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Identifying Women with Indicators of Subfertility in a Statewide Population Database: Operationalizing the Missing Link in ART Research

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Abstract

Objective—To identify a group of deliveries to mothers with indicators of subfertility (SUBFERTILITY)

Design—Longitudinal cohort study

Setting—Massachusetts

Patients—334,152 deliveries to Massachusetts mothers in a Massachusetts hospital between July 1, 2004–December 31, 2008

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Interventions—None

Main Outcome Measure—Subfertility was defined by an indication on current or past birth certificate or hospital utilization data of infertility or assisted reproductive technology (ART) cycle prior to index delivery and no indication of ART use with index delivery.

Results—Initially 12,367 deliveries met the inclusion criteria for SUBFERTILITY (8,019 from birth certificates; 2,777 from hospital data; 1,571 from prior ART treatment). Removing deliveries from more than one data source resulted in 10,764 unique deliveries. Removing deliveries resulting from ART treatments left 6,238 deliveries in the SUBFERTILITY category. Demographic analysis indicated that deliveries in SUBFERTILITY were more similar to ART than to the fertile population.

Conclusions—We have demonstrated the feasibility of using existing population based linked public health datasets to identify SUBFERTILITY deliveries and we have used ART data to distinguish ART and SUBFERTILITY births. The SUBFERTILITY category can serve as a comparison group of subfertile patients for studies of ART delivery and longitudinal health outcomes.

Keywords

subfertility; assisted reproductive technology; population-based studies

Introduction

An estimated 14-16% of US women of reproductive age are infertile, and about 6-7% have ever received infertility treatment(1). The use of fertility-enhancing therapies, including assisted reproductive technologies (ART), has risen steadily in the United States due to several factors, including childbearing at older maternal ages(2). Worldwide about 233,000 babies are born through ART annually, of which more than 25% are born in the US(3). In 2011 in the US there were 163,038 ART cycles from 451 clinics resulting in 47,849 deliveries and 61,610 infants (1.6% of all U.S. births) (4).

Past research suggests that outcomes even in singleton pregnancies may be worse for women with assisted-conceptions when compared to their spontaneously-conceived counterparts, including greater risks for preterm birth, low birthweight, small-for-gestational age, cesarean delivery, and perinatal mortality(5-7). One study found children conceived through ART appear to have an excess of hospitalizations and health problems often associated with prematurity, growth-restriction at birth, or plurality, although the results were limited by small sample size(8). ART has also been associated with an increased prevalence of major birth defects when compared to spontaneous conceptions(9).

Outcomes of spontaneously-conceived pregnancies from population-based data in birth registries have been compared to results in ART related registries in Sweden(10), Denmark(11), Norway(12), Finland(13), Western Australia(9) and the US(14). Some studies of ART infant and childhood outcomes have utilized comparison groups other than spontaneous conceptions, such as subgroups by ART treatment parameters (14-16). When making comparisons among women treated for infertility, both the underlying cause and the

treatment parameters may influence the birth outcome and need to be considered in choosing appropriate controls or comparison groups(17, 18).

The challenge is to identify in a population based dataset a well measured comparison group of women with subfertility who did not receive ART. Subfertility or infertility is traditionally defined as failure to conceive after 12 months of unprotected intercourse, and has been shown to be a risk factor in itself for small-for-gestational-age (19) preeclampsia, low birthweight, prematurity and cesarean delivery independent of treatment(20-24). However, in most population-based data systems, such information has not been routinely collected.

This paper reports on the identification of a subfertile group of women as part of a population-based study to examine maternal and infant outcomes associated with ART. We utilized a Massachusetts longitudinal population-based public health database linked to clinical data from all Society for Assisted Reproductive Technology (SART) clinics in the state from 2004-2008 to identify women with indicators of subfertility who did not receive ART. This group will serve as a comparison group for ongoing studies of ART outcomes. This paper describes the identification of that subfertile population and compares the characteristics of their deliveries to those resulting from ART treatment and those deliveries from spontaneously-conceived pregnancies, discussing the implications for its use in future ART research.

