Report on

Analysis of Spatial and Temporal Variation of Selected Birth Defects in New Jersey

Demonstration Project on Selected Birth Defects and Environmental Factors in New Jersey

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New Jersey Department of Health and Senior Services
Consumer and Environmental Health Services
Environmental Public Health Tracking Project
and
Special Child Health and Early Intervention Services

In cooperation with the
New Jersey Department of Environmental Protection

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Overview of the Demonstration Project

The New Jersey Department of Health and Senior Services (NJDHSS) was awarded funding from the Centers for Disease Control and Prevention (CDC) to conduct three demonstration projects under the program, "Environmental and Health Effects Tracking," in cooperation with the New Jersey Department of Environmental Protection (NJDEP). The purpose of these demonstration projects is to develop and evaluate methods for linking ongoing, existing health effects and human exposure surveillance systems with existing systems for monitoring environmental hazards and exposures.

One of the three demonstration projects originally proposed by NJDHSS was to conduct enhanced surveillance of selected birth defects prevalence data using the NJDHSS Special Child Health Services (SCHS) Registry, and to conduct two case-control studies linking cases with one birth defect (hypospadias, identified two different ways) with data on environmental hazards and exposures. Neither of the case-control studies has been completed. The first of the case-control studies could not be undertaken due to human subject protection issues raised by the IRB. The second case-control hypospadias study will not be completed as a demonstration project due to time constraints. This report describes the temporal and spatial surveillance of six selected birth defects.

This demonstration project was conducted by the Environmental Public Health Tracking Project (EPHT) in Consumer and Environmental Health Services, NJDHSS, in partnership with Special Child Health and Early Intervention Services, NJDHSS, and the New Jersey Department of Environmental Protection (NJDEP).

Study Team

New Jersey Department of Health and Senior Services

Consumer and Environmental Health Services

Jerald Fagliano, M.P.H., Ph.D., Principal Investigator
Michael Berry, M.P.H.
Perry Cohn, Ph.D., M.P.H.
Barbara Goun, M.P.H., Ph.D., Project Coordinator
Patricia Haltmeier, L.P.N.
Richard Opiekun, M.S., M.A., Ph.D.

Family Health Services

Leslie Beres-Sochka, M.S.
Mary Knapp, R.N., M.S.N.
Marjorie Royle, Ph.D., consultant
Joseph A Sweatlock, Ph.D

New Jersey Department of Environmental Protection

Steven Anderson, M.S.
Linda Bonanno, Ph.D.
Judith Klotz, M.S., Dr.P.H., consultant

Summary

A collaborative demonstration project conducted analyses of spatial and temporal variation of selected birth defects using the NJDHSS Special Child Health Services (SCHS) Registry. The work was conducted by the Environmental Public Health Tracking Project (EPHT) in Consumer and Environmental Health Services, NJDHSS, in partnership with Special Child Health and Early Intervention Services, NJDHSS, and the New Jersey Department of Environmental Protection (NJDEP).

Temporal Trends: Analyses of temporal variation of selected birth defect groupings in New Jersey found generally stable annual birth defect incidence rates between 1993 - 2003 for Down syndrome; craniosynostosis; structure and flow-related cardiac defects; and hypospadias. Male rates for the cardiac defects group exceeded female rates for each of the 11 years. A small increase was seen among males in the rate of craniosynostosis between 1999 and 2001. Rates of cleft palate and or cleft lip appear to be generally decreasing slightly. Rates for gastroschisis increased from 1999 through 2002, with a parallel decrease in omphalocele rates from 1999 through 2003. One plausible explanation for the changes in gastroschisis and omphalocele rates is that they may be due to improved case confirmation activities. During the years 1998 through 2003, the NJ SCHS had additional funding available that made it possible to conduct a medical record review for each reported child diagnosed with selected birth defects, which included omphalocele and gastroschisis. The intertwined diagnosis of the two diseases may have caused some cases of omphalocele to be determined on record review to actually be gastroschisis during the interval for which medical record review was conducted.

Spatial Trends: When the birth defects groupings were analyzed using SaTScan software in order to examine possible geographic clustering of the birth defects cases, no statistically significant clusters were found for Down syndrome; structure and flow-related cardiac defects; cleft palate and or cleft lip; gastroschisis; or omphalocele. Statistically significant clusters were found for two birth defect groups: craniosynostosis and hypospadias. SaTScan identified one statistically significant cluster of craniosynostosis cases, located in northwestern Middlesex County and extending into Somerset County. The cluster includes 71 cases, has an SIR of 1.8, and p-value of 0.01. Non-significant craniosynostosis clusters were identified in Passaic and Camden Counties. It is noteworthy that the three craniosynostosis clusters are each located in close proximity to one of New Jersey's regional craniofacial treatment centers. Two statistically significant clusters of hypospadias cases were identified by SaTScan. The largest statistically significant cluster incorporates nearly the entire northwestern portion of New Jersey, and includes Sussex, Passaic, Essex, Somerset, Union, Warren, and Hunterdon Counties. The cluster includes 1,113 cases, and has an SIR of 1.3, and p-value of 0.001. The second statistically significant cluster incorporates nearly the entire south-central portion of New Jersey, and includes Burlington, Camden, Gloucester, Atlantic, Ocean, and Monmouth Counties. The cluster includes 821 cases, and has an SIR of 1.2, and p-value of 0.001. A non-significant hypospadias cluster was found in Essex County.

While it is possible the temporal and spatial variations in rates noted are due to true

underlying variations in the frequency of these defects in New Jersey live born children, there are multiple factors that could cause birth defect incidence rates to be incomplete, inaccurate, or misleading. Some specific and general issues that might affect rates of birth defects include: variation in the diagnosis and ICD coding of birth defects; potentially incomplete case ascertainment; changes in rates due to improved case confirmation activities; selective termination of pregnancies; and differential rates of geocoding success by year or region of birth. Additionally, the rates presented were not adjusted for maternal age.

Lessons Learned: This demonstration project resulted in a successful collaboration among staff of the EPHT project in CEHS, the SCHS, and NJDEP. Through the development of birth defect selection criteria, protocol, and data analyses, the various agency representatives had input into the kinds of questions asked of the data, and the methods of analysis.

The demonstration project examined selected birth defect data in ways that go beyond the descriptive analyses routinely conducted and presented by the SCHS. A new analytical tool (SaTScan) was applied to examine spatial clustering in birth defect incidence data in New Jersey for the first time.

The demonstration project increased the understanding of the New Jersey EPHT Project regarding the strengths and limitations of the birth defects and birth certificate data available from the NJDHSS. Difficulties were found regarding the geocoding of longitude, latitude, and county/municipality that occurred for some birth years between 1993 and 2003.

Data quality, completeness, and reliability are essential ongoing issues for variables in health outcome datasets of interest to EPHT Programs. The NJ EPHT Project has repeatedly found that while data stewards often have excellent quality control programs in place for those variables of importance to their specific program area, EPHT projects often seek to use previously unused or underused variables, such as the geocoded residential address or municipality of residence. We learned valuable lessons from difficulties experienced in linking existing health outcome datasets due to use of differing municipal coding schema, and in using latitude and longitude variables. Future EPHT activities in New Jersey will be able to utilize our enhanced understanding of these challenges.

__Introduction__

Birth defects are a significant public health concern in the United States, affecting approximately 3 to 5% of all live births in the United States, 20% of all infant deaths, and a significant but unknown proportion of pregnancy terminations. They are a leading cause of infant mortality. Birth defects also have a major impact on quality of life issues for the affected individuals and their families. The cause is unknown for approximately 65 to 80% of birth defect cases. In New Jersey, approximately 5,000 children each year, or 4% of all live births, are registered with one or more birth defects.

Surveillance systems have been developed to monitor the occurrence of birth defects for both epidemiologic analysis and the provision of health care and social services. These systems vary greatly in how cases are obtained (active or passive reporting), scope (livebirths, stillbirths, and terminations), the ages and the diagnoses of the children mandated to be reported, the data elements collected, and whether they are linked to follow-up services to affected families. Such differences are important when comparing statistics across states. Birth defect surveillance systems do not routinely gather detailed, measured data on environmental exposures or other potential risk factors that might be associated with the occurrence of birth defects.

New Jersey's Birth Defects Surveillance System

The NJDHSS Special Child Health Services (SCHS) Registry, also known as the New Jersey Birth Defects Registry, collects demographic and medical information for New Jersey residents diagnosed from birth through age one with various birth defects and special needs conditions. New Jersey has the oldest requirement in the nation for the reporting of children with birth defects. Beginning in 1928, New Jersey implemented reporting for children with selected orthopedic conditions. Since 1985, New Jersey has maintained the population-based SCHS Registry, and mandated the reporting of all live born children diagnosed with birth defects, including metabolic, hearing, and genetic disorders excluded by many state registries. The SCHS Registry collects the complete residential address at time of diagnosis for all children reported to the Registry.

New Jersey legislation, NJSA 26:8-40.2, requires confidential reporting of birth defect diagnoses by hospitals, physicians, medical examiners, laboratories, case management units, and other health providers. Compliance with this mandate is also required under New Jersey hospital licensing and physician reporting requirements. Additionally, children having special needs conditions may be voluntarily reported to the Registry. Each year, almost 14,000 registrations are received. Of these, almost 9,000 are new registrations; the remainder are either duplicate or updated registrations. Approximately 65% of registrations are for children with birth defects; the rest are for children with special needs conditions. The Registry mandates the reporting of all congenital conditions with the exception of about 120 minor conditions, such as skin tags and tongue tie. Multiple minor conditions are mandated to be reported to the Registry.

