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An earlier paper before this Section demonstrated empirically that infant mortality could increase as much as 40 percent among infants conceived during the same one-month interval without detection of the increase as a significant rise in infant mortality in any single month of delivery. (1) The failure to detect the increase is due to the varying times at which the infants subjected to the increase are delivered. In that paper we described seasonal variation for fetal losses over a three year period of conceptions, demonstrating the substantial excess loss among fetuses conceived during the rubella outbreak of 1963-64.

The present report is based on redistribution by month of the last menstrual period (LMP) of all live births and fetal deaths reported in New York City from 1960 to 1968. It covers 1,397,465 reported conceptions from January 1, 1960, to December 31, 1967, an eight year period. Of the total, 829,901 of the mothers were classified as white, 356,701 as nonwhite, and 211,863 as Puerto Rican, meaning that they were born on that island. These three ethnic divisions are used in New York City because obstetric experience differs among the three groups and each is reasonably large.

Several studies (2,3,4) have indicated that the LMP date is sufficiently accurately reported for the purposes of this research. It is estimated that 1.2 percent of the live births and 5.0 percent of the fetal deaths (2.2 percent of the total pregnancies reported) were lost to the study because of lack of information about the LMP date. In order better to detect and compare seasonal variations, since the level of the rates differs by ethnic group, all data were converted to a seasonal index by dividing the monthly rates for the aggregated eightperiod by the total rate for this octennium. To reduce random monthly variability and yet emphasize as far as possible monthly fluctuations, a two-month moving average, centered, was then calculated.

It is our purpose in this report to give a summary view of our findings rather than the details about any single aspect.

Seasonal Patterns of Conceptions

Although there are differences among the ethnic groups in the depth of the trough of conceptions during the early part of the year, they all follow a pattern of marked rise in frequency of conceptions toward the end of the year, usually about November. This pattern holds remarkably, regardless of hospital service (private or ward), maternal age, ethnic group or pregnancy order. A similar pattern is found for illegitimates of all three ethnic groups. The general pattern can be seen in Chart 1, where the combined data for all groups are illustrated to show that the shape of the annual curves (dash line) closely follows that for the aggregated eight-year experience (solid line). (5)

On the other hand, no evidence of seasonal variation could be found for the relative frequency of multiple births nor for sex ratios. (5)

Birthweight and Duration of Gestation

Mean birthweight is higher among summer conceptions (July to September) and the lowest mean birthweight occurs among fall and late winter (first quarter) conceptions. This pattern tends to be confirmed when we review the percent of births under 2,501 grams by month of conception. Yet, when this proportion for July to September is tested against the proportion for the rest of the year, the result is significant (at less than the .05 level) during the third quarter only for four of the 12 groups tested (ethnic group, sex, service). Nevertheless, although the differences were usually slight, the proportions of infants of low birthweight still were lower among these summer conceptions than among conceptions at other times of the year for seven of the eight remaining groups.

Altogether, these findings suggest a hypothesis that if the crucial first trimester of pregnancy coincides with the season when the risks of common viral and bacterial infections are least, the opportunities for optimal fetal growth and development or even survival will be enhanced. Of course, this is also the period of the year with maximum sunlight in the New York area and the time when fresh vegetables become available.

There is no doubt that birthweight and duration of gestation are associated. A peak in the mean duration of gestation was found also in the July-September period, but this was not the only peak and the crest varied among the ethnic groups. Moreover, the mean completed weeks of gestation appears to be too crude a measure for precise determination of the facts. When the proportion of deliveries at less than 36 weeks was considered, the higher proportions were found in the early part of the year and after midyear. Here again, the findings tended to be consistent with those for birthweight but with some shift. However, when one examines Chart II, showing both mean birthweights (by sex) and the percent of deliveries under 36 weeks of gestation (all live births), the inverse relationship between the two variables is evident. On the other hand, when the percent under 2,501 grams in birthweight is charted against the percent less than 36 weeks of gestation, a positive relationship by month of conception appears.

In summary, both birthweight and duration of gestation have a seasonal pattern, but it is not of marked degree, especially for birthweight. The evidence suggests that infants conceived during the summer months have a somewhat longer gestational interval and weigh more than those conceived in most other months. The variations in the means do not appear of much practical importance, but the proportions of low weight babies and those of short gestational interval do seem to vary enough seasonally to have clinical import.

Perinatal Losses

In general, and specifically for each ethnic group, maternal age and pregnancy order, perinatal mortality rates are seasonally high among winter conceptions and decline to a low about October. Neither component of the perinatal loss rate (late fetal and early infant deaths) departs from this pattern. Chart III is presented to show this pattern as indicated by the fetal death component, which is depicted in the lowest bank. Inclusion of this chart has the merit of demonstrating that a quite similar pattern generally exists for fetal losses at earlier gestational intervals.

These losses were unusually high, as was observed in the earlier study (1), during the latter part of 1963 and early 1964 during the course of the rubella epidemic in New York City. However, the rates were also unusually high from December 1964, through September, 1965. Thus far, we have been unable to explain the high rates for this interval.

