

CHANGES IN TWIN FREQUENCIES

by

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It often happens that in the development of a particular « character » there is interaction between the genetic and environmental factors so that only a proportion of the persons genetically predisposed actually develop the character in question. In these circumstances, quite large changes in population incidence may result from changes in social conditions without there necessarily being any alteration in the genetic structure of the population. This seems to have occurred for example in diabetes mellitus, the morbidity and mortality of which have been profoundly influenced by changing environmental conditions over the past forty years (Harris and McArthur, 1951). The twinning tendency, and particularly the tendency to binovular twinning, is another instance of a character dependent upon the interaction of genetic and environmental factors. While apparently requiring a certain hereditary predisposition, the frequency of occurrence is largely influenced by environmental factors such as the age and parity of the mother. It is therefore of interest to see whether there have been changes in population frequencies with time which may have arisen from changing social habits or changes in other environmental factors.

Until recently, the population statistics of births have received rather less attention than the statistics of mortality. Consequently the data required to investigate this problem fully are not yet available. However, the annual births in both Australia and Italy have been tabulated in sufficient detail over a sufficiently long period of time to allow a preliminary examination of the frequencies in the two countries, and the comparison between them is relevant to the problem. The detailed tabulations of births in the Commonwealth of Australia were begun in 1921, and similar tabulations of the births each year in Italy are available from 1930 onwards. The analyses which follow are based on figures taken from the official statistical publications of both countries, in which the terminologies employed are substantially the same. The word « maternity » is used to denote a pregnancy which has terminated in the birth of one or more infants (with no differentiation between live or still-births), so that a multiple birth, irrespective of the number of infants delivered, counts as only one maternity. This is not the case in the classification of maternities according to the number of previous children, for here children from earlier multiple births each count as one previous child.

Frequencies of twin-births in Australia

In the Australian statistics twin-births are tabulated with respect to the age of the mother at parturition and are further distinguished according to the sex composition of the pair. Hence estimates can be made of the relative frequencies of monovular and binovular twin pairs at each year of maternal age. Since the total number of twin births at each age are comparatively small, it is advisable to retain the customary division into five-year age-groups. The average annual frequencies in each of these maternal age-groups for the three 3-year periods 1922-24, 1935-7 and 1947-49 are shown in Table 1. The frequencies are expressed as the number of twin births per 1000 maternities and the standard errors of these rates are shown in parentheses. The monovular and binovular twins were differentiated by the simplest Weinberg method, the estimated monovular pairs being the number of like-sexed pairs in excess of the number of unlike-sexed pairs at each age. Although none of the age-specific rates for the two periods differ significantly, there has been an increase in the total frequency at each age. From the crude rates for all ages it would seem that the increase which has occurred over the 25-year interval can be attributed almost entirely to monovular twinning, but from the « corrected » rates for 1935-7 and 1947-9 (shown in the final row of the table) the frequency of binovular twinning also shows a slight increase. These corrected rates are more or less strictly comparable with the crude rates for 1922-4, for they were calculated by applying the 1935-7 and the 1947-9 age-specific rates in turn to the 1922-4 distribution of maternities to derive the number of twins expected at each age in 1935-7 and 1947-9 if the number and distribution of maternities had been the same for these years as in 1922-4. This manipulation emphasizes the increase in twin frequencies because, if the legitimate maternities are simultaneously classified according to maternal age and number of previous children, a higher proportion of young mothers and first maternities is found in 1947-9 than in 1922-4. The way in which this affects the frequencies can be gauged from Table 2, where the twin frequencies for the full classification of legitimate maternities in the three years 1947-9 is shown. It is clear from this table that the frequency of twin births increases both with maternal age and with the number of previous children. In general, the maximum frequency occurs at maternal age 35-39 years irrespective of the number of previous children; and at each age level there is a tendency for the frequency to increase as the number of previous children increases. The standard errors of the individual rates (shown in parentheses) are rather large, and it is perhaps easier to see the trend from the two series of standardized rates. In the computation of the standardized age-specific rates shown in the final column, the rates at each age level were applied to a common or standard population based on the classification of all legitimate maternities with respect to the number of previous children only. The expected number of twins so derived were summed along the rows and divided by the total number of maternities in the population to give a rate which is independent of differences with respect to parity amongst women of different ages. For the standardized rates shown in the final row of this table, the standard population used was the distribution of maternities with respect to age alone; the calculating procedure was as before except that the summations were made

