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THE FREQUENCY OF MONOVULAR AND BINOVULAR TWIN BIRTHS IN ITALY, 1949 - 1950

by

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One of the least controversial aspects of twinning is that relating to the variations in the frequency of twin births to women of different ages. The rise in frequency which accompanies increasing maternal age was noted first by Duncan (1865), and some thirty years later Bertillon (1898) observed that the frequency of twin births relative to all births was highest amongst women aged 36-40 years, after which age it decreased slightly. The birth statistics of Paris, in which twin births were classified simultaneously according to age of mother and sex-composition of the pair (viz. 2 males; 1 male, 1 female; or 2 females) enabled Weinberg (1901, 1909) to elaborate still further these changes in frequency with age of mother. By applying his "differential method" to the Parisian data he estimated the relative proportions of monovular and binovular twin pairs, and calculated the frequency with which the two types occurred in each maternal age-group. From this analysis he found that the increase in twin frequency with increasing maternal age could be assigned almost entirely to binovular twinning, for the frequency of monovular twinning remained virtually constant for all maternal ages. However it was not clear whether the increased frequency of diovulation implied by such increases in binovular twin frequency was a function solely of maternal age, or whether it could be attributed to the generally higher parity of women of advanced ages, or whether it was dependent on some combination of both maternal age and parity. The elucidation of this demands that twin births be classified in greater detail than is customary in official tabulations, although much can be inferred from investigations relating to all twin pairs, if it is assumed that the monovular twin frequency is constant at all maternal ages and parities. The reasonableness of this assumption of constant frequency was confirmed by Yerushalmy and Sheerar's (1940) analysis of the statistics of twin births in New York State exclusive of New York City in 1936 and 1937. Since these twin births were classified simultaneously according to the sex-composition of pairs, the rank of birth and age of mother, the authors were able to estimate the relative frequencies of monovular and binovular twin births at each age and birth rank. The conclusions drawn from their examination of these data were that the frequency of binovular twinning was independently related to both maternal age and birth rank, but more closely related to the rank of birth than to the age of the mother. However, the total number of twin births was relatively small; hence the standard errors of the frequencies tended to be large and rather wide grouping of birth ranks was necessary. Recently the Istituto Centrale di Statistica

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has made available to the author the statistics of all maternities in Italy for the years 1949 and 1950, with the births classified simultaneously for maternal age and rank of birth, and the twin births further differentiated according to the sex-composition of the pairs. This covers more than 1,800,000 maternities and 22,708 twin births: excluding those for which either maternal age or rank of birth or both were not stated, the number of twin births reduces to 22,625, 7441 male/male pairs, 7925 male/female pairs, 7259 female/female pairs. The detailed analysis of these data is presented in this paper.

The numbers of monovular and binovular twin pairs at each maternal age and birth rank were estimated according to the simplest Weinberg method, it being assumed that twice the number of unlike-sexed (i.e. male/female) pairs were binovular pairs and the remaining pairs monovular. Subsequently the numbers were recalculated taking the deviation from a 1:1 sex ratio into account, but the differences between the numbers obtained by the two methods were so small that all the figures quoted here relate to the original estimates. The frequencies per 1000 maternities for these "estimated" monovular and binovular twin pairs are given in Tables 1 and 2, with the standard errors of the rates shown in parentheses. It was found that, since the differences between the age-specific rates for birth ranks 4 and 5 and between those for births ranks 6, 7, and 8 were negligible, these could be combined with advantage into the two grouped ranks "4 or 5", and "6, 7, or 8", thereby reducing the random fluctuations consequent upon too small numbers.

Except perhaps for slight increases in the crude rates, (the age-specific rates for all birth ranks and the birth rank specific rates for all ages), with increasing age and birth rank, there is at first sight no particular trend in the monovular twin frequencies. There are differences between some of the individual rates and the crude total rates which reach levels of statistical significance, but they appear to be distributed about the table with no particular design. If, for example, the individual rates are compared with the birth rank-specific rates, it is found that, for birth rank 2, the frequency at ages 20-24 years is less than the rate amongst all births of this rank: for birth rank 3, the frequency at 20-24 years is greater than the total and that for 25-29 years is less than the frequency in all births of third rank. For all birth ranks combined, the rate at 20-24 years is less than, and that for 35-39 years is greater than the total rate for all ages, all birth ranks combined.

