

**An Epidemiologic Analysis of the Perceived Excess
in Infant and Fetal Deaths in O'Fallon, Missouri:
2003 Update**

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Summary

This is the 2003, and final, update of an epidemiologic investigation in response to an inquiry regarding a suspected cluster of fetal and infant deaths in the O'Fallon area, which has shown no evidence of an elevated fetal or infant mortality in the O'Fallon community. In addition, the examination of the causes of fetal and infant deaths did not support the hypothesis that a single environmental factor had caused the fetal and infant deaths in the O'Fallon community. Recognizing that any fetal or infant death is unacceptable, even if they are not occurring at significantly high rates, it is recommended that the O'Fallon community focus on broader issues affecting maternal health, maternal obstetric care, newborn medical care, and infant health.

Background

This 2003 update of a three-year study concludes a feto-infant death epidemiological investigation recommended by the Office of Epidemiology, Missouri Department of Health and Senior Services (DHSS) that began in September of 2001, covering the years of 1990 to 2000. The original investigation was in response to an inquiry received by the DHSS in January 2001 from a resident of the city of O'Fallon, Missouri. The inquirer anecdotally observed an increase in infant and fetal deaths in the city of O'Fallon, Missouri in the year 2000.

In the original investigation, the following analytical techniques were used: 1) case-series study with cases of fetal and infant deaths from the O'Fallon area where the inquirer thought there was a cluster of cases; 2) review of all fetal and infant deaths, by cause of death, from 1990 to 2000 using the international classification of disease codes, ICD-9 and ICD-10; and 3) cluster study which calculated statistical differences between observed and expected events and

performed the Ohno and Grimson statistical test for spatial clustering of cases in the O’Fallon community.

One of the most important findings of the original investigation and the first follow-up completed in December 2002, but formally submitted in June 2003, was that no statistically significant evidence supported the hypothesis that infant and fetal deaths recorded in O’Fallon in year 2000 and 2001 had increased. In addition, the greatly diverse causes of deaths indicated that a variety of causes and risk factors, rather than a single environmental exposure, had contributed to the fetal and infant deaths (Simoes et al., 2001 and Pagoada et al., 2002).

This third-year analysis completes the 24-month active surveillance on these indicators in St. Charles County and the O’Fallon area, as recommended in the original investigation, which showed no statistically significant increase in feto-infant deaths. Further, feto-infant mortality rates in both St. Charles County and the O’Fallon area remain consistently lower than the state rates as a whole.

Objectives

The main objectives for updating this study through 2002 were to: a) increase the statistical power of the analysis, by adding one more year of fetal and infant deaths data, and b) comply with the recommendation by the original investigation that a 24-month active surveillance follow-up be conducted.

Methods

Data and Study Population

The investigation used data from the live births and fetal deaths files maintained by the Center for Health Information, Management and Evaluation (CHIME) at DHSS. The data analyzed included live births, neonatal deaths (infant deaths < 28 days of age), post-neonatal deaths (infant deaths 28 days through one year) and fetal deaths (deaths in uterus at 20 or more weeks of pregnancy) for the state of Missouri, St. Charles County and for the zip codes that compose the city of O'Fallon. Fetal and infant (neonatal and post-neonatal) deaths were analyzed by cause of death. Because the focus was on determining whether an abnormal rate of fetal and infant deaths existed and clustered in O'Fallon individual zip codes, as well as in the whole O'Fallon area, the same geographic composition used in the previous investigation for the city of O'Fallon (i.e., zip codes 63304, 63366, 63376 and all zip codes combined) was used.

Analysis

Consistent with the original study and the first update report, fetal and infant death rates were calculated for Missouri, St. Charles County and the city of O'Fallon. These indicators, i.e., fetal, neonatal, post-neonatal, and total infant deaths, for O'Fallon (individual zip codes and all zip codes combined) were then compared to those of the reference populations, i.e., Missouri and St. Charles County. Furthermore, mortality rates for Missouri and St. Charles County were used to estimate expected infant and fetal deaths events for the city of O'Fallon as a whole and for the individual zip codes. Ratios of observed by expected events for St. Charles County and O'Fallon were also computed. In addition to the ratio of observed to expected events, standardized z-

statistics were calculated to determine whether differences between observed and expected number of cases were statistically significant.

