

Births Resulting From Assisted Reproductive Technology: Comparing Birth Certificate and National ART Surveillance System Data, 2011

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Abstract

Objectives—This report compares data on births resulting from assisted reproductive technology (ART) procedures from 2011 birth certificates with data from the 2011 National ART Surveillance System (NASS) among the subset of jurisdictions that adopted the 2003 revised birth certificate as of January 1, 2011, with information on ART.

Methods—Birth certificate data are based on 100% of births registered in 27 states and the District of Columbia. NASS data included all ART cycles initiated in 2010 or 2011 for which a live birth in 2011 was reported. The same reporting area was used for both data sources and represents 67% of all births in the United States in 2011. A ratio was computed by dividing the percentage of births resulting from ART procedures for NASS data by the percentage for birth certificate data. A ratio of 1.0 represents equivalent levels of reporting. Because this reporting area is not a random sample of births, the results are not generalizable to the United States as a whole.

Results—Overall, the percentage of births resulting from ART procedures was 2.06 times higher for NASS data (1.44%) compared with birth certificate data (0.70%). The ratio for each jurisdiction varied from 1.04 for Utah and Wisconsin to 7.50 for Florida. Higher-risk groups had more consistent reporting between data sources [e.g., triplet or higher-order multiples (1.36) compared with singletons (2.11)].

Conclusions—Births resulting from ART procedures appear to be underreported on the birth certificate; however, the magnitude of underreporting varied by jurisdiction and maternal-infant health characteristics.

Keywords: infertility treatment • data quality • vital statistics

Introduction

Assisted reproductive technology (ART) procedures, in which eggs and sperm are handled in a laboratory to produce a pregnancy,

are increasingly being used as a method to overcome infertility. In the United States, the number of ART procedures and ART-conceived births has risen steadily since the early 1980s (1). The rate of multiple births has paralleled this trend, with increases from 19.3 per 1,000 live births in 1980 to a peak of 34.9 in 2009 (2). This rise is largely attributed to the use of ovulation induction, ovarian stimulation, and multiple embryo transfer in ART procedures (3–5). The public health implications of these trends are considerable, because multiple births are related to increases in pregnancy complications and adverse birth outcomes compared with singletons (3). Other studies have suggested that ART may also be associated with potential health risks in singleton infants, such as low birthweight and preterm birth (6–8). These trends and consequences underscore the importance of reliable data to better understand maternal and infant health outcomes from ART procedures.

Much of the current knowledge of ART availability and use is based on the National ART Surveillance System (NASS), which is maintained by the Division of Reproductive Health (DRH) at the Centers for Disease Control and Prevention (CDC). NASS represents the most complete reporting of ART in the United States, with more than 95% of ART cycles captured (9). Detailed information is collected on patient obstetrical and medical history, infertility diagnosis, and ART procedures. However, because ART facilities provide most of the data, pregnancy information beyond the first trimester is minimal, and information on birth outcomes are self-reported by the ART patients or their obstetric providers following delivery. Thus, essential data on maternal and infant outcomes throughout pregnancy and after delivery are limited.

Recognizing the need for more comprehensive information on pregnancy and birth outcomes related to infertility treatments, the 2003 U.S. Standard Certificate of Live Birth (revised) introduced items on infertility treatment and type of treatment, including ART and non-ART procedures. The U.S. birth certificate is an essential data source for maternal and infant health information, providing annual data on all



births in the country. Advantages of birth certificate data include the capturing of detailed assessments of subpopulations and rare events, such as births from ART, and the fact that the birth certificate is the only national data source for births resulting from non-ART fertility treatment. However, previous studies based on the 1989-revised birth certificate have demonstrated underreporting for some medical and health items on the birth certificate (10–16). Fewer studies have assessed medical and health data from the 2003 birth certificate revision (17–20). Previous data quality studies of ART birth data were mainly conducted prior to the 2003 birth certificate revision when available on the state birth certificate (14,21–23), or among states using non-2003 birth certificate revision standards for infertility treatment and type (19). One statewide study (New York) evaluated the concordance of infertility treatment and type between the 2003 revised birth certificate and maternal report, but not with ART surveillance data (20).

The comparability of data on births resulting from ART procedures in the 2003 revised birth certificate with other national data sources across multiple reporting areas has not been reported. This report compares the overall and jurisdiction-specific contribution of ART to births from 2011 birth certificate data with 2011 NASS data among jurisdictions that adopted the 2003 revised birth certificate with information on ART. Reporting differences between the two data sources across select demographic and health characteristics and jurisdiction-specific indicators (e.g., health insurance mandates for infertility treatment and recent implementation of the revised birth certificate) are also assessed.

Methods

Birth certificate data

The revised birth certificate includes a checkbox item on whether the pregnancy resulted from infertility treatment and, if so, the type of infertility treatment used. The type of infertility treatment is reported as: a) “Fertility-enhancing drugs, Artificial insemination, or Intrauterine insemination,” and b) “Assisted reproductive technology [e.g., in vitro fertilization (IVF), gamete intrafallopian transfer (GIFT)].” One or both types of treatments can be reported for the same birth (24). This information is recommended to be obtained from the mother’s medical records (25).

