104	–
1993	198	88	268
1994	99	75	245
1995	117	87	371
1996	111	92	472

* Nuptial births; # Live births

4. *Sweden*

The twinning rate had remained constant between 1972 and 1977 (8.2-9.1) and gradually increased to 14.4 in 1996. The twinning rate increased by 60% from 1972 to 1996. The rate of triplet and higher order multiple births remained nearly constant between 1972 and 1985 (77-155) and increased to 549 in 1993 and decreased thereafter. The rate was 3.4-fold higher in 1996 than in 1974.

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Table 4 - Regression coefficiente of twinning and triplets rates on the year, standard error, and probability in each country, 1972-1996

Country	Period	Twins			Triplets		
		Regression coefficient	Standard error	Probability	Regression coefficient	Standard error	Probability
Denmark	1972-96	0.282	0.035	< 0.01	17.321	2.553	< 0.01
Finland	1975-96	0.177	0.033	< 0.01	16.311	2.607	< 0.01
Norway	1974-96	0.258	0.027	< 0.01	18.278	2.474	< 0.01
Sweden	1972-96	0.245	0.022	< 0.01	14.790	2.265	< 0.01
Austria	1972-96	0.106	0.016	< 0.01	6.974	1.253	< 0.01
Czech Republic	1972-96	0.000	0.000	Not sig.	-0.002	0.030	Not sig.
Slovak Republic	1972-96	–0.026	0.014	Not sig.	1.702	0.867	Not sig.
Germany	1972-96	0.178	0.018	< 0.01	13.881	1.298	< 0.01
Netherlands	1972-96	0.173	0.016	< 0.01	16.786	2.468	< 0.01
Switzerland	1972-96	0.144	0.011	< 0.01	10.604	1.509	< 0.01
England and Wales	1974-96	0.174	0.016	< 0.01	14.676	1.387	< 0.01
Canada	1972-96	0.091	0.009	< 0.01	8.769	0.871	< 0.01
Australia	1985-96	0.325	0.033	< 0.01	19.196	6.051	< 0.01
Japan	1974-96	0.115	0.011	< 0.01	9.657	1.047	< 0.01
Singapore	1972-96	0.058	0.017	< 0.01	10.118	2.001	< 0.01
Hong Kong	1972-96	0.096	0.010	< 0.01	8.510	1.092	< 0.01
Israel	1972-96 #	0.381	0.036	< 0.01	40.453	9.119	< 0.01

Period for triplet and higher order multiple births between 1982 and 1996.

Table 5 - The triplet rates for the earliest, the peak and the latest years in each country, 1972-1996

Country	Earliest		Peak		Latest		Declining triplet rate between the peak and the latest years (%)
	Year	Triplet rate	Year	Triplet Rate	Year	Triplet Rate	
Denmark	1972	197	1996	559	1996	559	0
Finland	1975	122	1992	545	1996	377	44
Norway	1974	50	1991	507	1996	441	13
Austria	1972	38	1996	303	1996	303	0
Czech Republic	1972	115	1996	320	1996	320	0
Slovak Republic	1972	124	1995	162	1996	149	8
Germany	1972	70	1996	483	1996	483	0
Netherlands	1972	79	1991	537	1996	436	19
Switzerland	1972	55	1996	386	1996	386	0
England and Wales	1974	94	1995	433	1996	402	8
Canada	1972	83	1996	320	1996	320	0
Japan	1974	58	1994	275	1996	258	6
Singapore	1972	87	1996	424	1996	424	0
Hong Kong	1972	86	1996	268	1996	268	0

