Data from birth and fetal death registrations in New York City were studied to identify short periods in which the risks of malformation or death were high or low. Certain patterns were detected. No excess deaths or malformations could be attributed to the Asian influenza epidemic of 1957.

A STUDY OF TEMPORAL VARIATIONS IN THE RISK OF FETAL MALFORMATION AND DEATH

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IN NEW YORK CITY, where registration of any product of conception is required by law, upwards of 20,000 fetal deaths are now reported each year. From these registrations it can be estimated that mortality in the third month of fetal life is at least 9 per 1,000 per week, or about twice the rate experienced by the population aged 85 and over. At earlier stages of development the true mortality may well be higher (though this is not confirmed by the deaths actually registered) and, on the most conservative estimate, deaths in the 40 weeks preceding birth must be as numerous as all deaths in the 50 years following birth.

Despite the large numbers involved, fetal mortality statistics have not been subjected to much detailed analysis, presumably because many important comparisons (e.g., between ethnic or economic groups) could be seriously biased by differences in the completeness of registration. However, such differences need not bias comparisons between one time-interval and another if it is possible to make a suitable adjustment for the rising trend in completeness of registration, while in comparisons between closely spaced intervals, such as successive months, this source of bias can be ignored.

There are, moreover, grounds for believing that studies of short-term variations in the fetal death rate should have some epidemiological interest. The association between maternal rubella and congenital deafness was first suggested by a consideration of the birth dates of affected children (Gregg, 1941). Non-random time-distributions have also been observed in congenital dislocation of the hip (Record and Edwards, 1958), in anencephalus and spina bifida (Edwards, 1958), in mental deficiency (Knobloch and Pasamanick, 1958) and in congenital esophageal atresia (Knox, 1959). In all these examples, recognition of the time-patterns depended on the fact that the affected fetuses survived to a near normal delivery date, but there is no reason to assume that this is a typical sequel to damage done in early pregnancy, whether by viruses or other agents. For example, in the prospective study by McDonald (1958) the group of women who had any acute febrile illness during the first 12 weeks of pregnancy appeared to have an increased risk of "spontaneous abortion" as well as of giving birth to a mature infant with diagnosable defect. Hence it seems quite possible that abortions of fetuses damaged in, for instance, the sixth week will be distributed over a wide range of gestational ages from 6 weeks onward. In such a situation quite large fluctuations in the risk of fatal damage to fetuses could pass unnoticed. Indeed, such fluctuations could only be reliably detected in a community where the following requirements were met:

1. There must be full reporting of early as well as of late fetal deaths.
2. The numbers of deaths recorded must be large enough to prevent chance fluctuations from blotting out true fluctuations in risk.
3. The population must be geographically compact, so that its members tend to be exposed to fluctuating influences at about the same time.

At present these requirements are more nearly met in New York City than anywhere else. This paper therefore presents a first attempt at analyzing some postwar New York City data in a manner intended to detect short-term variations in the risk of fetal malformation and death.

Recent Trend of Recorded Fetal Mortality in New York City

When the trend of recorded fetal mortality was reviewed a few years ago by Erhardt (1952), deaths after the 28th week of gestation appeared to be declining and those between the 13th and 28th weeks to be fairly stable, but the number of deaths reported at less than 13 weeks gestation was still rising rapidly. Since then the ratio between reported fetal deaths and live births has continued to rise but at a diminishing rate. In 1947 the reporting requirements were extended to cover all cases where a diagnosis of termination of pregnancy was made, whether or not the physician had seen any product of conception. If the trend of the 12 complete years since this change continues, the ratio of reported fetal deaths to live births will tend to a limit at about 0.137 (Figure 1), which is only 3 per cent above the level already attained in the years 1957-59. It is not suggested that this limit represents a "true" value of the ratio between fetal deaths and live births, only that it is a level at which reported fetal mortality may stabilize.

Monthly Variation in Total Fetal Deaths, 1949-54

For 6 of the 12 years covered by Figure 1 there have been published monthly totals of fetal deaths, of live births, and of the ratio between these totals (City of New York, 1957). Except as a somewhat crude method of adjusting for variation in month length, no purpose was served by calculating this ratio between fetal deaths and contemporary live births. The great majority of fetuses dying in a given month belong to "conception cohorts" which will not reach full term until several months later, so the number of such deaths is better assessed in relation to the live births occurring in some later month or months. In order to find an appropriate way of estimating short-term changes in fetal mortality during these years the absolute numbers of fetal deaths and of live births in each month of the years 1949-54 have been treated as follows:

1. Correction for variation in month length by reduction to numbers per day.
2. Adjustment for a rising linear trend which removed 77.6 per cent of the intermonth variance of deaths per day and 11.2 per cent of the variance of live births per day.
3. Calculation of correlations between the two series with time lags of live births behind fetal deaths of 10, 9, 8 . . . 1, 0 and −1 calendar months.

