
Analysis of the 2010 Birth Defects Registry

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EXECUTIVE SUMMARY

Birth defects are among the leading causes of infant death in Delaware and nationwide. For this reason, the state's birth defects registry was developed to collect and identify the diverse factors that may cause birth defects. This report on the birth defects registry has two objectives:

1. To provide a snapshot of the characteristics of mothers and infants listed in the birth defects registry, focusing only on those infants who were born to Delaware residents in 2010 ("registered infants").
2. To compare the demographic and health attributes of these infants to all infants born to Delaware residents in 2010.

In response to these objectives, a comprehensive set of analyses was performed on the mothers of the infants listed in the registry, on the infants listed in the registry, and on the registry itself. These analyses included but were not limited to a comparison of the demographic indicators and health status of mothers in the registry compared to all Delaware residents that gave birth in 2010, and an assessment of infants in the registry that expired within one year after birth. In addition, an investigation was conducted on whether infants listed in the registry were diagnosed with the same birth defect as a family member, recognizing the limitations that reported birth defect(s) of family member(s) were based on the mother's recollection of the birth defect(s) and that the medical records of the family member(s) were not reviewed.

Results indicated that mothers in the registry had generally the same age, education, race and ethnicity, and gravida as all Delaware residents that gave birth in 2010. Moreover, certain findings paralleled those found in other Delaware-specific maternal health assessments.

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INTRODUCTION

A birth defect, or congenital anomaly, is an abnormality of structure, function, or metabolism that typically occurs to an infant prior to birth and can cause mental or physical disabilities or even death.¹ Every 4½ minutes, an infant is born in the United States with a birth defect, and in 2009, birth defects accounted for about 1 in 5 infant deaths in the United States.² In Delaware, birth defects were the second leading cause of infant mortality in the 2006-2010 period, accounting for 14.9 percent of all infant deaths.³ Although genetic and environmental factors – individually or in combination – can cause birth defects, the causes of 7 out of 10 birth defects are unknown.¹

The Delaware Birth Defects Registry is a statewide program that collects and analyzes information on children with birth defects.⁴ The intent of the registry is to identify the environmental, genetic, and health risk factors that may ultimately cause birth defects. To be included as a case in the Delaware Birth Defects Registry, all of the following criteria must be met:

- The mother must reside in Delaware at the time of delivery/pregnancy outcome.
- The infant or fetus must have a birth defect or developmental disability monitored by the registry.
- The birth defect must be diagnosed prenatally or within one year after delivery.

The case definition includes all pregnancy outcomes (i.e., live births, spontaneous fetal deaths, and induced pregnancy terminations for a fetus weighing at least 350 grams, or in the absence of weight, 20 weeks of gestation).

This report has two objectives:

1. To provide a snapshot of the characteristics of mothers and infants listed in the birth defects registry, focusing only on those infants who were born to Delaware residents in 2010 (“registered infants”).
2. To compare the demographic and health attributes of these infants to all infants born to Delaware residents in 2010. This may assist in investigations on feto-infant health disparities and on policies relevant to maternal and child health.

These objectives were met through a meticulous analysis of the demographics, prior pregnancy history, and health conditions of the mother and an assessment of the reported birth defects and health status of the infant.

METHODOLOGY

Procedure for Case Finding and Ascertainment

Entries in the birth defects registry (“cases”) were identified through a routine review of primary source records. Primary sources currently included, but were not limited to, the following:

- Electronic birth records.
- Hospital electronic and paper medical records.
- Maternal Fetal Medicine electronic records.
- Vital Statistics.

- Licensed birthing centers.

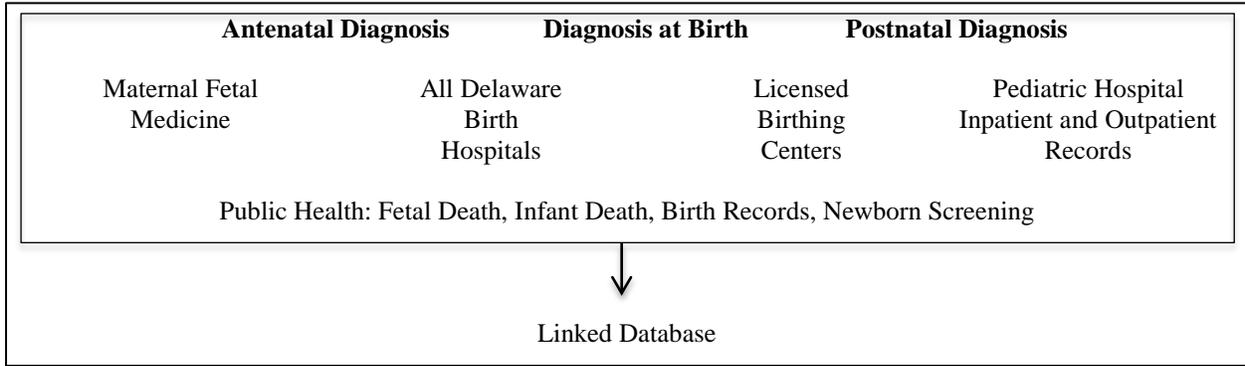
Cases were ascertained from multiple sources along three broad paths.

- *First Path.* The records of birth hospitals, licensed birthing centers, and midwives provided the first path for case detection. The frequency of visits to each facility was determined in part by the number of births per year in that facility. The Program Manager requested a list of all patients that were discharged during a specified birth cohort year and have one or more of the codes listed in Appendix A.
- *Second Path.* A second path for case detection involved collecting information from places where children may be prenatally diagnosed or where pregnancies may be terminated. The Program Manager requested a list of all patients that received prenatal care or testing from the Maternal Fetal Medicine groups during the specific birth cohort being abstracted and resulted in a diagnosis of one or more of the codes listed in Appendix A.
- *Third Path.* A third path of case detection involved the review of other sources by the program staff. One of these sources is the Delaware Office of Vital Statistics, which provided a list of names and date of birth or date of death. In addition to these records, staff also reviewed other data sets, such as Hospital Discharge Data and those collected by Newborn Screening – Blood Spot and Hearing. In addition to serving as a catch for any missed cases, these vital record reviews also provided a means for verifying data on completed cases and a source of data for incomplete cases.

Creation of a Potential Case List

Potential case lists were requested by the Program Manager through each institution's medical records department. Lists were created using software to query all births and/or fetal deaths for the ICD-9 codes tracked by the registry. When an institutional list was received, it was validated for the appropriate codes and any erroneous codes that were not tracked by the registry were removed. The lists were provided in a vertical formation in which each case has one line of data for each defect noted in the chart. The Program Manager used SPSS software to flatten the list into a horizontal formation in which each case has only one line of data with each suspected defect listed one after another. The fetal death, infant death, birth certificate and newborn screening lists were also prepared in this fashion. To obtain the suspected defects and/or cause of death from the fetal death list, a codebook of diagnoses provided by the Office of Vital Statistics was used. The infant death list was provided with ICD-10 diagnoses, which were translated into ICD-9 for consistency in the registry. The newborn screening list provided a description in words to note the screening abnormality which is transferred into ICD-9 codes by the registry team. The maternal fetal medicine groups provided potential case defect descriptions through cytogenic reports and fetal therapy lists, which were also translated into ICD-9 codes by the registry team. For any list in which defect descriptions are provided and ICD-9 codes are translated, both the code and original defect description were maintained in the registry for validation purposes.

Figure 1. Flowchart for the Creation of the Linked Database.



Once all lists are flattened and prepared for linking, the Program Manager used the Fine Grained Record Linkage (FRIL) software tool to link all lists together to create one unduplicated list of all potential cases. FRIL uses weighted matching parameters to assign a matched confidence level to the data. Since medical record numbers were different for each institution, the potential cases were matched on the baby’s first and last name, the mother’s first and last name, the baby’s date of birth, and the mother’s date of birth. The mother’s date of birth was not always available, especially from the pediatric hospital, in which case only the mother’s name was used to match. When the lists were matched together, the data from institution #1 was linked to institution #2. If the same mother/child pair existed in both datasets, the pair was linked together in order for the ICD-9 codes and suspected defects from both institutions to be associated with that child. This linking process maintains a unique list of cases in which no child was duplicated, but rather, data from subsequent institutions is appended to the already existing data for that child.

Upon completion of the unduplicated list, the Program Manger automatically uploaded all potential case information into the Delaware Birth Defects Registry Access database housed within the Christiana Care Health System. The Program Assistants/Chart Abstractors used the unduplicated list in the Microsoft Access database to complete their case confirmation and abstraction. The Program Manager sorted the unduplicated case list by defect group or institution using SPSS or the Microsoft Access database.

Case Ascertainment through Medical Records

If any of the conditions in Appendix A appeared during the case finding process, the medical record underwent a full review for any reportable defects that may be associated with these conditions. A Case Abstraction Form was then completed on all medical records where a reportable condition was confirmed. Once a Case Abstraction Form was completed on a confirmed case, additional information was entered in the Access Database. If the case was confirmed as a non-case, Program Assistants coded this as “not a case” in the database and no further information was collected for that case. A clinical geneticist made the confirmation of whether a case was a case or a non-case. All cases and non-cases were documented on the Delaware Birth Defects Progress Sheet for that cohort year.

Analysis of the Registry

Christiana Care Health System submitted the complete 2010 Delaware Birth Defects Registry database to the Delaware Division of Public Health (DPH). DPH made the database available to Forward Consultants, the evaluation specialist. Forward Consultants uploaded the database – set up as a secure Microsoft Excel spreadsheet – to Microsoft Access and analyzed the data using SQL code. Graphs, percent calculations, statistical analysis, and tables were generated in Microsoft Excel.

CHARACTERISTICS OF THE REGISTRY

Appendix B lists the fields included in the 2010 Delaware Birth Defects Registry. The registry consists of 454 unique infants. Because certain data may not be available for each case, many of the fields listed in Appendix B do not have data for each of the 454 infants. For this reason, the counts may not add to 454 in several of the tables in this analysis.

Data for the infants in the registry was abstracted from the facilities listed in Table 1.

Table 1. Facility from Where Infant Data Was Abstracted.

Facility	Number of Infants
A.I. DuPont Hospital	380
Christiana Care Hospital	181
Delaware Division of Public Health Newborn Screening Program	22
Delaware Health and Social Services Office of Vital Statistics	16
Kent General Hospital	15
Nanticoke Memorial Hospital	13
Christiana Care Health System Neonatal Intensive Care Unit	11
Delaware Center for Maternal and Fetal Medicine of Christiana Care	11
St. Francis Hospital	9
Beebe Hospital	8
Milford Memorial Hospital	2

Source: State of Delaware 2010 Birth Defects Registry.

CHARACTERISTICS OF MOTHERS IN THE REGISTRY

Mother’s Residence

The residence of the registered infants’ mothers is given in Table 2.

ANALYSIS OF THE 2010 BIRTH DEFECTS REGISTRY

Table 2. Location of Residence of Registered Infants' Mothers.^A

County	2010 Registry	All 2010 Events	Percentage of All 2010 Births in Registry
Kent	91	2,227	4.09%
New Castle	279	6,867	4.06%
Sussex	84	2,270	3.70%
Delaware	454	11,364	4.00%

Source: State of Delaware 2010 Birth Defects Registry.

Of the 279 infants' mothers that resided in New Castle County, 86 infants' mothers resided in Wilmington.

Mother's Age

Table 3 provides counts of the registered infants' mothers stratified by both age and county of residence.

Table 3. Age of Registered Infants' Mothers.

County/State	19 Years & Under	20-24 Years	25-29 Years	30-34 Years	35-39 Years	40 Years & Over
Kent	5	31	23	19	8	3
New Castle (w/o Wilmington)	11	32	57	49	29	15
Sussex	7	21	29	20	5	2
Wilmington	13	23	21	20	6	3
Delaware	36	107	130	108	48	23

Source: State of Delaware 2010 Birth Defects Registry.

Mother's Education

Table 4 displays the counts of registered infants' mothers stratified by county of residence and educational attainment. Note that the educational attainment was unknown or not available for 122 of the 454 infants' mothers (26.87% of all infants).

Table 4. Educational Attainment of Registered Infants' Mothers.

County/State	Less Than High School	Some High School Not Graduate	High School Graduate	3 or Less Years College	4 Or More Years College
Kent	2	8	21	8	25
New Castle (w/o Wilmington)	6	16	37	34	57
Sussex	3	12	16	11	14
Wilmington	8	16	19	8	11
Delaware	19	52	93	61	107

Source: State of Delaware 2010 Birth Defects Registry.

^A In this analysis, the zip code of the mother's residence was used to assign whether the mother resided in Wilmington or the remainder of New Castle County. In particular, zip codes 19801, 19802, 19804, 19805, and 19806 were used to indicate residence in Wilmington.

Mother's Race and Ethnicity

Table 5 provides the counts of registered infants' mothers stratified by the mother's race and ethnicity.^B

Table 5. Race and Ethnicity of Registered Infants' Mothers.

County/State	White Non-Hispanic	Black Non-Hispanic	Hispanic
Kent	50	28	6
New Castle (w/o Wilmington)	124	39	20
Sussex	63	7	14
Wilmington	21	43	19
Delaware	258	117	59

Source: State of Delaware 2010 Birth Defects Registry.

Appendix C.1 features graphs that compare the race and ethnicity of the mothers listed in the registry with the race and ethnicity of all mothers that gave birth in Delaware in 2010.⁵ The graphs are stratified by race and ethnicity ("White Non-Hispanic", "Black Non-Hispanic", and "Hispanic") as well as by the location of the mother's residence. No noteworthy statistically significant differences exist between the percentage of mothers in the registry and all mothers that gave birth in Delaware in 2010 in the race and ethnicity categories.^C

Mother's Pregnancy History**Gravida**

Appendix C.2 shows graphs of the gravida (the total number of times the mother has been pregnant) of the mother at the child's birth. These graphs compare the gravida of mothers listed in the registry with the gravida of all mothers that gave birth in Delaware in 2010.⁵ The graphs are stratified by the gravida value ("1", "2", "3", "4", "5", and "6 or More") as well as by the location of the mother's residence. As evidenced by these graphs, no meaningful, statistically significant differences exist between the gravida of mothers in the registry and mothers that gave birth in the other counties in 2010.^C

Previous Infant Death

Four (4) entries in the registry document that the mother had a previous birth that resulted in a neonatal death (death between 1 hour and 27 days after birth). No entries document that the mother had a previous birth that resulted in a postneonatal death (death between 28 days and 365 days after birth).

^B The race and ethnicity investigation was limited to "White Non-Hispanics", "Black Non-Hispanics", and "Hispanics". These three race and ethnicity designations represented 434 out of the 454 entries (95.59% of entries).

^C Statistical significance was established using 95% confidence intervals (CI). Note that the use of overlapping/non-overlapping of 95% confidence intervals (CI) to establish statistical significance results in a more conservative estimate of the probability of a true difference in the percentages than establishing the strict statistical definition of a 95% confidence level. Strictly speaking, it is possible for two percentages to be different at the 95% confidence level even though the 95% CIs overlap.

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Live Children

As displayed in Table 6, the majority of registered infants’ mothers had either no live children or one live child at the time of the birth of the infant entered into the birth defects registry.

Table 6. Count of Live Children for Mothers in Registry.

County/State	None	1	2	3	4 or More
Kent	36 (40.45%)	28 (31.46%)	11 (12.36%)	8 (8.99%)	6 (6.74%)
New Castle (w/o Wilmington)	85 (44.04%)	58 (30.05%)	29 (15.03%)	14 (7.25%)	7 (3.63%)
Sussex	32 (38.10%)	32 (38.10%)	12 (14.29%)	7 (8.33%)	1 (1.19%)
Wilmington	44 (51.16%)	21 (24.42%)	9 (10.47%)	4 (4.65%)	8 (9.30%)
Delaware	197 (43.58%)	139 (30.75%)	61 (13.5%)	33 (7.3%)	22 (4.87%)

Source: State of Delaware 2010 Birth Defects Registry.

Vitamin Use

As shown in Table 7, roughly 9 out of 10 registered infants’ mothers reported regular use of vitamins.

Table 7. Vitamin Use by Mothers in Registry.

Vitamin Use	Count	Percent
Yes	416	91.63%
No	7	1.54%
Not Stated	31	6.83%

Source: State of Delaware 2010 Birth Defects Registry.

Prenatal Care

As indicated by Table 8, the overwhelming majority of mothers received prenatal care during pregnancy; specifically, 448 infants (99.12% of infants) were to mothers that received some form of prenatal care.

Table 8. Prenatal Care during Pregnancy.

County/State	Yes	No	Not Stated
Kent	89	0	2
New Castle (w/o Wilmington)	192	1	0
Sussex	83	1	0
Wilmington	84	2	0
Delaware	448	4	2

Source: State of Delaware 2010 Birth Defects Registry.

Table 9 shows that the majority of infants in the registry – 364 infants (83.87% of infants) – have mothers that initiated prenatal care in the first trimester of pregnancy. The percentage of infants with mothers who received prenatal care in the first trimester ranged from 74.39% in Sussex to 88.17% in New Castle (excluding Wilmington); Kent was 85.06% and Wilmington was 82.28%. These figures do not include infants for which prenatal care initiation was unknown (“Unknown” column in Table 9). Of those infants for which prenatal care is reported for the mother, 13 infants (4.61% of infants) were to mothers that

initiated prenatal care in the third trimester. More than half of these mothers – 9 out of 13 – resided in either Sussex County or in Wilmington.

Table 9. Initiation of Prenatal Care during Pregnancy.

County/State	1st Trimester	2nd Trimester	3rd Trimester	Unknown
Kent	74	11	2	4
New Castle (w/o Wilmington)	164	20	2	7
Sussex	61	16	5	2
Wilmington	65	10	4	7
Delaware	364	57	13	20

Source: State of Delaware 2010 Birth Defects Registry.

Maternal Illnesses, Conditions, and Complications

Table 10 outlines the count of illnesses, conditions, and complications of the mothers (“condition”) listed in the registry and the count and percent of infant entries with this count. This table shows that 10.13% of infants have a mother that did not have any conditions listed. These findings reveal that the clear majority of infants in the registry – 68.50% of infants – have a mother reported as having multiple conditions.

Table 10. Count of Maternal Conditions by Registry Entry.

