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Trends in the Prevalence of Birth Defects in Illinois and Chicago 1989-2009

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TRENDS IN THE PREVALENCE OF BIRTH DEFECTS IN ILLINOIS AND CHICAGO 1989-2009

Illinois Department of Public Health
Division of Epidemiologic Studies

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**TRENDS IN THE PREVALENCE OF BIRTH DEFECTS IN
ILLINOIS AND CHICAGO
1989-2009**

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INTRODUCTION

Adverse pregnancy outcomes are recorded by the Illinois Department of Public Health (Department) for infants with congenital anomalies (birth defects) and other serious neonatal conditions. Each year in Illinois, the Department's Adverse Pregnancy Outcomes Reporting System (APORS) obtains information on thousands of such births throughout the state. Data about congenital anomalies identified in newborn infants were first collected statewide by APORS in 1989.

This information is collected for two important reasons. First, infants with a birth defect often need special services to help assure that they reach their full potential. These babies are, therefore, referred to their local health departments and other providers for follow-up services. Second, the data are collected for surveillance purposes. These may include describing disease patterns, tracking trends, conducting cluster investigations, and developing education and intervention strategies.

Birth defects are the leading cause of infant mortality in the United States and the second in Illinois; they contribute substantially to childhood morbidity and long-term disability. Known causes may be divided into four categories:
- genetic disorders (either hereditary or arising during conception);
- exposures to environmental chemicals (for example, medications, alcohol, cigarettes or solvents);
- mother's illness during pregnancy, exposing her baby to viral or bacterial infection; and
- diet.

However, most birth defects are likely a result of interactions between these factors. Another critical determinant of whether a child will develop a birth defect is the stage of fetal development at the time of exposure to one of the latter three causes. Fetal development is particularly vulnerable to disruption in the first trimester of pregnancy. Despite the increasing understanding of factors that give rise to birth defects, the causes of most birth defects remain unknown (U.S. Centers for Disease Control and Prevention.) The same congenital anomaly may have completely different causes in different individuals.

APORS is the most complete source of data on birth defects that exists in Illinois. All Illinois hospitals are mandated to report infants with adverse pregnancy outcomes born to Illinois women. (Members of the Illinois Perinatal Network in St. Louis also are required to report.) Until 2002, APORS was a passive surveillance system, relying primarily on reports sent to the

Department. Such passive systems are likely to underestimate birth defect rates. The Trust for America's Health gave APORS a rating of B because of this lack of active surveillance activities. (Only eight states received an A rating).

Since 1998, a number of projects have been carried out to identify cases and birth defects that have not been reported to APORS using the passive surveillance mechanism described above. These do not make a systematic active surveillance system, but are important elements of such a system. These projects are described in Table 1.

Table 1: Projects to Identify Cases and Birth Defects

Birth years	Study Title	Purpose
1996-1997	Out to One Year Study	Identify birth defects diagnosed in the first year of life, after the newborn hospital stay.
1999-2002	Active Case Finding	Identify major birth defects diagnosed in the first year of life at large Chicago hospitals, after the newborn hospital stay.
2000	Hospital Discharge Study	Identify birth defects noted in the hospital newborn stay discharge record, but not reported to APORS
1999-2009	Very Low Birth Weight Study	Identify children not reported to APORS, but with low birth weights or low APGAR scores recorded on their birth certificate.
2002 -2009	Active Case Verification	Identify unreported or misreported diagnoses through review of infant charts using criteria listed in Table 2

In 2002, APORS began systematic active case verification. This has continued with some modifications to the criteria that establish which charts are reviewed. Details are given in Table 2. Each of these conditions has a high likelihood of being associated with one or more birth defects.

Table 2: Criteria That Determine Which Charts are Reviewed

Birth years	Chart Review Criteria
2002 -2007	・ one or more birth defects; ・ very low birth weight (< 1500 g); ・ exposure to alcohol; ・ a diabetic mother; ・ a disturbance in neonatal tooth eruption; or ・ death before discharge.
2008 onwards	・ one or more of the birth defects included in this report; ・ a birth defect associated with birth defects included in this report; ・ exposure to alcohol; ・ a diabetic mother; ・ a disturbance in neonatal tooth eruption; or ・ death before discharge.

As the charts are reviewed, APORS staff correct and add to the information reported by the hospitals. Using active case verification, the APORS program identifies an additional 20 percent of the birth defects included in this report each year.

This increase in the number of verified diagnoses is the combined result of a number of factors:
   i. The APORS chart review takes place several months after discharge, and additional diagnoses have been made since the children were reported to APORS.
   ii. The diagnostic test results are placed in the chart after discharge and are not seen by the reporting hospital staff.
   iii. The hospital reporting staffs are likely to report one or two major birth defects for each child and may not include associated, but less significant birth defects.

At times however, defects may be reported that do not meet APORS' criteria because:
   i. a clinical diagnosis was suggested and reported, which was later ruled out by a diagnostic test;
   ii. some defects are only collected in special circumstances that were not met upon chart review;
   iii. a diagnosis was reported in general terms (e.g. heart anomaly) when a more specific diagnosis was available; or
   iv. the hospital report was in error, and there was no evidence in the chart for the reported diagnoses.

APORS case finding is an ongoing process; children with birth defects identified during the newborn stay are added for previous years whenever they are found. This report presents birth defect rates among newborns and infants up to 1 year of age, born in 2008 and 2009. Similar information is presented for Chicago alone.

As a result of the active case verification begun in 2002, the estimates of birth defect rates from 1989-2001 are not comparable to those for 2002 onwards. Therefore, for this report, the figures illustrating trends in birth defect rates show the data for all years, but indicate the change in collection methods by a break in the plotted lines.

METHODS

Calculation and Interpretation of Rates and Confidence Intervals
Forty-six categories of birth defects are included in this study. A listing of the International Classification of Diseases – Ninth Revision Clinical Modification (ICD-9-CM) codes for the selected birth defects is provided in Appendix A, together with a brief description of each birth defect.

Annual incidence rates (per 10,000 live births) for selected congenital anomalies identified during the newborn hospital stay or associated with a fetal death were calculated as

$$10,000 \times \frac{\text{number of infants with selected congenital anomaly}}{\text{number of live births}}$$

Similar rates were calculated for selected congenital anomalies identified in children up to 1 year of age. The numbers of live births were obtained from the Department's master birth files, provided by the Department's Center for Health Statistics.

Occurrence of a specific birth defect is assumed to be a rare event, therefore following a Poisson distribution. Exact confidence intervals were calculated for each rate (Armitage and Berry, page 134). Where there are a large number of birth defect cases, the confidence interval is narrow, indicating that the rate is stable. Where there are few birth defect cases, the confidence interval becomes very wide, indicating that the rate is not very stable and a small change in the number of infants born with the specific birth defect could result in a large change in the rate.

To compare two rates, it is important to look not just at their value, but also their confidence intervals. As a conservative approximation, if two confidence intervals overlap, then there is no evidence that the two rates are really different. If two confidence intervals do not overlap, then the rates are said to be statistically different. In this report, 95 percent confidence intervals are used; where the confidence intervals do not overlap, the rates are statistically different at the 5 percent level ($p < 0.05$).

Analysis of Trends
Trends in Illinois birth defect rates were modeled using a log-linear regression model (which is appropriate for data following a Poisson distribution). Analyses were performed using the Joinpoint Regression Program (Version 3.3.1, April 2008, Statistical Research and Applications Branch, National Cancer Institute). This software compares a linear model with a single slope to linear models with different slopes joined by one or more join-points. The model tests whether

the slope(s) are significantly different from 0 (whether there is a change over time) and whether any change in slope between two segments is statistically significant.

In this report, the trends have been examined for 1989-2001, and 2002-2009 separately since data for these two time periods are not comparable because of the different data collection methods used during each.

Multiple Comparisons
Since this report examines a large number of birth defects, the corresponding statistical tests are subject to the "multiple comparison problem." For a given birth defect, the observed rate is an estimate of the true birth defect rate in the population. When two rates from different times or groups are compared, statisticians will assert that the observed rates are evidence of the groups having differing birth defect rates, if the observed rates are so different that the chance of them coming from the same underlying population is less than 5 percent. The 5 percent type I error rate, however, suggests that when 100 comparisons are made, on average, five will provide statistical evidence that there are two true differing rates, when in fact there is no difference between the two groups. Therefore, the more comparisons that are made, the more may be statistically significant, just by chance. In this report, no explicit corrections were made for multiple comparisons; instead, exact probabilities are reported when discussing trends. The smaller the reported probability, the more likely it is that the difference is not simply the result of chance.

FINDINGS

Rates of Birth Defects
Birth defect rates for selected categories among Illinois newborns in 2008 and 2009 are presented in tables 4 and 5. The tables include rates based on the defects identified through the active case verification described above. The corresponding information for Chicago is presented in tables 6 and 7. In general, rates for Chicago are similar to those for Illinois as a whole. Where differences are observed, hospital reporting practices are likely to be at least partly accountable. In 2009, rates of heart defects – particularly transposition of great vessels, atrial septal defect and patent ductus arteriosus – are significantly lower for Illinois than Chicago. A similar difference was seen with atrial septal defects in 2008. In 2009, rates of Trisomy 18 were significantly lower in Illinois as a whole, than in Chicago; on the other hand, in 2008, rates of hypospadias/epispadias were significantly lower for Chicago than for Illinois. Caution should be used in interpreting these results because of the large number of comparisons made (see the discussion of multiple comparisons above).

Trend Analysis

Two birth defect categories can only be analyzed over a short time period. Gastroschisis and omphalocele are abdominal wall anomalies; the specific coding needed to identify the defects precisely has been used by the APORS birth defects registry since 2002. Hypospadias and epispadias are penile anomalies; the specific coding needed to identify these defects precisely has been used by the APORS birth defects registry since 1998. For each of these categories, therefore, there are only limited data available to examine trends.

For the remainder of the categories of birth defects, graphs of each birth defect rate over time are plotted in Figures 1 through 9. A regression line also is plotted for each birth defect. For the 1989-2001 data, the regression lines are usually log-linear, but may be made up of several straight line segments with different slopes. Statistically significant trends were found for 10 birth defects during this time period (listed in Table 3). Although examination of the graphs may show some other birth defects with a marked slope, the small number of cases means that the slope is not statistically significantly different from horizontal (no change with time). For the data collected between 2002 and 2009 four defects were found to have significant trends: cleft palate, rectal stenosis, pyloric stenosis and epispadias. Since this is a short period of time, and reflects a time of changes in data collection methods, the results from this time period are less reliable. Only log-linear regression lines were fitted.