The squares of the resulting correlation coefficients were plotted in Figure 2, where the highest correlation between (adjusted) daily number of fetal deaths and daily number of live births is obtained when the fetal deaths are related to the live births occurring 6 and 7 months later. This finding is in good agreement with expectation, because the distribution of fetal deaths by gestational

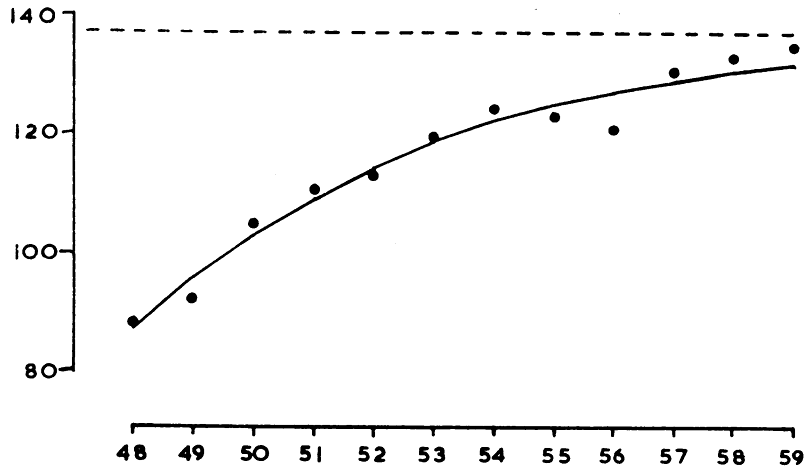

Figure 1—Fetal Deaths Registered in New York City, per 1,000 Live Births Registered in Same Year, 1948-1959

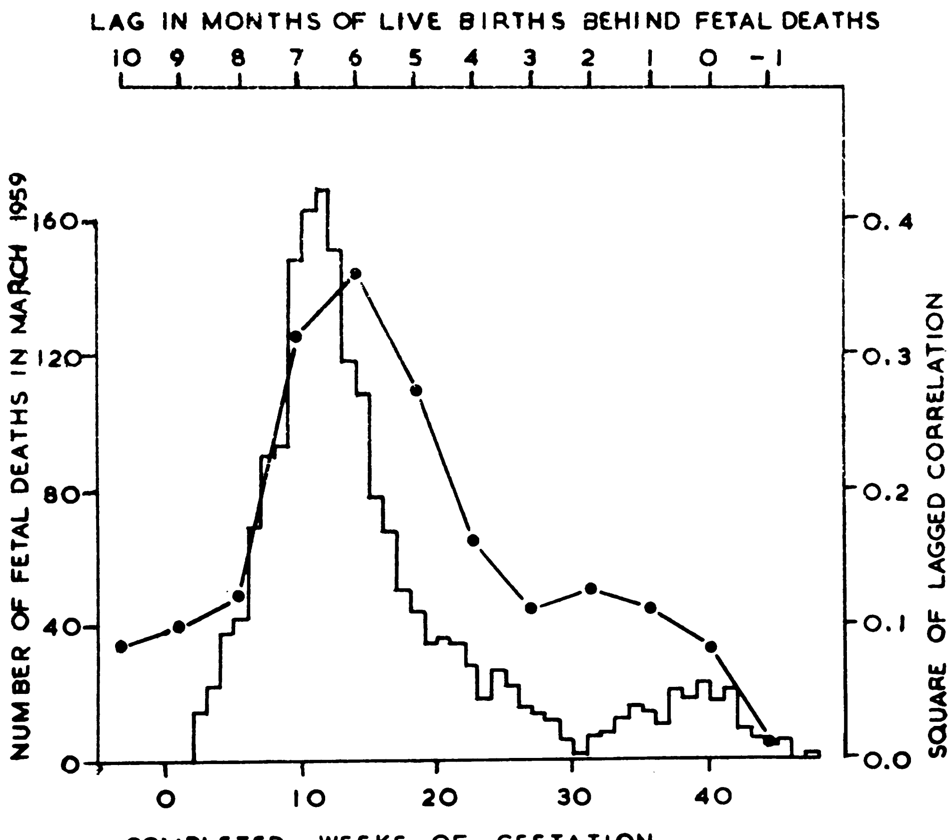

Figure 2—Illustrating the Modal Time Lag Between Fetal Deaths and Associated Live Births