Materials and Methods

Data Sources

This study linked detailed clinical information on ART treatment from all seven ART clinics in Massachusetts and the resultant live births and fetal deaths that took place between July 1, 2004 through December 31, 2008 in the Massachusetts Pregnancy to Early Life Longitudinal (PELL) Data System. Both the PELL(25)and the SART Clinic Outcome Reporting System (SARTCORS) (26) data systems have been described in previous research. The PELL data system has linked information on more than 99% of all births and fetal deaths in Massachusetts from 1998-2008 to corresponding hospital utilization data (admissions, outpatient stays and emergency room visits) for individual women and their children. This data is also longitudinally linked over time, facilitating analysis of maternal hospitalizations both prior to and subsequent to a given birth or fetal death. There were a total of 860,654 linked deliveries through 2008 and new years of data will be added to the system when vital statistics and hospital data are released by the Massachusetts Department of Public Health (MDPH) and the Massachusetts Center for Health Information and Analysis, the custodians of the PELL data. PELL is a relational data system composed of individual databases linked together by randomly-generated unique IDs for mother and infant. The PELL data system is housed at MDPH.

The SART CORS collects data from 451 ART clinics across the U.S. (covering 97% of all ART cycles)(4). Data from this system are reported to the CDC in compliance with the Fertility Clinic Success Rate and Certification Act of 1992 (Public Law 102-493, October 24, 1992). In 2004, following a contract change with CDC, SART gained access to the

SART CORS data system for the purposes of conducting research. The national SART CORS database for 2004-08 contains 642,927 ART treatment cycles. The database includes information on the ART therapy: infertility diagnoses, treatment parameters (e.g., oocyte source and state, transfer method, etc.), treatment outcomes (number of clinical intrauterine gestations, number of fetal hearts on early ultrasound, pregnancy losses), pregnancy outcomes (live born, stillborn, length of gestation, complications, plurality, and genders), as well as demographic factors (age, race/ethnicity). Approval for the study was granted by the Institutional Review Boards at the Massachusetts Department of Public Health and the Boston University School of Medicine as well as the institutions of the project's Co-Principal Investigators. This study was also approved by the Research Committee of SART.

Linkage of the Data Sources

We constructed the Massachusetts Outcomes Study of Assisted Reproductive Technologies (MOSART) database by linking the SARTCORS and PELL data systems for all Massachusetts children born in Massachusetts hospitals to Massachusetts resident women between July 1, 2004 and December 31, 2008. The starting date was chosen based on the availability of SART-CORS data (January 1, 2004) to allow us to capture any births associated with ART and the end date reflected the latest available data from both SART and PELL when we began the study. PELL data from July 1, 2004 and December 31, 2008 included 282,971 women with 334,152 deliveries resulting in 342,035 births which were linked to 42,649 ART cycles among 18,439 women from SART CORS. A deterministic 5 phase linkage algorithm methodology was implemented. The matching was based on common information in both records on the baby's date of birth (BDOB), Mother's date of birth (MDOB), as well as mother's first name (MFN); mother's last name (MLN); and father/partner's last name (FLN). We linked 9,092 SART CORS outcome records to PELL delivery records during that time frame.

There are multiple units of analysis that can be constructed using the MOSART database, specifically women, cycles, deliveries and children. For example, between 2004-2008 from the SART CORS database we identified 42,649 cycles among 18,439 women and matched 9,092 of those cycles to a PELL delivery record, which resulted in 11,729 live births and fetal deaths. In the development of a measure of deliveries to mothers with indicators of subfertility (termed SUBFERTILITY in this paper), we have focused primarily on deliveries as the unit of analysis, as multiple infants from the same pregnancy share the same exposure characteristics.

Creation of SUBFERTILITY measure

Our goal was to identify deliveries to mothers with indicators of subfertility who did not receive ART. The development of the measure was an iterative process that ultimately drew on multiple sources within both SARTCORS and PELL and took advantage of PELL's longitudinal linkage to explore the reproductive histories of mothers. Overall a delivery met our inclusion criteria for SUBFERTILITY if it met any of the following conditions from 3 different sources of data (Figure 1):

1. *Birth certificates* – if either of two fertility-treatment related items on the Massachusetts birth certificate were checked for a delivery from July 1, 2004-December 31, 2008 *or* on a delivery record to the same woman in the five years prior to an index pregnancy in 2004-2008; *or*
2. *Hospital Utilization* – if a woman had hospital contact (admission, observational stay or emergency department visit) for a condition specifically related to infertility associated with an index delivery *or* in the five years prior to an index pregnancy in 2004-2008; *or*
3. SART CORS – if a woman had an ART cycle in the past (as reported to SART CORS between 2004-2008), but did not have an ART cycle associated with the index delivery between 2004-2008.