Birth certificate data are based on 100% of births registered in 27 states and the District of Columbia that had implemented the 2003 revision of the birth certificate as of January 1, 2011, and reported information on infertility treatment *and* the type of infertility treatment used (24). (Not all revised jurisdictions collected information on type of infertility treatment during the study period; nine additional revised states report the use of infertility treatment but not the *type* of treatment used.) The 27 reporting states are: California, Colorado, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Louisiana, Maryland, Missouri, Montana, Nevada, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, South Dakota, Texas, Utah, Vermont, Wisconsin, and Wyoming. Births in these states represent 67% of all births in the United States in 2011.

Because this reporting area is not a random sample of births, the results are not generalizable to the United States as a whole. Differences between this reporting area and the entire United States in 2011 were found for age, race and ethnicity, marital status, birthweight of

4,000 grams or more, and multiple births, but no differences were seen for preterm, very preterm, low birthweight, and very low birthweight (see [Table](#) in this section). Unknown reporting of ART represented 0.8% of births in the reporting area and ranged from 0.03% (Colorado) to 5.8% (District of Columbia) across jurisdictions.

Demographic and health characteristics used in the [detailed tables](#) were selected based on item comparability between the birth certificate and NASS. For the birth certificate, maternal age and race are based on data collected from the mother (24). Race and Hispanic origin are

Table. Births by selected demographic and health characteristics: United States and 27 reporting states and District of Columbia, 2011

Characteristic	Reporting area ¹		United States		
	Mother	N	Percent	N	Percent
Race and Hispanic origin:					
All races and origins ²		2,670,545	100.00	3,953,590	100.00
Non-Hispanic		1,907,390	71.98	3,008,200	*76.62
White ³		1,330,268	50.20	2,146,566	*54.67
Black ³		387,027	14.61	582,345	*14.83
American Indian or Alaska Native ^{3,4}		24,293	0.92	39,187	*1.00
Asian or Pacific Islander ³		165,802	6.26	240,102	*6.12
Hispanic ⁵		750,282	26.90	907,677	*23.14
Mexican		479,689	18.10	566,699	*14.43
Puerto Rican		39,042	1.47	67,018	*1.71
Cuban		15,071	0.57	17,131	*0.44
Central or South American		97,007	3.66	136,221	*3.47
Other and unknown Hispanic		111,597	4.21	131,060	*3.34
Age (years):					
Under 20		229,683	8.60	333,746	*8.44
20–24		624,169	23.37	925,200	23.40
25–29		758,623	28.41	1,127,583	*28.52
30–34		661,478	24.77	986,682	*24.96
35–39		316,283	11.84	463,849	*11.73
40–54		80,309	3.01	116,530	*2.95
Unmarried		1,097,969	41.11	1,607,773	*40.67
Infant or delivery					
Very preterm ⁶		51,206	1.92	76,199	1.93
Preterm ⁷		311,876	11.69	463,163	11.73
Very low birthweight ⁸		38,114	1.43	56,754	1.44
Low birthweight ⁹		215,432	8.07	319,711	8.10
4,000 grams ¹⁰ or more		200,673	7.52	306,872	*7.77
Multiple births ¹¹		90,751	3.40	136,686	*3.46

* $p \leq 0.05$ based on a z test of proportions.

¹California, Colorado, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Louisiana, Maryland, Missouri, Montana, Nevada, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, South Dakota, Texas, Utah, Vermont, Wisconsin, and Wyoming.

²Includes Hispanic origin not stated.

³Race and Hispanic origin are reported separately on birth certificates. Race categories are consistent with 1977 Office of Management and Budget (OMB) standards. All states in the 27-state and District of Columbia reporting area reported multiple-race data for 2011, which were bridged to the single-race categories of the 1977 OMB standards for comparability with other states; see Technical Notes.

⁴Includes births to Aleuts and Eskimos.

⁵Includes persons of Hispanic origin of any race.

⁶Born prior to 32 completed weeks of gestation.

⁷Born prior to 37 completed weeks of gestation.

⁸Less than 1,500 grams (3 lb 4 oz).

⁹Less than 2,500 grams (5 lb 8 oz).

¹⁰Equivalent to 8 lb 14 oz.

¹¹Includes twin, triplet, and higher-order multiple deliveries.

reported separately and categorized as single-race non-Hispanic white, non-Hispanic black, and non-Hispanic other, and Hispanic births. Maternal age is grouped into six age groups consistent with classifications used in national ART summary reports: under 35, 35–37, 38–40, 41–42, 43–44, and 45 and over (9). Other characteristics included total birth order, gestational age, birthweight, plurality, and infant sex. Gestational age is primarily based on completed weeks of gestation from the date of last menstrual period (LMP), and total birth order is the total of live births (inclusive of current birth) and other pregnancy outcomes (24). Missing values for Hispanic origin (0.8%), total birth order (1.5%), gestational age (0.09%), and birthweight (0.08%) are excluded from analyses involving these variables. Maternal age, race, day of LMP when month and year are known, and plurality are imputed for birth records (24).

National ART Surveillance System

As mandated by the Fertility Clinic Success Rate and Certification Act of 1992 [Public Law 102–493 (October 24, 1992)], CDC has collected data on ART procedures performed in the United States since 1995. Data for 1995–2003 were obtained from the Society of Assisted Reproductive Technology (SART). CDC subsequently established the National ART Surveillance System, a Web-based tool for data collection (available from: <http://www.cdc.gov/art/NASS.htm>), currently administered under a contract with Westat, Inc. NASS data contain one record per cycle, and multiple cycles from an individual patient are not linked. Because cycles are not repeated when a pregnancy is established, this is equivalent to one ART cycle for each birth in a given year. For the 2011 reporting year, NASS is estimated to have included 97% of all ART cycles performed in the United States, in part because nonreporting clinics tend to be smaller than reporting clinics (9). Overall, 1.6% of the 3,953,590 births in the United States were from ART procedures, according to NASS data for 2011. In this report, the results for NASS represent the 27-state and Washington, D.C., reporting area that included the ART checkbox on the birth certificate.