For several defects, the direction of the trends between 1989 and 2001 and between 2002 and 2009 are in different directions. These apparent direction changes may be explained by the instability of the estimates of trend because of the small number of time points available since 2002. They also may reflect changes in data collection as APORS staff became more familiar with the new methods, and as diagnoses were more clearly defined. Alternatively, the trends may be real; the situation should become clearer as further years of data are collected using the new approach.

Table 3 also includes two columns (average percentage change) that give an estimate of how quickly the rate is changing over time (1989-2001 and 2002-2009). For example, the rate of endocardial cushion defect was significantly increasing by an average of 6.2 percent each year between 1989 and 2001, while from 2002 to 2009 the rate for this defect increased 3.9 percent each year. However, the change for the second time period is not statistically significant.

Table 3. Birth Defects Showing a Significant Trend in Incidence Rate
Between 1989 and 2001 or Between 2002 and 2009

Selected Birth Defect[1]	Significance of trend (P-value)	Average annual % change between 1989 and 2001[2]	Significance of trend (P-value)	Average annual % change between 2002 and 2009[2]
Atrial septal defect	0.00	9.6	not significant	-3.9
Endocardial cushion defect	0.00	6.2	not significant	3.9
Ebstein anomaly	0.02	6.2	not significant	-5.8
Pulmonary valve stenosis and atresia	0.00	7.1	not significant	-8.4
Patent ductus arteriosus	0.00	3.8	not significant	-2.3
Coarctation of aorta	0.02	3.5	not significant	-2.3
Cleft palate	not significant	0.1	0.03	-1.6
Rectal stenosis	not significant	0.9	0.02	-3.6
Pyloric stenosis	0.01	8.0	0.02	-24.5
Hirschsprung disease	0.00	5.9	not significant	-8.1
Obstructive genitourinary blockage	0.00	5.3	not significant	-2.5
Epispadias	--	--	0.01	10.0
Trisomy 18 (Edward Syndrome)	0.01	4.5	not significant	4.0

[1] Birth defects listed in tables 4 and 5 but not in this table did not show any significant changes in incidence rate over time.

[2] This is a measure of how quickly the rate is changing over time.

Source: Illinois Department of Public Health, Adverse Pregnancy Outcomes Reporting System, February 2012.

Defects Associated With Inadequate Folic Acid Intake

In 1992, the U.S. Centers for Disease Control and Prevention recommended that all women of childbearing age consume 0.4 mg of folic acid daily. The recommendation originated in research indicating that inadequate levels of folic acid in the first weeks of pregnancy increased the risk of having a baby with a neural tube defect (MRC Vitamin Study Research Group). In 1996, the U.S. Food and Drug Administration agreed that enriched cereal grain products must be fortified with folic acid, as a means to reduce the rate of neural tube defects in the United States (with implementation mandatory by January 1, 1998). Since then, a number of other low folic acid levels have been potentially implicated with other birth defects: Canfield *et al*. examined 16 congenital anomalies, previously examined by others, and found 11 defects with significant changes in prevalence pre- and post-fortification. These included neural tube defects, certain heart defects, cleft palate, omphalocele, Down syndrome, renal agenesis, limb reduction defects, urinary tract defects, brain defects and pylorus muscle defects.

Folic acid intake has increased in the general population since fortification in 1996, in part because many foods (cereals and flours) have been fortified with folic acid. It might, therefore, be expected that declines in the defects believed to be associated with low folic acid levels would emerge. Folate levels in women of child-bearing age have more than doubled since fortification (McDowell *et al.*)

Discussion of Illinois Results
Illinois data does not include birth defects that are diagnosed prenatally where the fetuses are subsequently terminated. This means that the Illinois observed incidence rates for conditions where terminations occur are lower than they should be. When examining trends, this will not affect the trend, provided that termination rate does not vary over time.

Between 1989 and 2001, spina bifida (without anencephalus) showed a marked, close to significant, decrease in the incidence rate of 2.0 percent each year (P=0.07). Since 2002, the rate of both anencephaly and spina bifida has been declining, although the slopes of the regression lines are not significantly different from a horizontal line indicating no change of slope.

Anotia and microtia occur more often in multiple births; in addition, Hispanic and Asian women are more likely to have a baby with anotia or microtia than non-Hispanic white women (Shaw *et al.,* Forrester & Hertz, Husain *et al.*) In Illinois between 1989 and 2009, 51.2 percent of anotia/microtia cases were born to Hispanic or Asian women; while they made up only 19.8 percent of births. The proportion of births to this group of women has been steadily increasing, and has more than doubled between 1989 and 2009. It is, therefore, not surprising that the rate of anotia/microtia is increasing in Illinois.

Between 1989 and 2001, six of the 13 cardiovascular defects increased significantly. This is in line with the findings reported by Botto *et al.* who reported increasing rates of ventricular septal defects, tetralogy of Fallot, atrioventricular defects and pulmonary stenosis. Much of these increases may be a result of the greater availability and use of diagnostic techniques. Between 2002 and 2009, most of these had decreased (although not significantly). Because there are only eight years being analyzed, the trends for the later period are still unstable; this may explain the direction change. It is also possible that the use of diagnostic techniques is reaching a plateau, causing the trend in these defects to level.

Between 2002 and 2009, cleft palate showed a significant decrease in the incidence rate of 1.6 percent each year (P=0.03). Risk factors for cleft palate include a family history of cleft, with more genetic mutations being identified as causing cleft palates. Cleft palates are more frequently seen in Asians or American Indians (and least frequently seen in African Americans.) Maternal smoking during pregnancy, and maternal use of some medications have been associated with cleft palate (Dixon *et al.*). Studies looking at the association between clefts and dietary factors have been more inconsistent; some studies have shown decrease in cleft palate with folic acid fortification while others have not (Johnson and Little.)

The rates of pyloric stenosis observed in Illinois increased significantly between 1989 and 2001, while between 2002 and 2009, there is a significant decrease. Other authors (Canfield *et al.*, Sommerfield *et al.*) have reported decreasing rates of pyloric stenosis over similar time frames. Pyloric stenosis is a challenging condition for Illinois to ascertain since it is often first diagnosed between 3 and 8 weeks of age, usually well after discharge from hospital. The reported rates in Illinois are very variable, it is plausible that as more data are collected, the observed trend will change. Rectal stenosis also is showing a significant decline in Illinois since 2002, having had a level incidence rate between 1989 and 2001. Hirschsprung's disease is another gastrointestinal condition usually diagnosed after discharge from hospital. The rates of this birth defect also show rather different behaviors before and after 2001: increasing significantly between 1989 and 2001 but decreasing (although not significantly) between 2002 and 2009. Each of these gastrointestinal defects can be associated with Down syndrome, another condition showing (non-significant) decrease between 2002 and 2009. Collection of additional years of data will help clarify the underlying trend for these conditions.

 Obstructive genitourinary blockages may not be symptomatic until several weeks into a baby's life. Substantially more cases are being identified through active case verification – tripling the number of cases found. This is another condition where a statistically significant increase in the incidence rate was found between 1989 and 2001. For 2002 to 2009, however, the trend in the incidence rate is not significantly different from 0. The rate of epispadias increased significantly between 2002 and 2009. Elliot *et al.* reported higher rates of epispadias in males of plural births than in singleton births. The same pattern is seen in Illinois data, with a ratio of 1.8:1 epispadias cases in plural births compared to singleton births. Since the proportion of multiple births is increasing, this may help explain the increase in the rate of epispadias.

The rate of Trisomy 18 increased between 1989 and 2001; this incidence of this condition increases with maternal age (Baty et al.) so again the observed increase probably reflects the increasing number of pregnancies among older women in Illinois.

Birth Defect Rates for Selected Categories Among Illinois and Chicago Newborns

2008-2009

Table 4. Number and Rate of Selected Birth Defects for 2008
Illinois

Selected Birth Defects Groups	N	Rate[1]	95% CI[2]	
A. Central Nervous System				
Anencephalus	18	1.0	(0.6,	1.6)
Spina bifida without anencephalus	51	2.9	(2.1,	3.8)
Hydrocephalus without spina bifida	132	7.5	(6.3,	8.9)
Encephalocele	8	0.5	(0.2,	0.9)
Microcephalus	78	4.4	(3.5,	5.5)
Total Selected CNS Defects	*287*	*16.2*	*(14.4,*	*18.2)*
B. Eye				
Anophthalmos/Microphthalmos	20	1.1	(0.7,	1.7)
Congenital cataract	15	0.8	(0.5,	1.4)
Aniridia	1	0.1	(0.0,	0.3)
Total Selected Eye Defects	*36*	*2.0*	*(1.4,*	*2.8)*
C. Ear				
Anotia/Microtia	20	1.1	(0.7,	1.7)
D. Cardiovascular				
Common truncus	9	0.5	(0.2,	1.0)
Transposition of great vessels	45	2.5	(1.9,	3.4)
Tetralogy of Fallot	50	2.8	(2.1,	3.7)
Ventricular septal defect	631	35.7	(33.0,	38.6)
Atrial septal defect[3]	360	20.4	(18.3,	22.6)
Endocardial cushion defect	85	4.8	(3.8,	6.0)
Pulmonary valve stenosis and atresia	42	2.4	(1.7,	3.2)
Tricuspid valve stenosis and atresia	24	1.4	(0.9,	2.0)
Ebstein anomaly	11	0.6	(0.3,	1.1)
Aortic valve stenosis	23	1.3	(0.8,	2.0)
Hypoplastic left heart syndrome	35	2.0	(1.4,	2.8)
Patent ductus arteriosus[3]	322	18.2	(16.3,	20.3)
Coarctation of aorta	36	2.0	(1.4,	2.8)
Total Selected Cardiovascular Defects	*1,673*	*94.7*	*(90.2,*	*99.4)*
F. Orofacial				
Cleft palate without cleft lip	82	4.6	(3.7,	5.8)
Cleft lip with and without cleft palate	131	7.4	(6.2,	8.8)
Choanal atresia	16	0.9	(0.5,	1.5)
Total Selected Orofacial Defects	*229*	*13.0*	*(11.3,*	*14.8)*
G. Gastrointestinal				
Esophageal atresia/Tracheosophageal fistula	29	1.6	(1.1,	2.4)
Rectal and large intestinal atresia/stenosis	64	3.6	(2.8,	4.6)
Pyloric stenosis	13	0.7	(0.4,	1.3)
Hirschsprung disease (congenital megacolon)	9	0.5	(0.2,	1.0)
Biliary atresia	1	0.1	(0.0,	0.3)
Total Selected Gastrointestinal Defects	*116*	*6.6*	*(5.4,*	*7.9)*

