

Assisted Reproductive Technology

National Summary Report

National Center for Chronic Disease Prevention and Health Promotion
Division of Reproductive Health



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6 Assisted **2017** Reproductive Technology

National Summary Report

October 2018



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2016

National Report



INTRODUCTION TO THE 2016 NATIONAL REPORT

Data provided by United States clinics that use assisted reproductive technology (ART) to treat infertility are a rich source of information about the factors that contribute to a successful ART treatment—the delivery of a healthy live-born infant. Pooling the data from all reporting clinics provides a national picture that could not be obtained by examining data from an individual clinic.

A patient's chances of having a pregnancy and a live birth when using ART are influenced by many factors, some of which are patient-related and outside a clinic's control (for example, the patient's age or the cause of infertility). Because the national data include information on many of these factors, this can give potential ART patients an idea of the average chances of success. Average chances, however, do not necessarily apply to a particular individual or couple. People considering ART should consult their physician to discuss all the factors that apply in their particular case.

The data for this national report come from the 463 fertility clinics in operation in 2016 that provided and verified data on the outcomes of all ART cycles started in their clinics. Of the 263,577 ART cycles performed in 2016 at these reporting clinics, 197,737 cycles (75%) were started with the intent to transfer at least one embryo. These 197,737 cycles resulted in 65,969 live births (deliveries of one or more living infants) and 76,897 infants.

Of the 197,737 ART cycles started in 2016 with the intent to transfer at least one embryo, 934 cycles were reported with the intent to thaw a patient's previously frozen egg, fertilize the egg, and then transfer the resulting embryo. However, because this cycle type (a cycle using fresh embryos from a patient's own previously frozen eggs) does not contribute to the calculation of any success

rates for the 463 clinics included in the *2016 Assisted Reproductive Technology Fertility Clinic Success Rates Report* (hereafter called the *2016 Fertility Clinic Success Rates Report*), the 934 cycles using fresh embryos from a patient's own previously frozen eggs are not included in the majority of this national report. The majority of the report uses the remaining 196,803 cycles including 3,329 fresh embryo cycles using previously frozen donor eggs.

Of the 263,577 ART cycles performed in 2016, 65,840 cycles (25%) were started with the intent of cryopreserving (freezing) and storing all resulting eggs or embryos for potential future use. However, because this cycle type (a banking cycle) cannot result in immediate pregnancy, the 65,840 banking cycles started in 2016 are not included in the majority of this national report.

The 263,577 total ART cycles performed in 2016 excludes 2 cycles started in which a new treatment procedure was being evaluated. The 2 new procedure cycles are not included in the majority of this national report because they do not contribute to the calculation of any success rates for the 463 clinics included in the *2016 Fertility Clinic Success Rates Report*.

The 2016 National Summary table on page 5 combines data from all 263,577 cycles reported by the 463 clinics. For an explanation of how to read this table, see pages 11–21 of the *2016 Fertility Clinic Success Rates Report* available at <https://www.cdc.gov/art/artdata/index.html>.

This national report consists of graphs and charts that use 2016 data to answer specific questions related to ART success rates. These figures are organized according to the type of ART procedure used. Some ART procedures use a woman's own eggs (nondonor cycles), and others use donated eggs or embryos (donor cycles).

As a result, although sperm used to create an embryo also may be either from a female patient's partner, a male patient, or a sperm donor, ART cycles in this report are classified according to the source of the egg.

In some procedures, the embryos that develop after fertilization are transferred back to the female patient or gestational carrier without having been frozen (fresh embryo transfer); in others, embryos that previously have been frozen (cryopreserved) for transfer at a later date are thawed and transferred to the female patient or gestational carrier (frozen embryo transfer). For both fresh and frozen embryo cycles, the eggs that are fertilized to create the embryos also may be fresh (never frozen) or frozen and thawed prior to fertilization.

The national report has five sections:

- Section 1, Overview (Figures 1 through 6): This section presents overall information about the different types of ART cycles performed in 2016. Figure 2 is the only figure in the report which contains information about all 263,579 ART cycles started in 2016. All other figures in Section 1 exclude 2 cycles in which a new treatment procedure was being evaluated (research cycles). Figures 4 and 5 also exclude 65,840 egg or embryo banking cycles and 934 cycles using fresh embryos from frozen nondonor eggs. Figure 6 excludes all cycles except those using fresh embryos from frozen (donor or nondonor) eggs. As a result, Figures 1 and 3 are based on 263,577 non-research cycles; Figure 6 is based on 4,263 fresh embryo from frozen egg cycles; and Figures 4 and 5 are based on 196,803 cycles using fresh embryos from fresh nondonor eggs, frozen embryos from nondonor eggs, or donor eggs performed in 2016 with the intent to transfer at least one egg or embryo.
- Section 2, ART cycles using fresh embryos from fresh nondonor eggs (Figures 7 through 36): This section presents information on the ART cycles performed in 2016 with the intent to transfer at least one fresh embryo from a fresh nondonor egg or at least one fresh nondonor egg. Because patients in this section are using their own eggs, rather than eggs from a female donor, all cycles performed in this section will be for female patients only. Figures in this section are based on 86,237 cycles resulting in 52,686 transfers.
- Section 3, ART cycles using frozen embryos from nondonor eggs (Figures 37 through 39): This section presents information on the ART cycles performed in 2016 with the intent to transfer at least one frozen embryo from a nondonor egg. Because patients in this section are using their own eggs, rather than eggs from a female donor, all cycles performed in the section will be for female patients only. Figures in this section are based on 86,266 cycles resulting in 79,910 transfers.
- Section 4, ART cycles using donor eggs (Figures 40 through 43): This section presents information on the ART cycles performed in 2016 with the intent to transfer at least one embryo from a donor egg or at least one donor egg. This includes cycles using fresh embryos from fresh donor eggs, fresh embryos from frozen donor eggs, frozen embryos from donor eggs, and donated embryos (embryos from another patient's ART treatment). Figures 40, 42, and 43 in this section are based on 24,300 cycles resulting in 21,318 transfers. Figure 41 excludes male patients, and is based on 23,251 cycles and 20,371 transfers.
- Section 5 (Figures 44 through 54) presents trends in the number of ART procedures and measures of success over the past 10 years, from 2007 through 2016. Beginning with cycles performed in 2016, data from 4,263 cycles using fresh embryos from frozen eggs are included in Figures 44 and 47.

2016 NATIONAL SUMMARY

Technical terms are defined in the Glossary of Terms (Appendix A, pages 63–66). For more information on how to interpret the statistics in this table, see pages 11–21 in the 2016 Assisted Reproductive Technology Fertility Clinic Success Rates Report.

2016 ART CYCLE PROFILE

Type of ART and Procedural Factors ^a				Patient Diagnosis ^{a,b}			
IVF	>99%	With ICSI	66%	Tubal factor	12%	Uterine factor	6%
Unstimulated	1%	PGD/PGS	22%	Ovulatory dysfunction	16%	Male factor	32%
Used gestational carrier	3%			Diminished ovarian reserve	31%	Other factor	21%
				Endometriosis	8%	Unknown factor	13%
						Multiple Factors:	
						Female factors only	13%
						Female & male factors	17%

2016 ART SUCCESS RATES^{c,d}

Total number of cycles^d: 263,577
(includes 934 cycle[s] using fresh embryos from frozen nondonor eggs)

Type of Cycle	Age of Patient				
	<35	35–37	38–40	41–42	>42
Fresh Embryos from Fresh Nondonor Eggs					
Number of cycles	36,625	18,278	16,109	8,264	6,961
Percentage of cancellations before retrieval (%)	6.2	10.9	16.3	20.0	22.6
Number of transfers	24,878	11,672	9,149	4,093	2,894
Average number of embryos transferred	1.5	1.7	2.0	2.4	2.4
Percentage of elective single embryo transfers (eSET) (%)	42.7	25.2	9.0	3.7	2.8
Outcomes per Cycle					
Percentage of cycles resulting in pregnancies (%)	35.9	29.5	21.7	12.6	6.3
Percentage of cycles resulting in live births (%)	31.0	24.0	15.5	8.0	3.2
Percentage of cycles resulting in singleton live births (%)	24.9	19.0	12.7	7.0	2.9
Percentage of cycles resulting in twin live births (%)	5.9	4.8	2.8	1.0	0.4
Percentage of cycles resulting in term, normal weight and singleton live births ^e (%)	21.0	15.8	10.4	5.6	2.2
Outcomes per Transfer					
Percentage of embryos transferred resulting in implantation (%)	41.8	32.6	22.0	11.7	5.9
Percentage of transfers resulting in pregnancies (%)	52.9	46.2	38.3	25.5	15.2
Percentage of transfers resulting in live births (%)	45.7	37.6	27.4	16.1	7.8
Percentage of transfers resulting in singleton live births (%)	36.7	29.8	22.3	14.1	6.9
Percentage of transfers resulting in twin live births (%)	8.7	7.6	4.8	2.0	0.9
Percentage of transfers resulting in term, normal weight and singleton live births ^e (%)	30.9	24.7	18.3	11.3	5.3
Frozen Embryos from Nondonor Eggs					
Number of cycles	39,894	21,400	15,529	5,749	3,694
Number of transfers	37,461	19,913	14,200	5,142	3,194
Estimated average number of transfers per retrieval	1.2	1.0	0.8	0.6	0.4
Average number of embryos transferred	1.4	1.4	1.4	1.4	1.6
Percentage of embryos transferred resulting in implantation (%)	49.6	46.7	42.6	35.5	23.9
Percentage of transfers resulting in pregnancies (%)	59.3	57.1	54.1	48.6	38.1
Percentage of transfers resulting in live births (%)	49.4	46.5	42.7	37.9	27.7
Percentage of transfers resulting in singleton live births (%)	41.5	40.3	37.9	34.5	25.2
Percentage of transfers resulting in twin live births (%)	7.8	6.1	4.7	3.3	2.5
Percentage of transfers resulting in term, normal weight and singleton live births ^e (%)	35.4	34.2	32.0	28.9	20.9
Number of Egg or Embryo Banking Cycles					
	20,949	14,556	14,913	7,661	7,761
Number of fertility preservation cycles	4,273	3,941	3,286	1,258	1,174
Donor Eggs^f					
	Fresh Eggs	Frozen Eggs	Frozen Embryos	Donated Embryos	
Number of cycles	5,644	3,329	13,458	1,869	
Number of transfers	4,446	2,723	12,391	1,758	
Average number of embryos transferred	1.5	1.5	1.4	1.7	
Percentage of embryos transferred resulting in implantation (%)	53.9	41.9	46.1	38.4	
Percentage of transfers resulting in pregnancies (%)	65.0	54.7	55.8	53.1	
Percentage of transfers resulting in live births (%)	54.6	44.9	44.8	42.7	
Percentage of transfers resulting in singleton live births (%)	41.7	36.2	37.7	33.9	
Percentage of transfers resulting in twin live births (%)	12.7	8.4	6.9	8.5	
Percentage of transfers resulting in term, normal weight and singleton live births ^e (%)	32.5	28.1	29.4	26.8	

CURRENT SERVICES & PROFILE

Number of reporting clinics: 463

Percentage of clinics that allow cycles involving:		Clinic profile:	
Donor eggs	88%	Single women	99%
Donor embryos	63%	Gestational carriers	88%
Embryo cryopreservation	>99%	SART member	82%
Egg cryopreservation	97%	Verified lab accreditation	
		Yes	92%
		No	5%
		Pending	2%

^a Excludes cycles evaluating new procedures and banking cycles; unstimulated percentage includes fresh egg cycles only.

^b Total patient diagnosis percentages may be greater than 100% because more than one diagnosis can be reported for each ART cycle.

^c Multiple-infant births (for example, twins) with at least one live infant are counted as one live birth.

^d Total cycle number and success rates exclude 2 cycle(s) evaluating new procedures. Success rates exclude cycles using fresh embryos from frozen nondonor eggs.

^e In this report, births are defined as term if at least 37 full weeks gestation and normal birth weight if at least 2,500 grams (approximately 5 pounds, 8 ounces).

^f All ages are reported together because previous data show that patient age does not materially affect success with donor eggs.

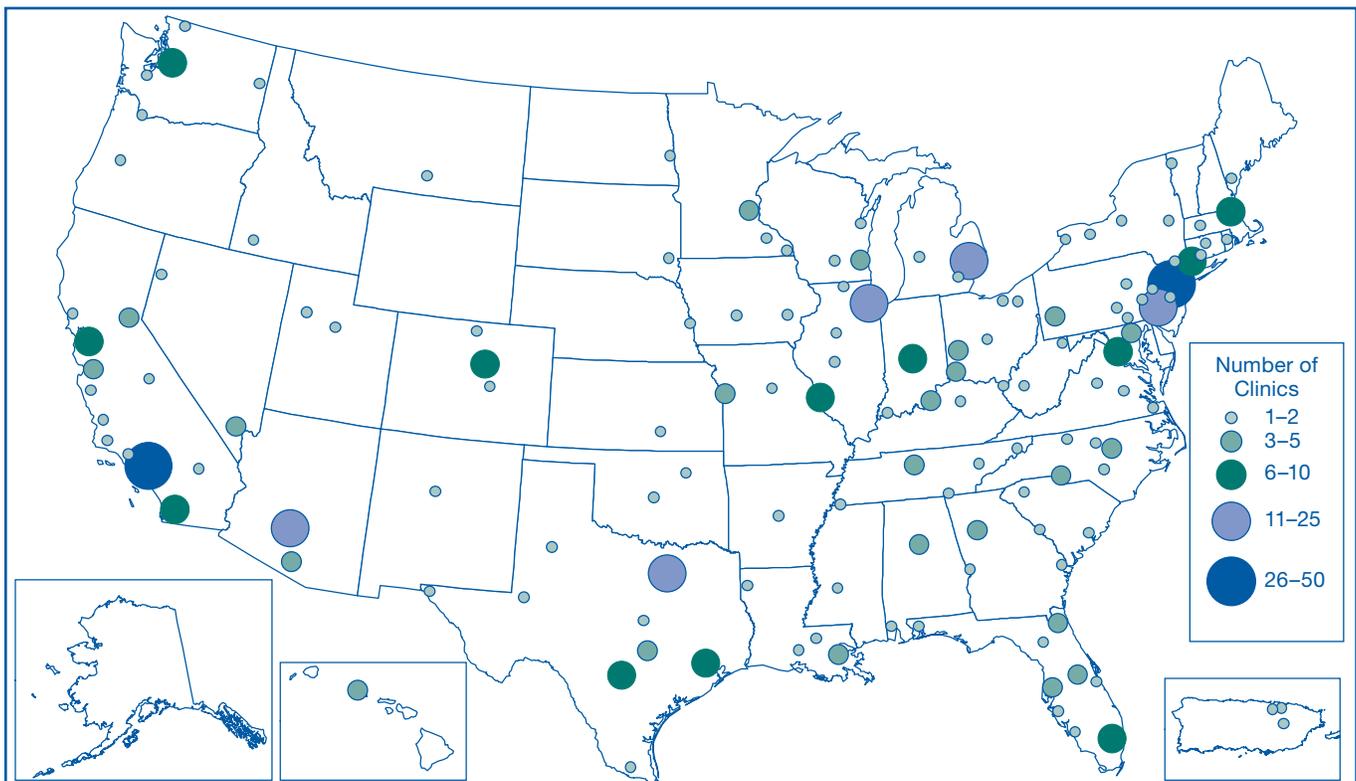
SECTION 1: OVERVIEW

Where are ART clinics located?

ART clinics are located throughout the United States. Figure 1 shows the locations of the 463 reporting clinics. Individual clinic tables with success rates and clinic profiles are published in the *2016 Fertility Clinic Success Rates Report*, arranged in alphabetical order by state, city, and clinic name. The number of clinics, cycles performed, live-birth deliveries, and infants born as a result of ART all have increased steadily

since CDC began collecting this information in 1995 (see Section 5, pages 50–60). Because in some cases more than one infant is born during a live-birth delivery (for example, twins), the total number of infants born is greater than the number of live-birth deliveries. CDC estimates that ART accounts for slightly less than 2% of total US births.

Figure 1
Locations of ART Clinics in the United States and Puerto Rico, 2016



Number of ART clinics in the United States in 2016.....	502
Number of ART clinics that submitted data.....	463
Total number of ART cycles started in 2016 at clinics reporting data.....	263,577*
Number of live-birth deliveries resulting from all ART cycles started in 2016.....	65,996
Number of infants born as a result of all ART cycles started in 2016.....	76,930

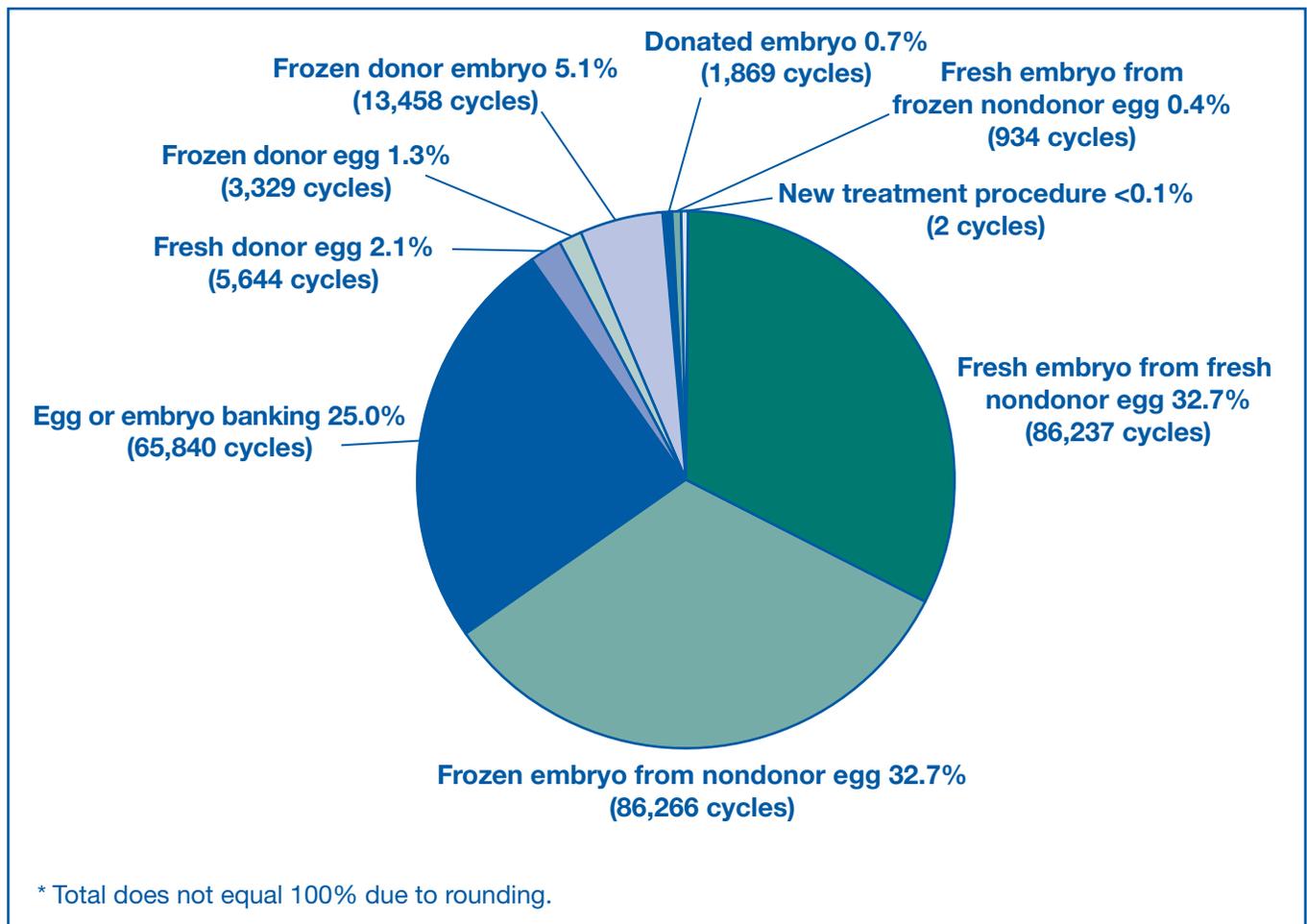
* Total includes 65,840 cycles with the intent to freeze all eggs or embryos and 934 cycles with the intent to fertilize previously frozen nondonor eggs and transfer resulting embryos. Figure 1 does not include 2 cycles evaluating a new treatment procedure. See the introduction on pages 3–4 for more details about the types of ART cycles performed and included in other figures.

What types of ART cycles were performed?

The majority (66%) of ART cycles in the United States in 2016 were performed with the intent to use a patient’s own eggs, or nondonor eggs. More specifically, 33% used fresh embryos from fresh nondonor eggs, less than 1% used fresh embryos from previously frozen and thawed nondonor eggs, and 33% used frozen embryos from nondonor eggs. In comparison, 9% of ART cycles intended to use eggs from a donor. More specifically, 2% used fresh embryos from fresh donor eggs, 1% used fresh embryos from previously frozen and thawed donor eggs,

5% used frozen embryos previously created from donor eggs, and about 1% used donated embryos in which a patient with unused embryos after ART treatment donates these embryos to another patient. There were 25% of cycles started in 2016 with the intent to freeze and store (or bank) all resulting eggs or embryos for potential future use. There were two cycles that involved the evaluation of a new treatment procedure. See the introduction on pages 3–4 for more details about the types of ART cycles performed and included in other figures.

Figure 2
Types of ART Cycles—United States,* 2016



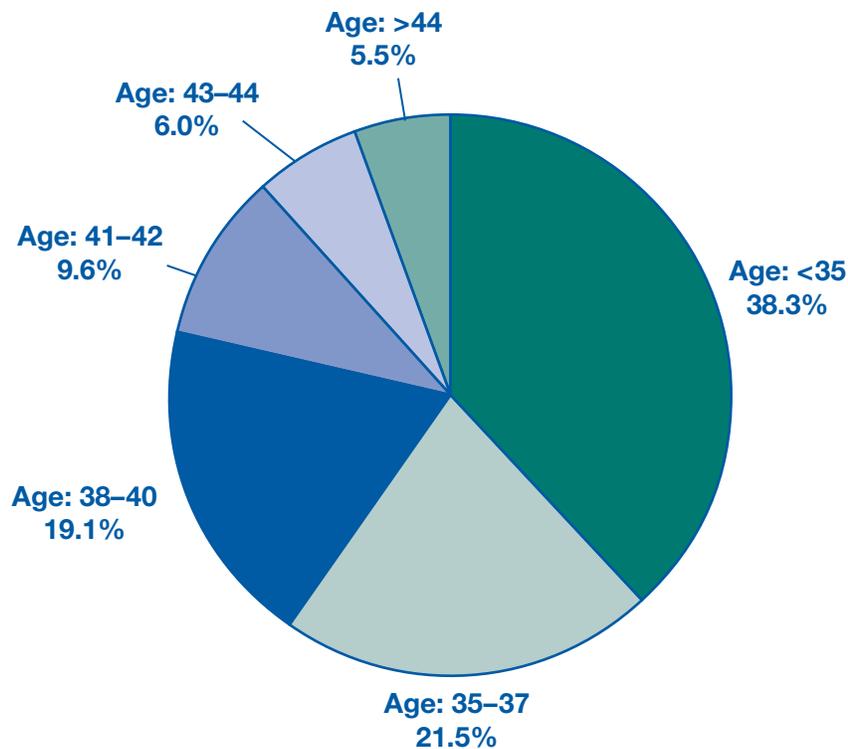
How old were ART patients?

As shown in Figure 3, which presents ART cycles performed in the United States in 2016 according to the age of the patient who had the procedure, the largest group of patients using ART services were patients younger than age 35. These patients represented approximately 38% of all ART cycles performed in 2016. There were 22% of ART cycles performed among patients aged 35–37, 19% among patients aged 38–40, 10% among patients aged 41–42, 6% among patients

aged 43–44, and 6% among patients older than age 44.

The average age of patients using ART services in 2016 was 36. Cycles with the intent to use fresh embryos from previously frozen nondonor eggs and cycles with the intent to bank all eggs or embryos are included in the data for this figure. See the introduction on pages 3–4 for more information about these cycle types.

Figure 3
ART Use by Age Group—United States,* 2016



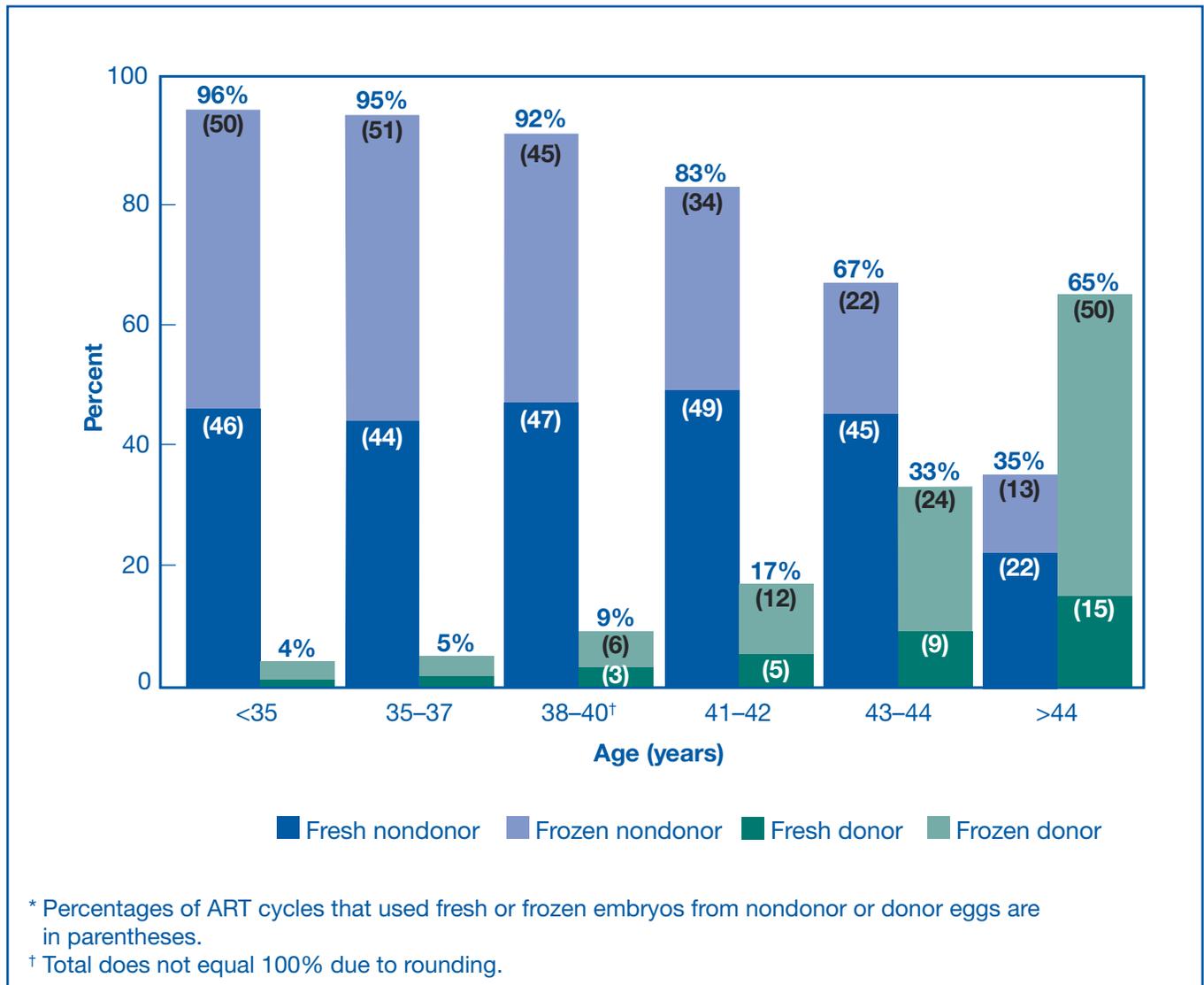
* Based on 263,577 cycles.

How did the types of ART cycles performed differ by a patient's age?

