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FACTORS ASSOCIATED WITH THE INCIDENCE OF CONGENITAL ANOMALIES: A Localized Investigation

Health Effects Research Laboratory
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FOREWORD

The many benefits of our modern, developing, industrial society are accompanied by certain hazards. Careful assessment of the relative risk of existing and new man-made environmental hazards is necessary for the establishment of sound regulatory policy. These regulations serve to enhance the quality of our environment in order to promote the public health and welfare and the productive capacity of our Nation's population.

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This report details the work and results of a program concerned with studying the relationship of congenital anomalies and parental exposure to radar at a Fort Rucker, Alabama military base. On the basis of retrospective data available for the study, this report concludes that there are no strong indications that the incidence of congenital anomalies in the Fort Rucker area is higher than normal.

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ABSTRACT

This report concludes that, in net terms, and on the basis of available retrospective data, primarily from birth records, there are no strong indications that the incidence of congenital anomalies in the Ft. Rucker, Alabama area is higher than normal. The original hypothesis that the situation might be serious has been traced, for the most part, to earlier reliance on faulty diagnosing and reporting, and especially to reliance on the birth certificate, which, there is reason to believe on the basis of the findings of this study, is a relatively insensitive instrument for measuring the incidence of congenital anomalies.

The attempt to relate this incidence to specific factors associated with military life, or in particular to factors associated with exposure to military radar, was largely unsuccessful because the military in effect denied access to pertinent records on the grounds that no prima facie case had been made that a problem really exists. Unfortunately, no fairly positive statement can be made denying the existence of a problem without access in the first place to pertinent military records, or access to present or past military personnel and families. The most conclusive type of information would, of course, involve a prospective research approach, and that was deemed not justifiable without at least the benefit of the findings of a defensible retrospective study.

FACTORS ASSOCIATED WITH THE INCIDENCE OF CONGENITAL ANOMALIES: A LOCALIZED INVESTIGATION

I. PURPOSE, STUDY PLAN, AND SUMMARY

A. Purpose

In 1971, Peacock[1] reported what appeared to be unusually high incidence rates of clubfoot and anomalies of the heart among infants born in Dale and Coffee Counties, Alabama. These findings were based on an analysis of birth record data for the period July 1969-November 1970. Dale and Coffee are adjacent counties in the southeastern part of the state and are the site of Fort Rucker, the Army Aviation Center.

These findings gave rise to concern about whether or not these congenital anomaly rates were in fact significantly higher than acceptable historical or concurrent controls. If higher rates can be shown to exist, then an investigation into possible causal factors would appear to be justified. In this investigation, environmental factors, non-ionizing radiation from radar, in particular, were of special concern as a contributor to higher-than-usual anomaly rates.

The purpose of this study is to extend through December 1972 the time period considered by Peacock and to examine the congenital anomaly incidence rates, as computed by ICDA[2] category, for the 67 counties in Alabama and for a stratified sample of 47 Alabama hospitals in order to determine whether or not a particular anomaly problem does in fact manifest itself in the area surrounding Fort Rucker.

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1. Peter Peacock, et al., "Congenital Anomalies in Alabama", Journal of the Medical Association of the State of Alabama, July, 1971, pp 42-50.

2. Public Health Services, U. S. Department of Health, Education and Welfare, Eighth Revision International Classification of Diseases, Adapted for Use in the United States, P.H.S. Publication #1693, Vol. 2, 1968.

B. Study Plan

During the study period July 1968-December 1972, the Birth Defects Center, Department of Pediatrics, School of Medicine, University of Alabama in Birmingham (UAB), maintained a file of all birth defects reported each month to the Bureau of Vital Statistics, Alabama Department of Public Health. Included on each record are the child's name, race, sex, and date and place of birth, the parent's name and address, name of attending physician, and the type of malformation, which was later assigned a four-digit ICDA code. The reported congenital anomaly incidence rates were determined, overall and by ICDA category for each Alabama county, by dividing the number of reported anomalous births by the number of live births reported to the Bureau of Vital Statistics during the study period.[1] In the absence of acceptable national rates, the incidence rates for Coffee and Dale Counties were then compared to the rates for the other 65 counties in Alabama.

Lyster Army Hospital at Fort Rucker was particularly suspect as having significantly higher-than-usual anomaly rates. This question was investigated by comparing Lyster's rates to those computed for a sample of 46 other Alabama hospitals. The sample included the 22 largest hospitals in the state and approximately 20 percent of the remaining hospitals. A questionnaire that requested information on factors that could possibly influence or explain the quality of anomaly reporting was submitted to each hospital in the sample. An equation that predicted a hospital's anomaly rate as a function of its "explanatory" variables was computed from data reported by the 46 hospitals. These "hospital variables", which were selected because they might be associated with reported anomaly rates, are:

1. Number of births at the hospital.

2. Number of incubators in service at each hospital.

3. Whether or not the "APGAR" newborn rating system is required by the hospital.

4. Number of hours after birth that the birth certificate is completed.

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1. It is important to realize that these rates are computed from birth certificate data and may not be a realistic measure of the true anomaly rate. The reported rates are multiplied by 1,000, thus resulting in number of anomalous births per 1,000 live births.

5. Average per capita income for the county in which the hospital is located.

6. Type hospital: government nonmilitary, nongovernment nonprofit, military, or nongovernment profit.

7. Who completes the birth certificates: medical records department, nurse, ward secretary, or other.

8. Whether or not the maternity or related staff attend in-service training programs.

9. Ratio of the number of pediatricians to the number of births during a specific week.

10. Ratio of the number of registered nurses to the number of births during a specific week.

11. Ratio of the number of licensed practical nurses to the number of births during a specific week.

12. Ratio of the number of ward clerks to the number of births during a specific week.

13. Average age of mothers giving birth at each hospital.

14. Percentage of nonwhite births for each hospital.

Values of Lyster Army Hospital's explanatory variables were then substituted into the prediction equation to see if the overall observed anomaly rate for Lyster fell within "normal" limits.

Finally, anomaly rates observed at Lyster for the study period were compared with some other congenital anomaly studies, whose purpose was to establish baseline rates against which rates determined at other hospitals or clinics could be compared. Particular attention was given to a recently reported study,[1] conducted at a hospital affiliated with Mayo Clinic. In the Mayo study, infants were observed for anomalies on the day of birth and, also, the fourth day after birth.

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1. Lloyd E. Harris, Lois A. Stayura, Perla F. Ramirez-Talavera, and John F. Annegers, "Congenital and Acquired Abnormalities Observed in Live-Born and Stillborn Neonates", Mayo Clinic Proceedings, Vol. 50, February 1975.

C. Summary

The findings in this Alabama study were of two types—evidence for and against the conclusion that there is an unusually high anomaly incidence rate in the Fort Rucker area. The evidence against such a conclusion is as follows:

1. During the study period July 1968-December 1972, the overall rates for Coffee and Dale Counties, in which Rucker is situated, rank only sixth and eighth among the 67 counties in Alabama.

2. Although the two highest rates in a sample of 47 hospitals are 17.7 at Lyster Army Hospital, Fort Rucker, and 18.0 at the Air Force Regional Hospital, Maxwell Air Force Base in Montgomery County, there are five other hospitals in the Alabama sample that have rates between 12.2 and 14.5. There is no statistically significant difference between these rates and Lyster's.

3. Prediction intervals show that Lyster's overall rate is well within what would be expected from a hospital with Lyster's characteristics.

4. When the addresses of the mothers of anomalous infants were plotted on county road maps, no significant clustering, especially in the vicinity of presumed radar sites, was apparent.

5. The rates, by ICDA category, from Lyster seem to be consistent with rates obtained from carefully controlled studies, such as one reported recently from Mayo Clinic.[1] Because there is no reason to believe that Mayo's rates are unusually high, they should serve as a reasonable "normal control" for the Rucker study.

6. When the occurrences of anomalies within categories with the highest rates at Lyster are plotted on a time axis, significant clustering is apparent. There is evidence that, in most cases, the reporting of anomalies within a cluster may be attributable mainly to one or two physicians, rather than to the several physicians on the staff at any one time.

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1. Ibid., Lloyd E. Harris, et al.

Two observations, however, prevent the question of an anomaly problem from being dismissed. They are:

1. The two highest rates from the hospital survey, at Fort Rucker and Maxwell AFB, are both from military installations and aviation centers. These rates cannot be explained easily by the fact that military hospitals are more alert to the presence of an anomaly, because the rates at Redstone Arsenal and Fort McClellan in Alabama are 7.1 and 0.7, respectively.

2. Thirteen of 17 counties with overall rates in the upper quartile lie within a contiguous band that has one terminus in Houston, the south-eastern-most county in Alabama, and that extends west-northwesterly to Marengo, one county removed from the Mississippi state line. The 20 counties in the southeast quadrant of Alabama have ten counties in the upper quartile, and this is more than can be explained by chance. This phenomenon, however, may involve more than a "military base" explanation.

Certainly, on the basis of the available data recorded on birth certificates, it cannot be concluded that an unusually large number of infants with congenital anomalies are born to military personnel at Fort Rucker or to other residents in the immediate area. Negative findings, however, such as those developed during the course of this study, leave some questions unanswered. It is possible, of course, for a birth certificate study to result in a positive finding. Because of the insensitivity of the measuring device, however, the true anomaly rate would probably have to be several times higher than "normal" in order to detect an abnormally high rate. In such a situation, it is possible that high rates would have been detected and reported to appropriate state or federal agencies by local medical associations, newspapers, or concerned citizens, before being detected by analysis of rates computed from birth certificates.

II. ANOMALY INCIDENCE RATES IN COFFEE AND DALE COUNTIES AND IN OTHER ALABAMA COUNTIES

A. County Anomaly Rates

Anomaly rates, overall and categorically (ICDA), and fetal death rates have been computed by race for each of 67 counties in Alabama. Because the rates for the nonwhite population are less than the state average, each county analysis for this report will be restricted to a consideration of the white population only (Table 1). The overall anomaly rates for the white population have been ranked (from highest to lowest) and plotted on a county map of Alabama. (See Figure 1, in which the county rank is stated within the parentheses under the rate; the shading on the map indicates the quartile grouping of the overall county rates.) Of the 17 counties in the third quartile (highest rates), 13 are in the southern half of the state. The counties with the eight highest overall anomaly rates for whites lie contiguously along a line with one terminus in Houston, the southeastern-most county, extending west-northwesterly to Marengo in the Black Belt, only one county removed from the Mississippi boundary. Within this band of counties, Coffee and Dale rank sixth and eighth, respectively, but Henry, Crenshaw, and Houston Counties, which adjoin either Coffee or Dale, are ranked second, third, and fifth, respectively. If these overall rates are higher than would otherwise be expected under "normal" circumstances, then the underlying problem is certainly not restricted to Coffee and Dale Counties, in which Fort Rucker is situated.

Anomaly rates for four categories selected because their rates at Lyster Army Hospital ranked among the top ten in the sample of 47 hospitals are also plotted on county maps of Alabama (Figures 2-5). These will be discussed in a later section.

B. Division of the Study Period into Early and Late Subsamples

The time period, July 1968-December 1972, under study in this project has been divided into an early period, which was originally observed by Peacock,[1] and a late period, which provides data for an independent test of the hypothesis[2] suggested by results

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1. Peter Peacock, et al., loc. cit.

2. The null hypothesis was that there is no difference in the congenital anomaly rates between Coffee and/or Dale Counties and the remainder of Alabama.

of Peacock's study of the early period. For purposes of this particular analysis, the early period was considered to be July 1969-December 1970 and the late period was considered to be January 1971-December 1972. Separate and combined incidence rates were computed for white residents of Coffee and Dale Counties (see Tables 2, 3, and 4). The number of live births among white residents in the two counties for the selected periods are presented in Table 5.

To determine the statistical significance of the rates for each anomaly and the all-anomalies category, the probability of obtaining the observed number of cases, or more, was computed under the assumption that the anomaly rate for the county or counties is the same as the rate for Alabama, excluding Coffee and Dale Counties. The probability thus obtained is reported as the "Binomial probability", or P-value for a one-tailed test of the null hypothesis. The assumption is also made that each infant in Coffee and Dale Counties has an equal probability of being congenitally malformed, and that the probability is the same as the rate for the remainder of the state for the comparable period.

There is little difference in the overall anomaly rates for the two counties during the combined period. The rate for Coffee is 12.0 and for Dale is 11.3, both being almost double the state rate of 6.2. When period differences are examined, a decrease from 13.9 to 9.0 is evident for Dale. However, a change of this magnitude provides insufficient evidence to reject equality of overall rates for the two periods. There is a slight, but insignificant, increase from 11.4 to 12.5 for Coffee.

Compared to the state rates, the only individual anomaly categories for Coffee County that appear to be significant for the combined period are Genital Organs (ICDA No. 752), and Other Limbs (755). All four of the Genital Organ Anomalies were reported during the late period, and the six anomalies in the Other Limbs category were divided equally between the two periods. No category showed a dramatic change from one period to the next, with the possible exceptions of the increase from zero to four in Other Limbs and a decrease from four to one in Clubfoot (754).

The individual anomaly categories for Dale County, in decreasing order of significance, are Genital Organs (ICDA No. 752), Circulatory (747), Other Limbs (755), and Musculoskeletal (756). It should be noted, though, that the occurrence of one or two cases of an anomaly with a low incidence in the state may produce a highly significant result for the county. This is evidenced in the Circulatory category, where the state rate is less than 0.05 per 1,000 births, and the reporting of two cases in Dale County results in a low P-value of 0.002. For three of the four most

significant categories for the combined period, the rates actually increased from the early period to the late period. Perhaps the greatest change among the individual categories was a decrease from six to two cases in Clubfoot.