Results

Table 1 displays live births, fetal, and infant deaths and their respective rates per 1,000 live births for Missouri, St. Charles County, the individual zip codes that comprise the city of O'Fallon, and O'Fallon (all the zip codes combined). Tables 2-4 show the number of fetal, neonatal, and post-neonatal deaths, by cause of death and year of occurrence in O'Fallon from 1990 to 2002; and Table 5 demonstrates the observed and expected events for each indicator, the ratio of observed to expected events, and the standardized z-statistic values for St. Charles County and O'Fallon. Figures 1-8 graphically display annual rates for fetal and infant deaths in each of the geographical areas being analyzed.

At the state level, the fetal death ratio has remained just over six per 1,000 live births during the period of analysis. The infant death rate in Missouri declined by more than 30 percent during most of the last 13-year period, from 9.4 infant deaths per 1,000 live births in 1990 to 7.2 in 2000. However, the infant death rate (per 1,000 live births) increased slightly to 7.4 in 2001 and again to 8.5 in 2002. The major component of infant death rate, neonatal death rate, has remained at approximately 5 per 1,000 live births for most of the period, and inched up to 5.6 in 2002, a rate similar to that in 1990 which was 5.7 per 1,000 live births. The post-neonatal death rate (per 1,000 live births), on the other hand, declined steadily from 3.8 in 1990 to 2.4 in 2000, and then inched up to 2.5 in 2001 and to 2.9 in 2002 (Table 1 and Figures 1-3).

The fetal death rate in St. Charles County shows more variability, than the state rate, as expected due to the smaller size of the population. A year-to-year comparison shows that overall

the fetal death rate in St. Charles County is lower than that of Missouri except for year 2002, during which the rates are equal, at 5.6 per 1,000 live births. Although a general decline in the fetal death rate is observed in St. Charles County during the period of analysis, it is worth noting that by 2002 the rate was higher, at 5.6 per 1,000 live births, than the 5.1 per 1,000 live births reported in 1990. The rate of infant deaths in St. Charles County was lower than that of Missouri for every single year during the study period, in spite of the slightly higher observed neonatal death rates in years 1997 and 1999 (Table 1 and Figures 1-3).

The aggregate data for 2000-2002 shows that the fetal death rate for the city of O'Fallon is lower than that of St. Charles County and of the entire state of Missouri, as was found using the aggregate data for 2000-2001 in the previous report (Pagoada et al., 2002). In 2002, the infant death rate (per 1,000 live births) was slightly higher in O'Fallon (6.7) than in St. Charles County (6.5). When the causes of deaths were examined, there were 27 different causes of fetal deaths listed in the death certificate throughout the period of analysis, and nine different causes of infant deaths in 2002 (Table 2). Therefore, it appears that the increase in the fetal death rate was most probably due to random variation than to a particular risk factor. As seen in Table 2, 'unspecified conditions originating in the perinatal period' is the leading cause of fetal deaths in O'Fallon during the study period. The second leading cause of fetal deaths in O'Fallon is 'other compression of umbilical cord,' responsible for 20 fetal deaths in the 13-year period analyzed (Table 2). Finally, Table 2 shows that a total of 12 fetal deaths, four in each year from 2000 to 2002, are attributed to 'unspecified cause'. The increase in the infant death rate in O'Fallon was due to an increase in the neonatal death rate from 2.2 per 1,000 live births in 2001 to 4.9 in 2002. Because 54 different causes of neonatal deaths (Table 3) were found during the 1990-2002

period, 10 of these in 2002, it is very unlikely that the increase in the neonatal death rate was due to a specific risk factor or environmental exposure as the cause of death.

The post-neonatal death rate in O'Fallon also increased from 1.1 per thousand live births in years 2000 and 2001 to 1.9 in 2002. As in the case of fetal and neonatal deaths, many different causes of post-neonatal deaths were found in the 13-year period analyzed in this study. Table 4 displays the 26 causes of post-neonatal deaths found in the city of O'Fallon from 1990 to 2002, four of which accounted for the post-neonatal deaths occurred in 2002. As shown in Table 4, SIDS was the leading cause of post-neonatal deaths in O'Fallon during the study period.