We initially included all deliveries meeting any of these criteria and then cross-referenced them to avoid duplication across the different sources. Finally, we excluded any current ART deliveries in order to identify deliveries with indicators of subfertility, but no ART. The process is detailed below.

Birth Certificate Data

The Massachusetts birth certificate includes two items related to fertility-treatment. The birth certificate items on infertility have been the subject of validation studies in the past and been found to have low sensitivity but were higher on specificity(27). Both are check boxes within a section on “Prenatal Tests and Procedures,” and ask mothers to “check all that apply.” One of the items listed is “Assisted reproductive technology (alternative methods of conception)” and a second is, “Fertility Drug.” Deliveries were initially included in SUBFERTILITY group if either of those boxes were checked for a birth between July 1, 2004 – December 31, 2008. Based on the assumption that maternal indicators of subfertility in earlier deliveries would not typically resolve in subsequent deliveries, we also took advantage of the longitudinal PELL data which allowed us to examine characteristics of mothers' prior deliveries back to 1998. We therefore also designated as SUBFERTILITY deliveries those between July 1, 2004 – December 31, 2008 if the mother had checked either infertility-related check box for a prior delivery within 5 years of the index pregnancy, even if she did not check either box for the current pregnancy.

Hospital Utilization

A second source of data for the SUBFERTILITY group was the file of hospital utilization which encompassed three related datasets: hospital admittance, observational stays, and emergency room visits. We included the ICD diagnosis codes directly indicating infertility: 628.0 (Infertility-Anovulation), 628.2 (Infertility-Tubal Origin), 628.3 (Infertility-Uterine Origin), 628.8 (Female Infertility of Other Specified Origin), 628.9 (Female Infertility of Unspecified Origin) and the V230 (Pregnancy With Diagnosis of Infertility). Once again we examined multiple possibilities for inclusion in the SUBFERTILITY category. A delivery between July 1, 2004 – December 31, 2008 could be included if: (a) one of the above codes was on an index delivery record in that time period or on a non-delivery hospitalization record occurring during the index pregnancy, *or* (b) if any one of the codes was associated

with a delivery to that mother in the five years prior to an index pregnancy between 2004 and 2008 or (c) the index delivery was to a mother who had a non-birth hospital utilization for one of these codes up to five years prior to the index pregnancy.

SART CORS

The third data source used to identify deliveries to women with indicators of subfertility was the SART CORS, specifically deliveries which were not the result of ART treatment, but were to mothers who had an ART cycle of treatment prior to the index pregnancy, whether or not the prior treatment cycle resulted in a delivery (e.g. a 2008 delivery linked to a 2005 treatment cycle). We excluded cases where ART cycles occurred after the index delivery. Deliveries which linked to a concurrent cycle were assigned to the ART group.

We then combined deliveries from all three sources to eliminate cases of duplication where the same deliveries were counted from more than one source. The file of deliveries was compared to our subgroup of ART deliveries and any deliveries that were in found in the ART subgroup were removed from the SUBFERTILITY file.

Data Analysis

The characteristics of each of the sources of the SUBFERTILITY variable were then compared to each other in terms of the demographic and health characteristics of the mothers. The measures of demographic characteristics were drawn from birth certificate records while the measures of diabetes and hypertension were based on variables that combined information from both the birth certificate and hospital discharge records. Chi-square tests of differences in proportions were done to compare results across categories. However, given the very large samples involved, even small differences were found to be statistically significant and hence the results reported focus on the substantive importance of the similarities and differences observed. Finally the characteristics of the mothers with SUBFERTILITY deliveries were compared to those with a delivery resulting from ART or spontaneous conceptions.

Results

From July 1, 2004 – December 31, 2008, we identified, 318,822 deliveries classified as spontaneous conceptions (FERTILE in Figure 1), 9,092 deliveries linked to ART records and 6,238 deliveries that were classified as SUBFERTILITY, that is deliveries to mothers with indicators of subfertility but who did not receive ART treatment for the index pregnancy. Figure 1 illustrates the process for identifying, combining and then refining the SUBFERTILITY measure. The categories in the figure correspond to the descriptions in the methods section above.

