

Infant Mortality Stratified by Maternal Age and Plurality in Florida: A comparative analysis of birth cohorts for 2000 and 2001

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Introduction

The infant death rate in Florida reached an all-time low in 2000 with a rate of 7.0 infant deaths per 1,000 live births. In the following years, the rate increased to 7.3 in 2001 and to 7.5 in 2002¹. In contrast, the national infant death rate was 6.9 in 2000, 6.8 in 2001 and, based on preliminary data released February 2004, increased to 7.0 for 2002². In light of Florida's increases in infant death rates, there have been attempts to account for the upward trend. It has been suggested that increases in the proportion of multiple births (twins, triplets, etc.) and increases in the proportion of older women giving birth may have contributed to the increases in infant death rates. The purpose of this analysis is to examine data related to multiple births and maternal age to assess the influence of these factors on infant death rates in Florida.

Methods

A retrospective cohort analysis was done using Florida resident births occurring in 2000 and 2001. The birth records were linked to infant death records for the infants who died within the first year of life.

Birth records include the age of the mother and the plurality of the birth. A plurality of one indicates a single birth and a plurality of two or more indicates a multiple birth. For example, plurality of two indicates the birth of a twin.

To analyze plurality and maternal age in relation to infant death, three categories were used for maternal age: 13 to 19, 20 to 35, and 36 to 50. Two categories were used for plurality: single births and multiple births. These categories were combined to create six mutually exclusive categories based on maternal age and plurality. These categories are given in the table below.

Category	Maternal Age	Plurality
1	13 to 19	Single
2	20 to 35	Single
3	36 to 50	Single
4	13 to 19	Multiple
5	20 to 35	Multiple
6	36 to 50	Multiple

Birth records with unknown maternal age or unknown plurality were excluded from the analysis. There were 408,276 total birth records and 197 (0.05%) were excluded due to missing data, leaving 408,089 (99.95%) available for analysis. The maternal age categories were based on an analysis of the relationship between maternal age and infant death rates (data not shown). Using one year maternal age increments, it was found that infant death rates were relatively high at age 13 and decreased as maternal age increased from 13 to 19. Infant death rates then remained consistent for ages 20 to 35, and increased from age 36 to 50. Based on this analysis, the maternal age categories of 13 to 19, 20 to 35 and 36 to 50 were selected.

Infant death rates were calculated for each of the six maternal age/plurality categories for 2000 and 2001. Differences between the rates for 2000 and 2001 within each category can be assumed to be independent of the influence of maternal age and plurality, since these factors remain constant within each age/plurality category. The results are compared to national statistics on plurality and maternal age².

Distribution-Adjusted Infant Deaths:

The proportions of the births in the six categories for the two years were compared to determine if there were increases in the proportions of births in the older maternal age and multiple birth categories. An estimate was made of the number of infant deaths in 2001 that are accounted for by the increases in births in the maternal age 36 to 50 and multiple birth categories. This was done by adjusting the number of 2001 births in each age/plurality category using the distribution of births in 2000. In effect this is the number of births that would have occurred in 2001, in each category, if the proportion of births in these categories had remained unchanged from 2000 to 2001. These births were then multiplied by the category-specific infant death rates for 2001 to obtain the distribution-adjusted number of infant deaths. In general terms, this method is known as a direct adjustment of the 2001 infant deaths using the births in 2000 as the standard population³. The differences between the distribution-adjusted infant deaths and the actual infant deaths in each category are the differences due to changes in the distribution of births across the age/plurality categories from 2000 to 2001.

Rate-Adjusted Infant Deaths:

An estimate was also made of the number of infant deaths in 2001 that are accounted for by the increases in the category-specific infant death rates from 2000 to 2001. This was done by multiplying the number of births for 2001 in each category by the category-specific infant death rates for 2000. This results in the rate-adjusted infant deaths for each category. In effect, the rate-adjusted infant deaths are the number of infant deaths that would have occurred in 2001 if the category-specific infant death rates had been the same in 2001 as they were in 2000. In general terms, this method is known as an indirect adjustment using the rates for 2000 to compute the adjusted infant deaths for 2001³. The rate-adjusted infant deaths are subtracted from the actual infant deaths to obtain the change in infant deaths due to changes in category-specific rates from 2000 to 2001.