Mortality indicators for each of the chosen zip codes that compose the city of O'Fallon are displayed in Table 1 and graphically compared to the reference populations of Missouri and St. Charles County in Figures 5 to 8. As expected, due to the small population sizes in each of the zip codes, all mortality indicators fluctuated widely during the study period.

The cumulative infant and fetal death rates observed in St. Charles County, O'Fallon, and the individual zip codes that compose the city of O'Fallon during the 1990-2002 period were generally lower than the expected rates. The two exceptions, i.e., post-neonatal death rate in O'Fallon Zip code 63376, and fetal deaths in O'Fallon Zip code 63304, were not statistically significant (Table 5).

Conclusions

The addition of one more year of data on fetal and infant death rates in the city of O'Fallon, Missouri did not show any statistically significant evidence that an increase in the number of events reported in this area had occurred. This finding is based on the comparison of infant and fetal deaths recorded in O'Fallon with those reported for St. Charles County and the

state of Missouri for the 13-year period analyzed in this study. The large number of causes of deaths accountable for the fetal and infant deaths occurring in O'Fallon (Tables 2-4) do not support the hypothesis that there is a prominent risk factor or environmental exposure causing fetal and infant deaths in O'Fallon. Instead, the fetal and infant deaths are likely due to various factors affecting maternal health, maternal care, newborn care, and infant health. These results are consistent with the findings of the original investigation and the update during 2002, in which a more complex analysis of these data utilizing clustering methodology was used, but also failed to demonstrate a true cluster of infant deaths, nor to pin-point an environmental exposure for the infant and fetal deaths.

Recommendations

Based on the combined findings from the original study, the update in 2002, and the present update, the Office of Epidemiology recommends that the 24-month active surveillance be closed. The O'Fallon community should instead focus its efforts on identifying broader issues affecting maternal health, maternal obstetric care, newborn medical care, and infant health (Besculides et al., 2001). Examples of such issues include, pre-conceptional health, risk factors for Sudden Infant Death Syndrome (such as infant sleep position, smoking, breastfeeding), prevention of injury, and newborn intensive care. When it comes to the loss of human lives, one is too many. Therefore, the Missouri Department of Health and Senior Services, through the Office of Epidemiology, is willing to provide the expertise and technical assistance to the O'Fallon community in identifying the main factors responsible for the observed fetal and infant fatalities and finding a solution to the problem.

Table 1. Fetal and Infant Deaths and Rates for Missouri, St. Charles and O'Fallon: 1990-2002

Fetal and Infant Deaths and Rate	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Missouri													
Live births	79135	78468	76005	75146	73279	72804	73733	73940	75242	75366	76329	75290	75167
Fetal deaths	525	520	497	493	423	434	440	446	450	448	430	410	455
Fetal death rate	6.6	6.6	6.5	6.6	5.8	6.0	6.0	6.0	6.0	5.9	5.6	5.4	6.1
Neonatal deaths	448	489	397	385	358	334	357	350	370	381	364	367	418
Neonatal death rate	5.7	6.2	5.2	5.1	4.9	4.6	4.8	4.7	4.9	5.1	4.8	4.9	5.6
Post-neonatal deaths	298	309	250	245	239	205	201	212	203	200	183	188	220
Post-neonatal death rate	3.8	3.9	3.3	3.3	3.3	2.8	2.7	2.9	2.7	2.7	2.4	2.5	2.9
Infant deaths	746	798	647	630	597	539	558	562	573	581	547	555	638
Infant death rate	9.4	10.2	8.5	8.4	8.1	7.4	7.6	7.6	7.6	7.7	7.2	7.4	8.5
St. Charles													
Live births	3886	3744	3735	3724	3681	3730	3971	3905	4095	4071	4244	4178	4279
Fetal deaths	20	14	17	12	19	14	17	16	15	11	13	21	24
Fetal death rate	5.1	3.7	4.6	3.2	5.2	3.8	4.3	4.1	3.7	2.7	3.1	5.0	5.6
Neonatal deaths	13	12	10	14	12	10	15	21	14	16	21	13	22
Neonatal death rate	3.3	3.2	2.7	3.8	3.3	2.7	3.8	5.4	3.4	3.9	4.9	3.1	5.1
Post-neonatal deaths	2	10	6	5	6	10	7	6	9	6	6	5	6
Post-neonatal death rate	0.5	2.7	1.6	1.3	1.6	2.7	1.8	1.5	2.2	1.5	1.4	1.2	1.4
Infant deaths	15	22	16	19	18	20	22	27	23	22	27	18	28
Infant death rate	3.9	5.9	4.3	5.1	4.9	5.4	5.5	6.9	5.6	5.4	6.4	4.3	6.5
O'Fallon (Zip code 63304)													
Live births	0	151	435	453	498	544	556	502	559	604	603	567	543
Fetal deaths	0	0	1	1	3	4	3	2	1	4	2	4	4
Fetal death rate	0	0	2.3	2.2	6.0	7.4	5.4	4.0	1.8	6.6	3.3	7.1	7.4
Neonatal deaths	0	0	0	2	0	1	3	5	2	3	0	0	5
Neonatal death rate	0	0	0	4.4	0	1.8	5.4	10.0	3.6	5.0	0	0	9.2
Post-neonatal deaths	0	0	0	1	0	2	2	0	1	0	1	1	1
Post-neonatal death rate	0	0	0	2.2	0	3.7	3.6	0	1.8	0	1.7	1.8	1.8
Infant deaths	0	0	0	3	04	3	5	5	3	3	1	1	6
Infant death rate	0	0	0	6.6	0	5.5	9.0	10.0	5.4	5.0	1.7	1.8	11.0