Table 1 - Australia: Average annual frequencies of twin births per 1000 maternities at each maternal age over the three 3-year periods 1922-4, 1935-7, 1947-9

Maternal age	Estimated monovular twin births			Estimated binovular twin births			All twin births		
	1922-4	1935-7	1947-9	1922-4	1935-7	1947-7	1922-4	1935-7	1947-9
	<20 years	3.3 (0.7)	3.2 (0.7)	3.4 (0.6)	2.4 (0.6)	3.3 (0.7)	2.8 (0.5)	5.7 (0.9)	6.5 (0.9)
20-24	3.2 (0.3)	3.2 (0.3)	3.5 (0.3)	3.8 (0.3)	4.4 (0.4)	4.8 (0.3)	7.0 (0.5)	7.6 (0.5)	8.3 (0.4)
25-29	2.7 (0.3)	2.8 (0.3)	3.7 (0.3)	6.8 (0.4)	7.3 (0.5)	7.3 (0.4)	9.5 (0.5)	10.1 (0.5)	11.0 (0.4)
30-34	3.4 (0.3)	4.2 (0.4)	4.2 (0.3)	9.5 (0.6)	9.4 (0.6)	9.6 (0.5)	12.9 (0.6)	13.6 (0.8)	13.8 (0.6)
35-39	3.0 (0.4)	4.0 (0.5)	3.5 (0.4)	11.3 (0.8)	12.1 (0.9)	12.3 (0.8)	14.3 (0.9)	16.1 (1.1)	15.8 (0.9)
40-44	3.6 (0.7)	5.5 (1.1)	4.7 (0.9)	8.1 (1.1)	6.9 (1.2)	7.5 (1.2)	11.7 (1.3)	12.4 (1.6)	12.2 (1.5)
45 +	3.4 (2.4)	8.7 (4.3)	6.1 (4.0)	2.2 (2.0)	—	1.8 (2.1)	5.6 (3.1)	8.7 (4.3)	7.9 (4.5)
All ages Crude	3.08 (0.15)	3.49 (0.17)	3.74 (0.14)	7.24 (0.23)	7.19 (0.25)	7.37 (0.21)	10.32 (0.27)	10.68 (0.30)	11.11 (0.24)
Corrected		3.57 (0.16)	3.78 (0.17)		7.57 (0.24)	7.74 (0.24)		11.14 (0.29)	11.52 (0.29)

Table 2 - Australia: Frequencies of legitimate twin births (per 1000 legitimate maternities) at each maternal age and number of previous children in the years 1947-9

Maternal age	Number of previous children						All mothers	
	0	1	2	3 or 4	5,6 or 7	8 or more	Crude	Standardized
<20 years	5.7 (0.5)	8.2 (1.6)	11.3 (6.5)	47.6 (46.5)	—	—	6.14 (0.51)	12.01 (1.00)
20-24	7.1 (0.3)	9.2 (0.5)	12.8 (1.0)	10.9 (1.8)	7.0 (7.0)	—	8.27 (0.24)	9.01 (0.26)
25-29	9.9 (0.4)	11.3 (0.4)	11.8 (0.6)	12.0 (0.8)	12.7 (2.1)	10.4 (10.4)	11.03 (0.26)	10.99 (0.26)
30-34	12.3 (0.8)	13.4 (0.6)	14.0 (0.7)	14.3 (0.8)	18.7 (1.6)	15.3 (4.0)	13.85 (0.35)	13.42 (0.34)
35-39	13.7 (1.3)	15.2 (1.1)	17.0 (1.1)	16.0 (1.0)	14.3 (1.4)	22.4 (3.1)	15.75 (0.52)	15.07 (0.50)
40 +	14.6 (2.6)	10.6 (2.1)	10.9 (2.0)	11.3 (1.6)	12.7 (1.9)	12.0 (2.5)	11.91 (0.84)	12.32 (2.57)
All ages Crude	8.67 (0.21)	11.42 (0.27)	13.38 (0.40)	13.67 (0.47)	15.21 (0.86)	17.07 (1.79)	11.19 (0.15)	
Standardized	9.95 (0.24)	11.41 (0.27)	13.04 (0.39)	14.45 (0.50)	11.84 (0.67)	9.30 (0.99)		11.19 (0.15)

down the columns. These rates are independent of differences with respect to age between women of various parities, and it seems from them that the effect of parity on the frequency may be greatest when there have been 3 or 4 previous children. The changes in frequency with respect to age remain unaltered: the rates increase to a maximum at ages 35-39 years and then decline.