The NJDHSS SCHS Registry is a combination active/passive registry. While many health entities are required by NJAC 8:20 to report to the Registry (including hospitals,

physicians, nurses, cytogenetic and clinical laboratories, and medical examiners), it is not possible to conduct a medical records review for each of the approximately 115,000 live births that occur to New Jersey residents each year. Instead, NJDHSS SCHS staff have implemented a strong quantitative quality assurance (QA) system that includes annual hospital audits, nurse-review of all infant death certificates, and provision of technical assistance to hospitals as needed. SCHS Registry staff conducts an annual medical records audit at all birthing and pediatric facilities in New Jersey. In order to ensure completeness of reporting and accuracy of diagnoses, Registry staff review for a three-month period all medical records of children aged one year or less with a discharge diagnosis indicating a birth defect. A summation session is held at the end of the visit, and written summaries are provided to the facilities. Facilities with less than acceptable reporting are required to review all births for the audit year. All facilities are required to register any eligible children not previously reported. Through these annual audits, hospital reporting has increased from 75% of cases in 1990, to almost 90% in 2000.

Additional referral sources are also used to ascertain cases. SCHS Registry nursing staff examines all New Jersey death certificates of children under age three. When unregistered children with birth defects are identified, the birthing facility and/or medical examiner's office is notified and requested to register the child. This process yields 25 to 30 registrations per year. The NJDHSS newborn biochemistry and hearing screening registries are reviewed quarterly, and registrations are completed for any unregistered children. County-based case management service units provide additional cases to the Registry through their connections to the Social Security Administration, the Catastrophic Illness in Children Relief Fund, the community, and self-referrals. County-based case management units register about 30 previously unregistered children each year, many of them out-of-state births. Another 30 to 50 infants are registered by out-of-state hospitals annually.

Reporting to the Registry is timely, as 60-70% of children born with any birth defect are reported to the Registry by the third month of life. Birth defects discernible at birth, such as neural tube defects, cleft lip and/or palate, and Down syndrome, are reported even faster, with approximately 80% of these children reported by the third month of life

Through the SCHS Registry, children are linked to the county-based case managers and their parents are informed of the availability of medical, educational, and financial services. For all children alive at time of registration, a copy of the registration form is sent to the Special Child Health and Early Intervention Services case management unit in the child's county of residence within 10 days of receipt by the NJDHSS. Families are offered case management/care coordination including development of Individual Service Plans (ISP) that address the need for comprehensive health, education, social, and rehabilitative services. Included in the ISPs are important enabling services such as transportation, economic assistance, service linkages, respite care, and support in terms of legal rights and safeguards. County-based case management staff also serve as a resource for parents, hospitals, physicians, and other medical providers on issues related to birth defects and related disorders.

The SCHS Registry is an active ongoing participant in the CDC's National Birth Defects Prevention Network (NBDPN) that coordinates the work of congenital malformations registries

across the country. A recent publication of the NBDPN (2004) provided a synopsis of case definitions, surveillance methods, case ascertainment, data management, and analysis information for the NJDHSS SCHS Registry. Through the NBDPN, New Jersey has participated in a variety of special studies, including rapid ascertainment of neural tube defects to monitor the effects of folic acid fortification in cereal.

The SCHS Registry has also been used to ascertain cases for two major national studies of birth defects in which New Jersey was a participant. During the years 1998 - 2003, the NJDHSS participated in the CDC's Centers for Birth Defect Research and Prevention Program. This program involved participation in the National Birth Defects Prevention Study (NBDPS), a 10-state multi-year study to investigate genetic and environmental causes of 31 specific structural birth defects, including cleft lip and palate, diaphragmatic hernias, neural tube defects, and a variety of cardiac defects. Each year, from January 1, 1998 through September 30, 2002, a sample of about 300 infants with these specific defects were identified from SCHS records, and a control group of about 100 infants was randomly selected from birth records. The study had three component parts: 1) nurse-reviewers examined clinical records for case infants and a clinical geneticist reviewed each record to ensure correct diagnosis and document specific birth defects and other medical conditions; 2) mothers in participating case and control families completed a one hour telephone interview covering events from the three months prior to pregnancy through delivery, including diet, medications, illnesses, and occupation, along with family history and limited paternal factors; and 3) mothers, fathers, and infants provided DNA from cheek-cell samples. A detailed study outline is provided in Yoon, Rasmussen, Lynberg et al., (2001). All de-identified data were transmitted to the CDC where they were merged with data from other participating sites. The database is available to all participating sites for data-analysis, with all projects approved by a data-sharing committee. Several reports have been published (Carmichael, et al., 2005; Werler, et al., 2004), and many more are ongoing, with over 100 separate studies proposed to date. In addition to the NBDPS, participating Centers conducted local research projects and other activities to improve surveillance.

New Jersey Population Demographics

New Jersey is an appropriate setting to conduct geographic and temporal analyses of birth defects. New Jersey has a large population, with an estimated population in July 2002 of over 8,590,000 residents. The number of births per year is also large, with approximately 115,000 live births to residents occurring each year (NJDHSS, 2005). With a land area of only 7,417 square miles, New Jersey is the most densely populated state in the U.S., with an average of 1,134 people per square mile. In addition, New Jersey has an ethnically diverse population. Fourteen percent of the population is African-American. The proportion of Hispanics is 13%, and 6% of the state's population is Asian, half of whom are from the Indian subcontinent. New Jersey's population resides in urban, suburban and rural areas.

Selection of Birth Defects for Enhanced Surveillance

An interagency study team, the New Jersey EPHT Birth Defects Work Team, was formed

to collaboratively supervise the design, implementation and analyses of the proposed birth defect-related EPHT demonstration projects. The intra- and inter-agency membership of the Birth Defects Work Team is shown at the end of this report.

The first task of the EPHT Birth Defects Work Team was to collaboratively select several specific birth defects groupings for descriptive (geographic patterns and temporal trends) analysis, and select one birth defect for more intensive epidemiologic study in relation to selected environmental factors.

The EPHT Birth Defects Work Team developed the following criteria for selection of birth defects for descriptive analysis and epidemiologic analysis:

- Defect typically apparent at birth and diagnosis made at birth;
- Coding and diagnosis of defect well agreed on, and not subject to differences between doctors or hospitals;
- Defect not highly likely to result in birth occurring in an out-of-state high risk hospital on the basis of prenatal diagnosis;
- Defect not likely to lead to high rates of elective termination of pregnancy.

These criteria were developed due to the potential for differential loss of cases by time and/or geography.

Based on the developed criteria, EPHT Birth Defects Work Team recommended the selected birth defect types, shown in Table 1, for descriptive analysis.

Table 1. Epidemiologic Characteristics of Birth Defects Selected for Descriptive Analysis

Birth Defect Type	ICD-9 Code	Epidemiology	New Jersey, 1997 – 2001	
			#	Rate/1000 live births
Cleft Palate and/or Cleft Lip	749.00-.04, 749.10-.14, 749.20-.25	Cleft lip and palate may occur individually or together. More common if parental history. Etiology considered genetic and environmental. Have been linked with maternal medications, folate deficiency, maternal diabetes, specific maternal and paternal occupations, solvent exposure, pesticides, chlorination byproducts, heavy metals, ionizing radiation, and maternal smoking	321 154 290	0.56 0.27 0.51
Structure and Flow-related Cardiac Defects	745.00, 745.10-.19, 745.20, 746.70, 747.41	Have been linked with maternal medications, maternal illness, specific maternal and paternal occupations, solvent exposure, pesticides, chlorination byproducts, heavy metals, ionizing radiation, and maternal smoking	35 210 228 124 46	0.06 0.37 0.40 0.22 0.08
Down syndrome	758.0	Caused by the presence of an extra chromosome number 21. Etiology linked with increased maternal age.	651	1.14
Hypospadias	752.61	Incidence believed to have doubled in last 25 years in US and Europe. More common if paternal history. Recent studies suggest association with exposures that affect hormone balance during pregnancy. Has been linked with maternal medications, assisted reproductive technologies, specific maternal and paternal occupations/exposures, pesticides, living near hazardous waste sites, dioxins	2045	3.57
Craniosynostosis	756.0	Has been linked with increased maternal age, fertility treatments, maternal smoking, maternal thyroid disease, and maternal medication	439	0.77
Gastroschisis Omphalocele	756.79 756.78	Believed to be related to disruption in blood flow to developing abdominal wall. Has been linked with maternal age, maternal medications, specific maternal and paternal occupations, solvent exposure, maternal radiation, and maternal smoking. Differential diagnosis between the two defects may be difficult. The true diagnosis may not be determined until surgery when the defect can be more thoroughly examined. Initial diagnosis of omphalocele may change to gastroschisis following surgery.	103 76	0.18 0.13

Sources: Special Child Health Services Registry, New Jersey Department of Health and Senior Services, personal communication.

Methods

Data on individual cases of the birth defects of interest were obtained from the SCHS Registry for the years 1993 through 2003. Some of the variables obtained for the individual cases had been previously added by the SCHS from the electronic birth certificate. Counts of live births to New Jersey residents were obtained from the NJDHSS Center for Health Statistics for each of the years 1993 through 2003 for use as the denominators for rates.

The NJDHSS SCHS Registry provided a single dataset to the study team staff in the NJDHSS CEHS. The dataset when obtained contained the following variables: unique identifier for child; up to eight ICD-9 codes for the selected birth defect diagnoses of interest; race of child; Hispanic ethnicity of child; mother's year of birth; birth weight of child; sex of child; prematurity (yes/no); plurality (single/twin/other multiple); month of child's birth; year of child's birth; residential address at time of birth defect registration (included separate fields for street number; street name; municipality; and zipcode); and county/municipality code at time of birth defect registration. The following variables were contained within the dataset obtained from the SCHS Registry and had been previously added from the child's electronic birth certificate: latitude of residence at birth, longitude of residence at birth; county/municipality code at time of birth; census tract code at birth; and census block code at birth.

Data Cleaning: Preliminary data analyses began with the inspection of the electronic data. Variables were reviewed for percentage of missing values, and variable values were reviewed to determine if they fell within valid ranges. Special emphasis was put on reviewing geocoding variables.

Temporal Analysis: For each of the six birth defect groups selected for analysis, annual sex-specific statewide rates per 1,000 live births were generated for the years 1993 to 2003. Results were plotted and inspected for temporal trend.

