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U.S. Regional Changes in Twinning Rates

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Abstract. The rise in twinning rates previously reported for U.S. between 1964 and 1987 after adjustment for maternal age and birth order occurred in each of the nine conventional geographic divisions except the Pacific States. Differences and consistencies in rank order among the divisions with respect to crude and adjusted twinning rates and other demographic parameters may hold clues to yet unidentified influences in twinning.

Key words: Twinning rates, Temporal variation, Geographic variation

Twinning rates in Europe declined at least into the 1970s, but in the United States (US) the decline ended soon after 1964 and rates increased at least into the 1980s [2]. The increase is not easily explained in terms of medical ovulation stimulants [2,3]. An unexplained break in the US trend was recorded in 1972 after a 2-year hiatus in reporting, when rates dropped back about 10%. The US observations depend on indirect standardization because age-and-parity-specific frequency of twin births has not been reported in the US since 1964. The two types of twins cannot be separated in this analysis.

Numbers of births in the US are large enough to permit regional analysis. Figures for the 48 contiguous States and the District of Columbia were combined into the usual nine geographic divisions, defined as follows:

New England	Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut
Middle Atlantic	New York, New Jersey, Pennsylvania
East North Central	Ohio, Indiana, Illinois, Michigan, Wisconsin
West North Central	Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas

South Atlantic	Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida
East South Central	Kentucky, Tennessee, Alabama, Mississippi
West South Central	Arkansas, Louisiana, Oklahoma, Texas
Mountain	Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada
Pacific	Washington, Oregon, California

METHODS

Data used in the analysis included numbers of live births and live births in twin deliveries, *by State*, from annual volumes of US vital statistics [5] for 1963-65, 1971-73, and 1981-83; all live births *by maternal age and birth order for each State* for 1964, 1972, and 1982 from the same source; *rates* of live-born twin pairs per 1000 live births by maternal age and birth order for 1964 from [4]; and numbers of *live births among twin deliveries* ending in at least one live birth, by maternal age, also from [4].

I have used a nine-fold classification of birth order (for brevity, the term parity will often be used, assuming that parity is one less than birth order): the first seven, 8 and over, and unspecified. I made six maternal age groups from the eight available by combining "under 15" and "45 and over" with the adjoining 5-year age groups and assuming that these small, outlying categories had the same rates as those with which they were combined.

Live births and live births in twin deliveries were combined in 3-year cohorts for each of the nine divisions to provide estimates of the twinning rates as live births in twin deliveries per 1000 live births for the central years, 1964, 1972 and 1982. These are referred to hereafter as *reported rates*.

Rates of live-born twin pairs in each age-and-parity group for 1964 given by Heuser [4] were modified by the empirical ratio, specific for age group:

$$\frac{\text{live births in twin deliveries}}{\text{twin deliveries ending in two live births}}.$$

This yielded 1964 *standard rates* of live births in twin deliveries per 1000 live births for each parity-by-maternal-age category. The overall twinning rate for 1964, or *reference rate*, was 0.018501.

The reported number of live births in each age-by-parity cell for 1964, 1972, and 1982, was multiplied by the corresponding standard rate and the result summed within division and year to yield the numbers of live births in twin deliveries expected if rates were the same as in 1964 for all US. These numbers divided by all live births in the same years and divisions yielded the *expected rates*.

Expected rates were paired with the reported rates first described to yield *adjusted rates*: the reported rate for each year and division was multiplied by the ratio of the reference rate, 0.018501, to the corresponding expected rate. In

addition to the approximations always involved in indirect standardization, these estimates include an undetermined error from matching 3-year-total reported twin births with only the central year of expected twins.

Table 1 - Live births in twin deliveries per 1,000 white live births for US total and for nine US divisions in 1964, 1972, and 1982[a]

Geographic area	1964		1972		1982	
	Reported (s.e.)	Adjusted	Reported (s.e.)	Adjusted	Reported (s.e.)	Adjusted
U.S. total	18.5 (0.060)	–	17.6 (0.066)	19.1	18.8 (0.065)	20.3
New England	19.0 (0.24)	18.9	17.3 (0.27)	18.5	19.8 (0.29)	21.1
Middle Atlantic	19.2 (0.14)	18.9	17.5 (0.16)	18.5	19.5 (0.18)	20.7
East North Central	18.9 (0.13)	18.6	18.7 (0.15)	20.2	19.5 (0.15)	21.1
West North Central	18.7 (0.20)	18.3	18.1 (0.23)	19.7	19.3 (0.22)	20.8
South Atlantic	17.2 (0.16)	17.8	16.4 (0.17)	18.2	18.0 (0.17)	19.8
East South Central	17.6 (0.24)	18.2	16.9 (0.26)	19.0	18.5 (0.27)	20.7
West South Central	17.8 (0.19)	18.0	16.3 (0.20)	18.0	18.8 (0.18)	20.7
Mountain	18.1 (0.27)	17.9	17.3 (0.28)	18.8	17.8 (0.24)	18.9
Pacific	18.7 (0.17)	19.1	18.4 (0.19)	20.2	18.0 (0.16)	19.3

[a] The figures give for each year the reported rate with its standard error and the rate adjusted indirectly to the age and parity distribution for total 1964 US births. Reported divisional rates are 3-year averages centering on 1964, 1972, and 1982.