Kitagawa: Distribution- and Rate-Adjusted Infant Deaths:

These two methods discussed above are similar to the Kitagawa⁴ method. The difference is the Kitagawa method combines elements of both the direct and indirect adjustment methods. For comparison purposes the Kitagawa formulas were also used and the results were compared to the results from the direct and indirect methods described above.

Results

Table 1 displays 2000 and 2001 infant death rates for each of the six maternal age and plurality categories. The total infant death rates are also given in Table 1 for 2000 and 2001. These rates differ slightly from the infant death rate published by the Florida Office of Vital Statistics because these rates are calculated from the births that occurred in the year and the infant deaths that occurred among those births, irrespective of the year in which the death occurred. The Vital Statistics infant death rates are calculated differently using the live births and infant deaths that occurred in the same year.

Table 1 and Table 2 provide the numbers and percentages for the births and infant deaths in Florida for 2000 and 2001. Table 1 shows that for five of the six categories, and overall, the infant death rate increased from 2000 to 2001. In one of the categories, the maternal age 13 to 19 multiple birth category, the difference in the 2000 and 2001 rates was statistically significant at the 0.05 alpha level.

Table 2 displays the percentage of births in each of the six maternal age and plurality categories for 2000 and 2001. The distribution of births among the six categories is very similar for the two analysis years. The percentage of multiple births increased from 2.96 percent in 2000 to 3.01 percent in 2001. Also, the percentage of births to mothers aged 36 to 50 increased from 10.87 percent in 2000 to 11.20 percent in 2001. The category that includes the largest number and percentage of births is the maternal age 20 to 35, singleton births category.

Nearly 75 percent of the births in Florida are represented in this category and the infant death rate increased from 2000 to 2001 in this category. The 2001 to 2000 rate ratio was 1.03 (Table 1) in the maternal age 20 to 35, singleton birth category. This increase is independent of the influence of multiple births and older maternal ages as those births are excluded from this category.

Nationally (Table 3), there was also a slight increase in the proportion of multiple births overall, and births to women aged 35 to 49. In Florida, the relative increase in births to mothers aged 36 to 50 was greater (3.04% in Table 2) than the national relative increase for births to women aged 35 to 49 (1.4% in Table 3). The national maternal age category of age 35 to 49 is slightly different from Florida's which is age 36 to 50. The relative increase in the proportion of multiple births was similar in Florida and nationally at 1.69% and 2.9% respectively.

Distribution-Adjusted Infant Deaths:

In Table 4, the distribution adjusted infant deaths are calculated and compared to the actual infant deaths for each of the six age/plurality categories. The number of actual infant deaths is higher than the distribution-adjusted infant deaths in three of the four categories for maternal ages 36 to 50 and plural births. The sum of the actual infant deaths in these four categories is 6.50 deaths higher than the sum of the adjusted-infant deaths in these four categories. However, this is more than offset by the net difference in the other two categories where the sum of the actual infant deaths is 8.17 lower than the sum of the distribution-adjusted infant deaths in these two categories. Overall, the actual infant death total for 2001 was 1,441 and the distribution-adjusted infant death total was 1,442.67 which means the actual infant deaths are 1.67 infant deaths less than the distribution-adjusted infant deaths. This can be interpreted to mean that if the distribution of births across the six categories had been the same in 2001 as it was in 2000, there would have been 1,442.67 infant deaths instead of the 1,441 infant deaths that actually occurred.

Rate-Adjusted Infant Deaths:

To assess the effects of changes in category-specific infant death rates independently of changes in the distribution of births in the six categories from 2000 to 2001, the rate-adjusted infant deaths were calculated. In Table 5, the rate-adjusted infant deaths are compared to the actual infant deaths for each of the six categories. The actual infant deaths are higher than the rate-adjusted infant deaths in five of the six categories. The total rate-adjusted infant deaths are 1,390.28 which is 50.72 lower than the actual number of infant deaths; 1,441. In summary, the changes in the infant death rates from 2000 to 2001, in the six categories, account for an increase of 50.72 infant deaths over what would have occurred if the infant death rates in each of the six categories had remained the same in 2001 as they were in 2000.

