Hospital Level and Delivery Volume And Neonatal Mortality Among Very Low Birth Weight Infants

Indiana, 2000-2005 Birth Cohort

(Published November 2008)

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Executive Summary

This report presents information on the delivery and neonatal deaths (under 28 days of age) of very low birth weight (VLBW, <1,500 grams) infants in Indiana between 2000 and 2005 according to hospitals' average annual delivery volume, VLBW delivery volume, and neonatal level of care. This study determined whether Indiana met the *Healthy People 2010 Objective* of increasing the proportion of VLBW infants born at level III hospitals (or subspecialty Perinatal centers) to 90 percent and examined the significant predictors of delivery outside level III hospitals. This study also assessed the impact of delivery outside level III hospitals on neonatal mortality rate of VLBW using the 2000-2005 linked birth/infant death data files.

Compared to all infants, VLBW infants were more likely to be delivered in hospitals with larger delivery volumes (more than 1000 per year) and higher level of neonatal care (level III). The proportion of VLBW infants born at level III hospitals increased from 82.9 percent in 2000 to 86.0 percent in 2002 and declined gradually to 84.5 percent in 2005, putting Indiana below the Healthy People 2010 Objective of 90 percent. The VLBW infants born at below level III hospitals were more likely to be less than 500 grams and less than 24 weeks of gestation and were less likely to be a multiple birth or cesarean delivery than those born at level III hospitals.

Controlling for the potential contributing factors, the strongest predictor of delivery outside level III hospitals was the mother's county of residency. Residents of non-metropolitan counties were 10.8 times more likely to deliver outside level III hospitals compared to residents of the large central metropolitan county (Marion). Other significant predictors were less than adequate prenatal care, prenatal smoking, no college education, and being a teenager.

The neonatal mortality rate of VLBW infants was highest for those born in hospitals with less 1,000 average annual deliveries and in hospitals with less than 10 average VLBW deliveries; the rates for VLBW infants born in larger hospitals were lower but did not follow a specific pattern. The neonatal mortality rate of VLBW infants delivered at below level III hospitals (307.0 deaths per 1,000 births) was significantly higher (by 43 percent) than the rate for those delivered at level III hospitals (215.3 deaths per 1,000 births); this pattern was consistent among non-Hispanic whites, non-Hispanic blacks, and Hispanics (higher rates by 45-47 percents) but it reached statistical significance only among non-Hispanic whites. Controlling for delivery variables and maternal demographic risk factors, delivery of VLBW infants at below level III hospitals was associated with significantly higher risk of death (Odds Ratio [OR] =1.5, 95% confidence interval [CI], 1.24 to 1.73); this association remained statistically significant when infant risk factors were also controlled (OR=1.2, 95% CI=1.01-1.50).

Results of this study suggest that increased use of hospitals with level III neonatal care might reduce neonatal mortality among VLBW infants. Indiana needs to boost its efforts in increasing the delivery of VLBW infants in subspecialty hospitals to reach *Healthy People 2010 Objective*, especially among residents of rural counties. The higher proportion of VLBW infants weighing less than 500 grams who are at the highest risk of death, among those delivered at below level III hospitals, warrants further investigations.

Preface

This report (*Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana, 2000-2005 Birth Cohort)* presents information on the delivery of very low birth weight (VLBW, <1,500 grams) infants in Indiana between 2000 and 2005 according to hospitals' average annual delivery volume, VLBW delivery volume, and neonatal level of care. This study determined whether Indiana met the *Healthy People 2010 Objective** (increase the proportion of VLBW infants born at level III hospitals or subspecialty perinatal centers to 90 percent), compared the characteristics of mothers who delivered at level III neonatal care hospitals to those who did not deliver at the recommended level, examined the significant predictors of delivery outside level III hospitals, and assessed the impact of delivery outside level III hospitals on neonatal mortality rate of VLBW.

The data for this study were obtained from the linked birth and death records of 6,725 VLBW infants who were born in Indiana hospitals between 2000 and 2005 and whose mothers were Indiana residents. Information on classification of Indiana hospitals according to levels of neonatal car, definitions of the levels of neonatal care, methods used for statistical analysis, prenatal care utilization index, and urbanization level of county of residence are presented in the Technical Notes. The numbers of all live births and VLBW births from 2000 to 2005 and level of neonatal care for all Indiana hospitals are presented in the Appendix A. Urbanization level of Indiana counties are presented in the Appendix B.

***Healthy People 2010 Objective**

Obstetrical Care (16-8)
Increase the proportion of very low birth weight (VLBW) infants born at level III hospitals or subspecialty perinatal centers.
Target: 90 percent

http://www.healthypeople.gov/document/HTML/Volume2/16MICH.htm

Highlights

Very Low Birth Weight (VLBW) Infants and Delivery Hospitals

Hospital Volume:

- During the period of 2000-2005, more than half a million infants were born in Indiana; more than 98 percent of them were born in Indiana hospitals. Of 497,767 Hoosier infants born in Indiana hospitals, 6,725 were very low birth weight (VLBW) infants (under 1,500 grams).

- Compared to all infants, VLBW infants were more likely to be delivered in hospitals with larger delivery volumes. Close to 60 percent of VLBW infants were born in hospitals with 2000 or higher annual deliveries compared to 40 percent of all births. (Table 1, Figure 1)

- Of all VLBW infants, 40.3 percent were born in hospitals that on average delivered more than 100 VLBW infants per year and 12.6 percent were born in hospitals with less than 10 annual VLBW deliveries. (Table 1, Figure 2)

Hospital Level of Neonatal Care:

- Based on hospitals' self-reported level of neonatal care:
    - 50 percent of all births and 85 percent of VLBW births were in level III hospitals. (Table 1, Figure 3)

    - Of all 6,725 VLBW deliveries in 104 Indiana hospitals during 2000-2005:
        - 5 percent (N=333) were delivered in level I hospitals; all of the 49 level I hospitals had less than 10 average annual VLBW deliveries.

        - 10.1 percent (N=680) were delivered in level II hospitals; of 34 level II hospitals, all but 3 had less than 10 average annual VLBW deliveries.

        - 3.9 percent (N=260) were delivered in level IIIA hospitals; only 2 hospitals were at this level and both had 10-24 annual VLBW deliveries.

        - 36.6 percent (N=2,459) were delivered in level IIIB hospitals; of 14 level IIIB hospitals, 4 hospitals had less than 25 annual VLBW deliveries.

        - 21.5 percent (N=1,447) were delivered in level IIIC hospitals; two of the three level IIIC hospitals had more than 100 VLBW deliveries per year.

        - 23.0 percent (N=1,546) were delivered in the 2 level IIID hospitals with more than 100 VLBW deliveries per year.

      (Table A, Table 1, Figure 4)

- The proportion of VLBW infants born at level III hospitals increased from 82.9 percent in 2000 to 86.0 percent in 2002 and declined gradually to 84.5 percent in 2005, putting Indiana below the Healthy People 2010 Objective of 90 percent. (Table 1, Figures 5-6)

- The VLBW infants born at below level III hospitals were more likely to have birth weight of less than 500 grams and be less than 24 weeks of gestation compared to those born at level III hospitals. (Table 2, Figures 7)

- Compared to mothers who delivered in level III hospitals, those whose VLBW infants were delivered at level I or II hospitals were more likely to be non-Hispanic white, resident of non-metropolitan counties, under 20 years of age, less educated, unmarried, late in beginning prenatal care, and smoker. (Table 2, Figures 8)

- The proportion of VLBW infants born at level III hospitals varied noticeably across different population subgroups.

    - 92 percent of non-Hispanic black mothers delivered in level III hospitals compared to 80-83 percents for non-Hispanic whites and Hispanics. (Figure 9)
    - 97 percent of mothers residing in the large central metropolitan county (Marion County) delivered in level III hospitals compared to 87 percent of those in small metropolitan counties and only 71 percent of those in non-metropolitan counties. (Figure 10)
    - Almost 90 percent of mothers who had more than high school education delivered in level III hospitals compared to 80 percent for those who had less than 12 years of education. (Figure 11)
    - 87 percent of mothers who received more than adequate prenatal care delivered in level III hospitals compared to 77 and 73 percents for those who received less than adequate or no care, respectively. (Figure 12)

- Controlling for the potential contributing factors (maternal race and Hispanic origin, age, education, marital status, prenatal care, smoking, and county of residency, the strongest predictor of delivery outside the level III hospitals was the mother's county of residency.

    - Compared to mothers who resided in the large central county (Marion County), those residing at non-metropolitan counties were 10.8 times more likely to deliver outside level III hospitals (95% confidence interval [CI], 7.8-15). Other significant predictors were less than adequate prenatal care, smoking, no college education, and under 20 years of age. (Table 3)

Neonatal Mortality of VLBW Infants According to Hospital Delivery Volume and Level of Neonatal Care

- The neonatal mortality rate of VLBW infants declined as the hospital total delivery volume increased from less than 1,000 per year (267.7 deaths per 1,000 births) to 2,000-2,999 per year (192.2), but the rate increased to 237.5 deaths per 1,000 births for VLBW infants delivered at hospitals with 3,000 or more annual deliveries. (Table 4, Figures 13)

- The neonatal mortality rate was highest for VLBW infants born in hospitals with less than 10 average annual VLBW deliveries (302.7 deaths per 1,000 births). However, the rates for infants born in hospitals with higher VLBW delivery volumes (10-<25, 25-<50, 50-<100, and 100+) fluctuated and did not follow a specific pattern. (Table 4, Figures 14)

- The neonatal mortality rate of VLBW infants delivered at level I hospitals (321.3 deaths per 1,000 births) and level II hospitals (300.0 deaths per 1,000 live births) were higher than the neonatal mortality rate of those delivered at level III hospitals (215.3 deaths per 1,000 births) by 49 and 39 percents, respectively. (Table 4, Figures 15)

- Among VLBW infants born at level III hospitals, the neonatal mortality rate was highest for those born at level IIID hospitals (243.9 deaths per 1,000 births) and lowest for those born at level IIIA hospitals (142.3). (Table 4, Figures 16)

- Classification of hospitals according to a combination of level of care and VLBW delivery volume showed a consistently higher neonatal mortality rate among VLBW infants born in hospitals with lower care level (I and II) and lower annual VLBW deliveries volume (<25 VLBW deliveries per year). The rates at level III hospitals with varying volumes of VLBW deliveries, however, fluctuated and did not follow a specific pattern. (Table 4, Figure 17)

- The neonatal mortality rates of VLBW infants delivered outside level III hospitals were consistently higher compared to those delivered at level III hospitals for non-Hispanic whites (by 45 percent), non-Hispanic blacks (by 48 percent), and Hispanics (by 47 percent) but the difference was statistically significance only for non-Hispanic whites. (Table 5, Figure 18)

- Compared with level III neonatal care, delivery of VLBW infants at lower levels was associated with significantly higher odds ratio for death (OR=1.6, 95% CI, 1.38 to 1.86). Controlling for maternal (race/Hispanic origin, age, education, marital status, parity, smoking, prenatal care, county of residency), delivery (multiple, cesarean), and infant (gender, congenital anomalies, and birth weight under 500 grams) variables, this association remained statistically significant (OR=1.2, 95% CI=1.01-1.50). (Figure 19)

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Table 1. Distribution of very low birth weight (VLBW) deliveries according to annual delivery volume, annual VLBW delivery volume, and level of neonatal care at the delivery hospital in Indiana, 2000-2005 live births

Hospital characteristic	2000	2001	2002	2003	2004	2005	2000-2005
VLBW deliveries	1,079	1,096	1,079	1,107	1,160	1,204	6,725
				Percent			
Total delivery volume, average per year							
<1,000	14.2	13.2	10.1	12.5	12.4	12.0	12.4
1,000-1,999	27.2	27.7	30.2	27.5	31.1	33.2	29.6
2,000-2,999	34.9	37.0	31.4	36.3	30.2	35.8	34.3
3,000+	23.7	22.1	28.3	23.8	26.3	19.0	23.8
VLBW delivery volume, average per year							
<10	12.9	12.9	11.2	12.7	12.8	13.1	12.6
10-24	10.1	8.9	9.1	11.9	12.2	13.4	11.0
25-49	17.6	19.6	17.2	17.2	14.7	21.7	18.0
50-99	21.1	19.9	15.9	18.2	17.8	16.2	18.1
100+	38.3	38.8	46.6	40.0	42.6	35.6	40.3
Neonatal level of care							
Level I	5.7	4.9	4.6	5.5	4.7	4.4	5.0
Level II	11.5	9.9	9.4	8.6	10.2	11.1	10.1
Level III	82.9	85.2	86.0	85.9	85.2	84.5	85.0
Level IIIA	3.2	4.2	3.2	4.6	3.8	4.2	3.9
Level IIIB	37.2	37.3	32.3	36.9	34.6	40.8	36.6
Level IIIC	22.4	22.8	24.7	22.4	19.9	17.4	21.5
Level IIID	20.0	20.9	25.9	22.0	26.9	22.1	23.0
Neonatal level of care and VLBW delivery volume							
Level I, <10 VLBW deliveries	5.7	4.9	4.6	5.5	4.7	4.4	5.0
Level II, <10 VLBW deliveries	6.9	7.1	5.9	6.1	6.9	8.1	6.9
Level II, 10-24 VLBW deliveries	4.6	2.7	3.4	2.5	3.3	3.0	3.3
Level III A or B, <25 VLBW deliveries	5.8	6.9	6.3	10.6	10.2	11.0	8.5
Level III B, 25-49 VLBW deliveries	17.6	19.6	17.2	17.2	14.7	21.7	18.0
Level III B or C, 50-99 VLBW deliveries	21.1	19.9	15.9	18.2	17.8	16.2	18.1
Level III C or D, 100+ VLBW deliveries	38.3	38.8	46.6	40.0	42.6	35.6	40.3

Note: Very low birth weight (VLBW) is under 1,500 g.

Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services

Table 2. Characteristics of very low birth weight infants according to level of neonatal care of the delivery hospital in Indiana, 2000-2005 live births

Characteristics	Level of care						
			Level III				
	Level I	Level II	All	IIIA	IIIB	IIIC	IIID
Maternal characteristics			Percent				
Race and Hispanic origin							
Non-Hispanic white	74.5	81.0	66.7	87.3	56.3	67.0	79.5
Non-Hispanic black	14.0	10.9	25.9	7.7	34.7	24.9	15.7
Hispanic	10.3	7.5	6.0	2.3	7.7	6.9	3.2
Resident of non-metropolitan county	48.6	42.1	19.5	1.2	14.7	22.4	27.7
Under 20 years of age	23.4	18.4	14.9	11.2	16.5	15.5	12.2
Less than adequate education	28.9	23.5	17.8	8.1	20.2	20.7	13.1
Unmarried	63.4	50.4	48.5	32.3	55.4	48.9	40.0
Fourth or higher birth order	14.1	10.2	12.9	8.5	14.7	12.9	10.8
First trimester prenatal care	61.0	71.3	76.0	93.1	74.1	73.0	78.9
Inadequate or no care*	21.0	16.9	10.0	4.6	13.6	11.4	3.8
Smoker	38.7	30.5	21.6	23.5	23.1	23.6	17.1
Delivery/Infant characteristic							
Multiple delivery	12.9	20.7	27.9	36.2	24.8	27.1	32.2
Cesarean delivery	44.9	45.5	61.0	71.9	57.5	64.0	62.0
Birth weight <500 grams	19.5	19.0	11.3	5.4	11.4	11.4	12.3
Gestatioanal age <24 weeks	24.9	22.9	14.8	8.1	15.8	13.8	15.2
5-min Apgar score of <7	55.3	47.7	35.7	28.5	34.2	35.3	39.7
Congenital anomaly	6.3	5.9	6.1	1.2	4.2	3.1	12.8

Note: Very low birth weight (VLBW) is under 1,500 g.