Some additional insight may be gained by pooling the results from the two counties. The five most significant categories for the combined period are the same as the four most significant for Dale County alone, with the addition of Clubfoot. The most significant category was Genital Organs (14 cases), which had a consistent rate for the two periods. The second most significant was Circulatory, but, because only two cases were reported in the two-county area for the combined period, not much significance can be attached to this result. The third was Other Limbs (15 cases), with consistent rates for the two periods. Fourth was Musculoskeletal with only four cases. Fifth was Clubfoot which showed the most dramatic change of all categories between the two periods. In the early period, the reporting of ten cases made Clubfoot the most significant finding, but the reporting of three cases during the late period resulted in a rate slightly lower than that of the state. The reason for this large difference may be attributable to the fact that Clubfoot is easily overdiagnosed, which may have been the case during the early period studied by Peacock.

In summary, it appears that virtually all differences in anomaly rates between the early and late time periods for Coffee and Dale Counties, separately and combined, are consistent, within the limits of statistical variation, with the hypothesis of equal rates for the two time periods. Therefore, for the purpose of comparing rates with the remainder of Alabama, it seems justifiable to pool rates over time periods and the two counties.

III. ANOMALY INCIDENCE RATES AT LYSTER ARMY HOSPITAL AND FORTY-SIX OTHER ALABAMA HOSPITALS

A. Hospital Anomaly Rates

Anomaly rates based on numbers of births and anomalies for the four and one-half year period extending from mid-1968 through 1972 have been computed (Table 6) for Lyster Army Hospital at Fort Rucker and for each of the 46 hospitals in the sample, which was selected as a basis on which to "adjust" the rates at Lyster. The hospital anomaly rates, it should be noted, are based on the number of live births plus the number of stillbirths, whereas the county rates are the number of anomalies or fetal deaths per 1,000 live births. Also, it was estimated that the number of births during the last half of 1968 was one-half the total number of births during 1968.

The Air Force Regional Hospital at Maxwell Air Force Base was highest, with an overall rate of 18.0. Lyster was next highest with 17.7, followed by L. V. Stabler (Butler County), 14.6; Henry County, 14.3; North Jackson (Jackson County), 13.4; Hale County, 12.5; and Burdick-West Memorial (Winston County), 12.2. Only one of the hospitals among those with the highest seven anomaly rates had a number of births plus stillbirths greater than the sample median of 3,673. On the lower end of the rate scale, three of the six very large hospitals (greater than 10,000 births during the period) were among those with the six lowest rates. University Hospital (University of Alabama in Birmingham) reported six anomalies among more than 15,000 births, with none during the years 1970-1972.

When the 46 rates for the hospitals (other than Lyster) in the study were correlated (unweighted observations) with the hospital variables listed in Section I(B), only two, number of births and whether or not APGAR was used, were significantly related to anomaly incidence. Both of these correlations were contrary to normal expectations. The larger hospitals had lower overall anomaly rates than the smaller hospitals (Figure 6) and those hospitals that used the APGAR scoring system had lower rates than those that did not. It should also be noted (Figure 6) that the smaller hospitals were much more variable in their overall anomaly rates than the larger hospitals. Surprisingly, the average age of the mother and percentage of nonwhite mothers were not associated with the anomaly rates. Another moderately surprising result is that the fetal death rate has no association with the anomaly rate.

B. Low Anomaly Rate at University Hospital

The anomaly rates at University Hospital in the Medical Center at the University of Alabama in Birmingham are of special interest in this study for at least two reasons. First, because it is a teaching and research hospital, one would expect thoroughness and expertise in the examination of births for anomalies. University Hospital would, therefore, be a likely candidate to use as a "control" hospital against which the rates at Lyster Hospital, or any hospital suspected of having high rates, could be compared. Secondly, University Hospital is in the sample of hospitals used to "adjust", by a regression analysis, the anomaly rates at Lyster for non-radar factors that reflect hospital characteristics. Because the regression analysis is weighted and University is the largest maternity hospital in the study, University has a great influence on conclusions derived from the analysis.

During the study period, July 1968-December 1972, a total of six anomalies were reported on certificates of 14,142 live births at University Hospital. All six of the anomalies occurred during the first 18 months of the study period, with not a single anomaly being reported for approximately 9,000 births during the last three years of the study. The overall anomaly rate of 0.4 per 1,000 live births computed for University Hospital ranks it 45th from the highest rate among the sample of 47 hospitals for which data are available, and is only about 1/15 the sample median rate of 6.4.

The Director of the Laboratory of Medical Genetics, a faculty member of the School of Nursing, with an emphasis on obstetrics, and the Director of the Newborn Division, Department of Pediatrics, who has published on certain types of anomalies, all from UAB, were interviewed in an attempt to find an explanation for the unusually low incidence rate at University Hospital.

The faculty member of the School of Nursing, who worked in the Department of Obstetrics and Gynecology at UAB during the study period, believes the reason that so few anomalies are recorded for births at University Hospital is a communication problem. The birth is registered in the delivery room, the mothers furnish information for the birth certificate, and a physician, perhaps a resident in obstetrics who did not make the delivery, may sign certificates for several births at one sitting. Many anomalies are noted in the nursery, which is under a different medical service, and may never be reported to the Department of Obstetrics, the unit responsible for reporting births. Also, unlike many hospitals where the records of infant and mother are kept together, University Hospital issues separate hospital numbers to the two patients, and their care is administered separately by two different services. The obstetrical nurse estimated that one or two out of every hundred or so births, apparently births with congenital malformations, are discussed at the perinatal conferences. She also said that she remembers that during the time she was employed by the Department of Obstetrics, which was a period of 3 or 4 years, there were 30 to 40 births with anomalies.

The geneticist who was interviewed said that "good" studies indicate that about 25 out of every 1,000 live births have an anomaly serious enough to require medical attention. These "good" studies, to which he referred, more than likely involve some follow-up after delivery, or at least some intensive examination before the infant leaves the hospital. This geneticist has a particular interest in mongolism, which occurs on average once in 600 births. One of his medical colleagues, wanting to study mongoloids, thus expected 40 to be born within

a six-month period, but only 9 were reported. Substantial under-reporting is suspected as the reason for the paucity of cases of mongolism.

The geneticist also commented on the difficulties in diagnosing and measuring the incidence of congenital anomalies. Some anomalies, such as Clubfoot, may be overly diagnosed. For instance, the feet of some infants naturally turn outward and are not necessarily Clubfoot, but are diagnosed as such. On the other hand, some anomalies, such as Cleft Lip and Palate, Hydrocephalus, Anencephalus, and Spina Bifida, are not difficult to diagnose. He also remarked that the Center for Disease Control (CDC) in Atlanta often observes clusters of cases in certain areas which apparently turn out to be artifacts of statistical variation. While not claiming to be a statistician, he recognizes the need for good statistical (prospective) studies and believes that conclusions drawn from birth certificate data are only impressions.

The communication problem referred to by the nurse was confirmed during an interview with the Director of the Newborn Division, Department of Pediatrics, University Hospital. He said that, although the Department of Obstetrics is responsible for reporting births, a member of the Department of Pediatrics sees a newborn infant four to six hours after birth. The pediatrician may note an anomaly once the infant is in the newborn nursery, but he has no obligation and, usually, no compulsion to mention it to the obstetrician who made the delivery. Therefore, except in unusual circumstances, the finding of an anomaly by a pediatrician is not reported on the birth certificate. He also said that the obstetrician does not, as a practice, look for anomalies and will not usually notice one unless it is overt. When informed of the anomaly incidence rate computed for University Hospital for a period during 1968-1972, he was not shocked at its being unusually low; however, in contrast to the medical geneticist who was interviewed, he did not seem to have a well-founded idea about what anomaly rates were accepted as "normal".

Interviews with a medical geneticist, a pediatrician, and a former obstetrics nurse indicate that a rather small fraction of the anomalous births at University Hospital are reported on birth certificates. Therefore, the overall rate determined for University is unacceptable as a control for Lyster Army Hospital, and its influence on any conclusions drawn from a regression analysis that adjusts incidence rates for hospital characteristics should be interpreted with caution.

C. Prediction Limits, Based on a Regression Analysis, for a Hospital with Certain Characteristics of Lyster Army Hospital

The purpose of the regression analysis is to see if the overall anomaly incidence rate for Lyster Army Hospital is within the limits of variation of a sample of 45[1] other Alabama hospitals when adjusted for the non-radar hospital factors, such as average age of mothers, percent of mothers who are nonwhite, and size and type of hospital. To this end, it seems appropriate to compute a prediction interval,[2] 95%, say, as opposed to a confidence interval,[3] for a hospital whose selected non-radar characteristics are the same as those of Lyster. A prediction interval is analogous to using the standard deviation, s, of a single observation to establish "normal" limits, whereas a confidence interval is analogous to using the standard error of the mean, $s/\sqrt{n}$, to measure the precision with which the mean is estimated.

Results of four regression analyses are summarized in Table 7. The unweighted analysis with no transformation of rates (Model 1) gives equal weight to each of the hospitals used in estimating the model parameters, but admits negative predicted values. Nevertheless, the results are not unreasonable when compared to those obtained by a proper transformation and weighting of the variables. A logarithmic transformation (Models 2, 3, and 4) of the anomaly rates precludes negative predicted values, but the observations used in the analysis should be weighted (Models 3 and 4) to make the variances for the observations approximately equal. These have been weighted by the number of anomalies reported at each hospital. A prediction interval was computed using all 18 independent variables (Model 3), but some of these had so little association with the anomaly rates that they actually "explained" less of the overall variance than was measured by the residual variance. Therefore, seven variables were excluded by the "backward elimination" variable selection procedure, and the prediction interval was re-computed (Model 4) and had narrower limits than those yielded by the full model analysis.

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1. Macon County Hospital, by far the smallest maternity hospital in the study, was excluded from the regression analysis.

2. Franklin A. Graybill, An Introduction to Linear Statistical Models, Volume I, McGraw-Hill Book Co., Inc., New York, 1961, pp 122-124.

3. Ibid., pp 121-122.

The anomaly rate, 17.7, observed at Lyster for the period July 1968-December 1972, is remarkably close to the rates of 18.8 and 17.2 predicted by the weighted models using transformed rates and, for each model, is well within those limits predicted for Lyster Army Hospital.

Similar type analyses were planned for certain categories selected on the basis of higher frequency of occurrence of these anomalies at Lyster. However, the number of hospitals with zero occurrences during the study period ranged from seven for Other Limbs to 31 for Musculoskeletal. Because the regression equation developed for the overall rate involved logarithmic transformations of the rates, those hospitals with zero rates would necessarily be dropped from the analysis, thus leaving, in most cases, an inadequate number of hospitals on which to base reasonable conclusions.

It is possible, though, to pool the data for Clubfoot, Other Limbs, and Musculoskeletal into a general heading of Musculoskeletal. These are categories in which Lyster ranked among the highest in the sample of 47 hospitals. Only five of the 47 hospitals failed to have at least one anomaly in the pooled classification. These five hospitals, with the exception of University Hospital, Birmingham, are all much smaller than Lyster, and can, with some justification, be dropped from a regression analysis. Because of time limitations, this analysis was not performed.

D. Analysis of Certain ICDA Congenital Anomaly Categories for Alabama Counties, Selected on Basis of their Rates at Lyster Army Hospital

Of the twenty ICDA categories for congenital anomalies, there are eleven in which Lyster either had no entries for the period July 1968-December 1972 or did not rank in the top ten in the sample of 47 Alabama hospitals. These categories are as follows:

ICDA	Anomaly
740	Anencephalus
741	Spina Bifida
742	Hydrocephalus
744	Eye
745	Ear, Face, Neck
748	Respiratory
749	Cleft Palate or Lip
751	Digestive System
753	Urinary System
758	Unspecified
759	Multiple

In addition to the above, there are four categories in which Lyster ranked in the top ten, but the number of anomalies for the four and one-half year period was either one or two and, therefore, should not cause any special concern. These are:

ICDA	Anomaly
743	Nervous System
747	Circulatory
750	Upper Alimentary
757	Skin, Hair, Nails

Because the aforementioned congenital anomaly categories either had two or fewer entries or had a comparatively low incidence rate, only the remaining categories, in which Lyster had at least five entries and ranked in the top ten within the sample of 47 hospitals, will be examined more closely:

		Lyster Army Hospital		
ICDA	Anomaly	Number	Rate, 1000^{-1}	Rank
746	Heart	12	2.5	3
752	Genital Organs	19	4.0	1
754	Clubfoot	19	4.0	2
755	Other Limbs	15	3.2	8
756	Musculoskeletal	5	1.1	2

Interestingly, the last three categories, Clubfoot, Other Limbs, and Musculoskeletal, are all musculoskeletal in nature and could well be combined for purposes of analysis.

Selected on the basis of Lyster's high rates relative to other Alabama hospitals, the categories of Heart, Genital Organs, Clubfoot, and Other Limbs have been depicted graphically on county maps of Alabama (Figures 2, 3, 4, 5). On each map, the category incidence rate, per 1,000 live births, and its rank within the state are given for each of the 67 counties for which anomalies were reported. Each quartile of rates has a different shading. Those counties which reported no anomalies for a particular category for the study period have entries of 0 and are unranked.