There were 12,367 deliveries that initially met the inclusion criteria for SUBFERTILITY (8,019 from birth certificates; 2,777 from hospital data; 1,571 from a prior ART cycle). After accounting for deliveries identified in more than one data source, we had 10,764 unique deliveries to mothers with an indicator of subfertility. After excluding deliveries resulting directly from a current cycle of ART we had 6,238 deliveries in the SUBFERTILITY measure. Slightly more than 86% of deliveries were identified through

only one source of information, and the remaining 14% were identified in more than one source.

Table 1 presents the distribution of maternal socio-demographic and health characteristics for SUBFERTILITY deliveries drawn from the different sources. The totals represent deliveries included in the SUBFERTILITY measure from the identified source *after* removal of the ART deliveries. Each of the sources is described in more detail above. We clustered the specific individual sources by whether they were drawn from a mother's current or prior experiences. The table lists cases drawn exclusively from each of the five stated sources as well as the group of deliveries that were identified in more than one of these sources. Deliveries drawn from five of the six source groups (the exception is "prior hospital contacts") are quite similar in most demographic features, including race/ethnicity, educational status, marital status, payer source, smoking, and prenatal care. For example, in the case of race/ethnicity, between 83% and 88% of mothers in five of the six source groups were non-Hispanic white. Likewise between 68% and 72% of mothers in each of the five groups had at least a bachelor's degree, 91% to 95% had private insurance coverage for their delivery and less than 3% smoked. The group of deliveries identified only through prior hospital utilization had a lower percentage of non-Hispanic white mothers and those with private insurance, and a higher percentage of mothers under age 25, with a high school education or less.

There were some differences even among the five similar source groups. Deliveries identified only from prior ART clinic data were most likely to involve mothers 35 and older (66%) compared to other groups. As might be expected, deliveries identified from current sources were much more likely to be primiparous than cases identified from prior births or hospitalizations. Deliveries identified only from the ART item on the birth certificate were also more likely to be unmarried mothers (8%) than those identified from other sources. Mothers whose deliveries were identified from the current birth certificate items were most likely to have been identified as having gestational diabetes (11%) or pregnancy related hypertension (16%) compared to all other groups. The rate of multiple deliveries varied notably across the respective contributors to the SUBFERTILITY measure with the highest rates among deliveries drawn from the index pregnancy birth certificate measures (18%).

Table 2 presents an alternative organization of the data comparing deliveries identified from only current information (through birth certificate or hospital utilization records or both) to deliveries identified only from mothers' prior experiences (prior births, ART cycles, hospital utilization prior to the index pregnancy or some combination of these). The third column examines the subset of deliveries that were identified from both a current delivery *and* prior experiences. Across sources there were minimal differences in the proportions of non-Hispanic white mothers, college graduates, private insurance use, and nonsmokers. In terms of medical risk, rates of maternal gestational diabetes and pregnancy induced hypertension were higher among women whose subfertile deliveries were identified at the time of the index pregnancy or delivery compared to those identified from data prior to the index pregnancy or delivery. The most notable differences were that deliveries identified from current indicators involved mothers who were younger, lower parity and more likely unmarried than those drawn from mothers' past indicators. The rate of multiple births was

much higher among cases identified from the index delivery (16%) compared to cases identified from data on prior experiences (3%).

Table 3 presents the demographic distributions of the three fertility status groups in the MOSART study: deliveries resulting from ART, deliveries to mothers with indicators of subfertility who did not have ART (SUBFERTILITY) and deliveries to mothers who did not have ART or a reported indicator of subfertility (FERTILE). The ART deliveries were consistently more similar to the SUBFERTILITY group than to the FERTILE group. This pattern was observed across mothers' age, race/ethnicity, education, marital status, payer source, most medical risk factors (except pregnancy induced hypertension), smoking and adequacy of prenatal care. In the case of plurality, the proportion of SUBFERTILITY deliveries that were multiples (10%) was distinctly higher than the FERTILE group (1%), but notably less than the ART group (28%).