Spatial Analysis: Spatial analysis was conducted to identify clustering of high or low occurrence for each of the six specific birth defect groups. The spatial unit of analysis was the x,y centroid of the municipality of mother's residence. If found, variation could be caused by geographic differences in diagnostic completeness (for example, loss of unreported cases to out of state hospitals, or over- or underreporting by individual physicians or delivery hospitals), or due to underlying differences in true occurrence of the birth defect.

The NJDHSS used SaTScan software for spatial analysis in order to examine possible geographic clustering of birth defects. SaTScan (Kulldorff et al., 2004; Kulldorff et al., 1998) is used to test the null hypothesis of complete spatial randomness against the alternative hypothesis that the odds of being a case in zone z is greater than the odds of being a case outside that zone (Kulldorff, 1997). Zones of aggregated cells are constructed by allowing the radii of circles to vary continuously according to pre-determined parameters.

The NJDHSS has previously used SaTScan to identify geographic areas with high relative rates of late stage breast cancer (Roche et al., 2002). SaTScan has no a-priori

assumptions about whether or where a cluster exists. It identifies a cluster at any location of any size (up to a maximum size), and minimizes the problem of multiple comparison tests. The scan statistic, which is generally used to test if a one-dimensional point process is random, has been extended in the SaTScan application to detect clusters in a multi-dimensional Poisson or Bernoulli point process (Kulldorff, 1997). For the spatial scan, a circular window of varying radius is moved systematically through the study area. The scan window starts at each location in the database. The maximum size of each window will not exceed 50% of the total population-at-risk size of the study period, but may be set to a lower proportion by the analyst. Rate ratios are computed for each window relative to all other areas. This process is repeated across the whole study area. A number of potential clusters may thus be identified. The output of SaTScan for each cluster includes geographical information on the cluster, the rate ratio, and the p-value.

Protection of Human Subjects

IRB approval for this descriptive section of the demonstration project was not sought, as this work is an enhancement of routine public health surveillance. Data access was limited to staff of the NJDHSS. The NJDHSS has long-standing mechanisms in place to safeguard the use of confidential health data by qualified NJDHSS scientists and researchers. All identifying birth defect case information obtained from the NJDHSS SCHS Registry will remain completely confidential, and no contact with any birth defect cases or their families was undertaken.

Results

Data Completeness

A total of 10,089 records for individual children with birth defects were obtained from the SCHS Registry. The completeness of most variables in the dataset was generally very good. A small number of variables however had greater than 5% missing values. These variables were: race, 7% missing; prematurity, 8% missing; plurality, 8% missing; year of mother's birth, 16% missing; and Hispanic ethnicity of child, 20% missing. Most of the children (96%) had one birth defect diagnosis among the seven diagnostic codes of interest, and nearly 4% had been diagnosed with two or more of the selected birth defects.

Data Issues

About 96% of cases (n=8,297 from a subset of 8,609 cases) had latitude and longitude data available from the electronic birth certificate. However, when the latitude and longitude values were examined, it was apparent that different variable coding schemes were used in different years, requiring substantial effort to standardize the values to a consistent, useable format. Common errors found were: absence of decimal point in longitude or latitude fields (2,835 occurrences); extra unknown digit entered prior to minus sign in longitude (2,706 occurrences); space entered in longitude or latitude in lieu of decimal point (867 occurrences). Following multiple data clean up activities, a total of 7,865 birth defect cases (91%) were considered to be usably geocoded (6,239 with repaired geocoding and 1,626 with original

geocoding).

Temporal Trends

Birth defects of interest were collapsed into seven groups. The group label and the birth defects counts and rates are detailed in Table 2, below. For this report, gastroschisis and omphalocele are presented separately.

Table 2.   Frequencies of Birth Defects Selected for Descriptive Analysis, New Jersey Live Births, 1993 – 2003

Birth Defects Included	Number of Cases, 1993 - 2003		Rate/1,000 Live Births	
	Males	Females	Males	Females
Cleft palate, and or cleft lip	923	783	1.42	1.26
Down syndrome	767	705	1.18	1.14
Craniosynostosis	557	391	0.86	0.63
Structure and flow-related cardiac defects	799	545	1.23	0.88
Gastroschisis	100	93	0.15	0.15
Omphalocele	80	63	0.12	0.10
Hypospadias	4,654	Not applicable	7.17	Not applicable

Annual rates (1993 – 2003) for the selected birth defect groups were graphed by sex (see Figures 1 - 7), and temporal trends are described in Table 3.

Table 3. Time Trends for Birth Defects, New Jersey Live Births, 1993 - 2003

Birth Defect Group	Comments on Trends Observed
Cleft palate, and or cleft lip	Rates in both males and females appear to be slightly decreasing throughout the 11-year interval. Male rates appear to exceed female rates for most years.
Down syndrome	Rates in both males and females appear to be generally steady throughout the 11-year period.
Craniosynostosis	Rates of craniosynostosis appear to have been generally steady in females during the interval. Rates among males however were elevated during the years 1999 – 2001.
Structure and flow-related cardiac defects	Rates in both males and females appear to be generally steady throughout the 11-year period. Male rates exceed female rates for all years.
Gastroschisis	Rates in both males and females appear to be slightly elevated during the years 1999 through 2002.
Omphalocele	Rates in both males and females appear to be slightly diminished during the years 1999 through 2003.
Hypospadias	Rates appear to be generally steady throughout the 11-year interval.

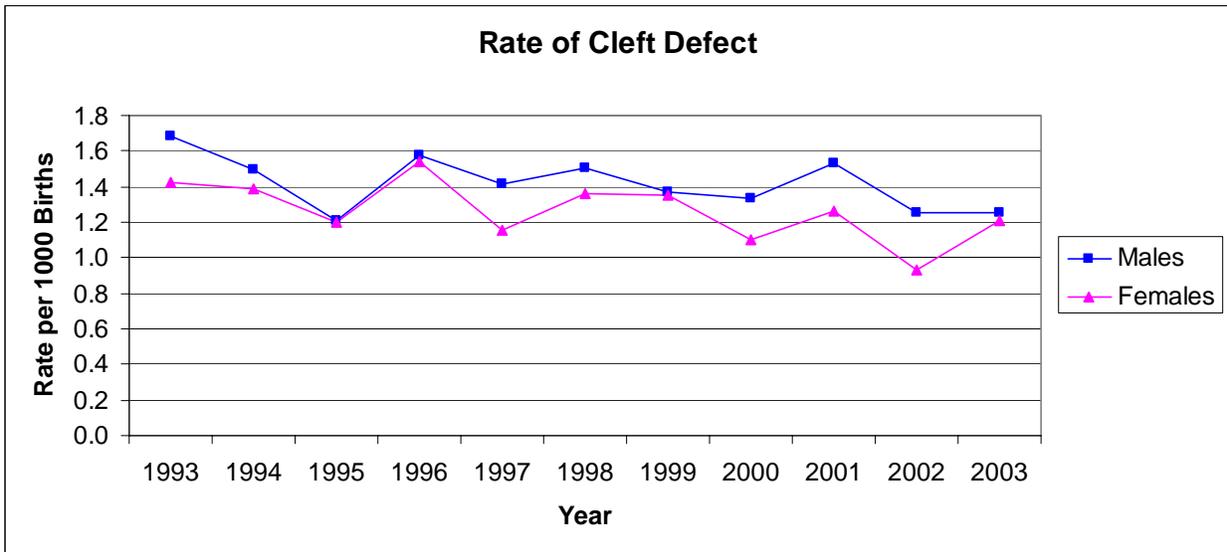*Figure 1: Rates of Cleft Lip and/or Palate Defects, New Jersey Live Births, 1993 - 2003*

Figure 2: Rates of Down Syndrome, New Jersey Live Births, 1993 - 2003
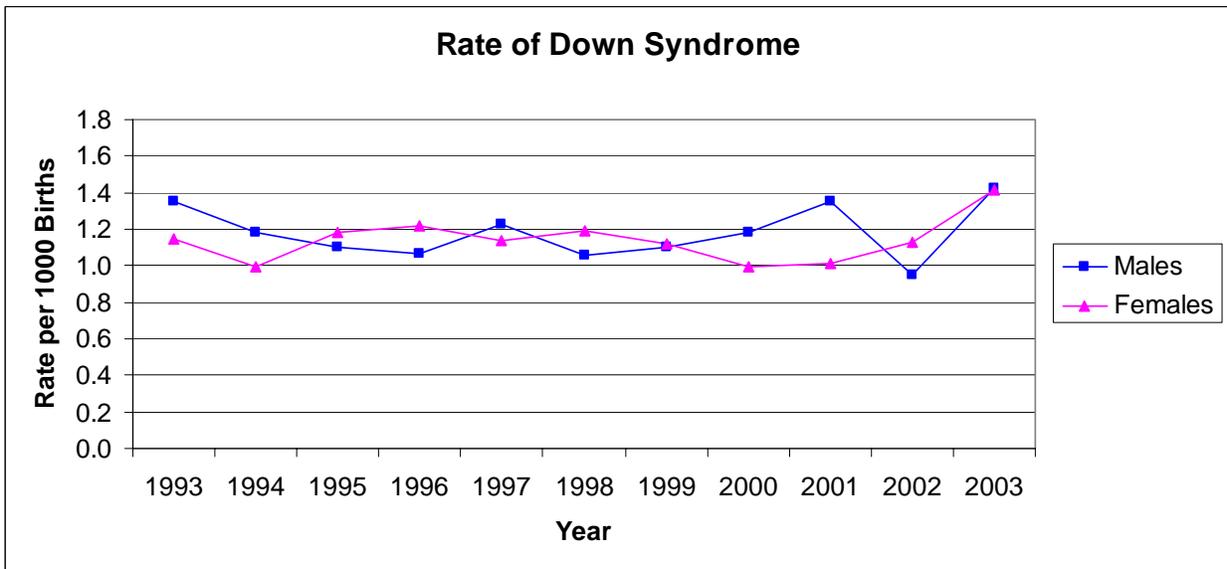
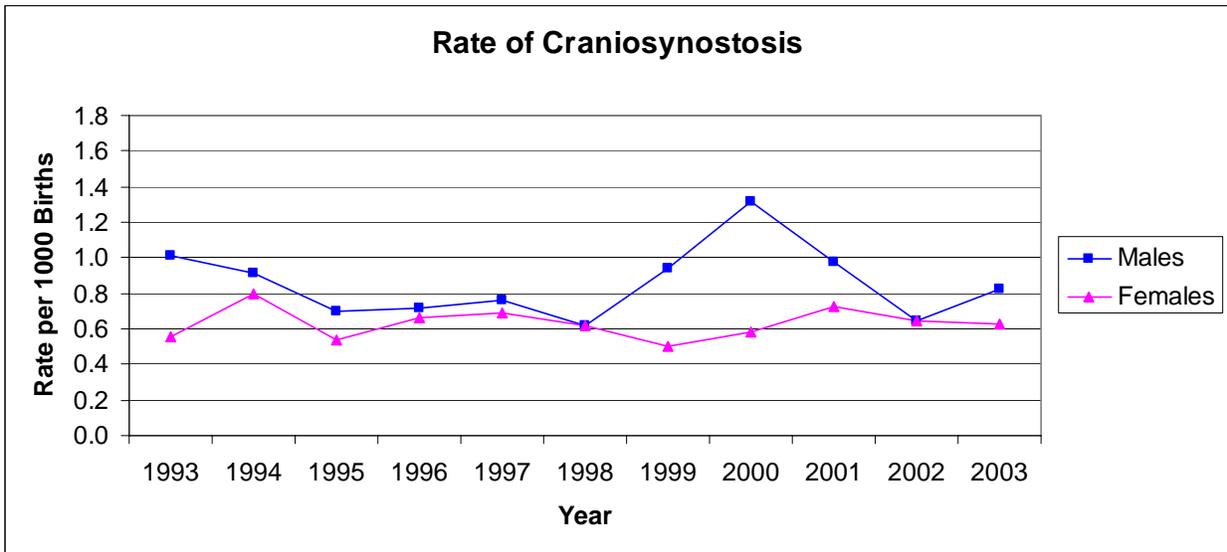*Figure 3: Rates of Craniosynostosis, New Jersey Live Births, 1993 - 2003*