Because the four individual categories were chosen for having high rates at Lyster Army Hospital, it is not surprising that the rates for Dale and Coffee Counties, in which Fort Rucker is located, rank among the top ten in the state. However, there is only one category, Genital Organs, in which either or both counties rank within the top five; Dale ranks first and Coffee, fourth. For each of the other three selected categories, there are two counties bordering Coffee or Dale that have higher rates than both Coffee and Dale. In fact, Houston is one of the two counties with rates higher than Coffee and Dale in each of the

three categories. Using other Alabama counties as controls, we cannot conclude that a serious congenital anomaly problem is manifesting itself in these selected categories. Any problem, if one exists, extends beyond Coffee and Dale Counties.

E. Analysis of Certain ICDA Congenital Anomaly Categories for Lyster Army Hospital

The race, sex, attending physician, and residence of mother for each of the 84 anomalous infants born at Lyster Army Hospital during the study period are listed by month and year of birth for each of the anomaly categories which included more than two infants (Table 8).

There were a total of 17 attending physicians during the four and one-half year period, none of whom reported an anomaly either before or after a particular two-year interval. This observation suggests that these physicians were stationed at Lyster Army Hospital for a period not exceeding two years. At any particular time during the study period there were at least four to six attending physicians on the staff.

Examination of time trends within the individual categories and, also, across categories reveal several interesting patterns:

1. Four of the five diagnoses for Cleft Palate or Lip were made within a seven-month period during the early part of the study. Interestingly, all four were reported by Physician B, who had only four other diagnoses of anomalies. Given that Physician B had eight anomalies to report, four appears to be a disproportionate number to report for a particular category.

2. Within the Heart category, there appears to be a moderate amount of clustering in late 1968 and early 1969. Most of these were reported by Physicians C and B.

3. Three equally spaced clusters are apparent within Genital Organs, and the reporting within any one cluster cannot be credited to one or two physicians.

4. A heavy concentration of reported Clubfoot is evident in 1969, twelve of the nineteen cases for the entire study period occurring within this one year. However, six of the twelve may be attributed to Physician D, and, perhaps significantly, he reported no other type of congenital anomaly.

5. Within the Other Limbs category, there is a moderate amount of clustering during late 1970 and 1971, but half of that may be ascribed to Physician F, who made almost twice as many diagnoses, fifteen, for all categories than any other physician at Lyster.

With the exception of Genital Organs, the apparent clusters are attributable primarily to one or two physicians of the minimum of four to six who are responsible for reporting births in a given month. These phenomena may be explained by one or more of the following reasons:

1. A physician is particularly alert to the occurrence of a certain type anomaly and reports it when it exists (true positive).

2. A physician is overly zealous concerning a certain type and reports it when it does not really exist (false positive).

3. Particular clusters, which are attributable to one or two physicians, are chance phenomena.

With the paucity of information available and with no follow-up of these cases, it is impossible to determine with certainty which of the above reasons is pertinent. However, a very few instances of "overreporting", as in reason (2), above, would result in Lyster's relatively high ranking in some categories.

IV. COMPARISON OF ANOMALY INCIDENCE RATES AT LYSTER WITH THOSE OBTAINED FROM OTHER STUDIES

A. Overall Rates

Many problems that arise in measuring the incidence of congenital malformations are discussed by Warkany in Congenital Malformations.[1] Incidence rates are reported from at least 11 studies conducted at hospitals or clinics in several countries over a 30-year period. Differing interests of the authors and ethnic, racial, or geographic factors can influence incidence figures greatly. Also, the inclusion or exclusion of stillbirths

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1. Joseph Warkany, Congenital Malformations, Yearbook Medical Publishers, Chicago, 1971

and minor abnormalities, the length of time after birth that the newborn was observed for detection of an anomaly, as well as other factors, affect the rates. Nevertheless, examination of some of these figures may give an idea of what overall rates might be considered as "normal". These estimates of anomaly rates at hospitals and clinics ranged from 8.9 to 74 per 1,000 live births, with half the rates being between 13 and 30. The median value was about 20 computed for major anomalies in newborn babies.[1]

The estimates from clinics and hospitals are understandably higher than rates obtained from birth registration records. According to Warkany,[2] incidences from birth records varied from 7.4 to 11.6 in the United States. With special efforts, higher figures, between 13.7 and 19.8, were obtained in directed studies. The Lyster Army Hospital anomaly rate, also determined from birth records for the four and one-half year study period, was 17.7, with approximate 95 percent confidence limits of 13.9 and 21.4. Certainly the Lyster rate is consistent with those obtainable from directed birth certificate studies.

B. Rates by ICDA Category

A recent paper by Harris, et al,[3] reports on abnormalities observed during the first four days of life in 21,142 live-born infants born at a Mayo Clinic affiliated hospital in Rochester, Minnesota, during the period January 1, 1951 through December 31, 1963. The purpose of the Mayo study was to provide base-line data on the incidence of abnormalities present at birth for use in comparative studies among different populations. The newborn infants were examined for congenital anomalies within the first 24 hours after birth and later in the newborn nursery. The large majority of the mothers were from the Rochester area, and the population represented is almost entirely of Northern European extraction.

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1. P. M. Marden, D. W. Smith, and M. J. McDonald, "Congenital Anomalies in the Newborn Infant, including Minor Variations. A study of 4,412 Babies by Surface Examination for Anomalies and Buccal Smear for Sex Chromatin", Journal of Pediatrics, Vol. 64, p 357, 1964.

2. J. Warkany and H. Kalter, "Congenital Malformations", New England Journal of Medicine, Vol. 265, p 993 and p 1046, 1961.

3. Ibid, Lloyd E. Harris, et al.

Each of the 89 anomalies reported for the 84 anomalous infants born at Lyster during the study period has been assigned a four-digit ICDA code. The rate (per 1,000 live births) for each category was then computed and compared to the corresponding rates reported in the Mayo study (Table 9). One cannot reasonably expect a perfect assignment for each of the anomalies to its appropriate sub-classification, but in most cases, the category to which an anomaly belonged seemed clear from its description on the birth certificate. Only the categories in which Lyster had an entry are given, there being as many more categories in which Mayo reported an anomaly and Lyster reported none.

For the 29 categories compared in Table 9 there are 18 in which the Lyster rate exceeds the Mayo rate, although most of the 18 positive differences are obviously trivial. A more objective test would be to compute the probability of obtaining the observed number of Lyster anomalies, or more, in 4,750 live births, given that the total number of anomalies for a particular category in the combined study groups is that number observed. This test is performed by means of an F statistic, and is described in Brownlee.[1] The P-value thus obtained is a measure of the departure of the observed rates from the hypothesis of equal rates; the smaller the P-value, the more significant the difference in rates. If significance is claimed for P-values less than 0.10, then the only significant differences are for 755.7, Other Anomaly of Lower Limbs ($P < .05$), and 754, Clubfoot ($P < .001$).

In the category Other Anomaly of Lower Limbs, there are no entries from Mayo and two from Lyster; from Lyster, one is a positional bowing of a leg and the other is an anomaly of the foot (clubfoot?). An improper classification of an anomaly in either study would cause a seemingly significant finding.

The difference in rates in the Clubfoot category are highly significant. However, it is well-known that this anomaly is easily over-diagnosed. It was noted in a previous section that 12 of the 19 reported cases of Clubfoot occurred in the same year (1969) of the four and one-half year study period, and six of the twelve were reported by the same physician. Moreover, McIntosh, et al,[2] reports a Clubfoot (Talipes and/or Metatarsus Varus) rate of 13.4 per 1,000 live births compared to Lyster's 4.0.

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1. K. A. Brownlee, Statistical Theory and Methodology in Science and Engineering, 2nd Ed., John Wiley and Sons, Inc., New York, 1965, pp 183-185.

2. R. McIntosh, K. K. Merritt, M. R. Richards, M. H. Samuels, and M. T. Bellows, "The Incidence of Congenital Malformations: A Study of 5,964 Pregnancies", Pediatrics, Vol. 14, p 505, 1954.

Comparison of Lyster's rates with those measured in the Mayo study does not suggest that the Lyster rates are unusually high.

V. EARLY ATTEMPTS TO TEST ASSOCIATION OF LYSTER HOSPITAL ANOMALY INCIDENCE RATES WITH RESIDENTIAL AREA OF MOTHER AT TIME OF BIRTH

One of the principal reasons that this study was initiated was a concern that non-ionizing radiation from radar might possibly cause a higher incidence of anomalies among the newborn. Of course, if it cannot be established that the anomaly incidence rates are significantly higher than those in suitable controls, then an investigation to determine causal or associated factors cannot readily be justified.

In the early phases of this study, it appeared that the rates in the Fort Rucker area were considerably higher than elsewhere in the state, and plans were formulated to obtain data that might aid in explaining the high rates. These data were mainly medical and occupational items measured on military personnel and their spouses, who were stationed at Fort Rucker during the time interval being studied. However, when permission to obtain certain items of information was requested of the Office of the Surgeon General (OSG), Department of the Army, it was denied, although never formally.

An independent evaluation of the anomaly data, presented in previous sections of this report, shows that the Lyster rates are consistent with those found in several other studies and in other Alabama hospitals. Therefore, the acquisition of sensitive data from OSG for that reason does not appear to be necessary.

It is possible, however, for there to be an association between radar exposure and incidence of congenital anomalies, even though the average county and hospital incidence rates are within normal limits. Of interest, but impossible to measure with the data made available, is the within-county or within-geographical area variation of anomaly incidence. If radar is an environmental hazard, then sub-county areas with high radar intensity might also have a higher incidence of anomalies than other areas. This, of course, might cloud an association between occupational exposure and anomaly incidence.

Along these lines, consideration was given to measuring the relative risk of giving birth to an anomalous infant for a mother whose residence is within a radar-affected area. This requires that each birth in a sample of births be classified by two factors:

1. Radar exposure at a critical period before or during pregnancy.

2. Whether or not the infant is anomalous.

A. Classification According to Radar Exposure

Late in the study, a map was furnished to the Institute of a nine-county area of southeast Alabama and neighboring parts of Georgia and Florida on which navigational radar sites were indicated. Also included with the map was a classification of types of installations according to certain operational characteristics, such as power, frequency, and beam direction. Approximately 15 or 20 installations were active during the four and one-half year period under study. Had this information been received earlier, it may have been possible to determine the approximate areas that are subjected to hazardous amounts of non-ionizing radiation from these radar sites, and to determine thereby whether these areas have higher than normal incidences of congenital anomalies.

B. Need for Data on Normal Births

The data collected for the study pertained only to anomalous infants. Inquiries into the availability of similar information for a sample of normal births were made to the Alabama Bureau of Vital Statistics. It was learned that, with a moderate amount of effort, birth data for normal births matched by race and sex with the 84 anomalous infants born at Lyster could be provided. At first, a condition for obtaining this type data from Vital Statistics was approval of officials at Lyster Hospital, who had earlier said that authorization would be required from a higher source. Late in the program, the Institute was advised that, if permission could not be obtained through the hospital, the Institute could petition the State Board of Health for the birth records. Because of time and monetary constraints, this route was also not pursued further.

C. Location of Residences and Radar Sites on County Maps

In anticipation of acquiring data for normal births, the locations of radar sites and residences of most of the mothers of anomalous infants at time of birth were indicated on large county maps. No significant clustering was apparent near any of the radar sites. However, this crude analysis was unsatisfactory for at least two reasons:

1. No residences of mothers of normal infants could be used for comparison.

2. Residence of mother at time of delivery may not have been her residence before or soon after conception.

Because the areas affected by radar and the residences of the mothers can be accurately located on large county maps, it should be possible, with more data, to compute the relative risk of having an anomalous infant for mothers living within a radar-affected area. However, efforts in this regard have been inconclusive.

VI. CONCLUSIONS AND RECOMMENDATIONS

As was perhaps realized before this study began, the birth certificate is a highly insensitive device with which to measure anomaly incidence rates. Several reasons for this are obvious. Some defects are not recorded, even when recognized, because of possible future embarrassment to the parents or the child. This is especially true if it is a type anomaly that is correctable by simple surgery, or one that is self-correcting during the child's early life. Often the person responsible for furnishing the vital statistics for the birth has not been trained to recognize birth defects. In this case, only the most overt anomalies will be noticed, and then there is no guarantee that it will be recorded. In some hospitals, the birth record is completed without specific inquiry as to whether or not an anomaly was found. In these situations, it is only by accident that a malformation is recorded on the birth certificate. On the other hand, some anomalies, such as Clubfoot, are easily overdiagnosed, and a physician, or physicians, who think they detect certain types of anomalies when they do not exist can cause the overall anomaly rate in an area to be inflated.

Military hospitals, such as Lyster Army Hospital at Fort Rucker, Alabama, are atypical in certain respects. There is a complete turnover in the staff of obstetricians and pediatricians every two years. As concerns the appearance of certain anomalies during a certain period of time, there is sometimes no way of knowing whether this is characteristic of the medical staff stationed there, or whether it is an outbreak caused by some hazard. In addition to the turnover of physicians, the patient population is likely to be transitory. Thus, if radar, or any other factor, somehow caused a mother to give birth to an anomalous infant, and she was not at Lyster at time of delivery, the Lyster

rates would not reflect this. Moreover, it may be that most of the infants at Lyster are born of parents who lived elsewhere at a hypothetical critical time during pregnancy when radar could cause birth defects. These questions were not answerable during this particular study.

Three types of analyses lead to the conclusion that birth certificate data contains insufficient evidence with which to infer the existence of significantly higher rates in Dale and Coffee Counties, Alabama, and at Lyster Army Hospital, in particular. These are:

1. The county analysis, in which Coffee and Dale ranked only sixth and eighth in overall rates among the 67 counties in Alabama.