Unfortunately in the early periods the twin births were not tabulated with this detailed classification. However, for 1922-4 the numbers of legitimate twin births which were first births can be distinguished for each age of mother, and the frequencies amongst all legitimate first maternities are shown in Table 3, together with the corresponding rates for the years 1947-9, and the proportions of legitimate first maternities amongst all maternities at each age. Although the proportions of first maternities is higher in 1947-9 than in 1922-4, the frequency of twinning amongst first maternities at each age is virtually identical in the two periods. The numbers of births at age 40 years or higher are small and the difference in frequency at this age is not statistically significant.

Table 3 - Australia: Frequencies of twin births amongst all legitimate first maternities and proportions of legitimate first maternities amongst all maternities in the years 1947-9.

Maternal age	Twin births per 1000 legitimate first maternities		Percent. of legitimate first maternities amongst all maternities	
	1922-4	1947-9	1922-4	1947-9
<20 years	5.9 (0.7)	5.7 (0.5)	62	70
20-24	7.3 (0.4)	7.1 (0.3)	48	57
25-29	9.9 (0.5)	9.9 (0.4)	30	32
30-34	12.2 (0.9)	12.3 (0.8)	16	19
35-39	13.2 (1.6)	13.7 (1.3)	9	14
40 +	8.0 (2.5)	14.6 (2.6)	6	12
All ages	8.9 (0.2)	8.7 (0.2)	28	36

One not unexpected consequence of the higher proportion of first maternities and slightly younger mothers is the change in the proportion of monovular twins amongst all twins. In 1922-4, 29.9+0.7% of twins were monovular; by 1935-7 the proportion had increased to 32.7+0.8%, and in 1947-9 33.7+0.6% were monovular. The sex ratio amongst twin births has not altered.

It is difficult to reconcile this progressive increase in frequencies with the changes in the age and parity distributions unless there have been changes in the system of registration, or other environmental factors are having some effect. This latter point can be checked to a certain extent by employing a technique commonly used in the analysis of mortality statistics. Since the total number of maternities, and the number of like- and unlike-sexed twin births to women at each year of age are published each year, one can

distinguish from these statistics the births to women who were themselves born in one particular year. Hence, one can calculate the frequencies with which the women of this « cohort » give birth to twins in each year of their reproductive period. If this is done for other « cohorts » of women, born in different years, the comparison between the age-specific rates for each cohort should indicate the degree to which environmental factors other than age affect the incidence of twinning. Because of the differentiation in the statistics of like-and unlike-sexed twin pairs, one can also estimate the numbers of monovular twin pairs and calculate the frequencies of monovular twin births amongst each cohort. The lack of the double classification of twin births for the early years of tabulation means that variations amongst the cohorts with respect to number of previous children will be confounded with other factors.

Table 4 - Australia: Frequencies of twin births (per 1000 maternities) at each age amongst « cohorts » of women differentiated according to their year of birth

Age (Years)	Year of birth of cohorts								Approximate standard errors
	1891	1896	1901	1906	1911	1916	1921	1926	
15-19				7.0	6.3	4.3	4.7	5.3	0.9
20-24			7.4	7.5	7.6	7.6	9.6	8.0	0.5
25-29		9.1	10.2	9.4	10.3	10.2	10.4		0.5
30-34	13.9	13.1	13.0	13.8	13.9	14.5			0.7
35-39	16.5	15.3	15.1	17.2	15.0				1.0
40-44	11.4	11.9	16.2	12.7					1.6
45-49	6.6	10.3	2.2						3.7

Table 5 - Australia: Frequencies of estimated monovular twin births (per 1000 maternities) at each age amongst « cohorts » of women differentiated according to their year of birth

Age (Years)	Year of birth of cohorts								Approximate standard errors
	1891	1896	1901	1906	1911	1916	1921	1926	
15-19				3.5	4.0	3.5	1.8	4.1	0.7
20-24			3.3	3.2	2.6	3.1	3.4	3.6	0.3
25-29		3.0	3.9	3.1	3.3	2.7	3.6		0.3
30-34	4.3	2.9	4.8	3.9	4.7	3.6			0.4
35-39	3.0	4.2	4.5	4.0	2.7				0.5
40-44	4.4	8.9	3.4	4.5					1.0
45-49	6.6	5.1	2.2						3.2