The variations in frequency can be demonstrated more clearly with a table of χ. If it is assumed that monovular twin births occur with a constant frequency at all ages and birth ranks, the number of twins expected at each age and birth rank can be calculated by applying this rate to the number of maternities at each age and birth rank. There are then three comparisons of observed and expected numbers which can be tested by χ^2, the individual cells of the two-way table and the two series of totals, one classified for age alone, the other distinguishing only birth ranks. In addition, the individual contributions to the total χ^2 indicate the magnitude of the deviation of any particulare age/birth rank group. For this purpose it is more convenient to use the square root of the χ^2-contribution since it can be given a sign to indicate the direction of the deviation. Excluding all maternities for which either maternal age or birth rank or both were not stated, the frequency of monovular twin births in these data is 3.753 per 1000 maternities.

Table 1 - Estimated monovular twin births in Italy, 1949 and 1950: frequency per 1000 maternities at each age and rank of birth.

Maternal age group	Rank of birth						All ranks of birth	
	1	2	3	4 or 5	6,7 or 8	9 or higher	Crude	Standardized
<20	3.8 (0.3)	4.1 (0.7)	7.7 (2.9)	22.9 (13.1)	—	—	3.89 (0.25)	6.76 (.43)
20-24	3.4 (0.1)	3.1 (0.2)	4.8 (0.4)	3.9 (0.6)	—	—	3.39 (0.09)	3.19 (0.08)
25-29	3.9 (0.1)	3.7 (0.1)	3.1 (0.2)	4.0 (0.2)	4.3 (0.7)	—	3.72 (0.08)	3.69 (0.08)
30-34	3.4 (0.2)	4.0 (0.2)	3.9 (0.2)	3.4 (0.2)	3.8 (0.3)	0.7 (0.5)	3.66 (0.11)	3.59 (0.10)
35-39	4.7 (0.4)	4.5 (0.3)	3.0 (0.3)	4.6 (0.2)	4.1 (0.2)	4.0 (0.5)	4.15 (0.12)	4.32 (0.12)
40 +	4.6 (0.8)	5.4 (0.8)	2.6 (0.5)	4.0 (0.4)	4.0 (0.3)	4.6 (0.4)	4.08 (0.18)	4.37 (0.20)
All ages								
Crude	3.67 (0.08)	3.73 (0.09)	3.52 (0.12)	4.01 (0.12)	4.01 (0.16)	4.13 (0.29)	3.73(0.05)	
Standardized	3.86 (0.08)	3.88 (0.09)	3.75 (0.12)	4.64 (0.14)	3.01 (0.14)	1.07 (0.07)		3.73 (0.05)

Table 2 - Estimated binovular twin births in Italy, 1949 and 1950: frequency per 1000 maternities at each age and rank of birth.

Maternal age group	Rank of birth						All ranks of birth	
	1	2	3	4 or 5	6,7 or 8	9 or higher	Crude	Standardized
<20	2.2 (0.2)	2.3 (0.5)	6.6 (2.7)	—	—	—	2.27 (0.19)	2.28 (0.19)
20-24	4.9 (0.1)	5.3 (0.2)	5.4 (0.4)	9.1 (1.0)	21.4 (7.5)	—	5.17 (0.11)	7.02 (0.15)
25-29	6.6 (0.2)	6.7 (0.2)	9.1 (0.3)	10.0 (0.4)	12.7 (1.2)	8.2 (5.7)	7.50 (0.11)	8.05 (0.12)
30-34	10.2 (0.4)	9.9 (0.4)	11.7 (0.4)	13.3 (0.4)	15.3 (0.7)	16.8 (2.4)	11.81 (0.19)	11.43 (0.18)
35-39	11.1 (0.6)	10.6 (0.5)	13.2 (0.5)	15.1 (0.4)	16.2 (0.5)	19.4 (1.0)	14.30 (0.22)	12.53 (0.19)
40+	8.7 (1.1)	7.4 (0.9)	7.1 (0.8)	9.8 (0.6)	9.9 (0.5)	9.9 (0.6)	9.39 (0.28)	8.45 (0.25)
All ages								
Crude	6.09 (0.10)	7.21 (0.13)	9.90 (0.20)	12.55(0.22)	14.24(0.30)	13.82(0.52)	8.76 (0.07)	
Standardized	7.55 (0.12)	7.47 (0.13)	9.15 (0.18)	10.84(0.19)	15.13(0.32)	9.42(0.36)		8.76 (0.07)