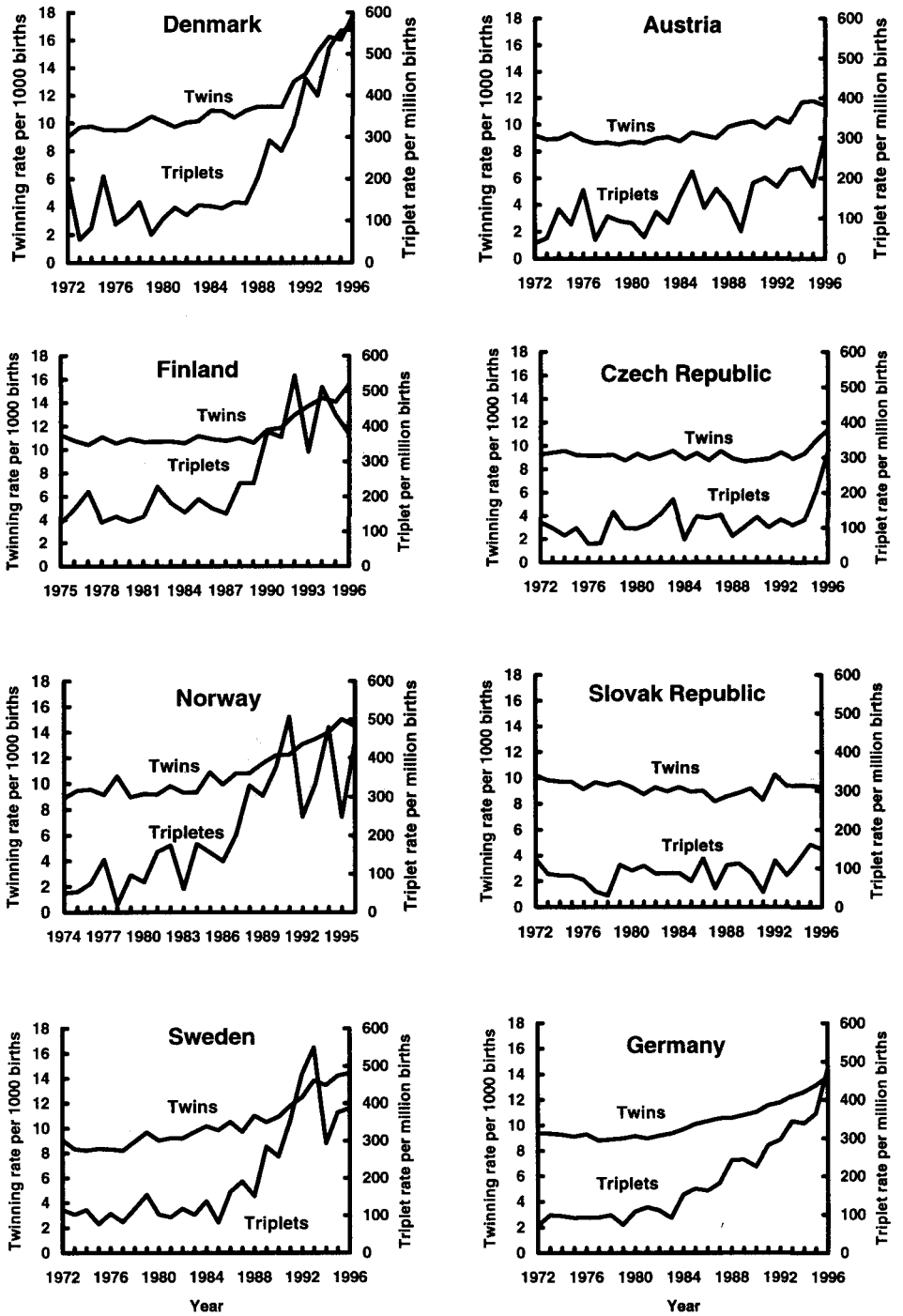

Fig. 1a - Secular changes in the twinning and the triplet rates in 16 countries, 1972-1996.