*According to Kotelchuck Index (7-8).

Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services

Table 3. Odds ratios for delivery of very low birth weight infants at below level III neonatal care hospitals according to maternal characteristics: Indiana, 2000-2005 live births

Maternal characteristics	Unadjusted		Adjusted	
	OR	(95% CI)	OR	(95% CI)
Race and Hispanic origin				
Non-Hispnaic black	0.62	(0.56-0.69)	0.74	(0.66-0.83)
Non-Hispanic white	--		--	
Non-Hispanic other race	0.47	(0.23-0.98)	0.82	(0.38-1.75)
Hispanic	1.18	(0.92-1.51)	1.30	(0.98-1.72)
Age, years				
<20	1.57	(1.28-1.94)	1.32	(1.03-1.69)
20-24	1.34	(1.11-1.61)	1.16	(0.95-1.41)
25-29	--		--	
30-34	1.01	(0.81-1.25)	1.13	(0.90-1.41)
35+	0.82	(0.63-1.06)	0.84	(0.64-1.10)
Education, years				
<12	1.99	(1.67-2.36)	1.46	(1.17-1.82)
12	1.69	(1.43-1.99)	1.35	(1.12-1.62)
>12	--		--	
Marital status				
Single	1.30	(1.13-1.48)	1.17	(0.98-1.40)
Married	--		--	
Prenatal care				
Less than adequate	1.88	(1.60-2.21)	1.85	(1.54-2.21)
Adequate or more	--		--	
Smoking status during pregnancy				
Smoker	1.81	(1.56-2.09)	1.37	(1.15-1.62)
Non-smoker	--		--	
County of residency				
Large central metro	--		--	
Large fringe metro	5.41	(3.90-7.50)	5.84	(4.19-8.15)
Small metro	4.62	(3.36-6.35)	4.40	(3.18-6.10)
Non-metro	12.20	(8.91-16.68)	10.84	(7.82-15.02)

Note: Very low birth weight (VLBW) is under 1,500 g.

--Reference category

Table 4. Births, neonatal deaths, and neonatal mortality rates of very low birth weight infants according to hospital characteristics: Indiana, 2000-2005 birth cohort

Hospital characteristic	VLBW infants		Neonatal mortality rate
	Births	Neonatal deaths	
All	6,725	1,541	229.1
Total delivery volume, average per year			
<1,000	833	223	267.7
1,000-1,999	1,987	495	249.1
2,000-2,999	2,305	443	192.2
3,000+	1,600	380	237.5
VLBW delivery volume, average per year			
<25	1,587	401	252.7
<10	849	257	302.7
10-24	738	144	195.1
25-49	1,211	288	237.8
50-99	1,220	220	180.3
100+	2,707	632	233.5
Neonatal level of care			
Below level III	**1,013**	**311**	**307.0**
Level I	333	107	321.3
Level II	680	204	300.0
Level III	**5712**	**1230**	**215.3**
Level IIIA	260	37	142.3
Level IIIB	2459	526	213.9
Level IIIC	1447	290	200.4
Level IIID	1546	377	243.9
Neonatal level of care and VLBW delivery volume			
Level I, <10 VLBW deliveries	333	107	321.3
Level II, <10 VLBW deliveries	461	138	299.3
Level II, 10-24 VLBW deliveries	219	66	301.4
Level III A or B, <25 VLBW deliveries	574	90	156.8
Level III B, 25-49 VLBW deliveries	1211	288	237.8
Level III B or C, 50-99 VLBW deliveries	1220	220	180.3
Level III C or D, 100+ VLBW deliveries	2707	632	233.5

Note: Very low birth weight (VLBW) is under 1,500 g.

Neonatal is less than 28 days of age.

Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services

Table 5. Births, neonatal deaths, and neonatal mortality rates of VLBW infants by race and Hispanic origin of mother according to hospital neonatal level of care: Indiana, 2000-2005 birth cohort

Race and Hispanic origin of mother	VLBW infants		Neonatal mortality rate
	Births	Neonatal deaths	
All	6,725	1,541	229.1
Below level III	1,013	311	307.0 *
Level III	5,712	1,230	215.3
Non-Hispanic white	4,599	1,008	219.2
Below level III	793	234	295.1 *
Level III	3,806	774	203.4
Non-Hispanic black	1,595	392	245.8
Below level III	120	42	350.0
Level III	1,475	350	237.3
Hispanic	429	120	279.7
Below level III	85	32	376.5
Level III	344	88	255.8

Note: Very low birth weight (VLBW) is under 1,500 g.

Neonatal is less than 28 days of age.

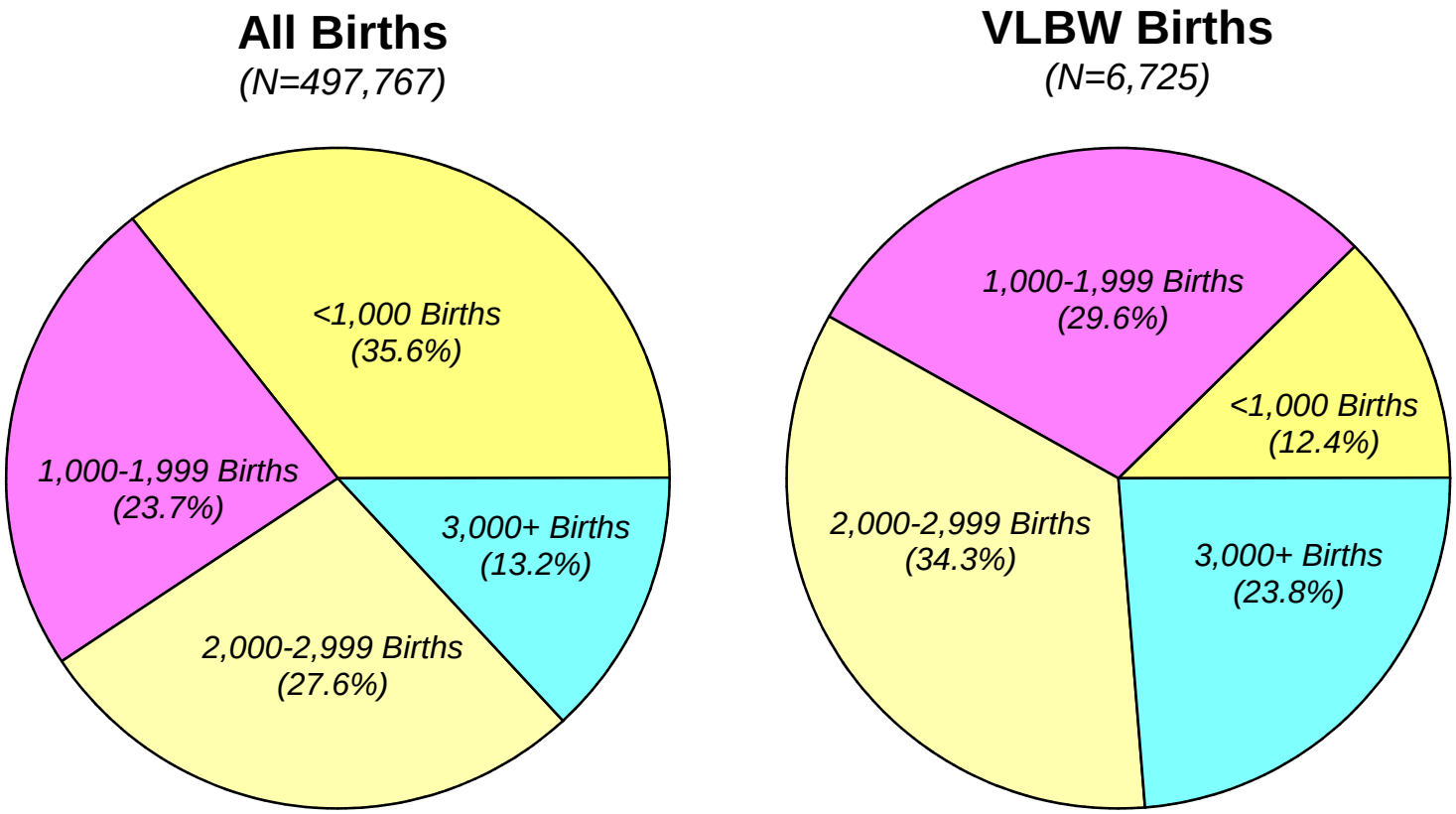
*Significantly higher than level III ($p<0.05$).

Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services

Figure 1

Percent Distribution of All Births and VLBW Births By Hospital Average Annual Delivery Volume

Indiana, 2000-2005 Live Births



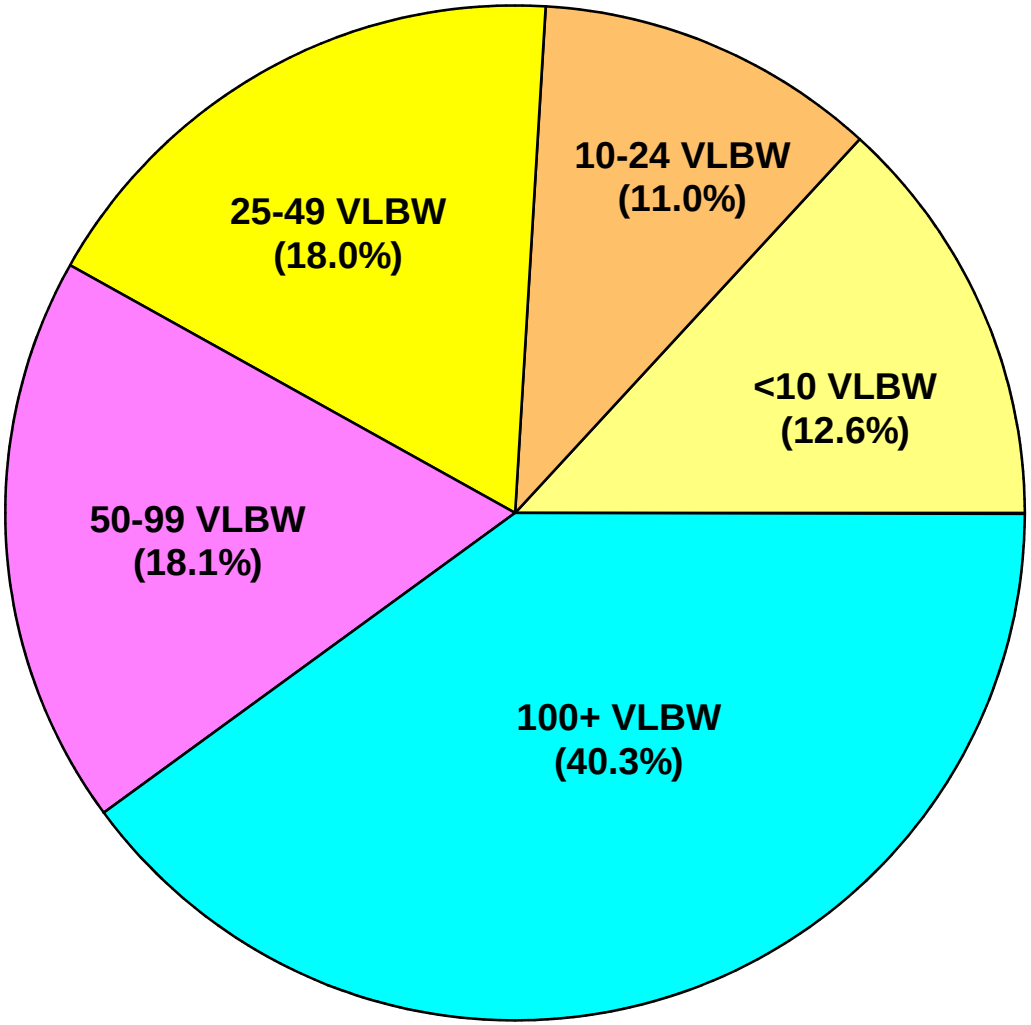
Note: VLBW=Very low birth weight (<1,500 g)
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services
Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort, Table 1

Figure 2

Percent Distribution of VLBW Deliveries By Hospital Average Annual VLBW Delivery Volume

Indiana, 2000-2005 Live Births

(N=6,725)



Note: VLBW=Very low birth weight (<1,500 g)

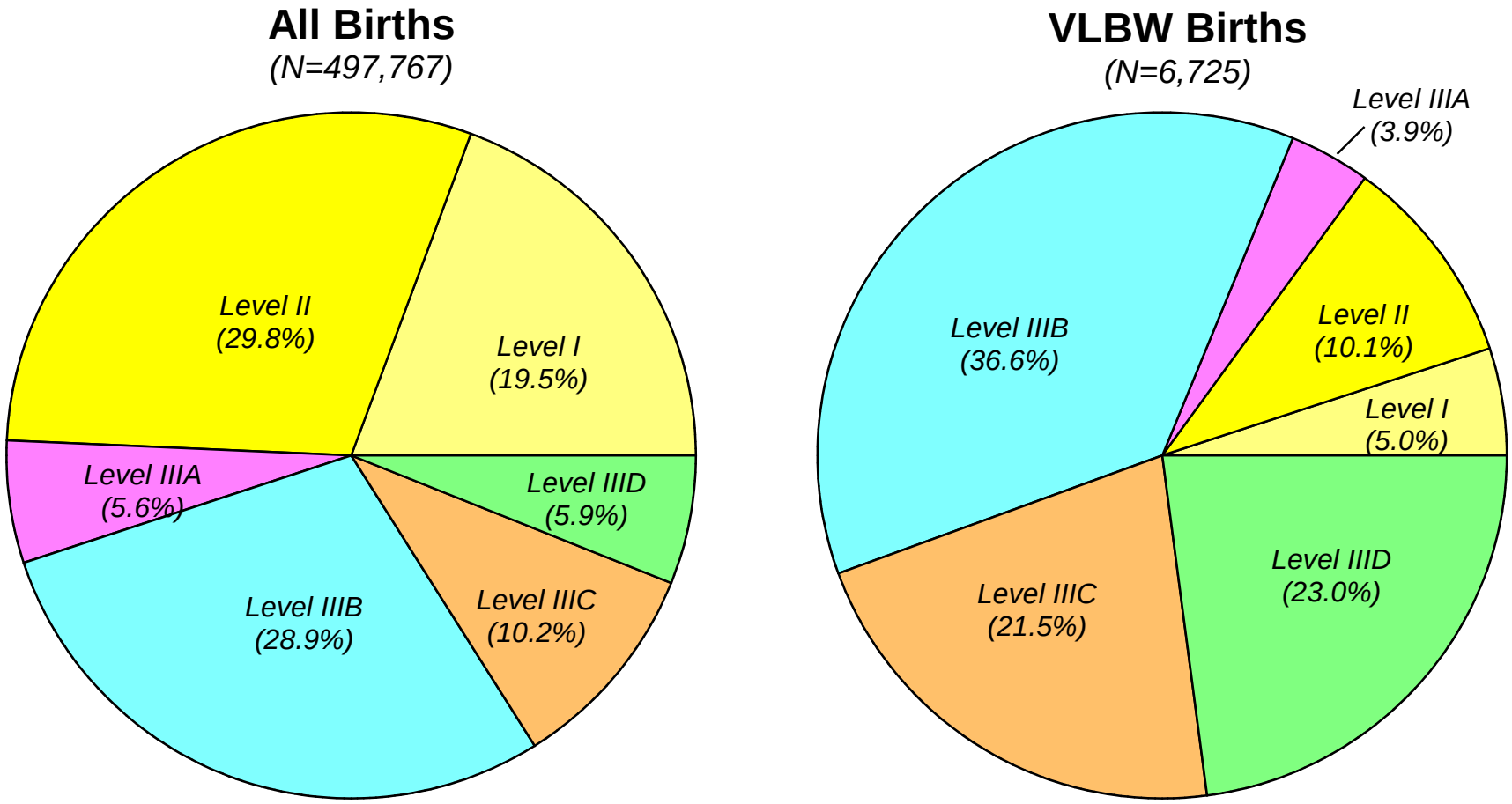
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services

Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort, Table 1

Figure 3

Percent Distribution of All Births and VLBW Births By Hospital Neonatal Level of Care

Indiana, 2000-2005 Live Births

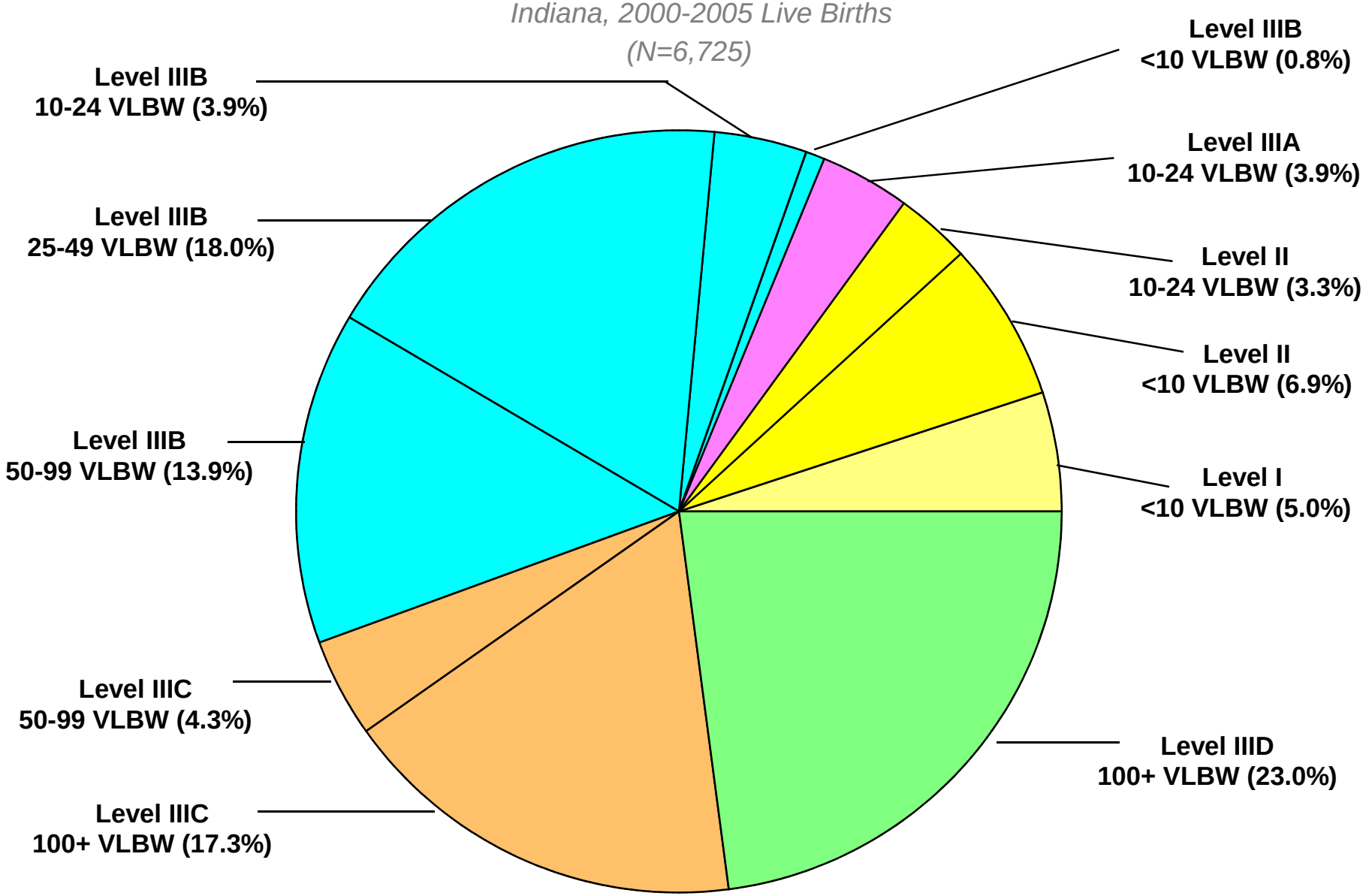


Note: VLBW=Very low birth weight (<1,500 g)
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services
Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort, Table 1

Figure 4

Percent Distribution of VLBW Births By Hospital Level of Care and Average Annual VLBW Delivery Volume

Indiana, 2000-2005 Live Births
(N=6,725)

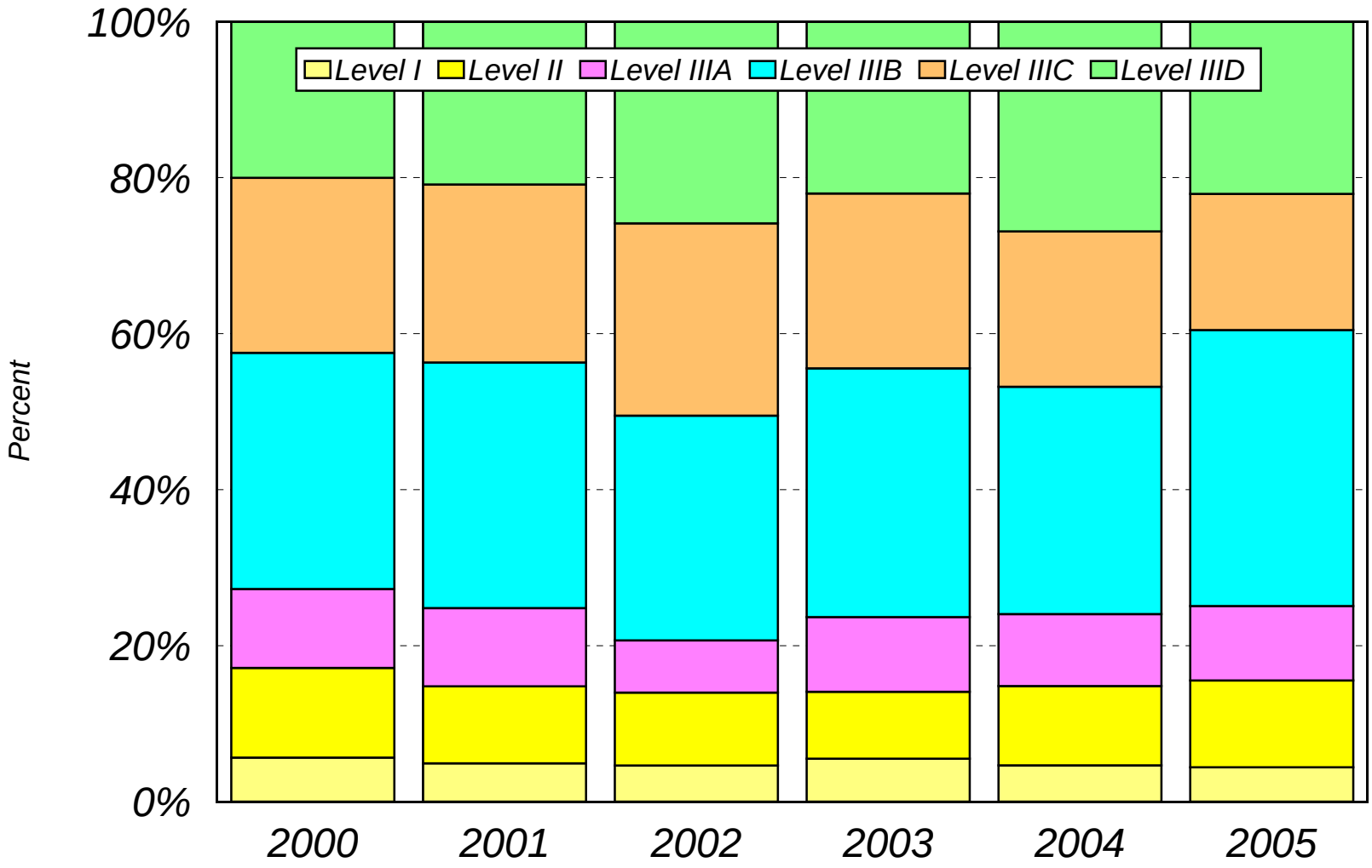


Note: VLBW=Very low birth weight (<1,500 g)
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services
Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort

Figure 5

Trends in Distribution of VLBW Deliveries By Hospital Noenatal Level of Care

Indiana, 2000-2005 Live Births

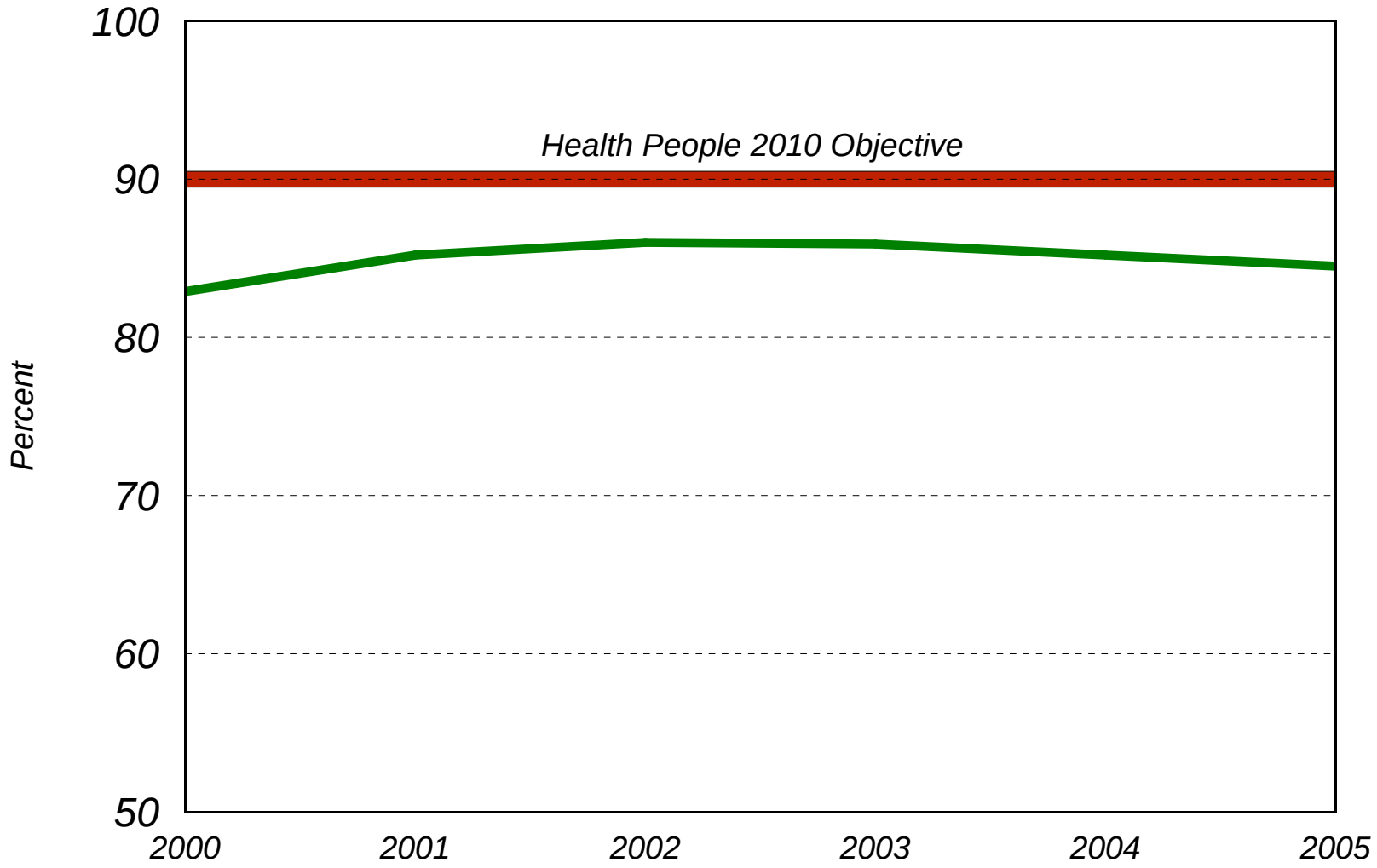


Note: VLBW=Very low birth weight (<1,500 g)
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services
Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort, Table 1

Figure 6

Proportion of VLBW Infants born at Level III Hospitals

Indiana, 2000-2005 Live Births

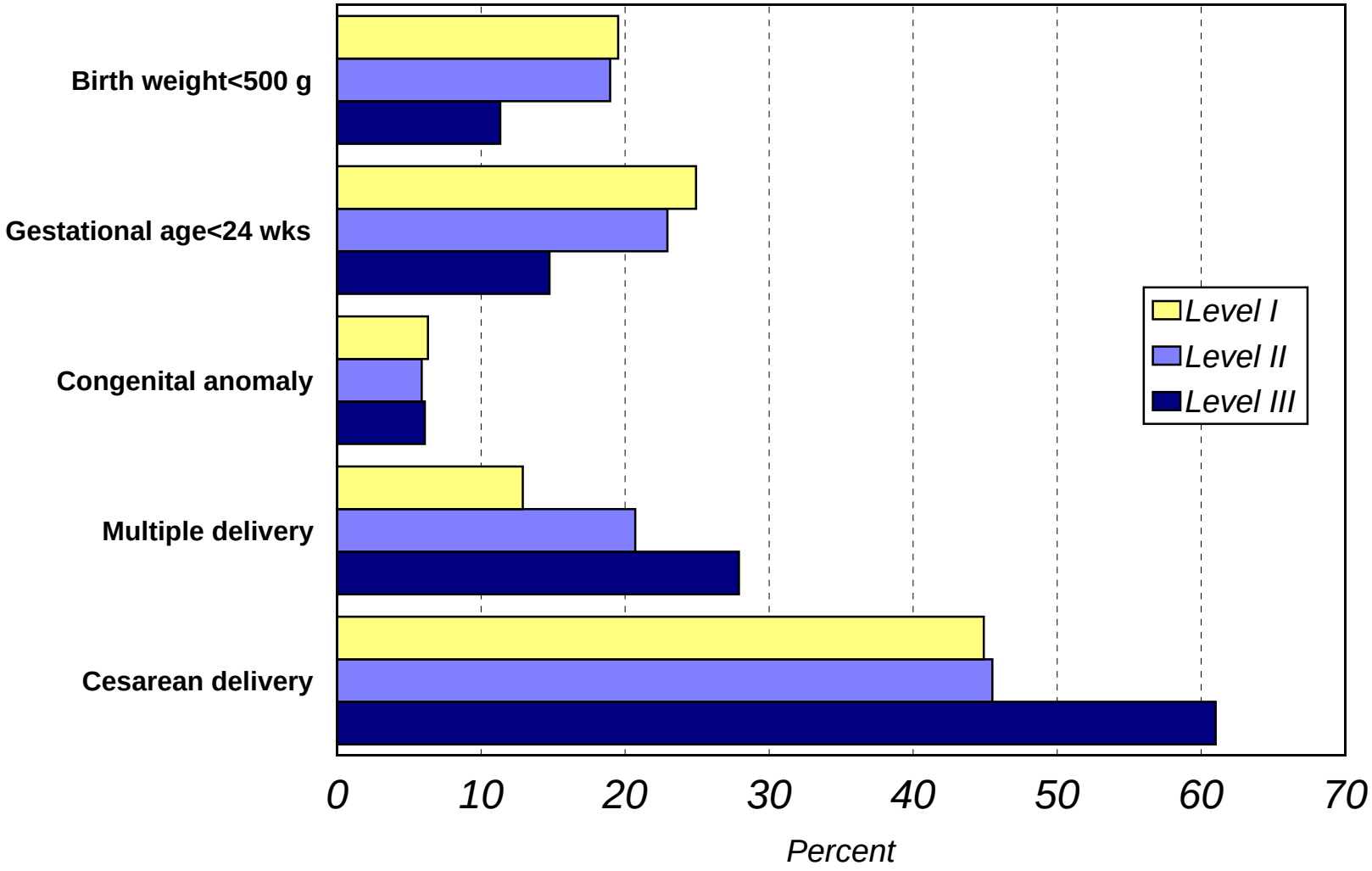


Note: VLBW=Very low birth weight (<1,500 g)
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services
Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort, Table 1