2. The hospital analysis, in which the observed rate for Lyster was well within limits determined from other hospitals.

3. Comparison with other studies, particularly one reported recently from Mayo Clinic, in which the rates were, for the most part, consistent with those reported for Lyster.

It may be that, before a problem is serious enough to be detected by analyses based on birth certificates, it would have been obvious to, or at least highly suspected by, local residents and local medical practitioners, especially those whose practice includes obstetrics and pediatrics. Sensitive methods of detection should therefore be based on well designed studies in which tighter control can be exerted on the techniques used to diagnose and report congenital anomalies. These are usually of a prospective nature and may involve thousands of patients, especially when attempting to detect events that are relatively rare.

If a number of responsible persons are convinced that a serious health problem is prevalent in their community, then it should not be too difficult to enlist the support of local residents in verifying the problem and investigating its cause. An investigation of a problem involving birth defects would necessarily require the cooperation of almost all health professionals in the area, particularly physicians whose practice includes obstetrics or pediatrics, hospital administrators, and the public health department.

Investigations of causal factors, or factors associated with birth phenomena, would require obtaining information about factors such as nutrition, occupation, other disease, medical

regimens, and residence of the parents during the year or so before delivery. This information gathering process could perhaps be initiated with the first prenatal visit of the prospective mother. A standard protocol that includes items designed to reveal anomalies that are not immediately obvious, or that could possibly be caused by radiation exposure, could be developed by a committee of experts on congenital anomalies and on factors suspected to be associated with anomalies. The protocol could then be followed uniformly immediately after birth and then again before the newborn infant leaves the hospital. Because all congenital defects are not apparent at birth, the infant might be re-examined according to a standard protocol a few months after birth. The entire data collection process—prenatal, perinatal, and postnatal—might be coordinated by the county and state public health departments.

As noted elsewhere in this report, a problem, if it exists, apparently extends beyond Coffee and Dale Counties. Some neighboring counties have higher rates, both overall and in most ICDA categories. As a minimal consequence of this report, comparable data for the years since 1972 should be acquired to see if the same anomaly pattern exists. If so, the cause of such higher rates should be investigated. It may be simply that for reasons not entirely apparent at present there is over-reporting in some areas and under-reporting in others.

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Table 1
Anomaly Incidence Rates per 1,000 Births in Children Born to White Residents, by County, Alabama, 1969-1972

County	Live births	Anomaly rates: Over-all	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	Fetal deaths
			ICDA categories																				
Autauga	1260	9.5	0.0	1.6	0.0	0.8	0.0	0.8	0.0	0.0	0.0	0.8	0.0	0.8	1.6	0.0	2.4	1.6	0.0	0.0	0.0	0.8	11.9
Baldwin	3322	5.7	0.0	0.6	0.3	0.3	0.0	0.0	0.9	0.0	0.3	0.6	0.0	0.0	0.6	0.3	0.9	0.0	0.3	0.0	0.3	0.9	11.7
Barbour	726	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	1.4	0.0	0.0	0.0	0.0	17.9
Bibb	709	2.8	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	8.5
Blount	1753	8.6	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.3	0.0	0.0	0.0	0.0	2.3	1.1	0.0	0.0	0.0	1.1	5.7
Bullock	199	10.1	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	20.1
Butler	744	18.8	0.0	5.4	0.0	0.0	0.0	1.3	0.0	0.0	0.0	5.4	2.7	1.3	0.0	0.0	1.3	1.3	0.0	0.0	0.0	4.0	12.1
Calhoun	5986	6.5	0.3	0.7	0.3	0.3	0.0	0.2	0.0	0.0	0.0	0.8	0.2	0.5	0.2	0.0	1.0	2.2	0.0	0.0	0.0	0.7	13.4
Chambers	1465	11.6	0.0	1.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	2.7	4.1	0.0	0.0	0.0	0.7	13.7
Cherokee	858	2.3	1.2	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	21.0
Chilton	1385	6.5	0.0	2.2	1.4	0.0	0.7	0.7	0.0	0.0	0.0	0.7	0.0	0.0	1.4	0.0	0.7	0.7	0.0	0.0	0.0	0.7	22.4
Choctaw	689	4.4	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	1.5	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.2
Clarke	1028	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	1.0	0.0	0.0	1.0	1.9	1.0	0.0	0.0	0.0	11.7
Clay	661	9.1	0.0	3.0	0.0	0.0	0.0	0.0	3.0	0.0	1.5	0.0	0.0	1.5	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	21.2
Cleburne	625	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.6
Coffee	2549	12.9	0.0	1.2	0.0	0.4	0.0	0.0	1.2	0.0	0.0	2.0	0.0	0.0	1.6	0.0	2.7	2.4	0.4	0.0	0.0	1.2	7.8
Colbert	2727	2.6	0.0	0.0	0.4	0.0	0.0	0.0	0.4	0.0	0.0	0.7	0.0	0.4	0.4	0.0	0.0	0.7	0.0	0.0	0.0	0.0	10.6
Conecuh	496	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.1
Coosa	354	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	19.8
Covington	1790	6.1	0.0	1.1	0.6	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.6	0.6	0.6	1.1	1.7	0.1	0.0	0.0	0.0	20.7
Crenshaw	551	16.3	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	5.4	0.0	0.0	5.4	3.6	0.0	0.0	0.0	0.0	20.0
Cullman	3315	7.8	0.0	0.6	0.3	0.0	0.0	0.9	0.9	0.0	0.3	0.3	0.0	0.3	1.5	0.0	1.2	1.5	0.3	0.0	0.0	0.9	16.9
Dale	4699	12.1	0.0	0.9	0.0	0.2	0.0	0.2	1.1	0.4	0.2	1.1	0.2	0.4	2.3	0.0	2.6	2.3	0.9	0.2	0.2	0.0	10.4

Table 1 (Cont'd)
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County	Live births	Anomaly rates: Over-all	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	Fetal deaths
		ICDA categories																					
Dallas	2430	9.9	0.4	0.8	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.8	0.0	1.2	1.2	0.0	0.8	2.5	0.4	0.4	0.0	0.8	12.8
DeKalb	2762	8.7	0.7	1.1	0.0	0.0	0.0	0.4	0.0	0.0	0.0	1.4	0.0	0.4	0.4	0.4	2.9	1.1	0.0	0.0	0.4	0.0	14.5
Elmore	1552	7.7	0.0	0.0	1.3	0.0	0.0	0.0	1.3	0.0	0.0	0.6	0.0	0.6	0.6	0.0	1.3	1.9	0.6	0.0	0.6	0.0	9.7
Escambia	1818	6.6	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.6	0.6	1.1	0.0	0.0	1.1	0.6	1.1	0.0	0.6	10.5
Etowah	5504	7.3	0.2	1.3	0.2	0.0	0.0	0.4	0.4	0.2	0.2	1.3	0.2	0.2	1.1	0.0	1.3	0.9	0.0	0.0	0.0	0.4	15.1
Fayette	823	2.4	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	12.2
Franklin	1683	5.9	0.0	0.6	0.6	0.0	0.0	0.0	0.6	0.0	0.6	0.6	0.0	0.6	0.0	0.0	1.2	1.2	0.6	0.0	0.0	0.6	16.0
Geneva	1213	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.8	0.0	0.0	0.0	0.0	7.4
Greene	98	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.2
Hale	270	7.4	0.0	3.7	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.5
Henry	475	16.8	4.2	4.2	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	4.2	12.6
Houston	3338	14.1	0.0	2.7	0.0	0.0	0.3	0.3	1.5	0.0	0.0	1.2	0.0	0.0	1.5	0.0	3.6	3.0	0.6	0.0	0.0	0.9	10.2
Jackson	2893	10.4	0.0	1.4	0.3	0.0	0.0	0.3	1.0	0.0	0.0	0.7	0.0	0.7	0.7	0.0	3.1	1.0	0.7	0.3	0.0	1.4	18.3
Jefferson	26725	8.3	0.1	1.3	0.3	0.3	0.1	0.2	0.4	0.0	0.0	1.7	0.2	0.3	0.9	0.1	1.3	1.5	0.1	0.1	0.1	0.4	11.2
Lamar	838	8.4	0.0	1.2	0.0	0.0	0.0	1.2	0.0	0.0	0.0	1.2	1.2	0.0	0.0	0.0	0.0	2.4	1.2	0.0	0.0	0.0	4.8
Lauderdale	3886	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.3
Lawrence	1582	4.4	0.6	0.6	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	1.9	0.6	0.0	0.0	0.6	0.6	12.0
Lee	3068	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.3	0.0	0.7	0.0	0.7	0.7	0.7	0.0	0.0	0.0	11.1
Limestone	2523	3.2	0.0	0.4	0.8	0.0	0.0	0.0	0.4	0.0	0.4	0.4	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.4	0.0	12.3
Lowndes	169	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9
Macon	244	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.3
Madison	11092	4.4	0.0	0.5	0.5	0.0	0.0	0.0	0.5	0.1	0.1	0.7	0.2	0.2	0.5	0.2	0.8	0.5	0.0	0.0	0.0	0.4	12.7
Marengo	719	12.5	0.0	1.4	0.0	0.0	0.0	0.0	1.4	0.0	0.0	2.8	0.0	0.0	1.4	0.0	0.0	4.2	1.4	0.0	0.0	0.0	11.1

Table 1 (Cont'd)
Anomaly Incidence Rates per 1,000 Births in Children Born to White Residents, by County, Alabama, 1969-1972

County	Live births	Anomaly rates: Over-all	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	Fetal deaths
			ICDA categories																				
Marion	1585	4.4	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.6	1.9	0.0	0.0	0.0	0.0	0.0	12.6
Marshall	3712	8.4	0.0	0.8	0.0	0.3	0.5	0.3	0.3	0.0	0.3	0.8	0.0	0.5	1.1	0.0	1.3	1.6	1.1	0.3	0.0	1.1	15.1
Mobile	15755	4.1	0.1	0.6	0.3	0.0	0.1	0.1	0.7	0.0	0.0	0.4	0.0	0.1	0.1	0.1	0.8	0.6	0.1	0.0	0.0	0.3	10.5
Monroe	757	10.6	2.6	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	2.6	1.3	1.3	0.0	0.0	0.0	0.0	0.0	0.0	1.3	10.6
Montgomery	6590	9.9	0.2	1.1	0.3	0.2	0.0	0.5	0.6	0.0	0.0	2.0	0.2	0.3	0.8	0.2	2.3	1.4	0.3	0.0	0.0	0.9	15.5
Morgan	5228	3.3	0.2	0.4	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.2	0.4	0.8	0.0	0.4	0.4	0.0	0.0	0.0	0.4	13.4
Perry	319	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0	18.8
Pickens	621	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.9
Pike	1110	9.0	0.0	0.9	0.0	0.0	0.0	0.9	0.9	0.0	0.0	0.9	0.0	0.0	0.9	0.0	0.9	1.8	0.0	0.9	0.0	0.9	9.0
Randolph	914	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	13.1
Russell	1986	4.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	1.5	0.0	1.0	0.5	0.0	0.0	0.0	0.0	15.6
St. Clair	1751	8.0	0.0	0.6	0.0	0.0	0.0	0.6	0.6	0.0	0.0	1.7	0.0	0.0	1.7	0.0	1.1	1.7	0.6	0.0	0.0	0.0	14.8
Shelby	2292	6.5	0.0	0.4	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.9	0.0	0.0	1.3	0.0	1.7	1.3	0.0	0.4	0.0	0.0	15.3
Sumter	323	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	3.1
Talladega	3331	4.5	0.0	1.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3	0.0	2.1	1.2	0.0	0.3	0.0	0.0	13.5
Tallapoosa	1603	2.5	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.6	0.0	0.6	0.0	0.0	0.0	0.0	0.0	16.2
Tuscaloosa	5401	1.1	0.0	0.2	0.2	0.0	0.2	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.4	11.3
Walker	3861	4.1	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.0	0.0	1.0	0.0	0.0	0.3	0.0	1.0	1.3	0.5	0.0	0.0	0.3	15.5
Washington	847	3.5	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.2	0.0	0.0	0.0	15.3
Wilcox	347	14.4	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	0.0	0.0	0.0	5.8	8.6
Winston	1386	10.1	0.0	2.2	0.0	0.0	0.0	0.7	0.7	0.0	0.0	2.2	0.7	0.0	0.0	0.0	0.7	3.6	0.0	0.0	0.0	0.0	17.3
State	173315	6.5	0.1	0.9	0.2	0.1	0.1	0.2	0.5	0.0	0.1	1.0	0.1	0.3	0.7	0.1	1.2	1.2	0.2	0.1	0.1	0.4	12.7

Table 2
Incidence of Congenital Anomalies by ICDA Category and Fetal Deaths Among White Residents, Coffee County, Alabama, Selected Time Periods, July, 1969-December, 1972