Figure 4 shows that, in 2016, the percentage of ART cycles in which a female patient used her own eggs declined with age, while the percentage of ART cycles using a donor egg increased with age. The vast majority (96%) of patients younger than age 35 used their own eggs (nondonor), and about 4% used donor eggs, while 33% of patients aged 43–44 and 65% of patients older than age 44 used donor eggs. Percentages

of fresh nondonor cycles (fresh embryos from fresh nondonor eggs) performed were greater than frozen nondonor embryo cycles in patients older than age 37. Percentages of frozen donor cycles (frozen embryos from donor eggs or frozen donated embryos) were greater than fresh donor cycles (fresh embryos from fresh donor eggs or fresh donated embryos) in all age groups.

Figure 4
Types of ART Cycles by Age Group—United States,* 2016



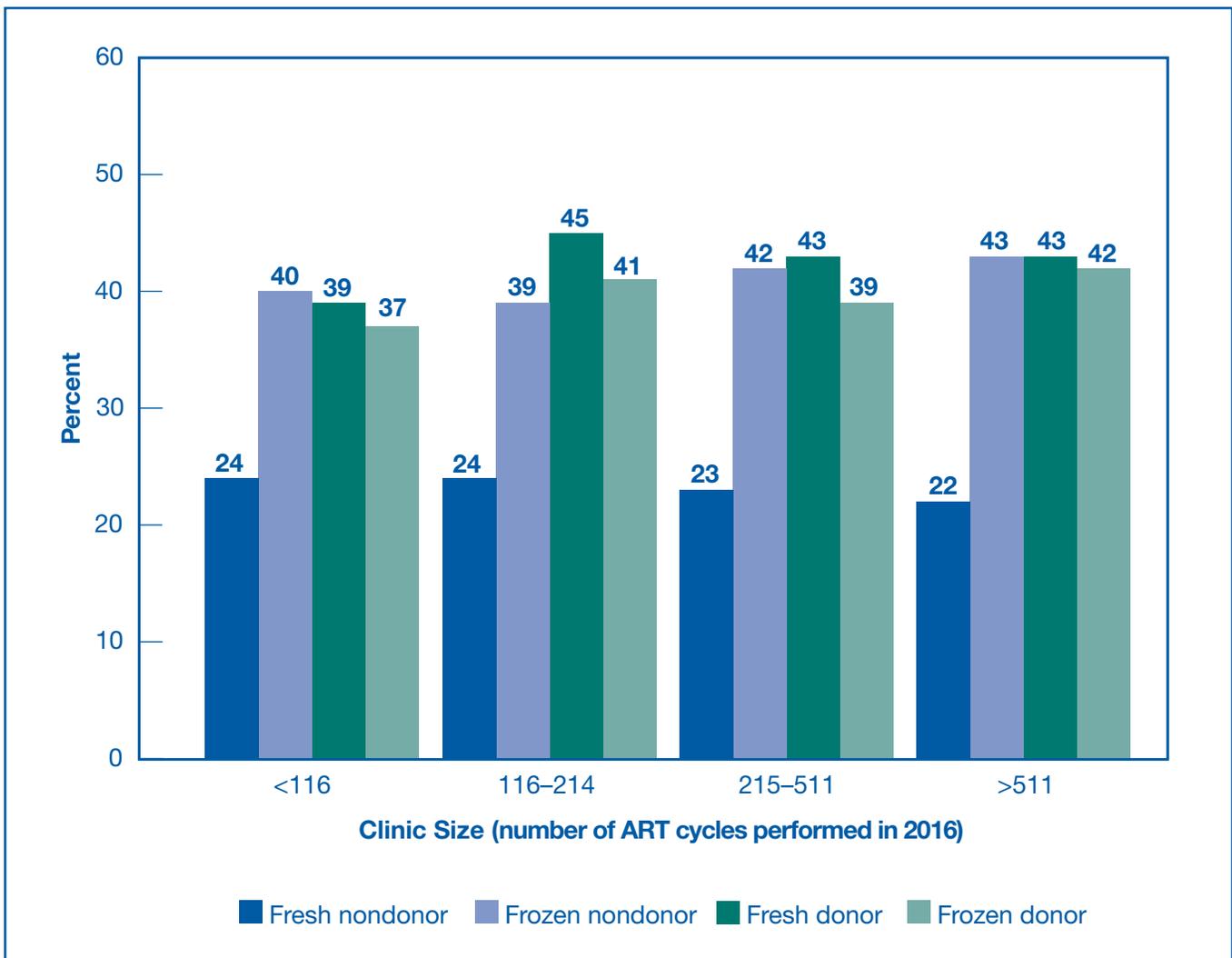
What was the relationship between clinic size and the percentage of ART cycles that resulted in live births?

As shown in Figure 5, the number of ART procedures performed varied among fertility clinics in the United States. In 2016, the percentage of ART cycles that resulted in live births using frozen nondonor embryos or frozen donor embryos (frozen embryos from donor eggs or frozen donated embryos) generally increased as the clinic size increased. The percentage of cycles resulting in live births generally decreased

as the clinic size increased for cycles using fresh embryos from fresh nondonor eggs.

For Figure 5, clinics were divided equally into four groups from smallest to largest (called quartiles) based on the number of ART cycles they performed in 2016. The percentage for each group by type of ART shows the average percentage of ART cycles that resulted in live births for clinics in that group.

Figure 5
Percentages of ART Cycles That Resulted in Live Births, by Type of ART and Clinic Size—United States, 2016

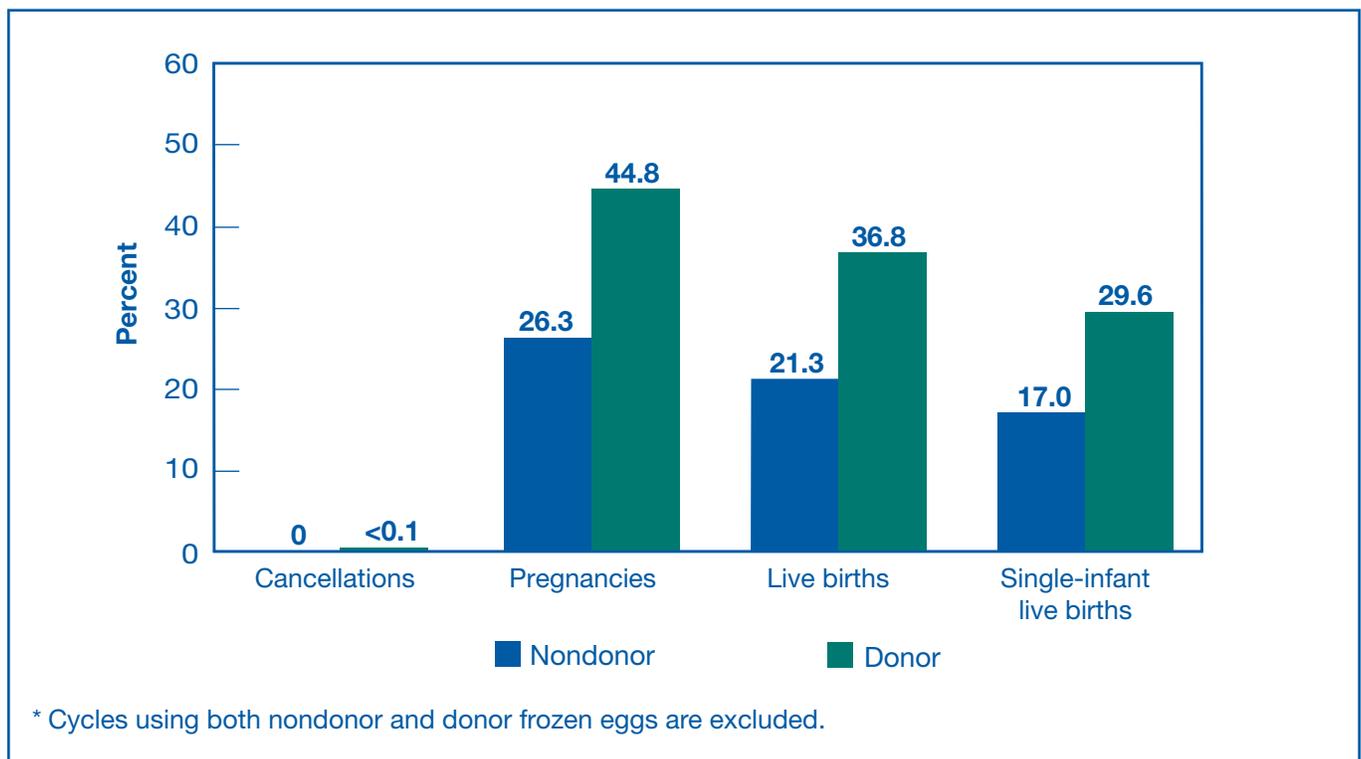


How many frozen egg cycles were conducted and what were the outcomes of these cycles?

As shown in Figure 2 (page 8), about 2% of ART cycles started in 2016 were performed with the intent to fertilize previously frozen and thawed eggs and transfer the resulting fresh embryo(s) during the current cycle. While the 934 cycles using fresh embryos from frozen nondonor eggs performed in 2016 do not contribute to any success rate calculations in the ART reports, these cycles can produce successful ART outcomes. Figure 6 shows that of the cycles that used a patient's own frozen eggs and a fresh embryo, zero cycles resulted in cancellations, approximately 26% in pregnancies, 21% in live births, and 17% in single-infant live births.

Of the cycles that used fresh embryos from frozen donor eggs, less than 1% resulted in cancellations, 45% in pregnancies, 37% in live births, and 30% in single-infant live births. Patients often freeze their own eggs to preserve their future fertility. Reasons a patient may seek fertility preservation include undergoing medical treatments that may affect future fertility (for example, chemotherapy or radiation) or electing to delay childbearing. Patients often use frozen donor eggs when achieving pregnancy with their own eggs is unlikely, for example, in the case of diminished ovarian reserve.

Figure 6
Percentages of ART Cycles Using Fresh Embryos from Frozen Nondonor or Donor Eggs That Resulted in Cancellations, Pregnancies, Live Births, and Single-Infant Live Births,* 2016



SECTION 2: ART CYCLES USING FRESH EMBRYOS FROM FRESH NONDONOR EGGS

What are the steps for an ART cycle?

An ART **cycle is started** when a woman begins taking medication to stimulate the ovaries to develop eggs or, if no drugs are given, when the woman begins having her ovaries monitored (using ultrasound or blood tests) for natural egg production.

If eggs are produced, the cycle then progresses to **egg retrieval**, a surgical procedure in which eggs are collected from a woman's ovaries.

Once retrieved, eggs are combined with sperm in the laboratory. If fertilization is successful, one or more of the resulting embryos are selected for **transfer**, most often into a woman's uterus through the cervix (IVF), but sometimes into the fallopian tubes (GIFT or ZIFT).

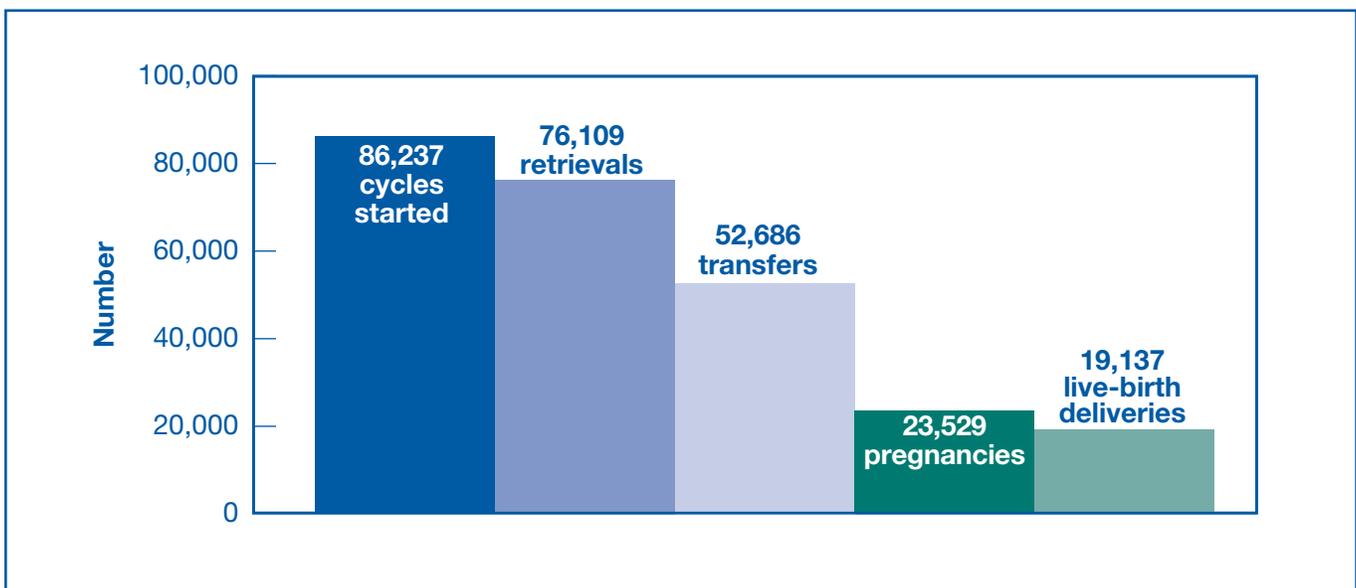
If one or more of the transferred embryos implant within the woman's uterus, the cycle then may progress to clinical **pregnancy**.

Finally, the pregnancy may progress to a **live birth**, the delivery of one or more live-born infants. (The birth of twins, triplets, or more is counted as one live birth.)

A cycle may be stopped at any step for specific medical reasons (for example, no eggs are produced or the embryo transfer was not successful) or by patient choice.

Figure 7 presents the steps for an ART cycle using fresh embryos from fresh nondonor eggs and shows how ART patients in 2016 progressed through these stages toward pregnancy and live birth.

Figure 7
Outcomes of ART Cycles Using Fresh Embryos from Fresh Nondonor Eggs, by Stage, 2016

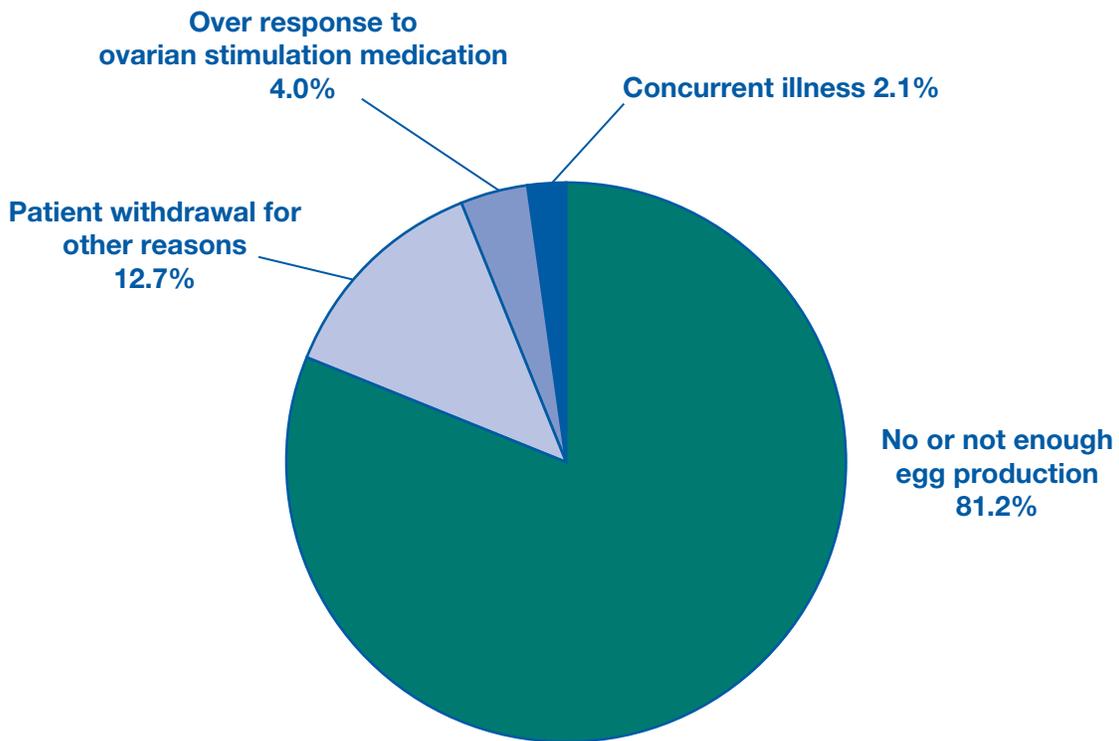


Why were some ART cycles canceled?

In 2016, a total of 10,128 ART cycles (about 12% of all 86,237 cycles using fresh embryos from fresh nondonor eggs) were canceled before the egg retrieval step (see Figure 7, page 13). Figure 8 shows the reasons that the cycles were canceled. For approximately 81% of these cycles, there was

no or not enough egg production. Other reasons included an over response to ovarian stimulation medications (that is, a potential for ovarian hyperstimulation syndrome), concurrent illness, or patient withdrawal for other reasons.

Figure 8
Reasons ART Cycles Using Fresh Embryos from Fresh Nondonor Eggs Were Canceled,* 2016



* Based on 10,128 ART cycles.

How are success rates of ART measured?

Figure 9 shows success rates for ART cycles using fresh embryos from fresh nondonor eggs in 2016. Most success measures have increased slightly since CDC began monitoring them in 1995 (see Section 5, pages 50–60).

Percentage of cycles that resulted in a pregnancy. This rate includes all cycles started, even if they were canceled before retrieval or stopped after retrieval but before transfer. Some cycles are canceled before retrieval for reasons shown in Figure 8 (page 14), or stopped after retrieval but before transfer for reasons such as embryos not surviving or poor quality embryos.

Percentage of transfers that resulted in a pregnancy. This rate is higher than the percentage of cycles that resulted in a pregnancy because cycles that did not move forward to a transfer are excluded.

Percentage of cycles that resulted in a live birth (delivery of one or more live-born infants). This rate includes all cycles started.

This is referred to as the “basic live birth rate” in the Fertility Clinic Success Rate and Certification Act of 1992. This is lower than the percentage of cycles that resulted in a pregnancy, because some pregnancies end in miscarriage, induced abortion, or stillbirth (see Figure 11, page 17).

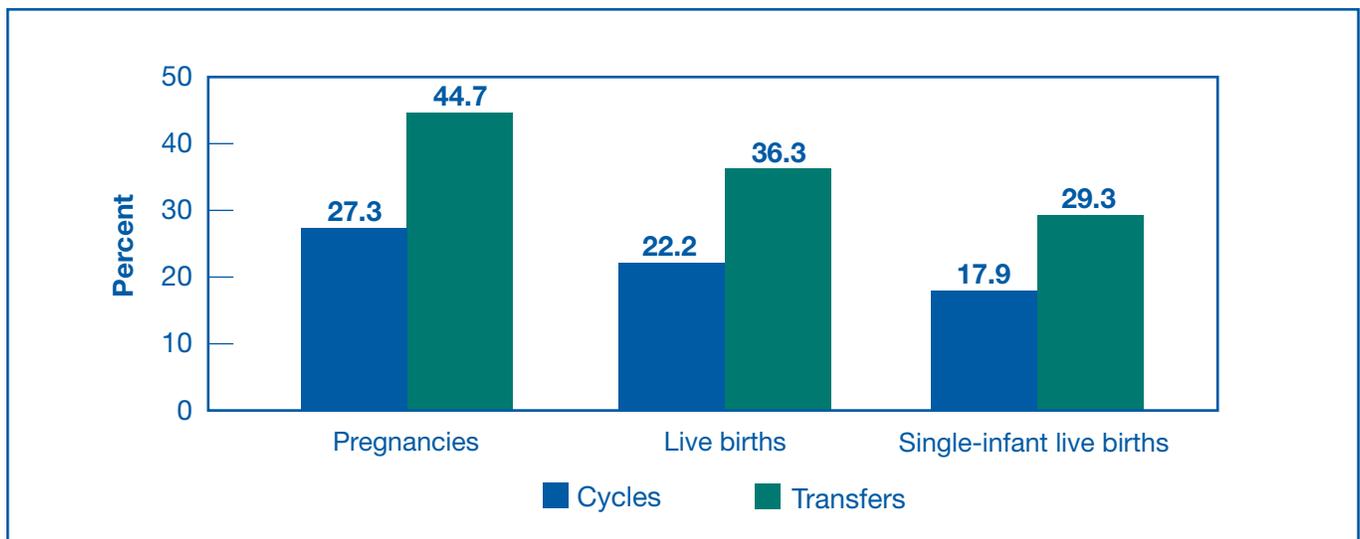
Percentage of transfers that resulted in a live birth. This rate is higher than the percentage of cycles that resulted in a live birth because cycles that did not move forward to a transfer are excluded.

Percentage of cycles that resulted in a single-infant live birth. This rate is important because single infants have a lower risk than multiple infants of poor health outcomes, including prematurity, low birth weight, disability, and death.

Percentage of transfers that resulted in a single-infant live birth. This rate is higher than the percentage of cycles that resulted in a single-infant live birth because cycles that did not move forward to a transfer are excluded.

Figure 9

Percentages of ART Cycles and Transfers Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Pregnancies, Live Births, and Single-Infant Live Births, 2016



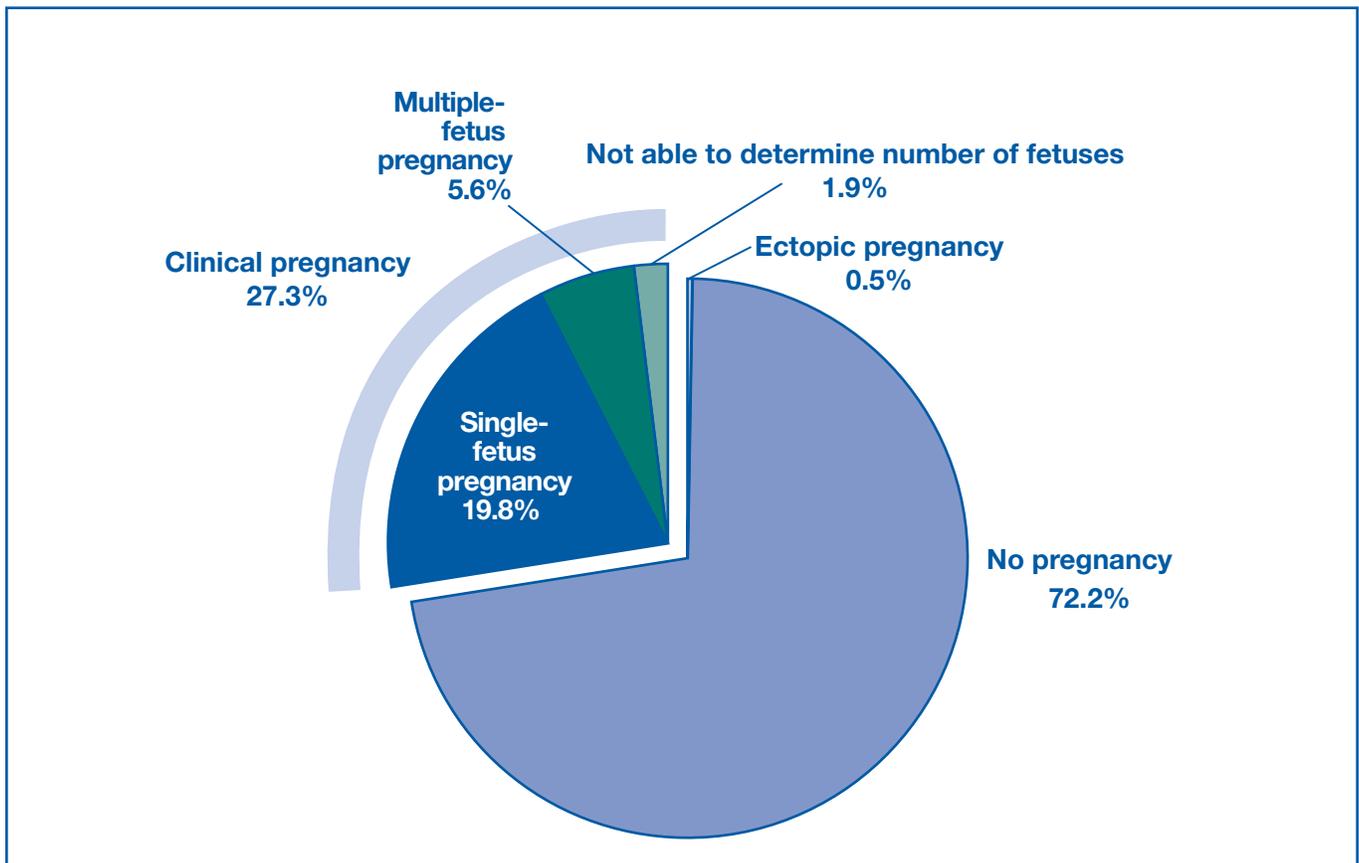
What percentage of ART cycles resulted in a pregnancy?

In total, about 27% of cycles using fresh embryos from fresh nondonor eggs that were started in 2016 resulted in clinical pregnancy; about 20% resulted in a single-fetus pregnancy, 6% in a multiple-fetus pregnancy, and 2% in a pregnancy where the number of fetuses could not be

determined (Figure 10). However, most of these cycles (approximately 72%) did not produce a pregnancy while a very small proportion (less than 1%) resulted in an ectopic pregnancy with the embryo implanted outside the uterus.

Figure 10

Outcomes of ART Cycles Using Fresh Embryos from Fresh Nondonor Eggs, 2016



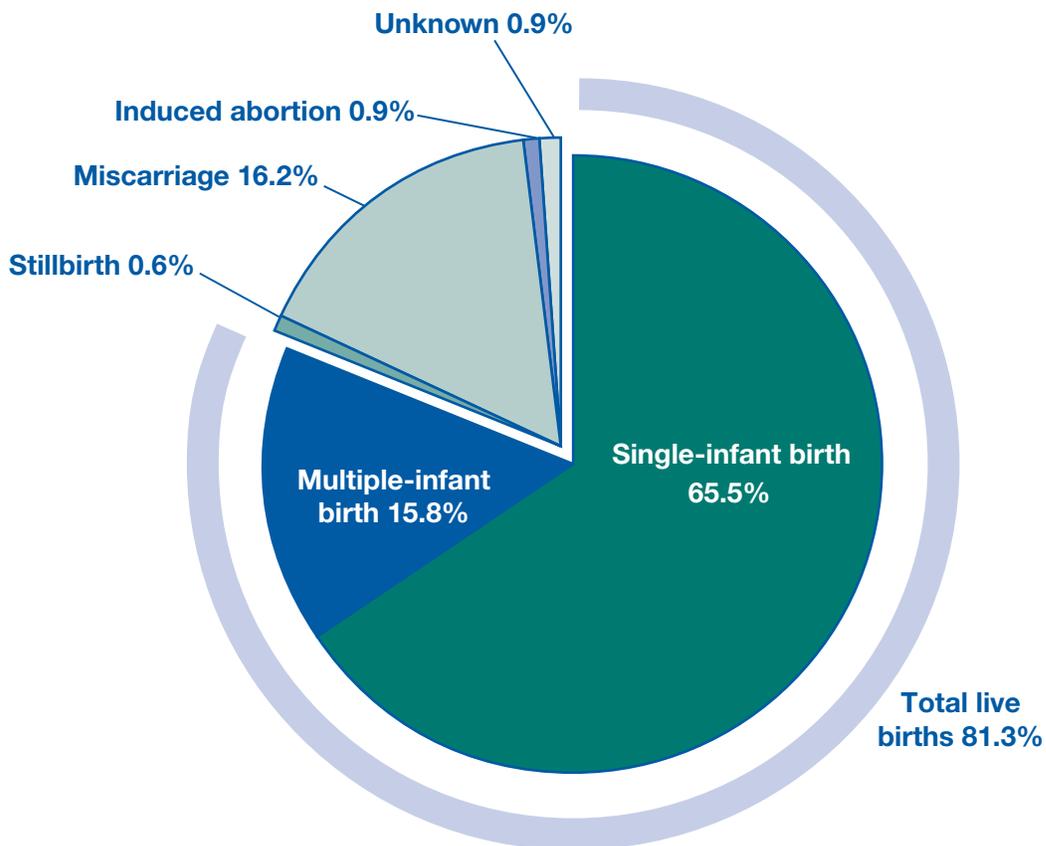
What percentage of ART pregnancies resulted in a live birth?