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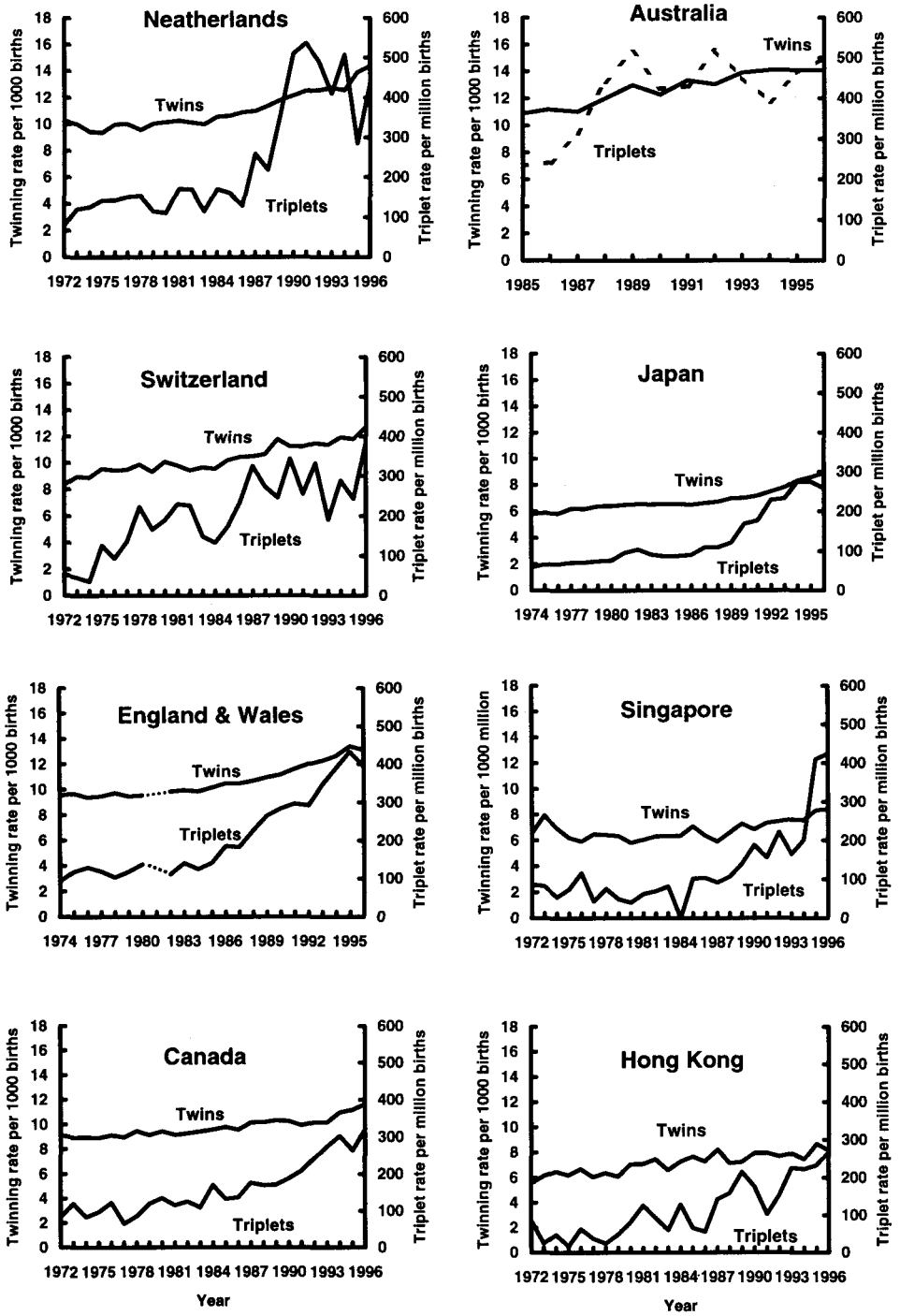

Fig. 1b - Secular changes in the twinning and the triplet rates in 16 countries, 1972-1996.

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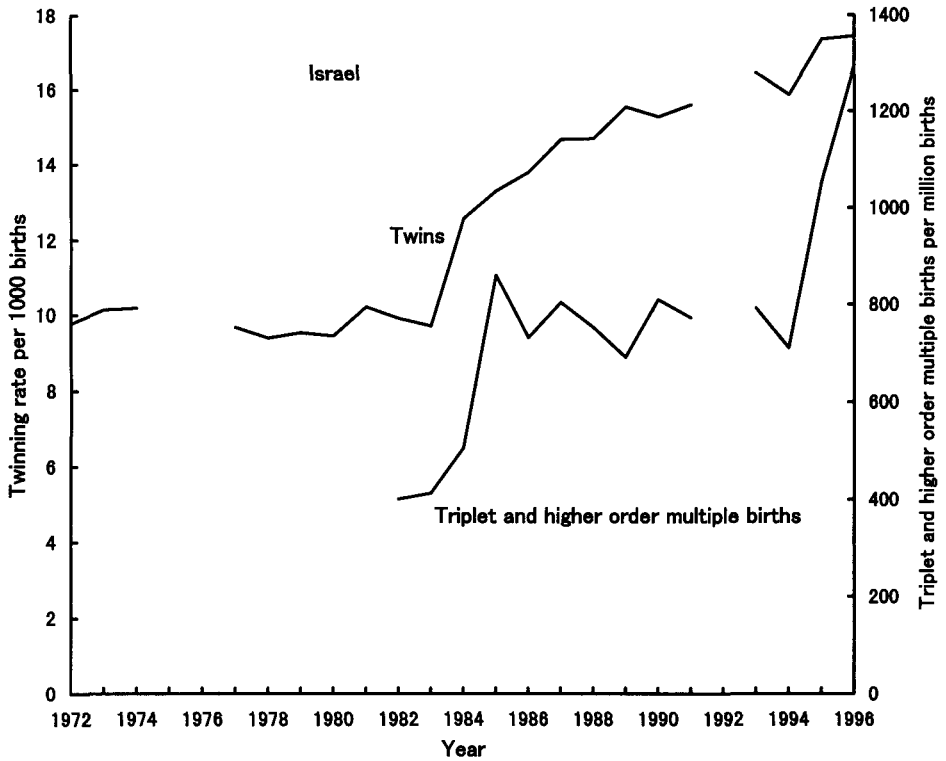

Fig. 2 - Secular changes in the live twinning rate and the rate of live triplet and higher order live multiple births in Israel, 1972-1996.