Figure 3—Average Seasonal Movement of Fetal Mortality, 1949-1954. Crosses: Based on 6-Month Lag of Live Births Behind Fetal Deaths. Spots: Based on 7-Month Lag.

age (also shown for a sample month* in Figure 2) has a very high peak at an age between 6 and 7 calendar months short of full term. The live births of 6 and 7 months later have therefore been used as the basis for assessing short-term variations in fetal mortality during these years.

In order to judge seasonal changes the trend-adjusted daily number of fetal deaths for January was averaged over the 6 years and then divided by the corresponding average daily number of live births in July; similarly the February average for fetal deaths was divided by the August average for live births and so on. The resulting quotients have been plotted in Figure 3, together with the alternative set obtained by using a 7-month lag between fetal deaths and live births. The two curves differ in detail but have important points of agreement:

1. Seasonal variation in mortality is confined within the range 90 per cent to 107 per cent of the year-round average.
2. Above average mortality occurs in the months February through June and in October.
3. The lowest mortality occurs in December (this is obscured in the raw figures by the rising trend which biases the December rates upwards), and below average rates also occur in November and August. The December minimum is particularly surprising since it coincides with the seasonal maximum of infant mortality in New York determined by Kutschenreuter (1959).

Though the seasonal variation shown in Figure 3 is not extreme, large numbers of deaths are involved; for if the December average had prevailed generally throughout these 6 years some 9,000-10,000 fewer registered fetal deaths would have occurred.

In order to judge other short-term variations, predicted numbers of deaths were calculated for single months on the basis both of a 6-month and a 7-month lag between fetal deaths and associated

* The month in question, March, 1959, falls outside the period 1949-54 but is the only period for which this distribution is available by individual weeks of gestation.

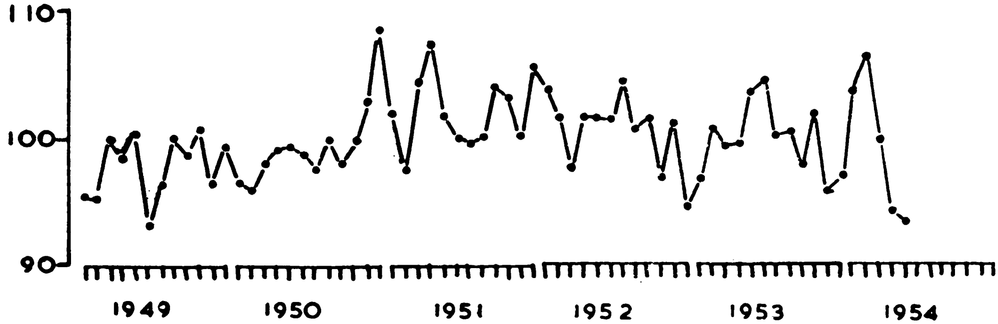

Figure 4—Fetal Deaths by Month of Occurrence 1949-1954, as Percentage of Expectation, Adjusted for Month Length, Trend, Average Seasonal Movement and Estimated Numbers at Risk

Table 1—Months of 1949-1954 with High or Low Totals of Fetal Deaths

Month	Difference Between Adjusted Total and Prediction Based on 6-Month Lag	Difference Between Adjusted Total and Prediction Based on 7-Month Lag	Unadjusted Total
January, 1949	−59	−56	1,195
June, 1949	−81	−87	1,159
December, 1950	+90	+140	1,447
March, 1951	+71	+71	1,614
April, 1951	+105	+111	1,517
December, 1951	+84	+81	1,532
January, 1952	+53	+62	1,617
July, 1952	+53	+84	1,631
December, 1952	−84	−78	1,423
January, 1953	−50	−53	1,566
June, 1953	+69	+78	1,712
January, 1954	+59	+62	1,767
February, 1954	+112	+95	1,723
April, 1954	−81	−126	1,643
May, 1954	−146	−87	1,698