Table 1. Fetal and Infant Deaths and Rates for Missouri, St. Charles and O'Fallon: 1990-2002 (Cont.)

Fetal and Infant Deaths and Rate	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
O'Fallon (Zip code 63366)													
Live births	603	633	613	684	748	738	857	874	988	991	1172	1228	1246
Fetal deaths	2	2	3	2	2	3	4	7	2	1	5	4	4
Fetal death rate	3.3	3.2	4.9	2.9	2.7	4.1	4.7	8.0	2.0	1.0	4.3	3.3	3.2
Neonatal deaths	1	2	2	4	5	1	2	3	2	2	8	2	5
Neonatal death rate	1.7	3.2	3.3	5.8	6.7	1.4	2.3	3.4	2.0	2.0	6.8	1.6	4.0
Post-neonatal deaths	0	0	1	1	1	2	0	0	1	2	1	0	3
Post-neonatal death rate	0	0	1.6	1.5	1.3	2.7	0	0	1.0	2.0	0.9	0	2.4
Infant deaths	1	2	3	5	6	3	2	3	3	4	9	2	8
Infant death rate	1.7	3.2	4.9	7.3	8.0	4.1	2.3	3.4	3.0	4.0	7.7	1.6	6.4
O'Fallon (Zip code 63376)													
Live births	891	948	1029	942	941	915	898	951	892	950	885	895	879
Fetal deaths	4	3	3	2	6	4	5	2	3	1	2	5	6
Fetal death rate	4.5	3.2	2.9	2.1	6.4	4.4	5.6	2.1	3.4	1.1	2.3	5.6	6.8
Neonatal deaths	0	2	3	2	3	1	1	3	4	4	4	4	3
Neonatal death rate	0	2.1	2.9	2.1	3.2	1.1	1.1	3.2	4.5	4.2	4.5	4.5	3.4
Post-neonatal deaths	0	4	3	1	1	2	2	1	3	3	1	2	1
Post-neonatal death rate	0	4.2	2.9	1.1	1.1	2.2	2.2	1.1	3.4	3.2	1.1	2.2	1.1
Infant deaths	0	6	6	3	4	3	3	4	7	7	5	6	4
Infant death rate	0	6.3	5.8	3.2	4.3	3.3	3.3	4.2	7.8	7.4	5.6	6.7	4.6
O'Fallon (All Zip codes)													
Live births	1494	1732	2077	2079	2187	2197	2311	2327	2439	2545	2660	2690	2668
Fetal deaths	6	5	7	5	11	11	12	11	6	6	9	13	14
Fetal death rate	4.0	2.9	3.4	2.4	5.0	5.0	5.2	4.7	2.5	2.4	3.4	4.8	5.2
Neonatal deaths	1	4	5	8	8	3	6	11	8	9	12	6	13
Neonatal death rate	0.7	2.3	2.4	3.8	3.7	1.4	2.6	4.7	3.3	3.5	4.5	2.2	4.9
Post-neonatal deaths	0	4	4	3	2	6	4	1	5	5	3	3	5
Post-neonatal death rate	0	2.3	1.9	1.4	0.9	2.7	1.7	0.4	2.1	2.0	1.1	1.1	1.9
Infant deaths	1	8	9	11	10	9	10	12	13	14	15	9	18
Infant death rate	0.7	4.6	4.3	5.3	4.6	4.1	4.3	5.2	5.3	5.5	5.6	3.3	6.7