Selected Birth Defects Groups	N	Rate[1]	95% CI[2]	
H. Genitourinary				
Renal agenesis/hypoplasia	69	3.9	(3.0,	4.9)
Bladder exstrophy	3	0.2	(0.0,	0.5)
Obstructive genitourinary defect	451	25.5	(23.2,	28.0)
Hypospadias/Epispadias	463	26.2	(23.9,	28.7)
Total Selected Genitourinary Defects	*986*	*55.8*	*(52.4,*	*59.4)*
I. Musculoskeletal				
Reduction deformity, upper limbs	55	3.1	(2.3,	4.1)
Reduction deformity, lower limbs	23	1.3	(0.8,	2.0)
Gastroschisis	58	3.3	(2.5,	4.2)
Omphalocele	36	2.0	(1.4,	2.8)
Congenital hip dislocation	46	2.6	(1.9,	3.5)
Diaphragmatic hernia	36	2.0	(1.4,	2.8)
Total Selected Musculoskeletal Defects	*254*	*14.4*	*(12.7,*	*16.3)*
J. Chromosomal				
Trisomy 13 (Patau syndrome)	22	1.2	(0.8,	1.9)
Trisomy 21 (Down syndrome)	201	11.4	(9.9,	13.1)
Trisomy 18 (Edward syndrome)	32	1.8	(1.2,	2.6)
Total Selected Chromosomal Defects	*255*	*14.4*	*(12.7,*	*16.3)*
Total All Selected Defects	***3,856***	***218.3***	***(211.5,***	***225.3)***

[1] Rate per 10,000 live births
[2] 95 percent confidence interval for rate
[3] Only children with gestational ages of 36 weeks or greater and who have another heart defect are included among cases with patent ductus arteriosus diagnoses and some atrial septal defect (ASD) cases (those where the chart describes a defect as a patent foramen ovale). These conditions are necessary for normal fetal circulation.

Source: Illinois Department of Public Health, Adverse Pregnancy Outcomes Reporting System, February 2012

Table 5. Number and Rate of Selected Birth Defects for 2009
Illinois

Selected Birth Defects Groups	N	Rate[1]	95% CI[2]	
A. Central Nervous System				
Anencephalus	18	1.1	(0.6,	1.7)
Spina bifida without anencephalus	37	2.2	(1.5,	3.0)
Hydrocephalus without spina bifida	114	6.7	(5.5,	8.0)
Encephalocele	17	1.0	(0.6,	1.6)
Microcephalus	86	5.0	(4.0,	6.2)
Total Selected CNS Defects	*272*	*15.9*	*(14.1,*	*17.9)*
B. Eye				
Anophthalmos/Microphthalmos	20	1.2	(0.7,	1.8)
Congenital cataract	11	0.6	(0.3,	1.2)
Aniridia	0	0.0	(0.0,	0.2)
Total Selected Eye Defects	*31*	*1.8*	*(1.2,*	*2.6)*
C. Ear				
Anotia/Microtia	30	1.8	(1.2,	2.5)
D. Cardiovascular				
Common truncus	13	0.8	(0.4,	1.3)
Transposition of great vessels	40	2.3	(1.7,	3.2)
Tetralogy of Fallot	50	2.9	(2.2,	3.9)
Ventricular septal defect	707	41.3	(38.3,	44.5)
Atrial septal defect[3]	405	23.7	(21.4,	26.1)
Endocardial cushion defect	76	4.4	(3.5,	5.6)
Pulmonary valve stenosis and atresia	44	2.6	(1.9,	3.5)
Tricuspid valve stenosis and atresia	33	1.9	(1.3,	2.7)
Ebstein anomaly	8	0.5	(0.2,	0.9)
Aortic valve stenosis	15	0.9	(0.5,	1.4)
Hypoplastic left heart syndrome	36	2.1	(1.5,	2.9)
Patent ductus arteriosus[3]	392	22.9	(20.7,	25.3)
Coarctation of aorta	56	3.3	(2.5,	4.3)
Total Selected Cardiovascular Defects	*1,875*	*109.6*	*(104.7,*	*114.7)*
F. Orofacial				
Cleft palate without cleft lip	81	4.7	(3.8,	5.9)
Cleft lip with and without cleft palate	142	8.3	(7.0,	9.8)
Choanal atresia	13	0.8	(0.4,	1.3)
Total Selected Orofacial Defects	*236*	*13.8*	*(12.1,*	*15.7)*
G. Gastrointestinal				
Esophageal atresia/Tracheosophageal fistula	37	2.2	(1.5,	3.0)
Rectal and large intestinal atresia/stenosis	56	3.3	(2.5,	4.3)
Pyloric stenosis	3	0.2	(0.0,	0.5)
Hirschsprung disease (congenital megacolon)	21	1.2	(0.8,	1.9)
Biliary atresia	2	0.1	(0.0,	0.4)
Total Selected Gastrointestinal Defects	*119*	*7.0*	*(5.8,*	*8.3)*

Selected Birth Defects Groups	N	Rate[1]	95% CI[2]	
H. Genitourinary				
Renal agenesis/hypoplasia	73	4.3	(3.3,	5.4)
Bladder exstrophy	7	0.4	(0.2,	0.8)
Obstructive genitourinary defect	365	21.3	(19.2,	23.6)
Hypospadias/Epispadias	453	26.5	(24.1,	29.0)
Total Selected Genitourinary Defects	*898*	*52.5*	*(49.1,*	*56.0)*
I. Musculoskeletal				
Reduction deformity, upper limbs	47	2.7	(2.0,	3.7)
Reduction deformity, lower limbs	27	1.6	(1.0,	2.3)
Gastroschisis	59	3.4	(2.6,	4.4)
Omphalocele	27	1.6	(1.0,	2.3)
Congenital hip dislocation	45	2.6	(1.9,	3.5)
Diaphragmatic hernia	48	2.8	(2.1,	3.7)
Total Selected Musculoskeletal Defects	*253*	*14.8*	*(13.0,*	*16.7)*
J. Chromosomal				
Trisomy 13 (Patau syndrome)	19	1.1	(0.7,	1.7)
Trisomy 21 (Down syndrome)	186	10.9	(9.4,	12.6)
Trisomy 18 (Edward syndrome)	44	2.6	(1.9,	3.5)
Total Selected Chromosomal Defects	*249*	*14.6*	*(12.8,*	*16.5)*
Total All Selected Defects	***3,963***	***231.7***	***(224.5,***	***239.0)***

[1] Rate per 10,000 live births
[2] 95 percent confidence interval for rate
[3] Only children with gestational ages of 36 weeks or greater and who have another heart defect are included among cases with patent ductus arteriosus diagnoses and some atrial septal defect (ASD) cases (those where the chart describes a defect as a patent foramen ovale). These conditions are necessary for normal fetal circulation.

Source: Illinois Department of Public Health, Adverse Pregnancy Outcomes Reporting System, February 2012

Table 6. Number and Rate of Selected Birth Defects for 2008
Chicago

Selected Birth Defects Groups	N	Rate[1]	95% CI[2]	
A. Central Nervous System				
Anencephalus	4	0.9	(0.2,	2.3)
Spina bifida without anencephalus	12	2.6	(1.4,	4.6)
Hydrocephalus without spina bifida	21	4.6	(2.9,	7.1)
Encephalocele	3	0.7	(0.1,	1.9)
Microcephalus	35	7.7	(5.4,	10.7)
Total Selected CNS Defects	*75*	*16.5*	*(13.0,*	*20.7)*
B. Eye				
Anophthalmos/Microphthalmos	7	1.5	(0.6,	3.2)
Congenital cataract	5	1.1	(0.4,	2.6)
Aniridia	1	0.2	(0.0,	1.2)
Total Selected Eye Defects	*13*	*2.9*	*(1.5,*	*4.9)*
C. Ear				
Anotia/Microtia	6	1.3	(0.5,	2.9)
D. Cardiovascular				
Common truncus	1	0.2	(0.0,	1.2)
Transposition of great vessels	10	2.2	(1.1,	4.1)
Tetralogy of Fallot	18	4.0	(2.4,	6.3)
Ventricular septal defect	154	33.9	(28.8,	39.7)
Atrial septal defect[3]	134	29.5	(24.7,	35.0)
Endocardial cushion defect	12	2.6	(1.4,	4.6)
Pulmonary valve stenosis and atresia	14	3.1	(1.7,	5.2)
Tricuspid valve stenosis and atresia	4	0.9	(0.2,	2.3)
Ebstein anomaly	5	1.1	(0.4,	2.6)
Aortic valve stenosis	3	0.7	(0.1,	1.9)
Hypoplastic left heart syndrome	3	0.7	(0.1,	1.9)
Patent ductus arteriosus[3]	74	16.3	(12.8,	20.5)
Coarctation of aorta	13	2.9	(1.5,	4.9)
Total Selected Cardiovascular Defects	*447*	*98.5*	*(89.6,*	*108.0)*
F. Orofacial				
Cleft palate without cleft lip	17	3.7	(2.2,	6.0)
Cleft lip with and without cleft palate	36	7.9	(5.6,	11.0)
Choanal atresia	5	1.1	(0.4,	2.6)
Total Selected Orofacial Defects	*58*	*12.8*	*(9.7,*	*16.5)*
G. Gastrointestinal				
Esophageal atresia/Tracheosophageal fistula	7	1.5	(0.6,	3.2)
Rectal and large intestinal atresia/stenosis	11	2.4	(1.2,	4.3)
Pyloric stenosis	4	0.9	(0.2,	2.3)
Hirschsprung disease (congenital megacolon)	3	0.7	(0.1,	1.9)
Biliary atresia	1	0.2	(0.0,	1.2)
Total Selected Gastrointestinal Defects	*26*	*5.7*	*(3.7,*	*8.4)*