Kitagawa: Distribution- and Rate-Adjusted Infant Deaths:

The Kitagawa method is similar to these adjustment techniques. Using the Kitagawa⁴ method (calculations not shown), infant deaths attributable to distribution changes from 2000 to 2001 were -1.5 and infant deaths attributable to rate changes were 50.3 from 2000 to 2001. These are additive so $(50.3 - 1.5) = 48.8$. This is close to the results in Tables 4 and 5 of -1.67 and 50.72. One advantage of the Kitagawa method is it allows for the addition of the infant deaths to obtain the total of 48.8 infant deaths attributable to both distribution and rate changes. The results used in Tables 4 and 5 are not directly additive but in this instance the sum of the results in Tables 4 and 5 is: $(50.72 - 1.67) = 49.05$ which is similar to the 48.8 obtained using the Kitagawa formulas.

Single Births With Maternal Age 20 to 35:

The stratified adjustment analyses pertain to all six age/plurality categories but the results for the maternal age 20 to 35, singleton birth category, are especially relevant. Results

in this category are not influenced by increased maternal age or multiple births. The proportion of births in this category increased from 74.41% in 2000 to 74.58% in 2001 (Table 2). The infant death rate for this category also increased from 5.26 per 1,000 live births in 2000 to 5.43 per 1,000 live births in 2001 (Table 1). As shown in the distribution-adjusted analysis, the increase in the proportion of births in this category accounted for an increase of 1.89 infant deaths (Table 4). The rate adjusted analysis shows that the increase in the infant death rate in this category accounted for an increase of 27.07 infant deaths (Table 5).

Discussion

For many years, the infant death rates in Florida have steadily declined. Recent increases in this key public health statistic have created special concern and attention to infant mortality and the factors influencing infant deaths. Multiple births and increased maternal age have been suggested explanations for the increase in infant mortality. Evidence presented here shows that the proportion and number of births in the older maternal age and multiple birth categories did increase from 2000 to 2001. Although increases in the births to older women and multiple births contributed to the increase in the infant death rate, this analysis suggests the influence of these factors amounted to an increase of 6.50 infant deaths from 2000 to 2001. By contrast, the number of infant deaths attributable to increases in risk of infant death, independent of changes in the proportions of older mothers and multiple births, was 50.72 infant deaths.

Perhaps the most compelling evidence that increases in births to older women and multiple births did not fully account for the rise in infant mortality rates from 2000 to 2001 can be seen in the data for singleton births with maternal ages 20 to 35. The infant death rates increased by three percent in this category from 2000 to 2001. The proportion of births in this category increased from 74.41% in 2000 to 74.58% in 2001. As described in the results section, the increase in the infant death rate in this category accounted for 27.07 infant deaths while the increase in the distribution of births in this category accounted for 1.89 infant deaths.

This category excludes multiple births and births with older maternal ages so these factors do not influence the increases in this category.

Clearly there are factors other than plurality and increased maternal age that are influencing the increase in the overall infant death rate from 2000 to 2001. Future analyses will continue to test hypotheses and examine data in a vigilant effort to understand and address infant mortality in Florida.

References

(1) Florida Vital Statistics Annual Report 2002 at:

http://www.doh.state.fl.us/planning_eval/vital_statistics/statistical_report.htm

(2) National Center for Health Statistics at:

<http://www.cdc.gov/nchs/products/pubs/pubd/hestats/infantmort/infantmort.htm>

(3) Mausner & Bahn Epidemiology – An Introductory Text by Judith S. Mausner and Shira Kramer. Pages 56-58. Published by W. B. Saunders Company, 1985.

(4) Kitagawa, Evelyn M. Components of Difference Between Two Rates. American Statistical Association Journal. December 1955.