Figure 7

Characteristics of VLBW Infants and Delivery According to Hospital Level of Neonatal Care

Indiana, 2000-2005 Live Births

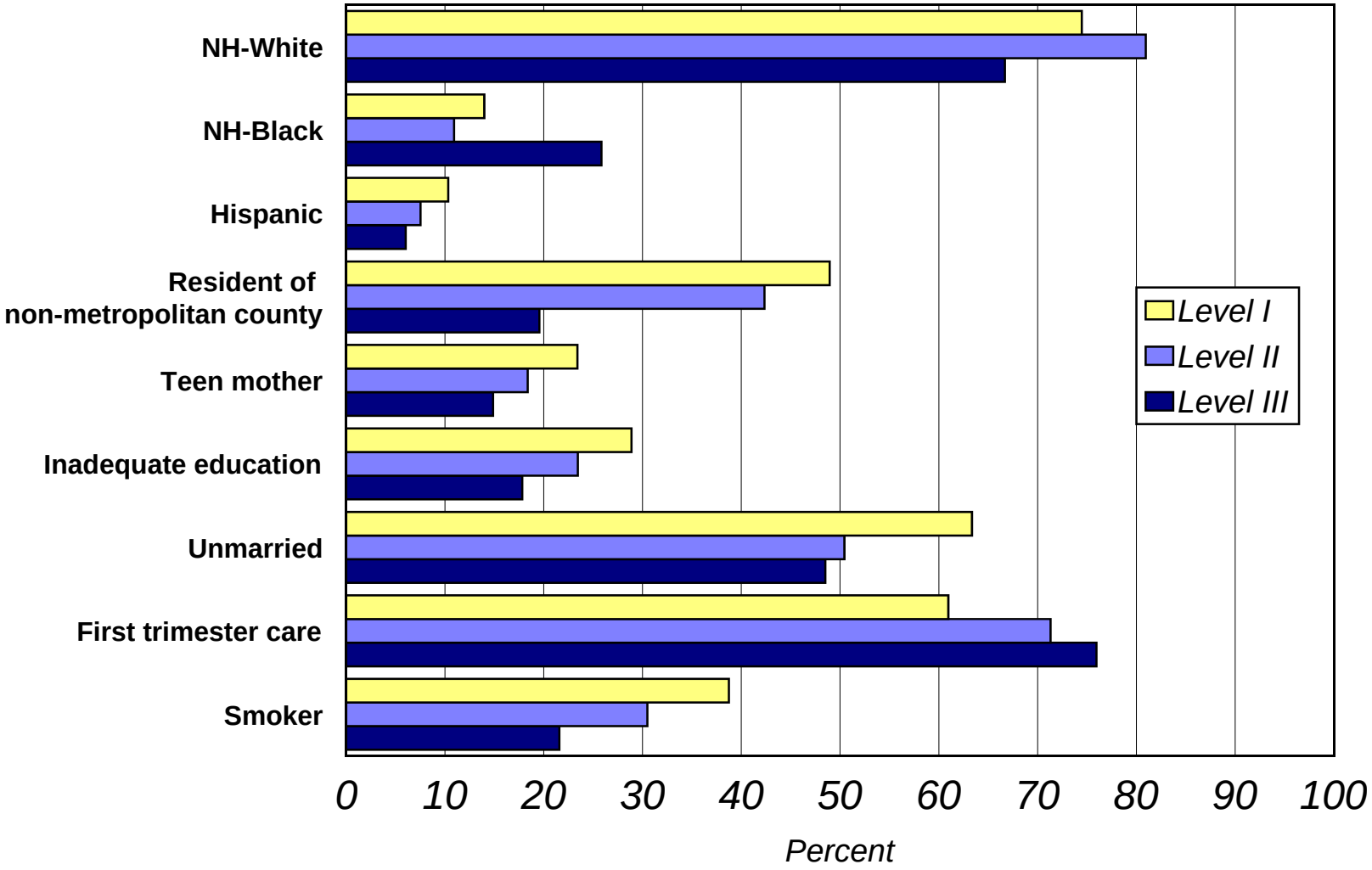


Note: VLBW=Very low birth weight (<1,500 g)
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services
Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort, Table 2

Figure 8

Characteristics of Mothers of VLBW Infants According to Hospital Level of Neonatal Care

Indiana, 2000-2005 Live Births

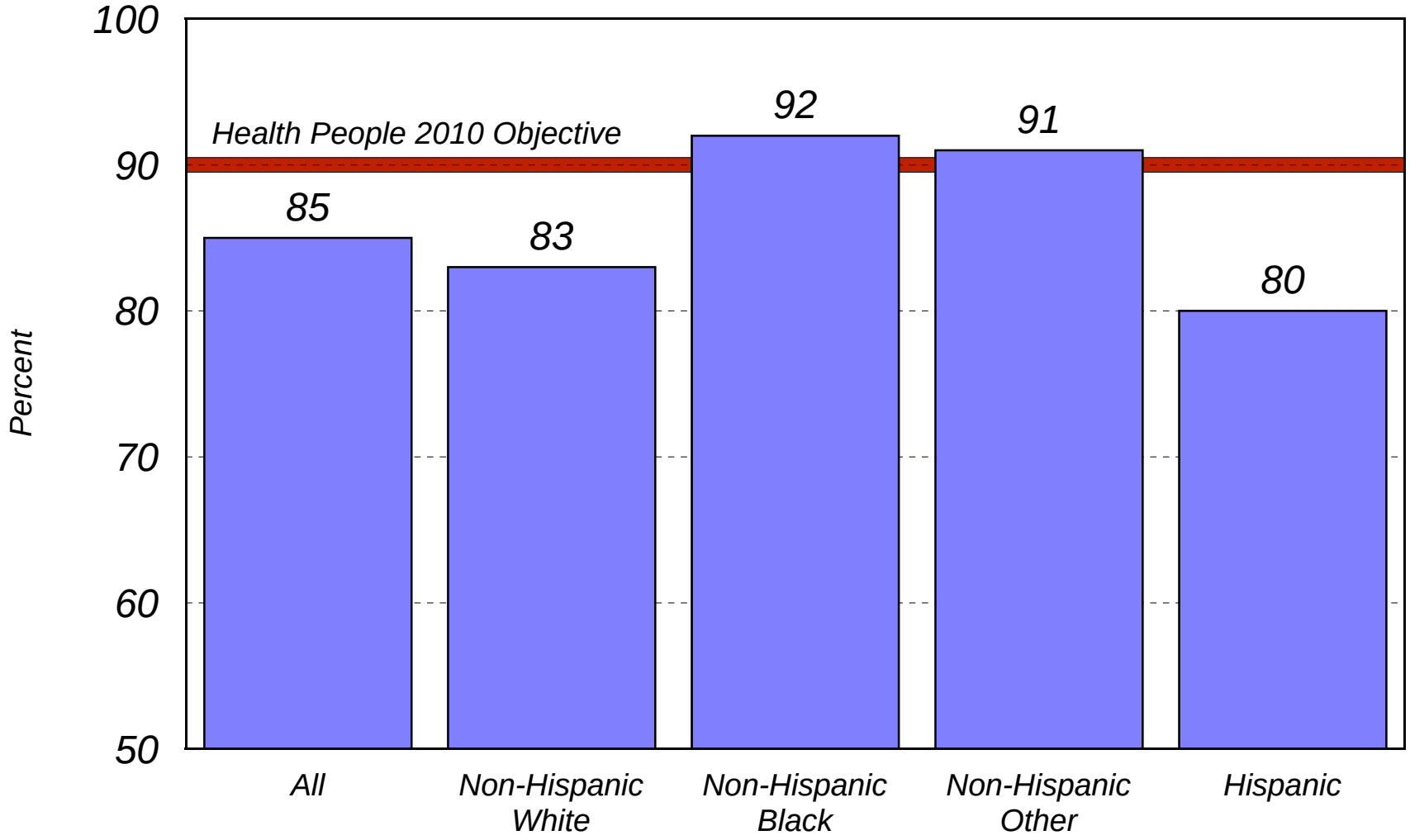


Note: VLBW=Very low birth weight (<1,500 g)
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services
Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort, Table 2

Figure 9

Proportion of VLBW Infants born at Level III Hospitals By Race and Hispanic Origin of Mother

Indiana, 2000-2005 Live Births

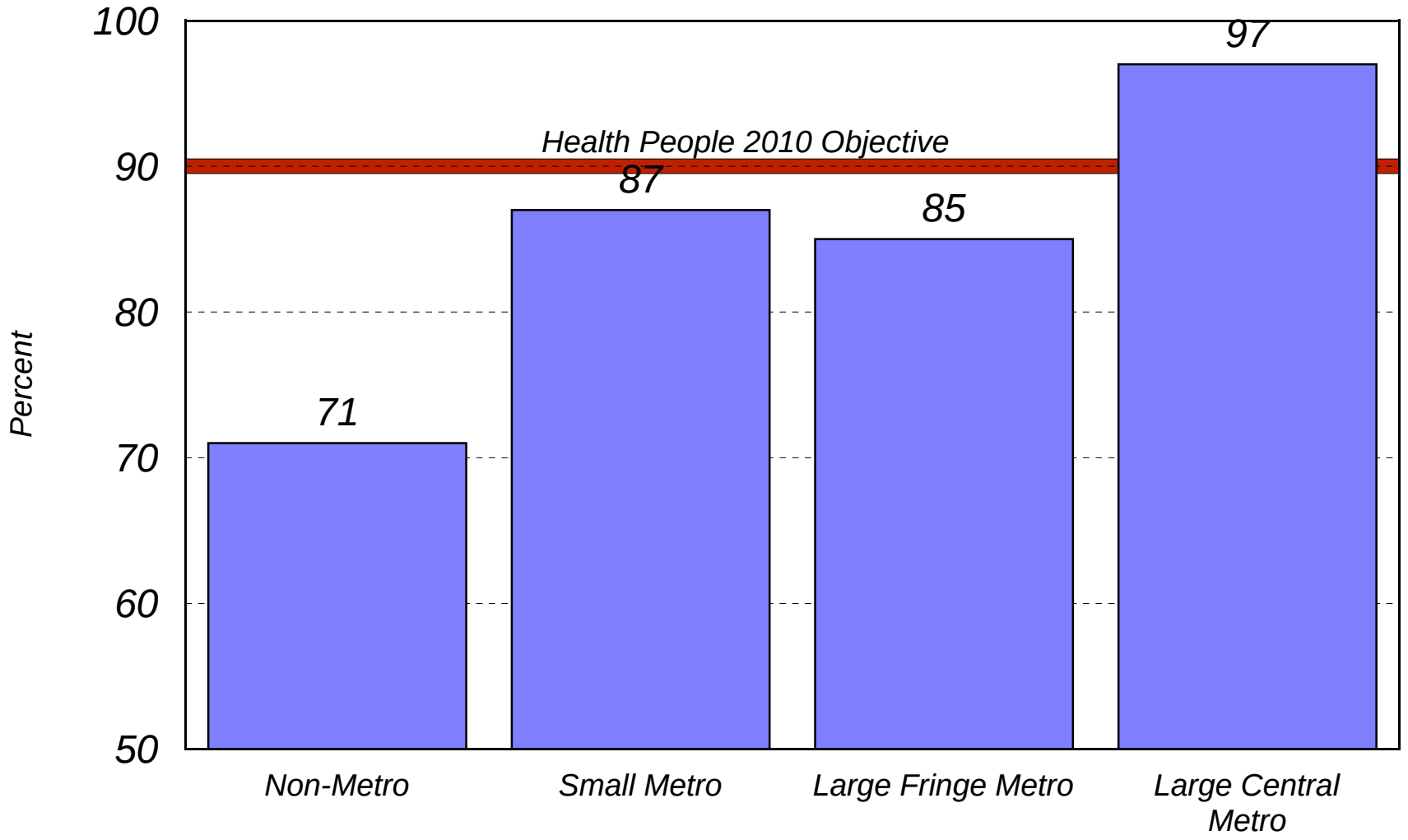


Note: VLBW=Very low birth weight (<1,500 g)
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services
Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort

Figure 10

Proportion of VLBW Infants born at Level III Hospitals According to County of Residency of Mother

Indiana, 2000-2005 Live Births

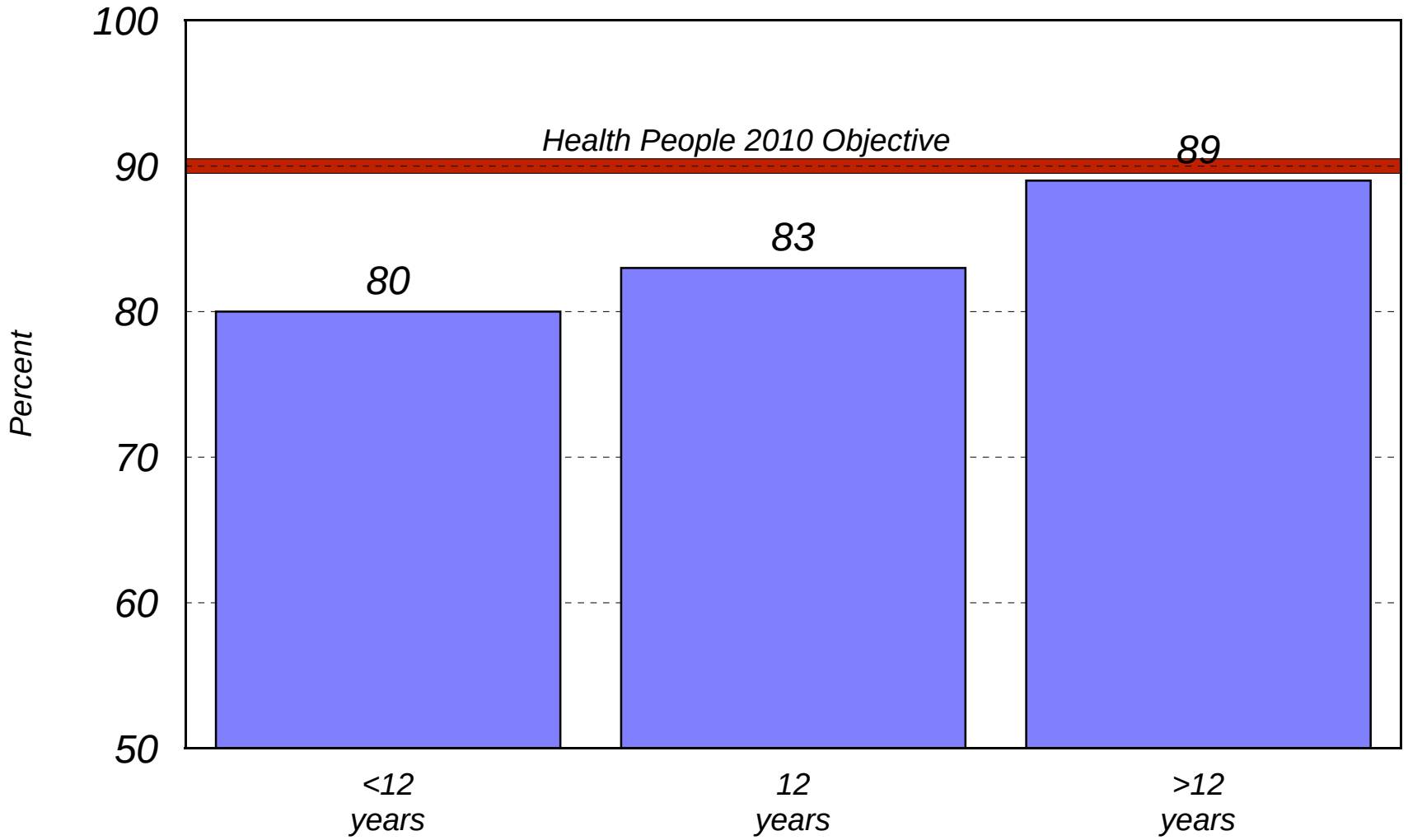


Note: VLBW=Very low birth weight (<1,500 g)
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services
Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort

Figure 11

Proportion of VLBW Infants born at Level III Hospitals By Educational Level of Mother

Indiana, 2000-2005 Live Births

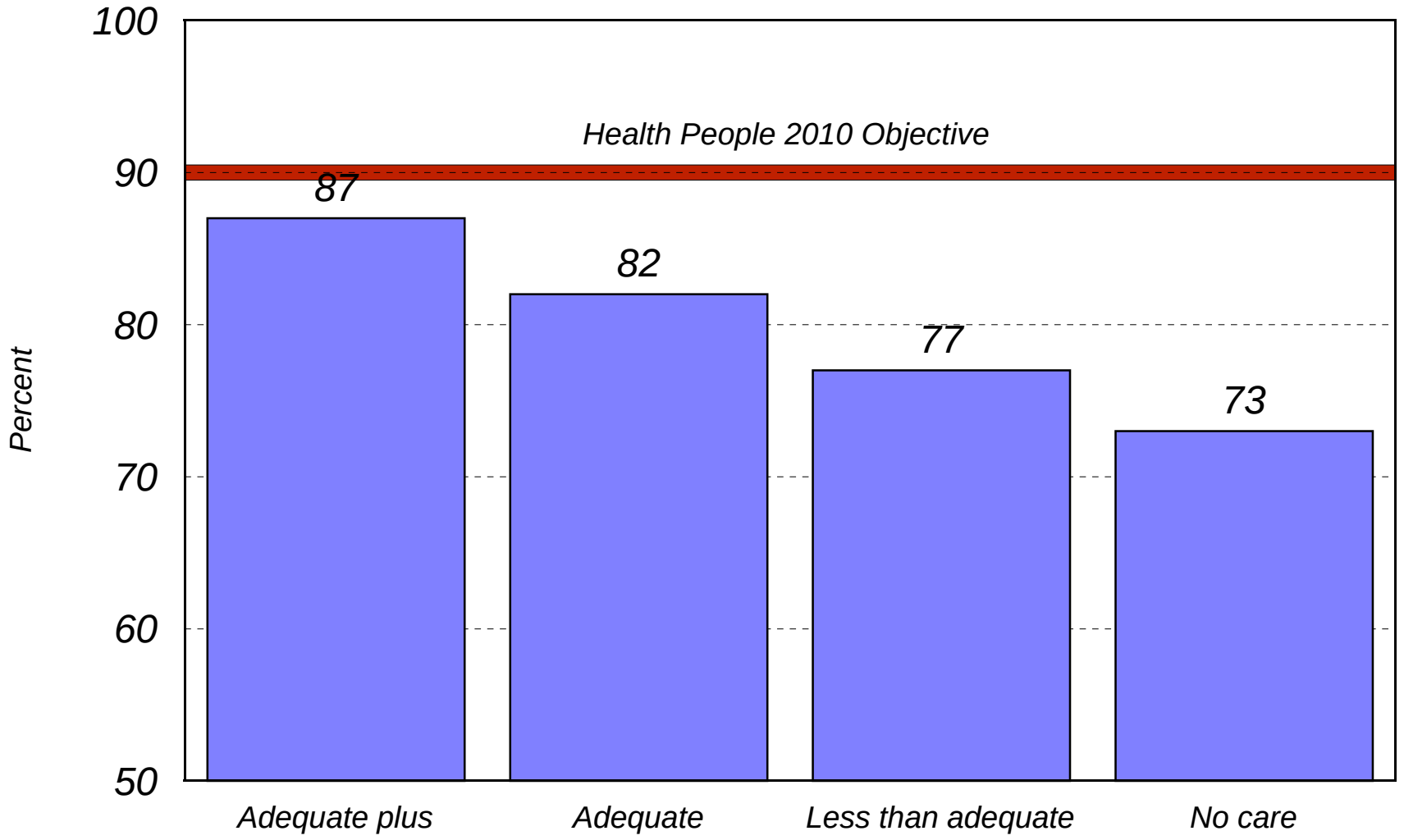


Note: VLBW=Very low birth weight (<1,500 g)
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services
Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort

Figure 12

Proportion of VLBW Infants born at Level III Hospitals By Adequacy of Prenatal Care*

Indiana, 2000-2005 Live Births



*Basend on APNCU Index (Kotelchuck Index)

Note: VLBW=Very low birth weight (<1,500 g)

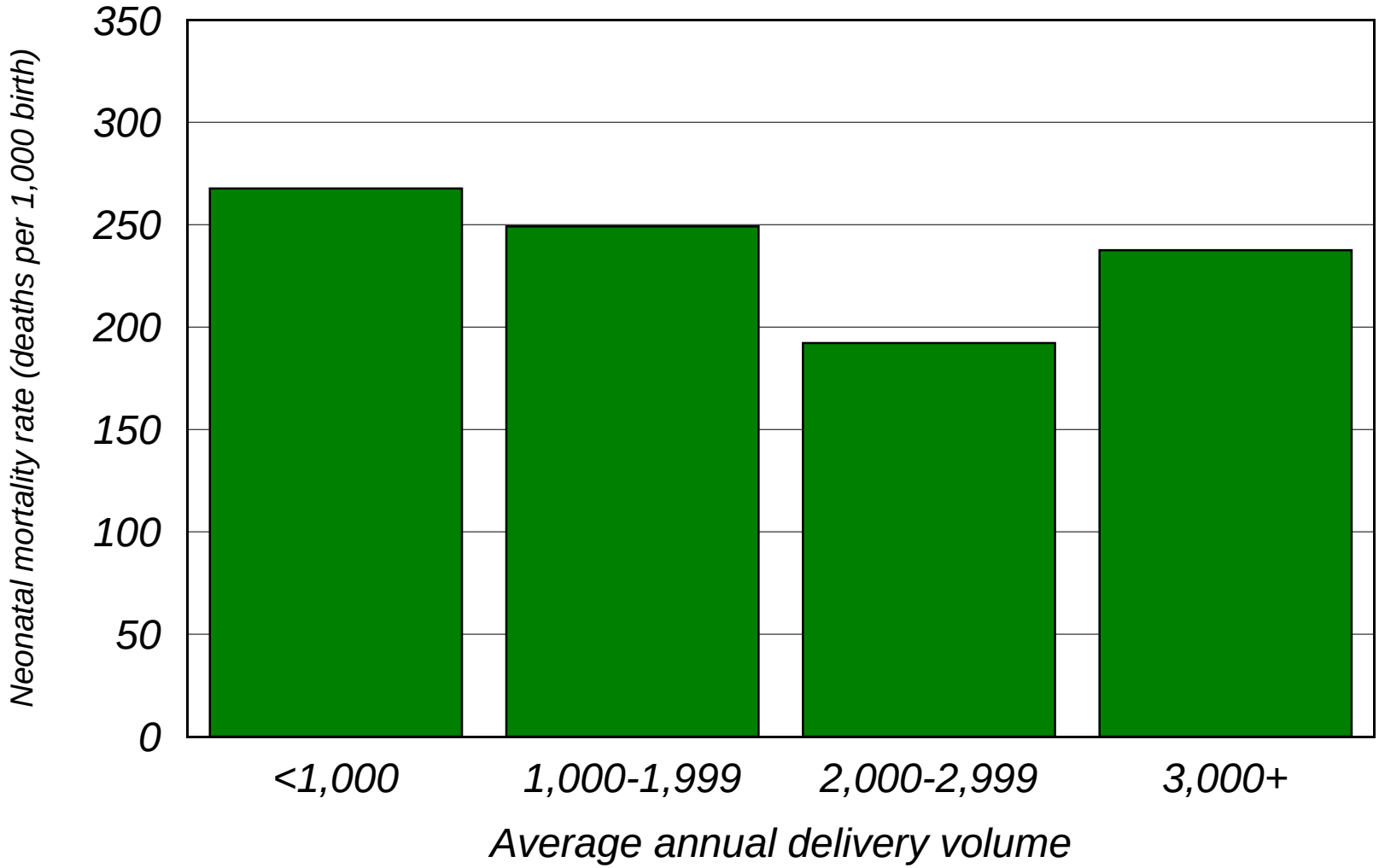
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services

Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort

Figure 13

Neonatal Mortality Rate of VLBW Infants By Hospital Average Annual Delivery Volume

Indiana, 2000-2005 Birth Cohort

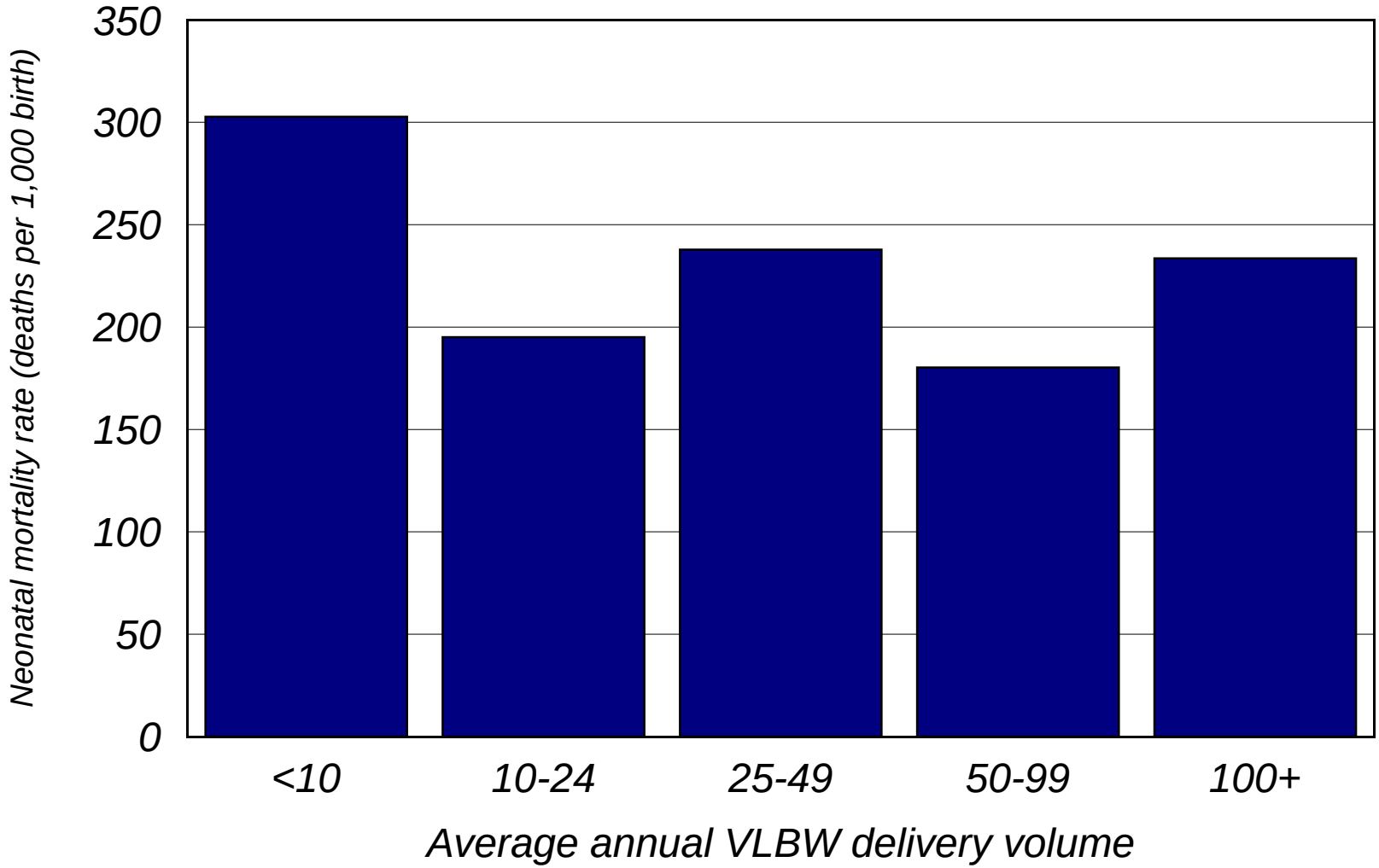


Note: VLBW=Very low birth weight (<1,500 g)
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services
Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort, Table 4

Figure 14

Neonatal Mortality Rate of VLBW Infants By Hospital Average Annual VLBW Delivery Volume

Indiana, 2000-2005 Birth Cohort

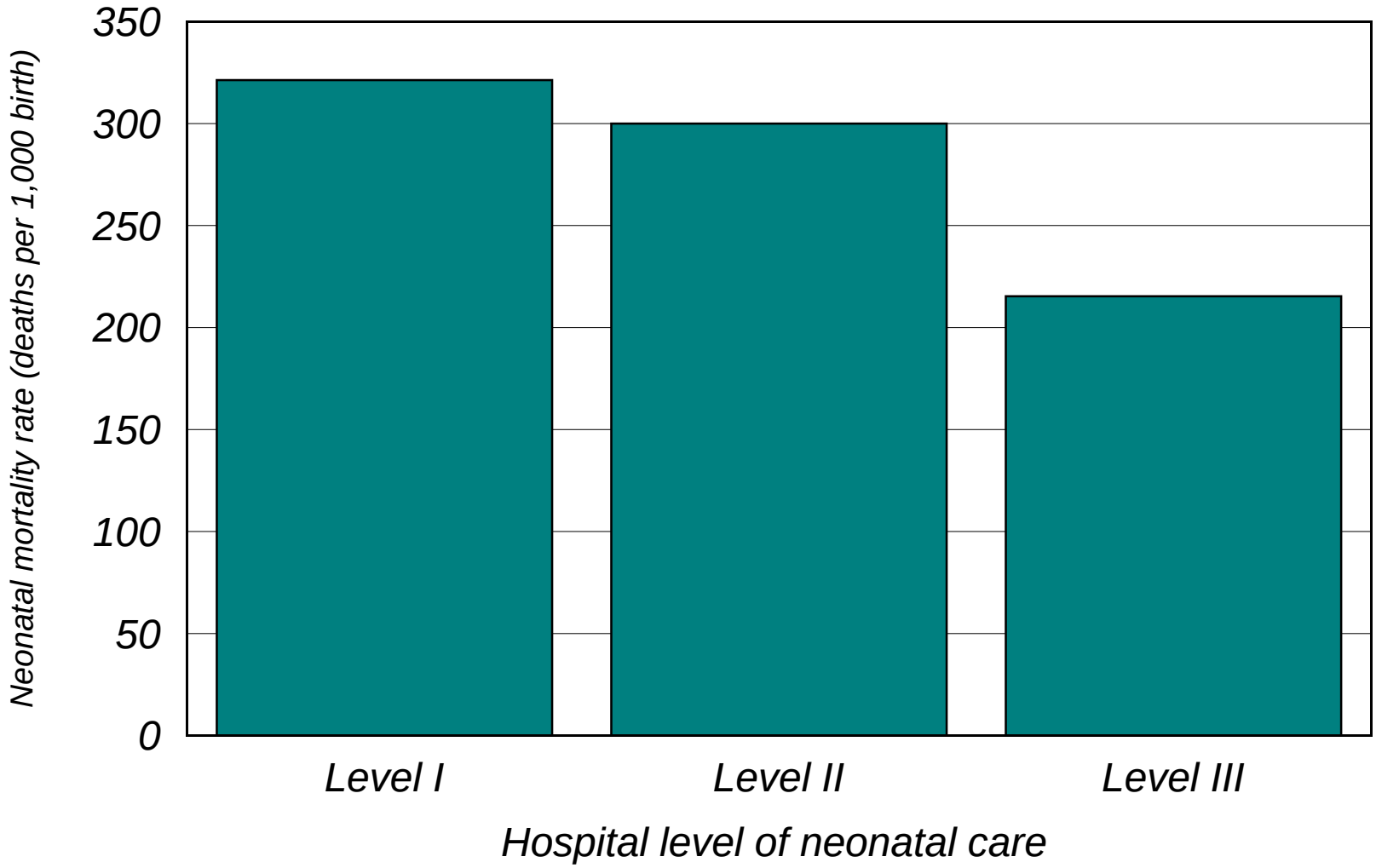


Note: VLBW=Very low birth weight (<1,500 g)
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services
Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort, Table 4