Selected Birth Defects Groups	N	Rate[1]	95% CI[2]	
H. Genitourinary				
Renal agenesis/hypoplasia	13	2.9	(1.5,	4.9)
Bladder exstrophy	1	0.2	(0.0,	1.2)
Obstructive genitourinary defect	105	23.1	(18.9,	28.0)
Hypospadias/Epispadias	69	15.2	(11.8,	19.2)
Total Selected Genitourinary Defects	*188*	*41.4*	*(35.7,*	*47.8)*
I. Musculoskeletal				
Reduction deformity, upper limbs	22	4.8	(3.0,	7.3)
Reduction deformity, lower limbs	7	1.5	(0.6,	3.2)
Gastroschisis	15	3.3	(1.8,	5.5)
Omphalocele	9	2.0	(0.9,	3.8)
Congenital hip dislocation	13	2.9	(1.5,	4.9)
Diaphragmatic hernia	11	2.4	(1.2,	4.3)
Total Selected Musculoskeletal Defects	*77*	*17.0*	*(13.4,*	*21.2)*
J. Chromosomal				
Trisomy 13 (Patau syndrome)	7	1.5	(0.6,	3.2)
Trisomy 21 (Down syndrome)	43	9.5	(6.9,	12.8)
Trisomy 18 (Edward syndrome)	17	3.7	(2.2,	6.0)
Total Selected Chromosomal Defects	*67*	*14.8*	*(11.4,*	*18.7)*
Total All Selected Defects	***955***	***210.4***	***(197.3,***	***224.2)***

[1] Rate per 10,000 live births
[2] 95 percent confidence interval for rate
[3] Only children with gestational ages of 36 weeks or greater and who have another heart defect are included among cases with patent ductus arteriosus diagnoses and some atrial septal defect (ASD) cases (those where the chart describes a defect as a patent foramen ovale). These conditions are necessary for normal fetal circulation.

Source: Illinois Department of Public Health, Adverse Pregnancy Outcomes Reporting System, February 2012

Table 7. Number and Rate of Selected Birth Defects for 2009
Chicago

Selected Birth Defects Groups	N	Rate[1]	95% CI[2]
A. Central Nervous System			
Anencephalus	5	1.1	(0.4, 2.6)
Spina bifida without anencephalus	5	1.1	(0.4, 2.6)
Hydrocephalus without spina bifida	27	6.1	(4.0, 8.8)
Encephalocele	6	1.3	(0.5, 2.9)
Microcephalus	24	5.4	(3.5, 8.0)
Total Selected CNS Defects	*67*	*15.1*	*(11.7, 19.1)*
B. Eye			
Anophthalmos/Microphthalmos	7	1.6	(0.6, 3.2)
Congenital cataract	3	0.7	(0.1, 2.0)
Aniridia	0	0.0	(0.0, 0.8)
Total Selected Eye Defects	*10*	*2.2*	*(1.1, 4.1)*
C. Ear			
Anotia/Microtia	15	3.4	(1.9, 5.6)
D. Cardiovascular			
Common truncus	2	0.4	(0.1, 1.6)
Transposition of great vessels	25	5.6	(3.6, 8.3)
Tetralogy of Fallot	14	3.1	(1.7, 5.3)
Ventricular septal defect	188	42.3	(36.5, 48.8)
Atrial septal defect[3]	210	47.2	(41.1, 54.1)
Endocardial cushion defect	20	4.5	(2.7, 6.9)
Pulmonary valve stenosis and atresia	16	3.6	(2.1, 5.8)
Tricuspid valve stenosis and atresia	5	1.1	(0.4, 2.6)
Ebstein anomaly	4	0.9	(0.2, 2.3)
Aortic valve stenosis	4	0.9	(0.2, 2.3)
Hypoplastic left heart syndrome	9	2.0	(0.9, 3.8)
Patent ductus arteriosus[3]	140	31.5	(26.5, 37.2)
Coarctation of aorta	20	4.5	(2.7, 6.9)
Total Selected Cardiovascular Defects	*657*	*147.8*	*(136.7, 159.6)*
F. Orofacial			
Cleft palate without cleft lip	21	4.7	(2.9, 7.2)
Cleft lip with and without cleft palate	32	7.2	(4.9, 10.2)
Choanal atresia	2	0.4	(0.1, 1.6)
Total Selected Orofacial Defects	*55*	*12.4*	*(9.3, 16.1)*
G. Gastrointestinal			
Esophageal atresia/Tracheosophageal fistula	6	1.3	(0.5, 2.9)
Rectal and large intestinal atresia/stenosis	12	2.7	(1.4, 4.7)
Pyloric stenosis	1	0.2	(0.0, 1.3)
Hirschsprung disease (congenital megacolon)	5	1.1	(0.4, 2.6)
Biliary atresia	0	0.0	(0.0, 0.8)
Total Selected Gastrointestinal Defects	*24*	*5.4*	*(3.5, 8.0)*

Selected Birth Defects Groups	N	Rate[1]	95% CI[2]	
H. Genitourinary				
Renal agenesis/hypoplasia	19	4.3	(2.6,	6.7)
Bladder exstrophy	0	0.0	(0.0,	0.8)
Obstructive genitourinary defect	89	20.0	(16.1,	24.6)
Hypospadias/Epispadias	104	23.4	(19.1,	28.4)
Total Selected Genitourinary Defects	*212*	*47.7*	*(41.5,*	*54.6)*
I. Musculoskeletal				
Reduction deformity, upper limbs	14	3.1	(1.7,	5.3)
Reduction deformity, lower limbs	10	2.2	(1.1,	4.1)
Gastroschisis	17	3.8	(2.2,	6.1)
Omphalocele	5	1.1	(0.4,	2.6)
Congenital hip dislocation	16	3.6	(2.1,	5.8)
Diaphragmatic hernia	15	3.4	(1.9,	5.6)
Total Selected Musculoskeletal Defects	*77*	*17.3*	*(13.7,*	*21.7)*
J. Chromosomal				
Trisomy 13 (Patau syndrome)	7	1.6	(0.6,	3.2)
Trispomy 21 (Down syndrome)	42	9.4	(6.8,	12.8)
Trisomy 18 (Edward syndrome)	27	6.1	(4.0,	8.8)
Total Selected Chromosomal Defects	*76*	*17.1*	*(13.5,*	*21.4)*
Total All Selected Defects	***1,193***	***268.4***	***(253.4,***	***284.1)***

[1] Rate per 10,000 live births
[2] 95 percent confidence interval for rate
[3] Only children with gestational ages of 36 weeks or greater and who have another heart defect are included among cases with patent ductus arteriosus diagnoses and some atrial septal defect (ASD) cases (those where the chart describes a defect as a patent foramen ovale). These conditions are necessary for normal fetal circulation.

Source: Illinois Department of Public Health, Adverse Pregnancy Outcomes Reporting System, February 2012

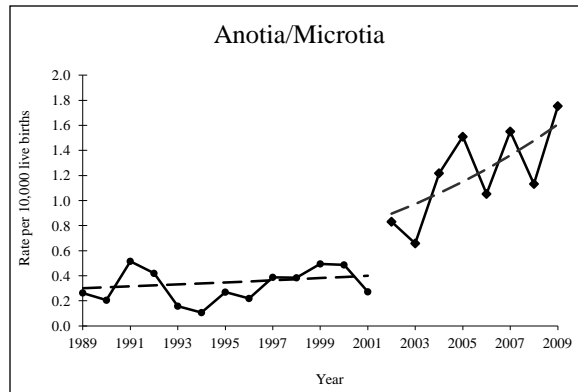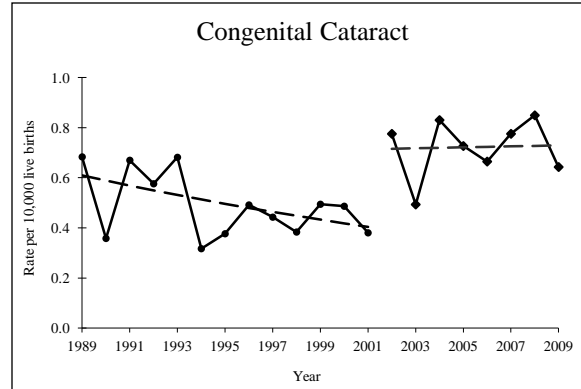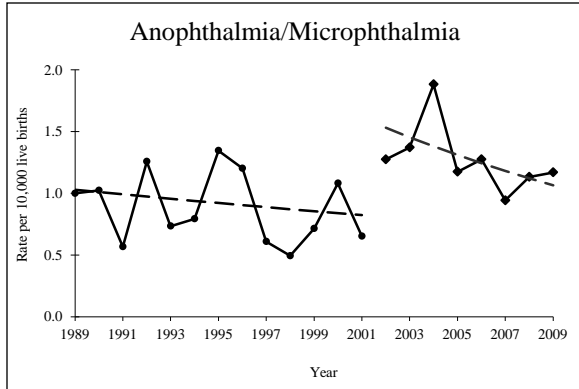# Trends in Birth Defect Rates for Selected Categories Among Illinois Newborns