Discussion

Analysis of the specific effect of ART on maternal and infant outcomes has been limited in the past by several important challenges, two of which are the focus of this paper (17). First is the need to find a balance between precise measurement of clinical ART data and a sufficient number of cases to be able to draw population-based conclusions. Second, is the lack of an appropriate comparison group of deliveries to mothers with indicators of subfertility. As the National Institutes of Health have noted, there remains a research need to: "...evaluate the effects of [ART] technologies on children in order to determine whether the adverse outcomes are specifically related to ART procedures or whether they are more closely related to the underlying infertility itself." (28)

This analysis reports on the use of a population-based longitudinal database linked to clinical ART data to develop a measure identifying deliveries which could serve as a comparison group for assessing outcomes of ART deliveries. Data from 2004-2008 from all Massachusetts ART clinics were linked to Massachusetts' birth and hospitalization data to create the analytic database for the Massachusetts Outcomes Study of Assisted Reproductive Technologies (MOSART) with the development of the SUBFERTILITY variable as an initial goal. The measure drew from multiple data sources: birth certificate items recording ART treatment or fertility drug use, hospital utilizations related to infertility, and prior use of ART which was not related to a current delivery. The result was the identification of 6,238 Massachusetts deliveries between July 1, 2004 and December 31, 2008 that met the inclusion criteria as distinct from 9,092 deliveries from ART and 318,822 deliveries from spontaneous conception.

In comparing SUBFERTILITY deliveries to those conceived through ART or those with no indicator of subfertility (FERTILE), SUBFERTILITY deliveries were generally comparable to ART deliveries with regard to demographic and health characteristics, and unlike FERTILE deliveries, with the exception of parity and the likelihood of a multiple delivery. In the case of parity and multiples, the deliveries in the SUBFERTILITY group varied by whether or not cases were identified from current deliveries or past experiences; the former was much more likely to be parity 1 and involve multiples.

As noted above, prior studies examining outcomes associated with ART have typically used as a comparison group spontaneously conceived deliveries[9-14] or compared one type of treatment against another [17-18]. There have been some examples where a “subfertility” comparison group has been constructed. Herbert and colleagues(29) used national survey data from Australia to identify women with subfertility, defined as more than 12 months of unprotected intercourse without a spontaneous conception, and then stratified their analysis by whether or not women identified as subfertile by this method had utilized IVF. Others, while comparing ART outcomes with population data have used matching by maternal and/or infant characteristics (13, 30-32). In essence, past research has had to rely either on sample survey data with a clear definition of subfertility but a limited sample size or a population-based study that attempted to offset the lack of a subfertility measure through matching or statistical adjustment.

Our development of a population-based measure identifying deliveries, and hence births, to mothers with indicators of subfertility who did not receive ART represents a significant advance which should enable further research into the extent to which maternal and infant outcomes of ART are related to the treatment as opposed to the underlying condition.

Our newly created measure has several advantages over past efforts. These include its population base allowing for greater statistical power, certainty of exclusion of deliveries resulting from ART, comparability in the socio-demographic characteristics of the SUBFERTILITY deliveries identified from multiple sources and the many important similarities between SUBFERTILITY and ART deliveries. Limitations to our approach include possible misclassification as FERTILE some deliveries to mothers with health conditions strongly related to subfertility (such as endometriosis) but for which there was no diagnosis of infertility. This misclassification could have resulted in some subfertile deliveries being included in the fertile group, but our concern was primarily to minimize misclassification in the other direction, the inclusion of fertile cases in the much smaller subfertility group. In analyses of outcomes related to SUBFERTILITY, we will be able to adjust for other medical diagnoses captured in hospital discharge or birth records. The subfertility group is also not a perfect match for the ART group, differing particularly in terms of the proportion of multiple births and parity. This difference could be a result of the lack of treatment data advising our definition of subfertility such that use or non-use of gonadotropins and other ovarian stimulation could not be determined or distinguished.

Moreover, the group of ART deliveries contain at least some pregnancies which could not have occurred in the absence of ART treatment, whereas the SUBFERTILITY group represents pregnancies that were, by definition, able to conceive without ART. As such, the SUBFERTILITY group may capture a generally more fecund population than the women who conceived with ART treatment. Adjustment for individual factors, including reproductive and non-reproductive health risks and socio-demographics will help control confounding related to these differences, however, the two groups may never be perfectly comparable.

A further limitation is that the SUBFERTILITY measure developed for this project is based on population level data from a single state. It is possible that the patient population seeking

fertility care in Massachusetts may be different than in other states and outcomes from Massachusetts may not be generally applicable to other parts of the country. The paper assumes that all births resulting from ART treatment are reported in SART data and while that is probably true in Massachusetts from 2004-2008, this assumption may be less true in other states and in different time frames. ART cycles may be performed in U.S. clinics that do not report to SART and patients may seek ART care and conceive in non-U.S. clinics but deliver in the U.S. The study is also not easily replicable by other states and can be used for surveillance purposes only when a state maintains both a longitudinally linked birth certificate/hospital utilization dataset and has access to clinical ART data. As more states develop linked databases(33) and develop linkages to ART data(34) this may become a possibility in the future.