On this basis the expected numbers of monovular twin births at each age and birth rank were calculated, and these and the values of χ derived from the comparison with the observed numbers are shown in Tables 3 and 4 respectively. In Table 4 a plus sign (+) indicates that the observed number of twins is greater than the number expected, a minus sign (—) that there were less twins observed than would be expected if the frequency of monovular twins was constant at all ages and birth ranks. The values of χ^2 for the three comparisons mentioned above are all statistically significant. For the whole table, $\chi^2 = 118.74$ with 28 degrees of freedom: for the age-group totals $\chi^2 = 31.563$ with 5 degrees of freedom. For both of these comparisons the chance of obtaining a larger value of χ^2 is less than 0.001. The age groups which contribute most to these values of χ^2 are the two groups 20-24 years and 35-39 years. In the first group the observed numbers of

Table 3 - Estimated monovular twin births in Italy, 1949 and 1950: and number expected assuming a constant frequency of 3.753 monovular twin births per 1000 maternities.

Maternal age group.	Rank of Birth												All ranks of birth.	
	1		2		3		4 or 5		6,7 or 8		9 or higher			
	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.
<20	201	200	39	35	7	3	3	1	—	—	—	—	250	239
20-24	871	970	364	442	166	130	37	35	—	2	—	—	1438	1578
25-29	858	826	729	731	306	370	265	249	38	33	—	1	2196	2210
30-34	198	218	322	300	251	243	276	301	136	124	2	11	1185	1208
35-39	135	108	188	157	137	171	368	302	304	277	75	70	1207	1085
40 +	33	27	48	34	29	42	103	97	158	150	128	105	499	455
All ages	2296	2349	1690	1699	896	959	1052	985	636	596	205	187	6775	6775

Table 4 - Table of χ for comparison of observed numbers of estimated monovular pairs with numbers expected on constant frequency of 3.753 monovular twin births per 1000 maternities

Maternal age group	Rank of birth						All ranks of birth
	1	2	3	4 or 5	6,7 or 8	9 or higher	
<20	+ 0.075			+ 1.510			+ 0.682
20-24	— 3.183	— 3.695	+ 3.194		+ 0.028		— 3.531
25-29	+ 1.135	— 0.068	— 3.327	+ 1.013	+ 0.679		— 0.298
30-34	— 1.380	+ 1.257	+ 0.503	— 1.453	+ 1.061	— 2.665	— 0.657
35-39	+ 2.644	+ 2.475	— 2.569	+ 3.785	+ 1.613	+ 0.574	+ 3.714
40 +	+ 1.230	+ 2.476	— 2.038	+ 0.610	+ 0.650	+ 2.231	+ 2.077
All ages	— 1.090	— 0.215	— 2.035	+ 2.125	+ 1.643	+ 1.311	

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monovular twins tend to be lower than the numbers expected, and in the second the observed frequency of twinning tends to be higher than the total rate. For the birth rank totals $\chi^2 = 14.308$ and, with 5 degrees of freedom, the chance of exceeding this value is approximately 0.014. The ranks responsible for the greatest contributions to this χ^2 are birth rank 3 and the grouped ranks 4 or 5.

These variations in frequency with age and birth rank can be summarised conveniently in ' standardized ' rates. The technique of standardization is frequently used to facilitate comparisons between series of age-specific rates, but it should be remembered that the magnitude of a standardized rate depends on the constitution of the population chosen as standard, and that in its calculation no account is taken of the standard errors of the individual rates. For these data, the total population of maternities is probably the best ' standard ' population to choose. Since it can be classified in two ways, (i) with respect to maternal age alone and (ii) with respect to birth rank alone, there are two series of standardized rates, one of which is independent of the age distribution of maternities and hence indicates the trend with respect to birth rank; the other, independent of birth ranks at each age level, showing the trend with respect to maternal age. These are shown in the final row and column respectively of Table 1. It would seem from these that monovular twinning is more closely related to age than to birth rank for, while the frequency tends to increase as the ages of mothers rise, the standardized rates decrease for births of higher ranks. The exceptionally high rates for ages <20 years and for birth ranks 4 or 5 should not be regarded too seriously for, if the one rate — age <20, birth rank 4 or 5 — is reduced by 1 standard error, the two standardized rates are reduced to 4.85 and 4.18 per 1000 maternities respectively. However, Yerushalmy & Sheerar also found a high monovular twin frequency amongst maternities of high rank at this age in their data, so this may not be a wholly chance phenomenon.