Rate of Craniosynostosis

Figure 4: Rates of Structure and Flow-related Cardiac Defects, New Jersey Live Births, 1993 - 2003

Rate of Cardiac Defects
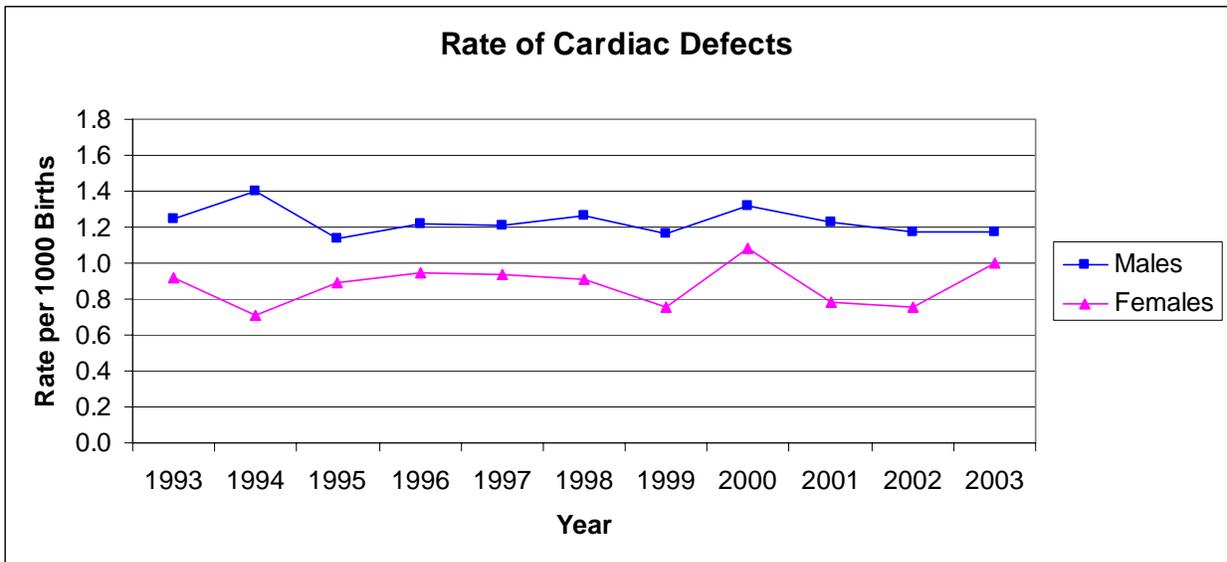
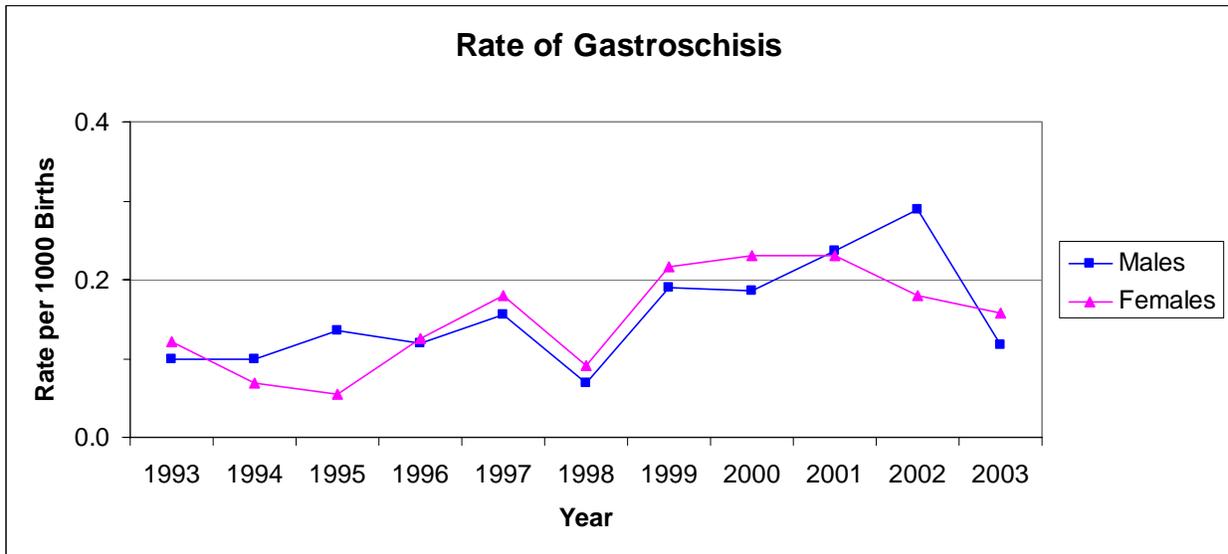*Figure 5: Rates of Gastroschisis, New Jersey Live Births, 1993 - 2003*

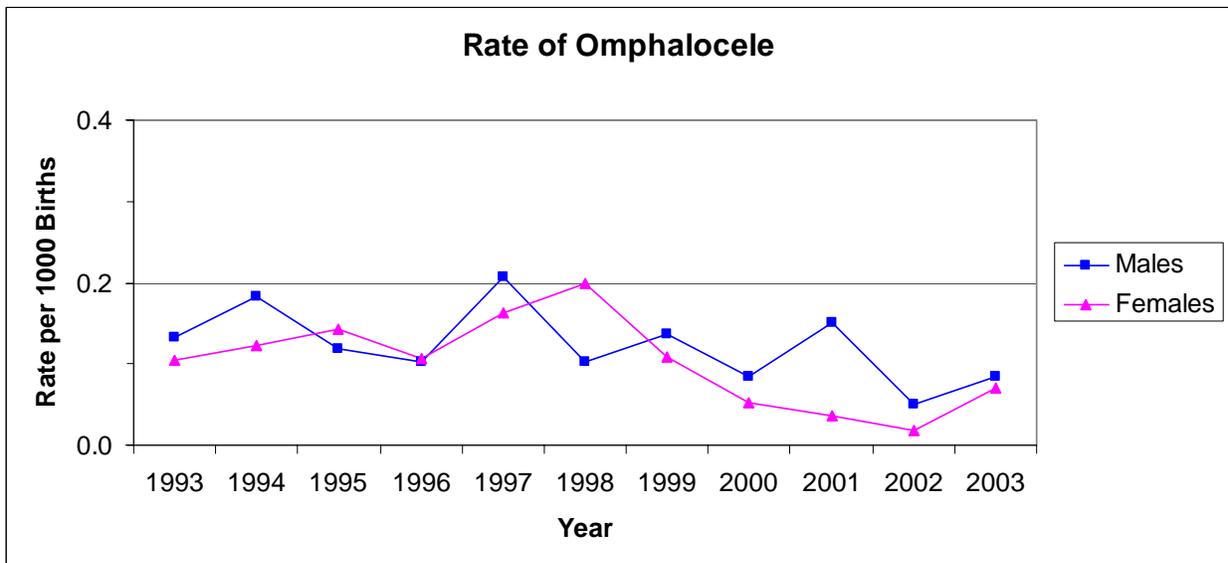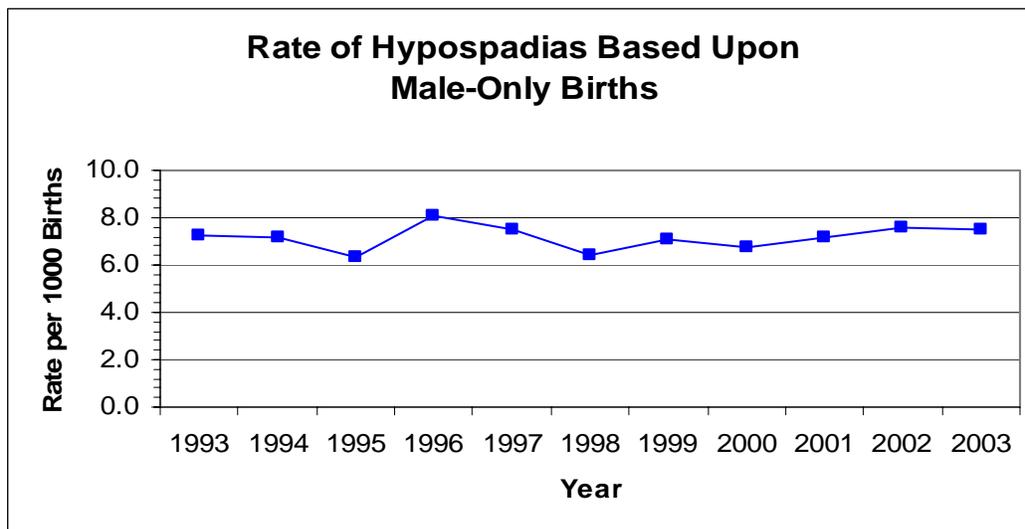*Figure 6: Rates of Omphalocele, New Jersey Live Births, 1993 - 2003*