FINDINGS

Reported and adjusted rates are shown in Table 1. Standard errors of the reported rates, which would be nearly correct for the adjusted rates, range from 0.13 to 0.29 live births in twin deliveries per 1000 live births.

For 1964, standardization of each geographic division to the national age and parity composition lowers the rates of five divisions and raises the rates of the other four. In the other years standardization raises all the twinning rates for the US as a whole and for every division, chiefly because of nation-wide declining parity relative to 1964. All adjusted rates for 1982 are numerically higher than those for 1964, but some of the adjusted rates for 1972 are not transitional. Thus the adjusted rates for New England and Middle Atlantic divisions are intermediate in rank instead of high; the Mountain division is intermediate instead of low. This reinforces the suspicion [2] of widespread errors in that year's reports.

Because maternal age and birth order (or parity) are the only well established variables that affect twinning rates within a population, the mean values of these variables for each division are given in Table 2. There is a strong negative correlation across divisions between mean maternal age and age-specific mean birth order, illustrated here by the age group 30-34. Age and overall birth order are not at all correlated. This implies that adjustment of twinning rates for maternal age alone should not be assumed to adjust simultaneously for birth order; the effects may be opposite.

Table 2 - Maternal age and birth order[a]

Geographic area	1964			1982		
	Mean age	Mean birth order		Mean age	Mean birth order	
		Overall	Ages 30-34		Overall	Ages 30-34
U.S. total	26.21	2.73	3.96	26.06	1.95	2.47
New England	27.01	2.61	3.59	26.75	1.85	2.21
Middle Atlantic	27.08	2.70	3.70	26.90	1.92	2.34
East North Central	26.42	2.86	4.16	26.08	1.98	2.59
West North Central	26.34	2.92	4.34	26.07	1.98	2.59
South Atlantic	25.62	2.54	3.73	25.93	1.81	2.24
East South Central	25.37	2.66	4.03	25.18	1.86	2.43
West South Central	25.48	2.78	4.25	25.29	1.99	2.67
Mountain	25.89	2.87	4.32	25.90	2.14	2.89
Pacific	25.78	2.64	3.87	26.22	2.01	2.53
Correlations		+0.096	-0.417		-0.092	-0.436

[a] For all live births in the years 1964 and 1982: mean age, mean birth order, and mean birth order within maternal age group 30-34, for US total and nine divisions. Product-moment correlations, across divisions, of mean age with overall mean birth order and with mean birth order in ages 30-34.

DISCUSSION

The variations in adjusted twinning rate in Table 1 may not pass a crude test of statistical significance, but internal consistency makes them significant and doubtless contains some clues to the causes of variation. The clues remain obscure, but it may help to point out the consistent patterns. In this discussion the 1972 data are ignored because they are erratic.

Least consistent between 1964 and 1982 is the Pacific division, which had the highest adjusted twinning rate in 1964 and next-to-lowest in 1982, the rate remaining almost constant while in all other divisions it increased. The large Asian population in these States, with its very low rate of DZ twinning, may explain the observation. In 1964 births to nonwhite, nonblack mothers constituted 2.8% of all births, while in 1982 they constituted 7.9%.

Elsewhere, twinning rates and demographic means are rather consistent between the two extreme years. After excluding the Pacific States, the New England States hold first rank in both crude and adjusted twinning, and the first four divisions, the northeastern one-third of the country, are all in the highest ranks. Again excepting the Pacific division, ranks by maternal age are nearly identical in 1964 and 1982, and ranks by birth order for mothers aged 30-34 are very similar. Other consistencies can be seen.

These findings emphasize the importance of as yet unknown factors influencing the twinning rate, about which there has been much speculation [1]. Adjustments used here are supposed to take full account of all variation that can be attributed to maternal age and parity, although adjustment is certainly not a perfect substitute

for fully specified data. Yet the adjusted or "intrinsic" rates vary temporally and geographically. While the intrinsic rate in Europe was apparently falling [6], that in the United States rose. Within the United States the rate rose in every region, but most regional differences persisted.

REFERENCES

1. Allen G (1983): Multiple births. In Bracken MB (ed): Perinatal Epidemiology. New York and Oxford: Oxford Univ. Press, pp 152-189.
2. Allen G (1987): The non-decline in U.S. twin birth rates, 1964-1983. Acta Genet Med Gemellol 36:313-323.
3. Allen G (in press): Frequency of triplets and triplet zygosyty types among U.S. births, 1964. Acta Genet Med Gemellol.
4. Heuser RL (1967): Multiple births, United States - 1964. Washington: US Government Printing Office (Public Health Service Publication No. 1000, Series 21, No. 14).
5. National Center for Health Statistics (1963-1983): Vital Statistics of the United States. Washington, DC: US Government Printing Office.
6. Parisi P, Caperna G (1982): Twinning rates, fertility, and industrialization: a secular study. Proceedings of the Sixth International Congress of Human Genetics, Jerusalem, 1981. New York: Alan R Liss, pp 375-394.

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