live births, with adjustment of both actual and predicted values for trend and for average seasonality. Figure 4 shows the percentage ratio between the adjusted actual values and the mean of the two predictions for each month from January, 1949, to May, 1954. Over these 65 months the range of variation was between 93.2 per cent (June, 1949) and 108.6 per cent (December, 1950) of the average prediction. In 15 months there was a discrepancy of 50 or more deaths above or below both the 6-month and the 7-month predictions. These months are listed in Table 1 where it will be noticed that ten of them form adjacent pairs with discrepancies of the same sign, three such pairs lying above and two lying below the predicted values. Hence the dates within this period for which there is best evidence of an excess fetal mortality—other than due to seasonal variation—are as follows: March-April, 1951, December, 1951-January, 1952, and January-February, 1954.

Early Fetal Mortality, 1957-59

Special tabulations were prepared for all live births and fetal deaths occurring in each calendar month of the years 1957-59, showing the distribution by gestational age and by type of malformation recorded, if any. Gestational age had been computed at the coding stage from the date of the last menstrual period as reported by the physicians* and cards were sorted into 11 4-week intervals as follows: 0-5 completed weeks (in effect 2-5 as reported durations of under 2 weeks were not encountered),

* This has proved more accurate than the former practice by which the reporting physicians were themselves required to enter an estimate of gestational age.

6-9 weeks, 10-13 . . . 38-41 and 42 or more (in effect 42-45). A residual class of deliveries at "unknown" gestational age have been excluded from all following sections of this paper; they amounted to 6 per cent of all fetal deaths and 2 per cent of all live births.

This cross-tabulation by gestational age and date of delivery greatly improves the chances of relating the numbers of fetal deaths to an appropriate population at risk. Even so, the numbers at risk were not directly enumerated, so denominators for rates and ratios still had to be computed more or less approximately (except in relation to events near full term, dealt with in the next section). For this purpose the data were treated as if deliveries had a rectangular distribution both over the days of each calendar month and over the days of each 4-week period of gestational age. (It was to make the latter assumption more acceptable that weeks of gestational age were grouped in the manner stated above rather than in the more conventional manner by completed lunar months of gestation; thus the main peak of deliveries at about 280 days came near the middle of an interval rather than at the boundary between 2 intervals.) On this basis it is simple, though laborious, to write down for any conception date the fraction of any gestational age-interval which will fall within each of the following calendar months. For example, if conception occurs on December 31 then, ignoring half days, 17/28ths of the 2-5-week interval will fall in January and the remaining 11/28ths in February. By suitable summations one can then compute a number of full-term (i.e., 38-41 week) deliveries corresponding to fetal deaths in (say) the 2-5-week interval during January, the appropriate estimator in this case being:

	4.6906%	of full-term deliveries in the following August
plus	61.2713%	" " " " " " September
plus	35.7842%	" " " " " " October
plus	0.2381%	" " " " " " November*

For monthly totals of fetal deaths in the 2-5-week interval 26 such numbers of corresponding full-term deliveries were computed; namely, those for January, 1957, through February, 1959 (the number for March, 1959, could not be computed without data on 42+ week births in January, 1960). Similar series, starting with January, 1957, were also computed for

	6-9	week deaths through March, 1959
	10-13	" " " April, 1959
	14-17	" " " May, 1959
	18-21	" " " June, 1959
and	22-25	" " " July, 1959

In the absence of true short-term fluctuations of fetal mortality the monthly totals of early fetal deaths should (subject to chance variations) be in some fixed or slowly changing ratio to the corresponding numbers of full-term deliveries. For each of the 6 earliest age-intervals there were therefore calculated:

1. A series of "expected" monthly totals of fetal deaths, proportional to the corresponding full-term deliveries and summing to the actual total of fetal deaths for 26, 27 . . . . or 31 months.
2. The best-fitting linear trend to these ratios (this proved to be negative for the 2 earliest intervals and very small positive for the third and fourth, while in the fifth and sixth the monthly rate of increase was estimated at 0.48 per cent and 0.66 per cent of the average value).
3. A revised expectation derived from this trend.
4. The percentage ratio of the actual number of fetal deaths to this revised expectation.

* Because of differences between the lengths of the calendar months these percentages do not add up to 100 per cent, though for all 12 months the sum is, of course, 1200 per cent; fortunately the study period 1957-59 does not include a leap year.