Labelling the cohorts according to their year of birth, the « 1906 cohort » was 15 years old in 1921 and they can be followed through until 1950 when they were 44 years old. The « 1901 cohort » can be traced in similar fashion between the ages of 20 and 49 years. These are the two cohorts for which the most complete data are available: earlier

and later cohorts cover a smaller range of ages. It is advisable to retain the conventional five-year age groups again because of the small numbers of twin births at each age. The frequencies of all twin births in each age group for eight cohorts of women born at five-yearly intervals from 1891 to 1926 are shown in Table 4, with the frequencies expressed as rates per 1000 maternities and the approximate standard errors for the rates at each age shown in the final column of the table. Table 5 shows the corresponding frequencies for the estimated monovular twin births, the number of like-sexed pairs in excess of the unlike-sexed pairs at each age being assumed to represent the monovular twin pairs at that age. Comparisons between the cohorts indicate that, neither for all twin births nor for the estimated monovular twin births are there any variations in frequency at any one age which cannot be regarded as chance variations. The age-specific rates for any particular cohort differ little either from those for the other cohorts or from the average annual frequencies shown in Table 1. From this (admittedly limited) data there is no indication of the source of the changes in frequency which have occurred.

Frequencies of twin births in Italy

The number of maternities in any one year in Italy far exceeds the numbers in Australia and is in fact roughly equivalent to 5 years of Australian data. The twin births, although they are classified according to age of mother and number of previous children, are not generally differentiated according to the sex composition of the pair. Recently the twin births for the years 1949 and 1950 were tabulated according to age of mother, number of previous children and sex composition of the pair, and the analysis of this material has been published elsewhere (McArthur, 1952).

The earliest 3-year periods for which the data are available is 1930-32 and the most recent 1948-50. The frequencies of twin births for each maternal age-group and each number of previous children in each period are shown in Table 6. Comparing the crude age-specific rates for the two periods, the frequency of twin births among maternities to women between the ages of 25 and 44 was significantly higher in the period 1930-32 than amongst maternities to women of the same ages in 1948-50. If however, the age-specific rates for women of corresponding parity are compared, in no instance is there any difference in frequency: nor do any of the crude rates specific for number of previous children differ significantly. If the 1948-50 rates are corrected for differences between the two populations of maternities with respect to their distributions according to age and number of previous children, these differences with respect to age vanishes. The «corrected» rates, which are shown in the final row and column of Table 6, were computed in similar fashion to those described earlier for the Australian data, and denote the frequencies of twin births which would have occurred in 1948-50 had the ages and number of previous children of the mothers been identical with those of 1930-32. The less dramatic changes in the corrected rates for the various numbers of previous children indicates that, within each of these classes, the age distribution of the mothers has remained fairly constant; whereas the numbers of previous children to women of ages 25-44 years have tended to decrease. In the first period there was a preponderance of maternities of high birth-rank

Table 6 - Italy: Frequency of twin births in all maternities distinguishing maternal age and number of previous children for the years 1930-32 (A) and 1948-50 (B). Twin births per 1000 maternities