NASS data used for the current analysis included all ART cycles initiated in 2010 or 2011 for which a live birth in 2011 was reported. These data are based on information from 407 ART clinics in the United States and included cycles using fresh and thawed embryos from patient or donor eggs. Information on residence was derived from the patient's state or territory of residence at the time of treatment. If this information was missing, the state or territory of residence was assigned as the state or territory in which the procedure was performed. Maternal age and total birth order were derived from the medical record, as reported by the ART clinics. Total birth order was calculated by summing the total number of prior pregnancies and the current live birth. For fresh cycles, gestational age was calculated by subtracting the date of oocyte retrieval from the infant's day of birth and adding 14 to the difference (to adjust for the theoretical LMP). For frozen cycles or fresh cycles missing the date of oocyte retrieval, gestational age was calculated by subtracting the date of embryo transfer from the infant's date of birth and adding 17 to the difference (to adjust for theoretical LMP as well as 3 days of embryo culture). Information on birthweight, plurality, and infant sex was collected by ART clinics and based on maternal report or confirmation from a physician or hospital.

Validation of NASS data is conducted annually to ensure clinics are reporting correctly. For 2010 and 2011, approximately 8% of the reporting clinics were randomly selected for data validation, with slightly greater weights given to larger clinics and those with low cancellation rates (26). Data for a randomly selected sample of ART cycles is compared with information in medical records, and discrepancy rates are calculated for selected variables. The discrepancy rates for pregnancy outcome (e.g., live birth) and number of infants born was 1% or less during 2010 and 2011. For date of pregnancy outcome, the discrepancy rate was approximately 4%.

Data analysis

The distributions of demographic and health characteristics among births resulting from ART procedures were compared by data sources, and differences were tested using a Pearson chi-squared test. More than 35% of race and ethnicity values were missing in NASS; therefore, only complete information for race and ethnicity was assessed among births resulting from ART procedures in NASS. Although percent distributions by race and ethnicity are shown in [Table 1](#), percentages of ART births by race and ethnicity were not further analyzed by data source due to the missing race and ethnicity values in NASS.

The percentage of births resulting from ART procedures was calculated for each data source. Because the birth certificate allowed for unknown reporting of ART, the number of ART births was divided by the total number of births excluding unknown ART values. In contrast, the denominator for NASS included all births from the birth certificate. A ratio was computed by dividing the percentages for NASS data by the percentages for birth certificate data, with a ratio of 1.0 representing equivalent levels of reporting for the two data sources.

The percentages of births from ART procedures were compared by jurisdiction and select maternal and infant characteristics separately for each data source (i.e., the data sources were not linked). For jurisdiction-specific analyses, statistically significant differences in the reporting by data source across states were assessed using a z test or likelihood ratio test. New York City is an independent vital statistics reporting area and was analyzed separately. Differences between data sources across maternal and infant characteristics were assessed using a likelihood ratio test to evaluate whether the magnitude of the NASS-to-birth certificate ratio varied across specific characteristics. Because previous studies have shown better reporting on the birth certificate with increased plurality, and plurality may vary by jurisdiction or other characteristics, additional analyses adjusting for plurality were also conducted.

Reporting differences were also evaluated between jurisdictions with and without some form of mandated health insurance for infertility treatment, and between jurisdictions that recently implemented the revised birth certificate (within the past 3 years) and those that had not. Jurisdictions with health insurance mandates for infertility treatment within this reporting area included: California, Illinois, Louisiana, Maryland, Montana, New York, New York City, Ohio, and Texas. Jurisdictions that had recently revised birth certificates in 2010 and 2011 for type of infertility treatment were: District of Columbia, Florida, Illinois, Louisiana, Maryland, Missouri, Nevada, North Carolina, Oklahoma, and Wisconsin. (Note: Florida had fully revised the birth certificate as of January 1, 2005, but had not adopted the revised question on type of infertility treatment until January 1, 2011.)

To assess whether differences could be attributed to other reporting characteristics of the jurisdictions, a Pearson's correlation coefficient (*r*) between jurisdiction-specific ratios, and the percentage of unknown reporting of ART on the birth certificate and total number of NASS-reported ART births across each jurisdiction, was calculated. A two-sided *p* value of less than 0.05 was considered statistically significant for all analyses.

Results

In the 27-state and Washington D.C., reporting area, the overall number of births resulting from ART procedures in NASS (38,496) was more than double the number from the birth certificate (18,560) (Table 1). The distributions of maternal and infant characteristics among ART births were generally comparable in both data sources, despite statistically significant differences across characteristics with the exception of infant sex. For the birth certificate and NASS, approximately one-half of ART births were among women under age

35 (47.4% for the birth certificate compared with 50.1% for NASS), with about one-third of births occurring preterm (less than 37 weeks of gestation, 37.3% compared with 37.4%, respectively) or low birthweight (less than 2,500 grams, 33.0% compared with 32.4%, respectively). In addition, the majority of ART births occurred among non-Hispanic white women (75.0% compared with 71.3%, respectively) and singleton infants (52.3% and 53.8%, respectively) in both data sources (note that 35% of values had unknown race and ethnicity in NASS data, and 2.8% of values had unknown Hispanic origin for birth certificate data). Similar proportions of male and female births were observed in both data sources (51.1% of male births for the birth certificate compared with 51.0% for NASS). Differences in proportions were greatest for total birth order, with 35.6% of ART births occurring among women with one birth from the birth certificate compared with 41.9% from NASS.