The increasing use of ART requires a more thorough examination of the outcomes of these births and a clarification of the degree to which outcomes are a function of the treatment or the underlying problem. That will occur only with the creation of appropriate comparison groups and this study represents an important initial step in the development of a research methodology that can be used to better understand the maternal and infant outcomes associated with ART births.

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Figure 1. Contribution of Different Sources of Data to SUBFERTILITY Measure

Table 1
DEMOGRAPHIC CHARACTERISTICS OF SUBFERTILITY SOURCES

	UNIQUE DELIVERIES IDENTIFIED FROM CURRENT EXPERIENCE			UNIQUE DELIVERIES IDENTIFIED FROM PRIOR EXPERIENCE			DELIVERIES IDENTIFIED IN MULTIPLE SOURCES	SUBFERTILITY ALL
	Birth Certificate	Hospital Contact	ART Data	Birth Certificate	Hospital Contact			
N	2298	419	1,079	1118	469		855	6,238
SOCIO-DEMOGRAPHIC	%	%	%	%	%		%	%
Mother's Age^d								
<25	2.3	NA	--	1.1	5.3		0.6	1.6
25-29	14.5	14.8	4.6	8.5	10.7		8.2	10.6
30-34	37.6	34.8	29.6	36.3	32.2		32.1	34.6
35-39	33.7	37.0	44.1	43.1	39.7		42.3	39.1
40	11.8	11.9	21.7	11.0	12.2		16.8	14.1
Mother's Race/Ethnicity^d								
Non-Hispanic White	85.6	87.1	83.3	87.7	75.9		86.8	85.1
Asian	6.3	5.3	7.0	4.9	7.0		5.7	6.1
Hispanic	4.7	3.1	3.1	4.5	9.6		2.8	4.4
Non-Hispanic Black	2.6	2.4	5.4	1.3	5.8		3.5	3.2
Other or Mixed	0.9	2.2	1.2	1.6	1.7		1.2	1.3
Mother's Education^d								
High School or GED	11.9	12.7	10.4	12.7	20.3		9.3	12.1
Some College or Associate Degree	17.3	17.7	19.9	19.6	14.8		18.5	18.2
Bachelor Degree or Post-graduate	70.8	69.7	69.7	67.7	64.9		72.3	69.7
Marital Status^d								
Not Married	7.8	3.3	2.8	3.9	9.2		4.1	5.5
Delivery Payer Source								
Private	91.5	90.7	95.2	92.5	81.9		95.0	92.0
HEALTH & BEHAVIORAL								
Parity^d								

	UNIQUE DELIVERIES IDENTIFIED FROM CURRENT EXPERIENCE		UNIQUE DELIVERIES IDENTIFIED FROM PRIOR EXPERIENCE			DELIVERIES IDENTIFIED IN MULTIPLE SOURCES	SUBFERTILITY ALL
	Birth Certificate	Hospital Contact	ART Data	Birth Certificate	Hospital Contact		
1	60.7	64.0	35.7	--	26.9	25.6	38.5
2	28.9	26.6	42.5	59.9	47.7	46.1	40.3
3	10.4	9.4	21.8	40.2	25.4	28.3	21.2
Maternal Medical Risk Factors							
Gestational Diabetes ^a	10.5	4.5	8.3	8.8	6.8	6.7	8.6
Other Diabetes ^a	2.4	NA	1.6	2.6	2.6	1.3	2.0
Pregnancy-Induced Hypertension ^a	15.8	8.1	9.6	8.1	9.0	11.9	11.8
Chronic Hypertension	3.1	2.6	2.6	2.2	3.6	2.5	2.8
Smoked During Pregnancy ^a	1.3	2.9	1.4	2.1	3.6	1.3	1.7
Adequate Plus Prenatal Care ^a	56.1	54.0	44.0	46.9	48.8	55.1	51.5
PLURALITY							
Multiples (Twins, Triplets, Quads) ^a	17.8	7.2	3.0	2.3	5.8	9.4	9.7