Count of Conditions	Count of Infant Entries	Percent of Total Infant Entries
0	46	10.13%
1	97	21.37%
2	94	20.70%
3	84	18.50%
4	59	13.00%
5	32	7.05%
6	16	3.52%
7	16	3.52%
8	8	1.76%
9	2	0.44%

Source: State of Delaware 2010 Birth Defects Registry.

Table 11 displays the counts for each of the maternal conditions listed in the registry.

Table 11. Count of Maternal Conditions.

Condition	Count	Condition	Count
Surgery-Non Gynecologic Non Transplant	223	Seizure Disorder	10
Surgery-Gynecologic	150	Coagulopathy	7
Tobacco	126	Heart Disease	7
Obesity	125	Diabetes Mellitus Type I	6
Alcohol	120	Other Psychiatric Disorders	6
Depression	79	Cancer	5
Illicit Drugs	56	Rubella Immune Status-Non-Immune	4
Diabetes Gestational	50	Hepatitis C	4
Hypertension (PIH)	49	Lupus	3
Thyroid Disease	37	Abdominal Trauma	1
Toxemia/Preeclampsia	37	Cytomegalovirus (CMV)	1
Chronic Hypertension	33	Hepatitis B	1
Genital Herpes	18	HIV/AIDS	1
Bipolar Disorder	17	Inflammatory Bowel Disease	1
Placenta Previa	17	RH Antibodies	1
Diabetes Mellitus Type II	14	Schizophrenia	1
Weight Loss	12	Syphilis	1

Source: *State of Delaware 2010 Birth Defects Registry.*

Tables 12-13 and Tables 15-19 provide the count of infant entries that correspond to a set of the most common conditions listed in Table 11. In each table, the counts are stratified by the mother's race and ethnicity^B and the location of the mother's residence at the time of the infant's birth. The percentage to the right of each count corresponds to the accompanying count divided by the total count of mothers that meet the criteria based on the two stratifying criteria; Table 5 displays these denominator values. For example, in Table 12, seventeen (17) infant entries were to mothers residing in Kent County that were White non-Hispanic, and according to the registry, were documented as having used some form of tobacco. These 17 infant entries represent 34.00% of all infant entries for mothers residing in Kent County that were White non-Hispanic. Caution should be exercised when examining these tables as several counts have small values (i.e., count of less than 5). In addition, information on alcohol use and tobacco use is based on what is recorded in the mother's medical record, which in turn, is based on what is reported by the mother to her health care provider.

Table 12 provides the count of infants in the registry who have a mother that reported having used some form of tobacco. Generally speaking, a higher percentage of White non-Hispanic mothers – as compared to the other two race and ethnicity groups – used some form of tobacco.

Table 12. Tobacco Use among Mothers in the Registry.

County/State ^D	White Non-Hispanic	Black Non-Hispanic	Hispanic ^E
Kent	17 (34.00%)	4 (14.29%)	0 (0.00%)
New Castle (w/o Wilmington)	46 (37.10%)	7 (17.95%)	1 (5.00%)
Sussex	24 (38.10%)	0 (0.00%)	1 (7.14%)
Wilmington	6 (28.57%)	13 (30.23%)	5 (26.32%)
Delaware	93 (36.05%)	24 (20.51%)	7 (11.86%)

Source: State of Delaware 2010 Birth Defects Registry.

Table 13 outlines the count of infants in the registry who have a mother that used some form of alcohol.

Table 13. Alcohol Use among Mothers in the Registry.

County/State ^D	White Non-Hispanic	Black Non-Hispanic	Hispanic ^E
Kent	8 (16.00%)	2 (7.14%)	0 (0.00%)
New Castle (w/o Wilmington)	53 (42.74%)	9 (23.08%)	3 (15.00%)
Sussex	13 (20.63%)	0 (0.00%)	0 (0.00%)
Wilmington	11 (52.38%)	14 (32.56%)	6 (31.58%)
Delaware	85 (32.95%)	25 (21.37%)	9 (15.25%)

Source: State of Delaware 2010 Birth Defects Registry.

Note that 54 infants (11.89% of infants) in the registry have a mother that was documented as having used *both* alcohol and tobacco. Also, 191 infants (42.07% of infants) have a mother documented as having used *either* alcohol or tobacco.

Table 14 delineates both alcohol and tobacco use by whether the registered infant’s mother used the substance *only before* pregnancy (“Only Before”) or *before and during* pregnancy (“Before/During”). No mothers stated that they used a substance *only during* pregnancy. The percentages in Table 14 were calculated by taking the neighboring count and dividing it by the total number of women in the respective county; Table 2 provides the total number of women in each county. For example, eight (8) registered infants’ mothers that resided in Kent County used alcohol only before pregnancy. This represents 8.79% of all registered infants’ mothers that resided in Kent County. Finally, the counts in Table 14 include all race and ethnicity groups.

These findings suggest that while fewer registered infants’ mothers used alcohol before and during pregnancy as compared to before pregnancy alone, *more* infants’ mothers continued use of tobacco during pregnancy as compared to registered infants’ mothers that only used tobacco prior to pregnancy.

^D Kent, Sussex, and Wilmington counts and percentages may be low due to differences in how these conditions were reported.

^E Hispanic counts and percentages may be low due to language and/or cultural barriers in reporting of these conditions.

Table 14. Alcohol and Tobacco Use during Pregnancy among Mothers in the Registry.

County/State ^D	Alcohol Use		Tobacco Use	
	Only Before	Before/During	Only Before	Before/During
Kent	8 (8.79%)	2 (2.20%)	2 (2.20%)	21 (23.08%)
New Castle (w/o Wilmington)	54 (27.98%)	11 (5.70%)	18 (9.33%)	36 (18.65%)
Sussex	8 (9.52%)	5 (5.95%)	3 (3.57%)	22 (26.19%)
Wilmington	26 (30.23%)	6 (6.98%)	12 (13.95%)	12 (13.95%)
Delaware	96 (21.15%)	24 (5.29%)	35 (7.71%)	91 (20.04%)

Source: State of Delaware 2010 Birth Defects Registry.

Table 15 reports the number of registered infants' mothers documented as having obesity. Aside from cells with low counts (less than 5), the percentages listed in the table generally approximate one another.

Table 15. Obesity among Mothers in the Registry.

County/State ^D	White Non-Hispanic	Black Non-Hispanic	Hispanic ^E
Kent	14 (28.00%)	10 (35.71%)	1 (16.67%)
New Castle (w/o Wilmington)	30 (24.19%)	16 (41.03%)	3 (15.00%)
Sussex	16 (25.40%)	2 (28.57%)	2 (14.29%)
Wilmington	5 (23.81%)	16 (37.21%)	5 (26.32%)
Delaware	65 (25.19%)	44 (37.61%)	11 (18.64%)

Source: State of Delaware 2010 Birth Defects Registry.

Although the counts are relatively low, the percentage of Black non-Hispanic mothers reported as obese is higher than the other two race and ethnicity groups, a finding consistent with other Delaware-specific maternal health assessments.^{6,7}

Table 16 lists the counts and percentages of registered infants' mothers with pregnancy-induced hypertension (PIH). Table 17 lists the counts and percentages of registered infants' mothers documented as having depression. Finally, Table 18 supplies the counts and percentages of registered infants' mothers reported as having gestational diabetes.

Table 16. Hypertension (PIH) among Mothers in the Registry.

County/State ^D	White Non-Hispanic	Black Non-Hispanic	Hispanic ^E
Kent	6 (12.00%)	4 (14.29%)	0 (0.00%)
New Castle (w/o Wilmington)	12 (9.68%)	9 (23.08%)	1 (5.00%)
Sussex	4 (6.35%)	0 (0.00%)	1 (7.14%)
Wilmington	2 (9.52%)	7 (16.28%)	1 (5.26%)
Delaware	24 (9.30%)	20 (17.09%)	3 (5.08%)

Source: State of Delaware 2010 Birth Defects Registry.

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Table 17. Depression among Mothers in the Registry.

County/State ^D	White Non-Hispanic	Black Non-Hispanic	Hispanic ^E
Kent	12 (24.00%)	2 (7.14%)	0 (0.00%)
New Castle (w/o Wilmington)	24 (19.35%)	5 (12.82%)	4 (20.00%)
Sussex	10 (15.87%)	1 (14.29%)	1 (7.14%)
Wilmington	2 (9.52%)	12 (27.91%)	4 (21.05%)
Delaware	48 (18.60%)	20 (17.09%)	9 (15.25%)

Source: State of Delaware 2010 Birth Defects Registry.

Table 18. Gestational Diabetes among Mothers in the Registry.

County/State ^D	White Non-Hispanic	Black Non-Hispanic	Hispanic ^E
Kent	6 (12.00%)	2 (7.14%)	0 (0.00%)
New Castle (w/o Wilmington)	16 (12.90%)	6 (15.38%)	2 (10.00%)
Sussex	5 (7.94%)	1 (14.29%)	3 (21.43%)
Wilmington	1 (4.76%)	3 (6.98%)	3 (15.79%)
Delaware	28 (10.85%)	12 (10.26%)	8 (13.56%)

Source: State of Delaware 2010 Birth Defects Registry.

Table 19 presents the counts of registered infants' mothers who have multiple (at least two) of the most commonly reported conditions from Table 11.

Table 19. Multiple Conditions of Mothers in the Registry.

County/State ^D	White Non-Hispanic	Black Non-Hispanic	Hispanic ^E
Kent	39 (78.00%)	14 (50.00%)	1 (16.67%)
New Castle (w/o Wilmington)	101 (81.45%)	31 (79.49%)	9 (45.00%)
Sussex	41 (65.08%)	2 (28.57%)	3 (21.43%)
Wilmington	16 (76.19%)	33 (76.74%)	11 (57.89%)
Delaware	197 (76.36%)	80 (68.38%)	24 (40.68%)

Source: State of Delaware 2010 Birth Defects Registry.

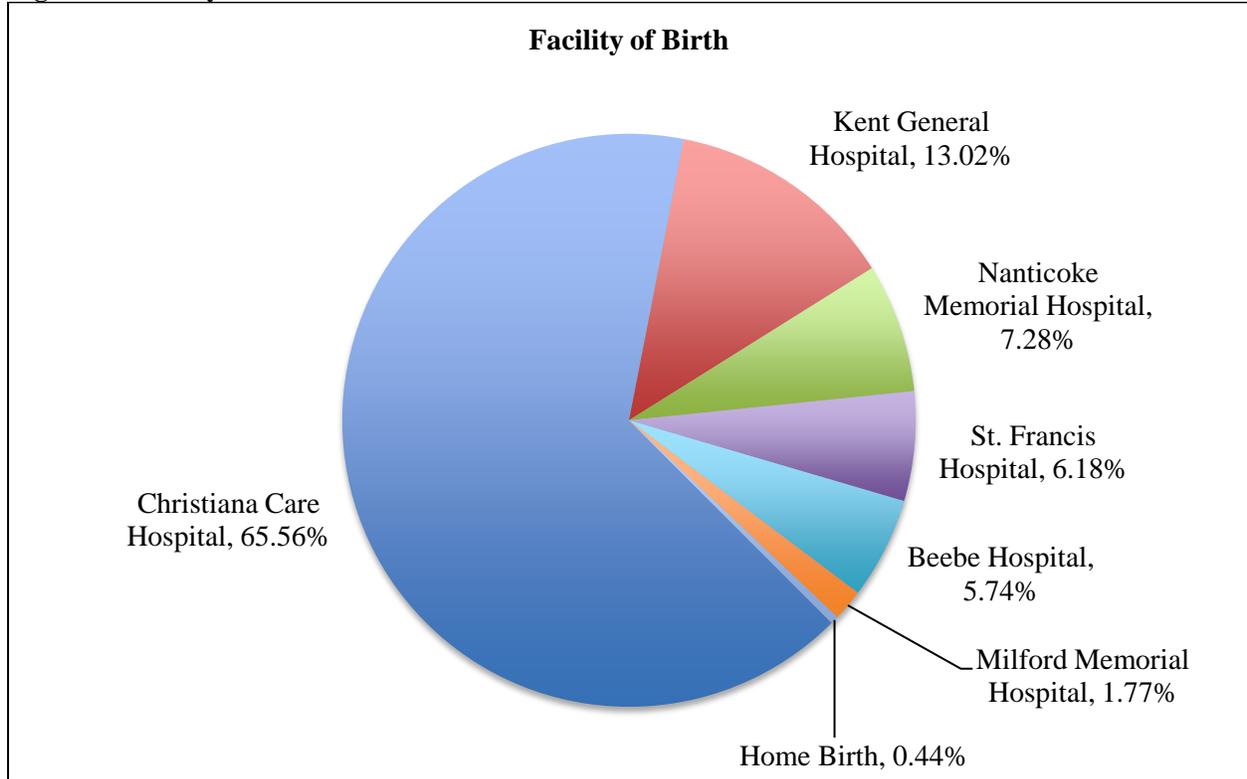
The results from Table 19 are not surprising given that these registered infants' mothers may have interrelated co-morbidities such as obesity, pregnancy-induced hypertension, and gestational diabetes. In addition, some of the counts and percentages may be due to the high count of registered infants' mothers who were reported as having used tobacco or alcohol. This may help to explain the relatively higher percentages reported for White non-Hispanic women in Table 19 given that a higher percentage of White non-Hispanic mothers - compared to the other two race and ethnicity groups - were reported as using some form of tobacco and/or alcohol.

CHARACTERISTICS OF INFANTS IN THE REGISTRY

Facility of Birth

As displayed in Figure 2, the majority of births in the registry occurred at Christiana Care Hospital.

Figure 2. Facility of Birth.



Source: State of Delaware 2010 Birth Defects Registry.

Gestational Weeks

Appendix C.3 displays graphs of the number of gestational weeks of the infant at birth. These graphs compare the number of gestational weeks of the infants listed in the registry with those of all infants born in Delaware in 2010.⁵ The graphs are stratified by different ranges of gestation (“Births Less than 32 Weeks of Gestation”, “Births Between 32 and 36 Weeks of Gestation”, and “Births 37 or More Weeks of Gestation”) as well as by the location of the mother’s residence. For all geographies, the “Births Less Than 32 Weeks of Gestation” graph shows that the percentage of infants in the registry was more than double that of the percentage of all infants born in 2010. Moreover, for all counties, the percentage of infants born at or above 37 weeks was consistently lower among infants in the registry as compared to infants born in 2010. These findings align with research that suggests an association exists between preterm birth and birth defects.^{8,9}

Pregnancy Outcome

Table 20 lists the numbers and percentages of live births and fetal deaths from the registry. In this assessment, fetal death includes stillbirth and termination of pregnancy.

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Table 20. Pregnancy Outcome for Registry Entries.

County	Live Birth		Fetal Death	
	Count	Percentage	Count	Percentage
Kent	89	97.80%	2	2.20%
New Castle (w/o Wilmington)	190	98.45%	3	1.55%
Sussex	81	96.43%	3	3.57%
Wilmington	84	97.67%	2	2.33%
Delaware	444	97.80%	10	2.20%

Source: State of Delaware 2010 Birth Defects Registry.

Plurality

Table 21 shows the number and percentage of infants that are singleton (a single birth), twins, or triplets.

Table 21. Plurality for Infants in the Registry.

Plurality	Count	Percentage
Singleton	432	95.15%
Twin	21	4.63%
Triplet	1	0.22%

Source: State of Delaware 2010 Birth Defects Registry.

Of the 21 infants that are part of a set of twins, 9 were the first-born twin and 12 were the second-born twin. For the triplet, the first-born was the infant diagnosed with a birth defect.

Gender

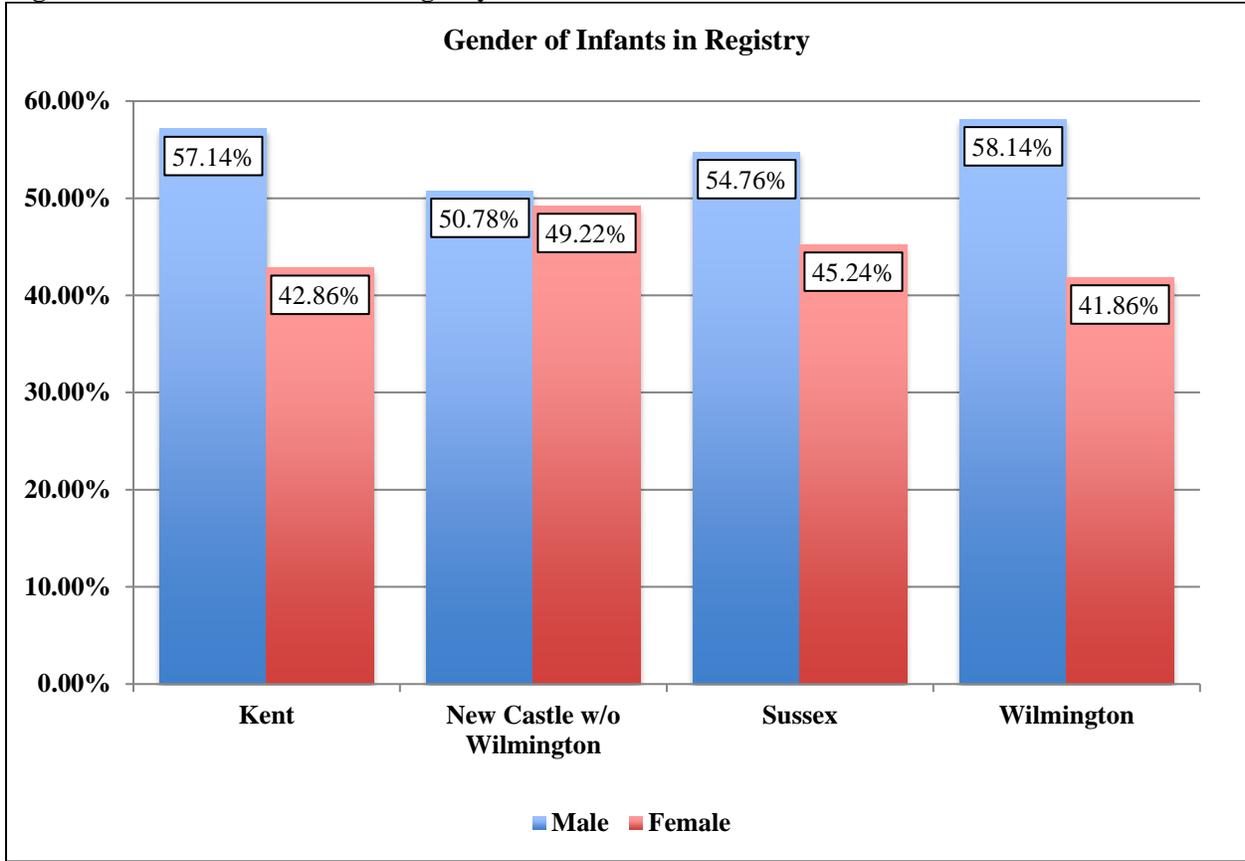
As indicated in Table 22 and Figure 3, the majority of infants in the registry were male.