Table 3. Neonatal Deaths, by Cause of Death, in O'Fallon: 1990-2002

CAUSE OF DEATH	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1. Respiratory distress syndrome		2	1	1	1		1						
2. Primary pulmonary hypertension				1									
3. Other primary cardiomyopathies				1									
4. Anencephalus			1						1			1	
5. Other specified anomalies of brain								1					
6. Tetralogy of Fallot								1	1				
7. Hypoplastic left heart syndrome					1		1						
8. Coarctation of aorta									1				
9. Other perinatal jaundice				1									
10. Agenesis, hypoplasia, and dysplasia of lung	1		1			1		1	1		1		
11. Anomalies of diaphragm		1					1	1					
12. Ichthyosis congenita								1					
13. Down's syndrome				1									
14. Edward's syndrome		1											
15. Autosomal deletion syndrome				1									
16. Conditions due to anomalies of unspecified chromosome									1				
17. Anomalies of spleen					1								
18. Other specified anomalies					1								
19. Incompetent cervix							1						
20. Premature rupture of membrane					1			1					
21. Oligohydramnios					1								1
22. Other form of placenta separation and hemorrhage			1	1									
23. Extreme immaturity				1		1	1	1	1		2		2
24. Subdural and cerebral hemorrhage					1								
25. Unspecified birth asphyxia								1					
26. Meconium aspiration syndrome					1								
27. Interstitial emphysema & related conditions									1				
28. Other infection specific to the perinatal period													
29. Necrotizing enterocolitis			1					1					
30. Other specified conditions originating in the perinatal period							1						
31. Unspecified conditions originating in the perinatal period						1							

Table 5. Infant and Fetal Deaths Observed and Expected Events, Ratios and Z-Values for St. Charles County and O'Fallon: 1990-2002

Geographic Area	Indicator	Observed Events	Expected Events	Observed/expected	Z-Statistics
St. Charles County	Fetal deaths	213	311	0.68	-5.56
	Neonatal deaths	193	262	0.74	-4.26
	Post-Neonatal deaths	84	153	0.55	-5.56
	Infant deaths	277	415	0.67	-6.77
O'Fallon (Zip code 63304)	Fetal deaths	29	24	1.21	1.02
	Neonatal deaths	21	23	0.91	-0.42
	Post-Neonatal deaths	9	10	0.90	-0.32
	Infant deaths	30	33	0.91	-0.52
O'Fallon (Zip code 63366)	Fetal deaths	41	47	0.87	-0.88
	Neonatal deaths	39	44	0.89	-0.75
	Post-Neonatal deaths	12	18	0.67	-1.41
	Infant deaths	51	62	0.82	-1.40
O'Fallon (Zip code 63376)	Fetal deaths	46	50	0.92	-0.57
	Neonatal deaths	34	45	0.76	-1.64
	Post-Neonatal deaths	24	20	1.20	0.89
	Infant deaths	58	65	0.89	-0.87
O'Fallon (All Zip codes)	Fetal deaths	116	121	0.96	-0.45
	Neonatal deaths	94	112	0.84	-1.70
	Post-Neonatal deaths	45	48	0.94	-0.43
	Infant deaths	139	160	0.87	-1.66