The variations in the estimated binovular twin frequencies are more clearly defined and constitute a fairly regular pattern. At each birth rank level the frequency of binovular twins increases to a maximum at ages 35-39 years and then declines sharply. The effect of the mother's parity appears to be independent of this maternal age effect, for at each age level there is a tendency for the frequency to increase continuously for each birth rank after the second. The age specific rates at birth ranks 1 and 2 are virtually identical, but thereafter the rates increase and the most significant differences occur between ranks 2 and 3. The frequency of twinning in the three age groups between 25 and 39 years is significantly higher among births of 3rd rank than among births of 2nd rank. Comparing the frequencies in birth ranks 3 and 4 or 5, all rates are higher in the higher birth ranks and, except for the one age group 25-29 years, the differences are statistically significant. Between the grouped birth ranks 4 or 5 and 6, 7, or 8, there are significant increases at ages 25-29 and 30-34 years; and between the two upper groups 6, 7, or 8 and 9 or higher, only the rate at ages 35-39 years increases significantly.

The only additional information to be obtained from standardization is that there may be a modal birth rank as well as a modal maternal age, that the binovular twin frequency may decrease after births of 8th rank just as it does after maternal age of 35-39 years. This contradicts the significant increase in frequency between the two highest

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ranks at maternal ages 35-39 years noted above, and since these standardized rates are unduly influenced by exceptionally high or low rates at the younger ages, it may well be that with more material this effect would vanish. Larger numbers of twins in the higher birth ranks would also reduce the standard errors of the rates so that both techniques would become more efficient.

These standardized rates can be used further to assess the relative importance ofthe two factors, maternal age and parity, in the aetiology of twinning. Theoretically the standardized birth rank-specific rates are independent of variations arising from differences in the maternal age distributions in each birth rank. The crude birth rank rates on the other hand include these variations with respect to age, so that any function of the differences between the two series of rates should provide a rough index of the relative effect of maternal age on the frequency. Similarly the same function of the differences between the crude and standardized age-specific rates should measure the influence of birth rank on the frequency of binovular twinning. The most obvious function to choose is probably the sum of the quotients formed by dividing the arithmetic difference between the rates (neglecting the sign) by its standard error. Fortunately in these data the number of age groups and the number of birth ranks are equal, and for the estimated monovular twins the two indices obtained by summing the five relevant quotients are 23 for the maternal age influence and 10 for rank of birth: for the estimated binovular twins the indices are 28 and 23 respectively. While it must be emphasized that these are only rough measures, it would appear that, if one factor is more closely related to the frequency of twinning than the other, then it is probably maternal age which is the more important, particularly in the case of monovular twinning.

Summary and Conclusions

Provided the assumptions underlying Weinberg's method of differentiation of types of twin pairs are correct, this analysis of the statistics of twin births in Italy in the two years 1949 and 1950 shows that there are variations in the frequency of monovular twin births greater than can be attributed to chance deviations from a constant frequency of monovular twinning. There is a tendency for the frequency to increase with maternal age, and for young mothers, a tendency for it to increase also with parity. In general, the occurrence of monovular twinning is probably more closely related to maternal age than to parity.

The frequency of binovular twinning appears to be independently related to both maternal age and parity. Amongst births of each rank the frequency of twin births increases to a maximum at maternal ages 35-39 years; and, at each age level, the frequency does not change between birth ranks 1 and 2 but subsequently increases fairly continuously. There is a suggestion that there may be a modal birth rank as well as a modal maternal age, and that binovular twinning may be no more closely related to maternal age than to parity.