Table 22. Gender of Infants in the Registry.

County	Total	Female	Male
Kent	91	39	52
New Castle	193	95	98
Sussex	84	38	46
Wilmington	86	36	50

Source: State of Delaware 2010 Birth Defects Registry.

Figure 3. Gender of Infants in Registry.



Source: State of Delaware 2010 Birth Defects Registry.

Growth Percentiles

The WHO Child Growth Standards¹⁰ were applied to calculate the percentages of infants in the registry that were below the 25th, between the 25th and 75th, and above the 75th percentiles in weight, length (stature), and head circumference. The age at birth (0 months) was used when aligning these percentiles and percentiles were adjusted based on the infant’s gender. The results of these growth percentile measures are intended to see if any correlations exist; a causal link between birth defects and these results cannot be established.

Weight Percentiles

Table 23 illustrates that a sizeable percentage of the infants in the birth defects registry are at or below the 25th percentile for weight at the time of birth.

Table 23. Weight Percentile at Time of Birth.

County/State	25 th and Below	Between 25 th – 75 th	75 th and Over
Kent	48.89%	26.67%	24.44%
New Castle w/o Wilmington	40.93%	31.61%	27.46%
Sussex	33.73%	44.58%	21.69%
Wilmington	37.21%	41.86%	20.93%
Delaware	40.49%	34.96%	24.56%

Source: State of Delaware 2010 Birth Defects Registry

Length (Stature) Percentiles

As shown in Table 24, the counties had a similar percentage of infants at or below the 25th percentile, between the 25th and 75th percentile, and at or above the 75th percentile for length at the time of birth.

Table 24. Length (Stature) at Time of Birth.

County/State	25 th and Below	Between 25 th – 75 th	75 th and Over
Kent	34.09%	18.18%	47.73%
New Castle w/o Wilmington	31.77%	27.08%	41.15%
Sussex	30.12%	28.92%	40.96%
Wilmington	36.47%	28.24%	35.29%
Delaware	32.81%	25.89%	41.29%

Source: State of Delaware 2010 Birth Defects Registry

Head Circumference Percentiles

Note that of the 454 infants in the registry, 390 (85.90%) had a head circumference reported. As evidenced by Table 25, a relatively large percentage of the infants in the birth defects registry are at or below the 25th percentile for head circumference at the time of birth.

Table 25. Head Circumference at Time of Birth.

County/State	25 th and Below	Between 25 th – 75 th	75 th and Over
Kent	44.58%	25.30%	30.12%
New Castle w/o Wilmington	44.03%	25.16%	30.82%
Sussex	42.50%	23.75%	33.75%
Wilmington	51.47%	22.06%	26.47%
Delaware	45.13%	24.36%	30.51%

Source: State of Delaware 2010 Birth Defects Registry

Diagnoses of Birth Defects

Each ICD-9 code was categorized as a “confirmed” or “possible/probable” diagnosis of a birth defect. In the registry, 447 infants (98.46% of infants) had only a “confirmed” diagnosis of a birth defect while 4 infants (0.88% of infants) had only a “possible/probable” diagnosis of a birth defect. Finally, 3 infants (0.66% of infants) had at least one “possible/probable” and at least one “confirmed” diagnosis of a birth defect. Given that almost all of the infants had a “confirmed” diagnosis of a birth defect, all infants were included in the analysis even if the infant had only a “possible/probable” diagnosis of a birth defect.

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Table 26 matches the number of reported ICD-9 codes for each infant listed in the registry. This table shows that approximately one-fifth (20.93%) of the infants had more than one diagnosed birth defect.

Table 26. Count of ICD-9 Codes for Infants in the Registry.

Count of Reported ICD-9 Codes	Count of Infants Meeting Criteria	Percent of Infants Meeting Criteria
1	359	79.07%
2	47	10.35%
3	19	4.19%
4	17	3.74%
5	4	0.88%
6	3	0.66%
7	3	0.66%
8	1	0.22%
9	1	0.22%
Total	454	100.00%

Source: State of Delaware 2010 Birth Defects Registry

Table 27 provides a count of the ICD-9 codes documented in the registry.

Table 27. ICD-9 Codes for Infants in the Registry.

ICD-9 Code	ICD-9 Code Description	Count
745	Bulbus cordis anomalies and anomalies of cardiac septal closure	146
754	Certain congenital musculoskeletal deformities	62
746	Other congenital abnormalities of the heart	56
752	Congenital anomalies of genital organs	51
758	Chromosomal anomalies	44
742	Other congenital anomalies of nervous system	42
753	Congenital anomalies of urinary system	36
747	Other congenital anomalies of circulatory system	30
756	Other congenital musculoskeletal anomalies	30
759	Other and unspecified congenital anomalies	21
750	Other congenital anomalies of upper alimentary tract	16
755	Other congenital anomalies of limbs	15
751	Other congenital anomalies of digestive system	14
743	Congenital anomalies of eye	12
282	Hereditary hemolytic anemias	10
749	Cleft palate	10
Other	–	37
Total		632

Source: State of Delaware 2010 Birth Defects Registry

A substantial number of codes are associated with congenital anomalies of the circulatory system (ICD-9 745, 746, and 747; 232 diagnoses or 36.71% of all diagnoses).

ANALYSIS OF THE 2010 BIRTH DEFECTS REGISTRY

Moreover, note that the ICD-9 code reported in the registry was used to generate the count in Table 27. This figure – 632 – is smaller than the overall number of diagnoses, which totaled 654.

Table 28 outlines the methods by which the birth defect was diagnosed. Roughly 3 out of 5 (59.94%) of the reported birth defects were definitively diagnosed by either echocardiogram or clinical (physical exam).

Table 28. Method of Diagnosis for Birth Defect.

Method of Diagnosis	Count of Diagnoses by Method	Percent of All Diagnoses
Echocardiogram	234	35.78%
Clinical	158	24.16%
Ultrasound	98	14.98%
Genetics	53	8.10%
Laboratory	36	5.50%
X-ray	30	4.59%
MRI	18	2.75%
Ophthalmologic Exam	10	1.53%
Autopsy	5	0.76%
Surgical Observation	5	0.76%
Audiogram	4	0.61%
CT Scan	3	0.46%
Total	654	100.00%

Source: State of Delaware 2010 Birth Defects Registry

Of the 654 birth defect diagnoses, 198 (30.28%) were confirmed at a prenatal visit while the remaining 456 (69.72%) were confirmed at a postnatal visit. Table 29 displays the count of infants in the registry for which all birth defects diagnoses were confirmed only during prenatal visits, only during postnatal visits, or at both prenatal and postnatal visits. For example, if an infant was diagnosed with multiple birth defects and all of these diagnoses were confirmed only at one or more prenatal visits, then the infant was counted in the “Prenatal” category. Likewise, if an infant was diagnosed with multiple birth defects and all of these diagnoses were confirmed only at one or more postnatal visits, then the infant was counted in the “Postnatal” category. Finally, if an infant had multiple birth defect diagnoses and some of these diagnoses were confirmed at a prenatal visit while other diagnoses were confirmed at a postnatal visit, then the infant was counted in the “Both” category.

Table 29. Infants with Diagnosis of All Birth Defects Confirmed at Prenatal, Postnatal, or Both.

Prenatal	Postnatal	Both
101 (22.25%)	314 (69.16%)	39 (8.59%)

Source: State of Delaware 2010 Birth Defects Registry

This table indicates that 22.25% of infants in the registry were diagnosed with one or more birth defects that were confirmed only at one or more prenatal visits. Moreover, the overwhelming majority of infants (69.16%) had a confirmed diagnosis of one or more birth defects only at one or more postnatal visits.

Family Member with Birth Defect

The reported birth defect(s) of family member(s) were based on the mother’s recollection of the birth defect(s); the medical records of the family member(s) were not reviewed. Accordingly, some bias in the reporting of birth defects by family member may have occurred. As shown in Table 30, 131 infants in the registry had at least one family member with a birth defect.

Table 30. Number of Family Members with Birth Defect.

Family Members with Birth Defect	Count
No Family Members	323
1 Family Member	75
2 Family Members	34
3 Family Members	11
4 Family Members	3
5 Family Member	4
6 Family Members	2
7 Family Members	1
8 Family Members	1
Total	454

Source: State of Delaware 2010 Birth Defects Registry

Table 31 provides the specific relation between the infant in the registry and the family member documented as having the birth defect. Although the “Cousin” and “Sibling” categories feature the highest counts, these categories may match to more than one specific individual as an individual may have multiple cousins or siblings. This contrasts with the “Birth Mother” and “Father” categories, which represent only one family member per infant in the registry.

Table 31. Family Members in the Registry.

Family Member	Count
Cousin (Maternal/Paternal Not Stated)	59
Sibling (Gender Not Stated)	43
Birth Mother	31
Aunt	30
Uncle	21
Father	16
Grandmother (Maternal/Paternal Not Stated)	8
Grandfather (Maternal/Paternal Not Stated)	8
Other	19
Total Family Members Reported with Birth Defect	235

Source: State of Delaware 2010 Birth Defects Registry

Table 32 lists the corresponding birth defect of the family member reported in the registry.

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Table 32. Birth Defects of Family Members in the Registry.

Birth Defect of Family Member	Count
Musculoskeletal Anomalies	45
Eye, Ear, Face, and Neck Anomalies	33
Chromosomal Anomalies	32
Circulatory Anomalies	30
Cognitive Impairment	20
Digestive Anomalies	20
Urinary Anomalies	9
Anemia	8
Autism	7
Nervous System Anomalies	7
Genital Anomalies	4
Other	20
Total Family Members Reported with Birth Defect	235

Source: State of Delaware 2010 Birth Defects Registry

Based on Table 31 and Table 32, 235 birth defects, at the most, could be analogous between infants in the registry and reported family members.

Table 33 indicates that 86 birth defects (36.60% of the 235 birth defects) were the same or similar between the infants and their respective family members.

Table 33. Commonly-Shared Birth Defects between Infants and Family Members in Registry.

Commonly-Shared Birth Defects	Count
Musculoskeletal Anomalies	32
Circulatory Anomalies	23
Chromosomal Anomalies	9
Eye, Ear, Face, and Neck Anomalies	7
Digestive Anomalies	4
Anemia	3
Genital Anomalies	3
Nervous System Anomalies	3
Urinary Anomalies	2
Total	86

Source: State of Delaware 2010 Birth Defects Registry

Of these 86 birth defects, 27 were diagnosed in a prenatal care setting and 59 were reported during a postnatal visit. The 27 birth defects that were reported during a prenatal visit are quite diverse: 6 diagnoses related to circulatory anomalies, one diagnosis related to digestive system anomalies, 17 diagnoses related to musculoskeletal anomalies, two diagnoses related to nervous system anomalies, and one diagnosis related to urinary system anomalies.

Infant Deaths in the Registry

In the registry, 26 entries (5.73% of entries) show documentation that a fetal or infant death occurred. Of these 26 entries, 10 were fetal deaths (stillbirth and termination of pregnancy) and 16 were documented as an infant death (infant with a live birth that expired within the first year after birth). According to the registry, an autopsy was performed on 7 of these 26 deaths. The results of the autopsy are not provided in the registry, and therefore, it cannot be determined whether the reported birth defect(s) was a causal factor for the death. With this in mind, this analysis of deaths is intended only to better understand the characteristics of this specific set of entries in the birth defect registry.

Characteristics of the Expired Infants

Table 34 describes where each of the mothers of the 26 expired infants and fetal deaths resided.

Table 34. Mother’s Residence for Expired Infants and Fetal Deaths in the Registry.

County/State of Residence	Count
Kent	6
New Castle (w/o Wilmington)	10
Sussex	5
Wilmington	5
Delaware	26

Source: State of Delaware 2010 Birth Defects Registry

Among the 16 infant deaths, 6 were female and 10 were male. Moreover, 9 were within one month of birth (neonatal death) with 4 neonatal deaths occurring on the day of birth. The remaining 7 deaths took place between one month after birth and one year after birth (postneonatal death). Eight (8) out of the 16 infants were born at term (greater than or equal to 37 gestational weeks) and 8 were born preterm (at less than or equal to 36 gestational weeks).

Table 35 provides the growth percentile measures for the 16 infant deaths in the registry. The “Total Infant Deaths” column provides the number out of the 16 infant deaths for which there exists data on the growth percentile measure. As evidenced by this table, the overwhelming majority of expired infants were at or below the 25th percentile for weight (81.25%), length (77.27%), and head circumference (80.00%) at the time of birth. Moreover, 7 of the 16 infants were below the 25th percentile on all three growth percentile measures.

Table 35. Growth Percentile Measures for the Infant Deaths in the Registry.

Growth Percentile Measure	Number Below 25th	Total Infant Deaths	Percentage
Weight	13	16	81.25%
Length (Stature)	10	14	77.27%
Head Circumference	8	10	80.00%

Source: State of Delaware 2010 Birth Defects Registry

Reported Birth Defects of the Infant Deaths in the Registry

Unlike Table 26 where 79.07% of infants in the registry had documentation of one birth defect, Table 36 indicates that only 18.75% of expired infants had only one reported birth defect. This may indicate that since a higher proportion of expired infants had more than one birth defect, these infants were more likely to have had multiple anomalies that may have resulted or contributed to the infant’s mortality. At the same time, these conclusions cannot be justified given the relatively low count of expired infants and the overall lack of autopsy data.

Table 36. Count of ICD-9 Codes for the Infant Deaths in the Registry.

Count of Reported ICD-9 Codes	Count of Infants Meeting Criteria	Percent of Infants Meeting Criteria
1	3	18.75%
2	5	31.25%
3	2	12.50%
4	2	12.50%
5	1	6.25%
6	1	6.25%
8	1	6.25%
9	1	6.25%
Total	16	100.00%

Source: State of Delaware 2010 Birth Defects Registry

Table 37 lists all of the ICD-9 codes provided in the registry for the 16 infant deaths. Note that the ICD-9 codes are listed in relatively the same order as those listed in Table 27.

Table 37. ICD-9 Codes for the Infant Deaths in the Registry.

ICD-9 Code	ICD-9 Code Description	Count
745	Bulbus cordis anomalies and anomalies of cardiac septal closure	9
746	Other congenital abnormalities of the heart	7
758	Chromosomal anomalies	6
747	Other congenital anomalies of circulatory system	5
742	Other congenital anomalies of nervous system	4
756	Other congenital musculoskeletal anomalies	4
753	Congenital anomalies of urinary system	3
740	Anencephalus and similar anomlies	2
743	Congenital anomalies of eye	2
749	Cleft palate	2
751	Other congenital anomalies of digestive system	2
752	Congenital anomalies of genital organs	2
759	Other and unspecified congenital anomalies	2
352	Disorders of other cranial nerves	1
744	Congenital anomalies of ear, face, and neck	1
748	Congenital anomalies of respiratory system	1
755	Other congenital anomalies of limbs	1
Total		54

Source: State of Delaware 2010 Birth Defects Registry

Family Member with Birth Defect among Infant Deaths in the Registry

The registry documents 5 of the 16 infants as having a family member with a birth defect. Of the 5 infants, 4 infants had one family member with a birth defect and one infant had 6 family members with a birth defect. This results in 10 [(4•1) + (1•6)] possible linkages in similar birth defects between the expired infants and respective family members. Of these 10 familial relations, three were with the infant's sibling, two were with the infant's cousin, one was with the infant's aunt, one was with the infant's grandmother, one was with the infant's mother, and two were with other relatives of the infant. Two of these 10 relations shared a similar birth defect: an expired infant and her brother (or half brother) each had a birth defect involving their nervous systems and an expired infant and his cousin each had a birth defect related to a chromosomal anomaly.

Again, it is important to note that the reported birth defect(s) of family member(s) were based on the mother's recollection of the birth defect(s) and that the medical records of the family member(s) were not reviewed. Moreover, as aforementioned, the results of the autopsy are not provided in the registry, and therefore, it cannot be determined whether the reported birth defect(s) was a causal factor for the death.

Illnesses, Conditions, and Complications of Mothers of the Infant Deaths in the Registry

Table 38 presents the number of illnesses, conditions, and complications ("conditions") of the mothers of the 16 registry entries documented as infant deaths. As shown in this table, only 6.25% of the mothers with an infant death had no reported conditions and 81.25% had multiple conditions.

Table 38. Number of Reported Conditions for Mothers of Infant Deaths in the Registry.

Number of Reported Conditions	Number of Infant Entries Meeting Criteria	Percent of Infant Entries Meeting Criteria
0	1	6.25%
1	2	12.50%
2	2	12.50%
3	4	25.00%
4	2	12.50%
5	3	18.75%
8	1	6.25%
9	1	6.25%
Total	16	100.00%

Source: State of Delaware 2010 Birth Defects Registry

Table 39 provides counts for all of the maternal conditions listed for the 22 infant deaths in the registry.

Table 39. Count of Maternal Conditions for Expired Infants in the Registry.

Condition	Count	Condition	Count
Surgery-Gynecologic	11	Coagulopathy	1
Surgery-Non Gynecologic Non Transplant	8	Diabetes Gestational	1
Obesity	7	Diabetes Mellitus Type II	1
Tobacco	7	Heart Disease	1
Alcohol	4	Hypertension (PIH)	1
Chronic Hypertension	4	Other Psychiatric Disorders	1
Depression	3	Seizure Disorder	1
Illicit Drugs	2	Toxemia/Preeclampsia	1
Thyroid Disease	2	Weight Loss	1
Bipolar Disorder	1		

Source: State of Delaware 2010 Birth Defects Registry

DISCUSSION

The results show that mothers to infants in the registry had generally the same age, education, race and ethnicity, and gravida as all mothers that gave birth in Delaware in 2010. Moreover, the majority of mothers in the registry regularly used vitamins and had their first prenatal visit in the first trimester of pregnancy. Finally, as shown in Table 14, a smaller percentage of mothers consumed alcohol during pregnancy as opposed to before pregnancy.