Anomaly	ICDA code	Early period (7/69-12/70)				Late period (1/71-12/72)				Combined period (7/69-12/72)			
		Observed cases[1]	Observed rate[2]	Binomial probability[3]	Expected rate[4]	Observed cases[1]	Observed rate[2]	Binomial probability[3]	Expected rate[4]	Observed cases[1]	Observed rate[2]	Binomial probability[3]	Expected rate[4]
All[5]		11	11.4	0.062	6.7	16	12.5	0.005	5.9	27	12.0	0.001	6.2
Anencephalus	740	0	0.0	1.000	0.1	0	0.0	1.000	0.1	0	0.0	1.000	0.1
Spina bifida	741	0	0.0	1.000	0.9	2	1.6	0.288	0.8	2	0.9	0.581	0.9
Hydrocephalus	742	0	0.0	1.000	0.1	0	0.0	1.000	0.2	0	0.0	1.000	0.2
Nervous system	743	0	0.0	1.000	0.1	1	0.8	0.105	0.1	1	0.4	0.170	0.1
Eye	744	0	0.0	1.000	0.1	0	0.0	1.000	0.0	0	0.0	1.000	0.1
Ear, face, neck	745	0	0.0	1.000	0.2	0	0.0	1.000	0.2	0	0.0	1.000	0.2
Heart	746	1	1.0	0.363	0.5	1	0.8	0.462	0.5	2	0.9	0.290	0.5
Circulatory	747	0	0.0	1.000	0.0	0	0.0	1.000	0.0	0	0.0	1.000	0.0
Respiratory	748	0	0.0	1.000	0.1	0	0.0	1.000	0.1	0	0.0	1.000	0.1
Cleft palate, lip	749	1	1.0	0.629	1.0	2	1.6	0.294	0.8	3	1.3	0.344	0.9
Upper alimentary	750	0	0.0	1.000	0.2	0	0.0	1.000	0.1	0	0.0	1.000	0.1
Digestive system	751	0	0.0	1.000	0.2	0	0.0	1.000	0.3	0	0.0	1.000	0.3
Genital organs	752	0	0.0	1.000	0.7	4	3.1	0.003	0.5	4	1.8	0.037	0.6
Urinary system	753	0	0.0	1.000	0.1	0	0.0	1.000	0.1	0	0.0	1.000	0.1
Clubfoot	754	4	4.1	0.032	1.2	1	0.8	0.761	1.1	5	2.2	0.125	1.2
Other limbs	755	3	3.1	0.120	1.2	3	2.3	0.129	1.0	6	2.7	0.039	1.1
Musculoskeletal	756	0	0.0	1.000	0.2	1	0.8	0.212	0.2	1	0.4	0.342	0.2
Skin, hair, nails	757	0	0.0	1.000	0.1	0	0.0	1.000	0.0	0	0.0	1.000	0.1
Unspecified	758	0	0.0	1.000	0.1	0	0.0	1.000	0.0	0	0.0	1.000	0.1
Multiple	759	2	2.1	0.071	0.5	1	0.8	0.444	0.5	3	1.3	0.085	0.5
Fetal deaths[6]		6	6.2	0.983	12.7	12	9.3	0.894	12.8	18	8.0	0.987	12.8

1. Number of anomalies recorded on birth certificates and fetal deaths reported for Coffee County by the Bureau of Vital Statistics, Alabama Department of Public Health.

2. Number of anomalies or fetal deaths per 1,000 live births.

3. The probability of obtaining the observed number, or more, of anomalies or fetal deaths, if the risk for each individual in Coffee County were the rate experienced by the State of Alabama, excluding Coffee and Dale Counties, for the same period.

4. The rate expected for Coffee County, if its rate were the same as that experienced by the State of Alabama, excluding Dale and Coffee Counties, for the same period.

5. The overall anomaly category counts an infant with more than one anomaly just once and does not include fetal deaths.

6. Not considered an anomaly.

Table 3
Incidence of Congenital Anomalies by ICDA Category and Fetal Deaths Among White Residents, Dale County, Alabama, Selected Time Periods, July, 1969-December, 1972

Anomaly	ICDA code	Early period (7/69-12/70) Observed cases[1]	Observed rate[2]	Binomial probability[3]	Expected rate[4]	Late period (1/71-12/72) Observed cases[1]	Observed rate[2]	Binomial probability[3]	Expected rate[4]	Combined period (7/69-12/72) Observed cases[1]	Observed rate[2]	Binomial probability[3]	Expected rate[4]
All[5]		27	13.9	0.000	6.7	20	9.0	0.045	5.9	47	11.3	0.000	6.2
Anencephalus	740	0	0.0	1.000	0.1	0	0.0	1.000	0.1	0	0.0	1.000	0.1
Spina bifida	741	3	1.5	0.266	0.9	1	0.4	0.842	0.8	4	1.0	0.490	0.9
Hydrocephalus	742	0	0.0	1.000	0.1	0	0.0	1.000	0.2	0	0.0	1.000	0.2
Nervous system	743	1	0.5	0.141	0.1	0	0.0	1.000	0.1	1	0.2	0.292	0.1
Eye	744	0	0.0	1.000	0.1	0	0.0	1.000	0.0	0	0.0	1.000	0.1
Ear, face, neck	745	0	0.0	1.000	0.2	1	0.4	0.301	0.2	1	0.2	0.566	0.2
Heart	746	2	1.0	0.231	0.5	1	0.4	0.658	0.5	3	0.7	0.319	0.5
Circulatory	747	0	0.0	1.000	0.0	2	0.9	0.000	0.0	2	0.5	0.002	0.0
Respiratory	748	0	0.0	1.000	0.1	1	0.4	0.129	0.1	1	0.2	0.250	0.1
Cleft palate, lip	749	3	1.5	0.323	1.0	2	0.9	0.558	0.8	5	1.2	0.342	0.9
Upper alimentary	750	1	0.5	0.283	0.2	0	0.0	1.000	0.1	1	0.2	0.421	0.1
Digestive system	751	2	1.0	0.077	0.2	0	0.0	1.000	0.3	2	0.5	0.340	0.3
Genital organs	752	6	3.1	0.002	0.7	4	1.8	0.022	0.5	10	2.4	0.000	0.6
Urinary system	753	0	0.0	1.000	0.1	0	0.0	1.000	0.1	0	0.0	1.000	0.1
Clubfoot	754	6	3.1	0.035	1.2	2	0.9	0.708	1.1	8	1.9	0.119	1.2
Other limbs	755	3	1.5	0.436	1.2	6	2.7	0.022	1.0	9	2.2	0.042	1.1
Musculoskeletal	756	1	0.5	0.305	0.2	2	0.9	0.065	0.2	3	0.7	0.044	0.2
Skin, hair, nails	757	0	0.0	1.000	0.1	0	0.0	1.000	0.0	0	0.0	1.000	0.1
Unspecified	758	0	0.0	1.000	0.1	1	0.4	0.104	0.0	1	0.2	0.206	0.1
Multiple	759	0	0.0	1.000	0.5	0	0.0	1.000	0.5	0	0.0	1.000	0.5
Fetal deaths[6]		16	8.2	0.976	12.7	29	13.0	0.483	12.8	45	10.8	0.888	12.8

1. Number of anomalies recorded on birth certificates and fetal deaths reported for Dale County by the Bureau of Vital Statistics, Alabama Department of Public Health.

2. Number of anomalies or fetal deaths per 1,000 live births.

3. The probability of obtaining the observed number, or more, of anomalies or fetal deaths, if the risk for each individual in Dale County were the rate experienced by the State of Alabama, excluding Coffee and Dale Counties, for the same period.

4. The rate expected for Dale County, if its rate were the same as that experienced by the State of Alabama, excluding Dale and Coffee Counties, for the same period.

5. The overall anomaly category counts an infant with more than one anomaly just once and does not include fetal deaths.

6. Not considered an anomaly.

Table 4
Incidence of Congenital Anomalies by ICDA Category and Fetal Deaths Among White Residents, Dale and Coffee Counties, Alabama, Selected Time Periods, July, 1969-December, 1972

Anomaly	ICDA code	Early period (7/69-12/70)				Late period (1/71-12/72)				Combined period (7/69-12/72)			
		Observed cases[1]	Observed rate[2]	Binomial probability[3]	Expected rate[4]	Observed cases[1]	Observed rate[2]	Binomial probability[3]	Expected rate[4]	Observed cases[1]	Observed rate[2]	Binomial probability[3]	Expected rate[4]
All[5]		38	13.0	0.000	6.7	36	10.3	0.001	5.9	74	11.5	0.000	6.2
Anencephalus	740	0	0.0	1.000	0.1	0	0.0	1.000	0.1	0	0.0	1.000	0.1
Spina bifida	741	3	1.0	0.500	0.9	3	0.9	0.556	0.8	6	0.9	0.484	0.9
Hydrocephalus	742	0	0.0	1.000	0.1	0	0.0	1.000	0.2	0	0.0	1.000	0.2
Nervous system	743	1	0.3	0.203	0.1	1	0.3	0.262	0.1	2	0.3	0.100	0.1
Eye	744	0	0.0	1.000	0.1	0	0.0	1.000	0.0	0	0.0	1.000	0.1
Ear, face, neck	745	0	0.0	1.000	0.2	1	0.3	0.431	0.2	1	0.2	0.723	0.2
Heart	746	3	1.0	0.157	0.5	2	0.6	0.505	0.5	5	0.8	0.194	0.5
Circulatory	747	0	0.0	1.000	0.0	2	0.6	0.001	0.0	2	0.3	0.004	0.0
Respiratory	748	0	0.0	1.000	0.1	1	0.3	0.195	0.1	1	0.2	0.358	0.1
Cleft palate, lip	749	4	1.4	0.350	1.0	4	1.1	0.342	0.8	8	1.2	0.246	0.9
Upper alimentary	750	1	0.3	0.392	0.2	0	0.0	1.000	0.1	1	0.2	0.569	0.1
Digestive system	751	2	0.7	0.149	0.2	0	0.0	1.000	0.3	2	0.3	0.554	0.3
Genital organs	752	6	2.1	0.013	0.7	8	2.3	0.000	0.5	14	2.2	0.000	0.6
Urinary system	753	0	0.0	1.000	0.1	0	0.0	1.000	0.1	0	0.0	1.000	0.1
Clubfoot	754	10	3.4	0.004	1.2	3	0.9	0.748	1.1	13	2.0	0.042	1.2
Other limbs	755	6	2.1	0.159	1.2	9	2.6	0.008	1.0	15	2.3	0.006	1.1
Musculoskeletal	756	1	0.3	0.419	0.2	3	0.9	0.029	0.2	4	0.6	0.033	0.2
Skin, hair, nails	757	0	0.0	1.000	0.1	0	0.0	1.000	0.0	0	0.0	1.000	0.1
Unspecified	758	0	0.0	1.000	0.1	1	0.3	0.159	0.0	1	0.2	0.298	0.1
Multiple	759	2	0.7	0.378	0.5	1	0.3	0.799	0.5	3	0.5	0.559	0.5
Fetal deaths[6]		22	7.6	0.997	12.7	41	11.7	0.738	12.8	63	9.8	0.987	12.8

1. Number of anomalies recorded on birth certificates and fetal deaths reported for Dale and Coffee Counties by the Bureau of Vital Statistics, Alabama Department of Public Health.

2. Number of anomalies or fetal deaths per 1,000 live births.

3. The probability of obtaining the observed number, or more, of anomalies or fetal deaths, if the risk for each individual in Dale and Coffee Counties were the rate experienced by the State of Alabama, excluding Dale and Coffee Counties, for the same period.

4. The rate expected for Dale and Coffee Counties, if its rate were the same as that experienced by the State of Alabama, excluding Dale and Coffee Counties for the same period.

5. The overall anomaly category counts an infant with more than one anomaly just once and does not include fetal deaths.

6. Not considered an anomaly.

Table 5
Live Births, White Residents Only, Coffee and Dale Counties, and Alabama excluding Coffee and Dale Counties, Selected Time Periods, July, 1969-December, 1972

Area	Early period (7/69-12/70)	Late period (1/71-12/72)	Combined period (7/69-12/72)
Coffee County	965	1,284	2,249
Dale County	1,948	2,225	4,173
Coffee and Dale Counties	2,913	3,509	6,422
State of Alabama, excluding Coffee and Dale Counties	64,313	80,834	145,147

Table 6
Anomaly and Fetal Death Rates for 47 Selected Hospitals, Alabama, 1968-1972