Figure 1. Fetal Death Rates in Missouri, St. Charles and O'Fallon All Zipcodes

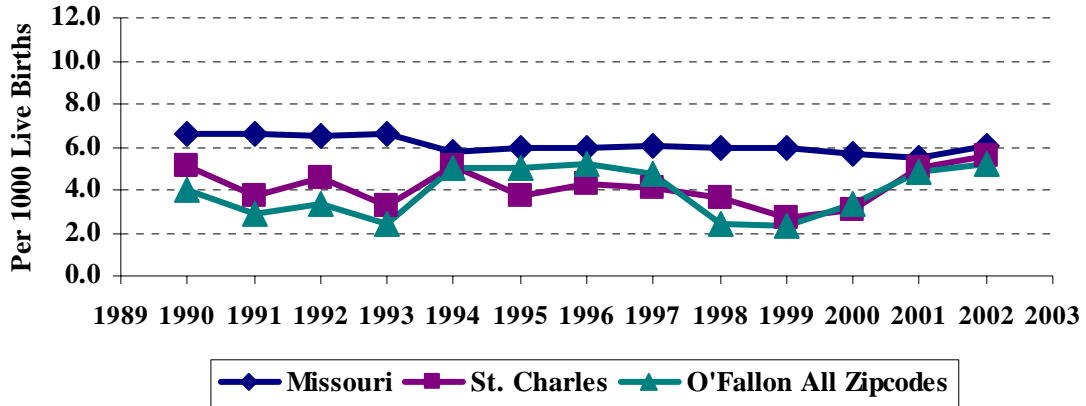


Figure 2. Neonatal Death Rates in Missouri, St. Charles and O'Fallon All Zipcodes

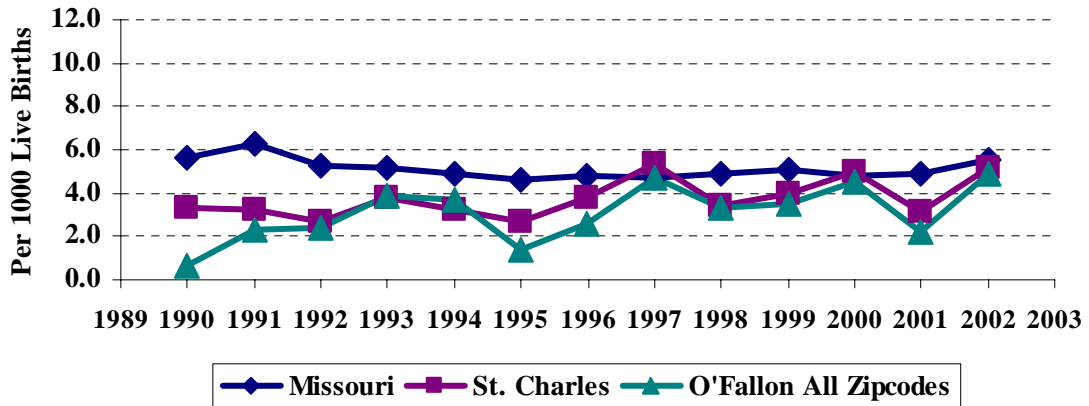


Figure 3. Postneonatal Death Rates in Missouri, St. Charles and O'Fallon All Zipcodes