Figure 7: Rate of Hypospadias, New Jersey Live Male Births, 1993 – 2003

Rate of Hypospadias Based Upon Male-Only Births

Spatial Clustering

Cleft palate, and or cleft lip: A total of 923 male and 783 female cases were identified for the period 1993 – 2003. Of these 1,564 (91.7%) could be assigned to the mother's municipality of residence. While no statistically significant spatial clusters were identified using SaTScan software, six non-statistically significant clusters were identified and are shown in light blue in Figure 8.

Down syndrome: A total of 767 male and 705 female cases were identified for the period 1993 – 2003. Of these 1,350 (91.8%) could be assigned to the mother's municipality of residence. While no statistically significant spatial clusters were identified using SaTScan software, eight non-statistically significant clusters were identified and are shown in light blue in Figure 9.

Craniosynostosis: A total of 557 male and 391 female cases were identified for the period 1993 – 2003. Of these 896 (94.5%) could be assigned to the mother's municipality of residence. As shown in Figure 10, SaTScan identified one statistically significant cluster, located in northwestern Middlesex County and extending into Somerset County. The cluster is shown in red in Figure 10. The cluster includes 71 cases, has an SIR of 1.8, and p-value of 0.01. Two non-significant craniosynostosis clusters, shown in light blue, were identified in Passaic and Camden Counties.

Cardiac Defects: A total of 799 male and 545 female cases were identified for the period 1993 – 2003. Of these 1,252 (93.1%) could be assigned to the mother's municipality of residence. While no statistically significant spatial clusters were identified using SaTScan software, seven non-statistically significant clusters were identified and are shown in light blue

in Figure 11.

Gastroschisis: A total of 100 male and 93 female cases were identified for the period 1993 – 2003. Of these 188 (97.4%) could be assigned to the mother's municipality of residence. While no statistically significant spatial clusters were identified using SaTScan software, six non-statistically significant clusters were identified and are shown in light blue in Figure 12.

Omphalocele: A total of 80 male and 63 female cases were identified for the period 1993 – 2003. Of these 139 (97.2%) could be assigned to the mother's municipality of residence. While no statistically significant spatial clusters were identified using SaTScan software, four non-statistically significant clusters were identified and are shown in light blue in Figure 13.
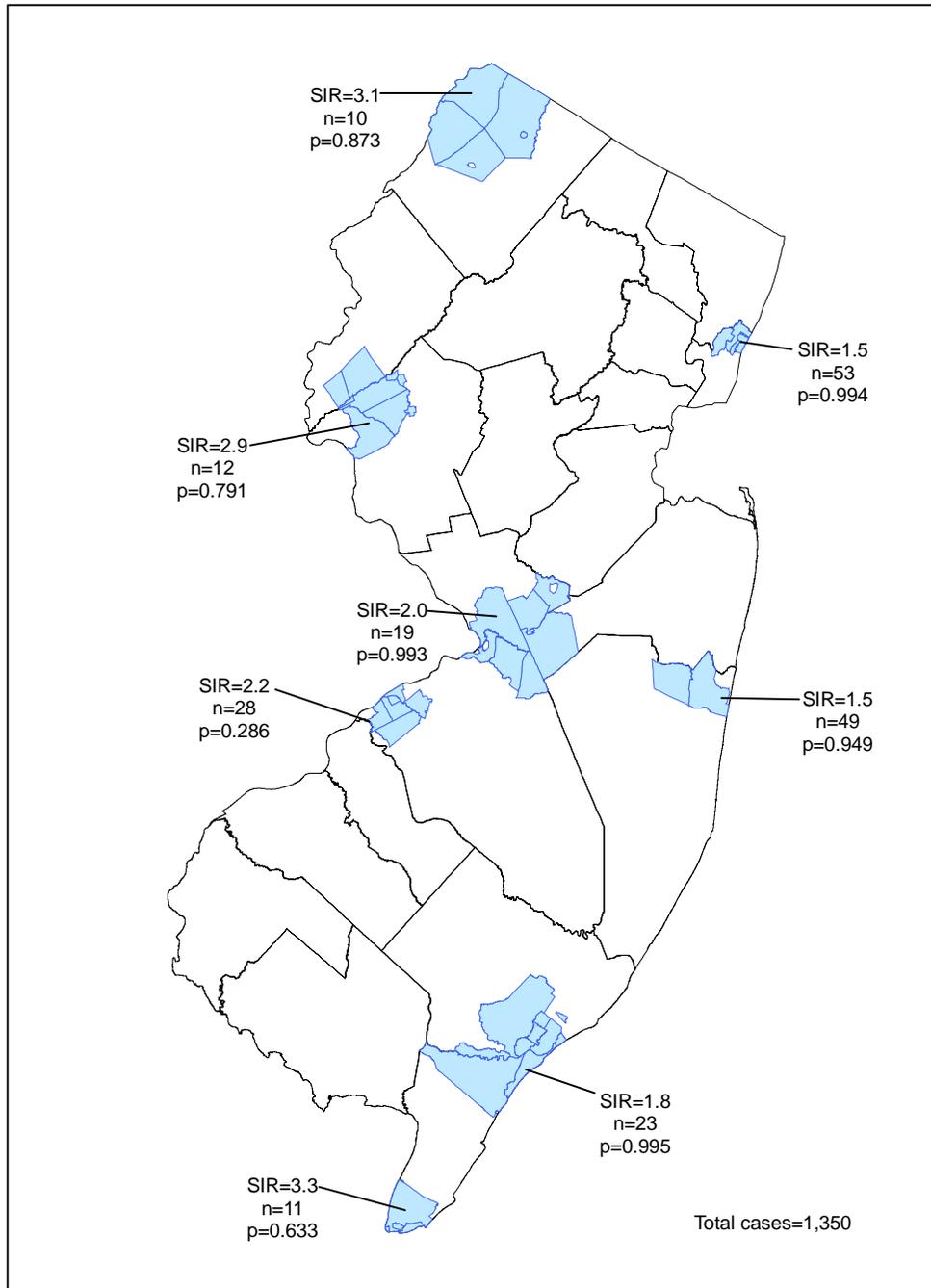
Hypospadias: A total of 4,654 male cases were identified for the period 1993 – 2003. Of these 4,518 (97.1%) could be assigned to the mother's municipality of residence. Two statistically significant clusters of hypospadias cases were identified by SaTScan and are shown in red in Figure 14. The largest statistically significant cluster incorporates nearly the entire northwestern portion of New Jersey, and includes Sussex, Passaic, Essex, Somerset, Union, Warren, and Hunterdon Counties. The cluster includes 1,113 cases, and has an SIR of 1.3, and p-value of 0.001. The second statistically significant cluster incorporates nearly the entire south-central portion of New Jersey, and includes Burlington, Camden, Gloucester, Atlantic, Ocean, and Monmouth Counties. The cluster includes 821 cases, and has an SIR of 1.2, and p-value of 0.001. A non-significant hypospadias cluster, shown in light blue, was found in Essex County.