However, this same table reveals that a higher percentage of registered infants’ mothers were likely to use tobacco before and during pregnancy rather than only prior to pregnancy. This finding is consistent with results from other Delaware-specific maternal health assessments.^{6,7} Table 40 provides a cursory

comparison of the birth defects registry results and the most applicable Delaware’s 2009 Pregnancy Risk Assessment Monitoring System (PRAMS) results for the remaining selected maternal conditions.

Table 40. Comparison of 2010 Birth Defects Registry with 2009 PRAMS by Maternal Condition.

Maternal Condition	2010 Birth Defects Registry	2009 PRAMS
Obesity	27.65%	21.98% ^F
Pregnancy-Induced Hypertension	10.83%	14.05% ^G
Depression	17.74%	12.42% ^H
Gestational Diabetes	11.06%	7.92% ^I

Source: State of Delaware 2010 Birth Defects Registry

Unlike mothers in the registry, infants in the registry have generally different demographic and health attributes as compared to all infants born in Delaware. At the state level, a higher percentage of registered infants are born preterm and male. Moreover, although comparisons for growth percentile measures cannot be made, a higher proportion of infants in the registry are typically at or below the 25th percentile for birth weight, body length, or head circumference.

Furthermore, as indicated in Table 26, roughly four out of five registered infants had documentation of one birth defect with the remaining one out of five having multiple birth defects reported. The registry lists 131 infants as having at least one or more family members with a birth defect, bringing the total count of familial connections to 235. Finally, the registry documented 10 fetal deaths and 16 infant deaths, and in comparison to all infants in the registry, a lower proportion of these 16 infant deaths (three out of 16) had only one birth defect.

The results of this report should add more to the body of knowledge of maternal and child wellbeing in Delaware. Although the etiology of a birth defect generally cannot be uncovered, this report may afford some cursory insights about what factors could be modified to reduce the incidence of birth defects in Delaware.

^F In PRAMS, this was calculated by taking the sum of the CDC’s assigned weighted averages of the respondents who had a BMI of 30 or greater and dividing this value by the CDC’s weighted averages of all respondents.

^G In PRAMS, this is item 27E: “During your most recent pregnancy, did you have a problem with high blood pressure, hypertension (including pregnancy-induced hypertension [PIH]), preeclampsia, or toxemia?”

^H In PRAMS, this is item 61A: “Since your new baby was born, have you often or always felt down, depressed, or sad?”

^I In PRAMS, this is item 26: “During your most recent pregnancy, were you told by a doctor, nurse, or other health care worker that you had gestational diabetes?”

ANALYSIS OF THE 2010 BIRTH DEFECTS REGISTRY

APPENDIX A. Birth Defects Registry Reportable Diagnoses.

ICD-9 Code	Diagnosis
090.2	Congenital syphilis
090.9	Congenital syphilis
237.70	Neurofibromatosis
243.00	Congenital hypothyroidism
270.10	Phenylketonuria
270.7	Glutaric Aciduria, Type I
271.1	Galactosemia
277.00	Cystic Fibrosis
277.6	Biotinidase deficiency
277.85	Disorders of fatty acid oxidation
282.4	Other hemoglobinopathies
282.60	Sickle cell disease
317.0	Developmental delay
318.0	Developmental delay
318.2	Developmental delay
389.15	Sensorineural hearing loss
389.18	Sensorineural hearing loss
740.0	Anencephalus
741.0	Spina bifida
741.9	Spina bifida
742.0	Encephalocele
742.1	Microcephalus
742.2	Agenesis of corpus callosum
742.2	Holoprosencephaly
742.2	Lissencephaly
742.2	Septo-optic dysplasia
742.3	Hydrocephalus
742.4	Other congenital anomalies of nervous system
742.4	Porencephaly
742.59	Tethered cord
743.1	Microphthalmia
743.20	Glaucoma
743.30	Congenital cataract
743.31	Congenital cataract
743.34	Congenital cataract
743.46	Coloboma
744.23	Microtia
745.10	Transposition of great arteries
745.11	Double outlet right ventricle
745.2	Tetralogy of Fallot
745.3	Single ventricle
745.4	Ventricular septal defect
745.5	Atrial septal defect
745.61	Endocardial cushion defect
745.69	Endocardial cushion defect
746.01	Dysplastic pulmonary valve
746.01	Pulmonary valve atresia

ANALYSIS OF THE 2010 BIRTH DEFECTS REGISTRY

APPENDIX A. Birth Defects Registry Reportable Diagnoses. *Continued.*

ICD-9 Code	Diagnosis
746.02	Pulmonary valve stenosis
746.1	Tricuspid valve dysplasia
746.1	Tricuspid valve dysplasia
746.3	Aortic valve stenosis
746.4	Bicuspid aortic valve
746.5	Mitral stenosis
746.6	Mitral atresia
746.7	Hypoplastic left heart syndrome
746.89	Other specified congenital anomalies of heart
747.0	Patent ductus arteriosus
747.10	Coarctation of aorta
747.4	Anomalous pulmonary venous return
747.49	Other anomalies of the great veins
748.0	Choanal atresia
748.4	Congenital cystic adenomatoid malformation
748.5	Lung hypoplasia
749.00	Cleft palate without cleft lip
749.02	Cleft palate without cleft lip
749.1	Cleft lip without cleft palate
749.2	Cleft lip with cleft palate
749.23	Cleft lip with cleft palate
750.3	Tracheoesophageal fistula
750.3	Tracheoesophageal fistula with esophageal atresia
750.5	Pyloric stenosis
751.10	Atresia of intestine
751.2	Anorectal malformation
751.2	Atresia of intestine
751.4	Malrotation of intestine
751.61	Biliary atresia
752.61	Hypospadias
753.0	Renal agenesis
753.15	Cystic/dysplastic kidneys
753.2	Obstructive genitourinary defect
753.3	Horseshoe kidney
753.6	Obstructive genitourinary defect
754.2	Scoliosis
754.30	Developmental hip dysplasia
754.31	Developmental hip dysplasia
754.51	Club foot
754.60	Club foot
754.70	Club foot
754.88	Other specified anomalies of hands
754.89	Arthrogyrosis multiplex congenital
755.21	Reduction defect, upper limbs
755.26	Reduction defect, upper limbs
755.27	Reduction defect, upper limbs
755.28	Reduction defect, upper limbs

ANALYSIS OF THE 2010 BIRTH DEFECTS REGISTRY

APPENDIX A. Birth Defects Registry Reportable Diagnoses. *Continued.*

ICD-9 Code	Diagnosis
755.30	Reduction defect, lower limbs
755.39	Reduction defect, lower limbs
755.4	Adactyly
756.0	Craniosynostosis
756.0	Macrocephaly
756.0	Multiple congenital anomaly syndrome
756.1	Vertebrae anomalies
756.3	Other anomalies of rib and sternum
756.4	Achondroplasia
756.51	Osteogenesis imperfecta
756.6	Diaphragmatic hernia
756.7	Gastroschisis
756.9	Other skeletal dysplasia
758.0	Trisomy 21
758.1	Trisomy 13
758.2	Trisomy 18
758.30	Autosomal deletion syndromes
758.50	Other conditions due to autosomal anomalies
758.60	Gonadal dysgenesis
758.80	Other conditions due to sex chromosome anomalies
759.89	Other specified anomalies
762.8	Amniotic band disruption complex
771.1	Congenital cytomegalovirus

ANALYSIS OF THE 2010 BIRTH DEFECTS REGISTRY

APPENDIX B. Birth Defects Registry Fields.

Field	Description
Study_ID	Unique Identifier for Child
C_FNAME	Child First Name
C_MNAME	Child Middle Name
C_LNAME	Child Last Name
C_DOO	Child Date of Birth
C_SSN	Child Social Security Number
M_FNAME	Mother First Name
M_MNAME	Mother Middle Name
M_LNAME	Mother Last Name
M_DOB	Maternal Date of Birth
M_SSN	Maternal Social Security Number
FACILITYNAME.1, FACILITYNAME.2, FACILITYNAME.3, FACILITYNAME.4, FACILITYNAME.5, FACILITYNAME.6, FACILITYNAME.7, FACILITYNAME.8, FACILITYNAME.9, FACILITYNAME.10, FACILITYNAME.11, FACILITYNAME.12	Facility Where Entry was Abstracted
M_MRN_CCHS, M_MRN_AIDUPONT, M_MRN_BAYHEALTH, M_MRN_NBS, M_MRN_VITALS, M_MRN_KENTGENERAL, M_MRN_STFRANCIS, M_MRN_NANTICOKE, M_MRN_BEEBE, M_MRN_BIRTHCENTER, M_MRN_NICU, M_MRN_MILFORD	Maternal ID at Facility Where Entry was Abstracted
C_MRN_CCHS, C_MRN_AIDUPONT, C_MRN_BAYHEALTH, C_MRN_NBS, C_MRN_VITALS, C_MRN_KENTGENERAL, C_MRN_STFRANCIS, C_MRN_NANTICOKE, C_MRN_BEEBE, C_MRN_BIRTHCENTER, C_MRN_NICU, C_MRN_MILFORD	Child ID at Facility Where Entry was Abstracted
M_ADD	Mother's Address
M_CITY	Mother's City
M_ZIP	Mother's Zip Code
M_HPHNE	Mother's Home Phone
M_OB	Mother's Obstetrician
LMP	Last Menstrual Period Date
EDC	Estimated Date of Delivery
GRAVID	Mother's Gravida
PARA	Mother's Para
LIV_CHDN	Number of Live Children to Mother
STB_CHDN	Number of Stillborn Children
SP_AB	Number of Prior Spontaneous Abortions
EL_AB	Number of Prior Elective Abortions
NN_DEATH	Number of Prior Neonatal Deaths
PN_DEATH	Number of Prior Postneonatal Deaths
MB_PRIOR	Number of Prior Birth Defects
WTGAIN	Maternal Weight Gain During Pregnancy
PREG_OUT	Pregnancy Outcome

ANALYSIS OF THE 2010 BIRTH DEFECTS REGISTRY

APPENDIX B. Birth Defects Registry Fields. *Continued*

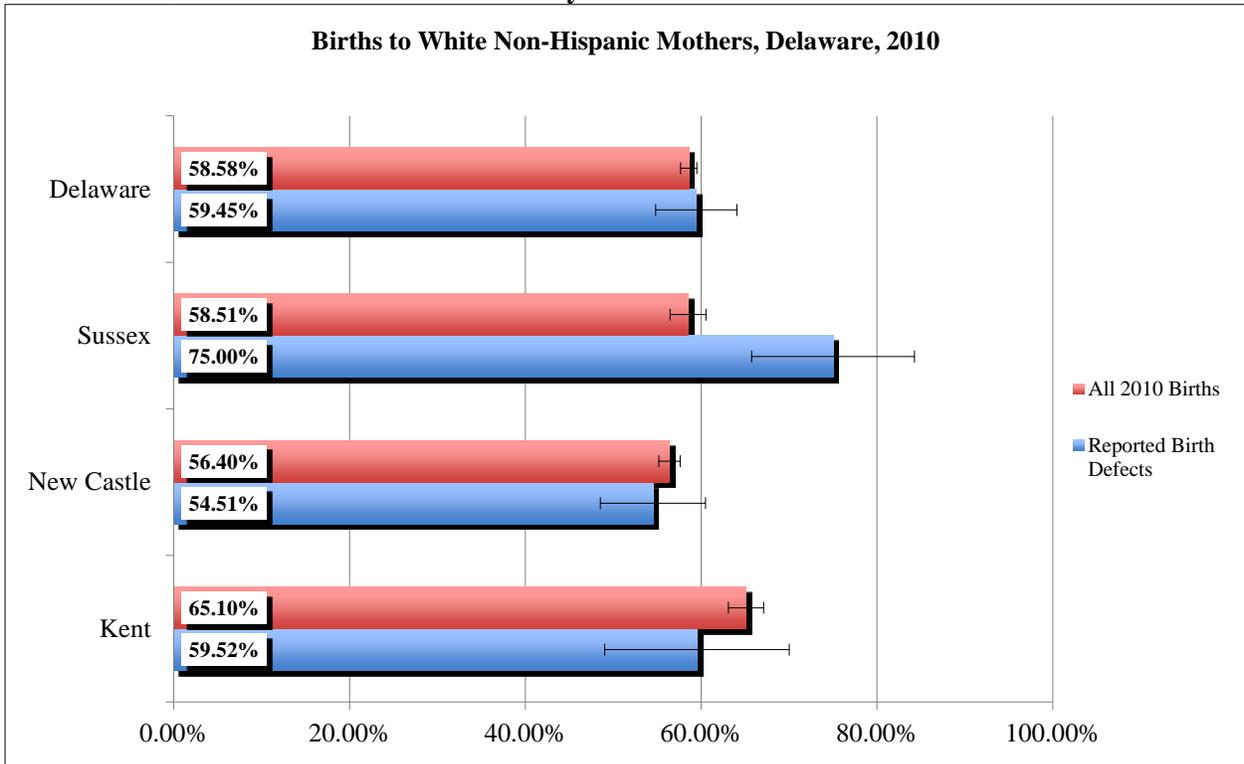
Field	Description
F_FNAME	Father's First Name
F_MNAME	Father's Middle Name
F_LNAME	Father's Last Name
F_DOB	Father's Date of Birth
F_SSN	Father's Social Security Number
MCURR_ADD	Mother's Current Address
MCURR_CITY	Mother's Current City
MCURR_ZIP	Mother's Current Zip Code
M_RACE	Mother's Race
M_ETHNICITY	Mother's Ethnicity
M_EDUC_LVL	Mother's Educational Level
M_OCC	Mother's Occupation
F_RACE	Father's Race
F_ETHNICITY	Father's Ethnicity
F_EDUC_LVL	Father's Educational Level
F_OCC	Father's Occupation
PRENATAL_CARE	Prenatal Care (Y/N)
PRENATAL_CARE_DATE	Prenatal Care Start Date
PRENATAL_CARE_TRIMESTER	Trimester When Prenatal Care Started
VITAMIN_USE	Vitamin Use (Y/N)
MAT_COND.1, MAT_COND.2, MAT_COND.3, MAT_COND.4, MAT_COND.5, MAT_COND.6, MAT_COND.7, MAT_COND.8	Maternal Illness, Condition, or Complication
COND_COM.1, COND_COM.2, COND_COM.3, COND_COM.4, COND_COM.5, COND_COM.6, COND_COM.7, COND_COM.8	Time at which Maternal Illness, Condition, or Complication Occurred
C_ADDRES	Child's Street Address
C_CITY	Child's City of Residence
C_ZIP	Child's Zip Code
PED_NME	Name of Pediatrician
C_GEND	Child's Gender
BW_G	Child's Weight at Birth (g)
BL_CM	Child's Length at Birth (cm)
BL_IN	Child's Length at Birth (in)
BHC_CM	Child's Head Circumference at Birth (cm)
BHC_IN	Child's Head Circumference at Birth (in)
B_GA	Child's Gestational Weeks at Birth
PLURAL	Plurality
DESIGNATION	Plurality Birth Order
APGAR_1	Apgar at 1 Minute
APGAR_5	Apgar at 5 Minutes
APGAR_10	Apgar at 10 Minutes
EXPIRE	Expire (Y/N)
EXPIRE_D	Expiration Death
AUTOPSY	Autopsy (Y/N)
AUTOPSY_D	Autopsy Death
ADOPT_FOSTER	Adoption or Foster

ANALYSIS OF THE 2010 BIRTH DEFECTS REGISTRY

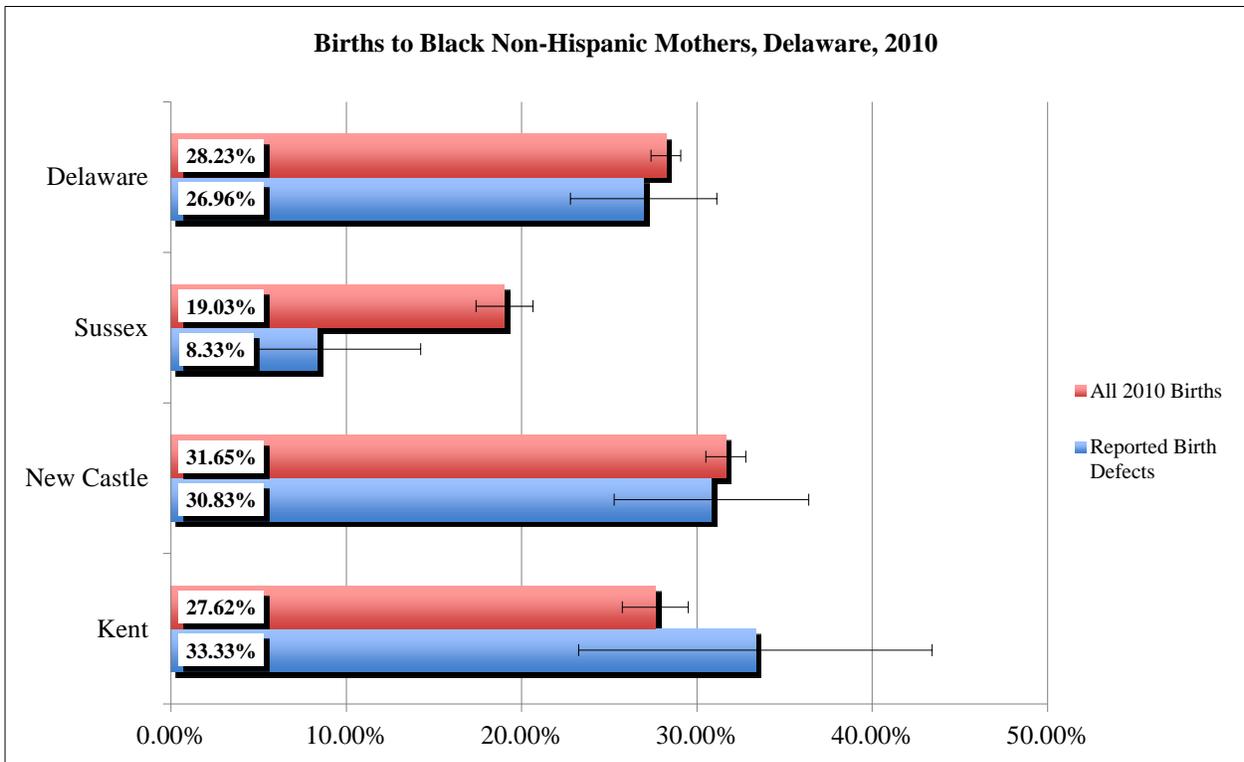
APPENDIX B. Birth Defects Registry Fields. *Continued*