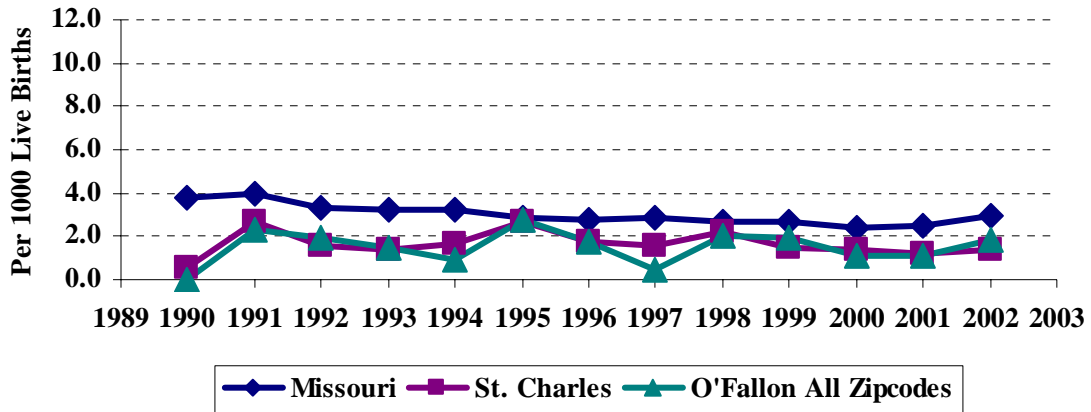


Figure 4. Infant Death Rates in Missouri, St. Charles and O'Fallon All Zipcodes

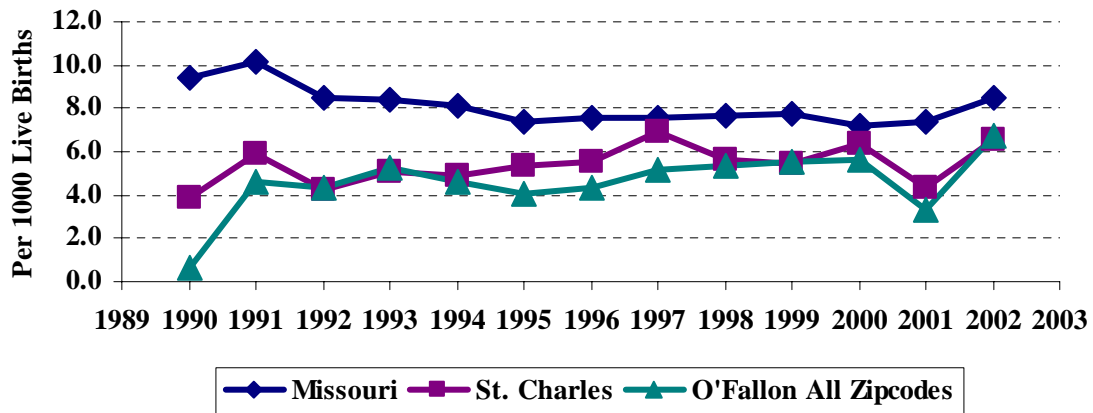


Figure 5. Fetal Death Rates in Missouri, St. Charles and O'Fallon Zipcode 63304

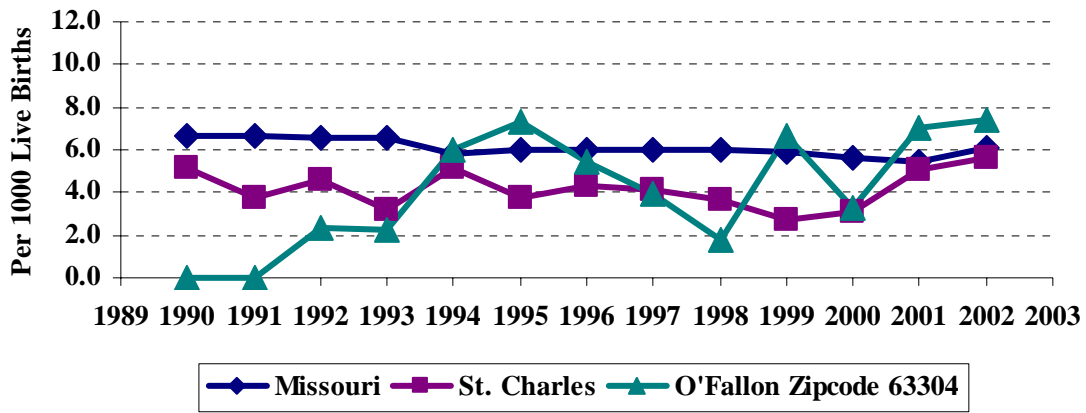


Figure 6. Fetal Death Rates in Missouri, St. Charles and O'Fallon Zipcode 63366