1989-2009

Figure 1. Trends in the Reported Prevalence Rates of Neural Tube Defects
per 10,000 Live Births
1989-2009
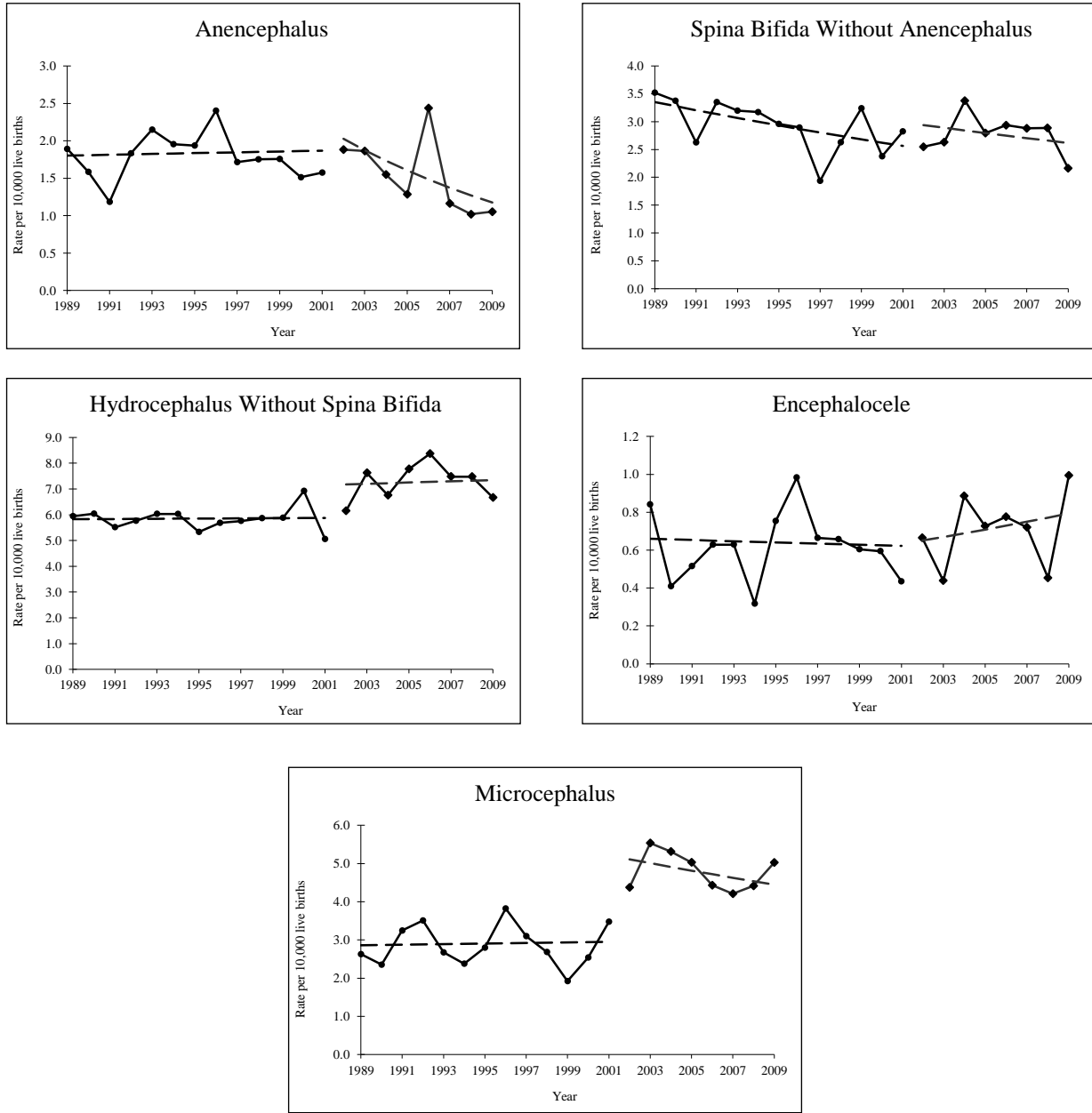
Figure 2. Trends in the Reported Prevalence Rates of Eye and Ear Defects
per 10,000 Live Births
1989-2009

Anophthalmia/Microphthalmia

Congenital Cataract

Anotia/Microtia

●————● Observed Rates   ------------ Regression Line

◆————◆ Observed Rates With Active Verification

Source: Illinois Department of Public Health, Adverse Pregnancy Outcomes Reporting System, February 2012

Figure 3A. Trends in the Reported Prevalence Rates of Cardiac Defects
per 10,000 Live Births
1989-2009

Common Truncus

Transposition of Great Vessels

Tetralogy of Fallot

Ventricular Septal Defect

Atrial Septal Defect[1]

●———● Observed Rates   - - - - - - - - - - Regression Line

◆———◆ Observed Rates With Active Verification

[1]Trend is significant for 1989-2001, but not for 2002-2009; details are given in Table 2.

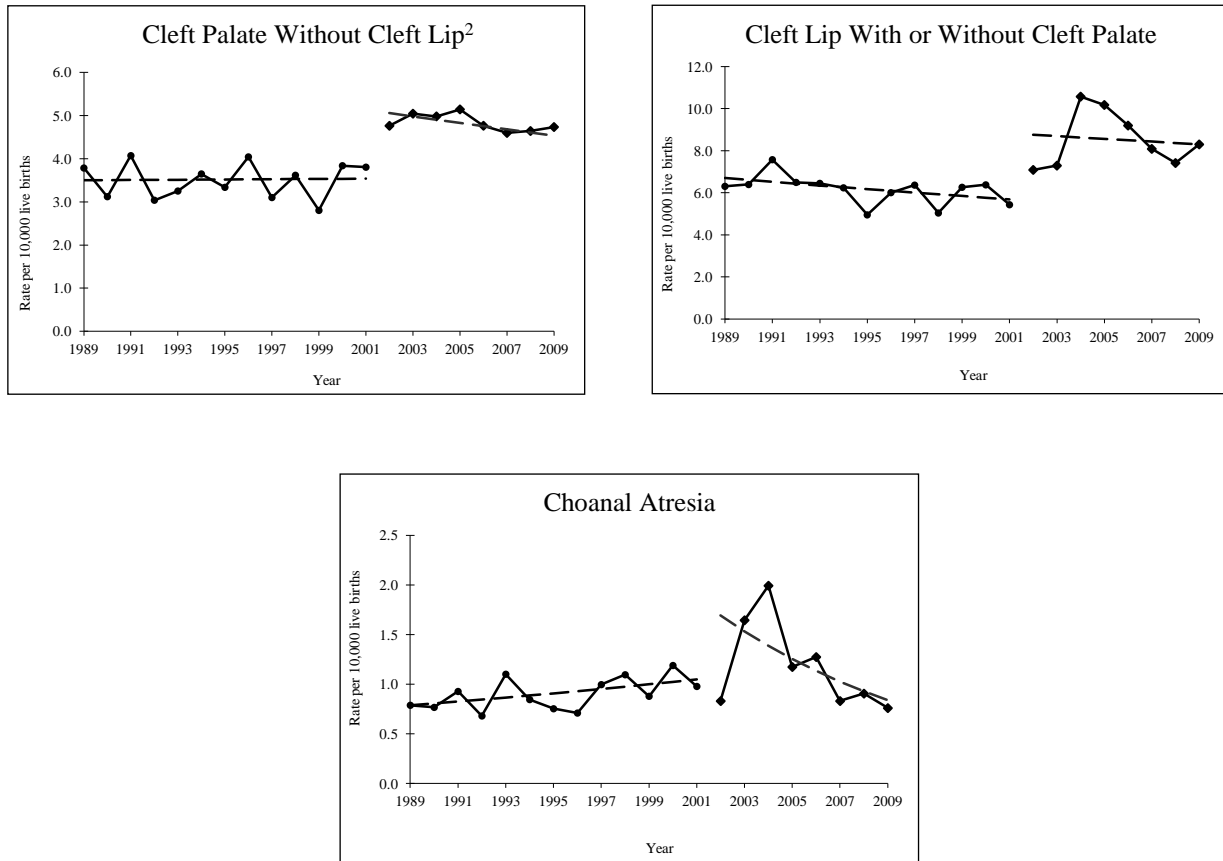Source: Illinois Department of Public Health, Adverse Pregnancy Outcomes Reporting System, February 2012

Figure 3B. Trends in the Reported Prevalence Rates of Cardiac Defects
per 10,000 Live Births
1989-2009

Endocardial Cushion[1]

Pulmonary Valve Atresia/Stenosis[1]

Tricuspid Valve Atresia/Stenosis

Ebstein Anomaly[1]

● ─────── ● Observed Rates   - - - - - - - - - - Regression Line

◆ ─────── ◆ Observed Rates With Active Verification
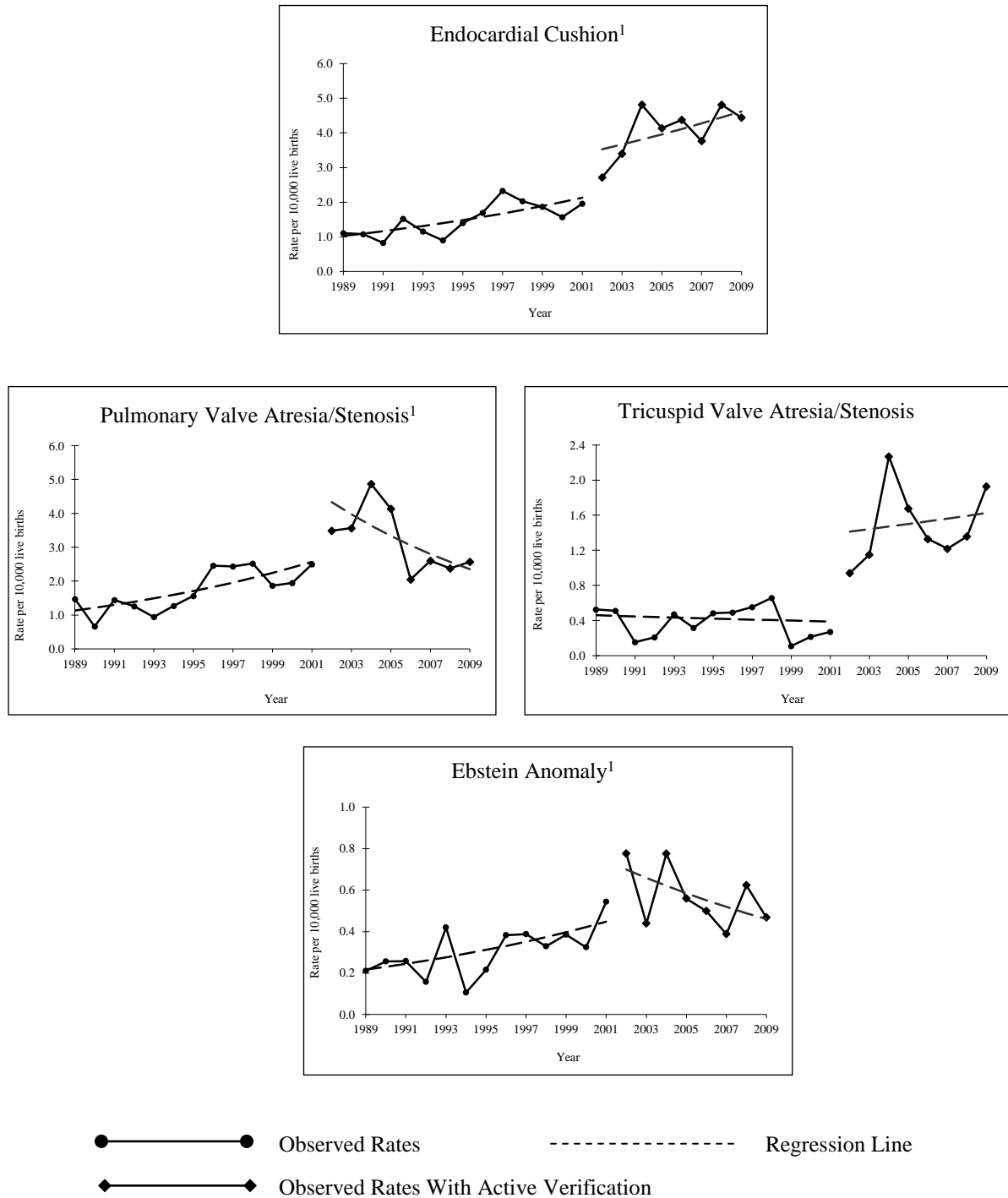
[1]Trend is significant for 1989-2001, but not for 2002-2009; details are given in Table 2.