Maternal age	Number of previous children							All maternities	
	0	1	2	3 or 4	5, 6 or 7	or 8 more	Crude	Corrected	
<21	A	6.3 (0.2)	6.2 (0.4)	7.0 (1.2)	16.0 (5.0)	16.4 (3.9) 20.1 (6.0)	—	6.31 (0.19)	6.43 (0.19)
	B	6.3 (0.2)	6.6 (0.5)	8.6 (1.4)	22.7 (6.2)				
21-24	A	8.2 (0.2)	7.9 (0.2)	9.9 (0.4)	12.3 (0.7)	16.4 (0.8) 17.3 (1.2)	27.3 (6.9)	8.51 (0.12)	8.86 (0.12)
	B	8.5 (0.2)	8.3 (0.2)	10.2 (0.5)	12.7 (1.0)				
25-29	A	11.6 (0.2)	10.4 (0.2)	12.3 (0.3)	13.7 (0.3)	16.4 (0.8) 17.3 (1.2)	12.1 (5.4)	12.06 (0.12)	11.89 (0.12)
	B	10.7 (0.2)	10.5 (0.2)	12.3 (0.3)	13.8 (0.4)				
30-34	A	14.3 (0.5)	13.6 (0.4)	15.3 (0.3)	17.0 (0.3)	20.1 (0.4) 20.0 (0.6)	24.1 (1.7)	16.55 (0.15)	16.54 (0.15)
	B	13.7 (0.4)	13.7 (0.3)	15.6 (0.4)	17.1 (0.4)				
35-39	A	17.7 (0.9)	15.0 (0.6)	18.5 (0.6)	19.8 (0.4)	21.2 (0.4) 20.5 (0.4)	24.6 (0.7)	20.07 (0.20)	19.56 (0.20)
	B	16.1 (0.6)	14.8 (0.5)	17.1 (0.5)	19.9 (0.4)				
40-44	A	13.7 (1.5)	11.4 (1.6)	14.2 (1.0)	15.0 (0.6)	16.2 (0.5) 15.0 (0.5)	17.1 (0.5)	15.82 (0.28)	14.68 (0.28)
	B	13.5 (1.1)	13.4 (1.0)	10.5 (0.8)	14.3 (0.6)				
45 +	A	13.8 (5.2)	4.8 (2.8)	10.1 (3.4)	8.9 (1.6)	6.6 (1.0) 7.4 (1.3)	7.7 (0.9)	7.67 (0.58)	5.97 (0.58)
	B	3.0 (2.1)	7.4 (3.3)	3.1 (1.8)	3.7 (1.2)				
All ages	A	9.69 (0.11)	10.22 (0.13)	13.50 (0.17)	16.39 (0.16)	19.29 (0.22)	19.54 (0.39)	13.54 (0.07)	13.40 (0.07)
Crude	B	9.83 (0.10)	10.82 (0.13)	13.65 (0.18)	16.69 (0.20)	18.71 (0.27)	18.50 (0.48)	12.61 (0.07)	
Corrected	B	9.41 (0.11)	10.44 (0.13)	13.35 (0.17)	16.42 (0.16)	18.84 (0.22)	18.34 (0.38)		

Table 7 - Italy: Frequencies of twin births per 1000 maternities amongst "cohorts" of women born at 5-yearly intervals from 1892 to 1927 and the average frequency amongst all cohorts, distinguishing maternal age and number of previous children

Maternal age	Cohort	Number of Previous Children							Cohort
		0	1	2	3 or 4	5,6 or 7	8 or more	Total	
15-19	A	5.6 (0.5)	8.5 (1.4)	17.1 (6.4)	16.1(16.0)	—	—	6.1 (0.5)	A born 1927
	B	5.7 (0.4)	7.9 (1.2)	9.2 (4.1)	—	—	—	6.1 (0.4)	B » 1922
	C	9.0 (0.7)	9.6 (1.7)	8.5 (4.9)	—	—	—	9.3 (0.7)	C » 1917
	D								D » 1912
	E								E » 1907
	F								F » 1902
	G								G » 1897
	H								H » 1982
	Mean	6.4 (0.3)	8.5 (0.8)	11.5 (3.0)	9.7 (9.7)	—	—	6.8 (0.3)	Mean
20-24	A								
	B	8.4 (0.3)	8.8 (0.4)	11.3 (0.8)	13.0 (1.6)	15.4 (7.7)		8.8 (0.2)	B
	C	8.3 (0.3)	8.0 (0.4)	9.0 (0.8)	11.1 (1.6)	20.1(11.5)		8.4 (0.2)	C
	D	8.7 (0.3)	7.6 (0.4)	8.9 (0.6)	11.3 (1.3)	36.8(13.7)		8.5 (0.2)	D
	E								
	F								
	G								
	H								
	Mean	8.5 (0.2)	8.1 (0.2)	9.7 (0.4)	11.8 (0.9)	23.4 (6.2)	—	8.6 (0.1)	Mean
25-29	A								
	B								
	C	11.0 (0.5)	10.0 (0.4)	13.4 (0.6)	13.0 (0.7)	13.6 (1.8)	—	11.4 (0.3)	C
	D	10.7 (0.3)	11.4 (0.4)	12.9 (0.5)	14.1 (1.6)	16.4 (1.6)	12.8 (9.0)	12.0 (0.2)	D
	E	10.9 (0.4)	10.5 (0.4)	12.2 (0.4)	13.7 (0.5)	16.2 (1.4)	18.5(10.6)	11.8 (0.2)	E
	F								
	G								
	H								
	Mean	10.8 (0.2)	10.7 (0.2)	12.7 (0.3)	13.7 (0.3)	15.8 (0.9)	10.4 (4.6)	11.8 (0.1)	Mean
30-34	A								
	B								
	C								
	D	13.6 (0.7)	15.5 (1.2)	15.8 (0.6)	16.6 (0.5)	18.3 (0.8)	14.0 (2.5)	15.3 (0.3)	D
	B	14.6 (0.7)	14.0 (0.6)	16.1 (0.6)	16.6 (0.5)	19.4 (0.7)	17.4 (2.3)	16.3 (0.3)	E
	F	12.8 (0.8)	13.7 (0.7)	15.6 (0.6)	16.2 (0.5)	17.2 (0.7)	18.0 (2.4)	15.6 (0.3)	F
	G								
	H								
	Mean	13.8 (0.4)	13.5 (0.3)	15.8 (0.3)	16.4 (0.3)	18.3 (0.4)	16.7 (1.4)	15.7 (0.2)	Mean