The percentage of births resulting from ART procedures was 2.06 times higher for NASS (1.44%) compared with the birth certificate (0.70%) in the reporting area (Table 2, Figure 1). Jurisdictions varied

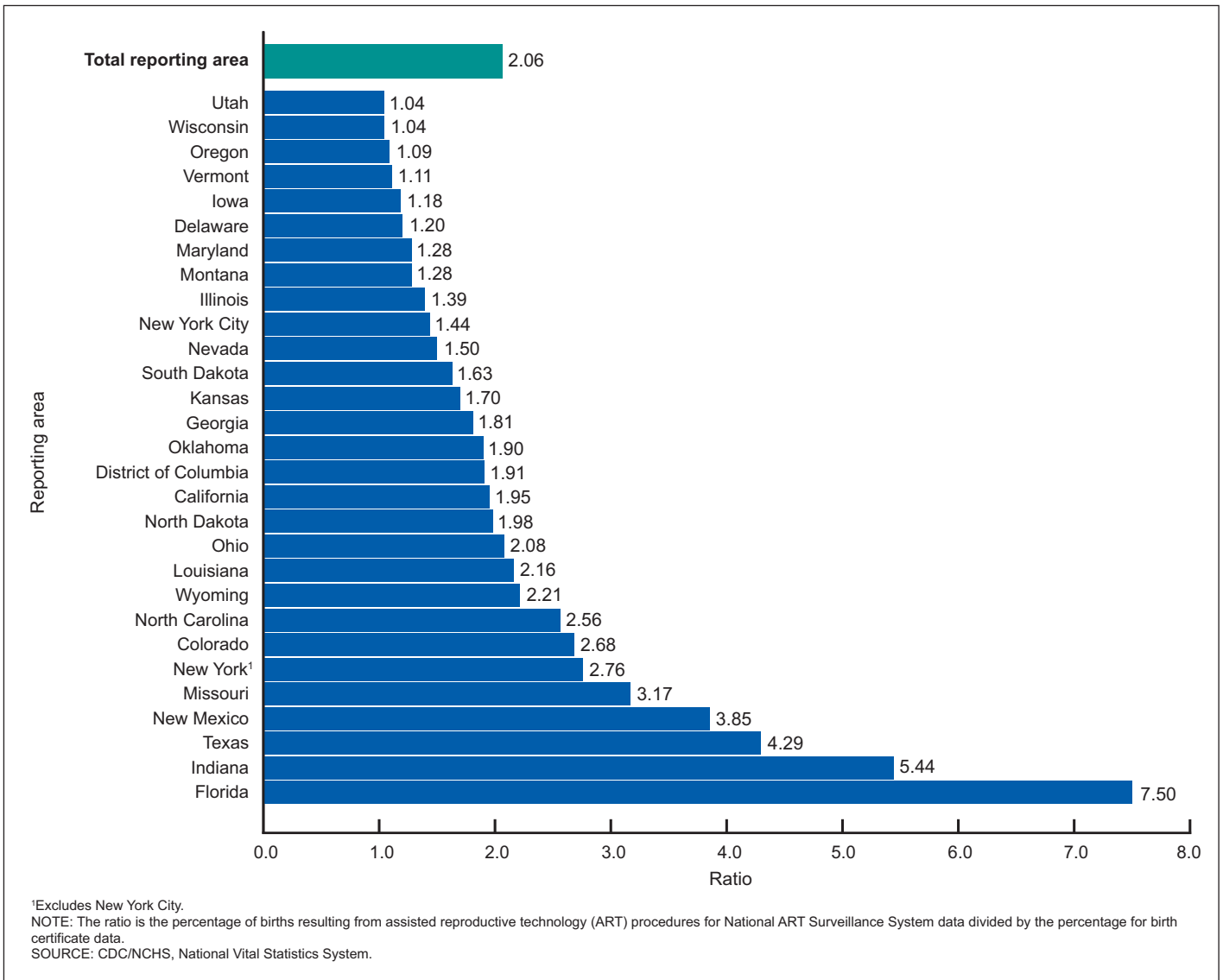


Figure 1. Ratio of births resulting from assisted reproductive technology procedures in National ART Surveillance System data compared with birth certificate data, by jurisdiction: 27 reporting areas and District of Columbia, 2011

by the extent of reporting differences (ratios) between NASS and the birth certificate, from 1.04 (no significant difference) for Utah and Wisconsin to 7.50 for Florida. Other jurisdictions that did not differ significantly between NASS and the birth certificate were: Delaware (1.20), Montana (1.28), Oregon (1.09), and Vermont (1.11). Adjusting for plurality had minimal effect on the overall findings, with a change in ratio from 2.06 to 2.05 for the overall reporting area after adjustment (data not shown). The correlation between the jurisdiction-specific ratios and the percentage reporting unknown on the birth certificate ($r = -0.09$) or total number of ART births in NASS ($r = 0.23$) was not statistically significant.