Rank by total anomaly rates	Hospital	County	Type hospital[a]	Reported number of births, 1968-1972[b]	Adjusted number of births, 1968-1972[c]	Number of births, 1968-1971[d]	APGAR scoring	Average hours after birth when birth certificate completed	Average age of mothers	Nonwhite mothers in percent	Births with anomalies		Fetal deaths	
											Number	Rate	Number	Rate
1	Air Force Regional (Maxwell)	Montgomery	GM	2,602	2,339	2,074	Yes	42	24.0	24.7	42	18.0	14	6.8
2	Lyster Army (Ft. Rucker)[h]	Dale	GM	(g)	4,750	(g)	Yes	8	23.0	7.8	77	16.2	55	11.6
3	L. V. Stabler Memorial	Butler	PNP	906	824	734	No	36	22.8	22.6	12	14.5	13	17.7
4	Henry County	Henry	GNM	321	279	(g)	No	12	22.0	64.6	4	14.3	(g)	(g)
5	North Jackson	Jackson	GNM	1,225	1,122	990	No	1	23.0	10.9	15	13.4	7	7.1
6	Hale County	Hale	GNM	935	878	735	No	24	22.1	76.4	11	12.5	20	27.2
7	Burdick-West Memorial	Winston	GNM	1,232	1,232	881[e]	Yes	8	17.3	0.2	15	12.2	12[e]	13.6
8	Carraway Methodist	Jefferson	PNP	4,897	4,362	4,086	Yes	48	24.0	10.2	52	11.9	51	12.5
9	Southeast Alabama General	Houston	GNM	4,766	4,396	3,646	Yes	8	23.7	19.4	52	11.8	47	12.9
10	New Vaughn Memorial	Dallas	PNP	3,971	3,819	2,792	Yes	48	22.7	33.7	45	11.8	49	17.6
11	St. Margaret's	Montgomery	PNP	3,314	3,000	2,627	No	36	24.0	19.5	34	11.3	43	16.4
12	Birmingham Baptist Medical Centers	Jefferson	PNP	15,780	14,570	12,548	Yes	24	24.7	12.8	135	9.3	148	11.8
13	Grove Hill Municipal	Clarke	GNM	596	556	431	No	8	24.0	50.3	5	9.0	10	23.2
14	John A. Andrew Memorial	Macon	PNP	8,213	7,467	6,269	Yes	24	22.2	97.3	67	9.0	130	20.7
15	Flowers	Houston	PP	2,615	2,380	2,069	Yes	24	18.8	16.0	21	8.8	24	11.6
16	Guntersville	Marshall	GNM	2,039	1,859	1,637	No	24	23.0	4.1	16	8.6	22	13.4
17	Anniston Memorial	Calhoun	GNM	8,099	7,335	6,473	Yes	9	24.0	21.2	62	8.4	166	25.6
18	Lamar County General	Lamar	GNM	406	363	331	No	48	21.2	27.8	3	8.3	4	12.1
19	East End Memorial	Jefferson	PNP	5,470	4,950	4,486	Yes	24	22.1	2.3	37	7.5	48	10.7
20	Holy Name of Jesus	Etowah	PNP	4,001	3,574	3,452	Yes	22	23.0	12.4	26	7.3	32	9.3
21	Redstone Arsenal	Madison	GM	1,767	1,545	1,599	Yes	8	25.0	15.0	11	7.1	16	10.0
22	Dale County	Dale	GMN	1,735	1,572	1,419	Yes	8	23.7	21.2	11	7.0	15	10.6
23	Montgomery Baptist	Montgomery	PNP	5,500	5,124	4,178	Yes	24	24.0	11.0	35	6.8	62	14.8
24	Lloyd Noland	Jefferson	PNP	2,636	2,347	2,241	Yes	24	26.1	54.8	15	6.4	46	20.5
25	Suburban	Mobile	PP	393	329	366	Yes	1	24.0	21.6	2	6.1	2	5.5
26	Baugh-Wiley-Smith	Morgan	PP	1,015	874	942	Yes	24	22.2	22.5	5	5.7	13	13.8
27	St. Vincents	Jefferson	PNP	6,162	5,564	3,548[e]	Yes	24	24.0	6.8	30	5.4	33[e]	9.3
28	Mizell Memorial	Covington	PNP	1,970	1,814	1,531	Yes	2	20.8	24.1	9	5.0	31	20.2
29	Baptist Memorial	Etowah	PNP	4,923	4,508	3,775	Yes	10	23.7	21.8	22	4.9	65	17.2
30	Guin	Marion	GNM	484	430	414	Yes	8	25.6	10.5	2	4.6	7	16.9
31	Thomas	Baldwin	GNM	960	879	804	Yes	120	23.0	25.3	4	4.6	9	11.2
32	Mobile Infirmary	Mobile	PNP	15,061	13,766	12,136	Yes	24	21.2	7.4	61	4.4	141	11.6
33	Peoples	Walker	GNM	4,476	4,060	3,644	No	13	19.8	8.8	16	3.9	64	17.6
34	Providence	Mobile	PNP	6,581	5,954	5,326	Yes	12	24.0	30.2	22	3.7	60	11.3
35	Huntsville	Madison	GNM	11,988	10,465	10,202[f]	Yes	30	22.3	31.4	38	3.6	117[f]	11.5
36	Medical Center	Madison	PNP	3,673	3,673	2,563[f]	Yes	24	22.2	5.5	12	3.3	27[f]	10.5
37	Arab	Marshall	GNM	1,544	1,379	1,265	Yes	12	24.8	0.1	4	2.9	18	14.2
38	Lee County	Lee	GNM	4,558	4,148	3,629	Yes	12	24.2	21.5	12	2.9	60	16.5
39	Sylacauga	Talladega	GNM	3,813	3,464	3,106	Yes	18	22.8	36.0	8	2.3	58	18.7
40	Colbert County	Colbert	GNM	4,832	4,378	3,951	Yes	12	25.8	22.9	9	2.0	59	14.9
41	D. W. McMillan Memorial	Escambia	GNM	1,747	1,602	1,331	Yes	1	23.0	36.8	2	1.2	18	13.5
42	Druid City	Tuscaloosa	GNM	11,529	10,474	9,222	Yes	24	24.2	33.2	12	1.1	137	14.8
43	Mobile General	Mobile	GNM	10,934	9,808	8,639	Yes	18	21.7	76.4	8	0.8	146	16.9
44	Noble Army (Ft. McClellan)	Calhoun	GM	1,668	1,483	1,431	Yes	48	24.0	20.5	1	0.7	11	7.7
45	University of Alabama	Jefferson	GNM	15,690	14,142	12,870	Yes	36	25.0	77.6	6	0.4	311	24.2
46	Eliza Coffee Memorial	Lauderdale	GNM	6,977	6,316	5,608	No	24	25.8	12.7	2	0.3	68	12.1
47	Macon County	Macon	GNM	68	54	(g)	Yes	24	22.6	60.0	0	0.0	(g)	(g)

a. Hospitals by type are coded: GM - Government, military
GNM - Government, nonmilitary
PP - Private, profit
PNP - Private, nonprofit

b. As reported to Southern Research Institute by the hospitals participating in this survey.

c. Estimated number of births during study period, mid-1968 through 1972, which is used as the denominator in calculating anomaly incidence rates. The number of births during the last half of 1968 is assumed to be one-half the total number of births during 1968.

d. Number of births, which is used as the denominator in calculating fetal death rates. The number of fetal deaths for each hospital in 1972 was unavailable for this study.

e. Data not available for 1968.

f. Data not available for 1968 and 1969.

g. Not available.

h. Data extracted from Phase I final report.

Table 7
Estimate of and 95% Prediction Interval for the Overall Anomaly Incidence Rate for a Hospital with 18 Non-Radar Characteristics of Lyster Army Hospital Using Four Regression Models

Model	Lower 95% prediction limit	Estimate of Lyster rate[a]	Upper 95% prediction limit
1. Unweighted, no transformation	0.7	11.4	22.1
2. Unweighted, log transformation	0.6	5.4	48.7
3. Weighted,[b] log transformation, full model[c]	4.7	18.8	75.0
4. Weighted, log transformation, reduced model[d]	6.1	17.2	48.2

a. The observed rate for Lyster for the period July 1968-December 1972 was 17.7.

b. Logarithmic transformation of rate, which precludes negative predicted rates, weighted by number of anomalies.

c. All 18 predictor (independent) variables included in the model.

d. Eleven predictor variables included in the model. Seven variables removed by the method of "backward elimination" "explained" less of the variation than was in the residual error.

Table 8
Race, Sex, Attending Physician, and Residence of Mother for Anomalous Infants Born at Lyster Army Hospital, Fort Rucker, Alabama, July 1968 through December 1972 by Major ICDA Category and Month and Year of Birth[a]

Year	Month	749 Cleft palate	746 Heart	752 Genital organs	754 Clubfoot	755 Other limbs	756 Musculo-skeletal	All other	Total infants
1972	12			2,BM,N,MID					1
	11			2,WM,M,FTR[b] 1,WM,Q,FTR	9,WM,M,FTR[b]	1,WM,M,FTR[b] 7,WM,P,FTR		7431,BF,O,FTR	4
	10				2,WM,O,DLV				1
	9							7419,WM,M,ENT	1
	8		9,WF,O,FTR			6,WF,P,FTR		7475,WM,P,OZK	3
	7			2,WM,O,DLV				7450,WM,P,FTR	2
	6			1,WM,O,ENT			8,WM,P,ENT		2
	5								0
	4								0
	3			2,WM,J,ENT	9,WM,J,ENT				2
	2							7419,WF,P,FTR	1
	1								0
1971	12		9,WF,J,DTN						1
	11								0
	10					7,WM,J,DLV			1
	9		9,WF,N,ELB			8,WF,O,OZK			2
	8								0
	7		9,WM,N,DTN						1
	6								0
	5	2,WM,I,OZK		1,WM,F,ENT		6,WF,M,ENT	8,WM,L,ENT 4,WF,K,DLV	7460 7473,WM,F,DLV	6
	4								0
	3					0,WF,F,ENT			1
	2			2,WM,J,DTN					1
	1		9,WF,F,OZK	2,WM,G,DLV					2
1970	12					1,WM,E,ENT			1
	11			4,WM,I,OZK					1
	10				8,BM,J,DLV 8,BF,F,ENT 8,WM,G,DLV	2,WM,F,ENT		7419,HM,I,DLV 7419,WF,J,OZK	6
	9			2,WM,E,JAC		0,BF,F,DLV			2
	8								0
	7				8,WM,F,DTN	0,WM,F,DLV			2
	6			1,WM,I,DLV					1
	5			2,WM,F,DLV					1
	4							7419,WF,I,FTR	1
	3								0
	2								0
	1		9,WM,F,BEL					7430,BM,I,ENT	2
1969	12								0
	11								0
	10			1,WM,E,OZK 1,WM,G,DLV	8,WM,G,ENT				3
	9			4,WM,H,DTN	8,WF,G,OZK		0,WM,F,DLV		3
	8			1,WM,F,CHP	8,WM,D,ENT 8,WF,F,ENT 8,WM,P,ENT (2)8,WM,D,FTR				6
	7		9,WM,E,DLV	1,WM,E,FTR				7502,WM,E,DLV	3
	6								0
	5		9,WF,B,FTR			6,WF,E,FTR		7571,WF,B,OZK	3
	4		9,WM,B,ENT	4,WM,C,DLV	1,WM,C,DLV[d] 2,WM,C,FTR	2 3,WM,C,DLV[d]	8,WM,E,ENT		5
	3	1,WM,B,ENT							1
	2	1,WM,D,ENT			9,WF,D,OZK 2,WP,D,ENT				3
	1		9,WF,C,DLV		8,WF,D,DLV				2
1968	12		9,WM,C,OZK						1
	11								0
	10	1,WM,B,ENT	9,WF,C,NEW			6,WF,B,ENT			3
	9	0,WM,B,OZK							1
	8					0,BM,A,ENT			1
	7								0
Total anomalies		5	12	19	19	16	5	13	89 / 84

Note: Footnotes and legend are on the following page.

Footnotes and Legend for Table 8

a. These anomalous births were reported to the Birth Defects Center, University of Alabama in Birmingham, through the Division of Vital Statistics, Alabama Department of Public Health. The major categories are those in which Lyster's rate ranked among the top ten in a stratified sample of 47 Alabama hospitals.

b. Infant with multiple birth defect reported in November, 1972.

c. Duplicate entry.

d. Infant with multiple birth defect reported in April, 1969.

Legend

1. The fourth digit of the indicated ICDA category, or the entire four-digit code, if the anomaly is in the All Other category.

2. Race and sex: W = White, B = Black, H = Hawaiian, M = Male, F = Female

3. Code for attending physician.

4. Residence of mother:

BEL = Bellwood	FTR = Fort Rucker
CHP = Chipley, Fla.	JAC = Jack
DLV = Daleville	OZK = Ozark
DTN = Dothan	MID = Midway
ELB = Elba	NEW = Newton
ENT = Enterprise	

Table 9
Comparison of Congenital Anomaly Incidence Rates between Lyster Army Hospital, July 1968 through December 1972, and Mayo Clinic, 1951-1963[1]

ICDA	Abnormality	Mayo Clinic[2] Number of anomalies	Mayo Clinic[2] Rate, per 1,000 live births	Lyster Army Hospital[3] Number of anomalies	Lyster Army Hospital[3] Rate, per 1,000 live births	F	Degrees of freedom for F-test	P-value
741	Spina Bifida	14	0.65	5	1.05	1.48	30,10	n.s.[4]
743.0	Encephalocele	3	0.14	1	0.21	1.11	8,2	n.s.
743.1	Microcephalus	4	0.19	1	0.21	0.89	10,2	n.s.
745.0	Atresia of Ear Canal	1	0.05	1	0.21	2.23	4,2	n.s.
746	Congenital Heart Disease	32	1.51	9	1.89	1.21	66,18	n.s.
	Heart Murmur		8.61		0.63	<1.00	-	n.s.
	Truncus Arteriosus	0	-	1	0.21	4.45	2,2	n.s.
747.3	Pulmonary Atresia	0	-	1	0.21	4.45	2,2	n.s.
747.5	Absence of Umbilical Artery	0	-	1	0.21	4.45	2,2	n.s.
749.0	Cleft Palate	8	0.38	1	0.21	<1.00	-	n.s.
749.1	Cleft Lip	9	0.43	3	0.63	1.34	20,6	n.s.
749.2	Cleft Lip and Palate	15	0.71	1	0.21	<1.00	-	n.s.
750.2	Tracheoesophageal Fistula	2	0.09	1	0.21	1.48	6,2	n.s.
752.1	Undescended Testicle	93[5]	8.52	8[6]	3.26	<1.00	-	n.s.
752.2	Hypospadias	69[5]	6.32	8[6]	3.26	<1.00	-	n.s.
752.4	Hydrocele	173[5]	15.84	3[6]	1.22	<1.00	-	n.s.
754	Clubfoot (all types)	25	1.18	19	4.00	3.25	52,38	P<0.001
755.0	Polydactyly	19	0.90	4	0.84	<1.00	-	n.s.
755.1	Syndactyly	7	0.33	2	0.42	1.11	16,4	n.s.
755.4	Reduction Deformities[7]	10	0.47	3	0.63	1.21	22,6	n.s.
755.6	Congenital Dislocation of Hip	12	0.57	4	0.84	1.37	26,8	n.s.
755.7	Other Anomaly of Lower Limb	0	-	2	0.42	8.90	2,4	P<0.05
755.8	Arthrogryposis	3	0.14	1	0.21	1.11	8,2	n.s.
756.0	Skull and Face Bones	5	0.24	1	0.21	<1.00	-	n.s.
756.4	Ribs	0	-	1	0.21	4.45	2,2	n.s.
756.8	Diaphramatic Hernia	1	0.05	1	0.21	2.23	4,2	n.s.
756.8	Absence of Pectoralis Major	5	0.24	1	0.21	<1.00	-	n.s.
756.8	Other Muscle, Tendon, Fascia	5	0.24	1	0.21	<1.00	-	n.s.
757.1	Pigmented Nevus	84	3.97	1	0.21	<1.00	-	n.s.