Figure 11 shows that approximately 81% of the pregnancies resulting from ART cycles using fresh embryos from fresh nondonor eggs in 2016 produced a live birth (66% were the birth of a single infant and approximately 16% were the birth of multiple infants). About 18% of

pregnancies resulted in miscarriage, stillbirth, induced abortion, or maternal death prior to birth (maternal deaths are not shown in Figure 11 due to the small number). For less than 1% of pregnancies, the outcome was unknown.

Figure 11

Outcomes of Pregnancies That Resulted from ART Cycles Using Fresh Embryos from Fresh Nondonor Eggs,*† 2016



* Maternal deaths prior to birth are not displayed due to small number of cycles.

† Total does not equal 100% due to rounding.

What percentage of ART cycles resulted in a multiple-fetus pregnancy or multiple-infant birth?

Part A of Figure 12 shows that among the 23,529 pregnancies that resulted from ART cycles using fresh embryos from fresh nondonor eggs in 2016, about 73% were single-fetus pregnancies and 21% were multiple-fetus pregnancies. The number of fetuses could not be accurately determined for 7% of pregnancies.

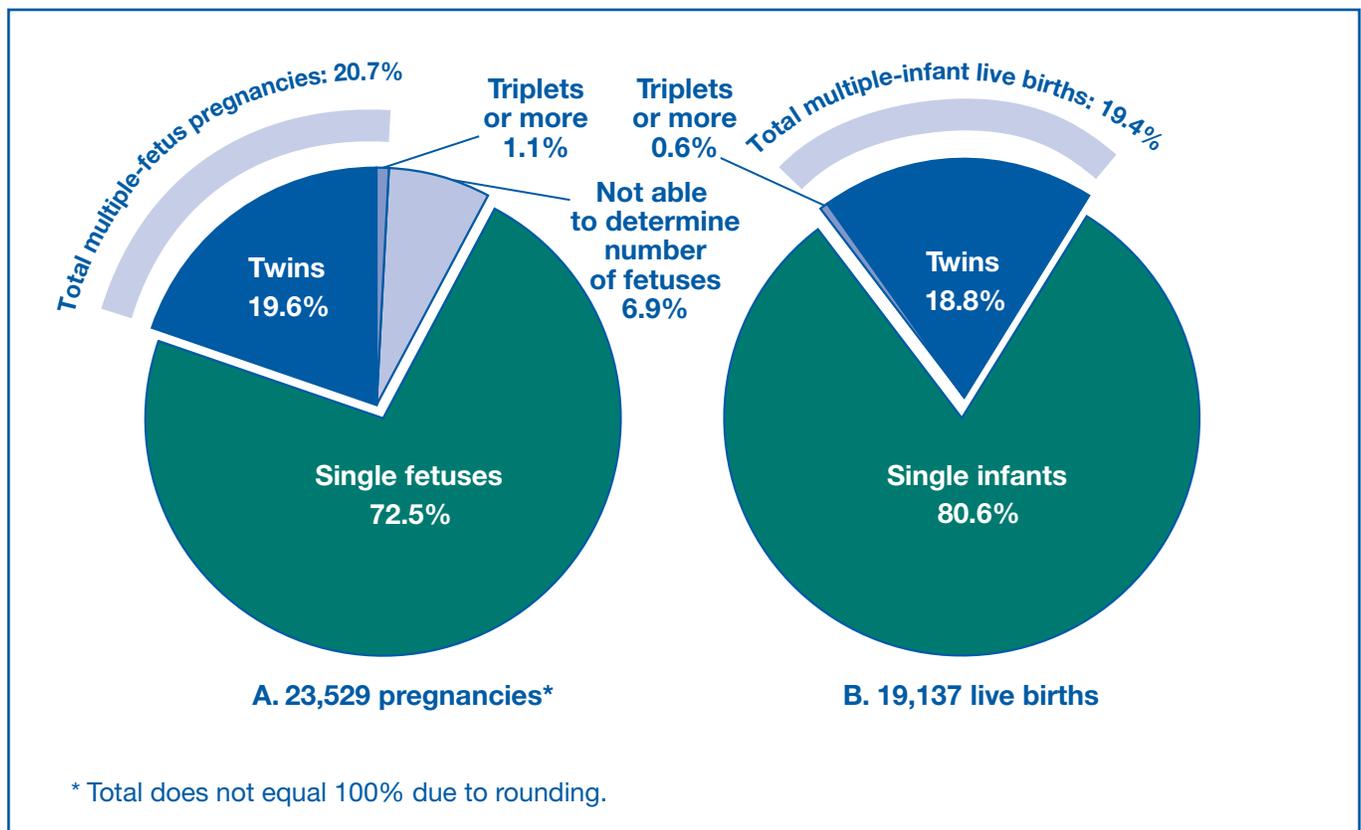
Of the 23,529 pregnancies that resulted from these ART cycles, 19,137 (81%) resulted in live

births. Part B of Figure 12 shows that about 19% of these live births resulted in more than one infant.

ART pregnancies are more likely to result in multiple-infant births (twins, triplets or more) than pregnancies resulting from natural conception because more than one embryo may be transferred.

Figure 12

Distribution of Multiple-Fetus Pregnancies and Multiple-Infant Live Births Among ART Cycles Using Fresh Embryos from Fresh Nondonor Eggs, 2016



What percentage of ART cycles resulted in a preterm or low birth weight infant?

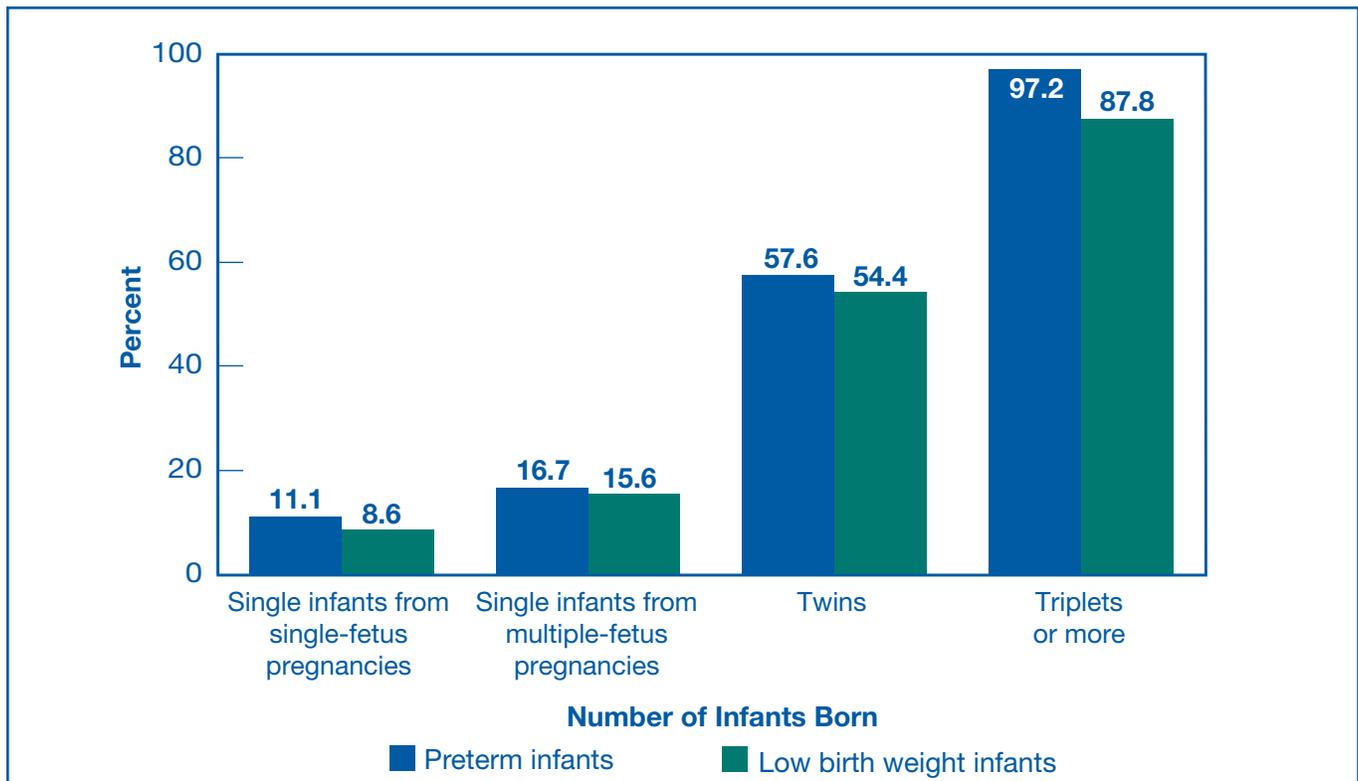
Percentages of preterm and low birth weight infants resulting from ART cycles that used fresh embryos from fresh nondonor eggs in 2016 increased as the number of infants born increased (Figure 13). Preterm infants are born to a woman giving birth before 37 full weeks of pregnancy and low birth weight infants are born weighing less than 2,500 grams (about 5 pounds, 8 ounces). Infants born preterm or with low birth weight are at greater risk of death in the first year of life, as well as other poor health outcomes, including visual and hearing problems, intellectual and learning disabilities, and behavioral and emotional problems throughout life. Preterm and low birth weight infants also can cause

considerable emotional and economic burdens for families.

For births resulting in a single live-born infant, percentages of preterm infants and low birth weight infants are shown separately for single- and multiple-fetus pregnancies. Among single live-born infants, percentages of preterm and low birth weight infants were higher for those from multiple-fetus pregnancies. In the general US population, where the live birth of a single infant is almost always the result of a single-fetus pregnancy, 10% of single live-born infants were preterm and 6% of single infants had low birth weight (data not shown).

Figure 13

Percentages of Preterm Infants or Infants with Low Birth Weight from ART Cycles Using Fresh Embryos from Fresh Nondonor Eggs, by Number of Infants Born, 2016



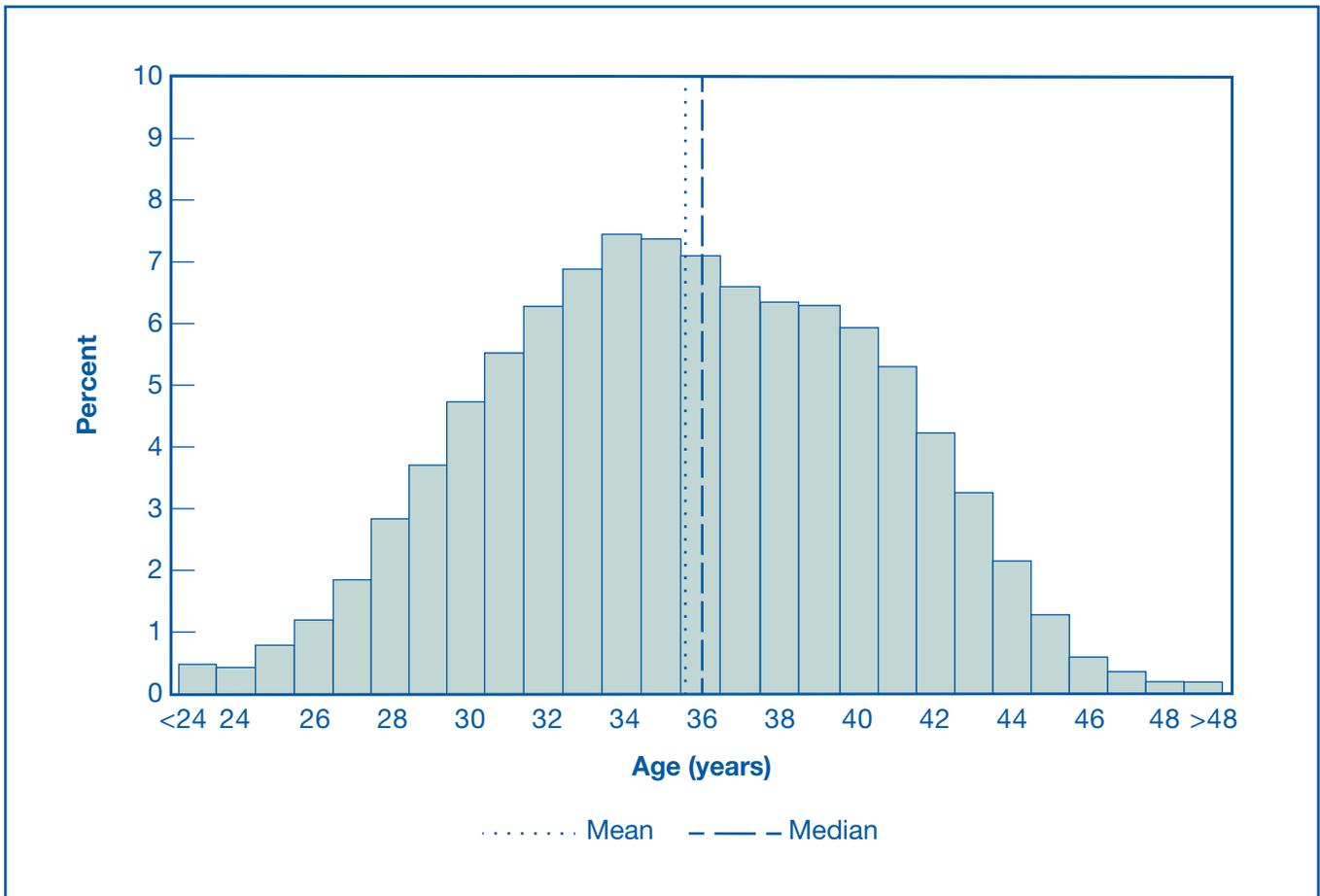
What were the ages of women who used ART?

The average (mean) age of women who had ART cycles using fresh embryos from fresh nondonor eggs in 2016 was almost 36 and the median age was 36 (Figure 14). About 11% of these cycles

were among women younger than age 30, 65% were among women aged 30–39, and 24% were among women aged 40 or older.

Figure 14

Age Distribution of Women Who Had ART Cycles Using Fresh Embryos from Fresh Nondonor Eggs, 2016



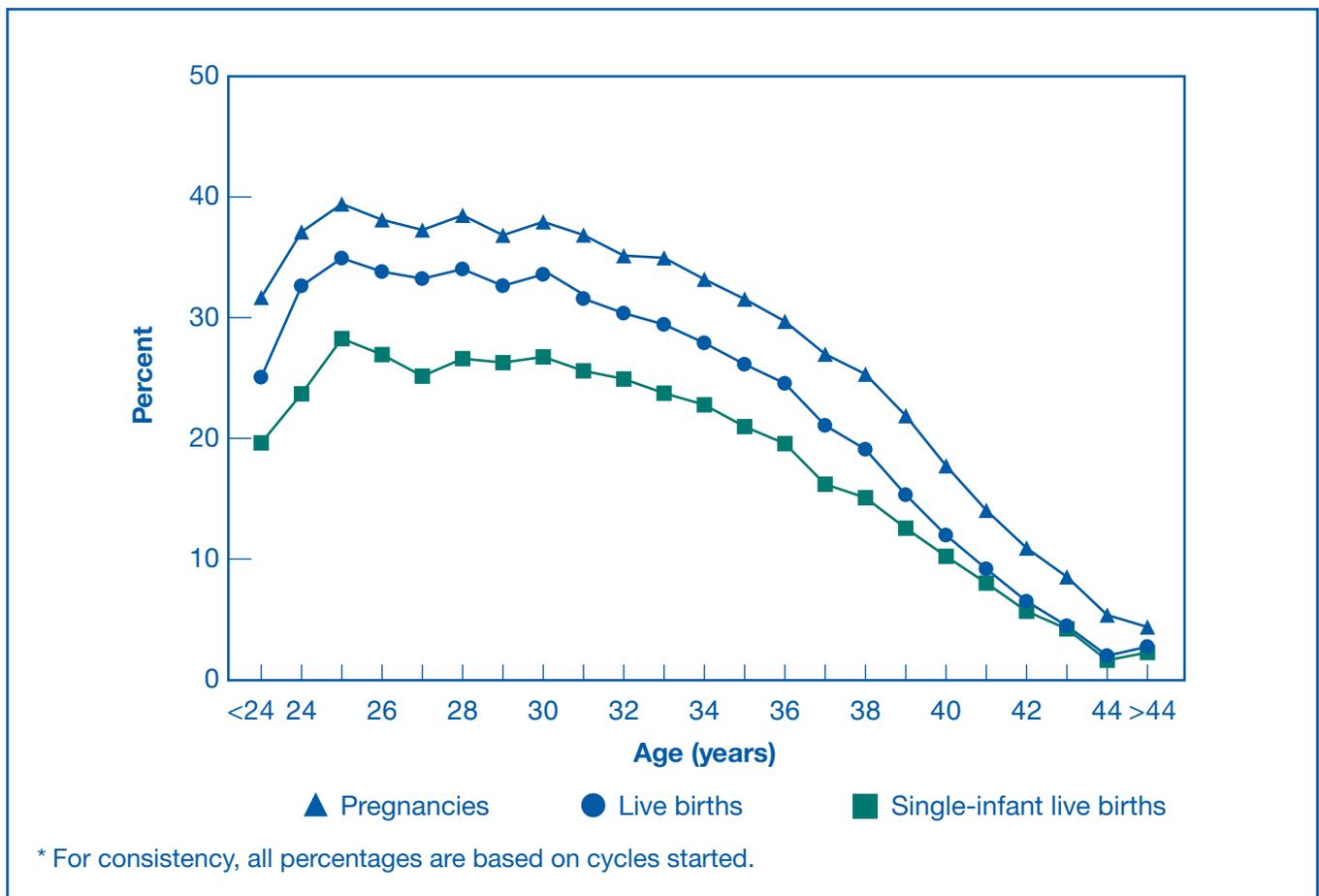
Did the percentage of pregnancies, live births, and births of a single live infant differ by a woman's age?

In general, percentages of ART cycles using fresh embryos from fresh nondonor eggs in 2016 that resulted in pregnancies, live births, and single-infant live births declined among women in their 30s onward (Figure 15). A woman's age is the most important factor for having a live birth when her own eggs are used. Percentages

of ART cycles resulting in total live births and births of a single live infant are different because multiple-infant deliveries count towards the total live births. For additional detail on percentages of ART cycles that resulted in pregnancies, live births, and single-infant live births among women aged 40 or older, see Figure 16 on page 22.

Figure 15

Percentages of ART Cycles Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Pregnancies, Live Births, and Single-Infant Live Births, by Age of Woman,* 2016



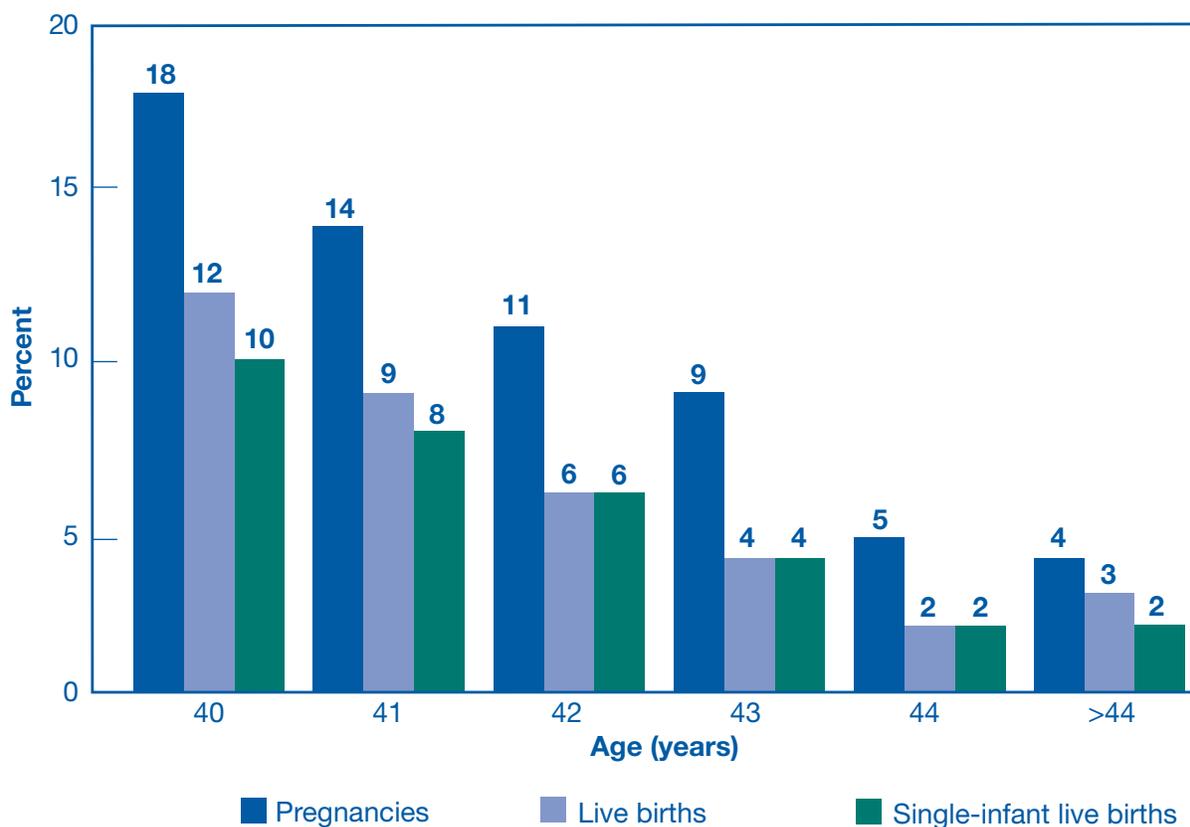
How did the percentage of ART cycles that resulted in pregnancies, live births, and births of single live infants differ among women aged 40 or older?

For women aged 40 or older, percentages of ART cycles using fresh embryos from fresh nondonor eggs in 2016 that resulted in pregnancies, live births, and single-infant live births declined as a woman's age increased (Figure 16). Among women age 40, the percentage of ART cycles resulting in pregnancy was about 18%, the percentage of ART cycles resulting in live births was 12%, and the percentage of ART cycles

resulting in single-infant live births was 10%. Percentages dropped steadily with each 1-year increase in age. Among women older than age 44, percentages of live births were 3% and single-infant live births were 2%. Women aged 40 or older generally have much higher percentages of live births using fresh embryos from fresh donor eggs (see Figure 41, page 47).

Figure 16

Percentages of ART Cycles Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Pregnancies, Live Births, and Single-Infant Live Births Among Women Aged 40 or Older,* 2016



* For consistency, all percentages are based on cycles started.

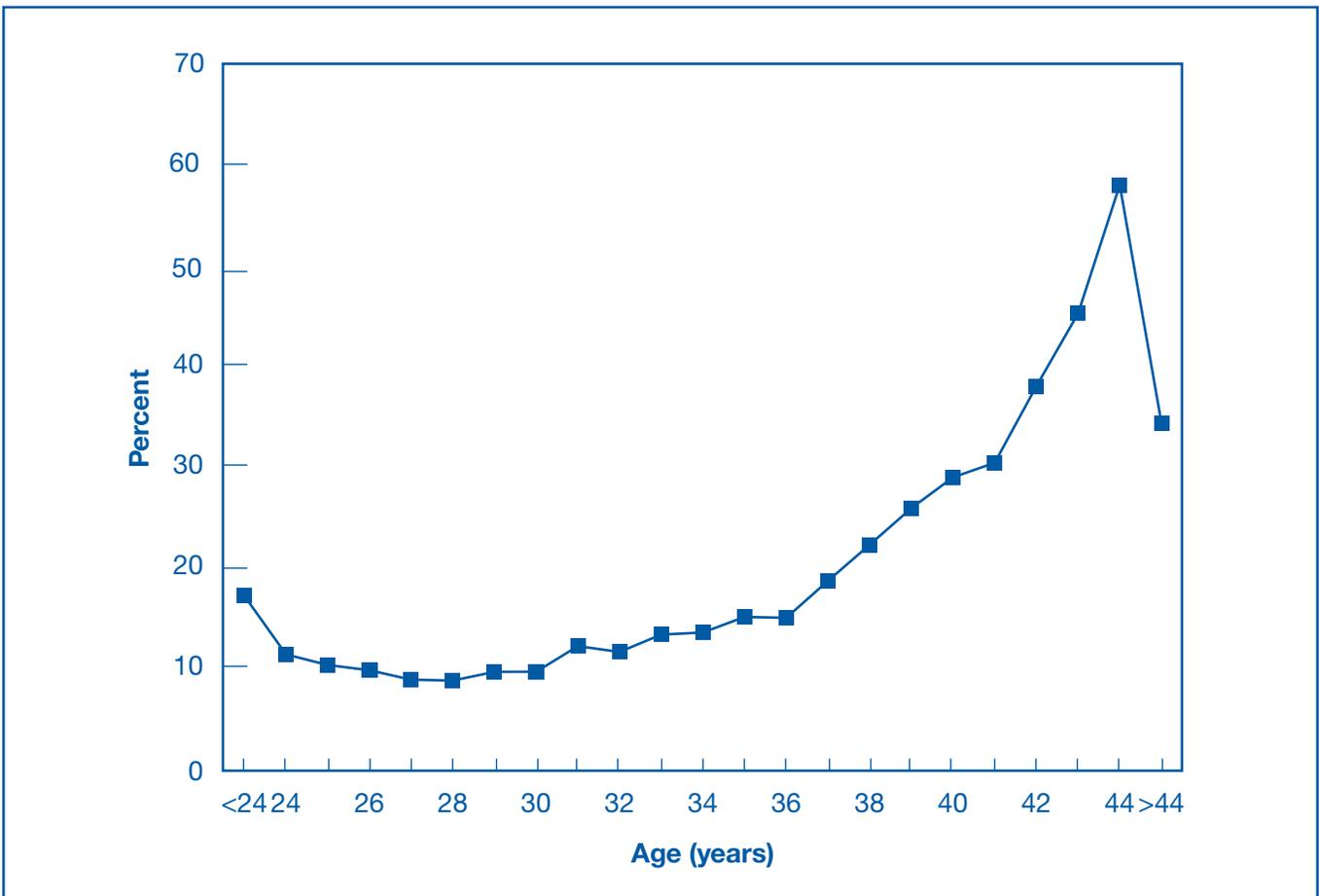
How did the percentage of cycles that resulted in miscarriage differ by a woman’s age?

Percentages of ART cycles using fresh embryos from fresh nondonor eggs in 2016 that resulted in miscarriage were below 17% among women younger than age 37 (Figure 17). The percentage of ART cycles that resulted in miscarriage began to increase rapidly among women in their late 30s and generally continued to increase as a woman’s age increased, reaching almost 29% at age 40 and 58% among women at age 44.

A woman’s age not only affects the percentage of cycles resulting in pregnancy when her own eggs are used, but also her risk of miscarriage. Previous data show that most miscarriages occur before week 14 (during the first trimester) among women of all ages undergoing ART. The risk of miscarriage among women undergoing ART procedures using fresh embryos from fresh nondonor eggs by age appears to be similar to those reported in various studies of other pregnant women in the United States.

Figure 17

Percentages of ART Cycles Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Miscarriage, by Age of Woman, 2016



How did a woman's age affect ART cycle progress and outcomes?