Table 1

**Infant Death Rates by Maternal Age and Plurality
Based on Linked Files for 2000 and 2001
(Infant Death Rates for 2000 and 2001 Birth Cohorts)**

Maternal Age	Plurality	2000 Births	2001 Births	2000 Infant Deaths	2001 Infant Deaths	2000 Infant Death Rate per 1000 Births	2001 Infant Death Rate per 1000 Births	2001 : 2000 Rate Ratio
13-19	single	24951	24034	252	231	10.10	9.61	0.95
20-35	single	151440	152569	796	829	5.26	5.43	1.03
36-50	single	21098	21793	137	148	6.49	6.79	1.05
13-19	multiple	419	413	20	35	47.73	84.75	1.78
20-35	multiple	4576	4631	156	167	34.09	36.06	1.06
36-50	multiple	1024	1131	24	31	23.44	27.41	1.17
Total		203508	204571	1385	1441	6.81	7.04	1.04

Table 2

**Distribution of Births by Maternal Age and Plurality
Based on Linked Files for 2000 and 2001
(Infant Death Rates for 2000 and 2001 Birth Cohorts)**

Maternal Age	Plurality	2000 Percent of Births	2001 Percent of Births	2001 Percent Minus 2000 Percent	2000 to 2001 Percent Change *
13-19	single	12.26%	11.75%	-0.51%	-4.16%
20-35	single	74.41%	74.58%	0.17%	0.23%
36-50	single	10.37%	10.65%	0.28%	2.70%
13-19	multiple	0.21%	0.20%	-0.01%	-4.76%
20-35	multiple	2.25%	2.26%	0.01%	0.44%
36-50	multiple	0.50%	0.55%	0.05%	10.00%
Total		100.00%	99.99%	-0.01%	-0.01%
Multiple	Percent	2.96%	3.01%	0.05%	1.69%
Age 36-50	Percent	10.87%	11.20%	0.33%	3.04%

* The calculation is: [(2001 percent - 2000 percent) / (2000 percent)] X 100

Table 3**U. S. Births by Maternal Age and Plurality for 2000 and 2001**

Maternal Age	U.S. Births 2000	U.S. Births 2001	Percent Births 2000	Percent Births 2001	2000 to 2001 Percent Change*
< 20	477509	453725	11.76%	11.27%	-4.2%
20 - 34	3034631	3022589	74.77%	75.08%	0.4%
35 - 49	546419	549380	13.46%	13.65%	1.4%
Unknown	255	239	0.01%	0.01%	0.0%
Total	4058814	4025933	100.00%	100.00%	0.0%
Plurality					
Single	3932573	3897216	96.89%	96.80%	-0.1%
Multiple	126241	128717	3.11%	3.20%	2.9%
Total	4058814	4025933	100.00%		

* The calculation is: [(2001 percent - 2000 percent) / (2000 percent)] X 100

Table 4

**Actual Infant Deaths for 2001 Compared to
Distribution-Adjusted Infant Deaths for 2001 ***

Maternal Age	Plurality	Adjusted 2001 Births	Distribution- Adjusted 2001 Infant Deaths *	Actual 2001 Infant Deaths	Actual Minus Adjusted 2001 Infant Deaths
13-19	single	25080	241.06	231.00	-10.06
20-35	single	152221	827.11	829.00	1.89
36-50	single	21214	144.07	148.00	3.93
13-19	multiple	430	36.41	35.00	-1.41
20-35	multiple	4603	165.98	167.00	1.02
36-50	multiple	1023	28.04	31.00	2.96
Total		204571	1442.67	1441.00	-1.67

* Births in 2001 are re-distributed into the 6 categories using the distribution for 2000. These births are multiplied by the category-specific infant death rates for 2001 to calculate the distribution-adjusted infant deaths for 2001.

Table 5

**Actual Infant Deaths for 2001 Compared to
Rate-Adjusted Infant Deaths for 2001 ***

Maternal Age	Plurality	2001 Births	Rate- Adjusted 2001 Infant Deaths *	Actual 2001 Infant Deaths	Actual Minus Adjusted 2001 Infant Deaths
13-19	single	24034	242.74	231.00	-11.74
20-35	single	152569	801.93	829.00	27.07
36-50	single	21793	141.51	148.00	6.49
13-19	multiple	413	19.71	35.00	15.29
20-35	multiple	4631	157.88	167.00	9.12
36-50	multiple	1131	26.51	31.00	4.49
Total		204571	1390.28	1441.00	50.72

* 2001 births X infant death rates for 2000 in each category