1. Harris, et al., loc. cit.

2. Live births at Mayo were 21,142.

3. Live births at Lyster were 4,750.

4. Nonsignificant.

5. Total male live births at Mayo were 10,919.

6. Total male live births at Lyster were approximately 2,453, based on assumption that proportion of male births at Lyster was same as that in Mayo study.

7. Combination of two cases of Reduction Deformities of Upper Limb (755.2) and one case of Lower Limb (755.3) at Lyster.

Figure 1

Number of OVERALL Congenital Anomalies per 1,000 Births of Children Born to White Residents, by County, Alabama, 1969-1972

Note: The OVERALL anomaly rate and, in parentheses, the relative rank of that rate within the state are given for each county. Counties with no anomalies are unranked.

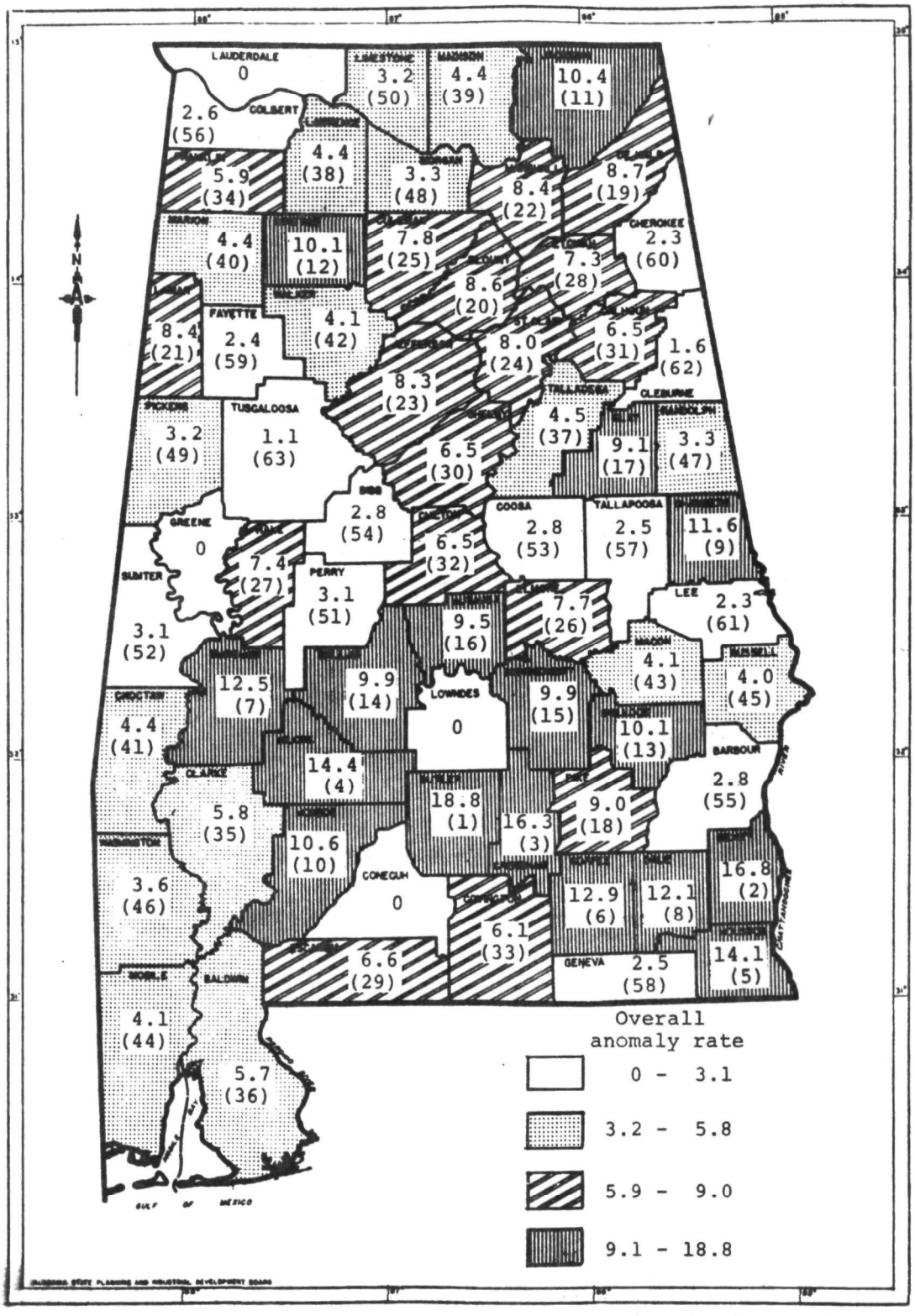


Figure 2

Number of HEART DISEASE Congenital Anomalies per 1,000 Births of Children Born to White Residents, by County, Alabama, 1969-1972

Note: The HEART DISEASE anomaly rate and, in parentheses, the relative rank of that rate within the state are given for each county. Counties with no anomalies are unranked.

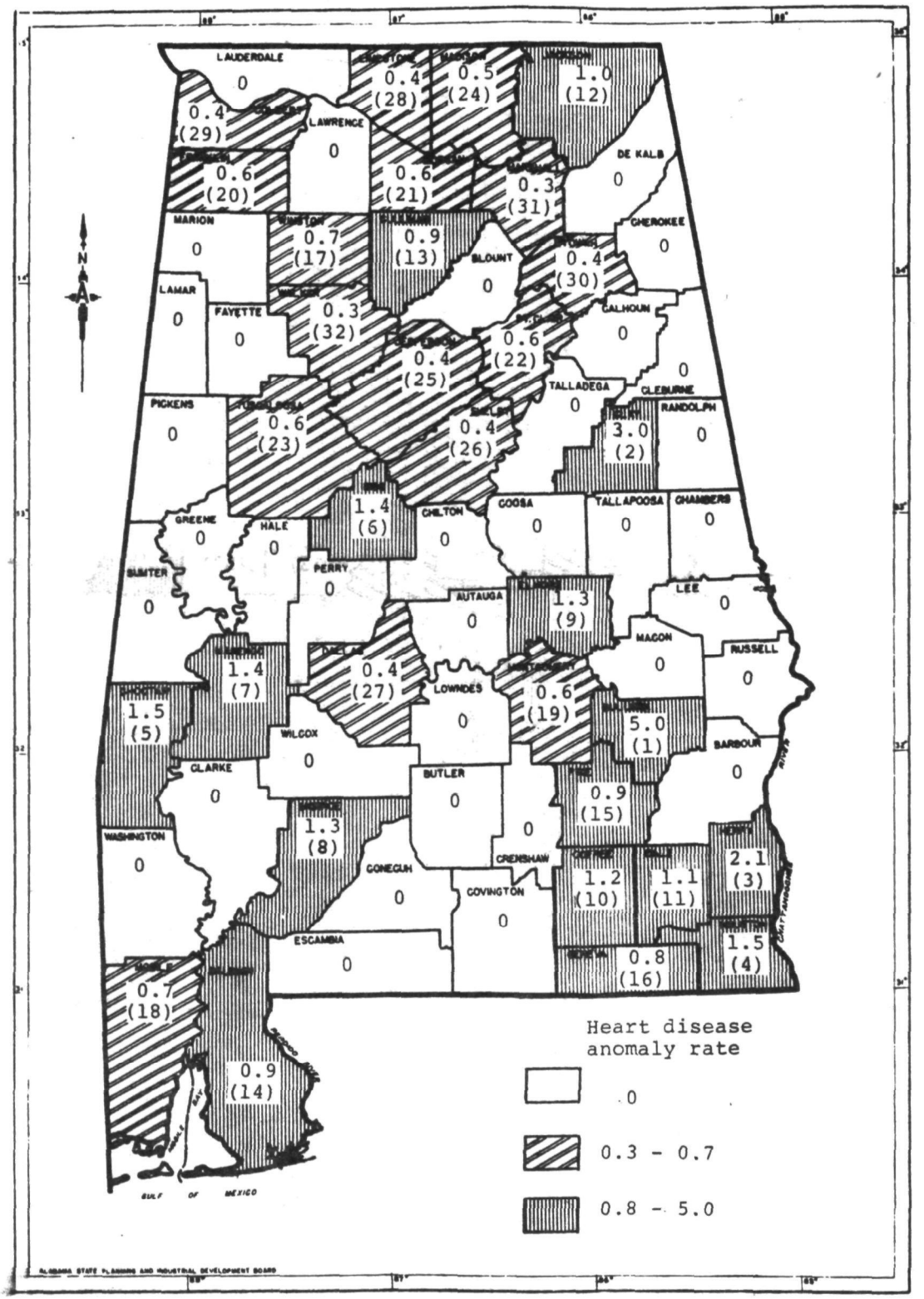


Figure 3

Number of GENITAL Congenital Anomalies per 1,000 Births of Children Born to White Residents, by County, Alabama, 1969-1972

Note: The GENITAL anomaly rate and, in parentheses, the relative rank of that rate within the state are given for each county. Counties with no anomalies are unranked.

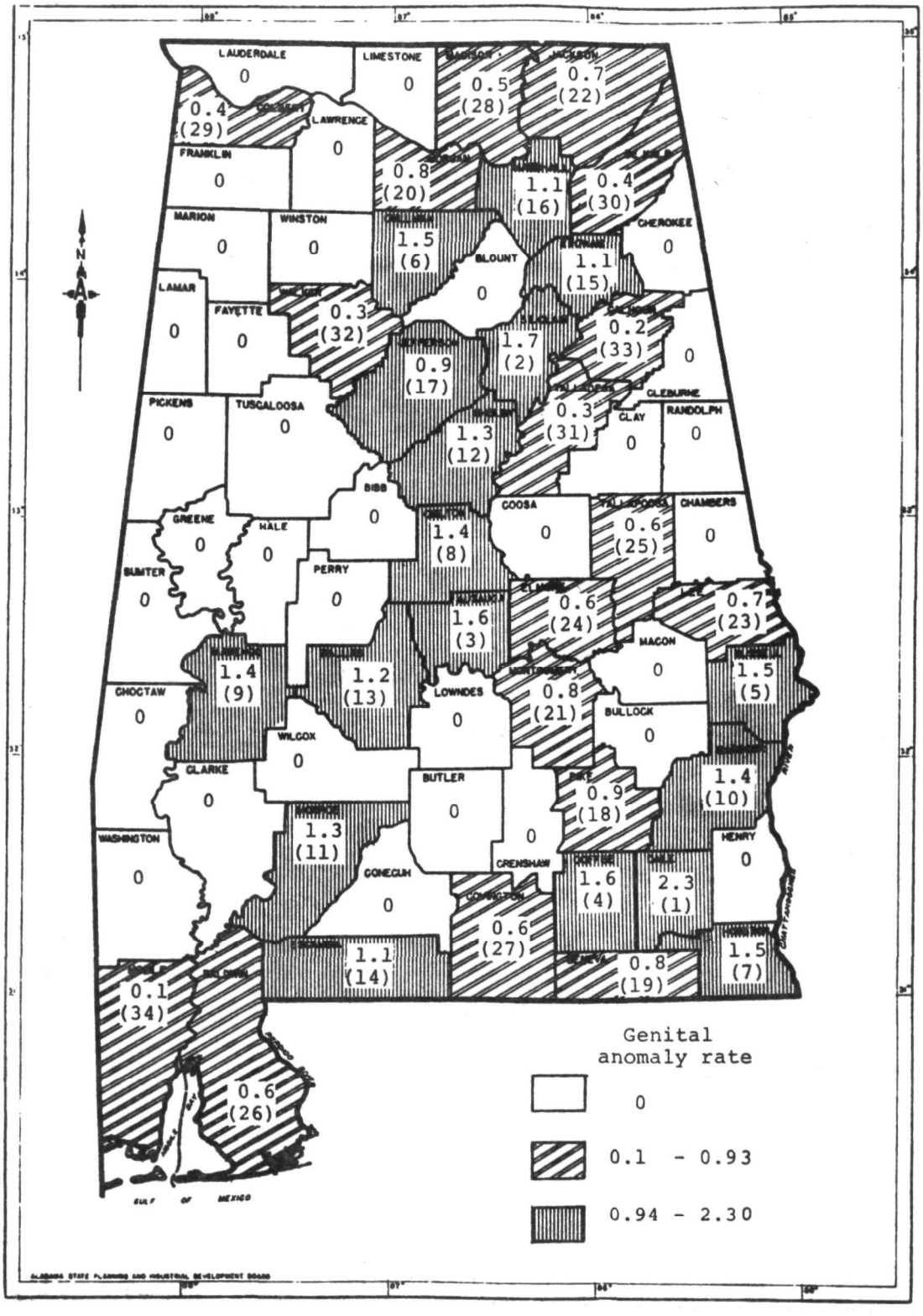


Figure 4

Number of CLUBFOOT Congenital Anomalies per 1,000 Birthis of Children Born to White Residents, by County, Alabama, 1969-1972

Note: The CLUBFOOT anomaly rate and, in parentheses, the relative rank of that rate within the state are given for each county. Counties with no anomalies are unranked.