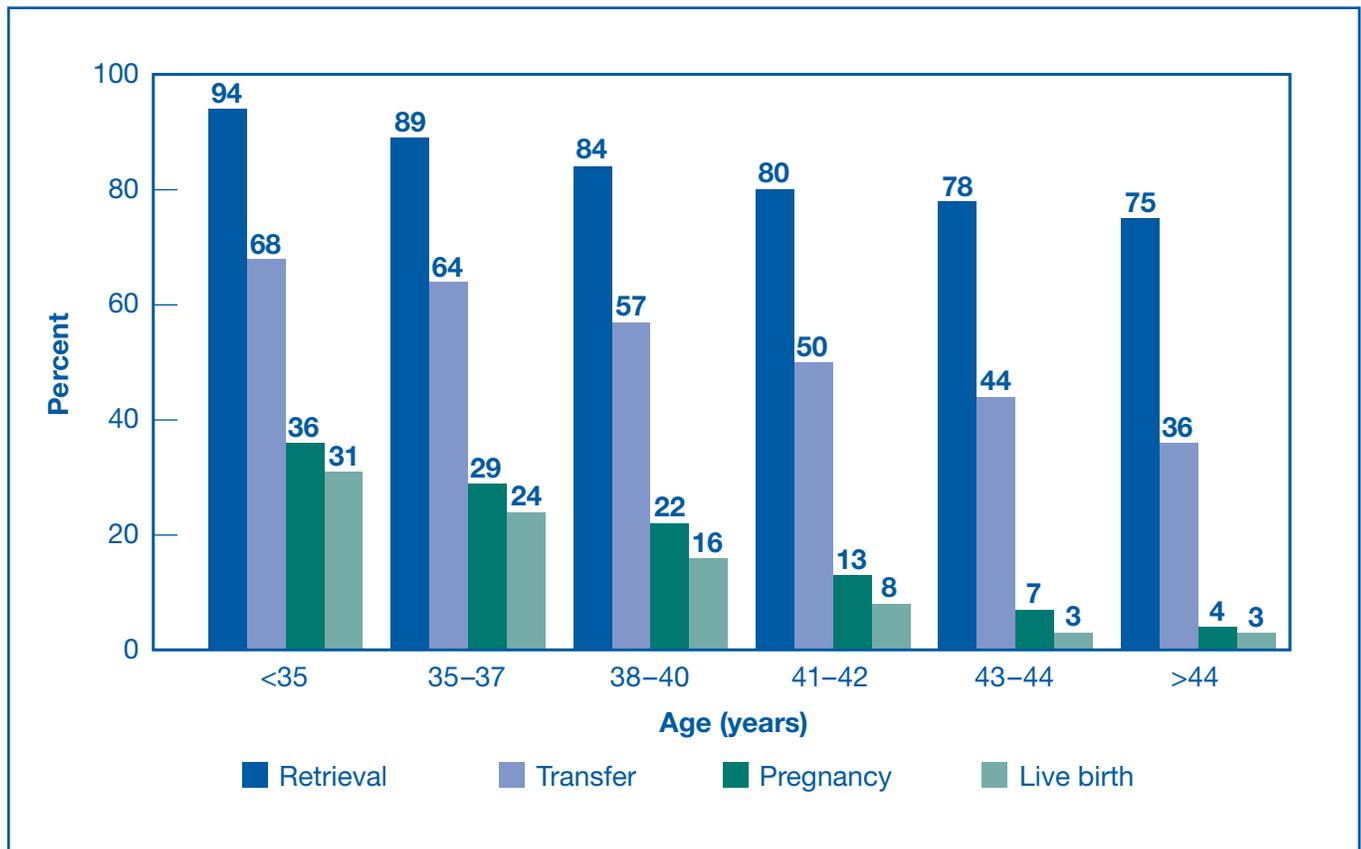
Figure 18 shows that the percentage of cycles progressing from the beginning of ART to pregnancy and live birth using a woman's own eggs decreases at every stage of ART as her age increases. Overall, 31% of cycles started in 2016 among women younger than age 35 resulted in live births. This percentage decreased to 24% among women aged 35–37, 16% among women aged 38–40, 8% among women aged 41–42, 3% among women aged 43–44, and 3% among women older than age 44.

As women get older:

- The likelihood of a successful response to ovarian stimulation and progression to **egg retrieval** decreases.
- Cycles that progress to egg retrieval are less likely to reach **transfer**.
- Cycles that progress to transfer are less likely to reach **pregnancy**.
- Cycles that progress to pregnancy are less likely to result in a **live birth** because the percentage of cycles ending in miscarriage increases (see Figure 17, page 23).

Figure 18

Outcomes of ART Cycles Using Fresh Embryos from Fresh Nondonor Eggs, by Stage and Age Group, 2016



What were the causes of infertility among ART patients?

Causes of infertility among ART patients include:

Tubal factor. Fallopian tubes are blocked or damaged, making it difficult for the egg to be fertilized or for an embryo to travel to the uterus.

Ovulatory dysfunction. Ovaries are not producing eggs normally. Reasons include polycystic ovary syndrome and multiple ovarian cysts.

Diminished ovarian reserve. The ability of the ovary to produce eggs is reduced. Reasons include congenital, medical, or surgical causes or advanced age.

Endometriosis. The presence of tissue similar to the uterine lining in abnormal locations. This condition can affect both fertilization of the egg and embryo implantation.

Uterine factor. A structural or functional disorder of the uterus that results in reduced fertility.

Male factor. A low sperm count or problems with sperm function that make it difficult for a sperm to fertilize an egg under normal conditions.

Other factor. Includes immunological problems, chromosomal abnormalities, chemotherapy, and serious illnesses.

Unknown factor. No clear cause of infertility is found in either partner.

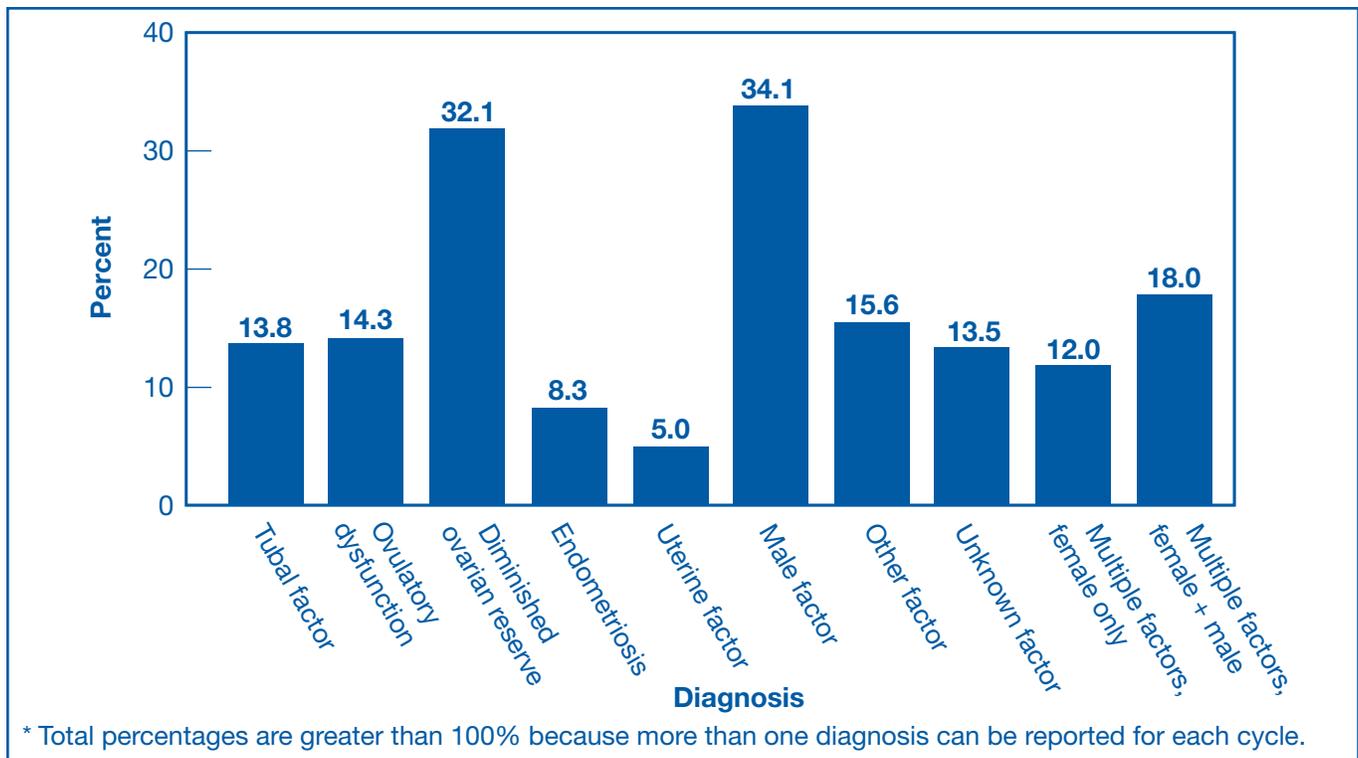
Multiple factors, female only. More than one female cause of infertility, and no male factor infertility.

Multiple factors, female and male. One or more female causes in addition to male factor infertility.

Figure 19 shows infertility diagnoses reported for each ART cycle using fresh embryos from fresh nondonor eggs performed in 2016. Diagnoses ranged from one infertility factor in the patient or partner to multiple infertility factors in either one or both. However, diagnostic procedures may vary among clinics, so the categorizations also may vary.

Figure 19

Percentages of ART Cycles Using Fresh Embryos from Fresh Nondonor Eggs, by Type of Infertility Diagnosis,* 2016



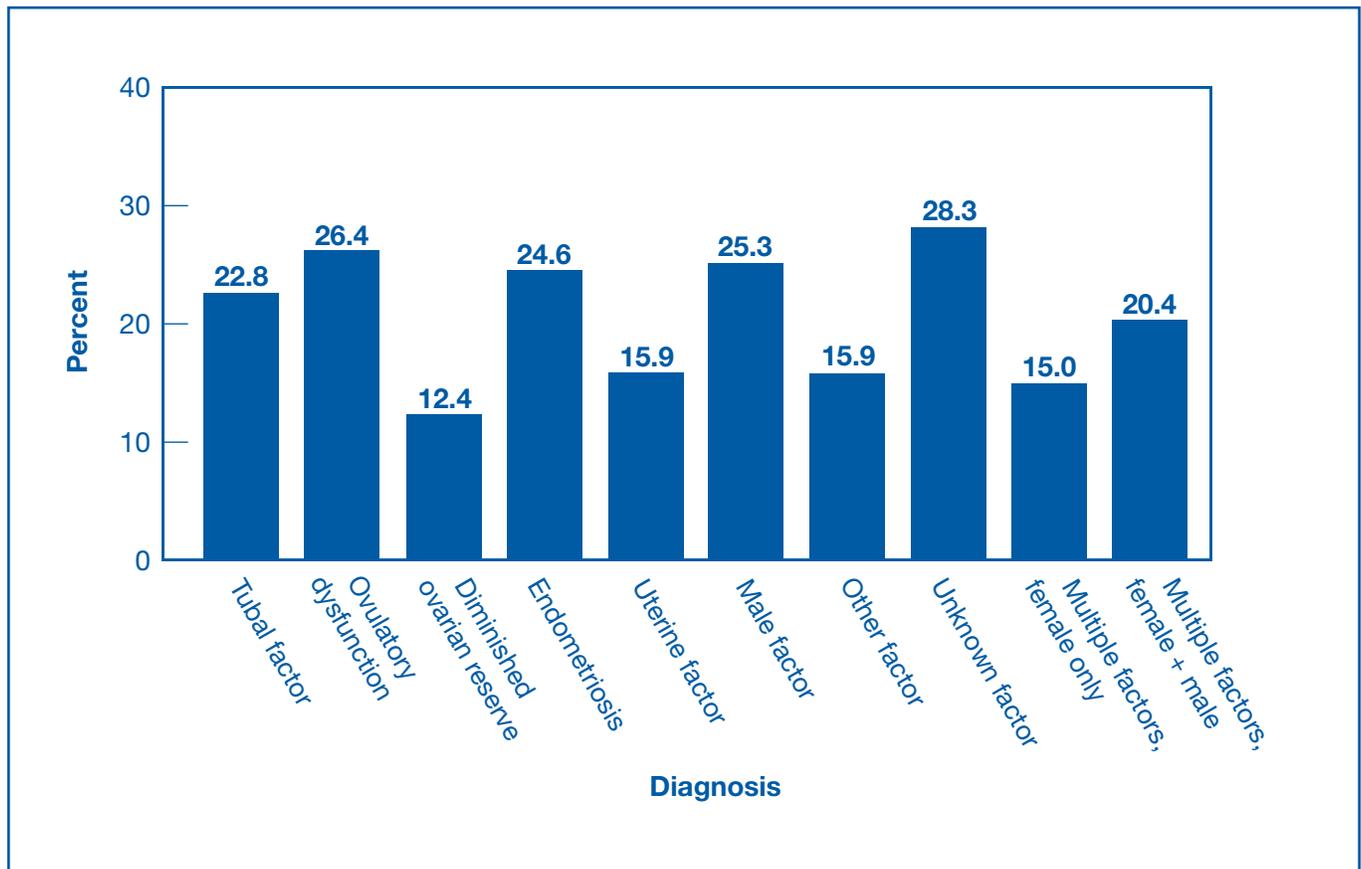
How did the type of infertility diagnosis affect the percentage of ART cycles that resulted in live births?

The national percentage of fresh nondonor ART cycles resulting in live births was slightly more than 22% in 2016 (see Figure 9, page 15). However, this percentage varied depending on the patient's diagnosis. In 2016, the percentage of ART cycles using fresh embryos from fresh nondonor eggs that resulted in live births

was *higher* than the national percentage for patients with tubal factor, ovulatory dysfunction, endometriosis, male factor, or unknown factor infertility; it was *lower* for patients with diminished ovarian reserve, uterine factor, "other" factor, or multiple infertility factors (Figure 20).

Figure 20

Percentages of ART Cycles Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Live Births, by Type of Infertility Diagnosis, 2016



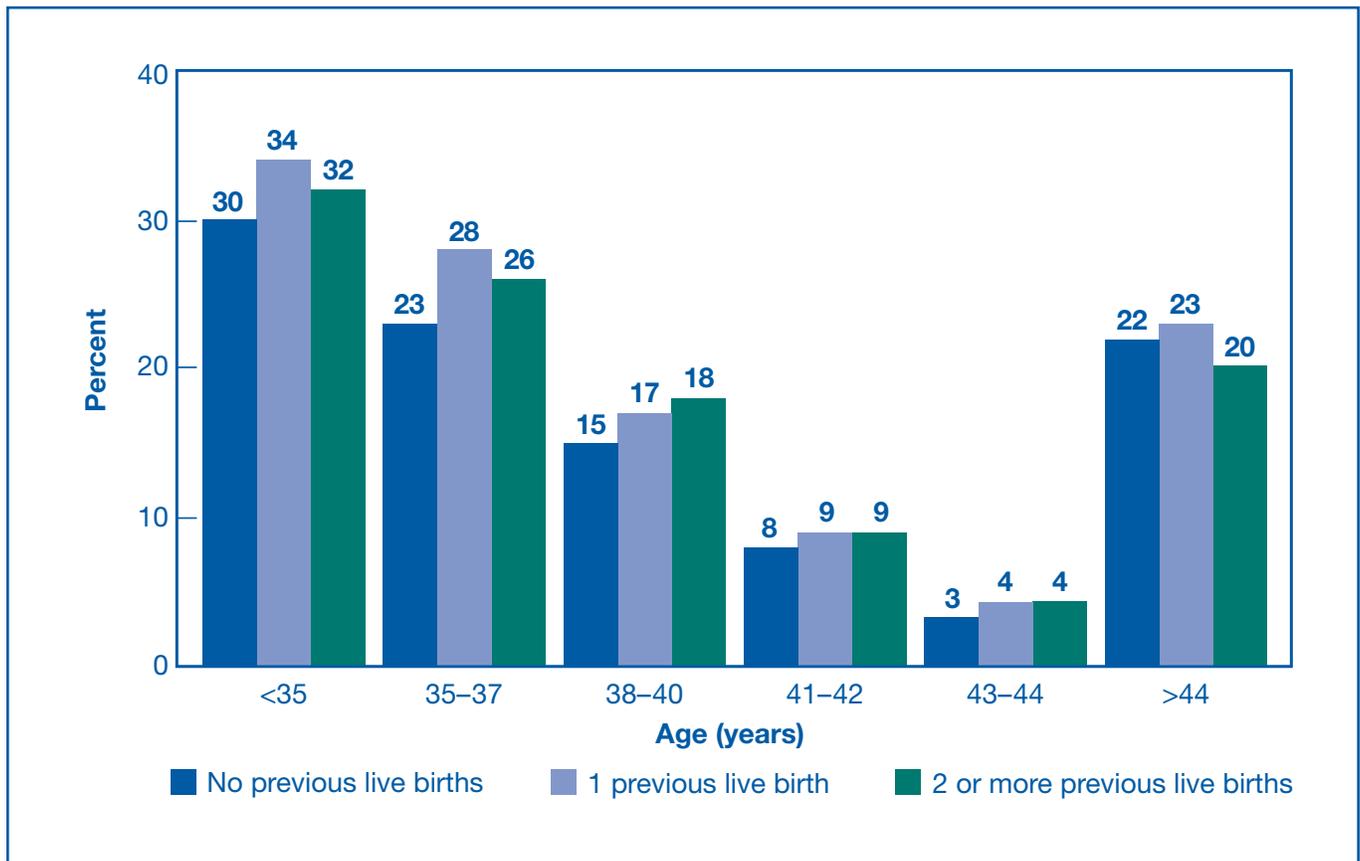
How did previous birth impact ART live-birth outcomes?

Generally, the percentage of ART cycles using fresh embryos from fresh nondonor eggs in 2016 that resulted in live births decreased among women aged 44 or younger, regardless of number of previous live births (Figure 21). Previous live-born infants could have been conceived naturally or through ART. In almost all age groups, the percentage of ART cycles that resulted in live

births was higher among women who had one or more previous live births compared with women who had no previous live births. About 73% of ART cycles performed in 2016 using fresh embryos from fresh nondonor eggs were among women who had no previous live births, although they may have had a previous pregnancy loss.

Figure 21

Percentages of ART Cycles Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Live Births, by Age Group and Number of Previous Live Births, 2016



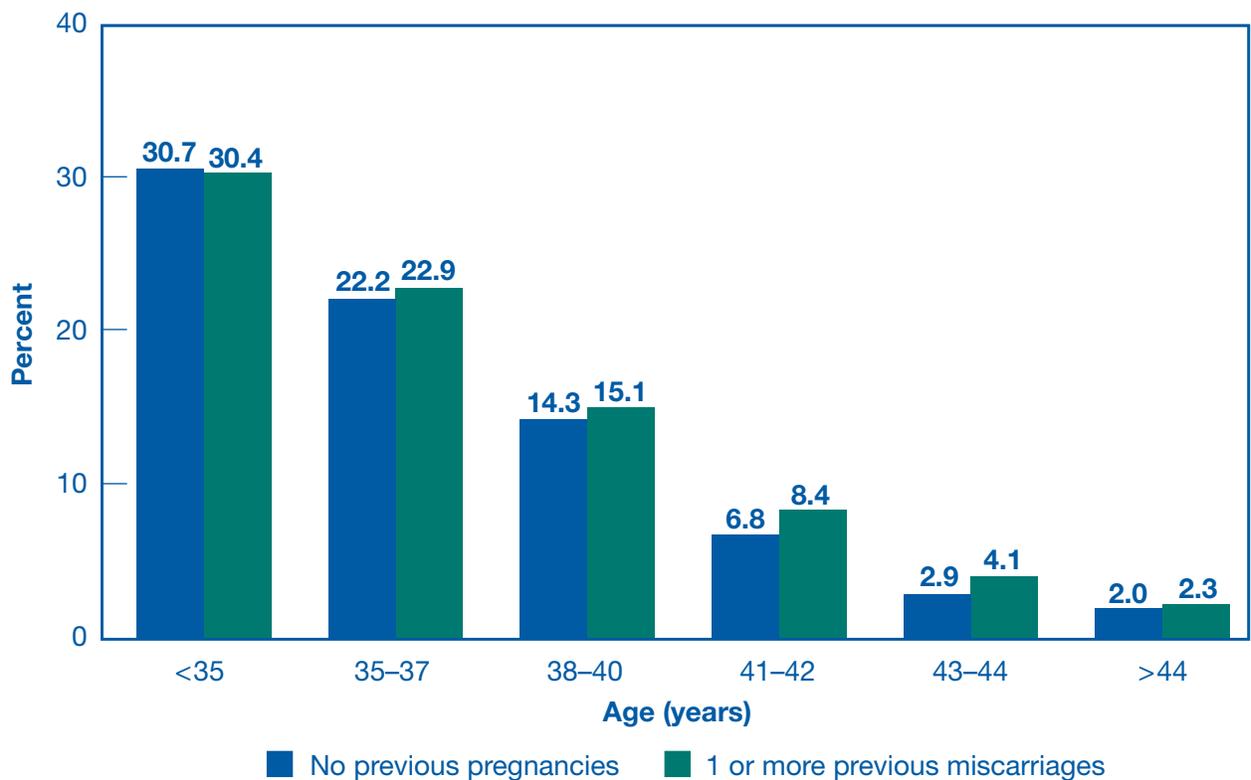
How did previous miscarriage impact ART live-birth outcomes among women with no previous births?

Among women younger than age 35, the percentage of ART cycles using fresh embryos from fresh nondonor eggs that resulted in live births was slightly lower with one or more previous miscarriages compared with never pregnant (Figure 22). Previous pregnancies ending in miscarriage could have been conceived naturally or through ART. Among women aged 35 or older, the percentage of ART cycles that

resulted in live births was higher with one or more previous miscarriages compared with never pregnant. In 2016, a total of 55,974 ART cycles using fresh embryos from fresh nondonor eggs were performed among women who had not previously given birth. However, about 25% of those cycles were reported by women with one or more previous pregnancies that resulted in miscarriage.

Figure 22

Percentages of ART Cycles Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Live Births, by Age Group and History of Miscarriage, Among Women with No Previous Births,* 2016



* Women reporting only previous ectopic pregnancies or pregnancies that ended in induced abortion are not included.

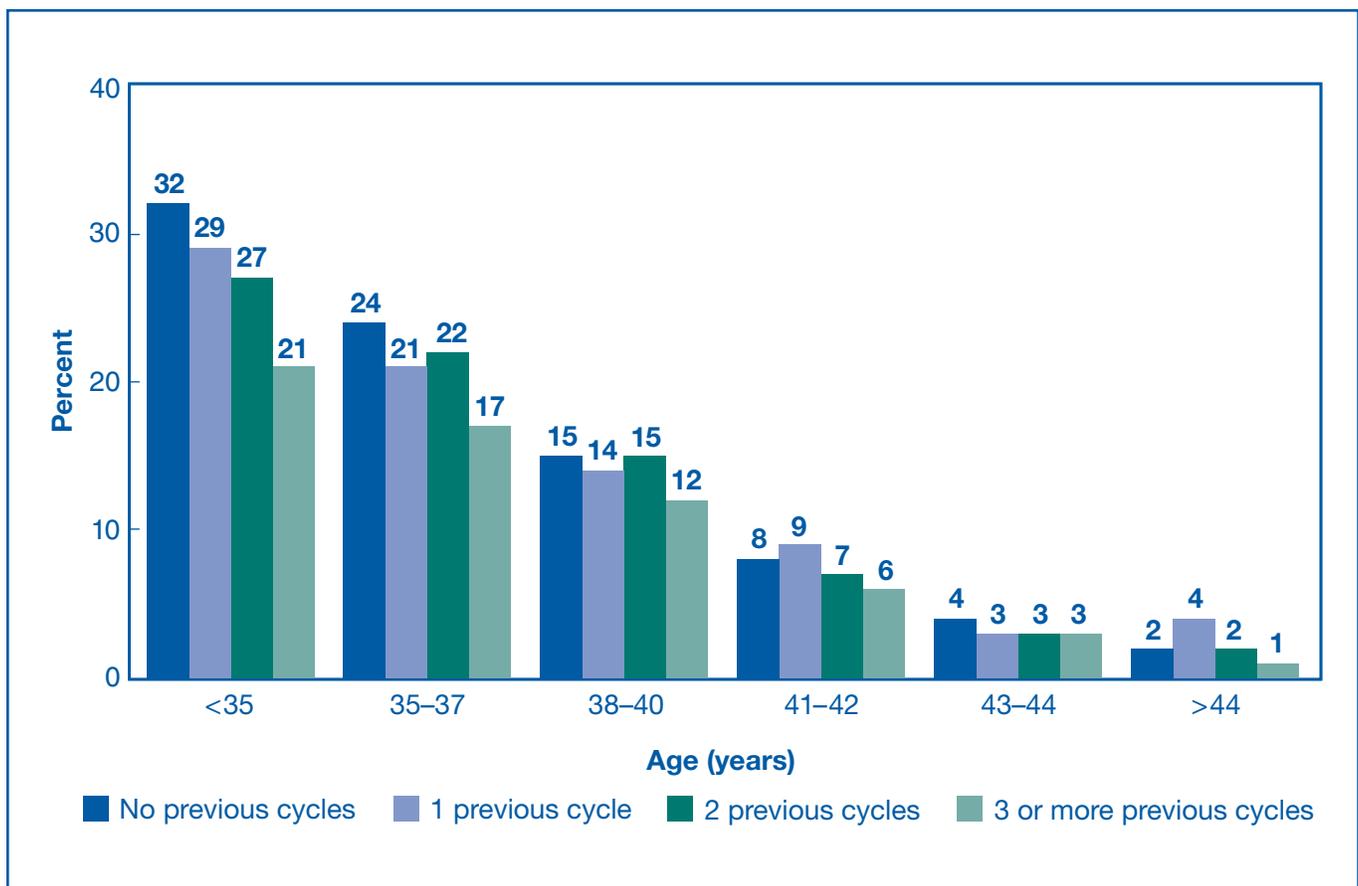
How did previous unsuccessful ART use impact ART live-birth outcomes among women with no previous births?

Among women with no previous births, in most age groups, the percentage of ART cycles using fresh embryos from fresh nondonor eggs that resulted in live births was lower with two or more previous unsuccessful ART cycles compared with no previous ART cycles (Figure 23). Among women younger than age 35, the percentage

of ART cycles resulting in live births decreased as the number of previous unsuccessful ART cycles increased. For about 38% of fresh nondonor ART cycles performed in 2016, one or more previous ART cycles were reported (this percentage includes previous ART cycles using either fresh or frozen embryos).

Figure 23

Percentages of ART Cycles Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Live Births, by Age Group and Number of Previous ART Cycles, Among Women with No Previous Live Births, 2016

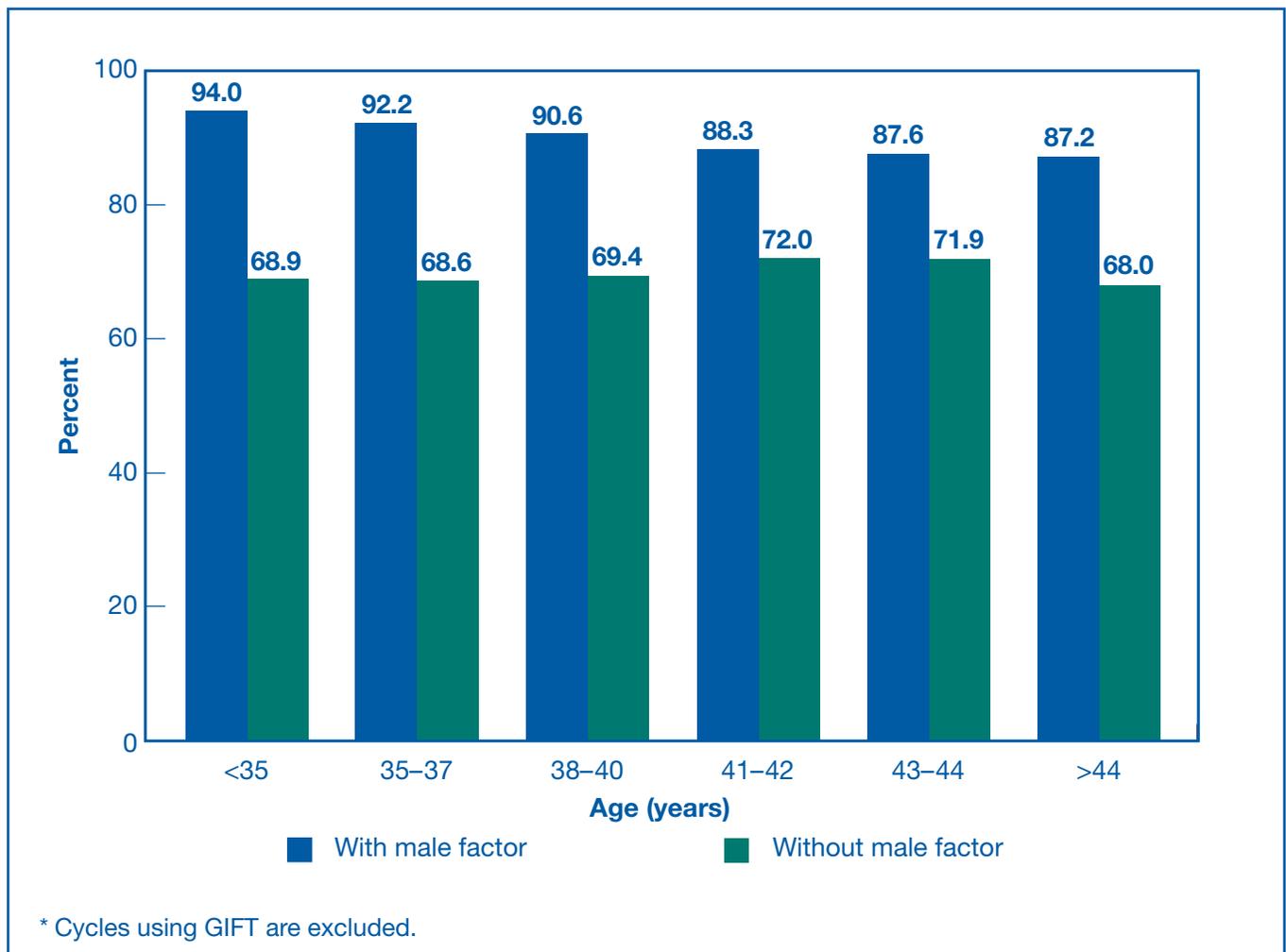


Did the use of ICSI differ by age group or by male factor infertility diagnosis?