Table 2—Months of 1957-1959 with High or Low Totals of Fetal Deaths at Gestational Ages 2 to 25 Completed Weeks

Month	Difference Between Actual and "Expected" Number of Deaths	Actual Number of Deaths
February, 1957	+62	1,461
March, 1957	+129	1,684
May, 1957	+69	1,575
August, 1957	+64	1,560
October, 1957	−57	1,459
November, 1957	−54	1,420
December, 1957	−141	1,385
January, 1958	−139	1,409
March, 1958	+88	1,670
July, 1958	−82	1,467
October, 1958	+67	1,581
February, 1959	+73	1,509
March, 1959	+70	1,550

At this stage it appeared that the discrepancies between actual numbers of fetal deaths and the trend-adjusted expectations were mostly within the range to be expected on a chance basis, but there were a few months in which agreement among the ratios for the various age-intervals seemed to point to a genuinely high or low mortality among previable fetuses in general. For example, in both December, 1957, and in the following month all 6 gestational age groups showed percentage ratios below 100, while in August, 1957, and again in March, 1958, all 6 groups showed an excess of actual over expected deaths. In general there was slightly better agreement among the 6 series of ratios when compared on the basis of contemporary death than on the basis of approximately contemporary conception ("cohort" method).

The actual totals of fetal deaths and the trend-adjusted expectations were therefore summed over the 6 age-intervals on this contemporary death basis to yield the composite ratios which have been plotted in Figure 5. Since over 80 per cent of reported fetal deaths occurred within these age-intervals, Figure 5 is essentially comparable with Figure 4, except that it does not incorporate any seasonal correction. In the aggregated data 13 months showed a discrepancy of 50 or more between the actual total of fetal deaths and the adjusted expectation (Table 2). In five instances the actual total was more than 50 below expectation, 4 of these being consecutive months (October, 1957, to January, 1958)—as it happens the 4 months immediately following the Asian influenza epidemic. Among the 8 months with more than 50 "extra" fetal deaths there were 2 pairs of adjacent months (February-March, 1957, and February-March, 1959).

The repetition in 1957 and 1959 of excess mortality in both February and March of course suggests a seasonal pattern, if it is permissible to speak of such a thing on the basis of as little as 3 years' data—some of which had to be discarded in the foregoing analysis. To recover this "wasted" data for study of possible seasonable variation during 1957-59 a repeat analysis was carried out as follows. First, the totals of fetal deaths at (for example) 2-5 weeks were added together for the 3 Januarys, Februarys, Decembers, and similarly with the full-term

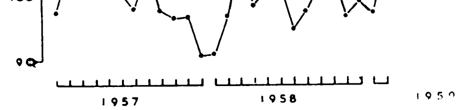

Figure 5—Early Fetal Mortality by Month of Occurrence 1957-1959, as Percentage of Expectation. Aggregate of Six Separately Computed Gestational Age-Groups Up to 25 Completed Weeks.

Table 3—Percentage Ratio of Actual to "Expected" Fetal Deaths, by Calendar Month, 1957-1959

Gestational Age (Weeks)	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
2-5	97.8	97.3	103.3	*108.6*	*100.9*	*95.0*	*87.5*	*87.9*	*102.9*	*119.0*	97.3	103.9
6-9	102.1	105.3	94.8	96.4	*100.4*	*98.0*	*95.7*	*97.0*	*102.5*	101.8	105.0	101.3
10-13	103.8	95.7	*101.7*	*101.5*	*99.3*	*96.3*	*93.2*	*95.4*	*102.9*	*106.1*	*99.0*	105.5
14-17	*108.6*	*104.4*	*103.4*	*101.7*	*100.8*	*94.4*	*88.9*	*92.7*	*100.2*	*107.7*	*98.6*	98.8
18-21	*92.7*	109.6	103.1	103.2	*107.6*	*99.8*	*86.9*	*88.9*	*93.5*	*102.1*	*111.6*	100.3
22-25	95.6	94.1	*111.5*	*108.1*	*104.2*	*100.1*	*86.0*	*94.3*	*95.2*	*105.1*	*106.9*	99.3

deliveries. These aggregates were then arranged in "circular time," that is, as if the aggregated Decembers of 1957-59 were followed by the aggregated Januarys of the same 3 years. Numbers of full-term deliveries corresponding to fetal deaths of each calendar month were then computed as before. This led to 6 further series of percentage ratios between actual and expected deaths, containing 12 values each, which are shown in Table 3. These ratios are essentially comparable with those plotted for earlier years in Figure 3, and agree with the earlier years in showing December as the month of lowest fetal mortality for all 6 of the age-intervals considered. In Table 3 the months have been arranged to read from June to May so as to set this December minimum in its context. For all 6 age-intervals the following inequalities will be seen to hold:

October > November > December < January < February.