Complications of Pregnancy

As used in this report, complications of pregnancy are those conditions listed as a check-off item on the birth certificate form as "conditions present during pregnancy". They include such conditions as eclampsia, preeclampsia, hypertensive disease, heart disease,

German measles (and trimester), tuberculosis, neoplasms and syphilis. As might be expected, the only one of the specific conditions that shows unequivocal and marked seasonal variation is rubella. an infectious disease with recognized seasonal variation in incidence. Chart IV illustrates the findings for several of these conditions and the marked seasonal pattern for rubella occurring in the first trimester of pregnancy is obvious. Tuberculosis appears peculiarly low among pregnancies starting late in the year, but findings seem negative for the other conditions shown on this chart. Chart V is included merely to demonstrate that combining rubella reported as occurring in different trimesters of pregnancy can conceal much information. The seasonal pattern is seriously dampened, as indicated by the upper panel. The lower panel makes it clear that women conceiving at different times of the year encounter the seasonal impact of rubella at different stages of pregnancy, and that the aggregation of these three curves produces the apparently mild seasonal pattern of the upper panel.

For preeclampsia, eclampsia and hypertensive disease (not shown here), there is some evidence that they are most likely to occur (or be exacerbated) among pregnancies starting during the middle of the year, with perhaps extra hazard for whites from preeclampsia during most of the first half of the year.

Congenital Anomalies

Congenital anomalies were coded in detail following to major extent the rubrics of the eighth revision of the International Classification of Diseases. Only those pregnancies reaching at least 17 weeks of gestation were included, since it was considered unlikely that anomalies would be identified or reported when pregnancy terminated earlier. However, to maximize the ascertainment from the existing records, malformations reported as causes of infant deaths were included whenever such malformations had not been reported on the corresponding birth certificates of the infants. Moreover, as many as three separate anomalies were coded in each case. The figures utilized here represent, therefore, the frequency of each anomaly and not counts of infants with anomalies.

Despite aggregation of data over an eight year interval, small numbers were found for most anomalies. Although suggestive



ACTUAL AND EIGHT-YEAR AVERAGE RATIOS* OF OBSERVED TO EXPECTED CONCEPTIONS,

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CHART III

700 YORK CITY, 1960-1967 BY MONTH OF CONCEPTION, ETHNIC GROUP AND DURATION OF GESTATION (WEEKS): ** TAR JAINUTTO THE OCTENNIAL RATE ** REPORTED FETAL DEATHS* PER I,000 CONCEPTIONS



TWD WONTH MOVING AVERAGE, CENTERED *EXCLUDES THERAPEUTIC ABORTIONS

COMPLICATIONS OF PREGNANCY

CHART IX

NEW YORK CITY, 1960-1967 BY ETHNIC GROUP AND MONTH OF CONCEPTION: *The subsection of the average octennial rate, REACHING AT LEAST IT WEEKS GESTATION. AVERAGE MONTHLY RATES SELECTED COMPLICATIONS OF PREGNANCY PER 100,000 CONCEPTIONS



REPORTED FREQUENCY OF RUBELLA AS COMPLICATION OF PREGNANCY PER 100,000 CONCEPTIONS REACHING AT LEAST 17 WEEKS GESTATION. AVERAGE MONTHLY RATES EXPRESSED AS MULTIPLES OF THE AVERAGE OCTENNIAL RATE* BY MONTH OF CONCEPTION AND TRIMESTER OF OCCURRENCE: NEW YORK CITY, 1960-1967

indications of variation by season of conception were sometimes noted for one or two of the ethnic groups or for either sex, or for either maternal age group into which the data were subdivided, we rejected a conclusion that such seasonal variation actually exists in most instances and wavered in others. We have looked for common patterns between the indicated population subgroups and have been disinclined usually to assert that seasonality exists when such a common pattern could not be reasonably identified. In so doing, we may have overlooked a true seasonal pattern that for some reason actually applies to only one ethnic group or one sex or one maternal age group.

We have concluded that there exists a possibility of higher risk of hemolytic disease among infants conceived about midyear, especially among nonwhites and Puerto Ricans. It also appears that in the New York City vicinity the frequency of anencephaly may be relatively high among spring conceptions. Clubfoot appears to be a higher risk among second and third quarter conceptions and reduction deformities of the limbs among those during the first and last quarters. There is a weak indication that other limb deformities may occur most frequently among fall conceptions. For both Mongolism and polydactyly, the influences are believed to be largely genetic, but an impression is obtained that a superimposed environmental influence may exist.

Summary

Conception is most likely to occur during the last quarter of the year in New York City, regardless of other factors. But infants conceived during the third quarter tend to be slightly heavier and of somewhat longer gestation than those conceived during the rest of the year. Perinatal and early fetal losses are relatively high among pregnancies starting in winter and become progressively lower until about October. Rubella in the first trimester is most frequent, as expected, among winter conceptions and conditions related to eclampsia appear to rise in midyear. Variation by season of conception for congenital malformations was not clear for most conditions, but anencephaly seems relatively high among pregnancies starting in spring and clubfoot among those starting throughout the middle of the year.

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