Figure 15

Neonatal Mortality Rate of VLBW Infants By Hospital Level of Neonatal Care

Indiana, 2000-2005 Birth Cohort

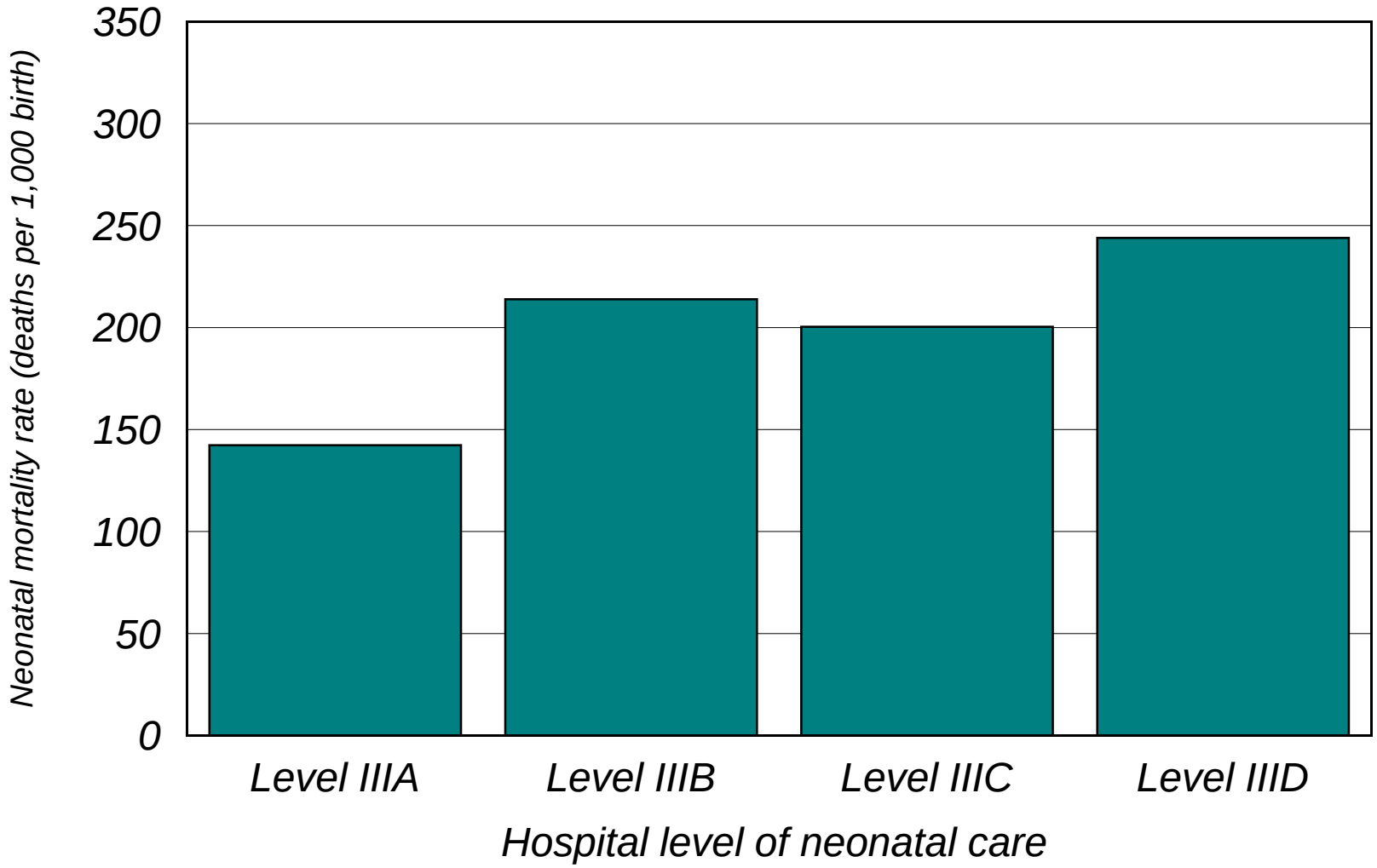


Note: VLBW=Very low birth weight (<1,500 g)
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services
Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort, Table 4

Figure 16

Neonatal Mortality Rate of VLBW Infants Born in Level III Hospitals

Indiana, 2000-2005 Birth Cohort

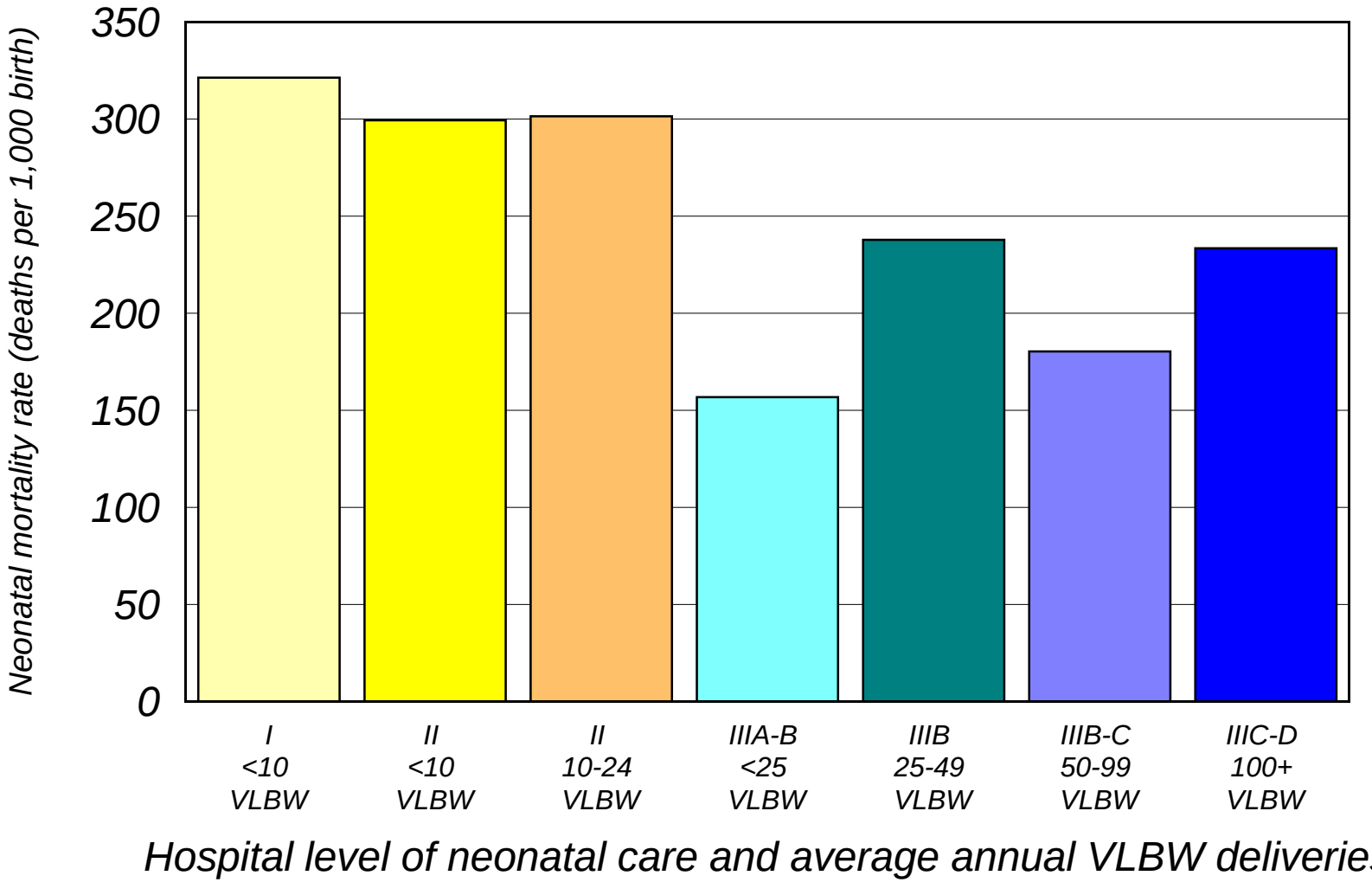


Note: VLBW=Very low birth weight (<1,500 g)
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services
Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort, Table 4

Figure 17

Neonatal Mortality Rate of VLBW Infants According to Hospital Level of Neonatal Care and Average Annual VLBW Deliveries

Indiana, 2000-2005 Birth Cohort



Note: VLBW=Very low birth weight (<1,500 g)

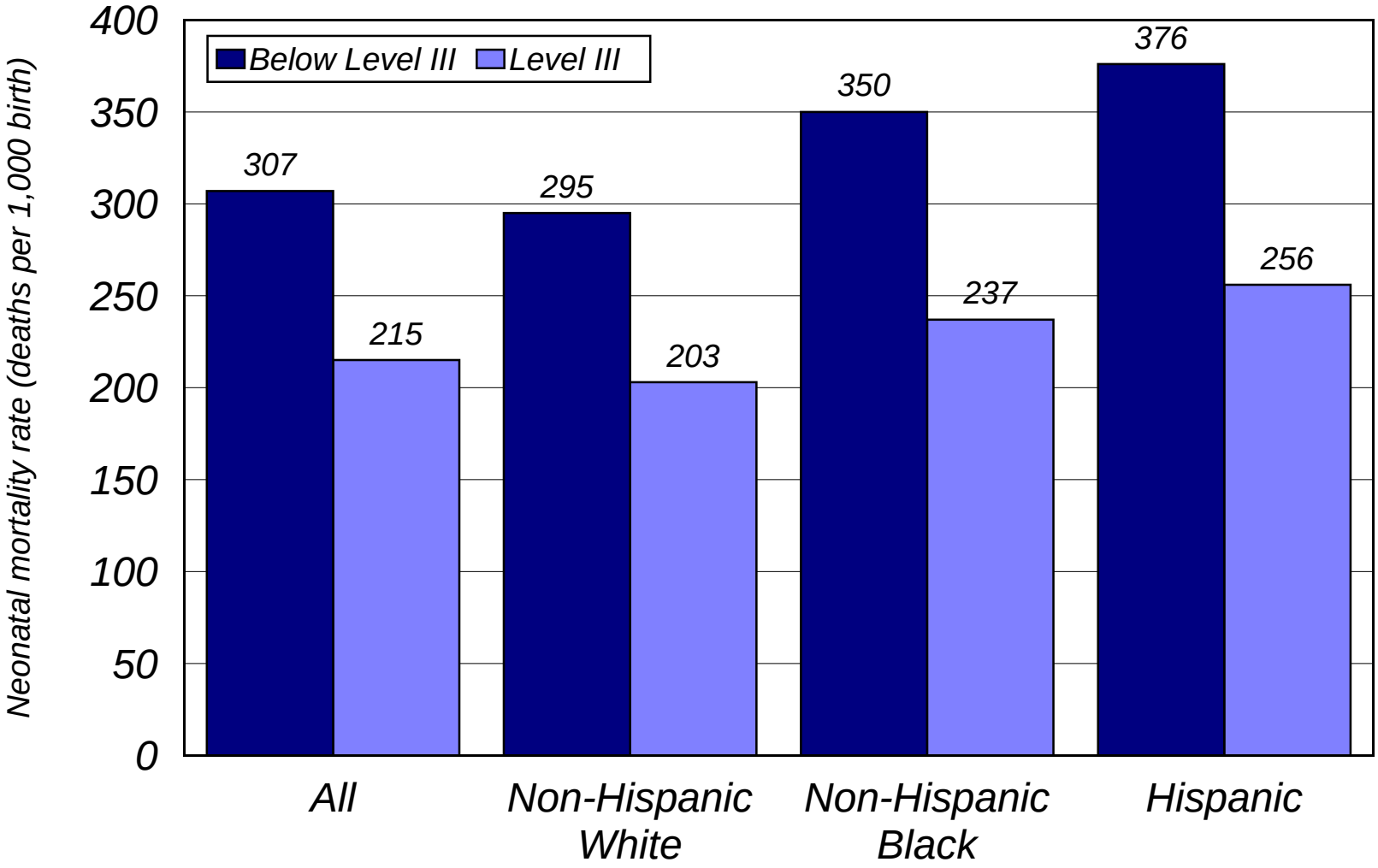
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services

Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort, Table 4

Figure 18

Neonatal Mortality Rate of VLBW Infants By Hospital Level of Neonatal Care According to Race and Hispanic Origin of Mother