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RIASSUNTO

Purchè le premesse che sono alla base del sistema di Weinberg di differenziazione dei tipi di coppie gemellari siano esatte, questa analisi delle statistiche delle nascite gemellari in Italia nei due anni 1949 e 1950 mostra che vi sono nella frequenza delle nascite gemellari monovulari delle differenze maggiori di quelle che possono essere attribuite a deviazioni accidentali da una frequenza costante di gemellanze monovulari. Vi è una tendenza della frequenza ad aumentare con l'età materna, e per le madri giovani una tendenza ad aumentare anche col numero dei parti. In generale, il verificarsi di gemellanze monovulari è probabilmente più strettamente connesso con l'età materna che con il numero di gravidanze.

La frequenza della gemellanza biovulare sembra esser indipendentemente connessa sia con l'età materna che con il numero di gravidanze. Fra le nascite di ogni grado la frequenza delle nascite gemellari aumenta fino ad un massimo alle età materne di 35-39 anni e, ad ogni livello di età, la frequenza non cambia fra i gradi di nascita 1 e 2, ma aumenta in seguito abbastanza continuamente. Vi è un accenno che vi possa essere un grado di nascita medio non meno di una età materna media, e che la gemellanza biovulare possa essere più strettamente collegata con l'età materna che non con il grado di nascita.

RÉSUMÉ

Bien que les indications qui sont à la base du système de Weinberg de différenciation des différents types de couples gémellaires soient exactes, cette analyse des statistiques des naissances gémellaires en Italie au cours des années 1949 et 1950 permet de constater qu'il y a dans la fréquence des naissances gémellaires monovulaires des différences plus grandes que celles pouvant être attribuées à des déviations accidentelles par une fréquence constante de gémellarités monovulaires. Il y a une tendance de la fréquence à augmenter avec l'âge maternel, et pour les jeunes mères une tendance à augmenter avec le nombre des accouchements. D'une manière générale, la constatation de gémellarités monovulaires est probablement plus étroitement liée avec l'âge maternel qu'avec le nombre de grossesses.

La fréquence des gémellarités biovulaires semble être indépendemment reliée soit avec l'âge maternel, soit avec le nombre de grossesses. Parmi les naissances de tous les degrés, la fréquence des naissances gémellaires augmente jusqu'à un maximum aux âges maternels allant de 35 à 39 ans et, à chaque niveau d'âge, la fréquence ne change pas entre les degrés de naissance 1 et 2, mais augmente par la suite assez continuellement. On mentionne qu'il peut y avoir un degré de naissance moyen ainsi qu'un âge maternel moyen, et que la gémellarité biovulaire peut être plus étroitement reliée avec l'âge maternel plutôt qu'avec le degré de naissance.

ZUSAMMENFASSUNG

Sind die Voraussetzungen, die auf Grund des Weinbergssystems sind, zur Differenzierung der verschiedenen Formen von Zwillingspaaren richtig, so zeigt diese statisch geprüfte Analyse der Zwillingsgeburten in Italien, in der Zeitperiode von 1949 bis 1950, dass, in der Häufigkeit der eineiigen Zwillingsgeburten, grössere Unterschiede sind, als diejenige die zu fälligen Abweichungen zugeschrieben werden können.

Wächst das Mutteralter, so zeigt die Häufigkeit eine Neigung mitzusteigern; ausserdem, bei jungen Muttern, wächst die Häufigkeit auch nach der Geburtszahl.

Allgemein gesagt, ist das Geschehen eineiigen Zwillingsgeburten wahrscheinlich mehr mit dem Mutteralter, statt als mit der Geburtszahl, verbunden.

Die Häufigkeit der zweieiigen Zwillingsschwangerschaft scheint, sowohl vom Mutteralter, wie von der Geburtszahl, unabhängig zu sein.

Im Vergleich mit anderen Geburten, wächst die Zwillingsgeburtshäufigkeit am meisten bis zum Mutteralter zwischen 35 und 39 Jahren, und, bei allen Altershöhen ändert sie zwischen 1. und 2. Geburtsgrad nicht, sondern sie wächst ziemlich in einem fort. Es sieht aus, dass ein mittlerer Geburtsgrad gebe, sowie ein mittleres Mutteralter, und dass die zweieiige Zwillingsgeburt mehr mit dem Mutteralter statt als mit dem Geburtsgrad verbunden werden kann.