In 5 of the age-intervals this pattern can be extended in one or both directions through the ratios printed in heavy type.

Reconstruction of Conception Cohorts

The main seasonal influence apparent in Table 3 affects all previable fetuses at about the same time. This contrasts with the sought after pattern in which damage done during the embryonic stage was to become manifest over succeeding

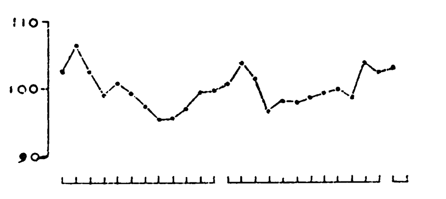

Figure 6—Total Antenatal Mortality of Monthly "Conception Cohorts" 1957-1959, as Percentage of Trend Value

months at increasing gestational ages. There is, however, one feature of Table 3 which might be held to suggest variation in a cohort rather than a contemporary influence pattern, namely, the series of above average ratios starting with deaths at 2-5 weeks in March and extending diagonally downward to deaths at 22-25 weeks in August. In a more extensive analysis—on the cruder basis of absolute numbers of deaths per day—it was found that when this diagonal was followed down to stillbirths at 42+ weeks in January, ratios in excess of 100 per cent occurred 10 times out of 11. The one exception was, as might be expected from the foregoing analysis, at the intersection of this diagonal with the December column. If this finding could be sustained by data from further years it would of course imply that infants conceived in the period February-March experience above average mortality throughout prenatal life.

A more refined estimate of comparative antenatal mortality among different conception-cohorts was computed by methods similar to those used in the previous section, once again invoking the assumption that all the relevant events (conceptions, fetal deaths, live births) have a rectangular distribution both over age-intervals and over calendar months. For example, the total deaths at 2-5 weeks' gestation of infants conceived in January were estimated as:

17.63% of 2-5 week deaths occurring in January
plus 79.59% " " " " " " February
plus 10.48% " " " " " " March

Altogether 132 such sets of percentages were needed, and from these an over-all antenatal mortality rate was estimated for the 25 monthly conception-cohorts from January, 1957, through January, 1959 (the February, 1959, cohort could not be completed without some data relating to January, 1960). These estimated mortality rates were found to have a slight upward trend. They are shown in Figure 6 as percentages of the trend value. Only one of the 25 points in Figure 6 falls outside the range ±5 per cent of the trend (February, 1957) but the average of the two February values is just over 105 per cent. A series of 7 consecutive values below 100 per cent occurred for conceptions from June through December, 1957 (thus straddling the period of the Asian influenza epidemic) and another series of 7 low values ran from April through October, 1958.

Late Fetal Mortality and Congenital Malformations, 1957-59

Concurrently with the sorting of all live births and fetal deaths by age and by month of delivery, a tally was kept of the numbers of infants for whom any entry had been punched in the malformation column of the record card, distinguishing the 10 3-digit categories of the ICD (WHO, 1957) from 750 to 759. The frequency of malformations recorded in the present data was substantially lower than that in the other studies, possibly because of incomplete recording (see Discussion, page 1686), but this should not affect comparability between months within the study period.

The number of malformed infants recorded among full-term (38-41 weeks) deliveries was about the same as the number of stillbirths in the same interval (just over 700 per year). These are particularly valuable records because they can be related to a fully enumerated population at risk (all full-term deliveries) and, for the first time in the present study, it becomes legitimate to employ tests of significance. Expected numbers of full-term stillbirths and full-term malformed infants (without distinction of type) were therefore calculated for each month of 1957-59 and compared with the actual numbers by means of chi-squared goodness-of-fit tests. These tests were applied in turn to the whole set of 36 individual months and to various 3-, 9- and 12-month aggregates, but in no instance was the total value of chi-squared significantly large, and in no instance did the departure from expectation form a suggestive pattern. However, when totals were formed of the numbers of full-term infants who were either stillborn or malformed or both (but without double-counting) a technically significant departure from even incidence was obtained (chi-squared on 36 d.f.=52.451, P approx. 1/40). This was largely attributable to a single high value for February, 1958, which arose as follows:

	Actual	Expected
Malformed liveborn	74	48.80
Malformed stillborn	6	5.11
Stillborn without malformation	70	53.69
Total	150	107.60

Table 4—Seasonal Distribution of Births Near Full-Term with Record of Various Types of Malformation

WHO Manual No.		Total Cases	Actual Number Recorded, as Percentage of "Expected" Number J.F.M.	A.M.J.	J.A.S.	O.N.D.	$P\{\chi^2(3)\}$
750	Monstrosity	101	101	116	115	67	0.30>P>.20
750(1)	Anencephalic still birth	39	105	93	79	123	0.90>P>.80
750(2)	Remainder of 750	62	99	130	138	32	0.02>P>.01
751	Spina bifida and meningocele	158	109	97	93	101	0.95>P>.90
752	Hydrocephalus	157	94	108	89	109	0.90>P>.80
753	Other malformations of nervous system	53	124	46	110	121	0.20>P>.10
754	Malformations of circulatory system	60	137	61	123	80	0.20>P>.10
755	Cleft palate, harelip	285	104	96	102	98	0.98>P>.95
756	Malformations of digestive system	80	92	111	97	100	0.95>P>.90
757	Malformations of genitourinary system	336	114	107	81	98	0.20>P>.10
758	Malformation of bone and joint	562	114	101	87	99	0.20>P>.10
759	Other and unspecified malformations	292	93	109	101	97	0.80>P>.70
748	Clubfoot	503	99	102	99	100	P>.99
749	Other deformities of musculo-skeletal system	65	50	56	143	147	0.01>P

Most of the "extra" records of full-term malformed infants in this month fell into two of the ten types distinguished, mainly Cleft Palate and Harelip (actual 16, expected 7.29) and Bone and Joint (actual 27, expected 14.94). This month made the largest single contributions to chi-squared both in the test relating to full-term stillbirths and in that relating to full-term malformations, and was largely responsible for generating a significant ($P<0.05$) correlation between the 36 nonoverlapping rates for stillbirth and for malformation. It is tempting to relate the excess of full-term stillbirths during February, 1958, to an excess of stillbirths at 34-37 weeks which occurred in January of that year, when there were 64 such events compared with an expected number of between 49 and 50. However, January, 1958, had only a trivial excess of reported malformations in the 34-37-week interval. Infants delivered at 37 weeks in mid-February, 1958, would already have completed at least 21 weeks of gestation before the peak of the 1957 influenza epidemic, which is therefore unlikely to have had any bearing on the above observations.

The monthly totals of full-term stillbirths and/or malformations when summed over the 3 years gave a slight suggestion of seasonal pattern: of the 6 highest ratios out of 12 between the actual and expected totals, 5 formed a continuous set from December through April.

A test was also made for seasonal variation in the frequency with which each type of malformation was recorded among full-term infants and the results are summarized in Table 4. No subdivision of the 3-digit categories of the ICD was attempted except in the case of No. 750, Monstrosities, where 2 classes have been distinguished: (1) infants for whom anencephaly was given (in another column of the record card) as the cause of fetal death, and (2) the remainder. This subdivision was thought to be of special interest because of the strongly marked winter excess of anencephalic stillbirths found in Scottish data over a number of years (Edwards, 1958). As it happened, the recorded frequency of full-term anencephalic stillbirths in the New York data was greater in the winter than in the summer quarters—but on the basis of only 39 cases. On extending the analysis to include all anencephalics recorded at gestations of 30 weeks or more (140 cases) it was found that the lowest frequency occurred near the turn of the year—whether cases were grouped by the month of delivery or approximately by the month of conception—though the variation was still far from being technically significant. On the other hand, the births of full-term monstrosities not recorded as anencephalic stillbirths did depart significantly from an even seasonal distribution ($P<0.02$) with the apparent excess in the spring and summer quarters. This proved in fact to be the only group of the ICD malformation chapter in which seasonal variation could be plausibly suspected on the basis of the full-term deliveries. A more striking instance, apparently of seasonal variation, was noted in one of the two cognate disease categories which had been tabulated at the same time and which are also shown in Table 4, namely deformities of the musculo-skeletal system other than Clubfoot. This rather miscellaneous group includes genu valgum and varum. Of the 65 affected full-term infants in this group only 17 had been delivered in the months January-June compared with 48 in the second half of the year, each of the three years 1957-59 separately showing a relative deficiency of cases in its first 6 months.