The percentage of retrievals using intracytoplasmic sperm injection (ICSI) among patients without male factor infertility ranged from 68% to 72% among all patient age groups (Figure 24). ICSI was developed to overcome problems with fertilization that sometimes occur with a diagnosis of male factor infertility. The use of ICSI

among patients with a diagnosis of male factor infertility was high among all patient age groups, ranging from 87% to 94%. In all age groups, the percentage of fresh nondonor retrievals that used ICSI was lower for patients with no diagnosis of male factor infertility than among patients with a male factor diagnosis.

Figure 24
Percentages of Fresh Nondonor Retrievals That Used ICSI,* 2016



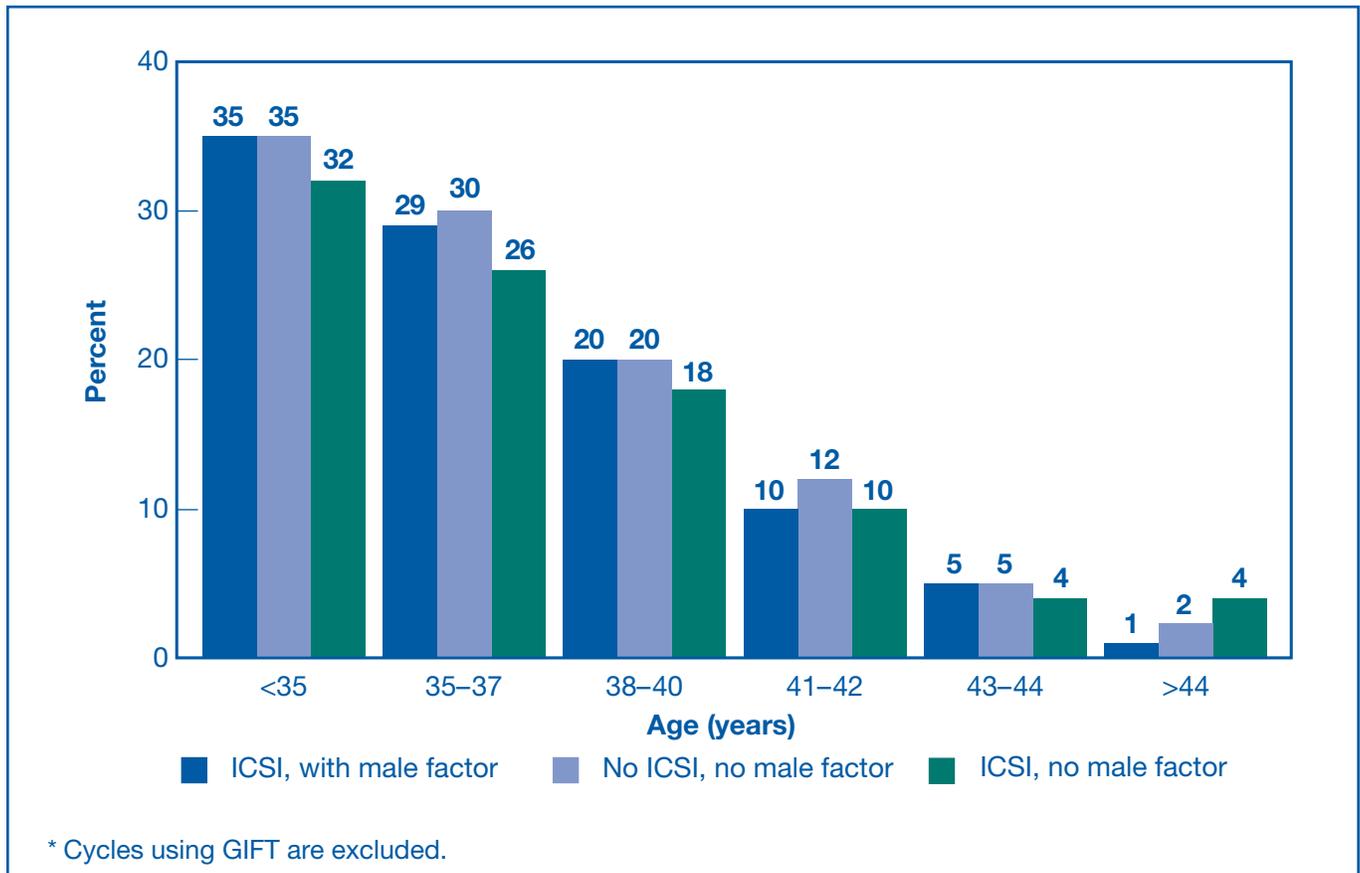
How did ICSI use and male factor infertility impact live-birth outcomes?

Among most age groups, percentages of retrievals that resulted in live births were higher when ICSI was used with a diagnosis of male factor infertility than when ICSI was used without a diagnosis of male factor infertility (Figure 25).

Among patients aged 44 or younger without male factor infertility, percentages of retrievals resulting in live births were lower for those using ICSI compared with those not using ICSI.

Figure 25

Percentages of Fresh Nondonor Retrievals That Resulted in Live Births Among Patients with or Without Diagnosed Male Factor Infertility, by Age Group and Use of ICSI,* 2016



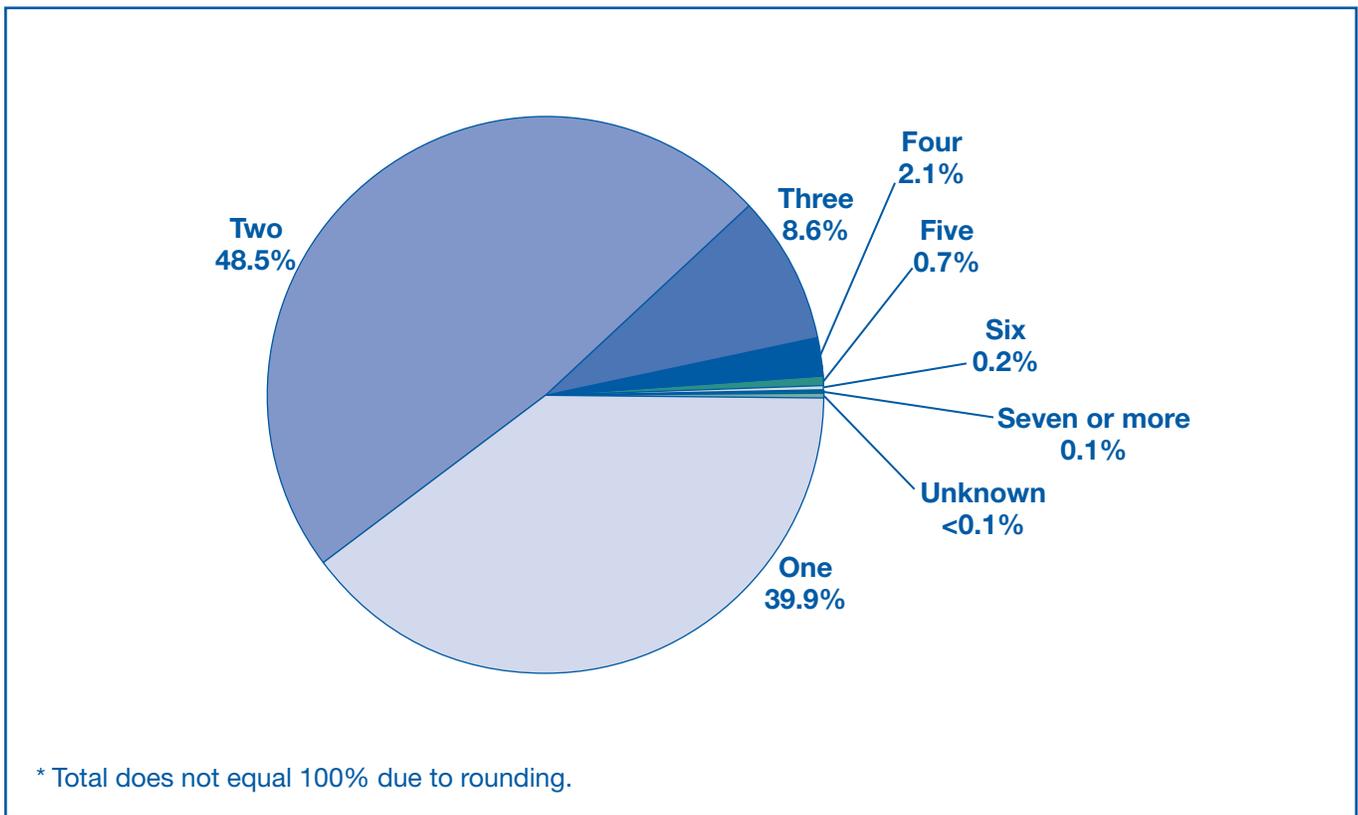
How many embryos were typically transferred in an ART procedure?

Figure 26 shows that in 2016, the majority (88%) of ART cycles that used fresh embryos from fresh nondonor eggs and progressed to the embryo transfer stage involved the transfer of one or

two embryos. About 9% involved the transfer of three embryos, 2% involved the transfer of four embryos, and 1% involved the transfer of five or more embryos.

Figure 26

Numbers of Embryos Transferred Among All Transfers Using Fresh Embryos from Fresh Nondonor Eggs,* 2016



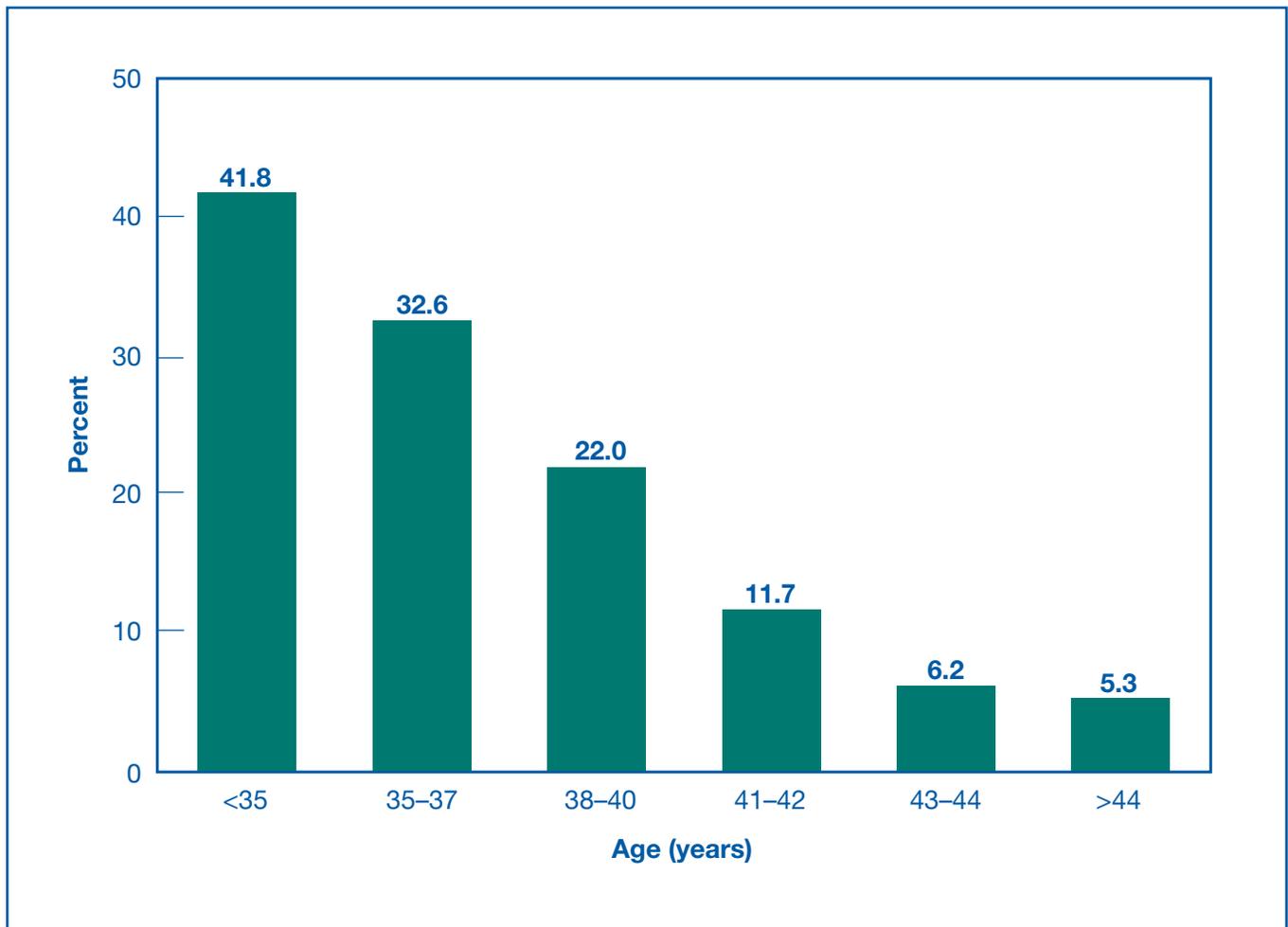
Did the implantation rate differ by a woman's age?

The percentage of transferred fresh embryos from fresh nondonor eggs that implanted decreased as the age of the woman increased (Figure 27). In 2016, the percentage of transferred fresh embryos from fresh nondonor eggs that resulted

in implantation was highest (approximately 42%) among women younger than age 35. The implantation percentage was lowest (about 5%) among women older than age 44.

Figure 27

Percentages of Embryos Transferred That Implanted Using Fresh Embryos from Fresh Nondonor Eggs, by Age Group, 2016



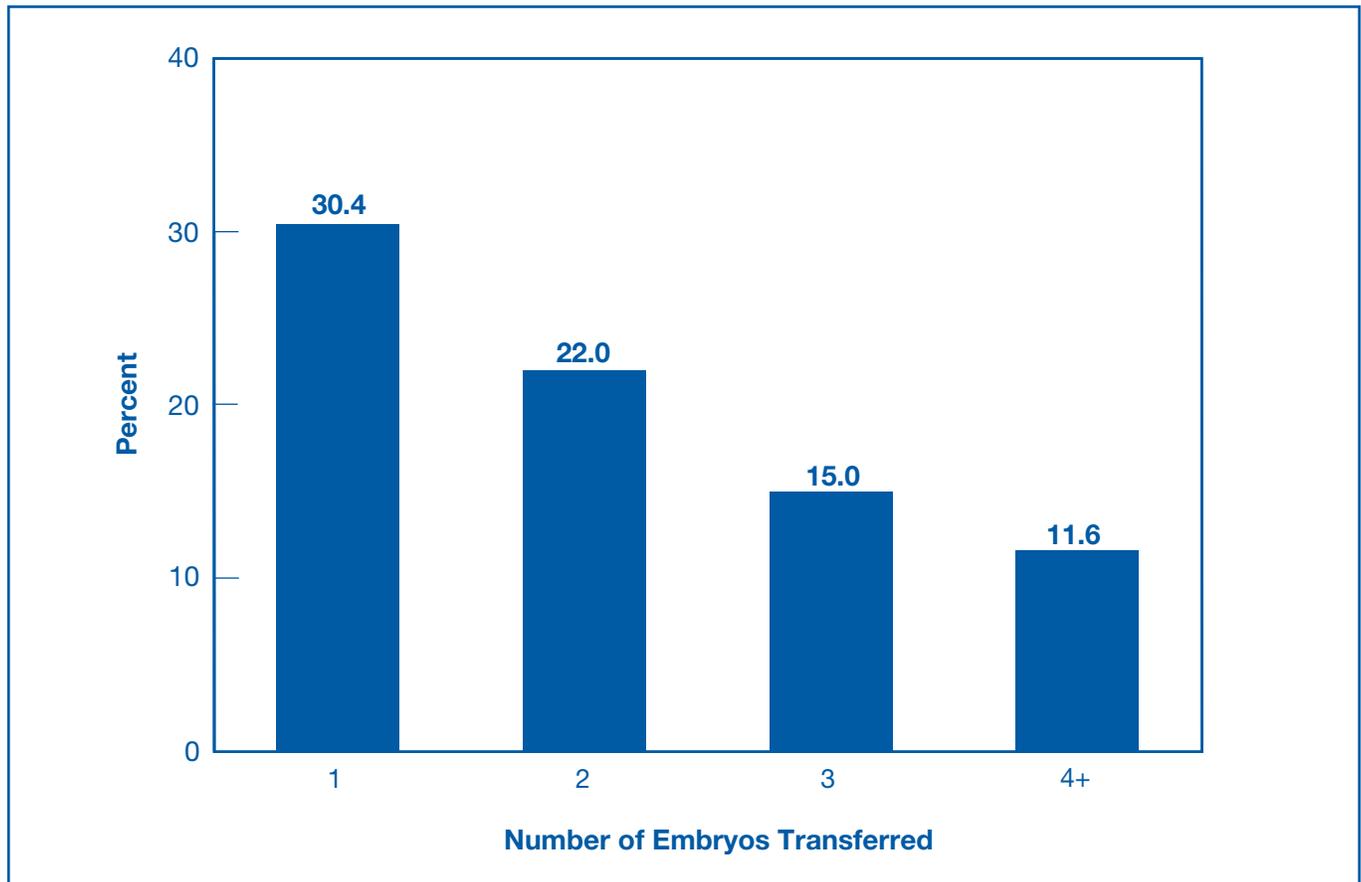
Did the number of embryos transferred impact the percentage of single, term, and normal birth weight infants born?

The percentage of transfers of fresh embryos from fresh nondonor eggs in 2016 resulting in the live birth of a single, term, and normal birth weight infant decreased as the number of embryos transferred increased (Figure 28). An infant is defined as term if born at 37 or more full weeks of pregnancy and as normal birth weight if at least 2,500 grams (about 5 pounds, 8 ounces). The percentage of transfers resulting in the live birth of a single, term, and normal birth weight

infant decreased from approximately 30% among cycles that involved the transfer of one embryo to 12% among cycles that involved the transfer of four or more embryos. Transferring more embryos increases the percentage of multiple-fetus pregnancies. Multiple-fetus pregnancies are associated with increased risk of poor outcomes for mothers and infants, including higher rates of prematurity, low birth weight, and pregnancy complications.

Figure 28

Percentages of Transfers Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Live Births of Single, Term, and Normal Birth Weight Infants, by Number of Embryos Transferred, 2016



Was the percentage of multiple-infant births higher if more embryos were transferred?

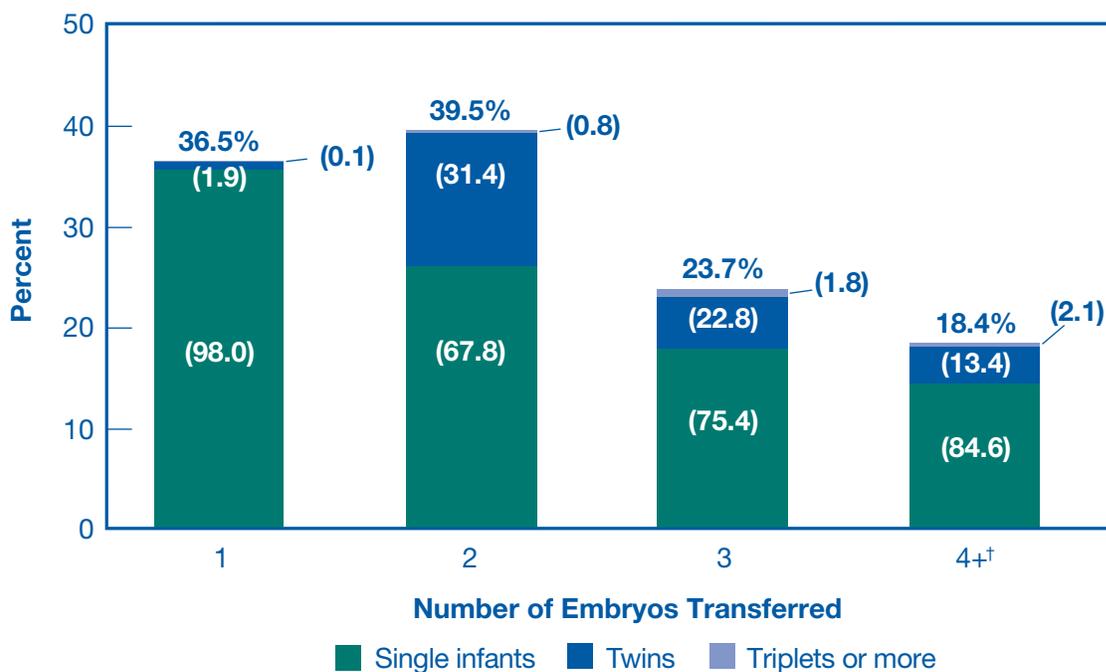
Among transfers of fresh embryos from fresh nondonor eggs, the percentage of multiple-infant births was lowest if one embryo was transferred, highest if two embryos were transferred, and otherwise decreased as more embryos were transferred (Figure 29). In 2016, the percentage of transfers that resulted in live births was highest (40%) when two embryos were transferred; however, the percentage of live births that were multiple-infant births also was highest (32%). Note that in rare cases a single embryo may divide and thus produce multiple-infant births. For this reason, small percentages of twins and triplets or more

resulted from a single embryo transfer, and a small percentage of triplets or more resulted when two embryos were transferred.

The relationship between the number of embryos transferred, the percentage of transfers resulting in live births, and the percentage of multiple-infant births is influenced by several factors, such as the woman's age and day of embryo transfer. See Figures 30 and 34 (pages 36 and 40) for more details on cycles with a higher percentage of transfers resulting in multiple-infant births.

Figure 29

Percentages of Transfers Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Live Births and Distribution of Number of Infants Born, by Number of Embryos Transferred,* 2016



* Percentages of transfers resulting in live births are shown on top of each bar graph. Percentages of live births that were single infants, twins, and triplets or more are in parentheses.

† Total does not equal 100% due to rounding.

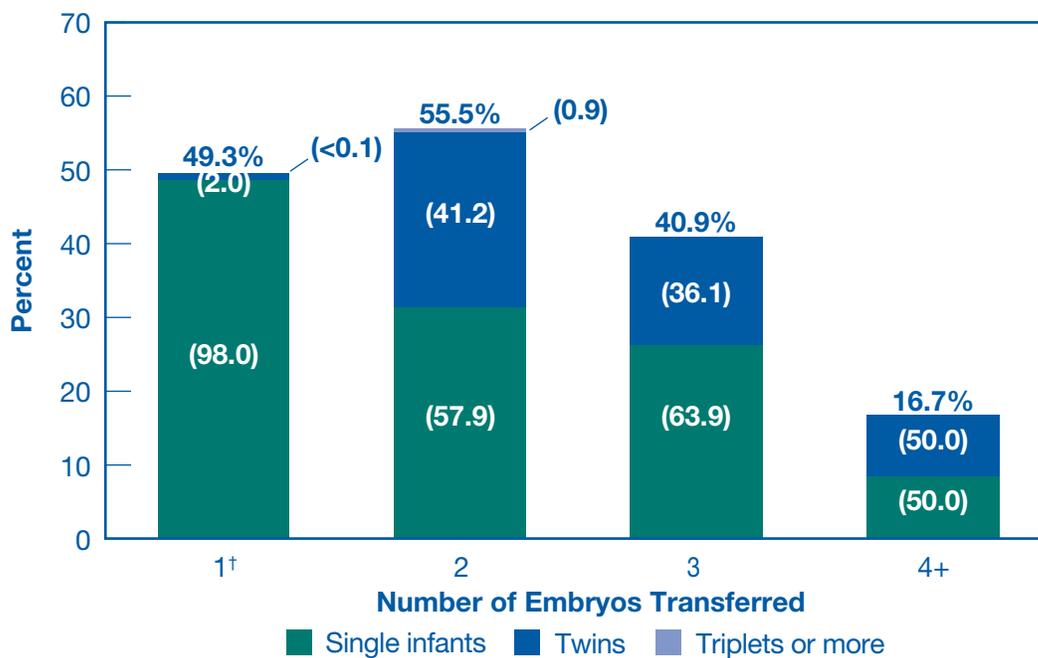
Was the percentage of live births higher if more embryos were transferred for good-prognosis women?

In 2016, among good-prognosis women, the percentage of transfers of fresh embryos from fresh nondonor eggs that resulted in live births was highest (56%) when two embryos were transferred; however, among transfers that resulted in live births, the percentage of single-infant live births was highest with the transfer of one embryo (98%) (Figure 30). Good-prognosis women are defined here as younger than age 35 with extra embryos available to set aside by choice for future cycles.

Note that in rare cases a single embryo may divide and thus produce multiple-infant births. For this reason, small percentages of twins and triplets or more resulted from a single embryo transfer, and a small percentage of triplets or more resulted when two embryos were transferred.

Figure 30

Percentages of Transfers Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Live Births and Distribution of Number of Infants Born Among Good-Prognosis Women, by Number of Embryos Transferred,* 2016



* Percentages of transfers resulting in live births are shown on top of each bar graph. Percentages of live births that were single infants, twins, and triplets or more are in parentheses.

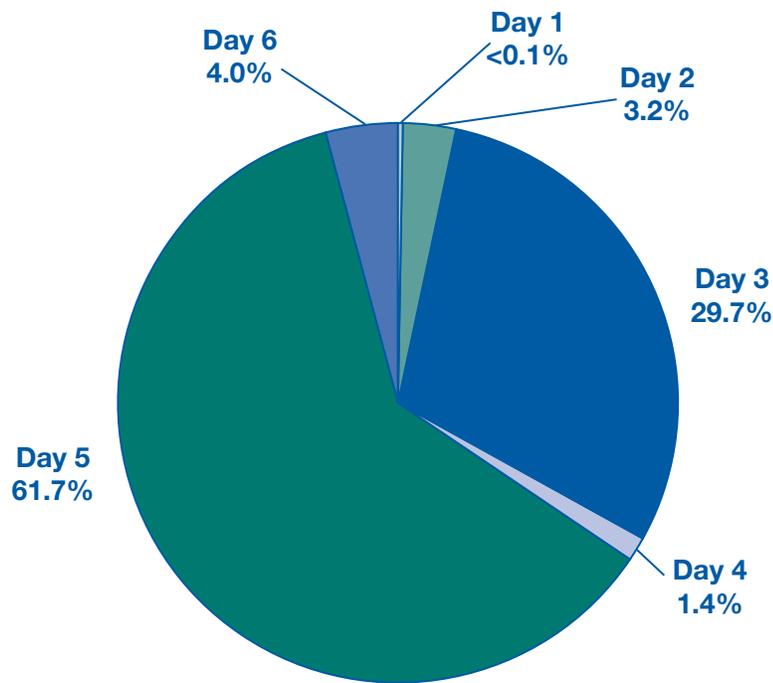
† Total does not equal 100% due to rounding.