Source: Illinois Department of Public Health, Adverse Pregnancy Outcomes Reporting System, February 2012

Figure 4. Trends in the Reported Prevalence Rates of Circulatory Defects
## per 10,000 Live Births
1989-2009
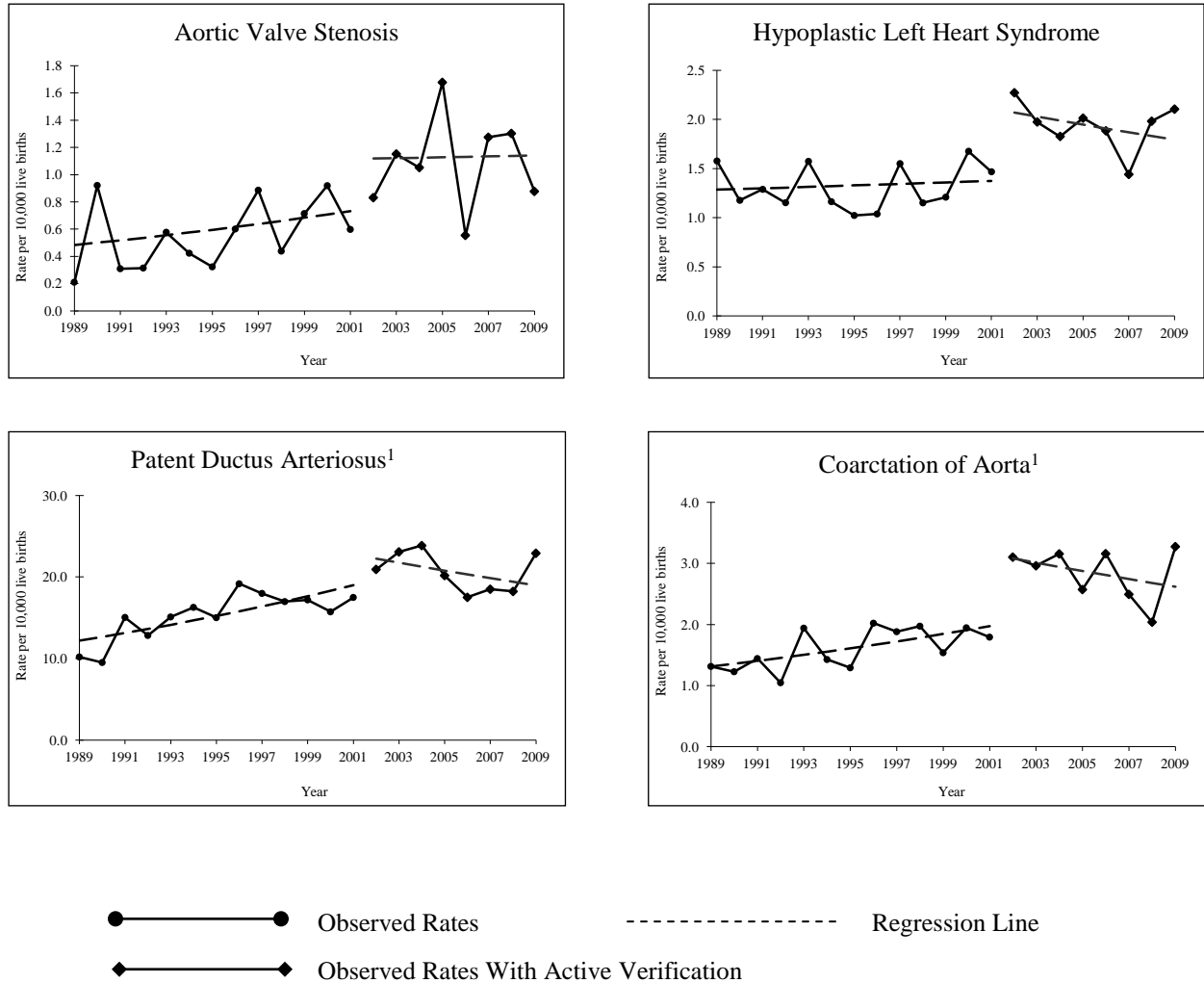
Aortic Valve Stenosis

Hypoplastic Left Heart Syndrome

Patent Ductus Arteriosus[1]

Coarctation of Aorta[1]

●————● Observed Rates   - - - - - - - - - - - - - - - Regression Line

◆————◆ Observed Rates With Active Verification

[1]Trend is significant for 1989-2001, but not for 2002-2009; details are given in Table 2.

Source: Illinois Department of Public Health, Adverse Pregnancy Outcomes Reporting System, February 2012

Figure 5. Trends in the Reported Prevalence Rates of Respiratory and Oral Defects per 10,000 Live Births 1989-2009
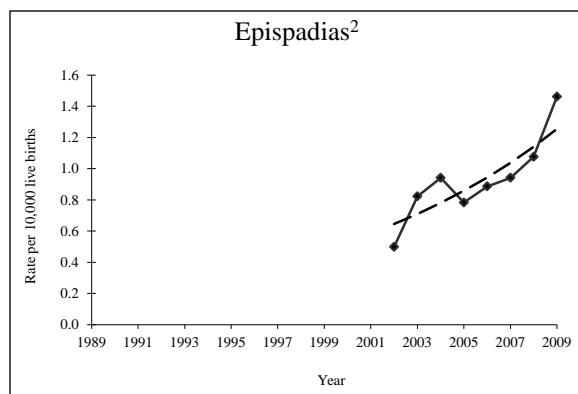

Cleft Palate Without Cleft Lip[2]

Cleft Lip With or Without Cleft Palate

Choanal Atresia

●————● Observed Rates   - - - - - - - - - - - - - - - Regression Line

◆————◆ Observed Rates With Active Verification

[2]Trend is significant for 2002-2009, but not for 1989-2001; details are given in Table 2.

Source: Illinois Department of Public Health, Adverse Pregnancy Outcomes Reporting System, February 2012

Figure 6. Trends in the Reported Prevalence Rates of Gastrointestinal Defects
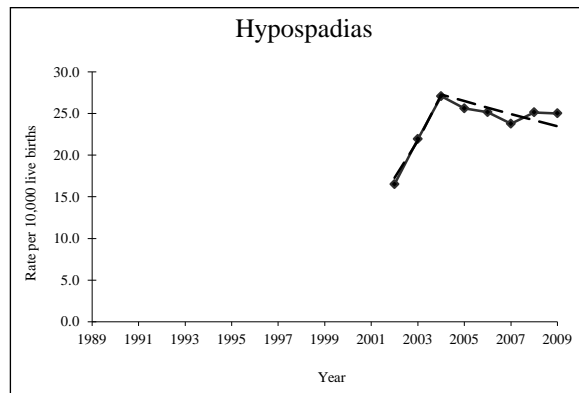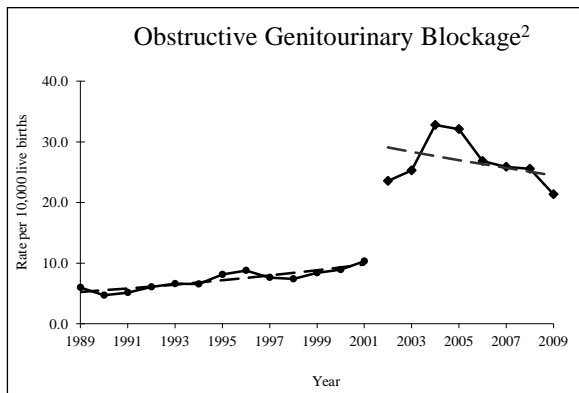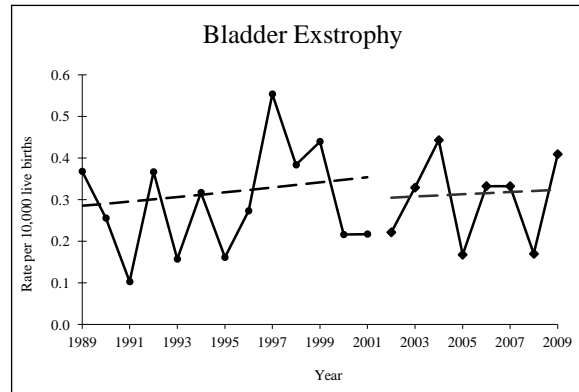## per 10,000 Live Births
1989-2009
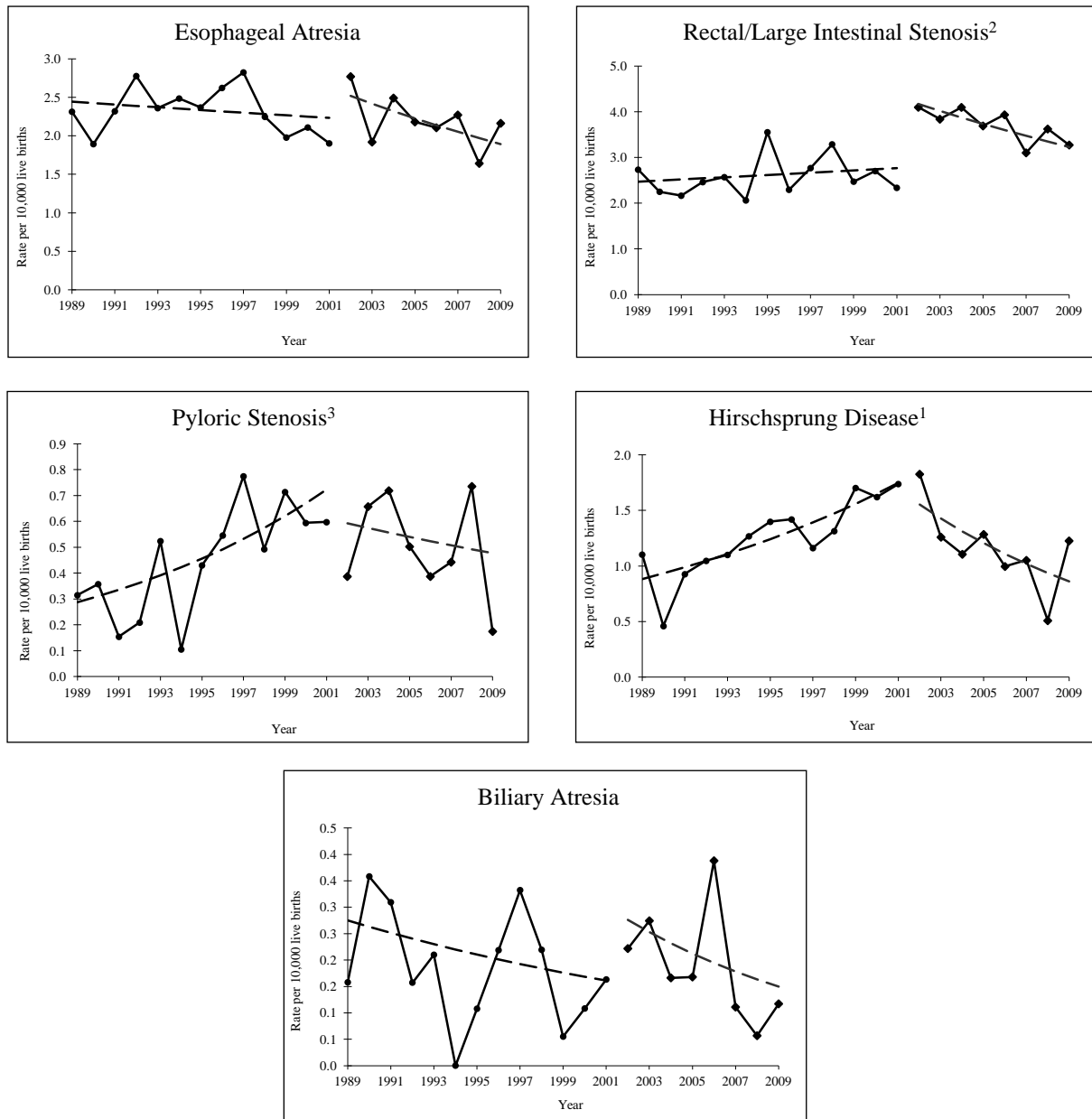
[1]Trend is significant for 1989-2001, but not for 2002-2009; details are given in Table 2.
[2]Trend is significant for 2002-2009, but not for 1989-2001; details are given in Table 2.
[3]Trend is significant for both 1989-2001 and 2002-2009; details are given in Table 2.