Jurisdictions differed by whether they had some form of mandated health insurance for infertility treatment (Table 2). Higher percentages of ART births were reported for NASS (1.66%) and the birth certificate (0.82%) among jurisdictions with mandates compared with those not having mandates (1.14% and 0.54%, respectively). Overall, the differences in births resulting from ART procedures between the two data sources were lower for jurisdictions with mandates (2.03) compared with jurisdictions lacking them (2.12).

The timing of revision status of the jurisdictions was also significant (Table 2). The percentage of ART births among jurisdictions that had recently (within the past 3 years) adopted the 2003 birth certificate was more comparable with NASS (1.85, or 1.55 after excluding Florida) than with jurisdictions that had been revised earlier (2.18).

While lower percentages of ART births were reported in birth certificate data, the patterns were similar across maternal and infant characteristics (Table 3). For example, the percentage of births resulting from ART procedures increased with maternal age and

plurality, and decreased with increasing gestational age and birthweight, for both data sources.

However, when comparing the level of ART births by data source (ratio), significant differences were observed across each of the maternal and infant health characteristics except for infant sex. For each maternal and infant characteristic, the data sources tended to be more consistently reported among the higher-risk groups—aged 45 and over (1.61), less than 32 weeks' gestation (1.68), birthweight less than 1,500 grams (1.55), and triplets or higher-order multiples (1.36)—compared with each respective lower-risk group (Figure 2). Adjusting for plurality had minimal effect on the overall findings.

Discussion

Comparison of the birth certificate and NASS data shows that births resulting from ART procedures are underreported on the birth certificate. The extent of underreporting varied substantially by jurisdiction and maternal-infant health characteristics. For some jurisdictions, such as Utah and Wisconsin, the percentage of ART births captured by the birth certificate was similar to NASS, suggesting the potential for the birth certificate to produce estimates of ART births consistent with NASS reporting. Characteristics, such as higher-order multiples and older maternal age, were also found to have greater similarity in levels of ART births across data sources. This may reflect increased attention to the infertility checkbox information in specific high-risk groups when completing the birth certificate (27–31). These findings should be considered when

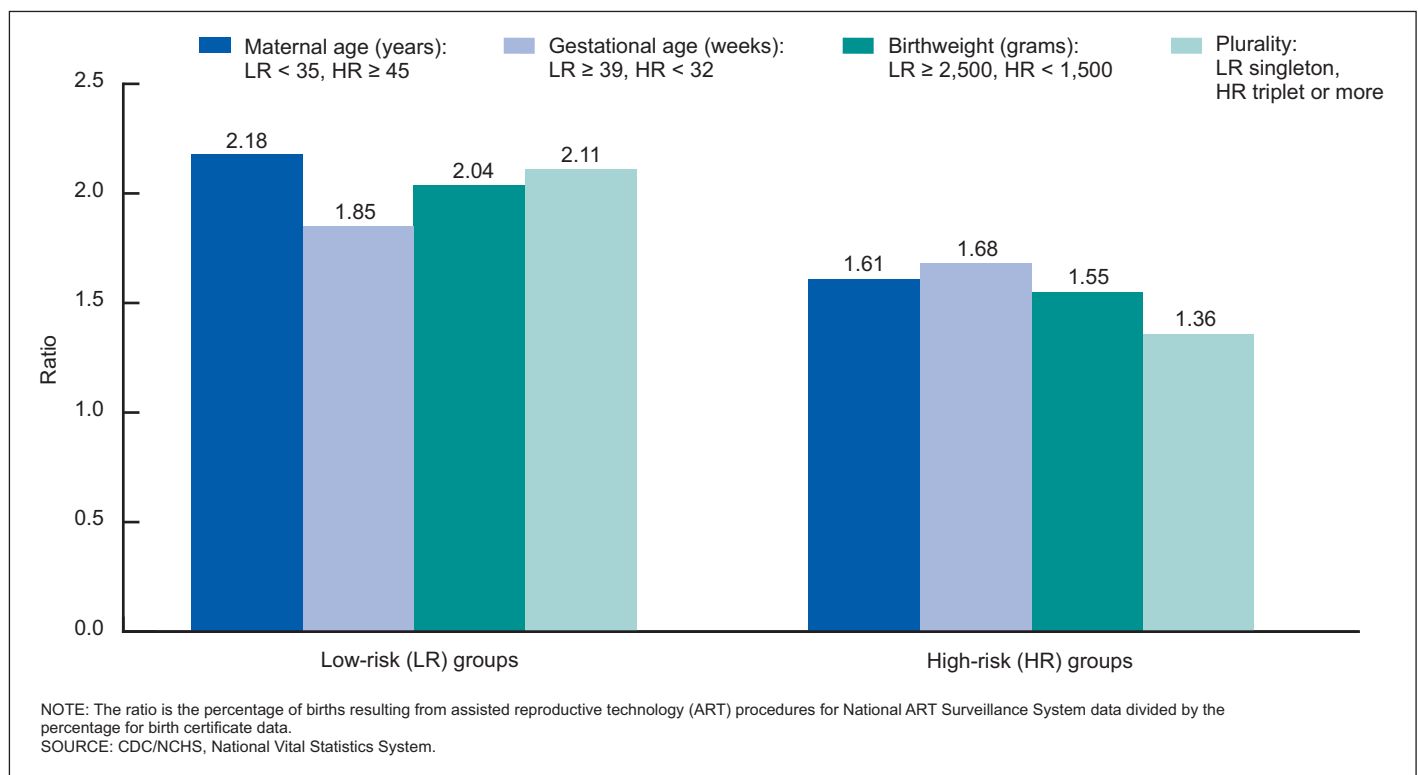


Figure 2. Ratio of births resulting from assisted reproductive technology procedures in National ART Surveillance System data compared with birth certificate data, by selected maternal and infant health characteristics: 27 reporting areas and District of Columbia, 2011

evaluating and improving the data quality of the ART checkbox item on the birth certificate.