Indiana, 2000-2005 Birth Cohort

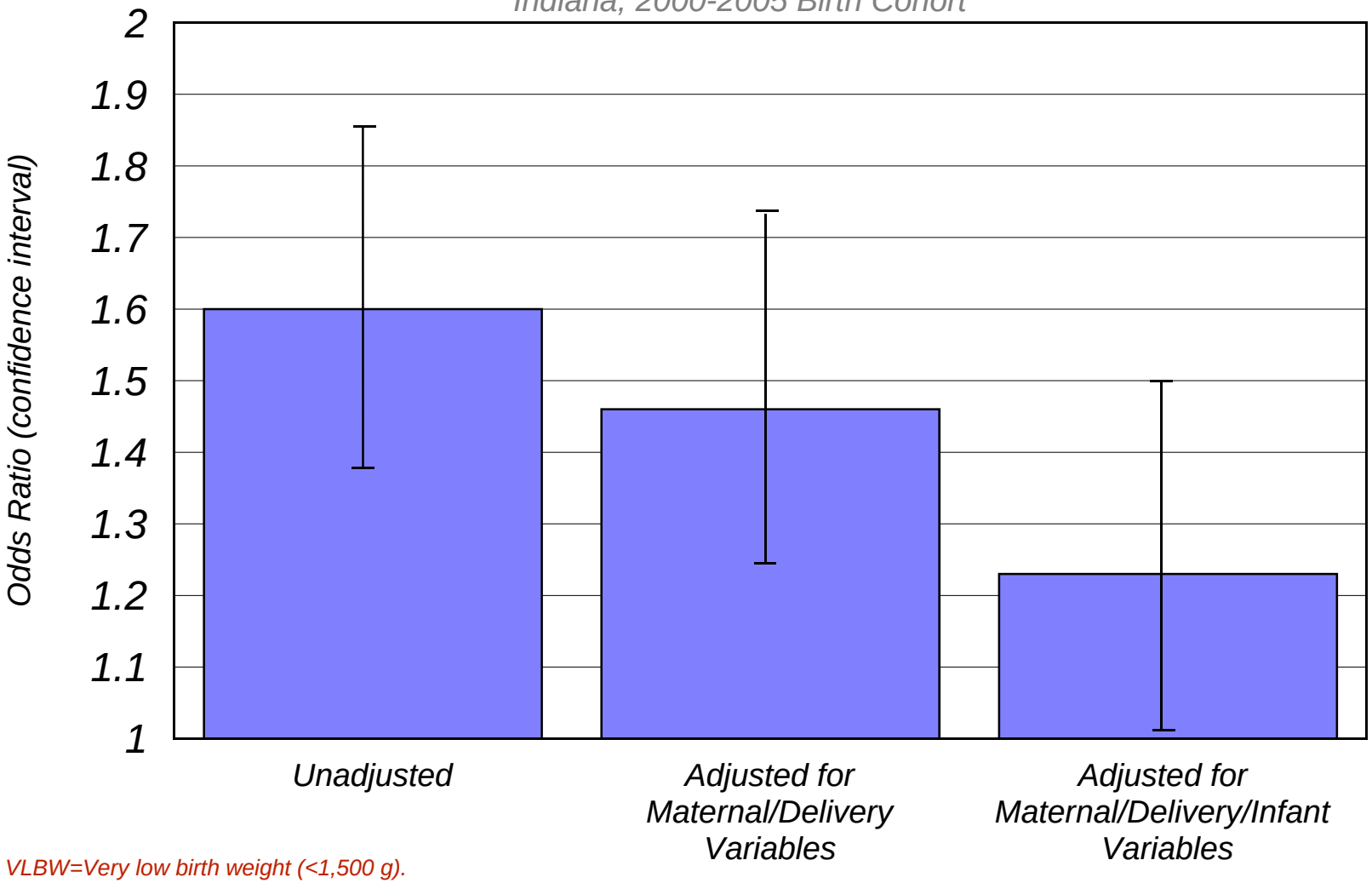


Note: VLBW=Very low birth weight (<1,500 g)
Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services
Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort, Table 5

Figure 19

Odds Ratios with 95% Confidence Intervals For Neonatal Death of VLBW Infants Delivered at Hospitals with Below Level III Neonatal Care

Indiana, 2000-2005 Birth Cohort



**Note: VLBW=Very low birth weight (<1,500 g).*
Reference group: VLBW infants delivered in level III hospitals;
Maternal/Delivery variables: Age, education, marital status, parity, smoking status, prenatal care, county of residency, multiple delivery, cesarean delivery.
Infant variables: Gender, congenital anomalies, and birth weight < 500 grams.

Source: Indiana State Department of Health, Maternal and Children's Special Health Care Services
Report: Hospital Level and Delivery Volume and Neonatal Mortality Among Very Low Birth Weight Infants: Indiana: 2000-2005 Birth Cohort

Table A. Classification of Indiana hospitals according to average annual delivery volume, total deliveries by birth weight during 2000-2005, and self-reported neonatal level of care in 2003 and 2008*

Hospital name	Number of deliveries in 2000-2005			Level of Care	
	All	<1,500 g	<500 g	2003	2008
All hospitals	514,454	7,196	904		
Under 1,000 deliveries per year (N=85)					
Parkview North Hospital / Fort Wayne (Opened OB in 2002)	2,732	11	1	---	---
Adams County Memorial Hospital / Decatur	1,307	3	1	I	I
Bedford Regional Medical Center / Bedford	1,008	1	0	II	IIB
Blackford County Hospital/ Hartford City (Closed OB in 2000)	30	0	0	---	
Cameron Memorial Community Hospital / Angola	1,878	5	2	I	I
Caylor-Nickel (Bluffton) Medical Center / Bluffton[1]	1,939	3	0	I	I
Clay County (St. Vincent Clay) Hospital / Brazil (Closed OB in 2003)	198	1	1	---	
Clinton County (St. Vincent Frankfort) Hospital / Frankfort	1,686	8	0	I	IIA
Community Hospital of Bremen / Bremen	177	0	0	I	I
Daviess County Hospital / Washington	2,409	16	2	II	I
Deaconess Hospital / Evansville (Closed OB in 2002)	1,995	10	3	---	
Dearborn County Hospital / Lawrenceburg	3,267	12	0	I	I
Decatur County Memorial Hospital / Greensburg	1,663	6	2	I	IIA
DeKalb Memorial Hospital / Auburn	2,629	5	0	I	I
Dukes Memorial Hospital / Peru	1,902	7	2	II	IIA
Dunn Memorial Hospital / Bedford	1,312	6	1	I	I
Fayette Memorial Hospital Association / Connersville	1,486	6	1	I	IIB
Witham Memorial Hospital / Lebanon (Opened OB in 2003)	724	3	0	I	IIA
Gibson General Hospital / Princeton	824	2	1	I	---
Good Samaritan Hospital / Vincennes	3,165	14	4	II	IIB
Greene County General Hospital / Linton	701	1	1	I	I
Hancock Memorial Hospital / Greenfield	3,300	6	0	II	IIA
Harrison County Hospital / Corydon	1,102	3	0	II	IIB
Hendricks Community Hospital / Danville	5,652	12	3	II	IIA
Clarian West Medical Center / Avon (Opened in 2004)	293	3	2	---	IIB
Henry County Memorial Hospital / New Castle	2,785	5	1	II	IIA
Howard County Community Hospital / Kokomo	4,202	27	3	II	IIB
Huntington Memorial (Parkview) Hospital / Huntington	1,578	3	1	I	IIB
Memorial Hospital (Schneck Medical Center) / Seymour	3,622	15	1	II	IIB
Jasper County Hospital / Rensselaer	782	2	0	I	I
Jay County Hospital / Portland	735	6	0	I	I
St. Vincent Jennings Hospital / North Vernon	4	0	0	---	---
Johnson Memorial Hospital / Franklin	3,762	6	2	I	I
The King's Daughters' Hospital and Health Services / Madison	2,274	6	0	I	IIA
Kosciusko Community Hospital / Warsaw	4,968	6	2	I	IIA
Vencor Hospital (Parkview La Grange) / La Grange	1,545	5	1	I	I
La Porte Hospital / La Porte	4,219	21	6	II	I
St. Francis Hospital and Health Centers / Mooresville	2,602	9	0	II	IIB
Margaret Mary Community Hospital / Batesville	2,713	8	2	II	IIA
Marion General Hospital / Marion	4,663	34	7	II	IIB
St. Joseph's Hospital Marshall County / Plymouth	2,415	11	3	II	I
Mary Sherman (Sullivan County Community) Hospital / Sullivan	887	7	0	I	I
McCray Memorial (Parkview Noble) Hospital / Kendallville	1,324	8	1	I	I
Memorial Hospital & Health Care Center / Jasper	4,775	12	3	I	IIB
Memorial Hospital / Logansport	3,420	8	1	II	IIA

Table A. Classification of Indiana hospitals according to average annual delivery volume, total deliveries by birth weight during 2000-2005, and self-reported neonatal level of care in 2003 and 2008*--Con.

Hospital name	Number of deliveries in 2000-2005			Level of care	
	All	<1,500 g	<500 g	2003	2008
Under 1,000 deliveries per year (N=85)					
Floyd Memorial Hospital & Health Service / New Albany	4,944	11	3	II	IIA
St. Vincent Mercy Hospital / Elwood (Closed OB in 2001)	142	2	1	---	
Methodist Hospitals, Inc., Northlake Campus / Gary	5,715	199	29	IIIB	III
St. Clare Medical Center (Culvert Union) / Crawfordsville	1,667	5	0	I	I
Morgan County Memorial Hospital / Martinsville	1,316	6	0	I	I
Orange County (Bloomington) Hospital / Paoli	978	3	1	I	I
St. Margaret Mercy Healthcare Centers-South / Dyer	2,901	7	2	II	---
Perry County Memorial Hospital / Tell City	541	0	0	I	I
Pulaski Memorial Hospital / Winamac	621	3	3	I	I
Putnam County Hospital / Greenscastle	1,368	3	1	I	I
St. Voncent Randolph County Hospital / Winchester	1,054	5	1	I	I
Reid Hospital & Health Care Services / Richmond	4,880	34	3	II	IIB
Riverview Hospital / Noblesville	4,749	7	2	II	IIB
Clarian North Medical Center-Riley North / Carmel (Opened in 2005)	110	0	0	---	IIIB
Rush Memorial Hospital / Rushville	2	0	0	---	
St. Anthony Hospital & Health Center / Michigan City	3,730	27	7	I	I
St. Anthony Medical Center / Crown Point	5,370	12	0	II	IIB
St. Catherine Hospital / East Chicago	4,034	25	7	I	I
St. John's Health System / Anderson	2,975	17	7	II	IIA
St. Joseph Community Hospital / Mishawaka	4,832	7	1	I	I
St. Joseph Hospital & Health Center / Kokomo	4,724	24	2	II	IIB
St. Joseph Medical Center / Fort Wayne	3,153	55	4	IIIB	IIIB
St. Joseph's Hospital / Huntingburg	727	8	3	I	---
St. Mary Medical Center / Hobart	2,997	14	4	I	IIB
Scott Memorial Hospital / Scottsburg	818	4	1	I	I
Starke Memorial Hospital / Knox	987	7	0	I	---
Columbia Terre Haute Regional Hospital / Terre Haute	4,689	9	3	II	IIB
Tipton County Memorial Hospital / Tipton	687	5	0	I	---
Community Hospital South / Indianapolis	4,084	7	1	II	IIA
West Central Community Hospital (Vermillion Co.) / Clinton	614	1	0	I	I
Wabash County Hospital / Wabash	598	1	0	I	---
St. Mary's Warrick Hospital / Boonsville	1	1	0	?	
Washington County Memorial Hospital / Salem	548	1	0	I	I
Welborn Memorial Baptist Hospital / Evansville (Closed 2001)	344	0	0	---	
Wells Community Hospital[1]/ Bluffton (merged in 2001 with Caylor N)	197	0	0	---	
White County Memorial Hospital / Monticello	853	3	0	I	I
Parkview Whitely (Whitely County Memorial) Hospital / Columbia C	1,671	5	0	I	I
Major Hospital / Shelbyville	2,320	13	6	II	IIB
Woodlawn Memorial Hospital / Rochester	1,144	2	0	I	IIB
Porter – Portage Campus / Portage	1,818	6	1	I	---

Table A. Classification of Indiana hospitals according to average annual delivery volume, total deliveries by birth weight during 2000-2005, and self-reported neonatal level of care in 2003 and 2008*--Con.

Hospital name	Number of deliveries in 2000-2005			Level of care	
	All	<1,500 g	<500 g	2003	2008
1,000-1,999 deliveries per year (N=16)					
DuPont Hospital / Fort Wayne (Opened OB in 2001)	8,301	98	6	IIIB	IIIB
Ball Memorial Hospital / Muncie	10,063	167	26	IIIB	IIIB
Columbus Regional Hospital / Columbus	8,537	36	5	II	IIA
Methodist Hospital, The South Lake Campus / Merrillville	6,118	87	9	IIIB	III
Clark Memorial Hospital / Jeffersonville	9,442	26	6	I	I
Community Hospital / Anderson	6,176	13	5	II	IIA
Community Hospital East/ Indianapolis	6,126	39	7	II	IIB
Elkhart General Hospital / Elkhart	10,191	71	17	II	IIB
Goshen General Hospital / Goshen	8,822	50	9	I	I
Clarian Health Partners Inc., IU- Riley Campus / Indianapolis	6,019	786	111	II-IIID	IB-IIIC
Lutheran Hospital / Ft Wayne	11,231	299	26	IIIC	IIIB
Porter Hospital / Valparaiso	6,761	95	12	II	IIB
St. Joseph Regional Medical Center / South Bend	7,090	90	7	IIIB	IIIB
St. Margaret Mercy Healthcare Centers-North / Hammond	6,269	168	33	IIIB	IIIA
St. Vincent Carmel Hospital/ Carmel (Opened OB in 2003)	3,350	10	5	II	IIIA
Union Hospital / Terre Haute	8,410	51	7	II	IIIB
2,000-2,999 deliveries per year (N=11)					
Bloomington Hospital / Bloomington	12,219	60	12	II	IIB
Community Hospital / Munster	13,696	210	35	IIIB	IIIB
Community Hospital-North / Indianapolis	12,417	133	6	IIIA	IIIB
Home Hospital / Lafayette	17,999	214	21	IIIB	IIIB
Memorial Hospital / South Bend	17,613	636	57	IIIC	IIIB
Parkview Memorial Hospital / Fort Wayne	15,128	334	42	IIIB-C	IIIB
St. Francis Hopital / Beech Grove, Indianapolis	15,530	129	8	IIIA	IIIB
St. Mary's Medical Center / Evansville	12,899	371	33	IIIB-C	IIIB
Wishard Memorial Hospital / Indianapolis	17,917	364	27	III?	IIIB
The Women's Hospital (Deaconess)/Newburgh (Opened OB in 2001)	11,332	185	33	IIIB	IIIB
St. Vincent (Columbia) Women's Hospital / Indianapolis	15,599	189	16	IIIB	IIIC
3,000 or more deliveries per year (N=2)					
Clarian Health Partners Inc., Methodist Campus / Indianapolis	23,918	623	93	IIIC	IIIB
St. Vincent Indianapolis Hospital / Indianapolis	23,724	780	79	IIID	---

*See Technical Notes for description of neonatal level of care; based on criteria set forth by the American Academy of Pediatrics, American College of Obstetricians and Gynecologist, and the March of Dimes (1-3).

[1]Caylor Nickle Medical Center combined with Wells Community Hospital in 2001 to form Bluffton Regional Medical Center

--- Unknwon level of care

Table B. Urbanization level of Indiana counties*

	County name	Urbanization level
1	Adams	Small metropolitan
2	Allen	Small metropolitan
3	Bartholomew	Non-metropolitan, with a city of 10,000 or more population
4	Benton	Non-metropolitan, without a city of 10,000 or more population
5	Blackford	Non-metropolitan, without a city of 10,000 or more population
6	Boone	Large fringe metropolitan
7	Brown	Non-metropolitan, without a city of 10,000 or more population
8	Carroll	Non-metropolitan, without a city of 10,000 or more population
9	Cass	Non-metropolitan, with a city of 10,000 or more population
10	Clark	Small metropolitan
11	Clay	Small metropolitan
12	Clinton	Small metropolitan
13	Crawford	Non-metropolitan, without a city of 10,000 or more population
14	Daviess	Non-metropolitan, with a city of 10,000 or more population
15	Dearborn	Large fringe metropolitan
16	Decatur	Non-metropolitan, without a city of 10,000 or more population
17	DeKalb	Small metropolitan
18	Delaware	Small metropolitan
19	Dubois	Non-metropolitan, with a city of 10,000 or more population
20	Elkhart	Small metropolitan
21	Fayette	Non-metropolitan, with a city of 10,000 or more population
22	Floyd	Small metropolitan
23	Fountain	Non-metropolitan, without a city of 10,000 or more population
24	Franklin	Non-metropolitan, without a city of 10,000 or more population
25	Fulton	Non-metropolitan, without a city of 10,000 or more population
26	Gibson	Non-metropolitan, without a city of 10,000 or more population
27	Grant	Non-metropolitan, with a city of 10,000 or more population
28	Greene	Non-metropolitan, without a city of 10,000 or more population
29	Hamilton	Large fringe metropolitan
30	Hancock	Large fringe metropolitan
31	Harrison	Small metropolitan
32	Hendricks	Large fringe metropolitan
33	Henry	Non-metropolitan, with a city of 10,000 or more population
34	Howard	Small metropolitan
35	Huntington	Small metropolitan
36	Jackson	Non-metropolitan, with a city of 10,000 or more population
37	Jasper	Non-metropolitan, without a city of 10,000 or more population
38	Jay	Non-metropolitan, without a city of 10,000 or more population
39	Jefferson	Non-metropolitan, with a city of 10,000 or more population
40	Jennings	Non-metropolitan, without a city of 10,000 or more population
41	Johnson	Large fringe metropolitan
42	Knox	Non-metropolitan, with a city of 10,000 or more population
43	Kosciusko	Non-metropolitan, with a city of 10,000 or more population
44	LaGrange	Non-metropolitan, without a city of 10,000 or more population
45	Lake	Large fringe metropolitan
46	LaPorte	Non-metropolitan, with a city of 10,000 or more population
47	Lawrence	Non-metropolitan, with a city of 10,000 or more population
48	Madison	Large fringe metropolitan

Table B. Urbanization level of Indiana counties*--Con.