Field	Description
FAM_MEM.1, FAM_MEM.2, FAM_MEM.3, FAM_MEM.4, FAM_MEM.5, FAM_MEM.6, FAM_MEM.7, FAM_MEM.8	Family Member with Birth Defect
FAM_MEM_BD.1, FAM_MEM_BD.2, FAM_MEM_BD.3, FAM_MEM_BD.4, FAM_MEM_BD.5, FAM_MEM_BD.6, FAM_MEM_BD.7, FAM_MEM_BD.8	Family Member's Birth Defect
MALF.1, MALF.2, MALF.3, MALF.4, MALF.5, MALF.6, MALF.7, MALF.8	ICD-9 Code and Description for Birth Defect
MALF_C.1, MALF_C.2, MALF_C.3, MALF_C.4, MALF_C.5, MALF_C.6, MALF_C.7, MALF_C.8, MALF_C.9	Note on Birth Defect
MALF_DXM.1, MALF_DXM.2, MALF_DXM.3, MALF_DXM.4, MALF_DXM.5, MALF_DXM.6, MALF_DXM.7, MALF_DXM.8, MALF_DXM.9	How Birth Defect was Diagnosed
MALF_DATE.1, MALF_DATE.2, MALF_DATE.3, MALF_DATE.4, MALF_DATE.5, MALF_DATE.6, MALF_DATE.7, MALF_DATE.8, MALF_DATE.9	Date Birth Defect was Diagnosed
MALF_WHEN.1, MALF_WHEN.2, MALF_WHEN.3, MALF_WHEN.4, MALF_WHEN.5, MALF_WHEN.6, MALF_WHEN.7, MALF_WHEN.8, MALF_WHEN.9	When Birth Defect was Diagnosed (Prenatal/Postneonatal)
MALF_CON.1, MALF_CON.2, MALF_CON.3, MALF_CON.4, MALF_CON.5, MALF_CON.6, MALF_CON.7, MALF_CON.8, MALF_CON.9	Confirmation of Birth Defect (Confirmed/Probable)
MALF_CD.1, MALF_CD.2, MALF_CD.3, MALF_CD.4, MALF_CD.5, MALF_CD.6, MALF_CD.7, MALF_CD.8, MALF_CD.9	ICD-9 Code for Birth Defect

APPENDIX C.1. Mother's Race and Ethnicity.