^a p < .05 for differences across sources of SUBFERTILITY variable

Table 2
SUBFERTILITY SOURCES BY TIME PERIOD

	DELIVERIES IDENTIFIED FROM CURRENT EXPERIENCE ¹	DELIVERIES IDENTIFIED FROM PRIOR EXPERIENCE ²	DELIVERIES IDENTIFIED IN BOTH CURRENT AND PRIOR EXPERIENCE ³
N	2,863	3,131	244
SOCIO-DEMOGRAPHIC	%	%	%
Mother's Age^a			
<25	2.2	1.2	NA
25-29	14.6	7.0	9.4
30-34	37.2	32.9	27.5
35-39	34.2	43.6	37.7
40	11.9	15.3	25.0
Mother's Race/Ethnicity			
Non-Hispanic White	86.0	84.5	82.8
Asian	6.2	6.0	6.2
Hispanic	4.2	4.5	4.1
Non-Hispanic Black	2.6	3.6	4.9
Other or Mixed	1.1	1.4	NA
Mother's Education			
High School or GED	12.0	12.4	10.3
Some College or Associate Degree	17.2	18.8	20.6
Bachelor Degree or Post-graduate	70.8	68.8	69.1
Marital Status			
Not Married ^a	7.1	3.9	7.4
DELIVERY PAYER SOURCE			
Private Insurance	91.5	92.3	94.3
HEALTH & BEHAVIORAL			
Parity^a			
1	61.3	17.2	43.4
2	28.7	51.3	37.3
3	10.0	31.6	19.3
Maternal Medical Risk Factors			
Gestational Diabetes ^a	9.6	7.9	6.2
Other Diabetes	2.1	2.0	NA
Pregnancy-Induced Hypertension ^a	14.6	8.8	18.0
Chronic Hypertension	3.0	2.5	4.1
Smoked During Pregnancy	1.5	2.0	-NA
Adequate Plus Prenatal Care ^a	56.0	46.4	64.9

	DELIVERIES IDENTIFIED FROM CURRENT EXPERIENCE ¹	DELIVERIES IDENTIFIED FROM PRIOR EXPERIENCE ²	DELIVERIES IDENTIFIED IN BOTH CURRENT AND PRIOR EXPERIENCE ³
PLURALITY			
Multiples (Twins, Triplets, Quads)^a	16.1	3.0	20.1

^a p < .05 for differences across sources of SUBFERTILITY variable

¹ Delivery identified from birth certificate or hospital utilization associated with index delivery or pregnancy only

² Delivery identified from ART treatment, birth certificate or hospital utilization prior to index delivery or pregnancy only

³ Delivery identified in records from both the index delivery or pregnancy *and* prior information

Table 3
COMPARISON OF CHARACTERISTICS OF SUBFERTILITY, ART AND FERTILE DELIVERIES

	FERTILE	SUBFERTILITY	ART
N	318,822	6,238	9,092
SOCIO-DEMOGRAPHIC	%	%	%
Mother's Age^a			
<25	23.5	1.6	0.3
25-29	24.9	10.6	8.1
30-34	30.3	34.6	32.0
35-39	17.6	39.1	39.3
40	3.7	14.1	20.3
Mother's Race/Ethnicity^a			
Non-Hispanic White	66.8	85.1	86.5
Asian	7.5	6.1	6.3
Hispanic	14.5	4.4	3.1
Non-Hispanic Black	8.7	3.2	3.0
Other or Mixed	2.4	1.3	1.1
Mother's Education^a			
High School or GED	38.0	12.1	9.4
Some College or Associate Degree	21.7	18.2	17.1
Bachelor Degree or Post-graduate	40.4	69.7	73.6
Marital Status			
Not Married ^a	34.1	5.5	3.8
Delivery Payer Source			
Private ^a	58.2	92.0	96.6
HEALTH & BEHAVIORAL			
Parity^a			
1	45.3	38.5	53.7
2	34.1	40.3	34.9
3	20.6	21.2	11.4
Maternal Medical Risk Factors			
Gestational Diabetes ^a	5.5	8.6	8.7
Other Diabetes ^a	1.1	2.0	2.1
Pregnancy-Induced Hypertension ^a	8.5	11.8	16.2
Chronic Hypertension ^a	1.6	2.8	3.2
Smoked During Pregnancy ^a	7.8	1.7	0.8
Adequate Plus Prenatal Care ^a	38.2	51.5	59.0

	FERTILE	SUBFERTILITY	ART
PLURALITY			
Multiples (Twins, Triplets, Quads)^a	1.4	9.7	27.9

^a p < .05 for differences across three categories of deliveries