5. *Austria*

The twinning rate had remained constant between 1972 and 1987 (8.5-9.4), and increased to 11.4 in 1996, where the rate increased by 20% from 1972 to 1996. Triplet rates increased by 8-fold from 38 in 1972 to 303 in 1996.

6. *The Czech Republic*

The twinning rate had remained nearly constant between 1972 and 1994 (8.7-9.6) and increased to 11.4 in 1996. Similarly, the triplet rate had remained constant during that period (53-181) and increased to 320 in 1996.

7. *The Slovak Republic*

Overall twinning rates had remained nearly constant between 1972 and 1996 (8.2-10.2). The triplet rate had remained constant between 1972 and 1994 (30-126) and increased to 162 in 1995.

8. *Germany*

The twinning rate had remained nearly constant between 1972 and 1983 (8.8-9.4) and increased to 13.8 in 1996. The rate increased by 50% from 1972 to 1996. As for triplets, the rate had remained nearly constant between 1972 and 1983 (70.3-119), and increased from 152 in 1984 to 483 in 1996. Triplet rates increased by 7-fold from 1972 to 1996.

9. *The Netherlands*

The twinning rate had remained nearly constant between 1972 and 1983 (9.4-10.3) and increased to 14.4 in 1996. The rate increased by 40% from 1972 to 1996. As for triplets, the rate increased gradually from 79 in 1972 to 129 in 1986, and rapidly increased thereafter up to 537 in 1991, and decreased thereafter. Triplet rates increased by 5.5-fold from 1972 to 1996.

10. *Switzerland*

The twinning rate increased by 50% from 8.4 in 1972 to 12.8 in 1996. Triplet rates rapidly increased from 54.7 in 1972 to 327 in 1987 and remained constant thereafter. Triplet rates increased by 7-fold from 1972 to 1996.

11. *England and Wales*

Twinning rates had remained nearly constant between 1974 and 1984 (9.5-10) and increased to 13.4 in 1996. The rate increased by 40% during that period. Triplet rates gradually increased from 94 in 1974 to 125 in 1984 and rapidly increased thereafter up to 402 in 1996. Triplet rates increased by 4.3-fold from 1974 to 1996.

12. *Canada*

The twinning rate increased by 27% from 9.2 in 1972 to 11.6 in 1996. Triplet rates gradually increased from 83 in 1972 to 187 in 1990, and rapidly increased up to 320 in 1996. Triplet rates increased by 3.9-fold from 1972 to 1996.

13. *The Australia*

The twinning rate increased by 30% from 10.9 per 1000 nuptial live births in 1985 to 14.1 by 1996. The rate of triplet and higher order multiple births increased from 234 per nuptial live births in 1985 to 441 in 1988 and had remained nearly constant between 1988 and 1996 (391-518). The rate increased by 2.1-fold from 1985 to 1996.

14. *Japan*

Twinning rates increased by 30% from 5.8 in 1974 to 8.9 in 1996. Triplet rates gradually increased from 58 in 1974 to 109 in 1988 and rapidly increased to 275 in 1994 and decreased thereafter. Triplet rates increased by 4.5-fold from 1974 to 1996.

15. *Singapore*

With one exception, the twinning rate had remained nearly constant between 1972 and 1990 (5.8-7.3) and increased to 8.4 in 1996. The exception was 7.9 in 1973. The twinning rate increased by 30% during that period. With one exception, the triplet rate had remained constant between 1972 and 1988 (40-116) and increased to 424 in 1996. The exception was 0 in 1984. Triplet rates increased by 4.9-fold from 1972 to 1996.

16. *Hong Kong*

Twinning rates increased from 5.5 in 1972 to 8.7 in 1995 and decreased thereafter. The twinning rate increased by 50% during that period. Triplet rates had remained constant between 1972 and 1980 (17-86) and rapidly increased to 268 in 1996, where the triplet rate increased 4.9-fold during the entire period.