Continued table 7

Maternal age	Cohort	Number of previous children							Cohort	
		0	1	2	3 or 4	5,6 or 7	8 or more	Total		
35-39	A									
	B									
	C									
	D									
	E	17.0 (1.2)	12.9 (0.9)	17.8 (0.9)	20.4 (0.7)	20.7 (0.7)	25.7 (1.4)	19.2 (0.4)	E	
	F	15.3 (1.3)	14.5 (1.1)	16.5 (1.0)	20.5 (0.7)	21.1 (1.2)	24.0 (1.2)	19.8 (0.4)	F	
	G	17.3 (1.6)	14.6 (1.1)	19.5 (1.1)	19.8 (0.7)	20.8 (0.6)	25.5 (1.4)	20.1 (1.2)	G	
	H									
	Mean	15.7 (0.8)	13.8 (0.6)	17.9 (0.6)	20.2 (0.4)	20.9 (0.4)	25.0 (0.8)	19.7 (0.2)	Mean	
40-44	A									
	B									
	C									
	D									
	E									
	F	6.6 (1.6)	10.3 (1.7)	11.3 (1.6)	15.0 (1.1)	17.3 (0.9)	19.3 (1.2)	15.8 (0.5)	F	
	G	11.9 (2.5)	9.0 (1.9)	11.2 (1.7)	14.2 (1.1)	14.9 (0.8)	15.5 (1.0)	14.6 (0.5)	G	
	H	12.3 (2.8)	10.7 (2.1)	14.3 (1.9)	14.6 (1.1)	15.5 (0.8)	16.9 (1.0)	15.3 (0.5)	H	
	Mean	9.7 (1.3)	10.0 (1.1)	12.2 (1.0)	14.6 (0.6)	15.8 (0.5)	17.5 (0.6)	15.2 (0.3)	Mean	
45-49	A									
	B									
	C									
	D									
	E									
	F									
	G	—	5.5 (5.5)	—	7.6 (3.1)	5.1 (1.7)	5.0 (1.7)	5.0 (1.0)	G	
	H	28.0(16.0)	—	14.5 (8.3)	10.2 (3.6)	5.9 (1.8)	7.9 (2.0)	8.0 (1.2)	H	
	Mean	12.2 (7.0)	3.4 (3.4)	6.8 (3.9)	9.5 (2.5)	5.5 (1.2)	6.5 (1.3)	6.5 (0.8)	Mean	

and first maternities constituted less than $\frac{1}{4}$ of all maternities. In 1948-50 more than $\frac{1}{3}$ of all maternities were first maternities.

Of the general trends common to the two periods, the most obvious is that the frequency of twin births appears to be independently related to both maternal age and the number of previous children. For each number of previous children the maximum frequency occurs at maternal ages 35-39 years, and at each age level the frequency tends to increase progressively for births of rank higher than the second. For maternities of first and second rank the frequency of twinning is virtually identical at each age, and the most significant increase in the age-specific rates occurs between maternities of second rank and those where there have already been two previous children. As there were no statistically significant differences between the age-specific rates when

Table 8 - Italy: Average frequency of twin births in all maternities distinguishing maternal age and number of previous children: A - Average of 1930-2 and 1948-50 frequencies, C - average frequency amongst all cohorts