Underreporting of ART on the birth certificate is consistent with other state-specific studies (14,19,21,22), despite differences in study designs and source of comparison (i.e., maternal report or ART surveillance data). The most recent validation study, using birth certificate data linked to NASS data in Massachusetts and Florida, found that the birth certificate captures about 30%–40% of ART births compared with NASS (19). Similarly, this report found Florida to have the highest level of underreporting across all jurisdictions (7.5 times higher ART births in NASS compared with the birth certificate). Although Massachusetts has included a checkbox on infertility treatment and type on the birth certificate since 1996, the state was not included in this study because it had not adopted the revised 2003 standard birth certificate standards as of 2011. As in this report, other studies have also shown that ART births were less likely to be reported on the birth certificate among younger women, singletons, and lower-risk births (19–22). The selective reporting area for ART births on the birth certificate should be taken into account, because it would not be representative of all ART births in the United States.

To test whether recent implementation of the revised birth certificate may affect data quality, jurisdictions that had adopted the revised birth certificate earlier were analyzed and found to have higher levels of underreporting (2.32) compared with more recently revised jurisdictions (1.85). This suggests that other jurisdictional factors might play a larger role in the level of reporting of ART births on the birth certificate. Finally, reporting differences were found to be greater in jurisdictions without mandated insurance coverage for infertility treatment (2.12) compared with those having mandated coverage (2.03). Although these differences were small, the availability of ART information from medical records may be more readily available in states offering private insurance policies for ART coverage. A prior study showed that ART was more likely to be correctly reported on the birth certificate for births to mothers whose prenatal care was provided by private insurance compared with public insurance (19).

Other factors may contribute to the reporting differences across jurisdictions found in this study. A number of initiatives were adopted during the 2003 revision process that aimed at re-engineering and standardizing the data collection process for the birth certificate to improve quality (25,32). For example, standardized maternal and facility worksheets to gather birth certificate information were developed, as well as a comprehensive guidebook for completing the facility worksheet to aid hospital staff in reporting items on the birth certificate. A recent National Association for Public Health Statistics and Information Systems (NAPHSIS) survey showed birth data quality improvement efforts differed across jurisdictions (33). Recommendations from this report included greater communication between and education of birth registration and vital statistics departments, adherence to standardized data collection instruments, and timelier evaluation of records for quality control. The extent of adoption of standardized material and quality improvement efforts, such as training of birth information specialists, may also have had an impact on the jurisdictional-level differences found in this study.

Because the birth certificate and NASS were not linked (i.e., each maternal record on the birth certificate corresponds to the same person

in NASS), the extent of consistency and discordancy between the two data sources could not be assessed at an individual level. For example, although reporting differences were found to be greater in jurisdictions without mandated insurance coverage for infertility treatment, it could not be determined whether women with insurance coverage for infertility treatment are less likely to be underreported without individually linked data. In addition, similar percentages of ART births on the birth certificate are assumed to represent greater consistency with NASS and better reporting, which may not be the case given the limitations of both data sources. For example, misinterpretation of medical records or incorrect information obtained from other sources (e.g., maternal report) for the birth certificate may result in more or less consistency across data sources. NASS data, while considered the most complete reporting of ART in the United States, is estimated to exclude approximately 5% of ART cycles performed in the nation (9).

A further limitation is that the data sources ascertain some maternal and infant health characteristics differently, such as gestational age, which may result in different distributions of these characteristics (34). Most notably, information on race and ethnicity was missing for 35% of ART births in NASS, which may limit comparisons of the distribution among ART births and precluded further evaluation. Nevertheless, previous analyses of race and ethnicity in NASS suggest that the distribution of missing values is consistent with the distributions of reported values, and no major differences were found in the distributions of these characteristics across the data sources (Table 1). National data sources for births to non-ART infertility treatment methods are not available and could not be assessed in this study. Finally, the extent to which these findings are representative of the United States is limited, because only 27 reporting states and the District of Columbia had adopted the revised 2003 birth certificate with information on type of infertility treatment as of January 1, 2011.

Births resulting from ART procedures are still relatively rare, but increasing, in the United States (1). The ability to understand the relationship between ART and maternal and infant health is limited with NASS and other smaller data sources. Recently, the National Public Health Action Plan for the Detection, Prevention, and Management of Infertility highlighted the need for improved surveillance of infertility and related factors (35). Improving the quality of this item in national birth certificate data could lead to better identification of potential health consequences related to infertility treatment. This study is a first step in characterizing the extent of reporting differences across jurisdictions on the birth certificate. A number of initiatives are under way to improve the quality of birth certificate data in general. CDC's National Center for Health Statistics (NCHS), NAPHSIS, and individual jurisdictional vital statistics departments are partnering to combine efforts and strategies to improve the quality of birth data. Recent reports of these efforts are available on the NAPHSIS website (33,36). As part of this initiative, interactive electronic-learning training for hospital staff (birth information specialists and clinical staff) is being developed to encourage further adoption of already available standardized resources for birth data collection. Further, efforts are ongoing to identify birth certificate items of poor data quality with little to no potential for improvement. Recommendations are being made to the jurisdictions to cease collecting identified items, and these data will be dropped from the national birth data file. Finally, NCHS contracts with 57 vital records reporting

areas are aimed at improving timeliness and accuracy through increased standardization, performance requirements, and jurisdictional support, where needed.