How long after egg retrieval did embryo transfer occur?

Once an ART cycle has progressed from egg retrieval to fertilization, the embryo(s) can be transferred into the woman’s uterus anytime in the next 1 to 6 days. As seen in Figure 31, transfers 3 days after retrieval (a day 3 transfer) and transfers

5 days after retrieval (a day 5 transfer) were the most common (30% and 62%, respectively) among those embryos that progressed to the embryo transfer stage.

Figure 31
Day of Embryo Transfer* Among Transfers Using Fresh Embryos from Fresh Nondonor Eggs,^{†‡} 2016



* Number of days following egg retrieval.

† Cycles using GIFT or ZIFT are excluded. Missing or implausible values for day of embryo transfer (that is, 0 or greater than 6) are not included.

‡ Total does not equal 100% due to rounding.

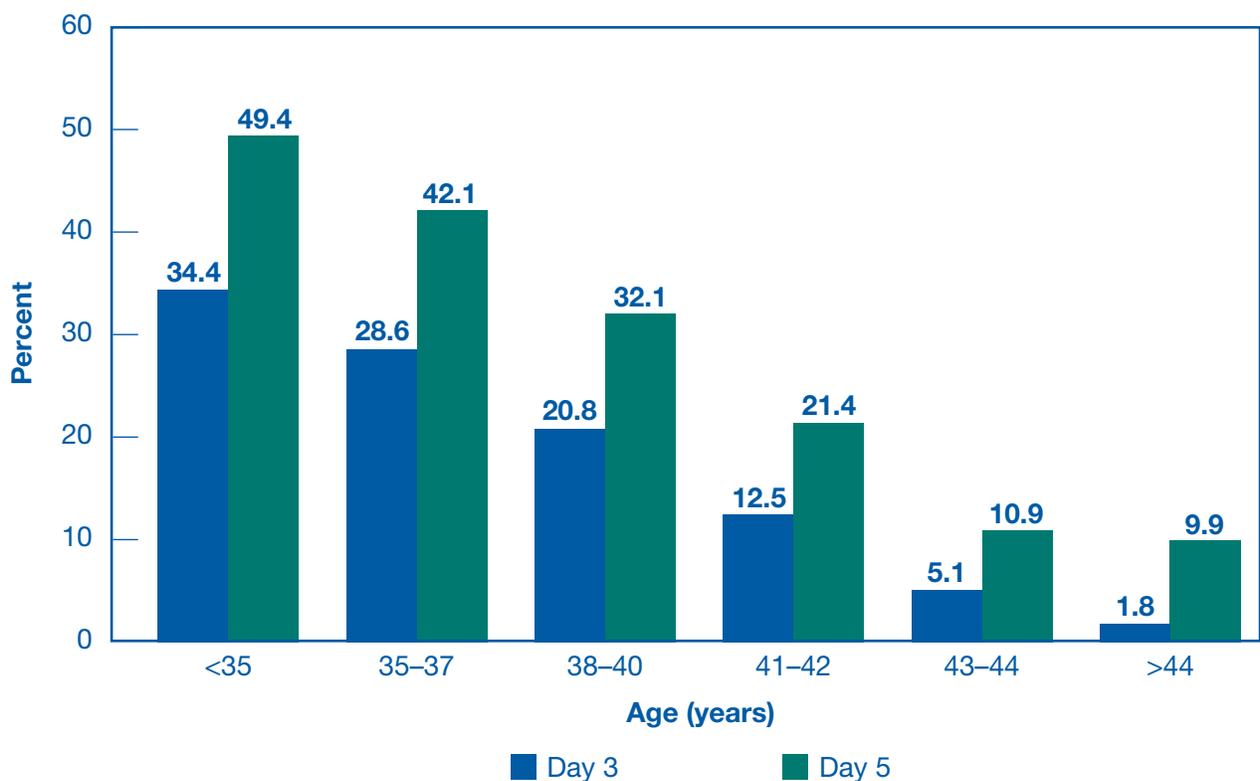
Was the percentage of live births higher for day 3 or day 5 transfers?

In 2016, for all age groups, live-birth percentages were higher for day 5 embryo transfers using fresh embryos from fresh nondonor eggs than for day 3 transfers, although percentages resulting in live births decreased with increasing age for both day 3 and day 5 transfers (Figure 32). As shown in Figure 31 (page 37), the vast majority

(approximately 91%) of ART fresh nondonor embryo transfers were performed on day 3 or day 5. While day 5 transfers have higher live-birth percentages, not all embryos will survive until day 5 and thus, a day 5 transfer may not be an option for all embryos.

Figure 32

Percentages of Day 3 and Day 5 Embryo Transfers Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Live Births, by Age Group,* 2016



* Cycles using GIFT or ZIFT are excluded. Embryo transfers performed on days 1, 2, 4, and 6 are not included because each of these accounted for a small proportion of procedures.

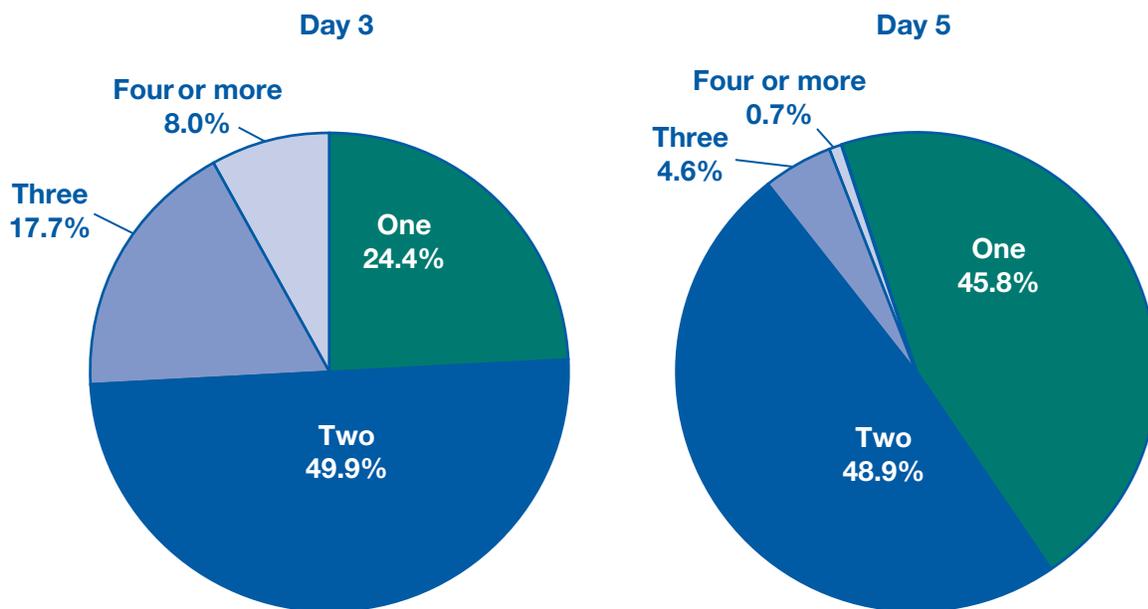
Did the number of embryos transferred differ for day 3 and day 5 transfers?

The percentage of transfers using fresh embryos from fresh nondonor eggs that involved one embryo was higher on day 5 than on day 3 (Figure 33). About 54% of day 5 transfers and 76% of day 3 transfers involved two or more embryos.

Transferring fewer numbers of embryos on day 5, however, did not translate into a lower percentage of multiple-infant births. See Figure 34 (page 40) for more details on the relationship between the day of transfer and multiple-infant births.

Figure 33

Numbers of Embryos Transferred on Day 3 and Day 5 Among Transfers Using Fresh Embryos from Fresh Nondonor Eggs,* 2016



* Cycles using GIFT or ZIFT are excluded. Embryo transfers performed on days 1, 2, 4, and 6 are not included because each of these accounted for a small proportion of procedures.

Did the percentage of multiple-infant births differ for day 3 and day 5 transfers?

The percentage of multiple-infant births was higher for day 5 transfers using fresh embryos from fresh nondonor eggs than for day 3 transfers (Figure 34). Part A of Figure 34 shows that among the 3,615 live births that occurred following the transfer of day 3 fresh embryos from fresh nondonor eggs, about 81% were single infants, and approximately 19% involved the birth of more than one infant (18% twins, and 1% triplets or more).

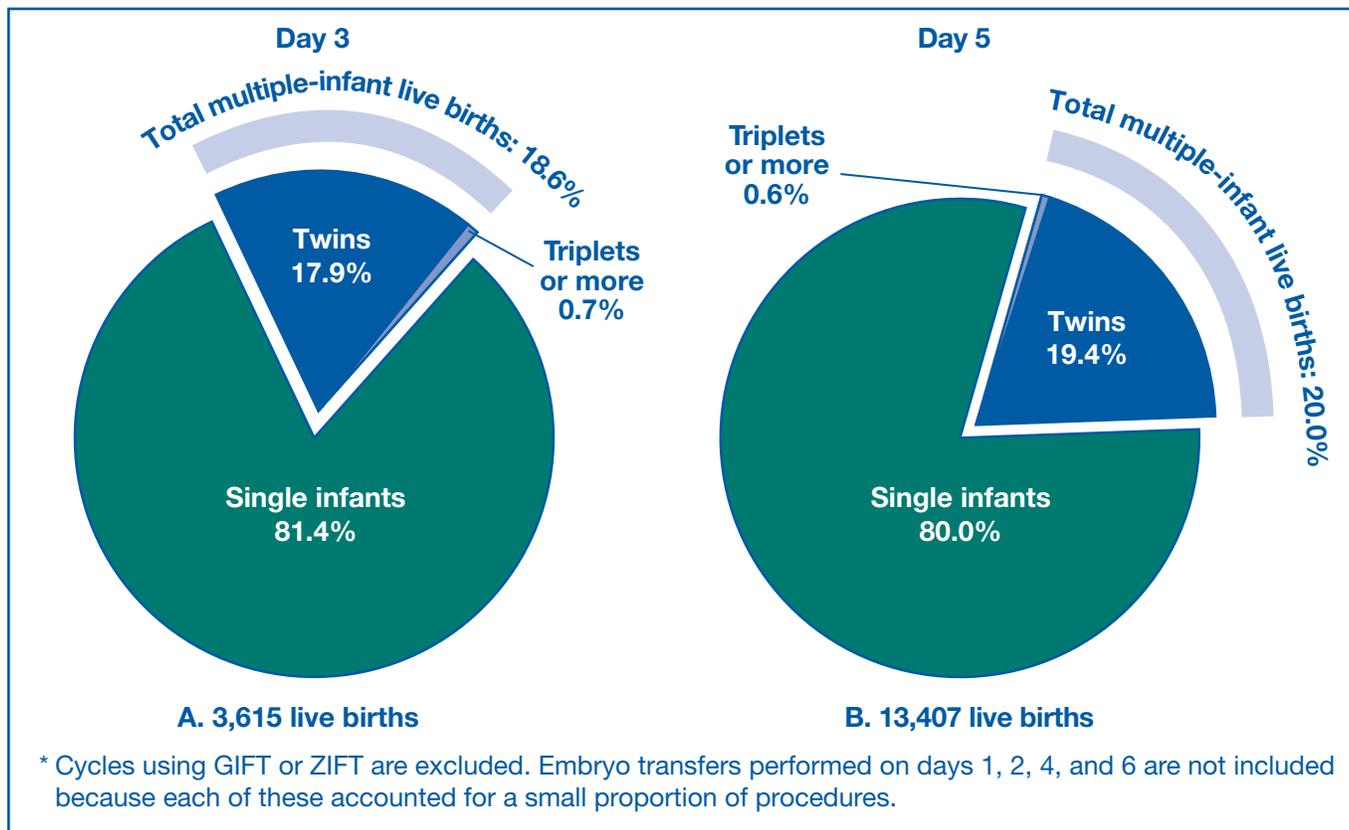
In 2016, a total of 13,407 live births occurred following the transfer of day 5 fresh embryos from

fresh nondonor eggs. Part B of Figure 34 shows that 20% of these live births involved the birth of more than one infant (19% twins and 1% triplets or more).

As shown in Figure 33 (page 39), fewer embryos were transferred on day 5 than on day 3, although the majority of day 5 transfers still involved the transfer of more than one embryo. The proportion of live births resulting in twins was higher among transfers performed on day 5 than on day 3. Thus, having a multiple-infant birth was more likely for day 5 embryo transfers.

Figure 34

Distribution of Number of Infants Born Among Day 3 and Day 5 Embryo Transfers Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Live Births,* 2016



Was the percentage of day 5 transfers that resulted in live births affected by the number of embryos transferred for good-prognosis women?

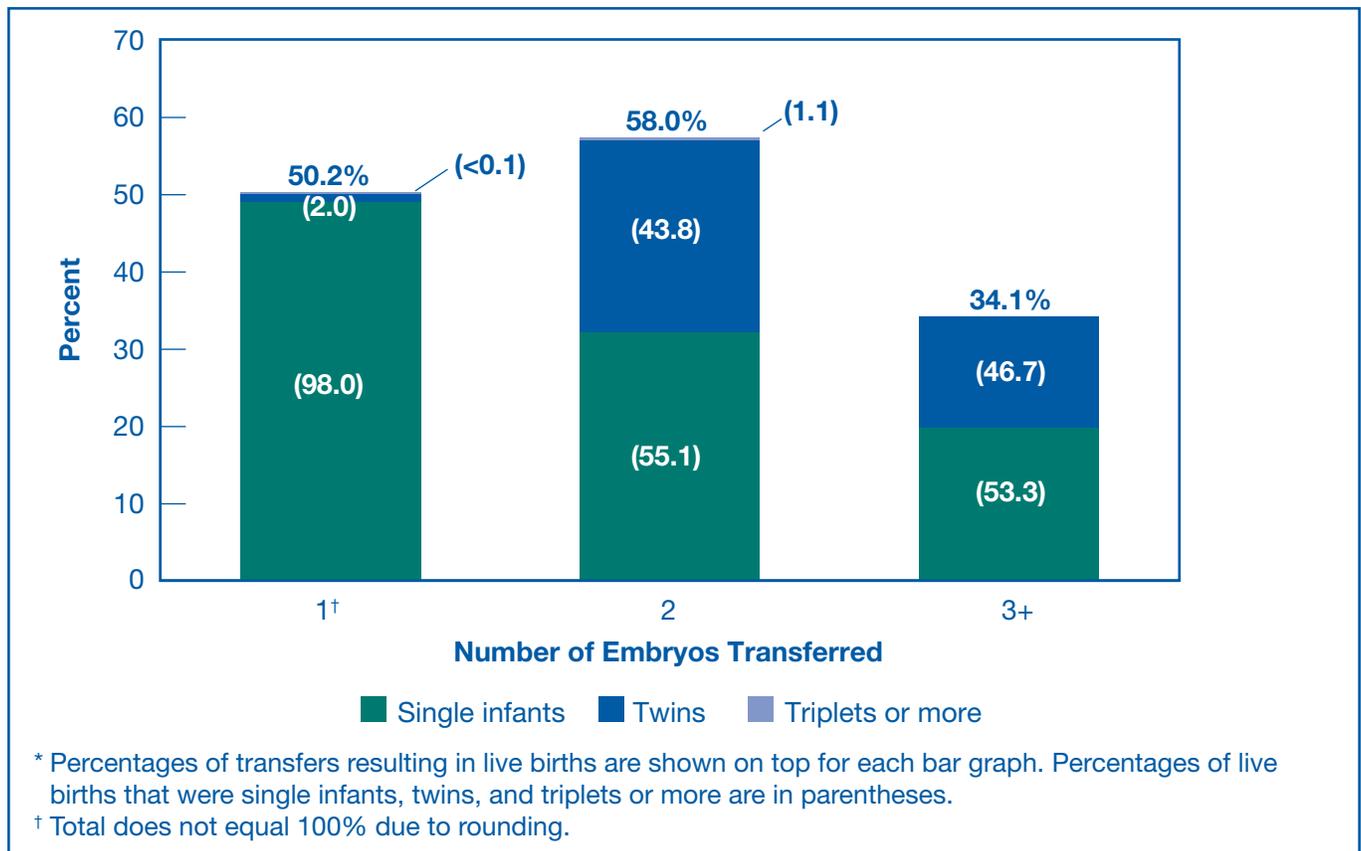
The percentage of day 5 transfers using fresh embryos from fresh nondonor eggs resulting in live births was highest when two embryos were transferred among good-prognosis women (Figure 35). Good-prognosis women are defined here as women younger than age 35 with extra embryos set aside for future cycles.

In 2016, the percentage of day 5 transfers resulting in live births when two embryos were transferred was 58%; however, of these, the

proportion of live births that were multiples (twins or more) was about 45%. The day 5 transfer of a single embryo resulted in the highest proportion of single-infant births (98%). Note that in rare cases a single embryo may divide and thus produce multiple-infant births. For this reason, small percentages of twins and triplets or more resulted from a single embryo transfer, and a small percentage of triplets or more resulted when two embryos were transferred.

Figure 35

Percentages of Day 5 Transfers Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Live Births and Distribution of Number of Infants Born Among Good-Prognosis Women, by Number of Embryos Transferred,* 2016



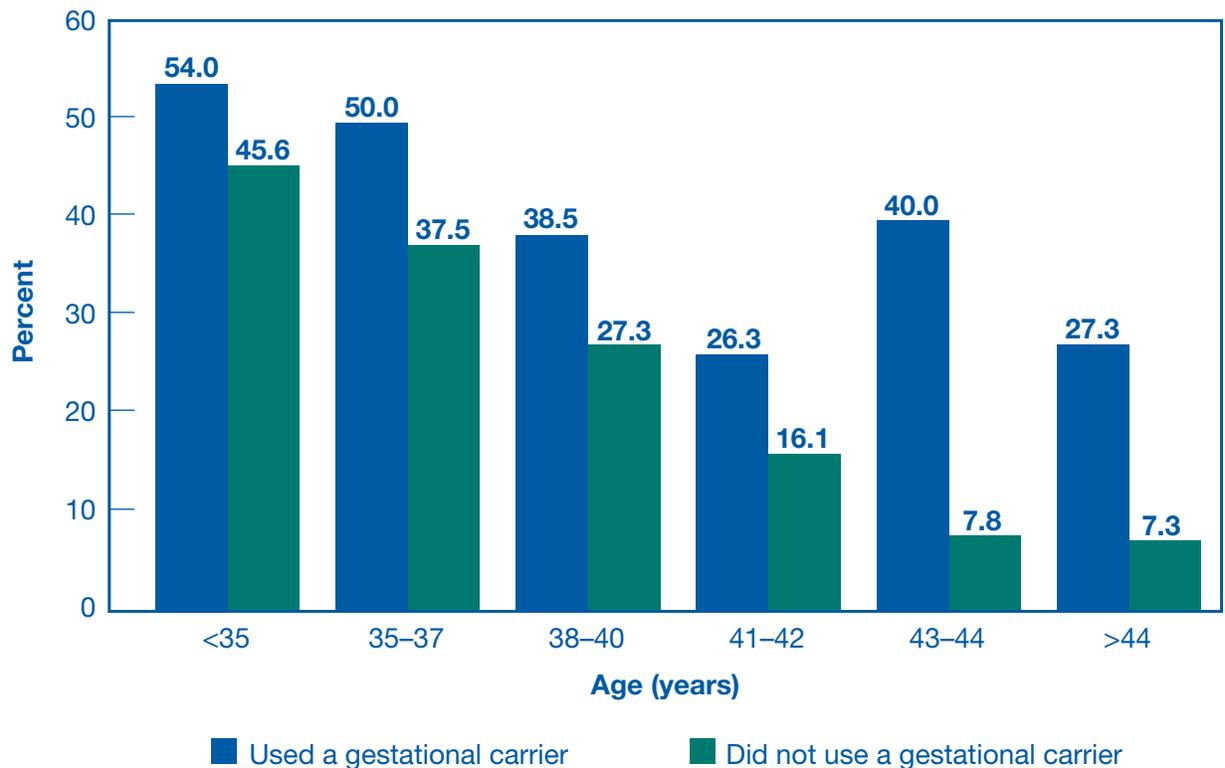
Did the percentage of transfers that resulted in live births differ by gestational carrier use?

Among all age groups the percentage of transfers using fresh embryos from fresh nondonor eggs that resulted in live births was higher for those using gestational carriers than for those that did not use a gestational carrier (Figure 36). A gestational carrier or gestational surrogate is a woman who agrees to carry a developing embryo created from another woman's egg for others. In 2016, gestational carriers were used

in about 1% of cycles using fresh embryos from fresh nondonor eggs. While the percentage of live births generally decreased with the patient's age with or without using a gestational carrier, percentages of live births when using a gestational carrier were about 8% to 13% higher among patients aged 42 or younger, and 20% to 32% higher among patients older than age 42.

Figure 36

Percentages of Transfers Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Live Births Among ART Cycles That Used Gestational Carriers and Those That Did Not, by Age Group,* 2016



* Age groups reflect the age of the ART patient, not the age of the gestational carrier.

SECTION 3: ART CYCLES USING FROZEN EMBRYOS FROM NONDONOR EGGS

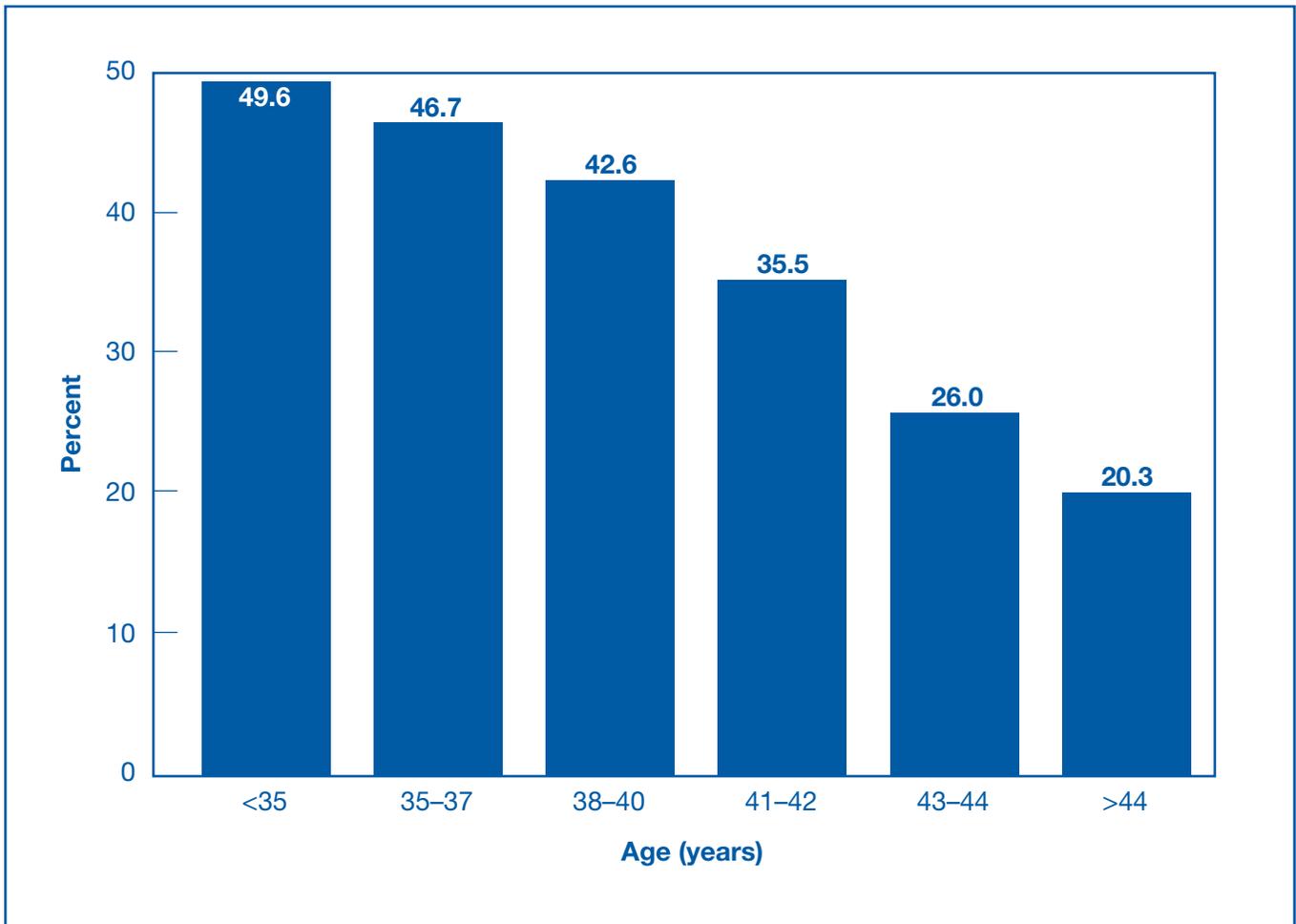
Did the implantation rate differ by a woman's age?

The percentage of transferred frozen nondonor embryos that implanted decreased with age from about 50% among women younger than age 35 to 20% among women older than age 44

(Figure 37). Note that for frozen cycles, although not shown, the age of the woman at the time of retrieval has a larger effect on implantation rates than the age of the woman at the time of transfer.

Figure 37

Percentages of Embryos Transferred That Implanted Using Frozen Embryos from Nondonor Eggs, by Age Group, 2016



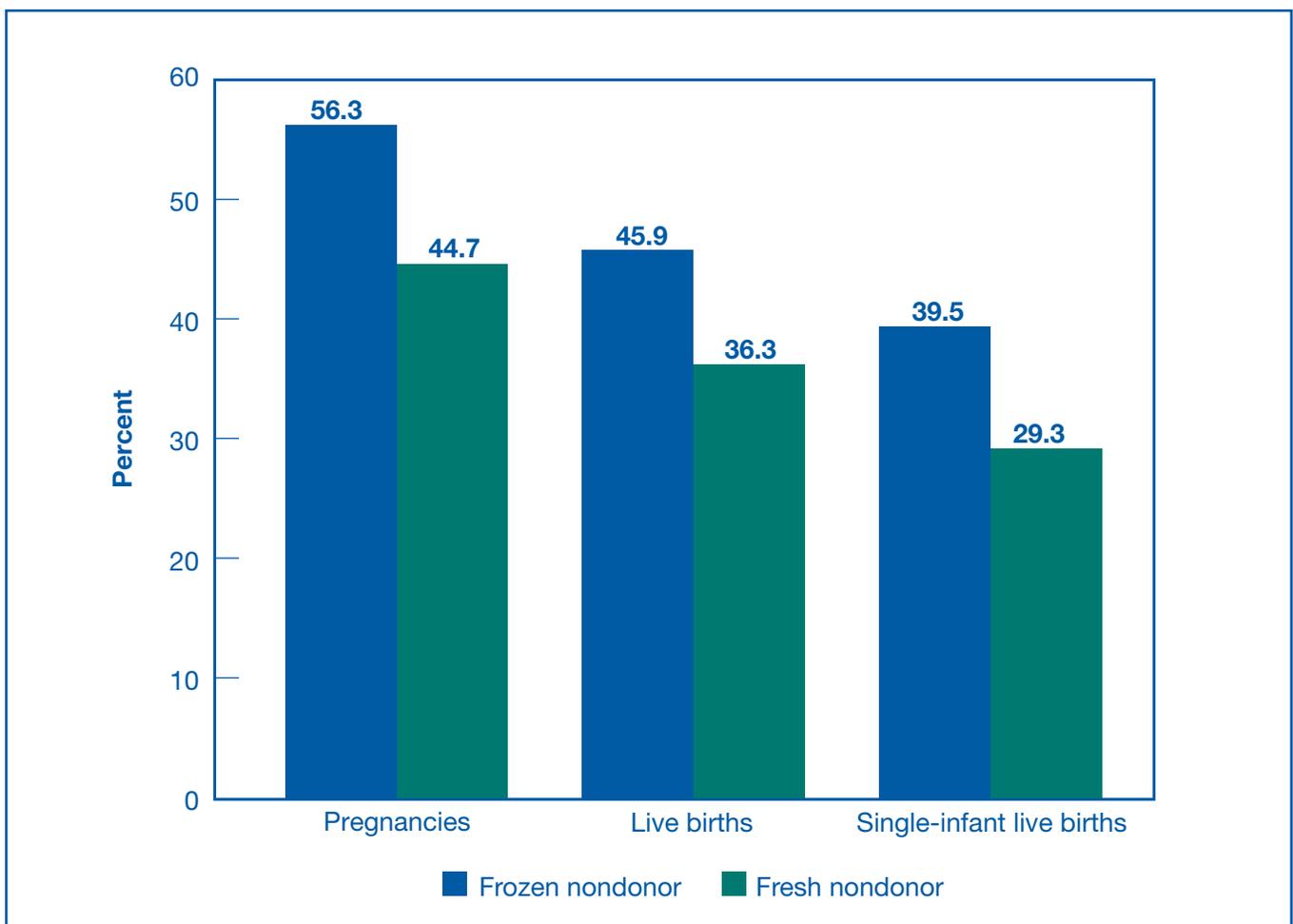
Was the percentage of transfers that resulted in pregnancies, live births, and single-infant live births higher for fresh or frozen embryos from nondonor eggs?