Maternal age	Number of previous children												All maternities	
	0		1		2		3 or 4		5,6 or 7		8 or			
	A	C	A	C	A	C	A	C	A	C	A	C	A	C
<21	6.3	6.7	6.4	8.0	7.8	9.0	19.3	8.6	18.3	23.4	—	—	6.3	7.0
21-24	8.4	8.8	8.1	8.3	10.1	10.0	12.5	12.0	18.3	23.4	—	—	8.6	8.9
25-29	11.1	10.8	10.5	10.7	12.3	12.7	13.7	13.7	16.8	15.8	19.7	10.4	11.7	11.8
30-34	14.0	13.8	13.6	13.5	15.5	15.8	17.0	16.4	20.0	18.3	22.7	16.7	16.1	15.7
35-39	16.9	15.7	14.9	13.8	17.8	17.9	19.9	20.2	20.8	20.9	24.3	25.0	19.4	19.7
40-44	13.6	9.7	12.4	10.0	12.3	12.2	14.7	14.6	15.6	15.8	16.5	17.5	15.1	15.2
45 +	8.4	12.2	6.1	3.4	6.6	6.8	6.3	9.5	7.0	5.5	6.8	6.5	6.8	6.5

there had been 3 or 4 previous children, nor were there differences between the rates amongst those maternities following 5, 6 or 7 previous children, the grouping of maternities into the two classes 3 or 4 and 5, 6 or 7 results in no loss of information.

In view of the similarities between the twin frequencies in the two periods, one would not expect to obtain much additional information from the consideration of « cohorts » of women. However, it is possible to separate births of different ranks and because of this it is perhaps of interest to show the data which are available. Eight cohorts were used, consisting of women born at 5-yearly intervals from 1892 to 1927. The maximum number of age-groups for which the numbers of maternities and twin births are known for any cohort is three, and the frequencies with which each cohort produced twins in each age group and for each number of previous children are shown in Table 7. The frequency for all cohorts taken together is given in each cell of this Table and again in Table 8 for comparison with the average frequency of the two periods 1930-2 and 1948-50. Here, the first two age groups of the cohorts have been adjusted to correspond with the <21, 21-24 years groups used in the annual tabulations, and although the standard errors of the rates are not given they are approximately the same as those shown in the previous tables. As in the Australian data, there is very close agreement not only between the various cohort frequencies but also between the two sets of « average » frequencies, the average of all cohorts and the average of the two annual frequencies.

Discussion and Conclusions

Although the two youngest age groups do not coincide exactly, comparison of the corresponding cells of Tables 2 and 6 shows that there is essentially no difference between the frequencies with which Australian and Italian women of the same age and parity give birth to twins. Waterhouse (1950) computed the rates for England and Wales over the 10½ year period 1938-1948 in similar detail and these agree closely with the rates given

here. The one difference between the countries lies in the equivalence of the age-specific rates for births of first and second rank in Italy, whereas the other two countries show a higher frequency of twin births amongst maternities of second rank than amongst first maternities. The differences in the crude *total* frequencies (for England and Wales there were 12.2 twin births per 1000 maternities) derive largely from differences between the populations with respect to their maternal age and parity distributions, and the most striking feature of this analysis is probably the demonstration of the effect of parity on the frequency of twinning. It was suggested elsewhere (McArthur 1952) that, while both maternal age and parity are independently related to the frequency of occurrence of binovular twinning, neither one nor the other is the more closely related and the importance of this double classification of births in both statistical and genetic investigations cannot be over-emphasized. For international comparisons in particular it is clearly no longer sufficient to have births classified only with respect to maternal age.

In view of the constancy of the twin frequencies shown in the Italian material, it is a little disconcerting to find that the frequency in Australia has shown a tendency to increase, in spite of an increasing proportion of first births. However, the way in which the frequencies have changed — the comparatively small increase in the binovular twin frequencies compared with the larger, progressive change in the monovular twin frequencies — suggests that the increase may perhaps be a result of improved ante-natal care during the past 25 years. Information on the frequency of miscarriages is not available and unfortunately there are no published data on the frequency of stillbirths in Australia from which the behaviour of the miscarriage rates might be inferred. The stillbirth figures for England and Wales were carefully examined by Sutherland (1949) who found that the rate had declined considerably between 1933 and 1944. Lowe and Record (1951) extended this analysis for England and Wales and noted that the stillbirth rates amongst like-sexed twin pairs were consistently higher than amongst unlike-sexed pairs. Moreover, while the stillbirth rates for unlike-sexed pairs were lowest for mothers less than 25 years of age and increased with maternal age, stillbirths amongst like-sexed twins occurred least frequently in the middle of the reproductive period. Improved antenatal care leading to a reduction in the stillbirth rate would, therefore, probably result in a larger number of twins being born to mothers of advanced ages (and parities) and of these, possibly a high proportion would be like-sexed twin pairs. While there is no direct evidence that this is occurring, the lack of any consistent variability in the frequencies amongst the various cohorts suggests that the deficiency in numbers of twins consequent on smaller family sizes is being offset by some such survival factor.