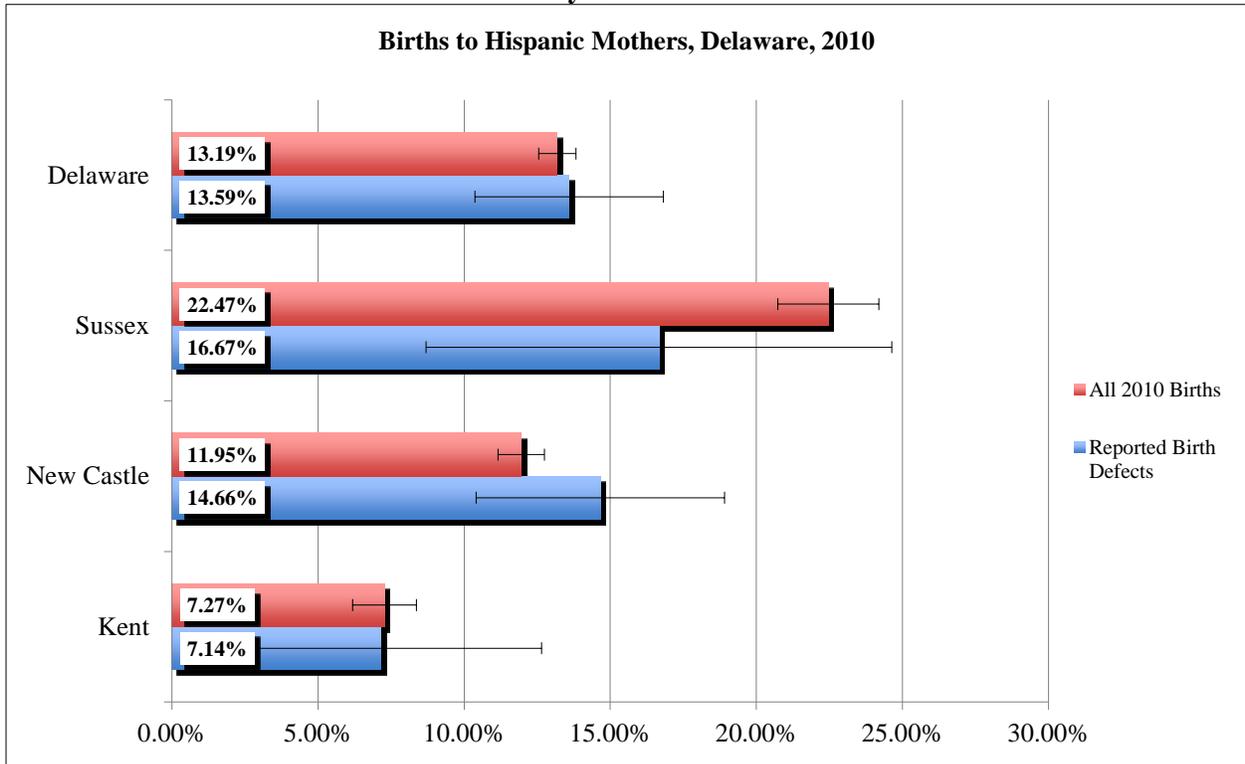


Source: State of Delaware 2010 Birth Defects Registry

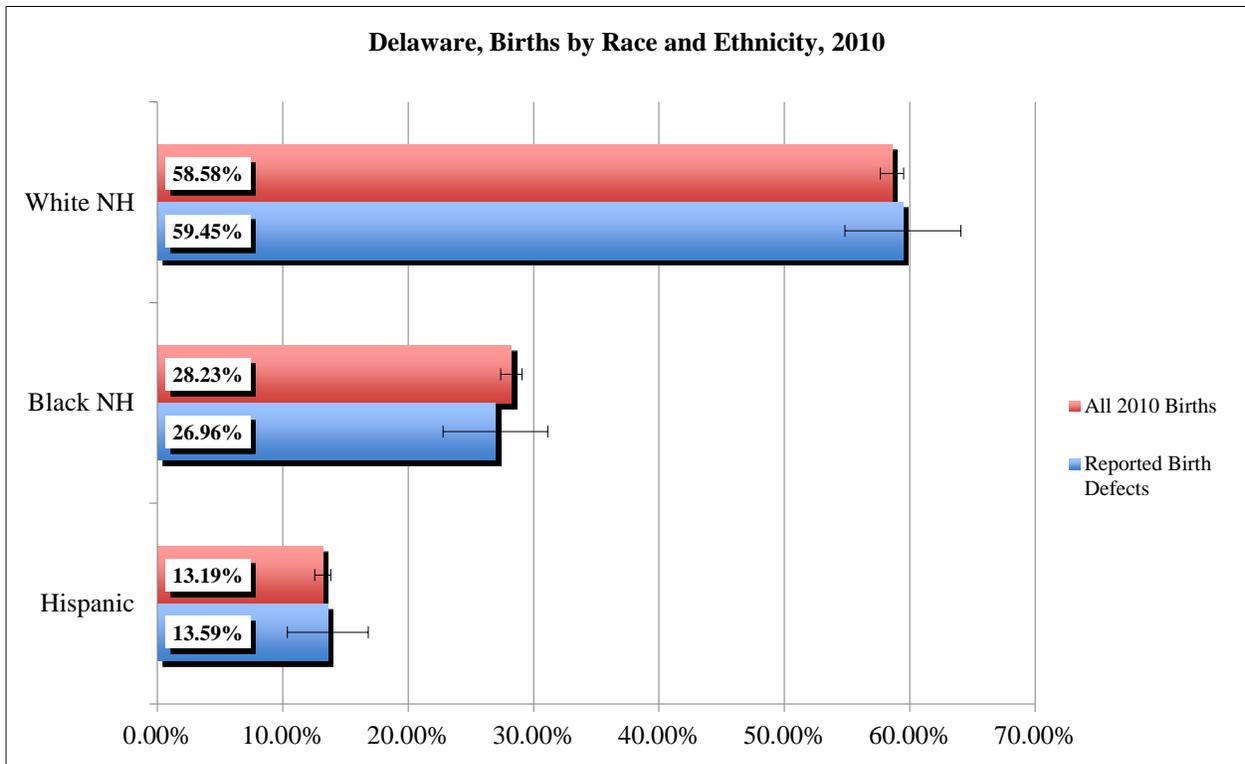


Source: State of Delaware 2010 Birth Defects Registry

APPENDIX C.1. Mother's Race and Ethnicity. *Continued*

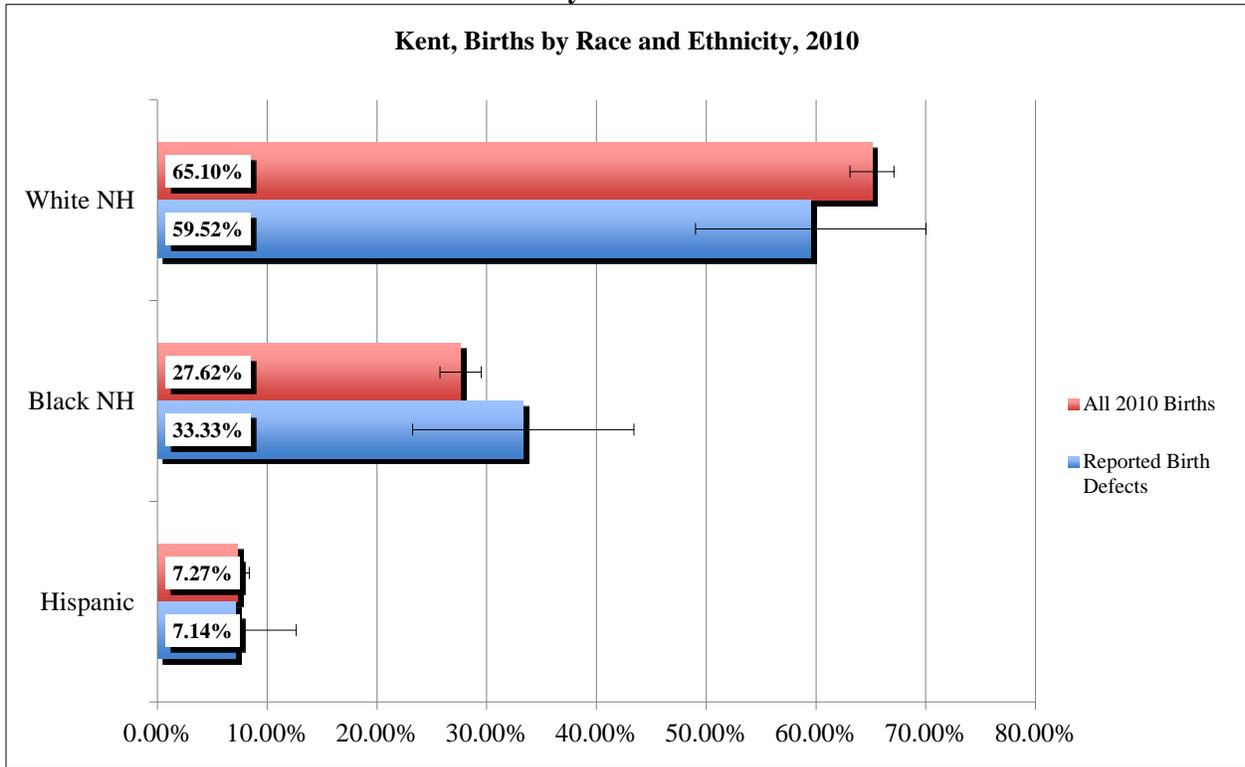


Source: State of Delaware 2010 Birth Defects Registry

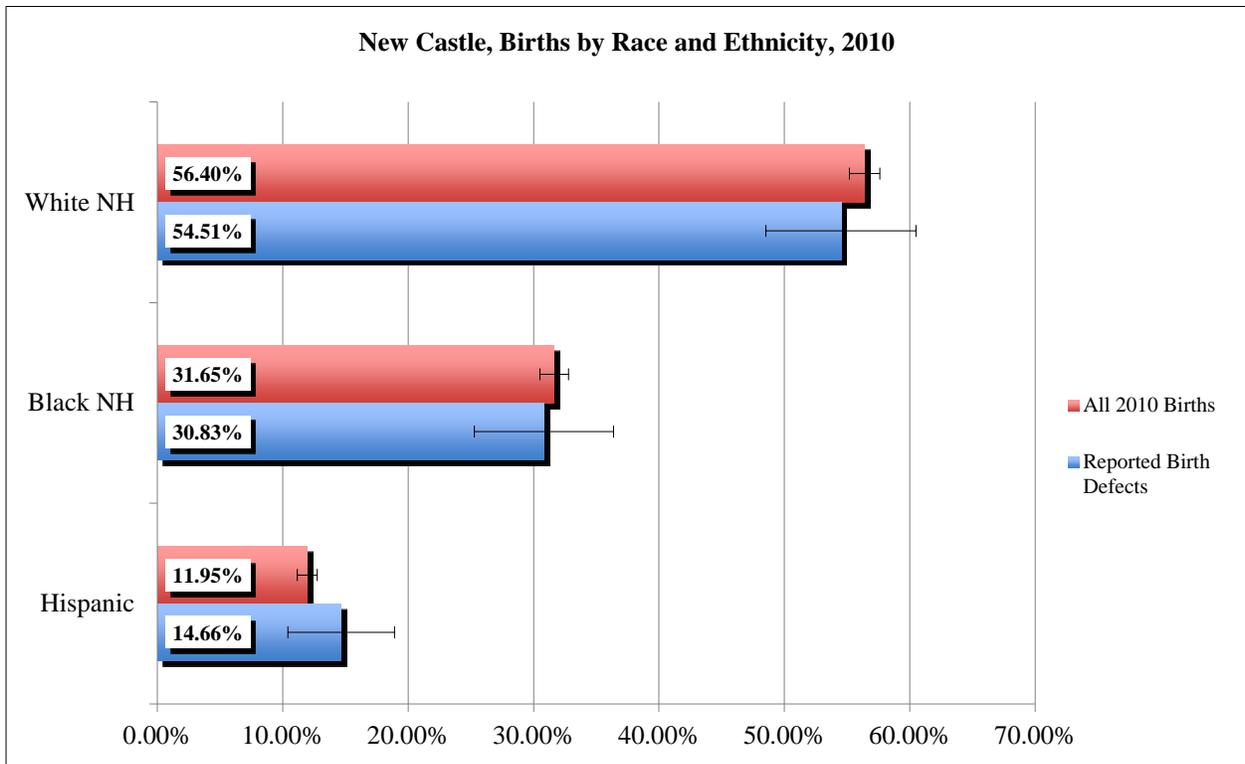


Source: State of Delaware 2010 Birth Defects Registry

APPENDIX C.1. Mother's Race and Ethnicity. *Continued*

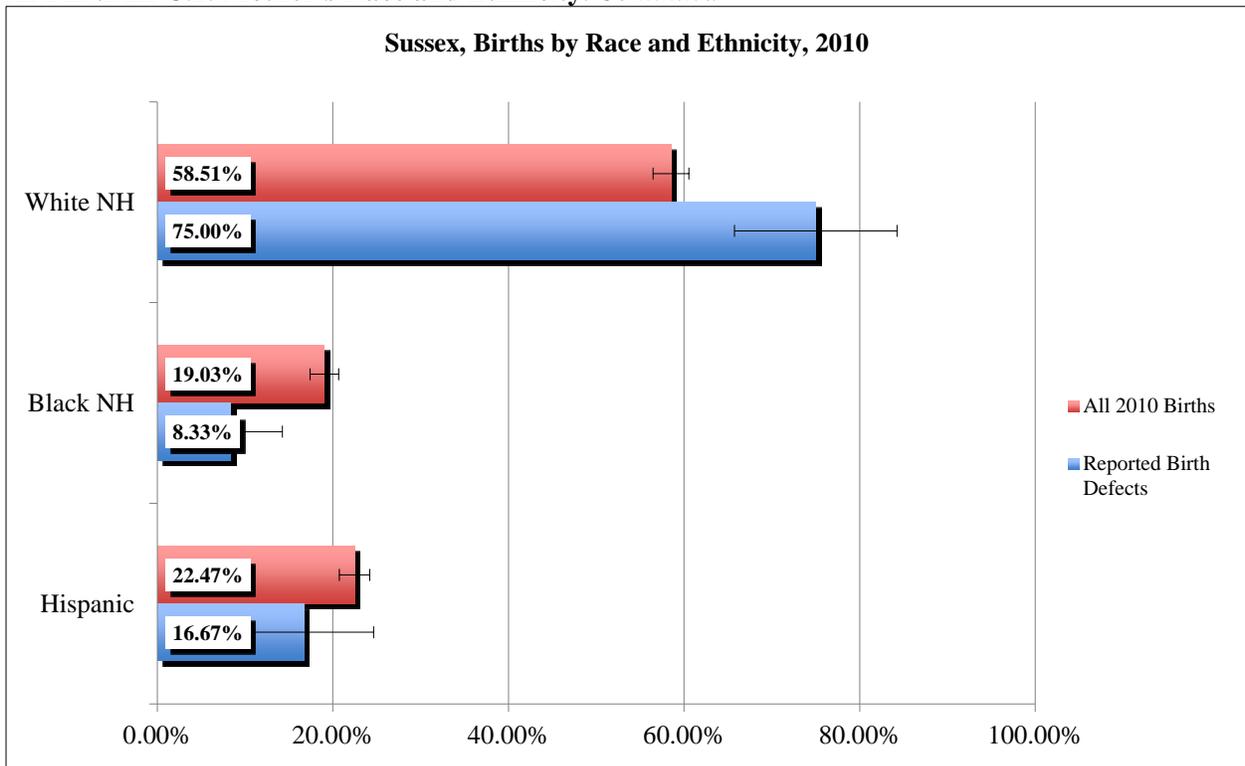


Source: State of Delaware 2010 Birth Defects Registry



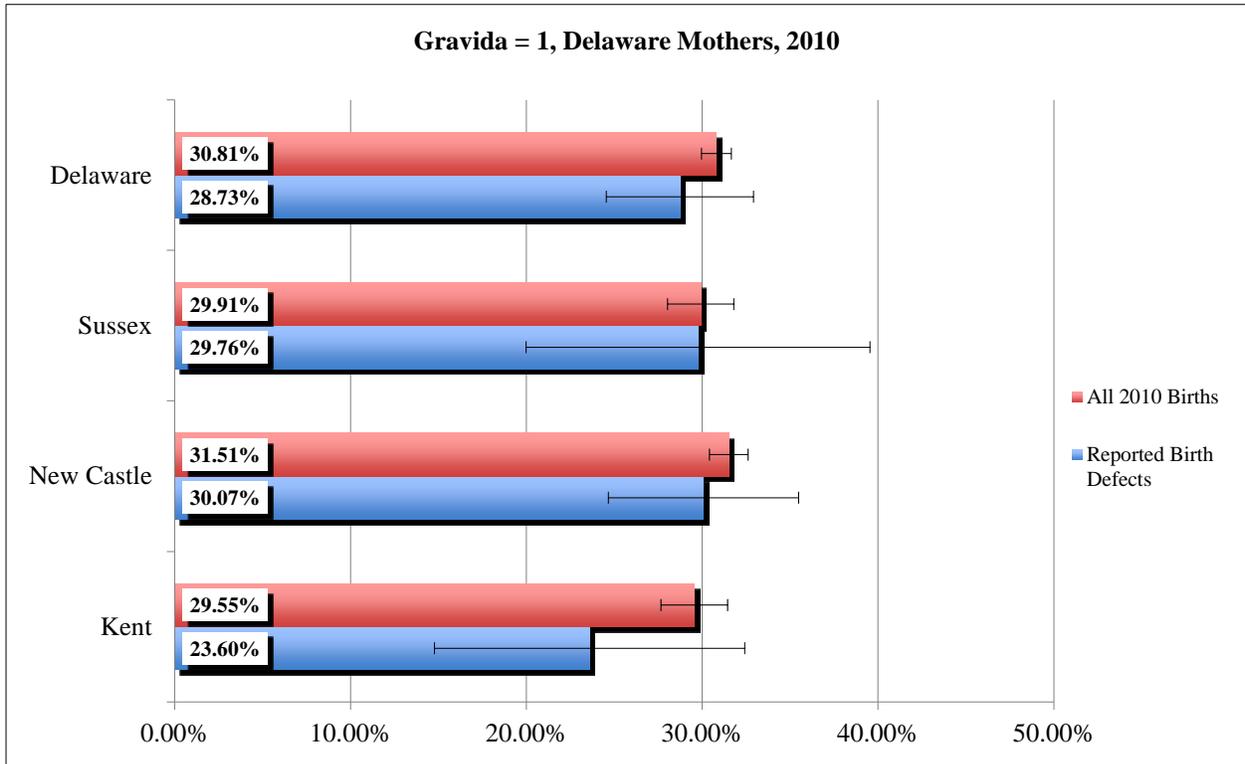
Source: State of Delaware 2010 Birth Defects Registry

APPENDIX C.1. Mother's Race and Ethnicity. *Continued*

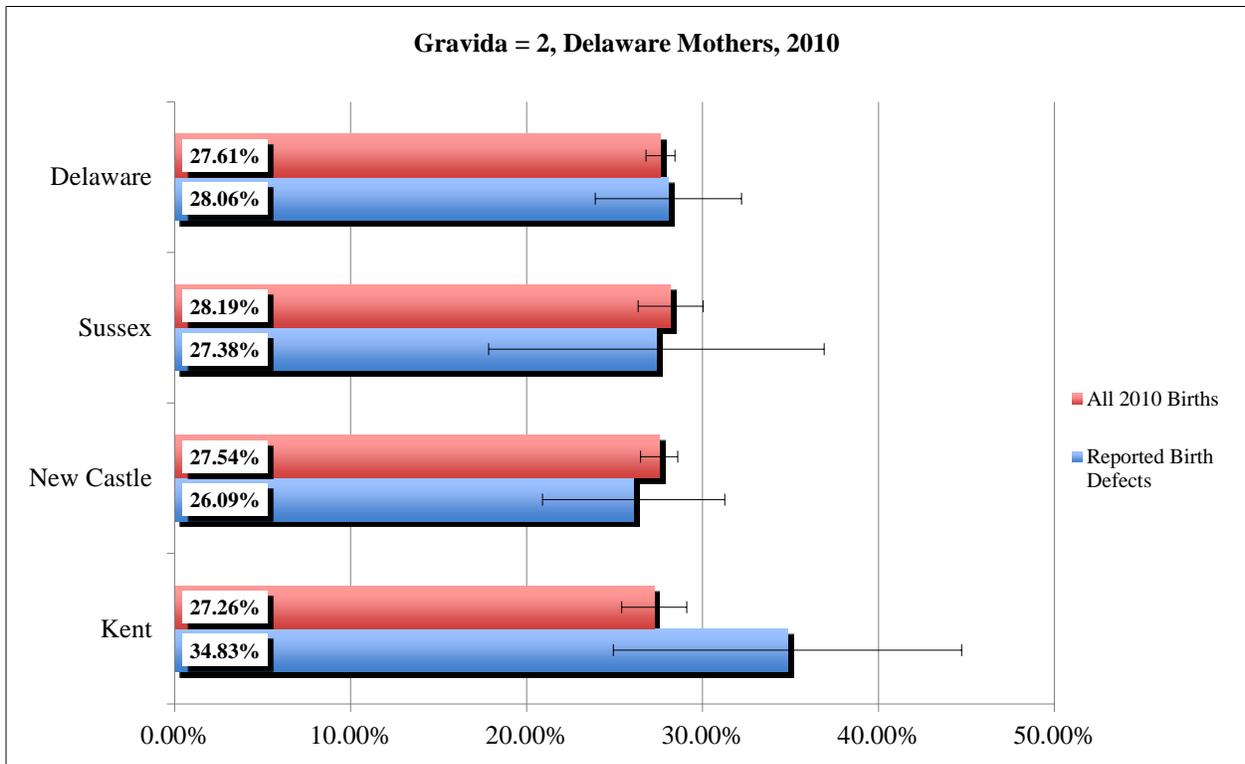


Source: State of Delaware 2010 Birth Defects Registry

APPENDIX C.2. Gravida.