Figure 38 shows that percentages of transfers resulting in pregnancies, live births, and single-infant live births were higher for frozen embryos from nondonor eggs than for fresh embryos from

fresh nondonor eggs in 2016. Frozen nondonor embryos were used in 86,266 ART cycles performed in 2016.

Figure 38

Percentages of Transfers Using Frozen or Fresh Embryos from Nondonor Eggs That Resulted in Pregnancies, Live Births, and Single-Infant Live Births, 2016



What percentage of ART cycles resulted in a multiple-fetus pregnancy or multiple-infant birth?

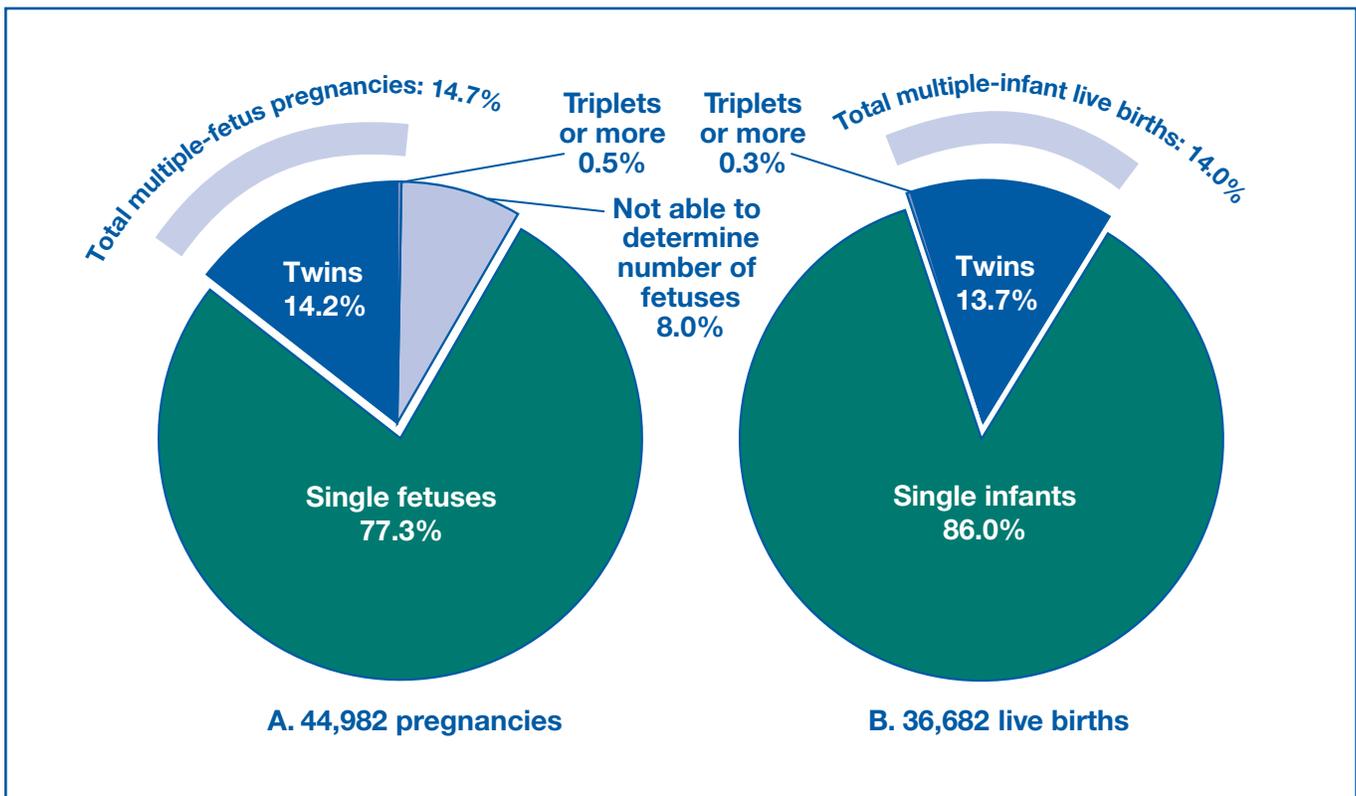
Part A of Figure 39 shows that among the 44,982 pregnancies that resulted from ART cycles using frozen embryos from nondonor eggs in 2016, 77% were single-fetus pregnancies and 15% were multiple-fetus pregnancies. The number of fetuses could not be accurately determined for 8% of pregnancies.

Of the 44,982 pregnancies that resulted from these ART cycles, 36,682 (82%) resulted in live births. Part B of Figure 39 shows that 14% of these live births resulted in more than one infant.

ART pregnancies are more likely to result in multiple-infant births (twins, triplets or more) than pregnancies resulting from natural conception because more than one embryo may be transferred. Multiple-infant births are associated with greater problems for both mothers and infants, including higher rates of caesarean section, prematurity, low birth weight, and infant disability or death.

Figure 39

Distribution of Multiple-Fetus Pregnancies and Multiple-Infant Live Births Among ART Cycles Using Frozen Embryos from Nondonor Eggs, 2016



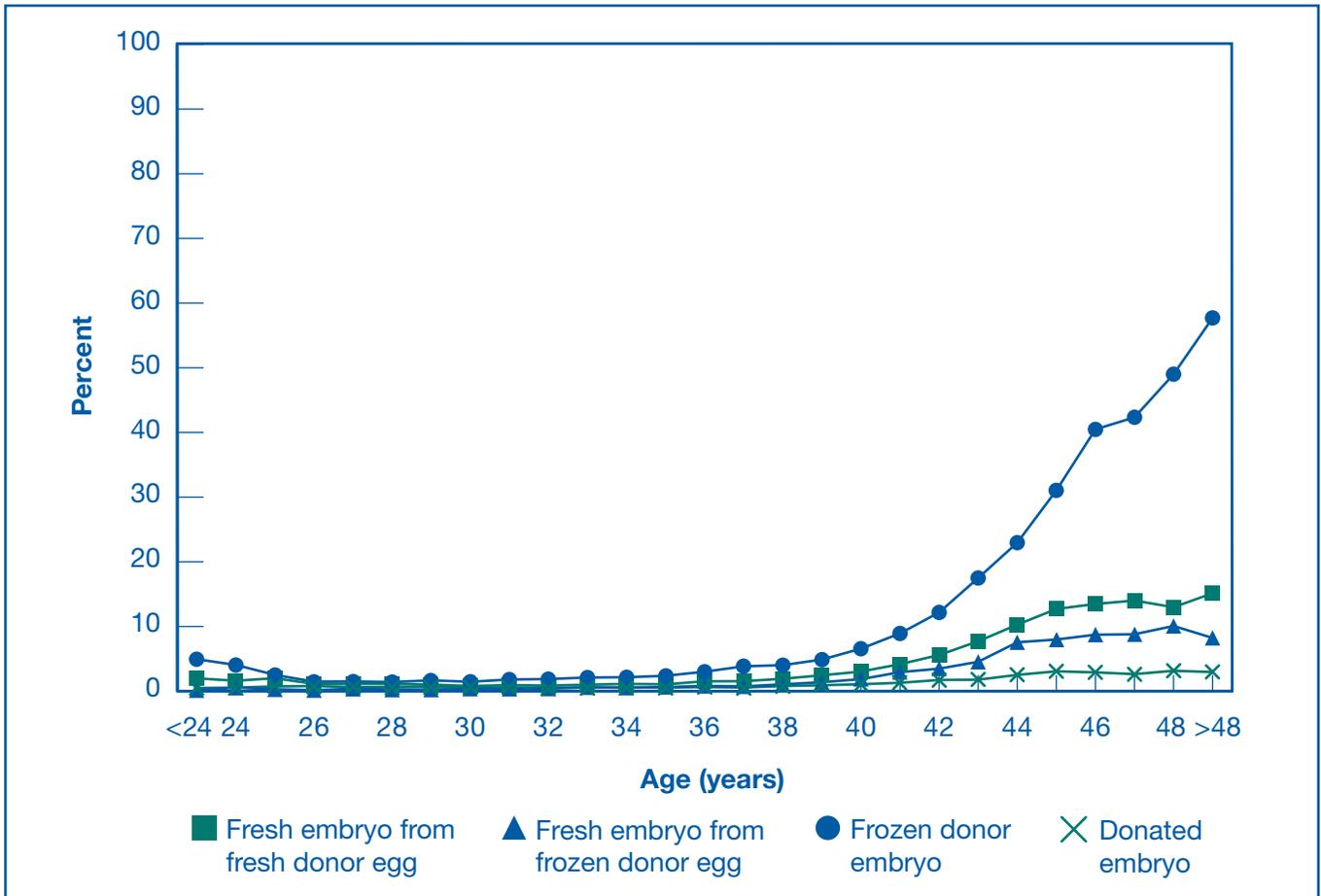
SECTION 4: ART CYCLES USING DONOR EGGS

Was the use of donor eggs higher among older patients undergoing ART?

ART using donor eggs is much more common among older patients than among younger patients (Figure 40). Donor eggs were used in 24,300 ART cycles performed in 2016, of which 1,869 used donated embryos from another patient or couple's ART treatment, 5,644 used fresh embryos created from fresh donor eggs, 3,329 used fresh embryos created from frozen

donor eggs, and 13,458 used frozen embryos created from donor eggs. The percentage of cycles performed with donor eggs increased after age 40. Among patients older than age 48, for example, approximately 68% of all ART cycles used donor eggs, of which more than two-thirds used frozen embryos created from donor eggs.

Figure 40
Percentages of ART Cycles Using Donor Eggs, by Age of Patient, 2016

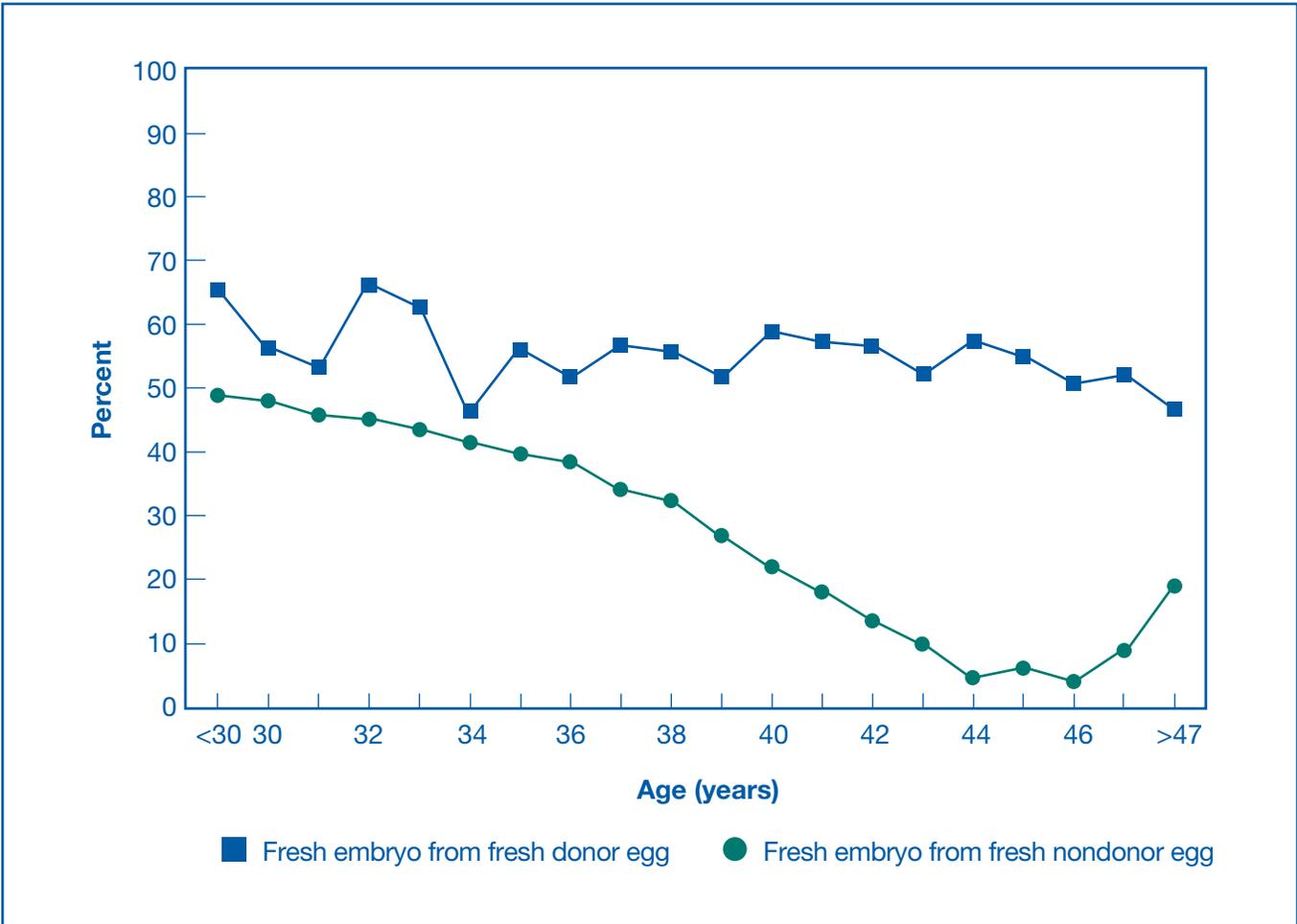


Did the percentage of ART transfers that resulted in live births differ for fresh embryos from fresh donor and fresh nondonor eggs?

The percentage of transfers using fresh embryos from fresh nondonor eggs resulting in live births generally decreased as the age of the woman increased (Figure 41). In contrast, since egg donors are typically in their 20s or early 30s, the percentage of transfers using fresh embryos from fresh donor eggs that resulted in live births

remained consistently above 50% among women of almost all ages. The likelihood of a fertilized egg implanting is related to the age of the woman who produced the egg. This figure is restricted to only female patients to isolate the relationship between female age and success rates.

Figure 41
Percentages of Transfers Using Fresh Embryos from Fresh Donor or Fresh Nondonor Eggs That Resulted in Live Births, by Age of Woman, 2016



What percentage of ART cycles resulted in a multiple-fetus pregnancy or multiple-infant birth?

Part A of Figure 42 shows that among the 2,888 pregnancies that resulted from ART cycles using fresh embryos from fresh donor eggs in 2016, about 69% were single-fetus pregnancies and 24% were multiple-fetus pregnancies. The number of fetuses could not be accurately determined for 6% of pregnancies.

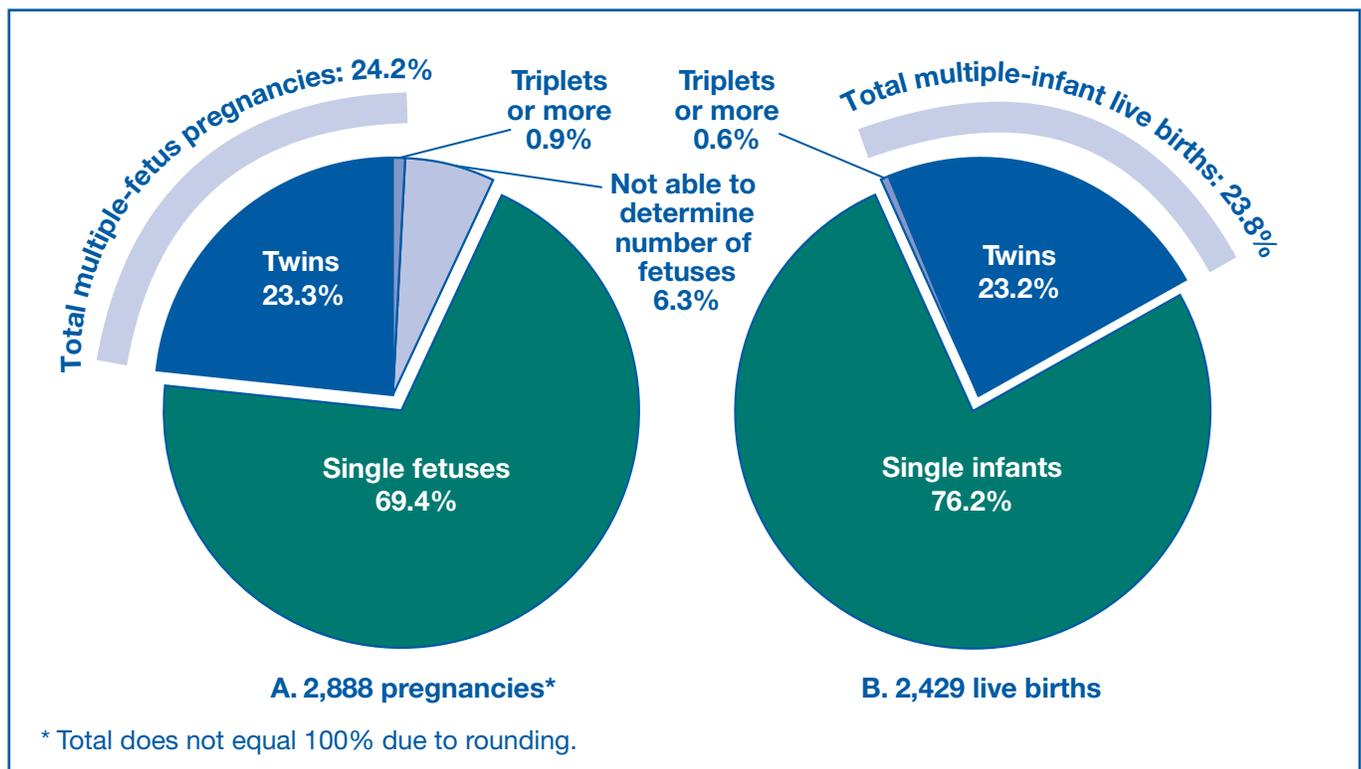
Of the 2,888 pregnancies that resulted from these ART cycles, 2,429 (84%) resulted in live births. Part B of Figure 42 shows that approximately

23% of these live births resulted in twins and less than 1% resulted in triplets or more.

ART pregnancies are more likely to result in multiple-infant births (twins, triplets or more) than pregnancies resulting from natural conception because more than one embryo may be transferred. Multiple-infant births are associated with greater problems for both mothers and infants, including higher rates of caesarean section, prematurity, low birth weight, and infant disability or death.

Figure 42

Distribution of Multiple-Fetus Pregnancies and Multiple-Infant Live Births Among ART Cycles Using Fresh Embryos from Fresh Donor Eggs, 2016



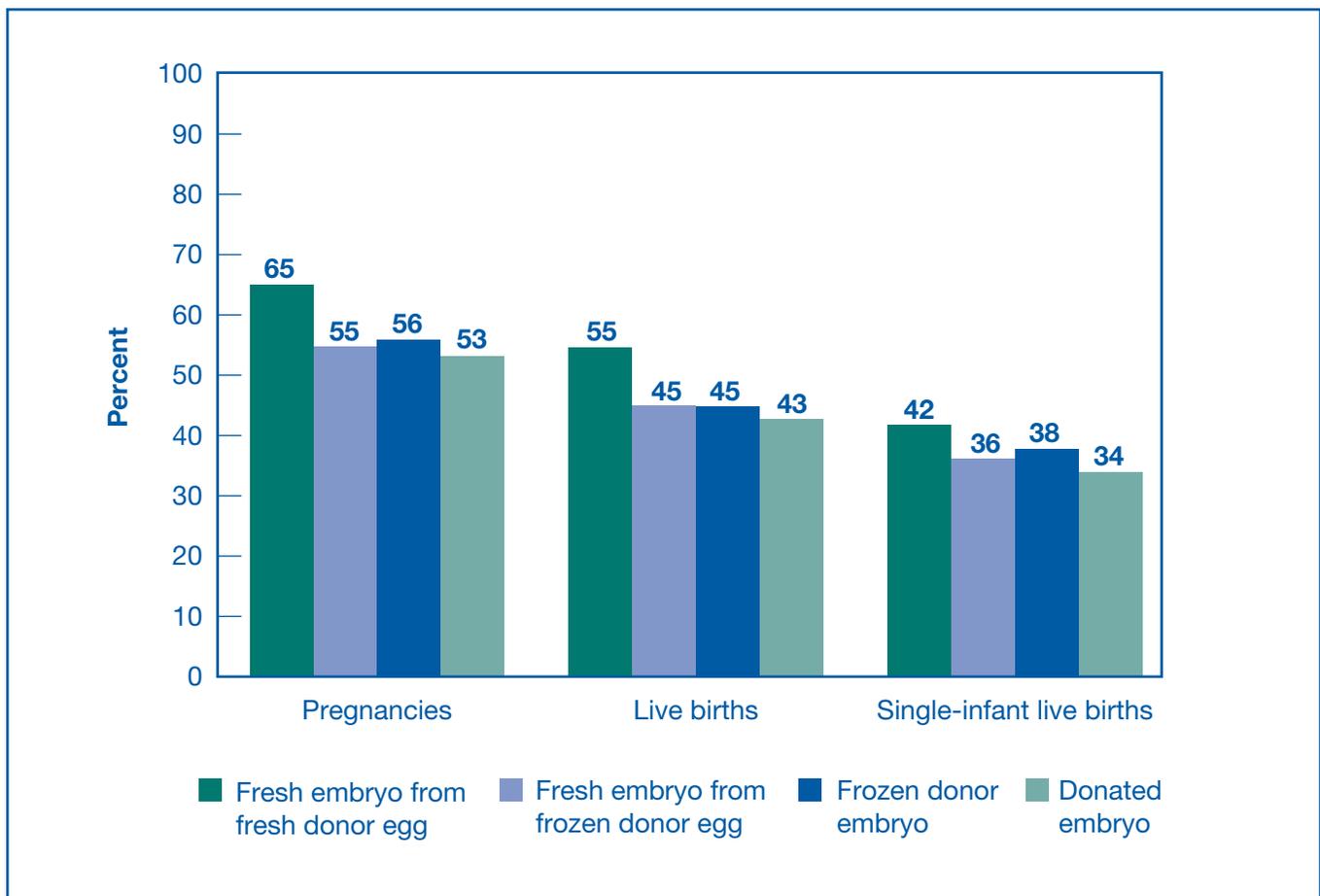
Did the percentage of transfers using donor eggs that resulted in pregnancies, live births, and single-infant live births differ by cycle type?

Figure 43 shows that in 2016, percentages of transfers resulting in pregnancies, live births, and single-infant live births were highest for transfers using fresh embryos from fresh donor eggs.

The average number of embryos transferred in 2016 was 1.7 for transfers of donated embryos, 1.5 for transfers of fresh embryos using fresh donor eggs, 1.5 for transfers of fresh embryos using frozen donor eggs, and 1.4 for transfers of frozen embryos using donor eggs.

Figure 43

Percentages of Transfers Using Donor Eggs or Embryos That Resulted in Pregnancies, Live Births, and Single-Infant Live Births, 2016



SECTION 5: ART TRENDS, 2007–2016

This report features an examination of trends for the most recent 10-year period, 2007–2016. Statistics for earlier years are available in CDC’s

previous annual publications of ART success rates and national summaries.

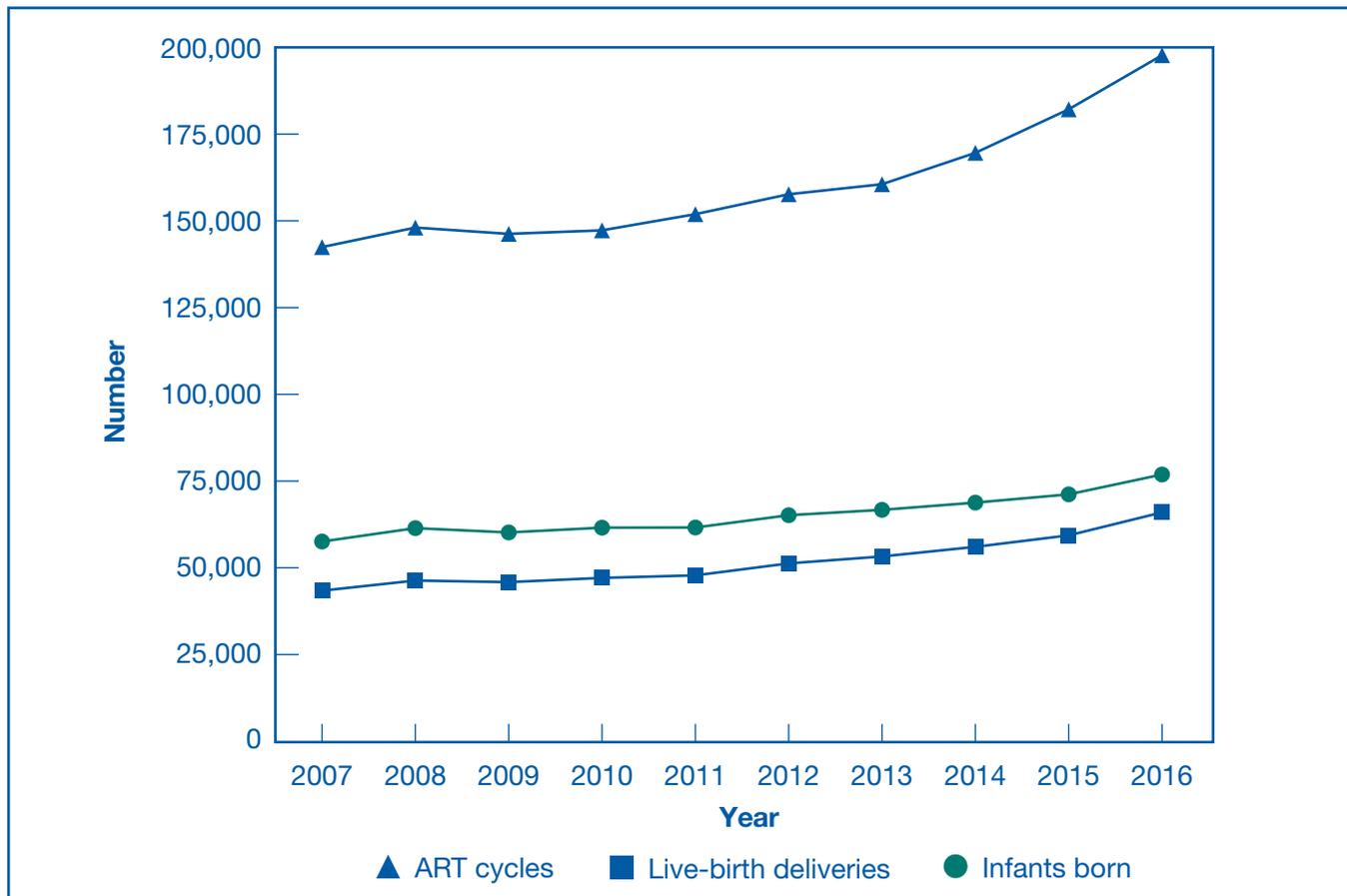
Has the use of ART increased?