Figure 8.   *SaTScan Geographical Cluster Analyses of Cleft Palate and/or Cleft Lip, New Jersey Live Births, 1993 – 2003*
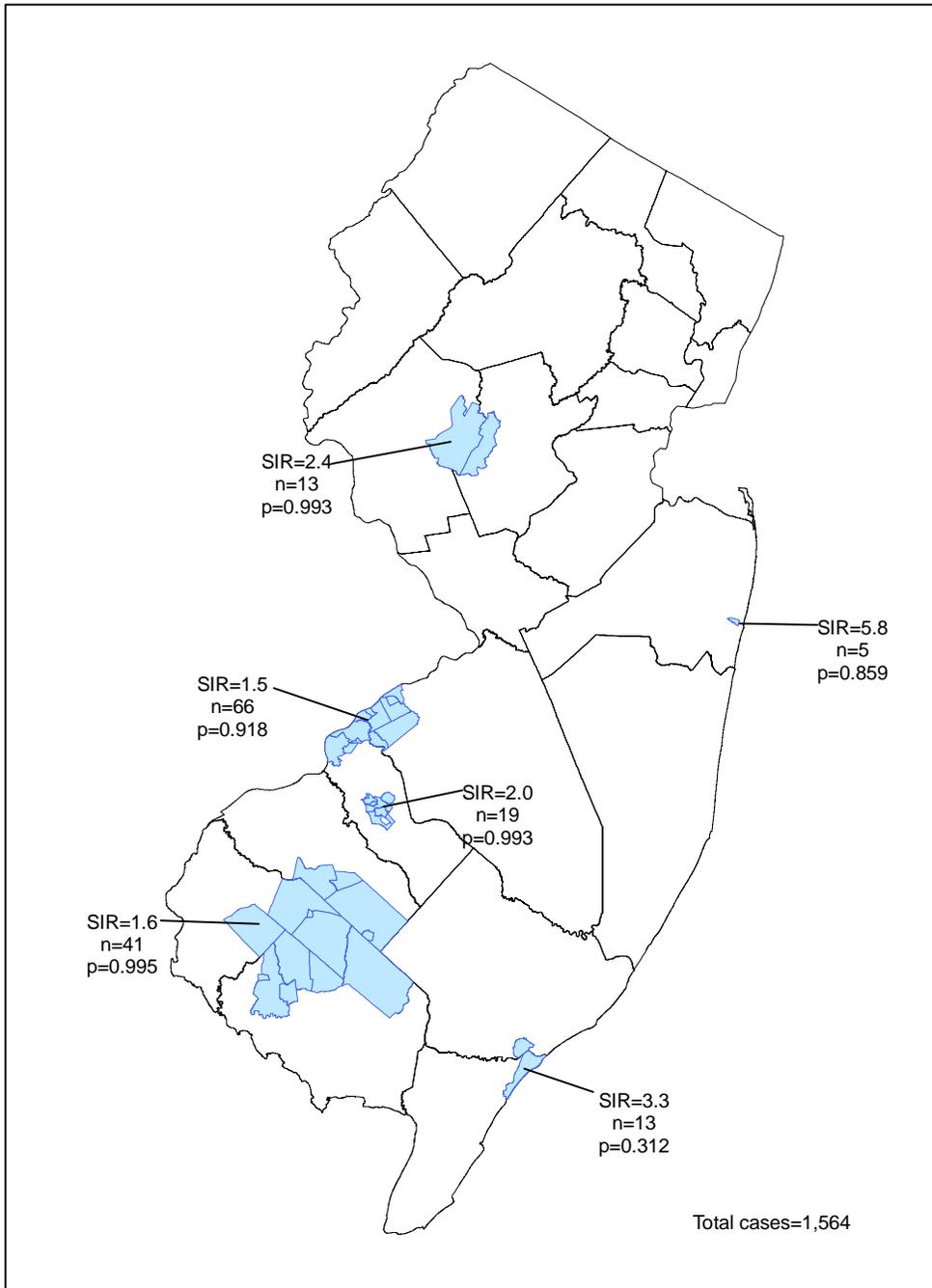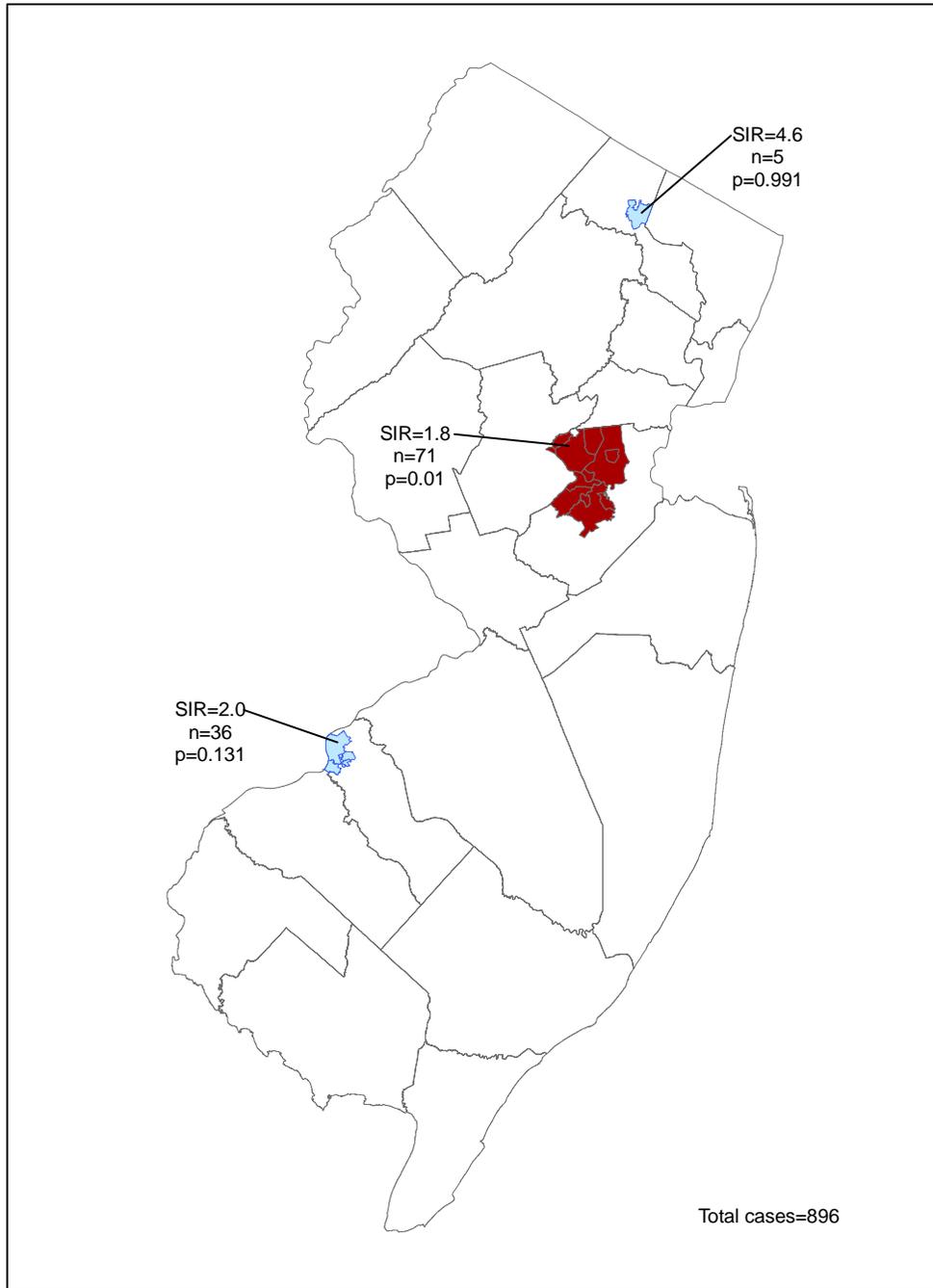

This map was generated as part of the CDC-funded Environmental and Health Effects Tracking demonstration project. This cluster analysis should be considered to be exploratory only, as results are dependent on the software parameters used, data completeness, and geocoding success rates.

*Figure 9.   SaTScan Geographical Cluster Analyses of Down Syndrome,
New Jersey Live Births, 1993 – 2003*

SIR=3.1
n=10
p=0.873

SIR=1.5
n=53
p=0.994

SIR=2.9
n=12
p=0.791

SIR=2.0
n=19
p=0.993

SIR=2.2
n=28
p=0.286

SIR=1.5
n=49
p=0.949

SIR=1.8
n=23
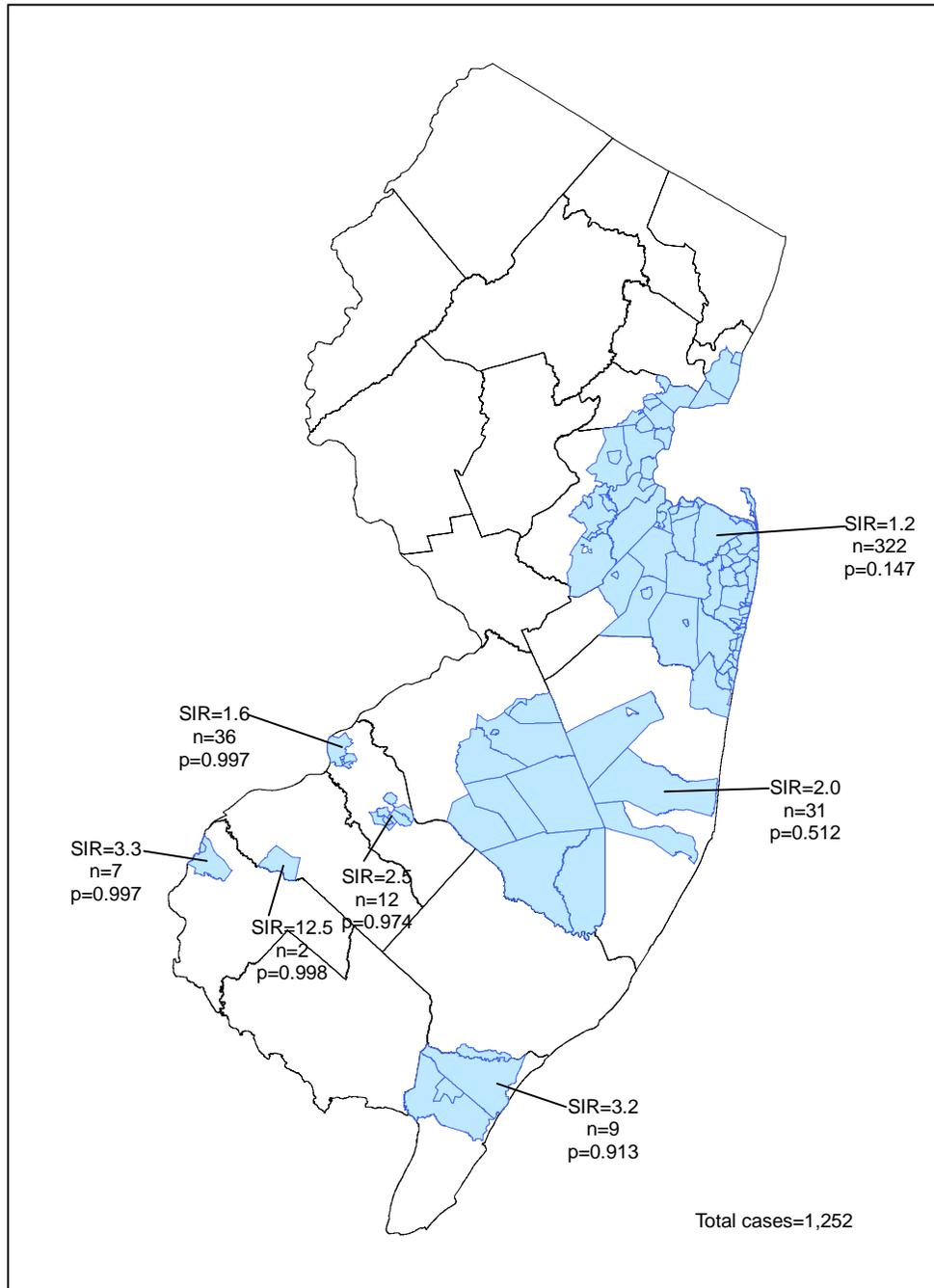p=0.995

SIR=3.3
n=11
p=0.633

Total cases=1,350

This map was generated as part of the CDC-funded Environmental and Health Effects Tracking demonstration project. This cluster analysis should be considered to be exploratory only, as results are dependent on the software parameters used, data completeness, and geocoding success rates.