Source: Illinois Department of Public Health, Adverse Pregnancy Outcomes Reporting System, February 2012

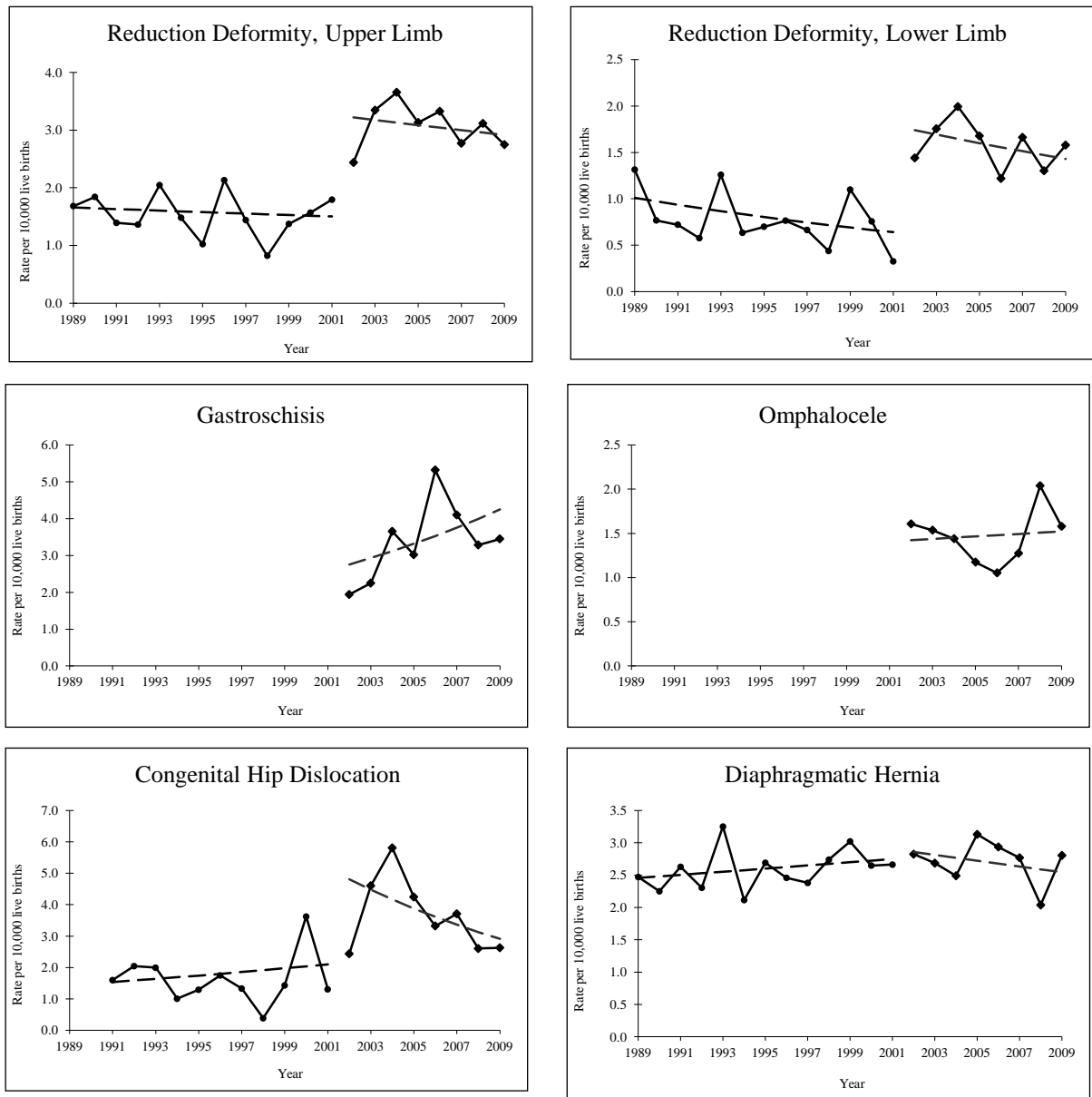# Figure 7. Trends in the Reported Prevalence Rates of Genitourinary Defects per 10,000 Live Births 1989-2009

[2]Trend is significant for 1989-2001, but not for 2002-2009; details are given in Table 2.

Source: Illinois Department of Public Health, Adverse Pregnancy Outcomes Reporting System, February 2012

Figure 8. Trends in the Reported Prevalence Rates of Musculoskeletal Defects per 10,000 Live Births 1989-2009

Reduction Deformity, Upper Limb

Reduction Deformity, Lower Limb

Gastroschisis

Omphalocele

Congenital Hip Dislocation

Diaphragmatic Hernia

● Observed Rates

----------------- Regression Line

◆ Observed Rates With Active Verification

Source: Illinois Department of Public Health, Adverse Pregnancy Outcomes Reporting System, February 2012

Figure 9. Trends in the Reported Prevalence Rates of Chromosomal Defects
per 10,000 Live Births
1989-2009
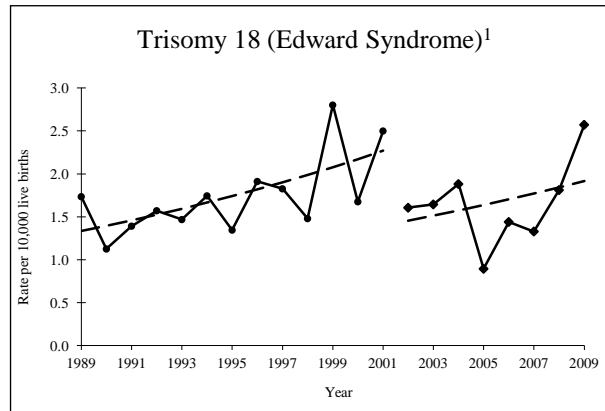
Trisomy 13 (Patau Syndrome)

Down Syndrome

Trisomy 18 (Edward Syndrome)[1]

●————● Observed Rates   - - - - - - - - - - - - - - Regression Line

◆————◆ Observed Rates With Active Verification

[1]Trend is significant for 1989-2001, but not for 2002-2009; details are given in Table 2.