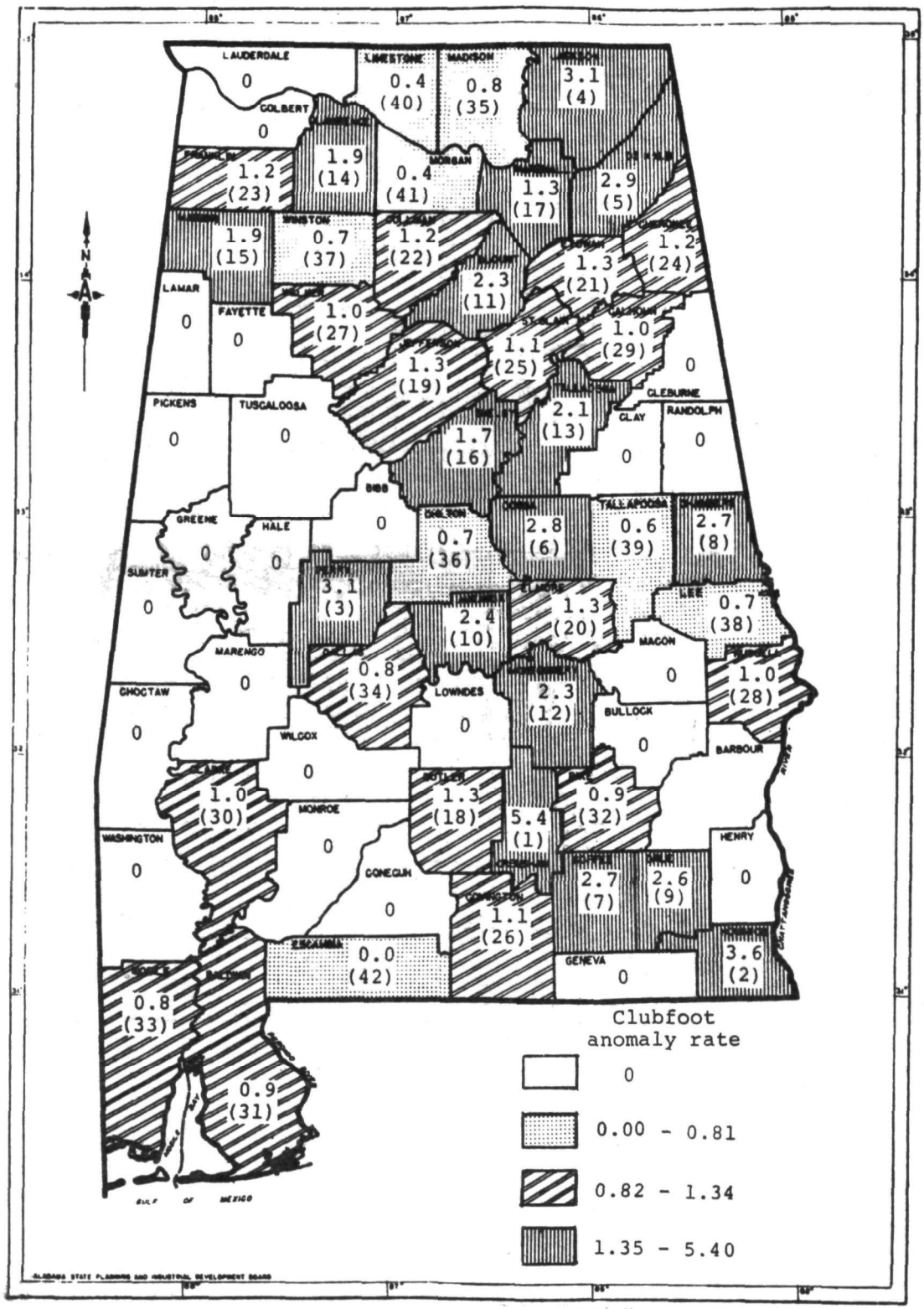


Figure 5
Number of OTHER LIMBS Congenital Anomalies per 1,000 Births of Children Born to White Residents, by County, Alabama, 1969-1972

Note: The OTHER LIMBS anomaly rate and, in parentheses, the relative rank of that rate within the state are given for each county. Counties with no anomalies are unranked.

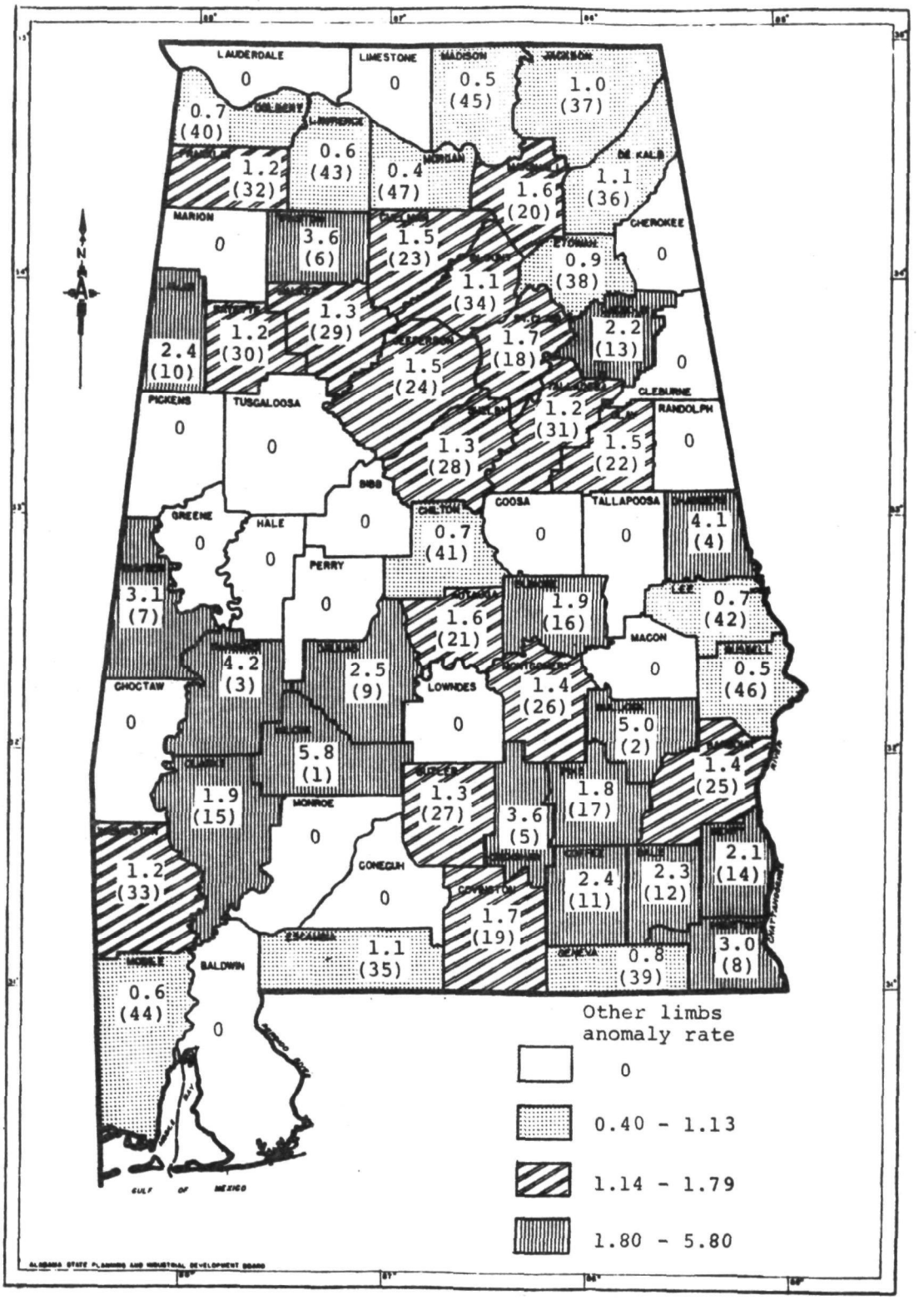
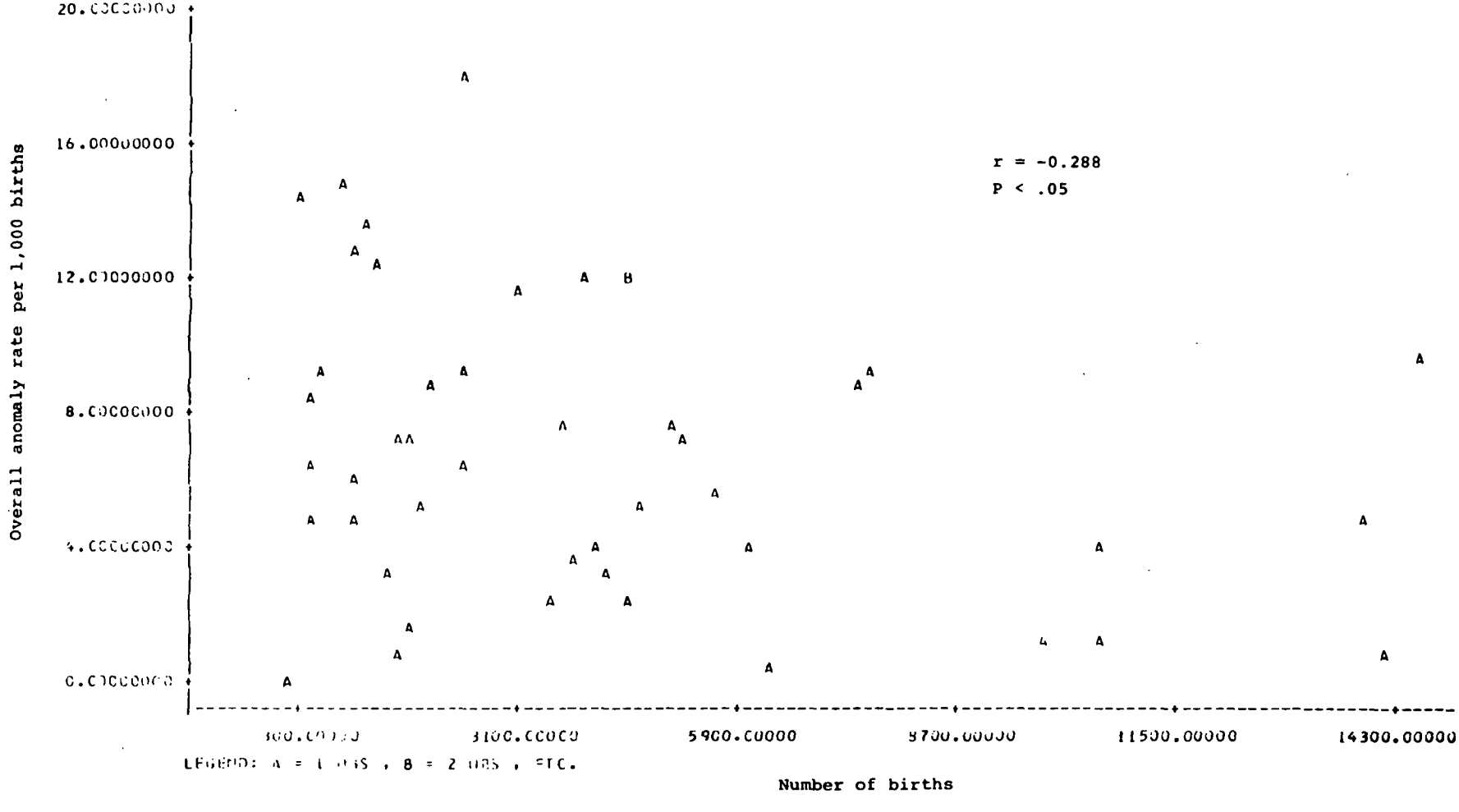


Figure 6
Anomaly Rates for 47 Hospitals, Alabama, 1968-1972
(Plot of overall anomaly rate versus number of study-period births)



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15. SUPPLEMENTARY NOTES

16. ABSTRACT

This report concludes that, in net terms, and on the basis of available retrospective data, primarily from birth records, there are no strong indications that the incidence of congenital anomalies in the Ft. Rucker, Alabama area is higher than normal. The original hypothesis that the situation might be serious has been traced, for the most part, to earlier reliance on faulty diagnosing and reporting, and especially to reliance on the birth certificate, which, there is reason to believe on the basis of the findings of this study, is a relatively insensitive instrument for measuring the incidence of congenital anomalies.

The attempt to relate this incidence to specific factors associated with military life, or in particular to factors associated with exposure to military radar, was largely unsuccessful because the miliary in effect denied access to pertinent records on the grounds that no prima facie case had been made that a problem really exists. Unfortunately, no fairly positive statement can be made denying the existence of a problem without access in the first place to pertinent military records, or access to present or past military personnel and families. The most conclusive type of information would, of course, involve a prospective research approach, and that was deemed not justifiable without at least the benefit of the findings of a defensible retrospective study.

17. KEY WORDS AND DOCUMENT ANALYSIS

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