Other research and recommendations may also improve data quality for ART on the birth certificate. The States Monitoring ART (SMART) Collaborative was formed among Massachusetts, Florida, Michigan, Connecticut, and CDC's DRH to establish, evaluate, improve, and promote state-based surveillance to monitor ART, infertility, and maternal and child health outcomes (37). Validation studies through linked birth certificate and NASS data are part of these efforts (19,23,38) and will provide a mechanism to assess birth data quality improvement efforts while also improving the understanding of maternal and child health outcomes related to ART procedures. Additional considerations discussed in the literature suggest obtaining information on infertility treatment from both the medical records and the mother, as another information source. Studies to evaluate this approach are under way (19). In addition, the standard American College of Obstetricians and Gynecologists form for collecting prenatal information includes a checkbox for ART procedures under medical history, along with the date and type of treatment if checked (39); however, not all providers may collect this information. A further approach to improving data collection of this item might be to work with providers to encourage the availability of infertility treatment questions on their prenatal records. The extent to which these efforts will contribute to improved data collection of births from ART procedures and infertility treatment remain to be examined.

In summary, ART is underreported on the birth certificate. However, more complete reporting in some jurisdictions suggests that this item could be responsive to quality improvement efforts currently under way.

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Table 1. Characteristics of births resulting from assisted reproductive technology procedures, for birth certificate and National ART Surveillance System: Total of 27 reporting states and District of Columbia, 2011

Characteristic	Birth certificate		National ART Surveillance System	
	Number of ART births	Percent	Number of ART births	Percent
Total ¹	18,560	100.0	38,496	100.0
Maternal age (years) ²			Maternal characteristics	
Under 35	8,806	47.4	19,285	50.1
35–37	3,982	21.5	7,949	20.6
38–40	2,821	15.2	5,905	15.3
41–42	1,221	6.6	2,354	6.1
43–44	736	4.0	1,379	3.6
45 and over	994	5.4	1,624	4.2
Race and ethnicity ²				
Non-Hispanic white	13,539	75.0	17,744	71.3
Non-Hispanic black	926	5.1	1,460	5.9
Non-Hispanic other	2,047	11.3	2,737	11.0
Hispanic	1,536	8.5	2,956	11.9
Total birth order ²				
1st	6,516	35.6	16,003	41.9
2nd	5,558	30.4	10,625	27.8
3rd or more	6,211	34.0	11,559	30.3
Gestational age (weeks) ²			Infant characteristics	
Less than 32	1,551	8.4	2,643	6.9
32–36	5,354	28.9	11,720	30.5
37–38	5,219	28.1	12,201	31.7
39 or more	6,429	34.7	11,873	30.9
Birthweight (grams) ²				
Less than 1,500	1,390	7.5	2,187	5.8
1,500–2,499	4,723	25.5	10,035	26.6
2,500 or more	12,424	67.0	25,440	67.5
Plurality ²				
Singleton	9,705	52.3	20,720	53.8
Twins	7,988	43.0	16,570	43.0
Triplets or more	867	4.7	1,206	3.1
Sex				
Male	9,487	51.1	19,466	51.0
Female	9,073	48.9	18,727	49.0
			Unknown values ³	
Maternal age	–	–	–	–
Race and ethnicity ⁴	512	2.8	13,599	35.3
Total birth order	275	1.5	309	0.8
Gestational age	7	0.04	59	0.2
Birthweight	23	0.1	834	2.2
Plurality	–	–	–	–
Infant sex	–	–	303	0.8

– Quantity zero.

¹Total number of births resulting from ART in 27-state and Washington, D.C., reporting area.² $p \leq 0.05$ based on Pearson chi-square test.³Number and percentage of unknown values for each characteristic among the total number of ART births for each data source.⁴Race is imputed on the birth certificate. Unknown values on the birth certificate apply to Hispanic origin only.

NOTE: ART is assisted reproductive technology.

Table 2. Births resulting from assisted reproductive technology procedures, for birth certificate and National ART Surveillance System: Total of 27 reporting states and District of Columbia, 2011