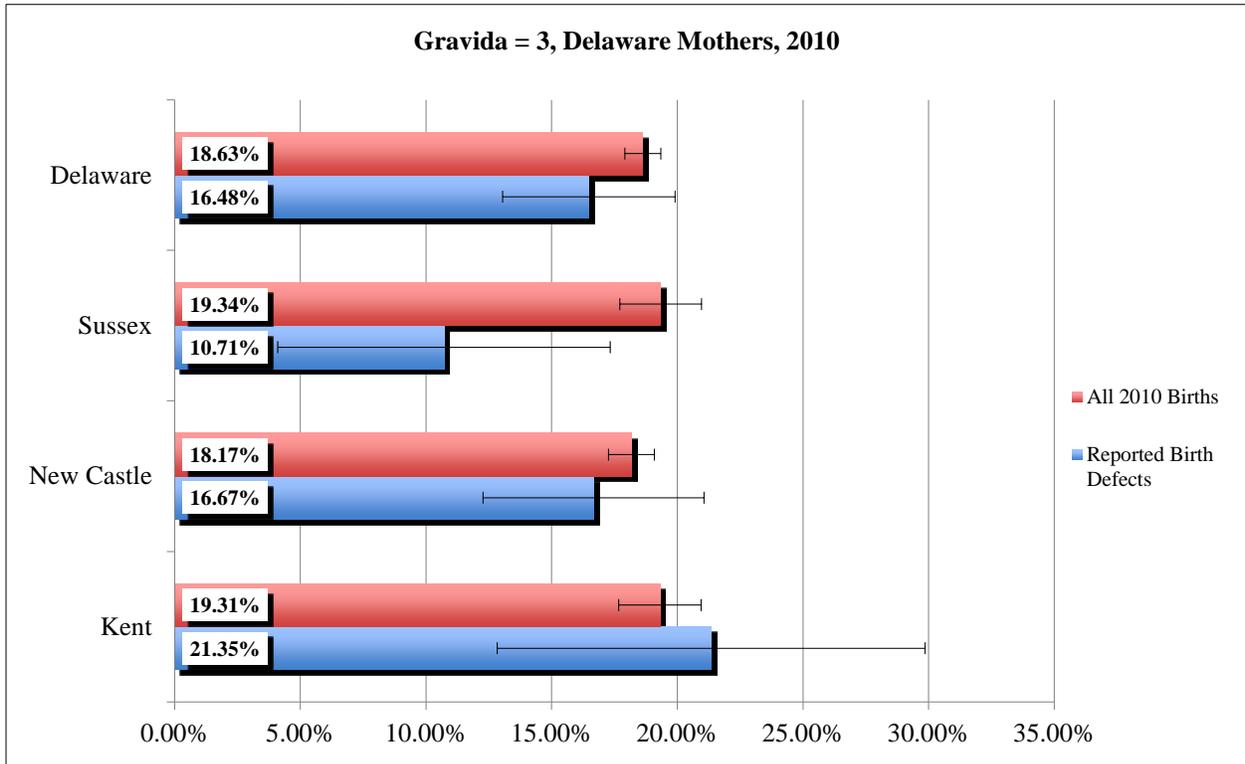


Source: State of Delaware 2010 Birth Defects Registry

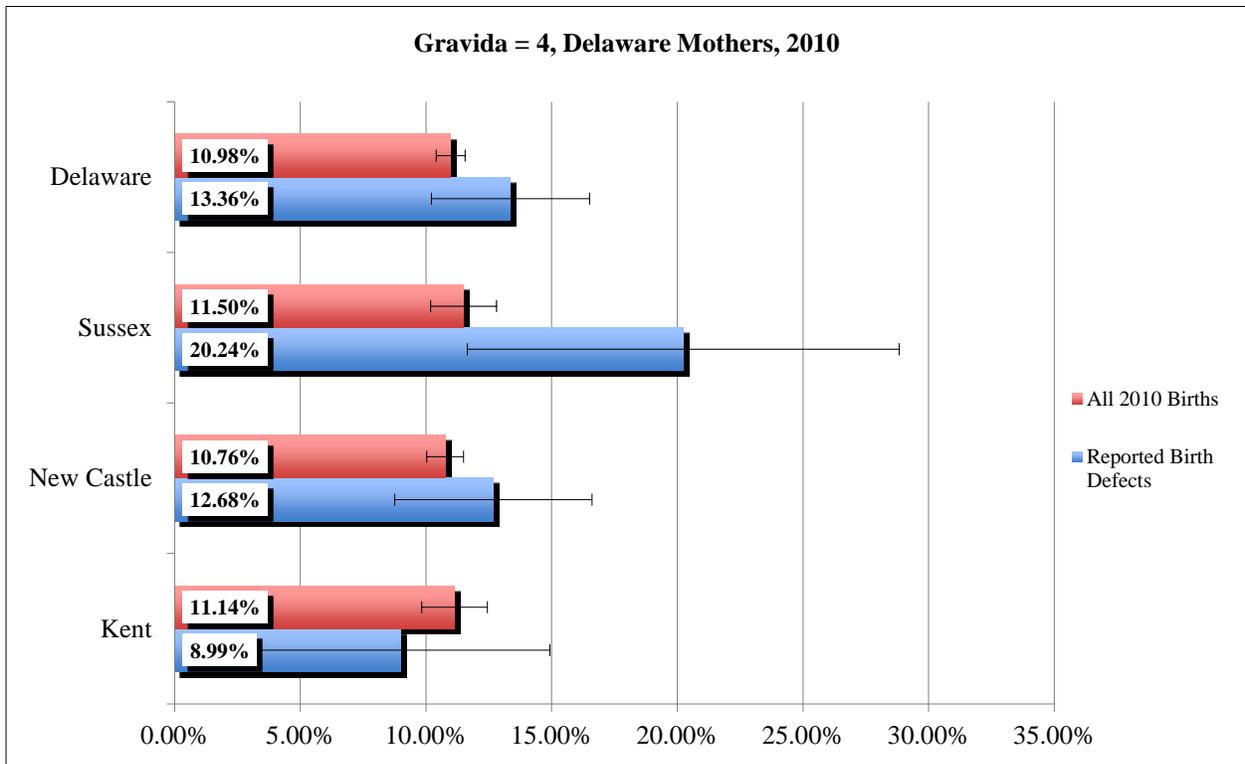


Source: State of Delaware 2010 Birth Defects Registry

APPENDIX C.2. Gravida. Continued

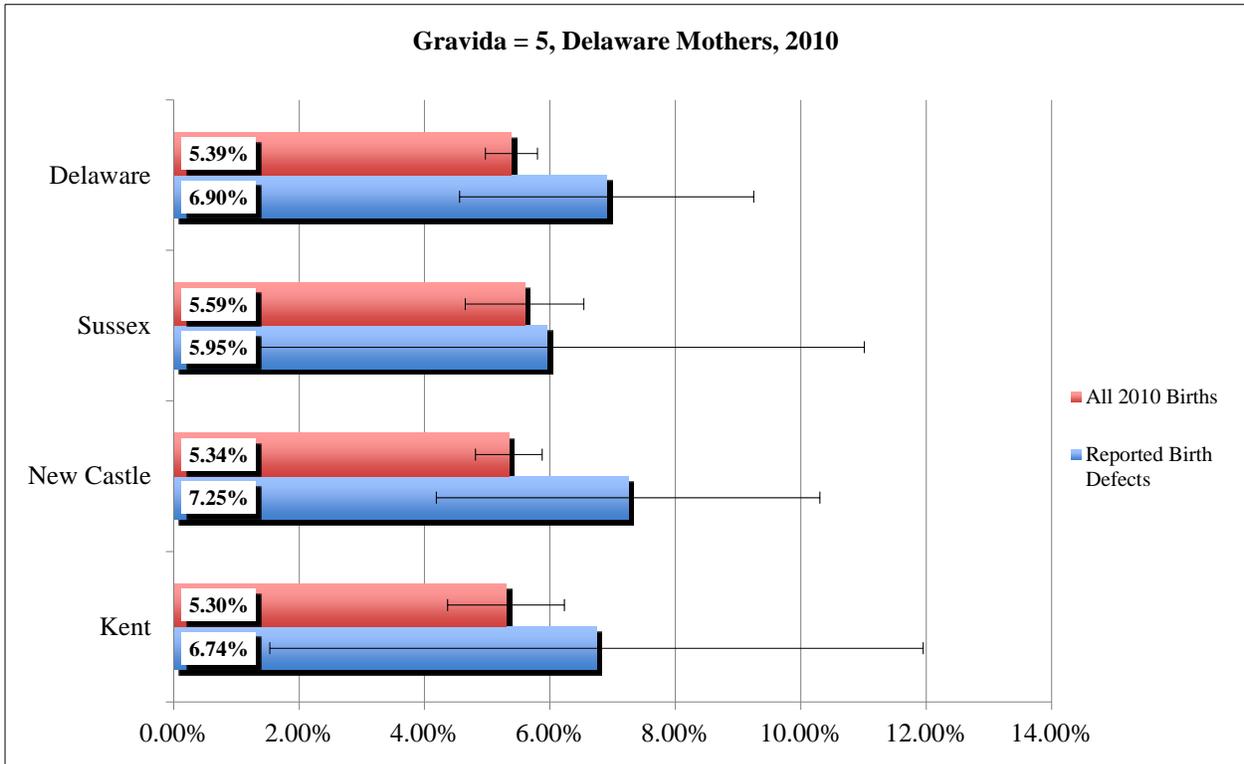


Source: State of Delaware 2010 Birth Defects Registry

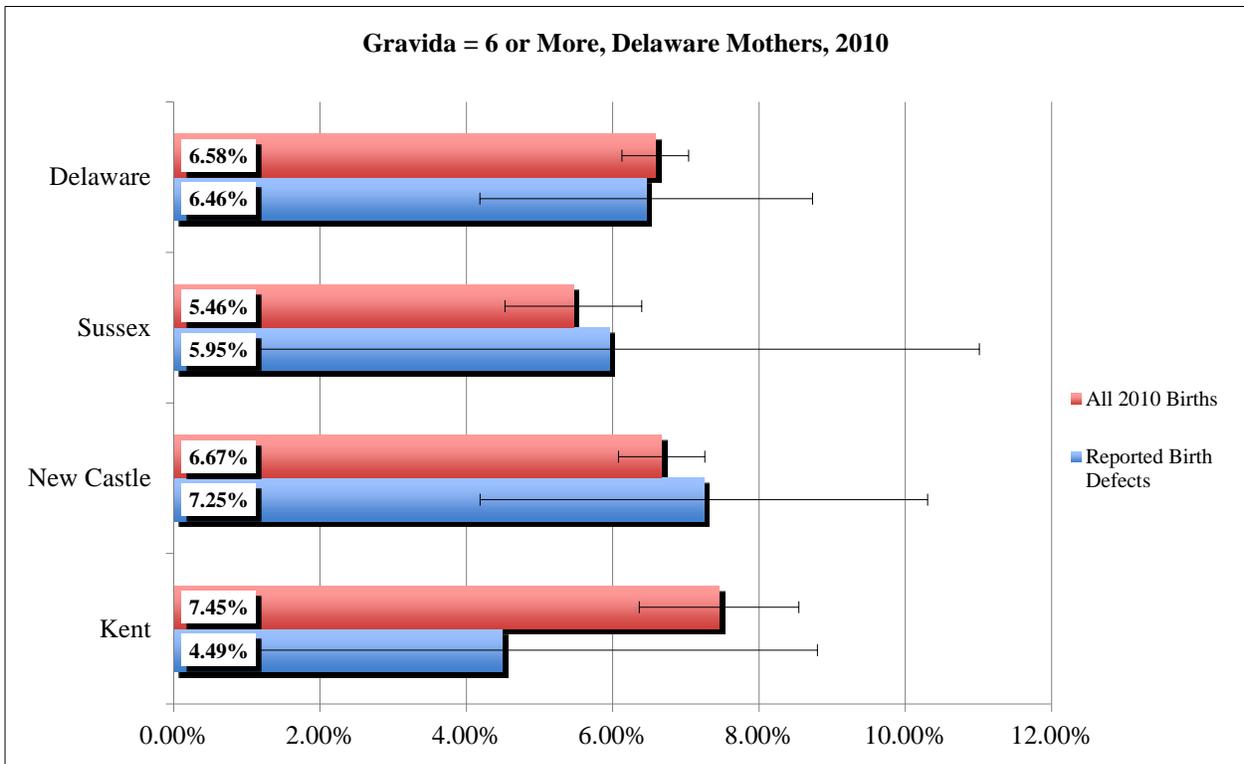


Source: State of Delaware 2010 Birth Defects Registry

APPENDIX C.2. Gravida. *Continued*



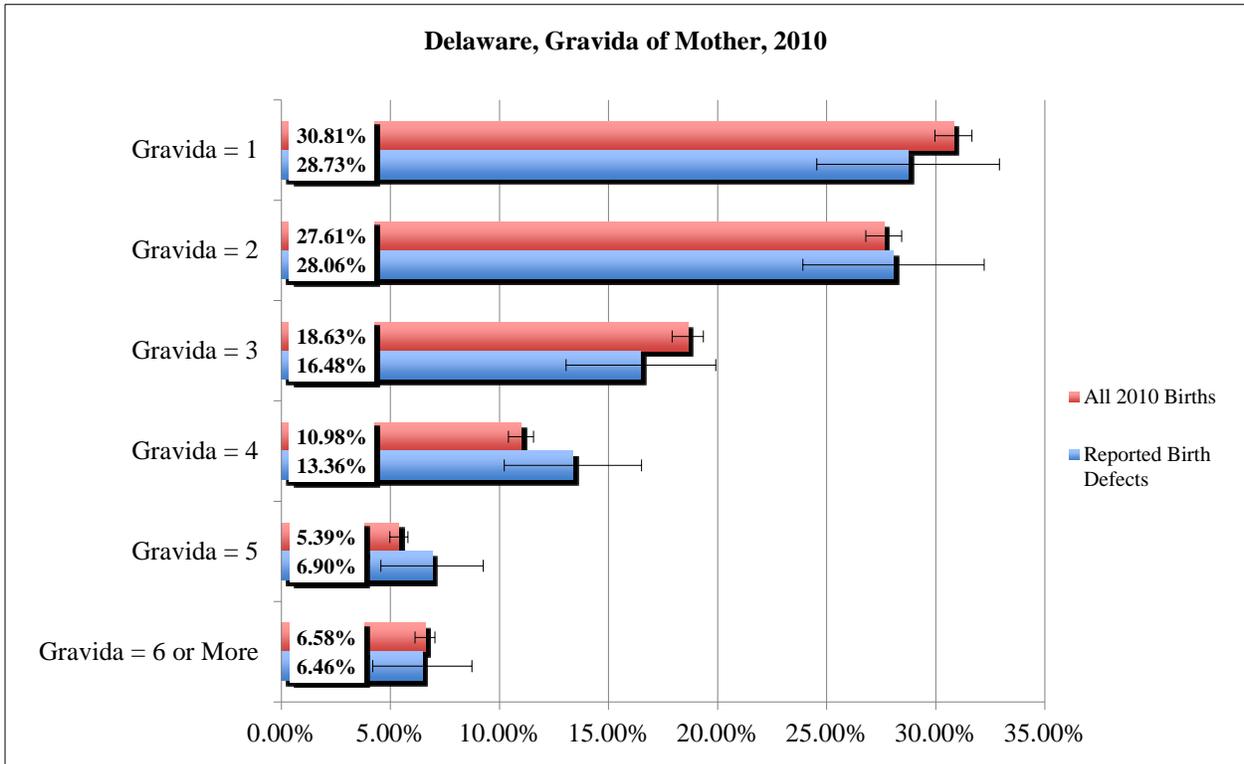
Source: State of Delaware 2010 Birth Defects Registry



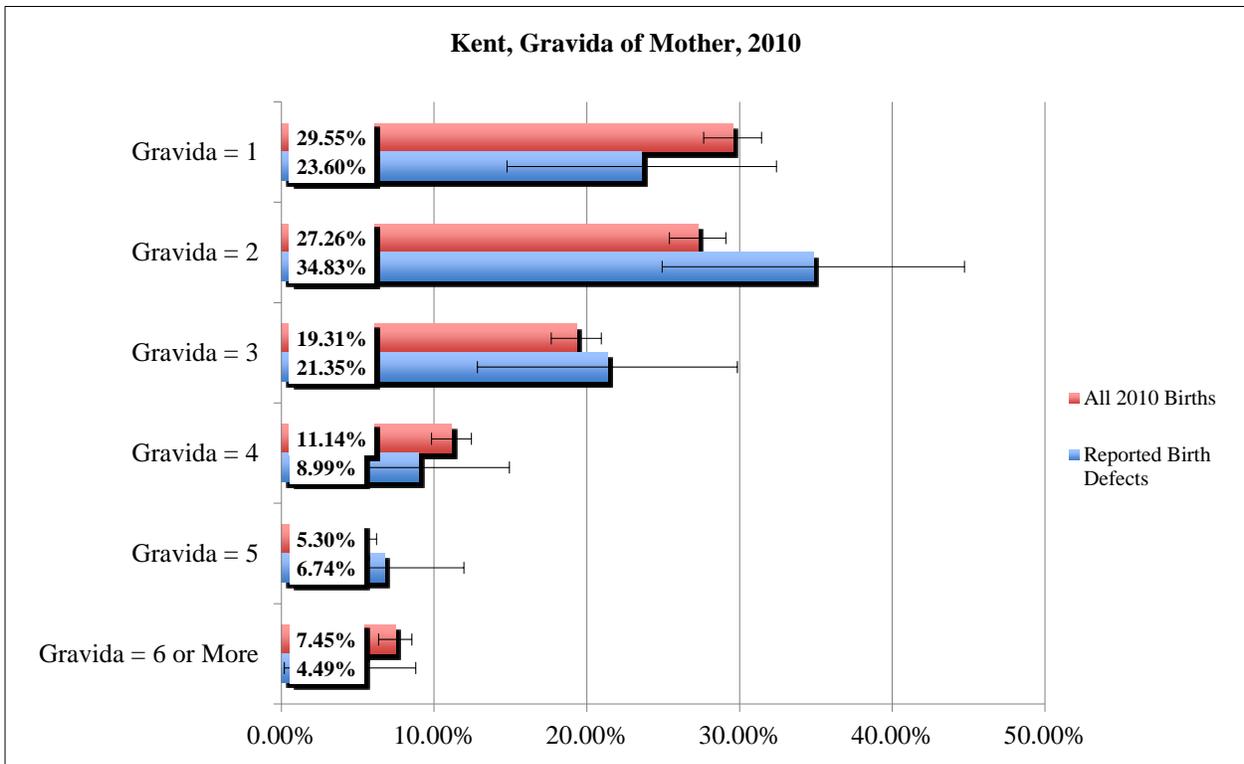
Source: State of Delaware 2010 Birth Defects Registry

ANALYSIS OF THE 2010 BIRTH DEFECTS REGISTRY

APPENDIX C.2. Gravida. *Continued*

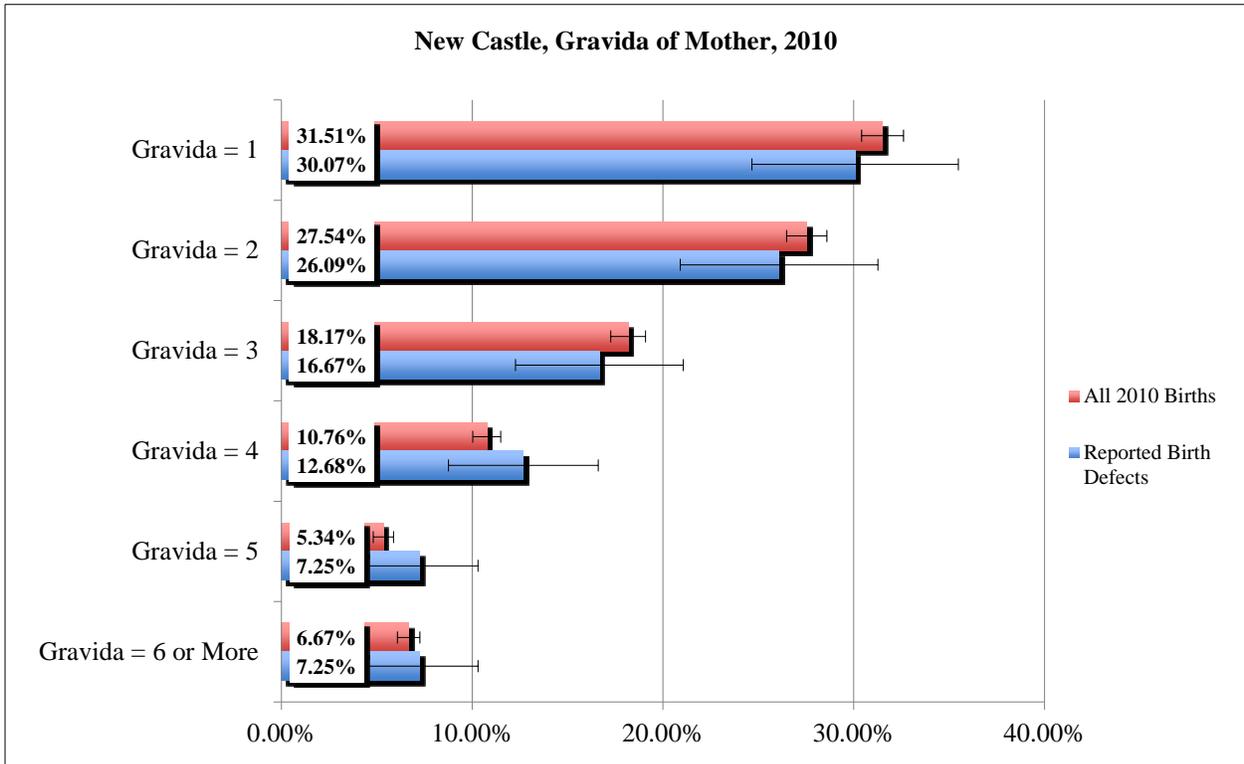


Source: State of Delaware 2010 Birth Defects Registry

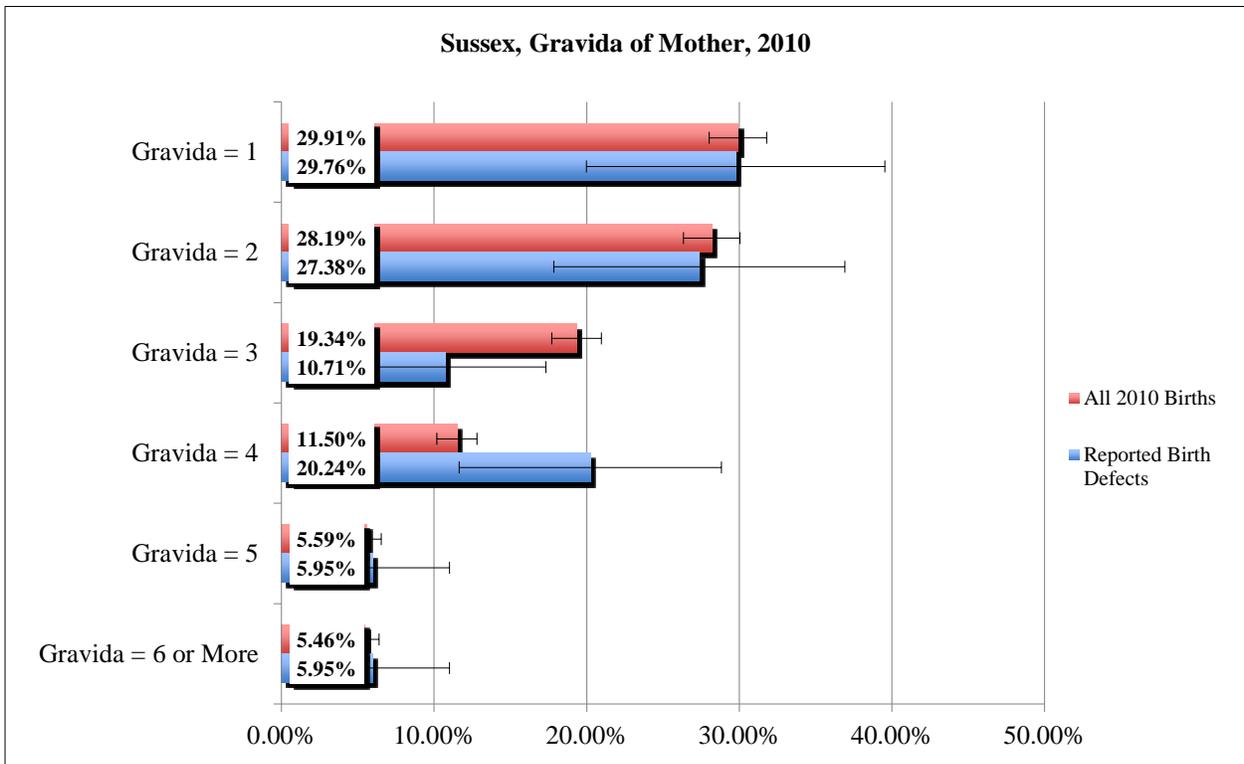


Source: State of Delaware 2010 Birth Defects Registry

APPENDIX C.2. Gravida. *Continued*

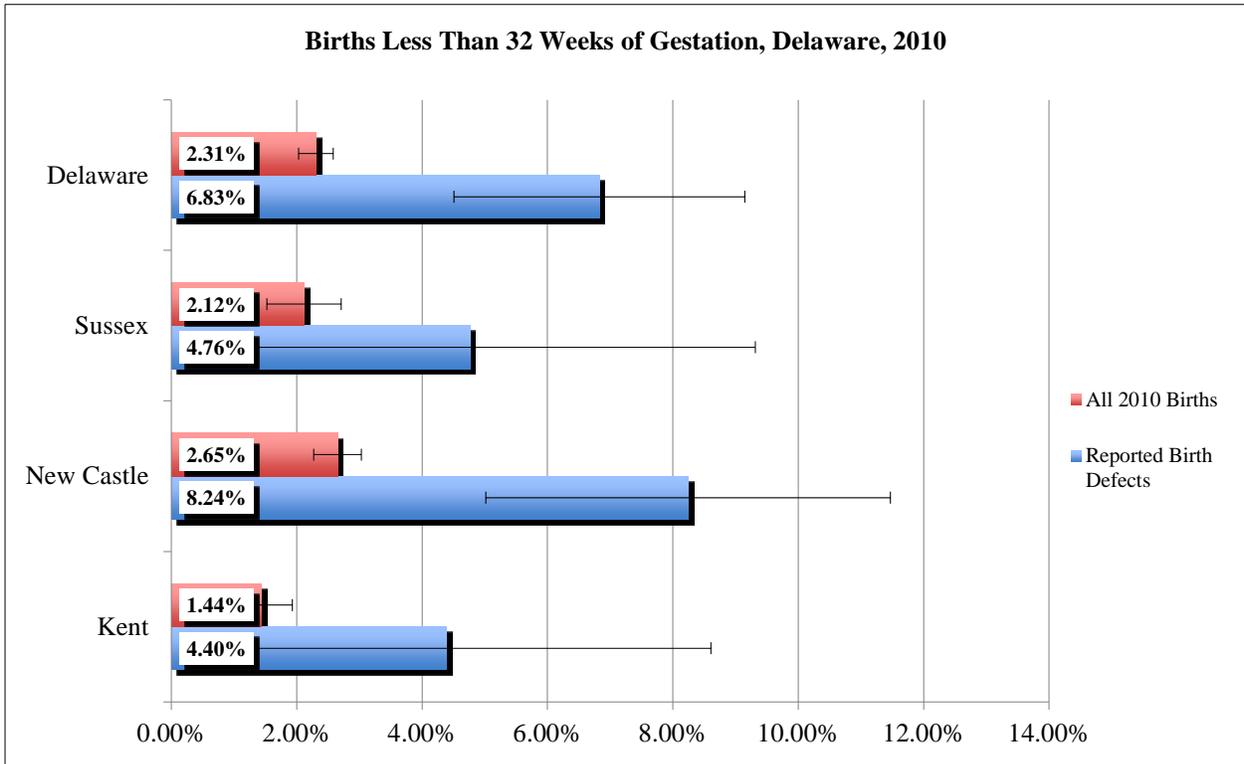


Source: State of Delaware 2010 Birth Defects Registry

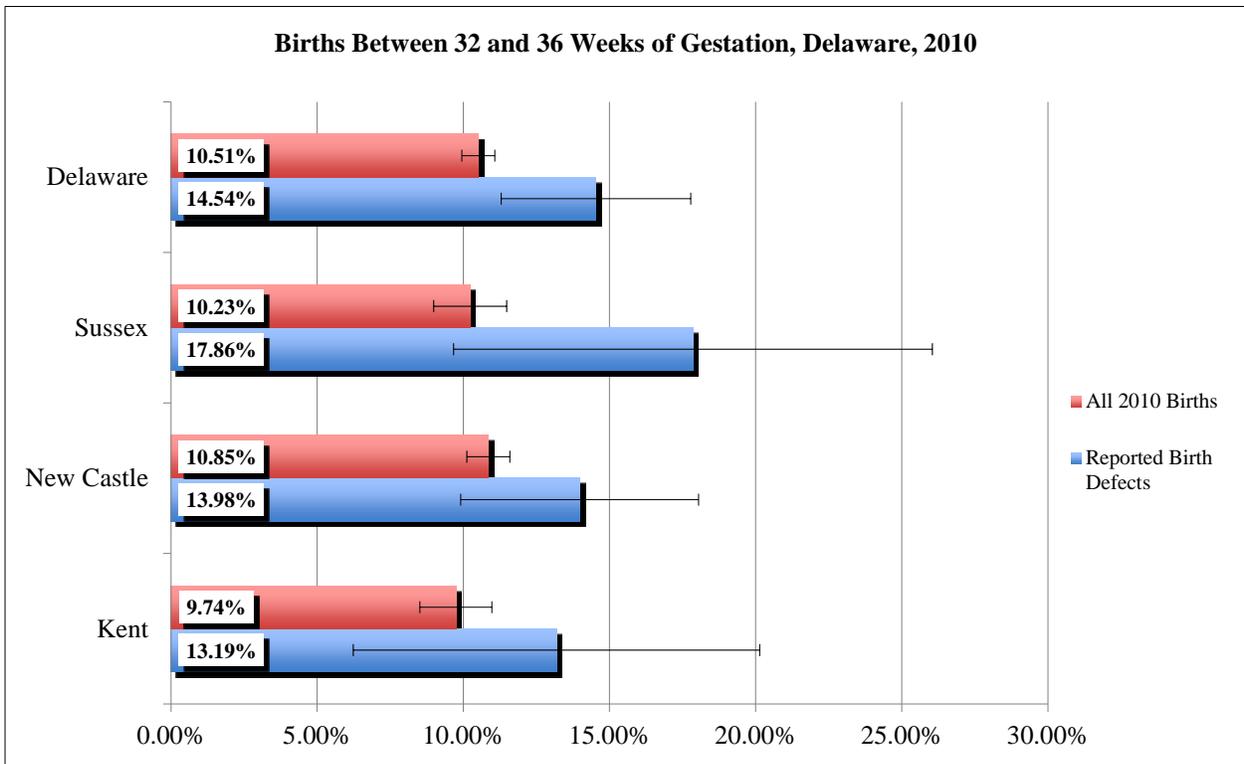


Source: State of Delaware 2010 Birth Defects Registry

APPENDIX C.3. Gestational Weeks.