It would seem that the general conclusion which must be drawn from the examination of these statistics is that, compared with the effects of maternal age and parity, other environmental factors play a very small role in the frequency of twinning. Provided maternal age and parity are distinguished, both the « cohort » method of analysis and detailed comparison between populations of different social habits and conditions should give a reasonable indication of the effect of these other factors, and in the data presented here there is no evidence of such effects. In fact, these data suggest that twinning is either wholly non-genetic in origin or that the interaction between genetic and environmental

factors involved is approximately the same in Australia, in Italy and probably in England and Wales. This is equivalent to saying that the gene frequency is either zero or has some constant value common to the populations of these three countries.

Summary

The statistics of twin births in Australia and Italy were examined and the frequencies within the two countries at different periods of time compared. There has been an increase in monovular twin frequencies in Australia over a period of 25 years in spite of an increasingly higher proportion of first maternities amongst total maternities and generally lower maternal age. The cause of the increase could not be ascertained because of insufficient information. The decrease in gross frequency which occurred in Italy was found to derive from the smaller number of maternities to women of high parity in recent years. The frequency of twin births to women of corresponding age and parity remained unaltered and differed only slightly from comparable groups of Australian women.

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SOMMARIO

Sono state esaminate le statistiche delle nascite gemellari in Australia e in Italia e sono state confrontate le frequenze nei due paesi in periodi differenti di tempo. Vi è stato un aumento nelle frequenze dei gemelli monovulari in Australia in un periodo di 25 anni nonostante una man mano crescente proporzione di prime maternità fra le maternità totali ed una età materna generalmente inferiore. La causa dell'aumento non si è potuta appurare per insufficienza di informazioni. La diminuzione nella frequenza totale che si è verificata in Italia è risultata derivante dal più piccolo numero di maternità per donne di alta fecondità negli anni recenti.

La frequenza di nascite gemellari per donne di età e numero di maternità corrispondente è rimasta inalterata ed ha avuto soltanto una leggera differenza rispetto a gruppi comparabili di donne australiane.

SUMMAIRE

Les statistiques des naissances gémellaires en Italie et en Australie, ont été examinées, de même qu'ont été confrontées les fréquences dans les deux pays au cours de période de temps différentes. On a enregistré une augmentation pour les fréquences des jumeaux monovulaires en Australie pendant une période de 25 ans nonobstant que croissait, petit à petit, une proportion de premières maternités entre les maternités totales et un âge maternel généralement inférieur. Une insuffisance d'information n'a pas permis de connaître la cause de cette augmentation. La diminution de la fréquence totale qui s'est vérifiée en dérive d'un nombre inférieur de maternité chez les femmes de haute fécondité au cours des récentes années. La fréquence de naissances gémellaires pour les femmes d'âge et le nombre correspondant de maternité est demeuré inaltéré. On note toutefois une légère différence par rapport à des groupes de comparaison de femmes australiennes.

ZUSAMMENFASSUNG

Man hat die Statistiken ueber Zwillingsgeburten in Australien und Italien geprueft und deren Haeufigkeit in den beiden Laendern in verschiedenen Zeitabschnitten verglichen. Im Verlauf von 25 Jahren hat sich in Australien eine Zunahme der eineiigen Zwillingsgeburten gezeigt, waehrend hingegen das Verhaeltnis der Erstgeburten gegenueber den Gesamtgeburten allmaechlich angestiegen und das Alter der Muetter im allgemeinen niedriger geworden war. Die Ursache dieses Anstiegs konnte mangels genuegender Angaben nicht genau festgestellt werden. Dan Absinken in der Gesamtanzahl der Geburten, das in Italien stattgefunden hat, ist darauf zurueckzufuehren, dass in den letzten Jahren die hochgradig fruchtbaren Frauen weniger Geburten hatten.

Die Haeufigkeit der Zwillingsgeburten bei Frauen entsprechenden Alter und dementsprechender Geburtenzahl ist unveraendert geblieben und zeigt nur geringe Unterschiede im Verhaeltnis zu den vergleichbaren Gruppen australischer Frauen.