Figure 10.   SaTScan Geographical Cluster Analyses of Craniosynostosis, New Jersey Live Births, 1993 - 2003

This map was generated as part of the CDC-funded Environmental and Health Effects Tracking demonstration project. This cluster analysis should be considered to be exploratory only, as results are dependent on the software parameters used, data completeness, and geocoding success rates.

Figure 11.   SaTScan Geographical Cluster Analyses of Structure and Flow-related Cardiac Defects, New Jersey Live Births, 1993 – 2003
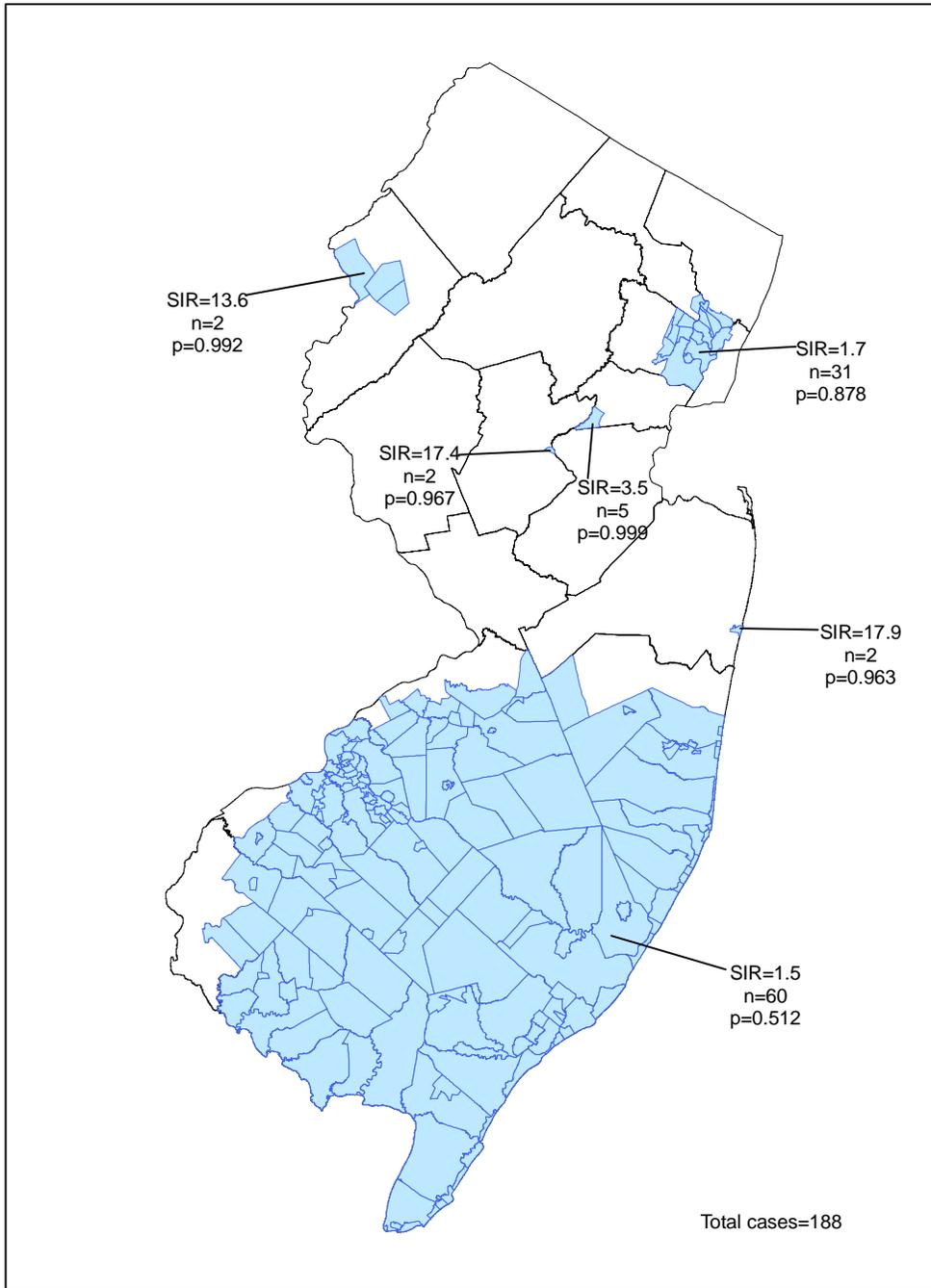

This map was generated as part of the CDC-funded Environmental and Health Effects Tracking demonstration project. This cluster analysis should be considered to be exploratory only, as results are dependent on the software parameters used, data completeness, and geocoding success rates.

*Figure 12.   SaTScan Geographical Cluster Analyses of Gastroschisis,
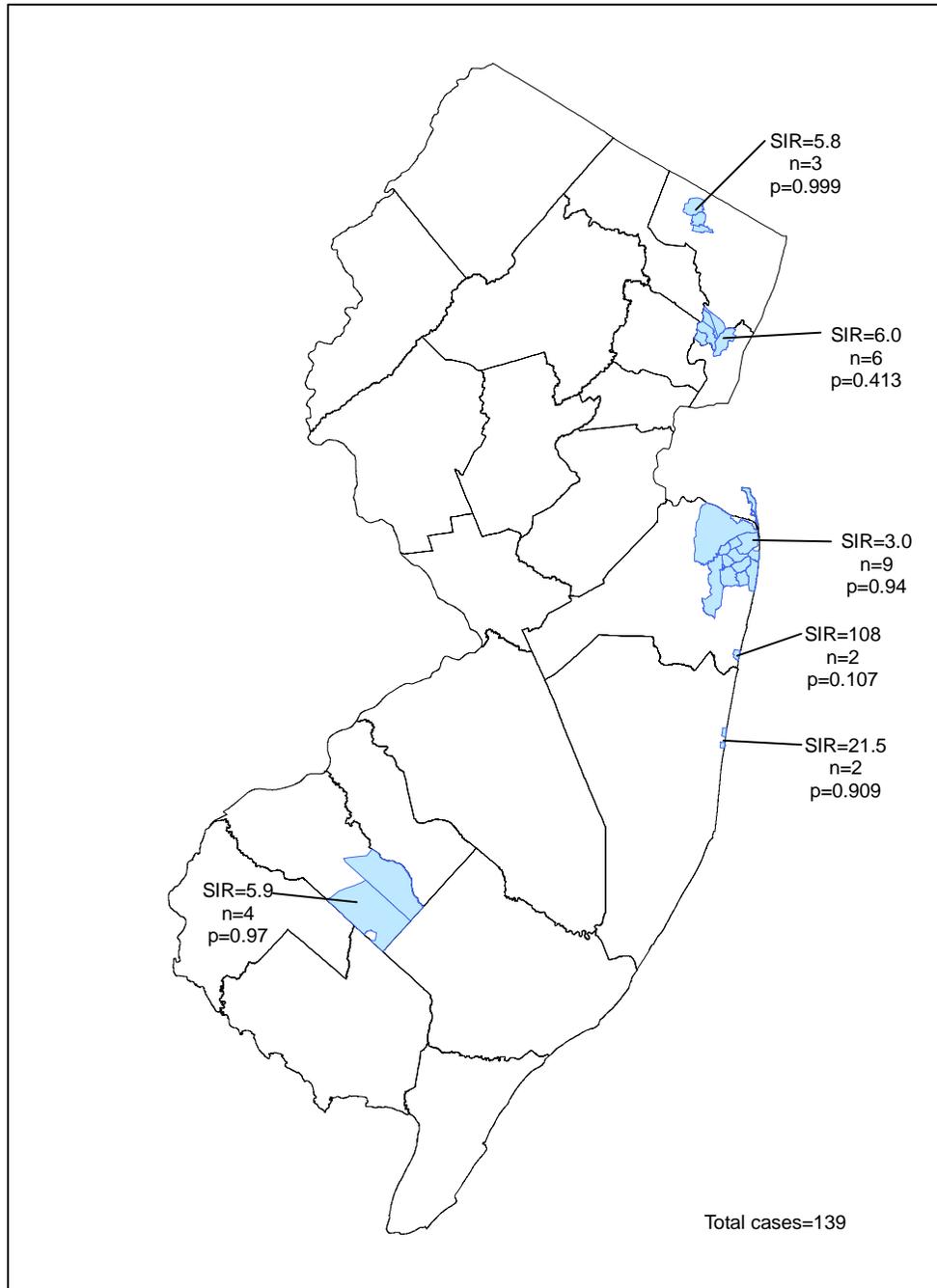New Jersey Live Births, 1993 – 2003*

This map was generated as part of the CDC-funded Environmental and Health Effects Tracking demonstration project. This cluster analysis should be considered to be exploratory only, as results are dependent on the software parameters used, data completeness, and geocoding success rates.