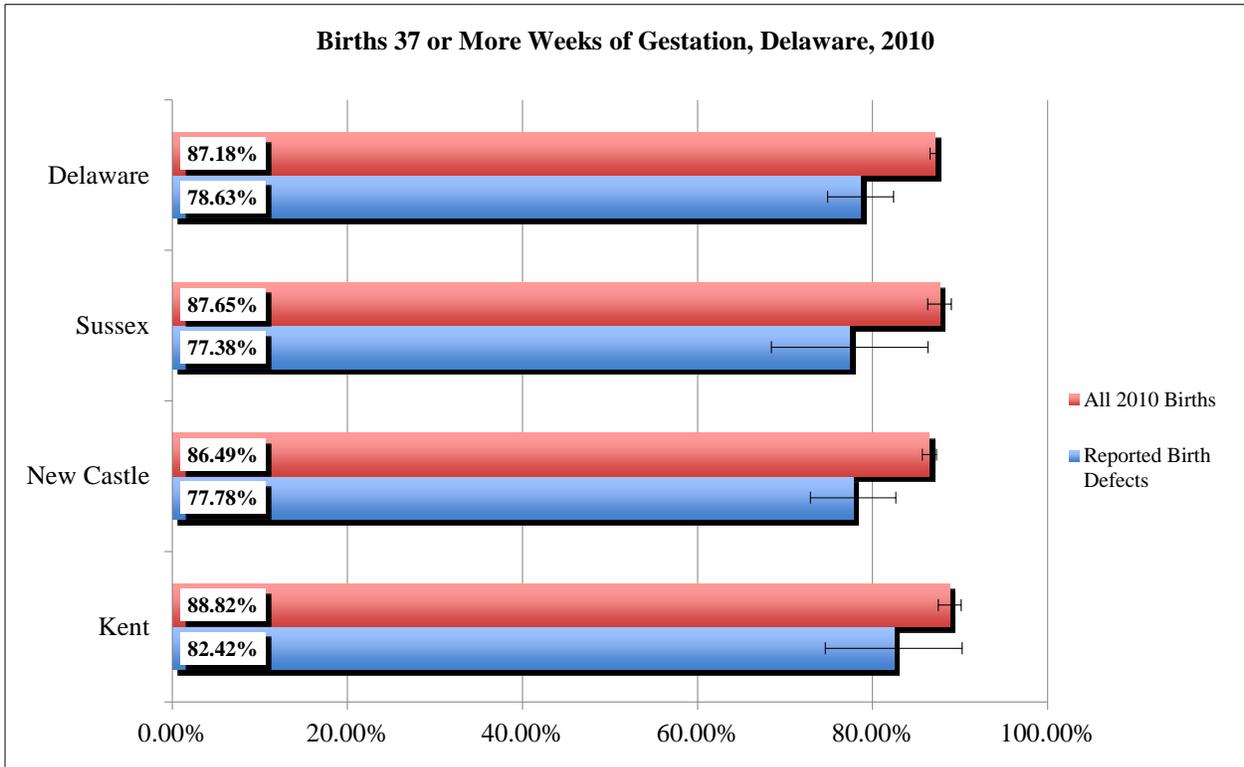


Source: State of Delaware 2010 Birth Defects Registry

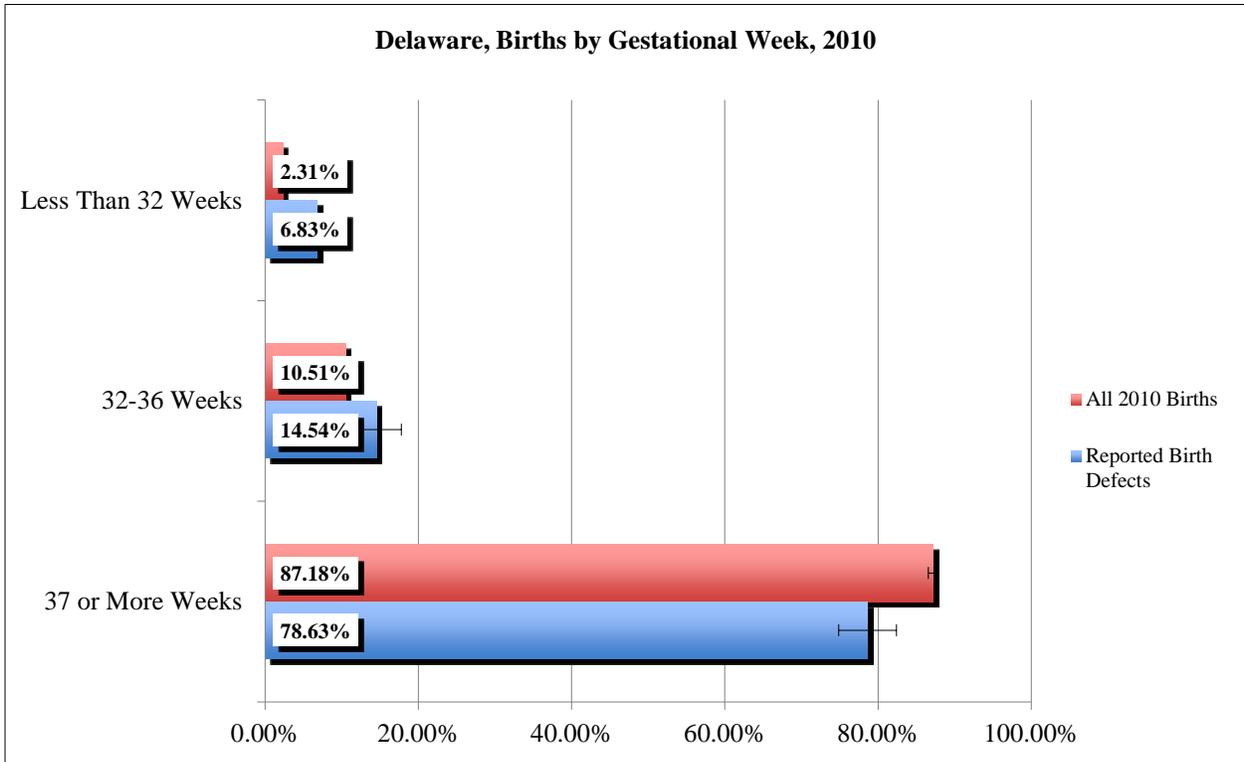


Source: State of Delaware 2010 Birth Defects Registry

APPENDIX C.3. Gestational Weeks. *Continued*

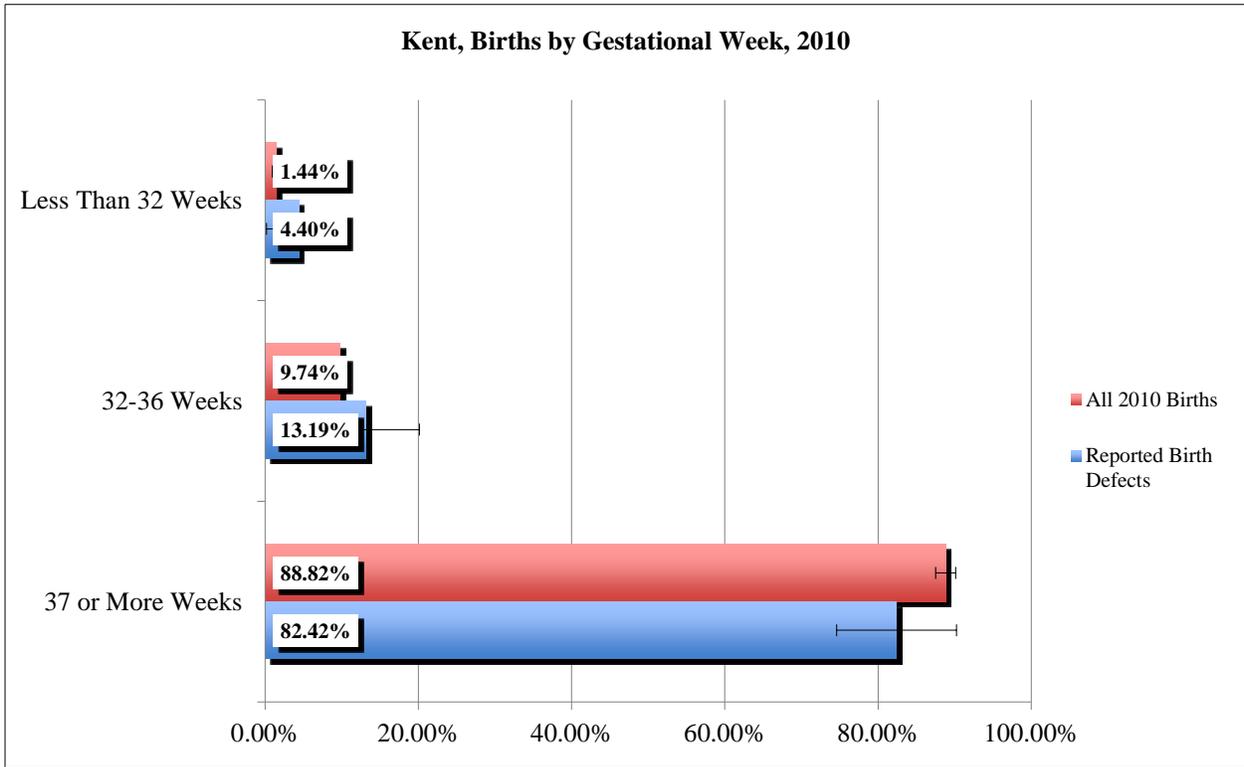


Source: State of Delaware 2010 Birth Defects Registry

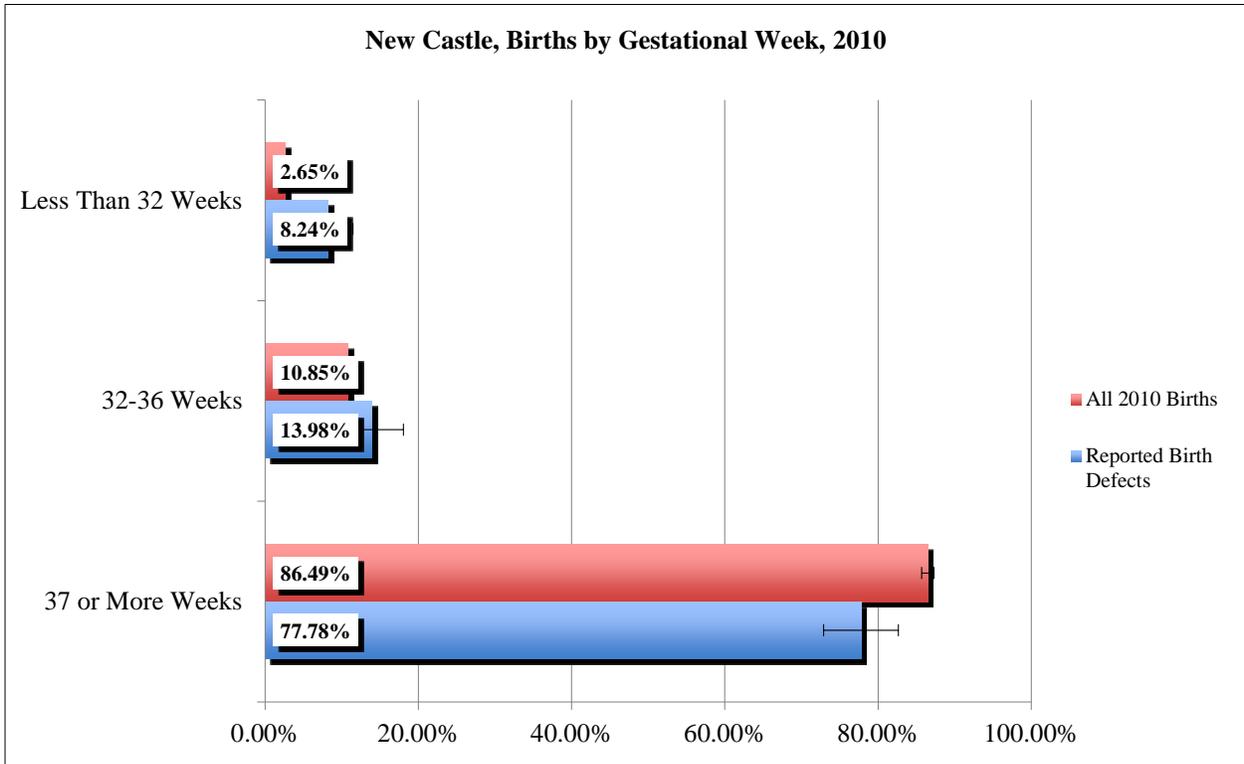


Source: State of Delaware 2010 Birth Defects Registry

APPENDIX C.3. Gestational Weeks. *Continued*

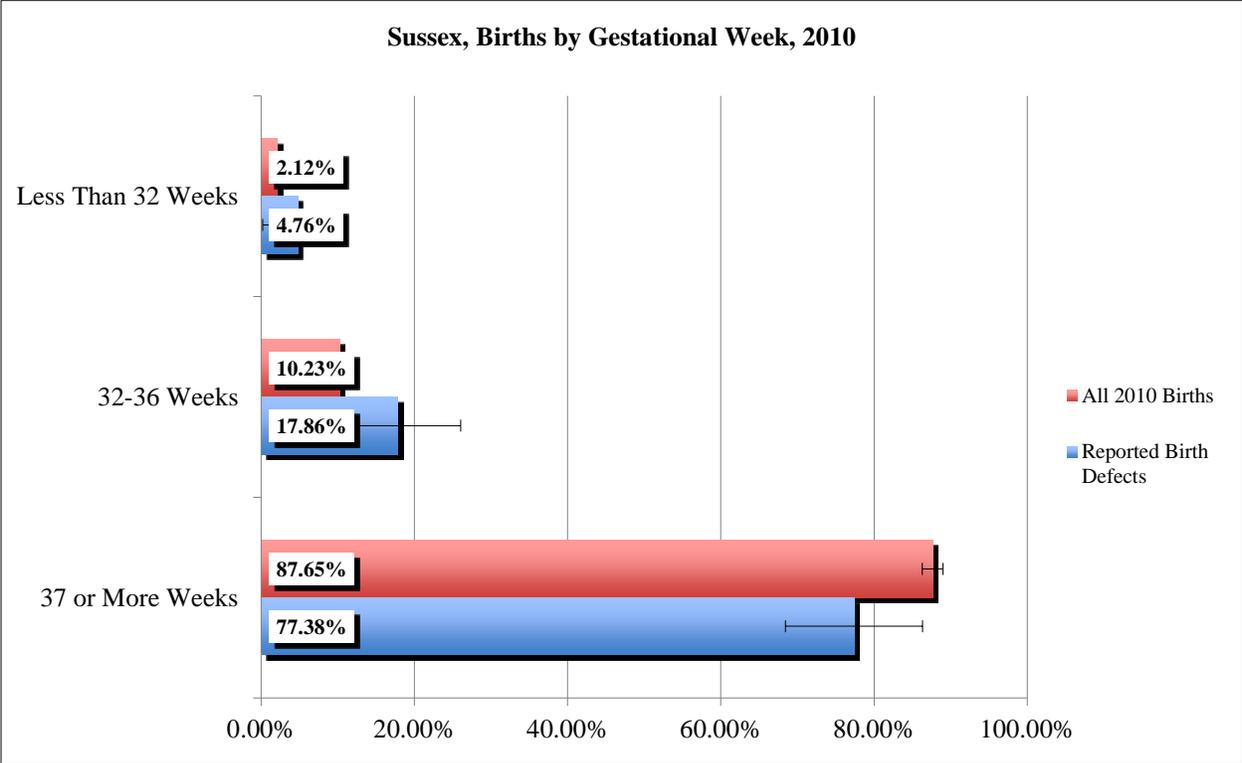


Source: State of Delaware 2010 Birth Defects Registry



Source: State of Delaware 2010 Birth Defects Registry

APPENDIX C.3. Gestational Weeks. *Continued*



Source: State of Delaware 2010 Birth Defects Registry

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- ⁷ Delaware Department of Health and Social Services, Division of Public Health. *Delaware Pregnancy Risk Assessment Monitoring System (PRAMS) 2009 Analysis*.
- ⁸ Honein, M. et al. (2009). The association between major birth defects and preterm birth. *Mat Child Health J*, 13(2): 164-75.
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