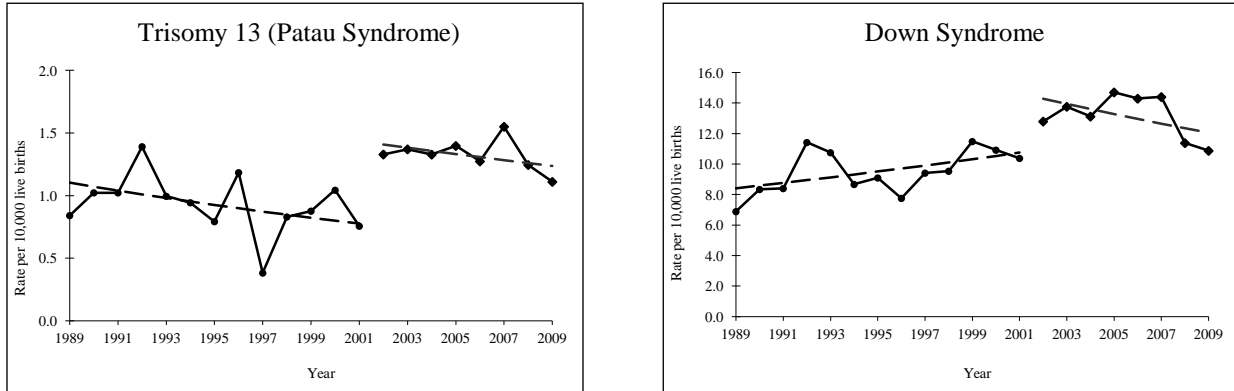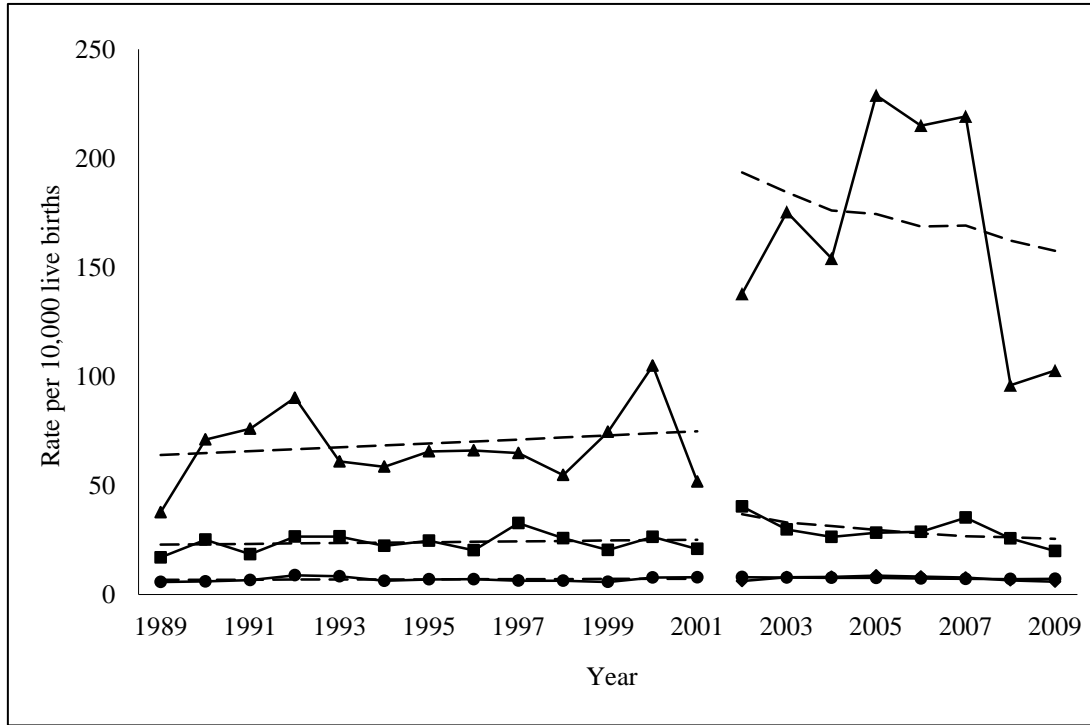Source: Illinois Department of Public Health, Adverse Pregnancy Outcomes Reporting System, February 2012

**Figure 10. Trends in the Reported Prevalence Rates of Trisomy 21 (Down Syndrome),
By Maternal Age at Delivery per 10,000 Live Births
1989-2009**

Mother's Age at Delivery (Years)			
)————)	Younger than 35	!————+	35-39
4————4	40 and older	- - - - - - - - -	Regression lines

Source: Illinois Department of Public Health, Adverse Pregnancy Outcomes Reporting System, February 2012

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APPENDIX 1

Description and ICD-9-CM Codes for Selected Birth Defects

Birth Defect	ICD-9-CM Codes	Description
Anencephalus	740.0-740.1	A neural tube defect that occurs when the head end of the neural tube fails to close, resulting in the absence of a major portion of the brain, skull and scalp. Includes craniorachischisis in which there is incomplete closure of the skull and spinal column.
Spina bifida without anencephalus	741.xx	A birth defect in which there is a bony defect in the vertebral column so that part of the spinal cord, which is normally protected within the vertebral column, is exposed. May be associated with hydrocephalus.
Encephalocele	742.0	A neural tube defect affecting the skull, resulting in the protrusion of the meninges and portions of the brain through a bony midline defect in the skull.
Microcephalus	742.1	An abnormally small head due to failure of brain growth. In precise terms, microcephaly is a head circumference that is more than two standard deviations below the normal mean for age, sex, race and gestation.
Hydrocephalus without spina bifida	742.3	An abnormal buildup of cerebrospinal fluid in the ventricles of the brain. The fluid is often under increased pressure and can compress and damage the brain.
Anophthalmos	743.0x	Absence of the eye, as a result of a congenital malformation of the globe.
Microphthalmos	743.1x	An abnormally small eye, a congenital malformation of the globe.
Congenital cataract	743.30-743.34	Opacity of the lens that occurs in the fetus at some time during the pregnancy and is present at birth.
Anotia	744.01	Congenital absence of the external ear (the auricle).
Microtia	744.23	Smallness of the auricle of the ear with a blind or absent external auditory meatus.
Common truncus	745.0	Failure of the fetal truncus arteriosus to divide into the aorta and pulmonary artery.
Transposition of great vessels	745.1x	A congenital heart defect in which the position of the two major vessels that carry blood away from the heart, the aorta and the pulmonary artery, is transposed.

Birth Defect	ICD-9-CM Codes	Description
Tetralogy of Fallot	745.2	A congenital defect of the heart consisting of four abnormalities (a ventricular septal defect, an overriding aorta, right ventricular hypertrophy, and pulmonary valve or artery stenosis or atresia) that results in insufficiently oxygenated blood pumped to the body.
Ventricular septal defect	745.4	A hole in the wall between the lower chambers of the heart.
Atrial septal defect	745.5	A hole in the wall between the upper chambers of the heart.
Endocardial cushion defect	745.6x	A spectrum of septal defects associated with persistence of the embryonic atrioventricular canal due to incomplete growth and fusion of the endocardial cushion.
Pulmonary valve stenosis and atresia	746.01/746.02	Absence or narrowing of the valve between the right ventricle and the pulmonary artery.
Tricuspid valve stenosis and atresia	746.1	Tricuspid atresia is the absence or pathological narrowing of the valve between the right atrium and ventricle, with the presence of an atrial defect through which all the systemic venous return reaches the left heart.
Ebstein anomaly	746.2	Deformation or displacement of the tricuspid valve with the septal and posterior leaflets being attached to the wall of the right ventricle.
Aortic valve stenosis	746.3	A narrowing or obstruction of the aortic heart valve, causing it to not open properly and to obstruct the flow of blood from the left ventricle to the aorta.
Hypoplastic left heart syndrome	746.7	A form of congenital heart disease in which the whole left half of the heart (including the aorta, aortic valve, left ventricle and mitral valve) is underdeveloped.
Patent ductus arteriosus	747.0	A condition when the channel between the pulmonary artery and the aorta fails to close at birth.
Coarctation of aorta	747.10	A birth defect in which the major artery from the heart (aorta) is narrowed somewhere along its length; most commonly the narrowing is just past the point where the aorta and the subclavian artery come together.
Choanal atresia	748.0	A congenital narrowing or blockage of the nasal airway by membranous or bony tissue.
Cleft palate without cleft lip	749.0x	An opening in the roof of the mouth (the palate) due to a failure of the palatal shelves to come fully together from either side of the mouth and fuse during embryonic development.
Cleft lip	749.1x	The presence of one or two vertical fissures in the upper lip resulting from failure of the normal process of fusion of the lip to come to completion during embryonic life.

Birth Defect	ICD-9-CM Codes	Description
Esophageal atresia/ Tracheoesophageal fistula	750.3	A narrowing or obstruction of the esophagus sometimes with a connection or hole between the lower esophagus and the trachea.
Pyloric stenosis	750.5	A narrowing of the outlet from the stomach to the small intestine (the pylorus).
Rectal and large intestinal atresia and stenosis	751.2	Absence, abnormal localization or blockage of the large intestine or rectum.
Hirschsprung disease	751.3	A congenital abnormality of the bowel in which there is absence of the ganglia (nerves) in the wall of the bowel.
Biliary atresia	751.61	Congenital absence or closure of the major bile ducts that drain bile from the liver.
Hypospadias	752.61	A relatively common abnormality of the penis that appears as an abnormal opening of the penis on the underside of the penis rather than at the end. (In females, the opening to the urinary tract is below the normal opening.)
Epispadias	752.62	A rare congenital defect, most common in males, in which the urethra opens on the top (dorsal) surface of the penis. (In females, the opening to the urinary tract is above the normal opening.)
Renal agenesis/hypoplasia	753.0	The absence or underdevelopment of the kidneys; may be bilateral or unilateral.
Obstructive genitourinary defect	753.2x, 753.6	Obstruction of ureter, renal pelvis, urethra or bladder neck.
Bladder exstrophy	753.5	An exstrophic bladder is one that is turned inside out like a rubber glove. Part of the abdominal wall and bladder wall are missing.
Congenital hip dislocation	754.30, 754.31, 354.35	A congenital defect in which the head of the femur does not articulate with the acetabulum of the pelvis because of an abnormal shallowness of the acetabulum.
Reduction deformity	755.2x, 755.3x	A shortening or absence of one or both limbs, it may be of upper or lower limbs.
Diaphragmatic hernia	756.6	A failure of the diaphragm to form completely, leaving a hole. Abdominal organs can protrude through the hole into the chest cavity and interfere with development of the heart and lungs.
Omphalocele	756.72	The intestine or other abdominal organs protrude from the base of the belly button. The intestines are covered by a thin layer of tissue.
Gastroschisis	756.73	A herniation of the abdominal contents through a defect in the abdominal wall.

Birth Defect	ICD-9-CM Codes	Description
Down syndrome	758.0	A syndrome arising from the presence of an extra number 21 chromosome resulting in mental retardation, distinctive malformations of the head and face, and other abnormalities.
Patau syndrome	758.1	A syndrome arising from the presence of an extra number 13 chromosome. Newborns have numerous internal and external abnormalities, including profound retardation.
Edward syndrome	758.2	A syndrome arising from the presence of an extra number 18 chromosome. It causes major physical abnormalities and severe mental retardation.