Discussion

Among the faults of the present study there are at least two which would be simple, if somewhat expensive, to avoid in any further work along the same lines. In the first place, the figures used include all the fetal deaths and live births which happened to occur within New York City, rather than those belonging to the resident population only. The official vital statistics of the city are often compiled on this basis because the registration of vital events affecting residents which occur outside the city pass through many different administrative channels and are not readily available except in summary form. However, these are known to be greatly outnumbered by the births and deaths of nonresidents occurring inside the city, which can be and should have been omitted. Failure to exclude this latter class of events must have resulted in a spuriously low ratio of fetal deaths to live births and has probably introduced errors into the time-comparisons, but these errors are likely to have been of a random rather than a systematic nature.

A more serious fault is the inaccuracy introduced into various estimates by the assumption that births and fetal deaths had a "rectangular" time-distribution within calendar months and within 4-week intervals of gestational age. Some such assumption is unavoidable, but would have less serious consequences if the data were tabulated initially by single weeks. Since the estimators involved are in the nature of 3- or 4-month moving averages some effects of this source of error on the present results can be guessed. Where only the denominator of the ratios had to be estimated, the numerators being "raw" frequencies (see Early Fetal Mortality, p. 1680), the estimators would make too little allowance for any abrupt, short-lived changes in the numbers at risk, hence the total amount of variation in the monthly ratios would be too large. Where the numerators as well as the denominators had to be estimated (see Reconstruction of Conception Cohorts, p. 1683) any true short-term variations in risk would tend to be smoothed out and the amount of intermonth variation understated.

The study of congenital malformations was hampered to an extent which had not been foreseen by paucity of numbers. This may have been due in part to omissions at the coding stage when, of two or more coexistent malformations, only the most serious could be punched on the card. Even so, the crop of major malformations was unexpectedly small. For instance, at the rate prevalent in Scotland during the same years (Registrar General for Scotland, 1960) New York City would have had some 60-70 cases per month of stillbirth attributable to malformations of the CNS, but the average actually recorded was between 12 and 13. So large a difference in reported incidence obviously brings the quality of the data into question. In defense of the data one may note that observations in Rhode Island (MacMahon, Pugh, and Ingalls, 1953) have suggested that a community with large Jewish representation might be expected to have a relatively low incidence of CNS malformations, and that the frequency of anencephalus in particular has been reported to show wide geographical variation (Penrose, 1957). Moreover the total recorded frequency of malformations among the live-born infants in New York (8 per 1,000) was identical with that found in West Virginia by Poole (1960), who also worked from birth certificate data. Whether or not the small number of malformations was due to underrecording the effect is the same; only rather gross variations in risk could have been detected.

One event which might have been expected to leave its mark on the malformation rate was the 1957 outbreak of Asian influenza. A prospective survey in Dublin (Coffey and Jessup, 1959) suggested that an attack by this virus during pregnancy could double the risk of fetal malformations as a whole. If the same risk factor* had applied to the New York victims of this epidemic, some associated excess of malformations would have been likely to show up in the present analysis, provided that about a quarter or more of the women pregnant during the epidemic were attacked. From the study by Greenberg, Jacobziner, Pakter and Weisl (1958) it is known that a disproportionately large number of pregnant women died during the epidemic in New York, but these authors did not estimate the incidence of nonfatal cases. A study by Ingalls (1960) also failed to detect any influence of the epidemic on the incidence of malformations among live-born infants in Pennsylvania. Nor did this one major epidemic of the period studied leave any clear trace on fetal mortality.

In general the fluctuations of fetal mortality appeared to be smaller than the fluctuations of postnatal mortality in New York studied by Kutschenreuter (1959), possibly because of the rather coarse (whole month) time-grouping used in the present study.

Summary

Data from birth and fetal death registrations in New York City since the war have been studied with the object of identifying any short periods in which the risks of malformation or death were high or low, relative to their trend values. The range of fluctuations in these risks was rather narrow, though the absolute numbers of deaths involved may be considerable. Previable age groups exhibited a seasonal minimum of mortality in December with relatively high rates in the late winter and spring. No trace could be found of any excess of deaths or malformations attributable to the Asian influenza epidemic of 1957. A patterned time-distribution was suggested for certain types of malformation.

* The Dublin material was heavily weighted with cases reporting influenza during the third trimester, among whom no increase of malformations occurred. An estimate of relative risk based only on cases in early pregnancy would come out much higher.

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