17. *Israel*

Figure 2 shows the live twinning rate per 1000 total births and the rate of live triplet and higher order live multiple births per million births during the period from 1972 to 1996 in Israel. The twinning rate had remained constant between 1972 and 1983 (9.4-10.2) and increased thereafter from 12.6 in 1984 to 17.4 in 1996. The rate increased by 80% during that period. The rate of triplet and higher order multiple births was 401-413 per million births in 1982-1983 and rapidly increased thereafter up to 861 in 1985 and had remained constant between 1985 and 1994 (691-861), and increased thereafter up to 1297 in 1996. The rate was 3-fold higher in 1996 than in 1982.

Table 5 shows the triplet rates for the earliest, the peak and the latest years in 14 countries during the period from 1972 to 1996. Declining rates for the latter two years were seen in 6 out of 14 countries during that period. In 8 countries, the peak year was in 1996, and followed by 1995. The declining triplet rate for that period was the highest in Finland (44%), followed by the Netherlands (19%), and Norway (13%). The triplet rate decreased after 1991 in Norway and the Netherlands, after 1992 in Finland. Triplet rates in these countries were 377-441 in 1996. In the latest examined year, the rate was the highest in Denmark (559), followed by Germany (483) and Norway (441). On the other hand, the lowest rate was seen in the Slovak Republic (149), followed by Japan (258), Hong Kong (268), and Austria (303).

DISCUSSION

From Figures 1 and 2, twinning and triplet rates increased in 15 out of 17 countries during the period from 1972 to 1996 whereas the rates had remained constant throughout the period in the Slovak Republic and in the Czech Republic with the exceptions of the latest two years. Twinning rates increased from 1.2-fold in Austria to 2-fold in Denmark during that period. These rates in the other 11 countries increased by the range of 1.2- and 2-fold during that period. In Australia, the twinning rate increased 1.3-fold from 1985 to 1996. As for triplets, the rate increased 3-fold in Denmark to 9-fold in Norway during that period, whereas the rates in the other countries increased by the range of 3-

and 9-fold during that period. Rates of triplet and higher order multiple births increased 2.1-fold in Australia, 3-fold in Israel, and 3.4-fold in Sweden during each examined period. In 15 out of 17 countries, many children had been born as a result of *IVF* since the introduction of this treatment [16]. The remaining two countries: the Czech and Slovak Republics had not been affected by fertility drugs and assisted reproductive techniques until recently [15]. In the present study, the rising twinning and triplet rates have been attributed to the higher proportion of mothers treated with ovulation-inducing hormones and partially attributed to *IVF* such as in England and Wales [13], Denmark [17], Japan [8, 18], and Sweden [14].

From Table 5, triplet rates decreased in Norway and the Netherlands after 1991, in Finland after 1992, and in Canada and Japan after 1994. According to Westergaard et al. [10], in 1991, "the Danish National Board of Health recommended that only two and never more than three oocytes or embryos should be transferred per treatment cycle, and when hormonal induction of ovulation is the only treatment a final ovulatory trigger should be given only if there are no more than three follicles ≥17mm". However, in the present study, the triplet rate did not decrease in Denmark.

Before the introduction of fertility drugs, the twinning rate was the highest in blacks, intermediate in Caucasians, and the lowest in Orientals [1]. Pollard [19] studied the twinning rates of 14 ethnic groups in California in the USA during the period from 1982 to 1988. He found that overall twinning rates were 13.2 for blacks, 10.1 for whites, and 7.2 for Asians. In the present study, the twinning rates were obtained in Caucasians and Orientals, but not in blacks. Twinning rates were higher in European countries, Canada, and Australia than in Asian countries. Among western countries including Australia, with a few exceptions, the twinning rate was the highest in Finland between 1975 and 1986 (10.4-14.4), and in Denmark between 1987 and 1996 (10.9-17.8). On the other hand, the lowest twinning rate was seen in Austria between 1976 and 1984 (8.5-9.1) and in the Slovak Republic between 1985 and 1996 (8.2-10.2). Among Asian countries, twinning rates indicated similar values (5.5-8.9) except in Israel (9.4-17.4) during the entire period. Similarly, before the introduction of fertility drugs, the triplet rate was higher in Caucasians than in the Japanese population [20]. From Table 5, triplet rates in 1996 were higher in Singapore, Hong Kong and Japan than in the Slovak Republic. Therefore, after the introduction of the assisted reproductive techniques such as *IVF*, the natural twinning and triplet rates have been changing depending on how popular these techniques have been in each country. Namely, the variations of these rates among countries were not only due to biological factors, but also to assisted reproductive techniques.

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