Jurisdiction	Number of births	Unknown ¹	Birth certificate ²		National ART Surveillance System ³		Ratio ⁴
			Number of ART births	Percent	Number of ART births	Percent	
Total reporting area ⁵	2,670,545	21,566	18,560	0.70	38,496	1.44	*2.06
California ⁶	502,120	236	3,854	0.77	7,552	1.50	*1.95
Colorado	65,055	21	393	0.60	1,047	1.61	*2.68
Delaware	11,257	43	140	1.25	169	1.50	1.20
District of Columbia ⁷	9,295	540	167	1.91	339	3.65	*1.91
Florida ⁷	213,414	1,581	337	0.16	2,569	1.20	*7.50
Georgia	132,409	5,988	739	0.58	1,384	1.05	*1.81
Illinois ^{6,7}	161,312	721	2,577	1.60	3,583	2.22	*1.39
Indiana	83,701	76	133	0.16	725	0.87	*5.44
Iowa	38,214	61	449	1.18	530	1.39	*1.18
Kansas	39,642	36	198	0.50	336	0.85	*1.70
Louisiana ^{6,7}	61,888	495	194	0.32	426	0.69	*2.16
Maryland ^{6,7}	73,093	1,113	1,567	2.18	2,032	2.78	*1.28
Missouri ⁷	76,117	254	219	0.29	703	0.92	*3.17
Montana ⁶	12,069	8	69	0.57	88	0.73	1.28
Nevada ⁷	35,296	62	356	1.01	538	1.52	*1.50
New Mexico	27,289	98	54	0.20	210	0.77	*3.85
New York (excluding New York City) ⁶	121,917	2,666	1,700	1.43	4,819	3.95	*2.76
New York City ⁶	119,395	556	1,046	0.88	1,519	1.27	*1.44
North Carolina ⁷	120,389	586	570	0.48	1,478	1.23	*2.56
North Dakota	9,527	36	48	0.51	96	1.01	*1.98
Ohio ⁶	137,918	4,289	648	0.48	1,382	1.00	*2.08
Oklahoma ⁷	52,272	888	199	0.39	385	0.74	*1.90
Oregon	45,155	27	578	1.28	627	1.39	1.09
South Dakota	11,846	27	60	0.51	98	0.83	*1.63
Texas ⁶	377,445	139	1,041	0.28	4,539	1.20	*4.29
Utah	51,223	460	520	1.02	544	1.06	1.04
Vermont	6,078	58	57	0.95	64	1.05	1.11
Wisconsin ⁷	67,810	493	619	0.92	652	0.96	1.04
Wyoming	7,399	8	28	0.38	62	0.84	*2.21
Insurance mandate ⁶							
Yes	1,567,157	10,223	12,696	0.82	25,940	1.66	2.03
No	1,103,388	11,343	5,864	0.54	12,556	1.14	**2.12
Recently revised ⁷							
Yes	870,886	6,733	6,805	0.79	12,705	1.46	1.85
No	1,799,659	14,833	11,755	0.66	25,791	1.43	**2.18

* $p \leq 0.05$ based on a z test of proportions comparing National ART Surveillance System and birth certificate data.

** $p \leq 0.05$ based on a likelihood ratio test comparing differences in ratios for jurisdictions categorized by infertility insurance mandate status or time of revision.

¹Birth records reported as unknown for the ART checkbox item.

²Denominator is all births excluding those reported as unknown for the ART checkbox item on the birth certificate.

³Denominator is all births reported on the birth certificate.

⁴Percentage of births resulting from ART procedures for National ART Surveillance System data divided by the percentage for birth certificate data.

⁵All revised states with information on ART on the 2011 birth certificate (67% of U.S. births in 2011).

⁶Jurisdictions having some type of insurance coverage mandate for infertility treatment.

⁷Jurisdictions that had revised birth certificates in 2010 and 2011 for type of infertility treatment.

NOTE: ART is assisted reproductive technology.

Table 3. Births resulting from assisted reproductive technology procedures for birth certificate and National ART Surveillance System, by selected characteristics: Total of 27 reporting states and District of Columbia, 2011

Characteristic	Number of births	Unknown ¹	Birth certificate ²		National ART Surveillance System ³		Ratio ⁴
			Number of ART births	Percent	Number of ART births	Percent	
Maternal age (years) ⁵			Maternal characteristics				
Under 35	2,273,953	17,862	8,806	0.39	19,285	0.85	2.18
35–37	228,392	2,020	3,982	1.76	7,949	3.48	1.98
38–40	117,937	1,157	2,821	2.42	5,905	5.01	2.07
41–42	33,299	307	1,221	3.70	2,354	7.07	1.91
43–44	11,717	134	736	6.35	1,379	11.77	1.85
45 and over	5,247	86	994	19.26	1,624	30.95	1.61
Total birth order ⁵							
1st	874,436	5,838	6,516	0.75	16,003	1.83	2.44
2nd	744,287	4,605	5,558	0.75	10,625	1.43	1.91
3rd or more	1,012,309	6,353	6,211	0.62	11,559	1.14	1.84
Gestational age (weeks) ⁵			Infant characteristics				
Less than 32	51,206	835	1,551	3.08	2,643	5.16	1.68
32–36	260,670	2,615	5,354	2.07	11,720	4.50	2.17
37–38	699,984	5,828	5,219	0.75	12,201	1.74	2.32
39 or more	1,656,415	11,891	6,429	0.39	11,873	0.72	1.85
Birthweight (grams) ⁵							
Less than 1,500	38,114	680	1,390	3.71	2,187	5.74	1.55
1,500–2,499	177,318	2,025	4,723	2.69	10,035	5.66	2.10
2,500 or more	2,452,891	18,602	12,424	0.51	25,440	1.04	2.04
Plurality ⁵							
Singleton	2,579,794	20,304	9,705	0.38	20,720	0.80	2.11
Twins	87,063	1,193	7,988	9.30	16,570	19.03	2.05
Triplets or more	3,688	69	867	23.96	1,206	32.70	1.36
Sex							
Male	1,366,590	11,041	9,487	0.70	19,466	1.42	2.03
Female	1,303,955	10,525	9,073	0.70	18,727	1.44	2.06

¹Birth records reported as unknown for the ART checkbox item.²Denominator is all births excluding those reported as unknown for the ART checkbox item on the birth certificate.³Denominator is all births reported on the birth certificate.⁴Percentage of births resulting from ART procedures for National ART Surveillance System data divided by the percentage for birth certificate data.⁵ $p \leq 0.05$ based on a likelihood ratio test.

NOTE: ART is assisted reproductive technology.

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