Figure 13.   SaTScan Geographical Cluster Analyses of Omphalocele,
New Jersey Live Births, 1993 – 2003

SIR=5.8
n=3
p=0.999

SIR=6.0
n=6
p=0.413

SIR=3.0
n=9
p=0.94

SIR=108
n=2
p=0.107

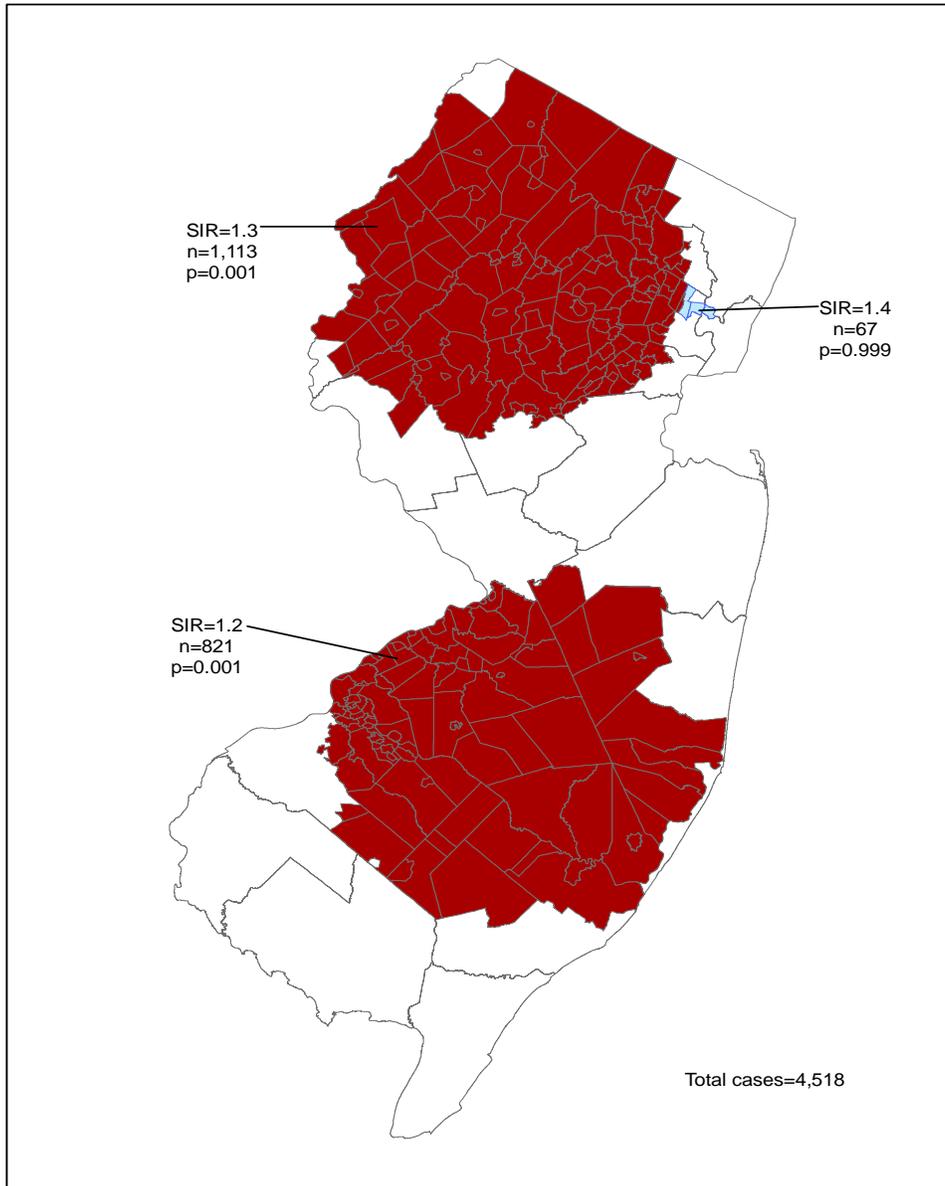SIR=21.5
n=2
p=0.909

SIR=5.9
n=4
p=0.97

Total cases=139

This map was generated as part of the CDC-funded Environmental and Health Effects Tracking demonstration project. This cluster analysis should be considered to be exploratory only, as results are dependent on the software parameters used, data completeness, and geocoding success rates.

***Figure 14.   SaTScan Geographical Cluster Analyses of Hypospadias,
New Jersey Live Male Births, 1993 – 2003***

SIR=1.3
n=1,113
p=0.001

SIR=1.4
n=67
p=0.999

SIR=1.2
n=821
p=0.001

Total cases=4,518

This map was generated as part of the CDC-funded Environmental and Health Effects Tracking demonstration project. This cluster analysis should be considered to be exploratory only, as results are dependent on the software parameters used, data completeness, and geocoding success rates.

Discussion

Summary of Findings

Temporal Trends: Results from this enhanced surveillance of selected birth defect groupings in New Jersey found generally stable annual birth defect incidence rates between 1993 through 2003 for Down syndrome, craniosynostosis, structure and flow-related cardiac defects, and hypospadias. Male rates for the cardiac defects group exceeded female rates for each of the 11 years. A small increase was seen among males in the rate of craniosynostosis between 1999 and 2001. Rates of cleft palate and or cleft lip appear to be generally decreasing slightly. Rates for gastroschisis increased from 1999 through 2002, with a parallel decrease in omphalocele rates from 1999 through 2003.

Spatial Patterns: When the birth defects groupings were analyzed using SaTScan software in order to examine possible geographic clustering of the birth defects cases, statistically significant clusters were found for two birth defect groups, craniosynostosis and hypospadias.

Interpretation of Findings

It is possible that observed temporal trends or spatial patterns are due to differences in diagnostic practices of these birth defects, incomplete ascertainment of cases, or differential rates of geocoding success by year or region of birth.

While it is possible the variations in rates noted are due to true underlying changes in the frequency of these defects in New Jersey live born children, there are multiple factors that might cause birth defect incidence rates to be incomplete, inaccurate, or misleading. Some specific and general issues that might affect rates of birth defects are discussed below.

Changes in rates due to improved case confirmation activities: During the years 1998 through 2003 the NJ SCHS had additional funding available that made it possible to conduct a medical record review for each reported child diagnosed with selected birth defects, which included omphalocele and gastroschisis. The medical record review was conducted by Registry staff in order to confirm the validity of each case diagnosis prior to attempting to recruit parental participation in the CDC-funded NBDPS multi-center research project. It is possible that the increase in gastroschisis and the decrease in omphalocele that are seen during 1999 through 2002 are due to this intervention. Registry staff believes that the inter-twined diagnosis of the two diseases may have caused some cases of omphalocele to be determined on record review to actually be gastroschisis during the interval for which medical record review was conducted.

Variation in the diagnosis and ICD coding of birth defects: Different hospitals may vary in the diagnosis and coding of birth defects. This could contribute to geographical variation in rates. If particular physicians and/or hospitals do vary in their diagnostic practices, this could cause intra-state and inter-state variation in birth defect rates.

Incomplete case ascertainment: New Jersey, like most states, does not have reciprocal birth defect reporting with nearby states. This is likely to result in the failure of the New Jersey Birth Defects Registry to capture information for some New Jersey children with birth defects who are diagnosed in out-of-state hospitals and medical facilities. This problem is likely to vary geographically, with families residing in closer proximity to New York City, Philadelphia, and Delaware most likely to utilize out of state facilities.

Variations in the coding of birth defects: Certain conditions may be coded as a broad functional defect in medical records instead of being coded to the underlying birth defect. This practice could vary by hospital and could lead to geographical variations in rates. Example: a child could be reported as having an anomaly of the skull and facial bones, instead being correctly reported as having craniosynostosis.

Diagnostic Bias: There may be geographical and socio-economic bias in the referral of children to tertiary centers for the follow up of suspect birth defects. This might be more of a problem with defects that are not especially severe. For example, it is noteworthy that the craniosynostosis clusters are each located in close proximity to one of New Jersey's regional craniofacial treatment centers. It is also possible that insurance issues may lead to over or undercoding of particular birth defects, in order for the child to qualify for needed testing, and medical or support services.

Selective termination of pregnancies: It is possible that elective pregnancy termination following the detection of birth defects during the prenatal period varies geographically. Factors such as access to prenatal testing, religious beliefs, and maternal age all may affect this process. These factors could combine to create varying regional rates of birth defects among live births for defects that can be detected early in pregnancy.

Difficulties in the coding of congenital versus acquired structural defects: There can be difficulties in accurately determining the true rates of some birth defects because congenital and acquired cases of the defect are not always differentiated in the coding system. Example: craniosynostosis may be either congenital or acquired, but in standard coding at present there is no way to differentiate acquired versus congenital.

Rates are not age-adjusted for maternal age: The rates presented here are not age-adjusted for age of the mother. This could lead to geographical variations in rates that are actually due to geographical variation in maternal age.

These findings offer interesting opportunities for future birth defect surveillance activities in New Jersey, but should be interpreted cautiously.

Lessons Learned from Demonstration Project Activities

This demonstration project resulted in a successful collaboration among staff of the EPHT project in CEHS, the SCHS, and NJDEP. Through the development of birth defect selection criteria, protocol, and data analyses, the various agency representatives had input into

the kinds of questions asked of the data, and the methods of analysis.

The demonstration project examined selected birth defect data in ways that go beyond the descriptive analyses routinely conducted and presented by the SCHS. A new analytical tool (SaTScan) was applied to examine spatial clustering in birth defect incidence data in New Jersey for the first time.

The demonstration project increased the understanding of the New Jersey EPHT Project regarding the strengths and limitations of the birth defects data available from the NJDHSS Special Child Health Services Registry and birth certificate data available from the NJDHSS. Difficulties were found regarding the geocoding of longitude, latitude, and county/municipality that occurred for some birth years between 1993 and 2003.

Data quality, completeness, and reliability are essential ongoing issues for variables in health outcome datasets of interest to EPHT Programs. The NJ EPHT Project has repeatedly found that while data stewards often have excellent quality control programs in place for those variables of importance to their specific program area, EPHT projects often seek to use previously unused or underused variables, such as the geocoded residential address or municipality of residence. We learned valuable lessons from difficulties experienced in linking existing health outcome datasets due to use of differing municipal coding schema, and in using latitude and longitude variables. Future EPHT activities in New Jersey will be able to utilize our enhanced understanding of these challenges.

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