	County name	Urbanization level
49	Marion	Large central metropolitan
50	Marshall	Non-metropolitan, without a city of 10,000 or more population
51	Martin	Non-metropolitan, without a city of 10,000 or more population
52	Miami	Non-metropolitan, with a city of 10,000 or more population
53	Monroe	Small metropolitan
54	Montgomery	Non-metropolitan, with a city of 10,000 or more population
55	Morgan	Large fringe metropolitan
56	Newton	Non-metropolitan, without a city of 10,000 or more population
57	Noble	Non-metropolitan, without a city of 10,000 or more population
58	Ohio	Large fringe metropolitan
59	Orange	Non-metropolitan, without a city of 10,000 or more population
60	Owen	Non-metropolitan, without a city of 10,000 or more population
61	Parke	Non-metropolitan, without a city of 10,000 or more population
62	Perry	Non-metropolitan, without a city of 10,000 or more population
63	Pike	Non-metropolitan, without a city of 10,000 or more population
64	Porter	Large fringe metropolitan
65	Posey	Small metropolitan
66	Pulaski	Non-metropolitan, without a city of 10,000 or more population
67	Putnam	Non-metropolitan, without a city of 10,000 or more population
68	Randolph	Non-metropolitan, without a city of 10,000 or more population
69	Ripley	Non-metropolitan, without a city of 10,000 or more population
70	Rush	Non-metropolitan, without a city of 10,000 or more population
71	St. Joseph	Small metropolitan
72	Scott	Small metropolitan
73	Shelby	Large fringe metropolitan
74	Spencer	Non-metropolitan, without a city of 10,000 or more population
75	Starke	Non-metropolitan, without a city of 10,000 or more population
76	Steuben	Non-metropolitan, without a city of 10,000 or more population
77	Sullivan	Non-metropolitan, without a city of 10,000 or more population
78	Switzerland	Non-metropolitan, without a city of 10,000 or more population
79	Tippecanoe	Small metropolitan
80	Tipton	Small metropolitan
81	Union	Non-metropolitan, without a city of 10,000 or more population
82	Vanderburgh	Small metropolitan
83	Vermillion	Small metropolitan
84	Vigo	Small metropolitan
85	Wabash	Non-metropolitan, with a city of 10,000 or more population
86	Warren	Non-metropolitan, without a city of 10,000 or more population
87	Warrick	Small metropolitan
88	Washington	Non-metropolitan, without a city of 10,000 or more population
89	Wayne	Non-metropolitan, with a city of 10,000 or more population
90	Wells	Small metropolitan
91	White	Non-metropolitan, without a city of 10,000 or more population
92	Whitley	Small metropolitan

*See Technical Notes for description of urbanization levels; based on classification used in "Health, United States, 2001" publication of NCHS (9).

Technical Notes

Classification of Indiana hospitals according to levels of neonatal care

During 2001-2002, Indiana Perinatal Network (IPN) in collaboration with Indiana State Department of Health, Maternal and Child Health Services and others conducted a survey of all delivery hospitals in Indiana to assess their level of care using the criteria set forth by the American Academy of Pediatrics-American College of Obstetricians and Gynecologists and the March of Dimes (1-3). Results of self-reported level of care for Indiana delivery hospitals were published in June 2005 in the IPN's consensus document "Levels of Hospital Perinatal Care in Indiana" and were used in this report for classification of hospitals according to neonatal level of care.

Definitions of hospital neonatal care level

Levels of neonatal care are defined as follows:

Basic neonatal care (level I)

- Well-newborn nursery
- Evaluation and postnatal care of healthy newborns
- Neonatal resuscitation
- Stabilization of ill newborns until transfer to a facility at which specialty neonatal care is provided

Specialty neonatal care (level II)

- Special care nursery
- Care of preterm infants with birth weight >=1,500 g
- Resuscitation and stabilization of preterm and/or ill infants before transfer to a facility at which newborn intensive care is provided

Subspecialty neonatal intensive care (level III)

Level IIIA

- Hospital or state-mandated restriction on type and/or duration of mechanical ventilation

Level IIIB

- No restrictions on type or duration of mechanical ventilation
- No major surgery

Level IIIC

- Major surgery performed on site (eg, omphalocele repair, tracheoesophageal fistula or esophageal atresia repair, bowel resection, myelomeningocele repair, ventriculoperitoneal shunt)
- No surgical repair of serious congenital heart anomalies that require cardiopulmonary bypass and /or ECMO for medical conditions

Level IIID

- Major surgery, surgical repair of serious congenital heart anomalies that require cardiopulmonary bypass, and/or ECMO for medical conditions

Computation of percentages

In computation of percentages (also referred to as prevalence or rate) and percent distributions, births for which a particular characteristic is unknown were subtracted from the figures for total births that were used as denominators before percentages and percent distributions were computed.

Birth cohort linked file

To create the 2000-2005 birth cohort linked files, death certificate numbers of infants (Indiana residents) who were born during 2000-2005 and died under one year of age (between 2000-2006) were matched and linked to their corresponding birth certificates. Accuracy of linking was determined by measuring consistency between various items common to both the birth and the death certificates such as date of birth, infant's first name, infant's last name, infant's sex, and mother's maiden name. This link created a single record, containing information found on both the birth and death certificates, from the two previously separate records. More than 98 percent of the Indiana resident infant death records were successfully matched with their corresponding birth records. Of the matched birth/infant death records, those who were not Indiana residents at the time of birth were excluded, and the remaining matched infant deaths (residents of Indiana at both the time of birth and the time of death) comprised the final 2000-2005 birth cohort linked file.

Infant mortality rate, random variation, and stability of rates

Infant mortality rates (IMR) are calculated by dividing the number of infant deaths in a certain category (numerator) by the number of live births in the same category (denominator), times 1,000. The IMR is subject to random (or chance) variation in the number of births or deaths involved.

In this report, the number of VLBW infants represents complete counts for those births in the State of Indiana for which the information on birth weight is available. Therefore, IMR are not subject to sampling error. However, when rates are compared over time, between areas, or among various subgroups, the number of events and the corresponding rates are subject to random variation. That is, the rate that actually occurred may be considered as one of a large number of possible different outcomes (rates) that could have arisen under the same circumstances. As a result, rates in a given population may tend to fluctuate from year to year even when the health of that population is unchanged. The simplest method for addressing the issue of random variation is the computation of 95 percent confidence interval. This interval indicates that it has 95 percent probability of including the true rate.

Random variation in rates based on a relatively small number of events tends to be larger than that for rates based on more frequently occurring events. To deal with the stability problem, six years of data are combined to increase the number of events, reduce the effect of random variation, and improve the reliability of rates in various categories.

When the number of events, in this case the number of infant deaths, is large, the relative standard error (RSE) is small, and the binomial distribution is used to estimate the 95 percent confidence interval (4). When the number of events in the numerator (infant deaths) is less

than 100, the confidence interval for the rate can be based on a Poisson distribution (4). The formula for RSE of the IMR is:

RSE = 100 x SQRT (1/D+1/B),

where D is the number of deaths, B is the number of births, and SQRT denotes square root of the expression in parentheses.

The formula for 95 percent confidence interval based on binomial distribution is:

Lower: IMR – 1.96 x IMR x RSE/100

Upper: IMR + 1.96 x IMR x RSE/100

The formula for 95 percent confidence interval based on Poisson distribution using Table III is:

Lower: IMR x L (D_{adj})

Upper: IMR x U (D_{adj})

where D_{adj} is the adjusted number of infant deaths used to take into account the RSE of the number of infant deaths and live births and is computed as follows:

$$D_{adj} = \frac{D \times B}{D + B}$$

L (D_{adj}) and U (D_{adj}) refer to the values in Table III corresponding to the value of D_{adj}.

Comparison of two infant mortality rates

If either of the two IMRs to be compared (R_1 or R_2) is based on less than 100 infant deaths, first compute the 95 percent confidence interval for each rate and then check to see if they overlap. If they do overlap, the difference is not statistically significant at the 0.05 level. If they do not overlap, the difference is considered statistically significant.

If both rates are based on 100 or more deaths, the following Z-test is used to test for significance:

$$Z = \frac{R_1 - R_2}{\text{SQRT}\left[(R_1)^2 \times (RSE_1/100)^2 + (R_2)^2 \times (RSE_2/100)^2\right]}$$

If Z is equal to or greater than 1.96, the difference is statistically significant at the 0.05 level; and if Z is less than 1.96, the difference is not statistically significant.

In this report, the statistical analyses were performed only on change in IMR between the two periods of 1990-1994 and 1999-2003 in various categories.

Statistical analysis

Logistic regression analysis was used to examine the association of maternal characteristics to delivery of VLBW infants outside level III hospitals. To control for the effect of potential confounders, multiple logistic regression was used to simultaneously control for the effect of maternal variables (race/Hispanic origin, age, education, marital status, parity, smoking status, prenatal care, and urbanization of county of residency) (5). Logistic regression analysis was also used to examine the association of hospital level of neonatal care to neonatal mortality of VLBW infants. Multiple logistic regression was used to control for the maternal, as well as delivery (multiple, cesarean), and infant (gender, congenital anomalies, and birth weight under 500 grams) characteristics.

Birth-weight edits

Birth-weight edits were performed according to National Center for Health Statistics (NCHS) guidelines (6). Birth weights below 227 grams and above 8,650 grams were considered as unknown. Birth weights within the acceptable range of 227 to 8,650 grams were checked for consistency with gestational age.

Prenatal care utilization

In addition to initiation of the prenatal care as a measure, different prenatal care indices have been developed as alternative measures based on the timing of the prenatal care, the number of prenatal visits, and the gestational age of the infant at birth. In this report, the Kotelchuck Adequacy of Prenatal Care Utilization (APNCU) Index is used (7). This Index includes the adequate plus care category for those women with unexpectedly large number of prenatal visits given the gestational age at delivery and the month prenatal care began.

The Kotelchuck Index does not assess the quality of the prenatal care; it simply assesses its utilization. The prenatal care utilization is considered inadequate if care is initiated after the fourth month of pregnancy regardless of the number of visits. Once prenatal care is initiated during the first four months of pregnancy, then the index is classified into inadequate, intermediate, adequate, or adequate plus if the ratio of actual-to-expected number of visits is less than 50 percent, 50-79 percent, 80-109 percent, or 110 percent and more, respectively. The adequate-plus category mainly includes women who are considered at high risk and receive extra prenatal services and have a disproportionately high share of low birth weight infants compared to other categories (8). The prenatal care index is considered unknown for mothers who have missing information or inconsistent values on the initiation of prenatal care, the number of visits, or gestational age, and for mothers with duration of gestation below 20 weeks and above 44 weeks (considered unacceptable values according to Kotelchuck Index).

Urbanization level of county of residence

Definition of urbanization levels

This report uses a five-level urbanization classification for counties. There are three urbanization levels for metropolitan counties and two for non-metropolitan counties. All 92 Indiana counties were assigned to one of the five levels.

The three levels for metropolitan (metro) counties are:

A. Large central
B. Large fringe
C. Small metro

The two levels for non-metropolitan (non-metro) counties are:

D. With a city of 10,000 or more population
E. Without a city of 10,000 or more population

In this report, urbanization level is for the county of residence of mother and the two separate categories of non-metropolitan counties are combined into one category of non-metropolitan due to the similar pattern between them.

Assignment of counties to the urbanization levels

The assignment of counties to the five urbanization levels used in this report is according to the levels used in Health, United States, 2001, Urban and Rural Health Chartbook (9) based on their classification in the Urban Influence code system (December 1996 Revision) developed by the Economic Research Service, U.S. Department of Agriculture (10). The categorization of counties as metropolitan or non-metropolitan in Urban Influence code system is based on the June 1993 Office of Management and Budget (OMB) definition of metropolitan areas according to the application of the 1990 metropolitan area standards (11). Metropolitan counties are those that are included in a metropolitan area. Non-metropolitan counties are those that are not included in a metropolitan area.

Metropolitan areas

OMB defines metropolitan areas according to published standards that are applied to Census Bureau data (11). The general concept of a metropolitan area is that of a core area containing a population nucleus, together with additional communities having a high degree of economic and social integration with that core. Metropolitan areas include metropolitan statistical areas (MSA's), consolidated metropolitan statistical areas (CMSA's), and primary metropolitan areas (PMSA's).

The 1990 standards specify that an MSA must include 1) at least one city with 50,000 or more inhabitants or 2) a Census Bureau-defined urbanization area of at least 50,000 inhabitants and a total metropolitan population of at least 100,000. In addition to the county or counties that contain the largest city, an MSA also includes counties that have a large portion of their population living in the urbanized area surrounding the largest city or that meet specified commuting and metropolitan character requirements. If an MSA has a population of 1 million or more and meets requirements specified in the standards, it is termed a CMSA, consisting of two or more major components recognized as PSMAs.

Urbanization levels for metropolitan counties

The urban influence code system classifies metropolitan counties as either large metro (county is an MSA/PMSA of 1 million or more population) or small metro (county is an MSA/PMSA of less than 1 million population). In this report, according to the levels used in Urban and Rural Health Chartbook (9), the large metro category of the Urban Influence code system was divided into two urbanization levels: large central metro and large fringe metro.

Therefore, the metro counties in this report were assigned to one of three urbanization levels as follows:

Large central metro- A county in a large (1 million or more population) MSA/PMSA was assigned to this urbanization level if it contains all or part of the largest central city of the MSA/PMSA. According to this classification, Marion County was the only county in this category.

Large fringe metro- A county in a large (1million or more population) MSA/PMSA was assigned to this urbanization level if it does not contain any part of the largest central city of the MSA/PMSA.

Small metro- A county was assigned to this urbanization level if it was in a small (less than 1 million population) MSA/PMSA.

Urbanization categories for non-metropolitan counties

The Urban Influence code system divides non-metropolitan counties into seven categories based on adjacency to a metropolitan area and size of the largest city. A county is considered to have a city with a specified size if it includes all to part of the city. In this report, based on the classification used in Rural and Urban Health Chartbook (9), the seven categories were collapsed in to two categories: non-metro counties with a city of 10,000 or more population and non-metro counties without a city of 10,000 or more population. The categories were collapsed based on size of city rather than on adjacency to a metropolitan area because the effect of small cities in non-metro areas is particularly important as their presence or absence affects health service availability.

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