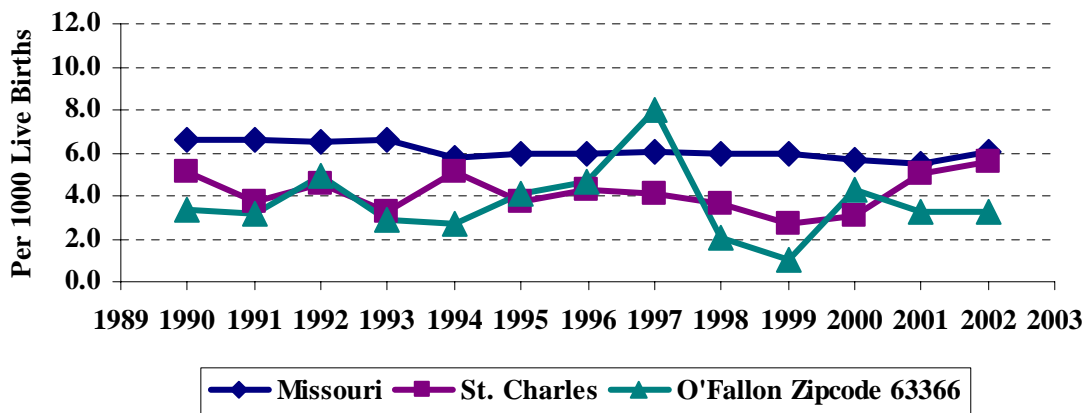


Figure 7. Fetal Death Rates in Missouri, St. Charles and O'Fallon Zipcode 63376

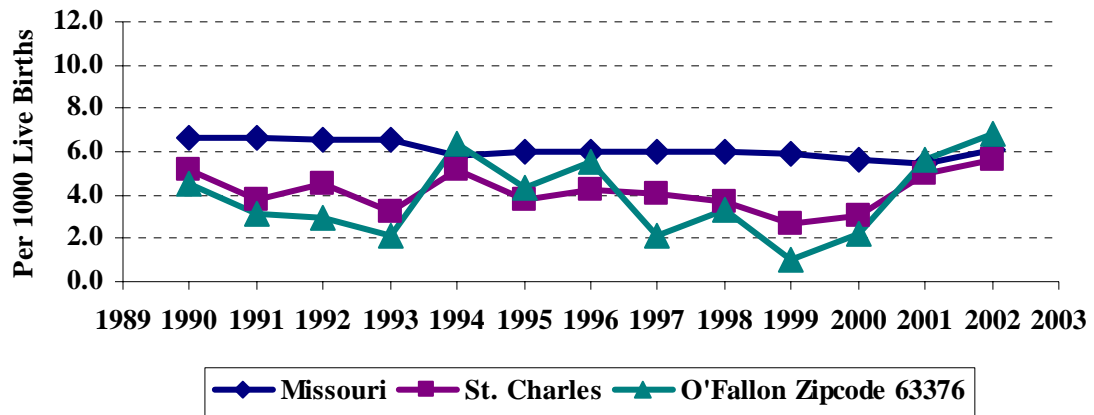
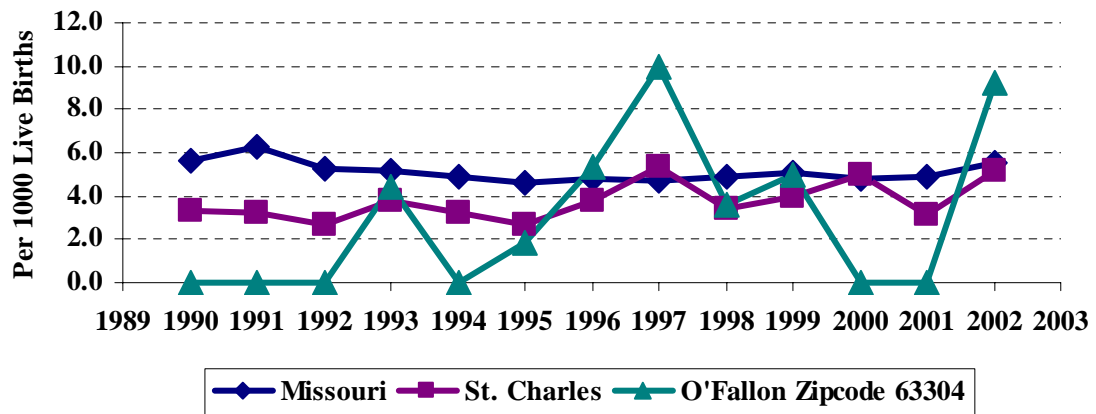


Figure 8. Neonatal Death Rates in Missouri, St. Charles and O'Fallon Zipcode 63304



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