Figure 44 shows that the number of ART cycles with the intent to transfer at least one embryo has increased 39%, from 142,435 cycles in 2007 to 197,737 in 2016. The number of live-birth deliveries in 2016 (65,969) was about one and a half times higher than in 2007 (43,412). The number of infants born who were conceived using ART increased from 57,569 in 2007 to 76,897 in

2016. Because more than one infant can be born during a live-birth delivery (for example, twins), the total number of infants born is greater than the number of live-birth deliveries. Beginning with cycles performed in 2016, data from cycles using fresh embryos from frozen eggs are included in this figure.

Figure 44

Numbers of ART Cycles Performed, Live-Birth Deliveries, and Infants Born Using ART, 2007–2016



What are egg or embryo banking cycles and have they increased?

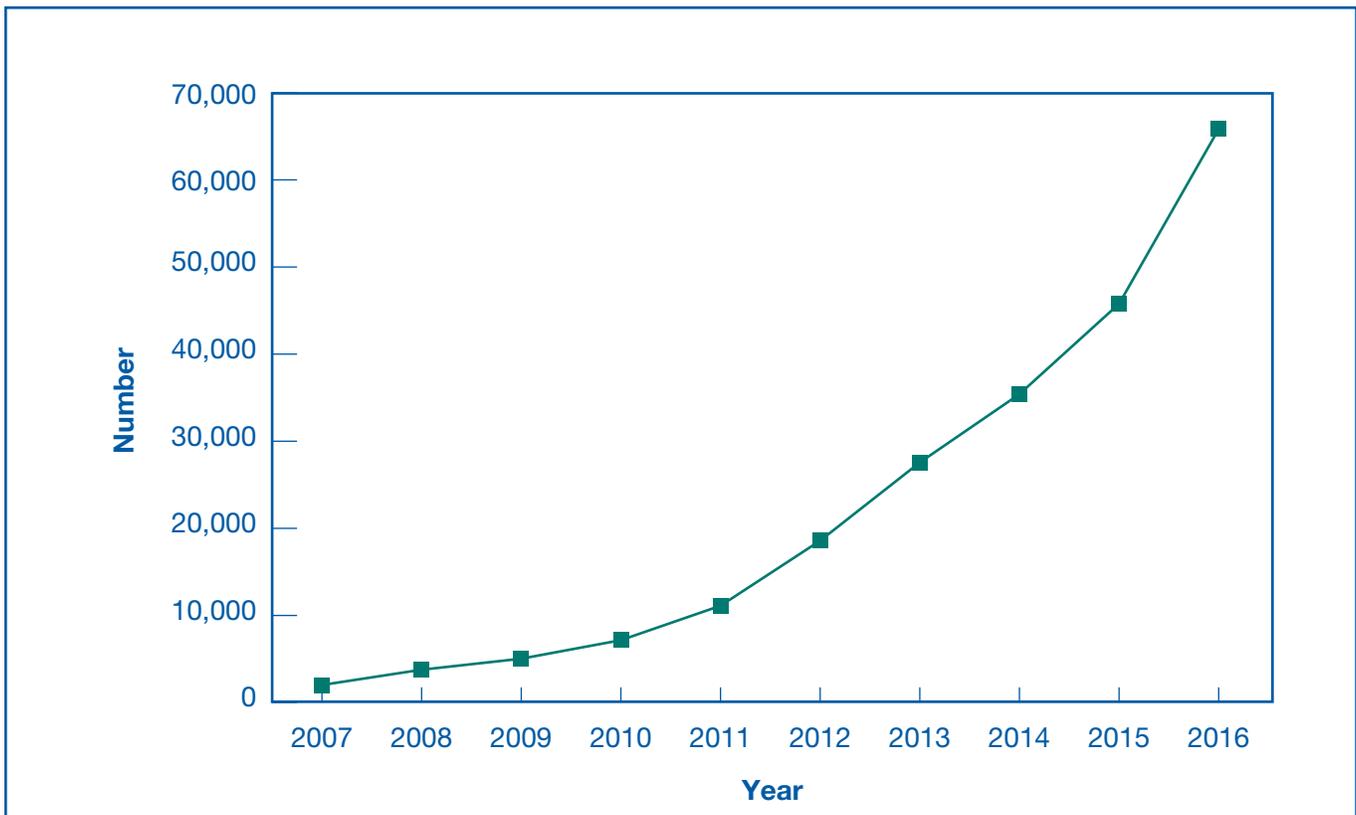
Figure 45 shows that the number of cycles performed for banking all fresh nondonor eggs or embryos increased dramatically from 2007 through 2016.

An egg or embryo banking cycle is an ART cycle started with the intention of freezing (cryopreserving) all resulting eggs or embryos for potential future use, when they may be thawed, fertilized (if eggs), and transferred. Banking cycles may be performed to avoid potentially negative effects of stimulation on conception or

to the fetus, or when it is necessary to wait for results of genetic testing. Egg or embryo banking also may be used when only a small number of eggs or embryos develop during one cycle. In this case, women may undergo several banking cycles to improve availability of good-quality eggs or embryos for later transfer. In other situations, patients may choose to freeze eggs or embryos because the patient or partner needs to undergo medical treatment that may harm their future reproduction capabilities, or to delay childbearing for other reasons.

Figure 45

Numbers of ART Cycles Performed for Banking All Fresh Nondonor Eggs or Embryos, 2007–2016



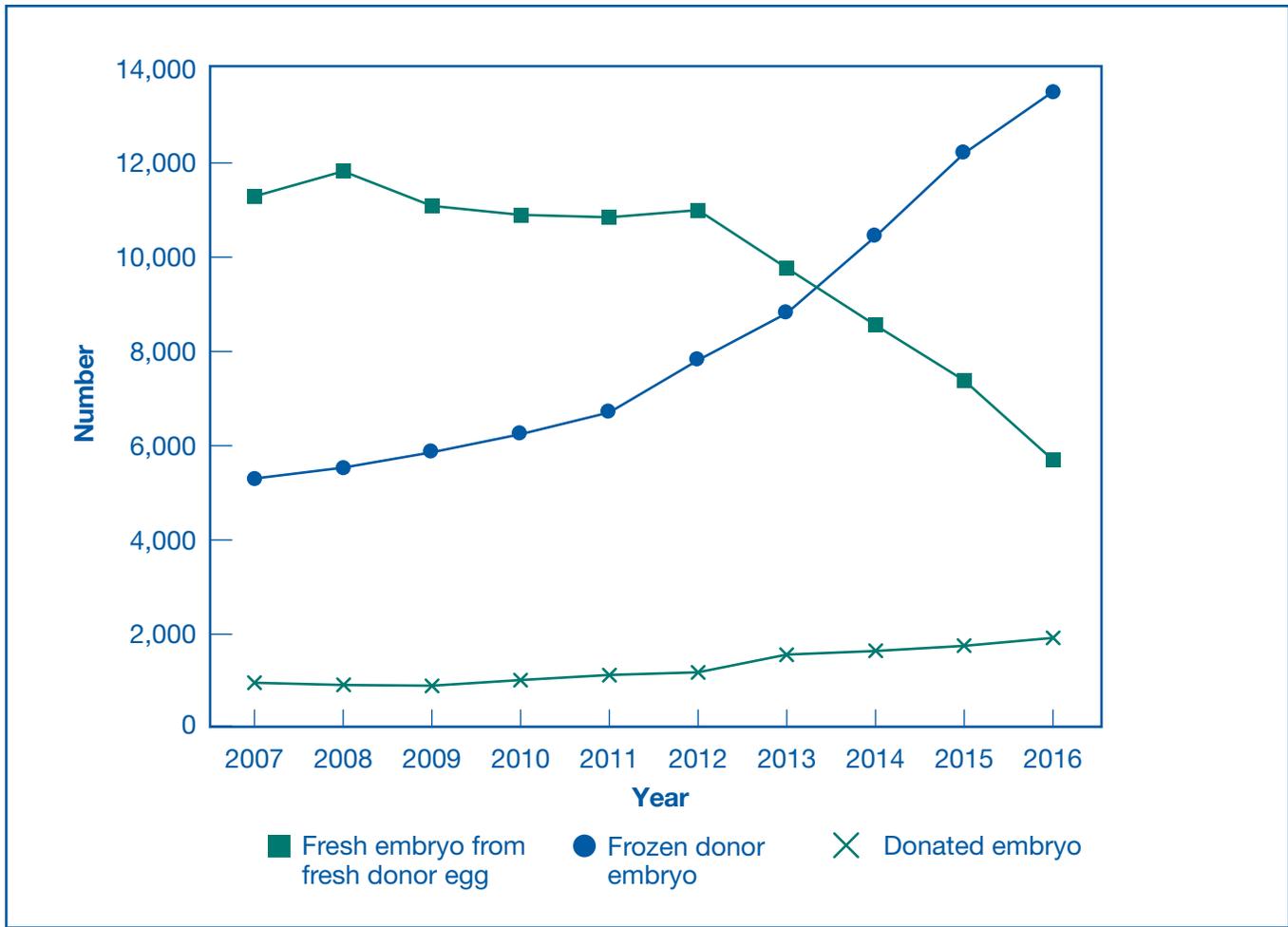
Has the number of cycles using donor eggs increased?

Figure 46 shows that the number of cycles performed using donated embryos increased from 917 in 2007 to 1,869 in 2016 and the number of cycles performed using frozen embryos from donor eggs increased from 5,250 in 2007 to 13,458 in 2016. However, the number of cycles performed using fresh embryos from fresh donor eggs decreased from 11,238 in 2007 to 5,644 in 2016.

previously used ART; neither the sperm nor egg is genetically related to the parent(s) who will raise the child. A fresh or frozen embryo cycle using a donor egg is a cycle in which an embryo is formed from the egg of one woman (the donor) and the sperm from her partner or a donor and then transferred to another woman (the recipient). Donor cycles are most commonly used by women with diminished ovarian reserve, usually as a result of advanced maternal age or premature ovarian insufficiency.

A donated embryo cycle is a cycle in which an embryo is donated by another patient who

Figure 46
Numbers of ART Cycles Using Donor Eggs, 2007–2016



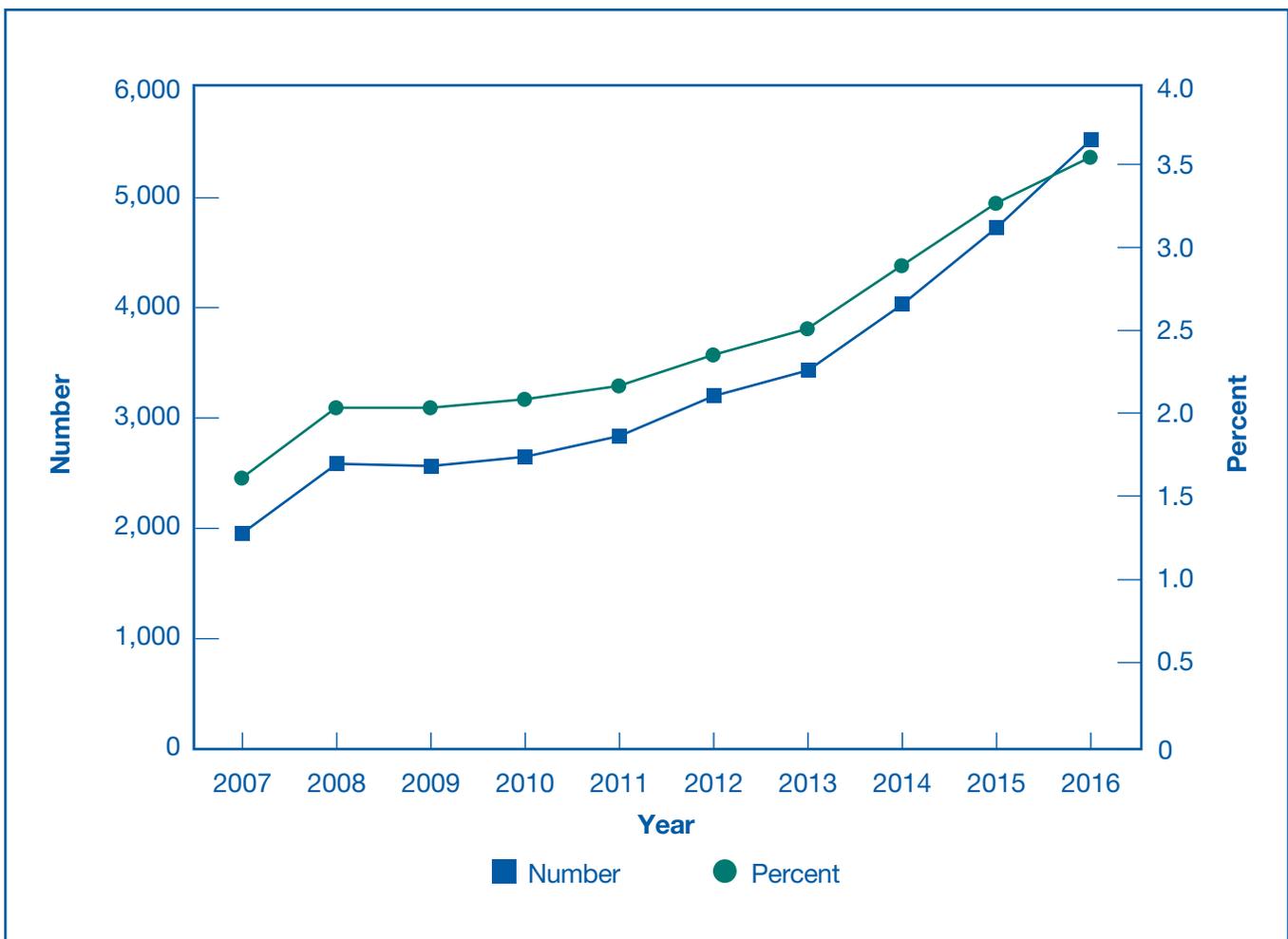
Has the number and percentage of transfers using gestational carriers increased?

Figure 47 shows that the number of transfers for ART cycles using gestational carriers almost tripled, from 1,957 in 2007 to 5,521 in 2016. The percentage of transfers using a gestational carrier among all transfers also increased, from less than 2% in 2007 to almost 4% in 2016.

A gestational carrier (also called a gestational surrogate) is a woman who agrees to carry a developing embryo created from another woman's egg for others. Beginning with cycles performed in 2016, data from cycles using fresh embryos from frozen eggs are included in this figure.

Figure 47

Numbers and Percentages of Transfers Using Gestational Carriers, 2007–2016



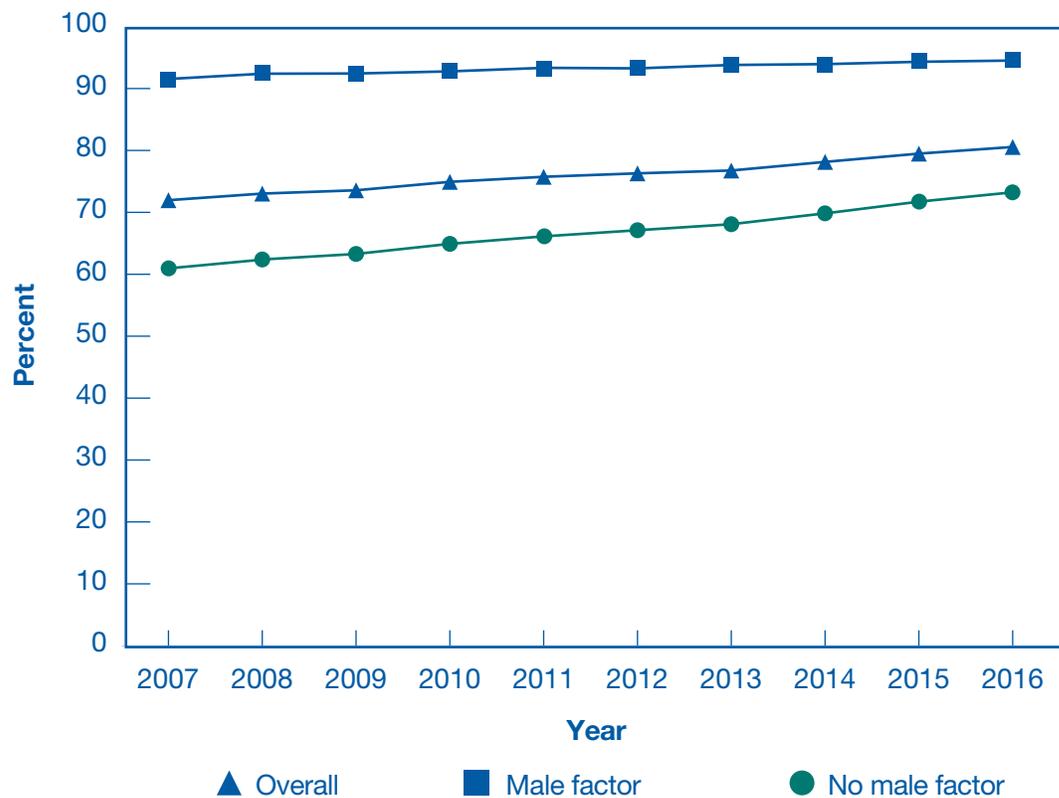
Has ICSI use changed over time?

Figure 48 shows that the percentage of retrievals using ICSI increased over time from 72% in 2007 to 81% in 2016. The increase in use was larger for patients with no diagnosis of male factor infertility

than for those patients with a diagnosis of male factor infertility, where ICSI use has remained consistently high over the last ten years.

Figure 48

Percentages of Retrievals Using Fresh Embryos from Fresh Donor or Fresh Nondonor Eggs That Used ICSI,* 2007–2016



* Cycles using GIFT are excluded.

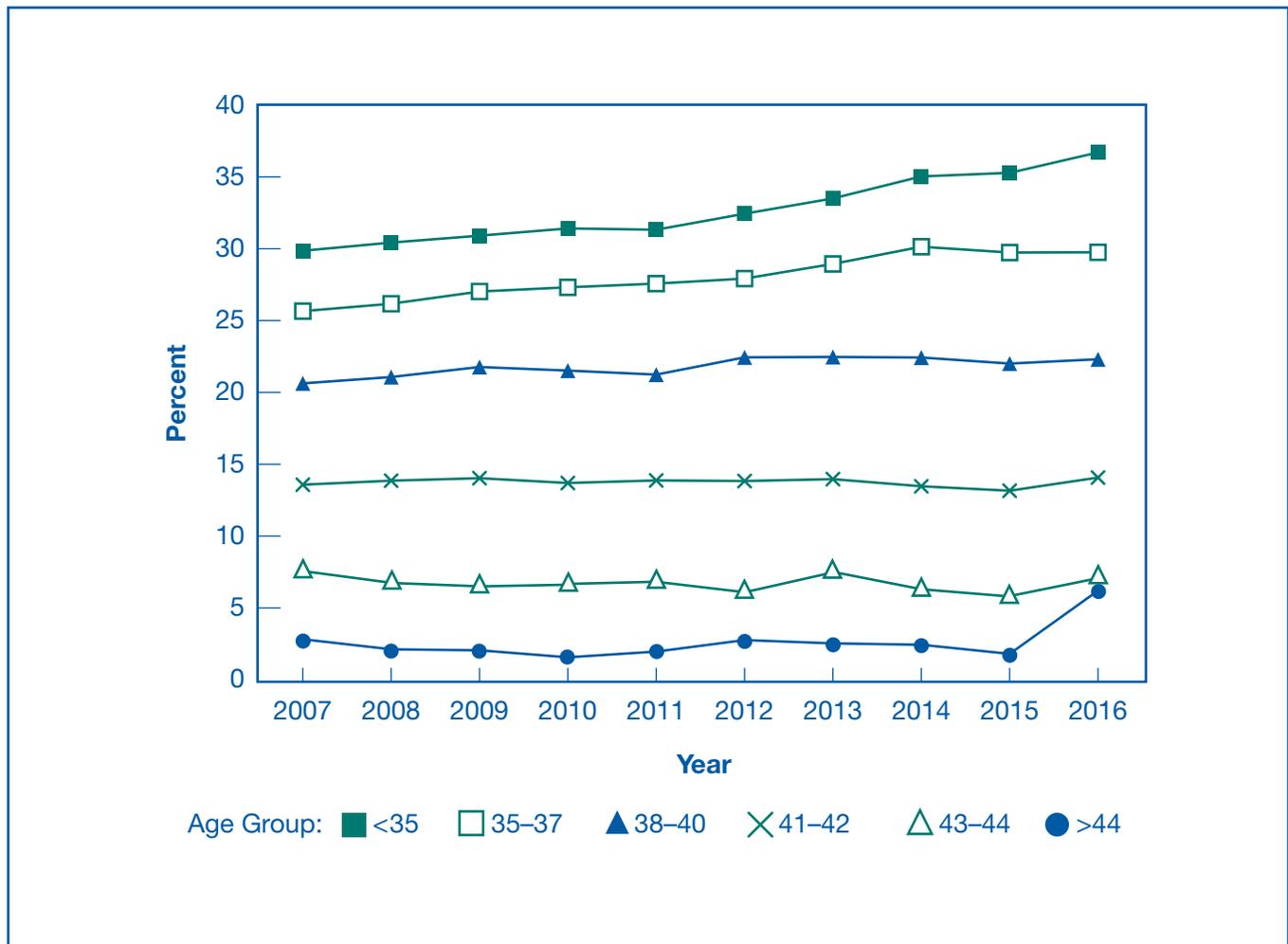
Has the percentage of transfers that resulted in single-infant live births changed?

From 2007 through 2016, the percentage of transfers using fresh embryos from fresh nondonor eggs that resulted in single-infant live births increased from 30% in 2007 to 37% in 2016 for patients younger than age 35, from 26% to 30% for patients aged 35–37, and from 21% to 22% for patients aged 38–40 (Figure 49).

Single-infant births have a lower risk than multiple-infant births for poor infant health outcomes, including prematurity, low birth weight, disability, and death.

Figure 49

Percentages of Transfers Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Single-Infant Live Births, by Age Group, 2007–2016



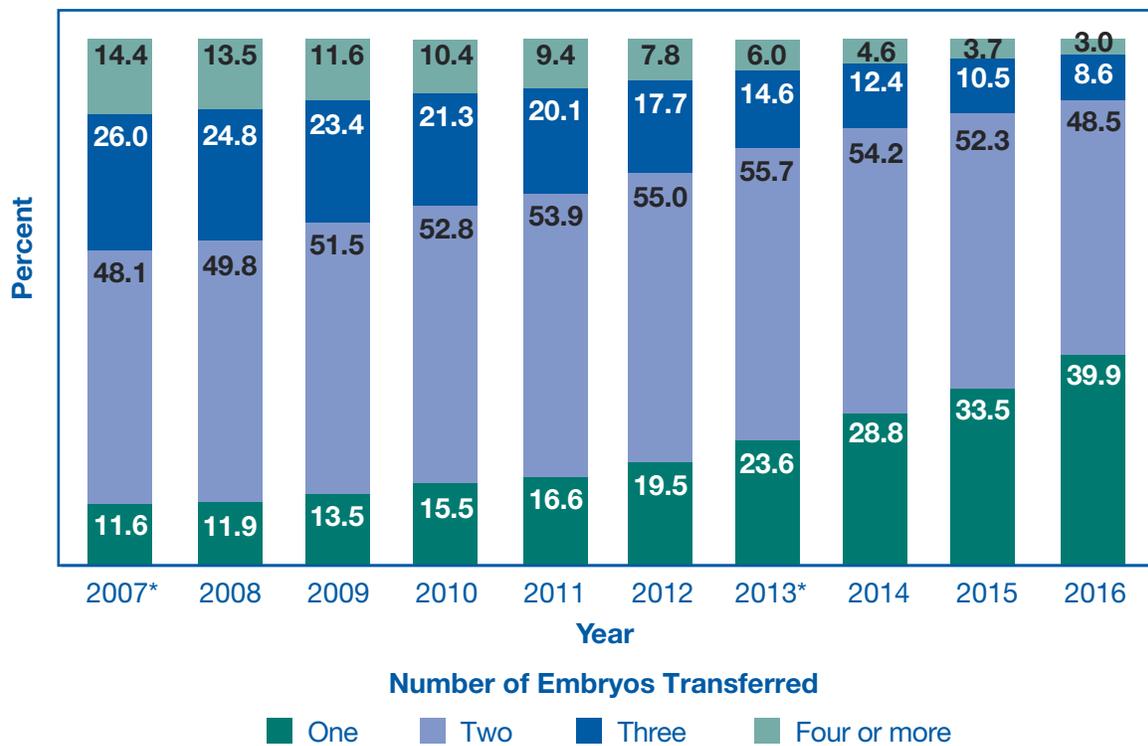
Has the number of embryos transferred changed?

From 2007 through 2016, transfers of one embryo more than tripled from 12% to 40%. Transfers of two embryos ranged from about 48% to 56% for all fresh embryos from fresh nondonor egg cycles that resulted in transfer (Figure 50).

During the same time period, transfers of three embryos decreased from 26% to about 9%, and transfers of four or more embryos decreased from approximately 14% to 3%.

Figure 50

Percentages of Transfers of One, Two, Three, or Four or More Fresh Embryos from Fresh Nondonor Eggs, 2007–2016



* Totals do not equal 100% due to rounding.

Has the percentage of elective single embryo transfers increased?

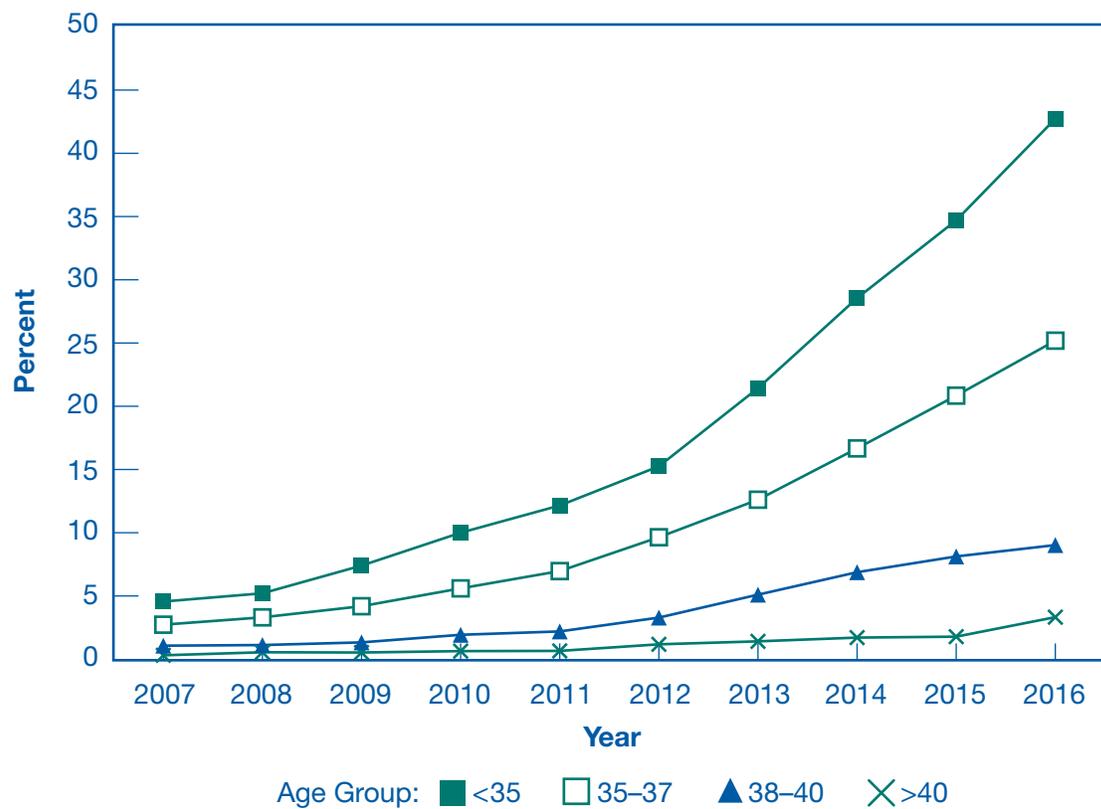
From 2007 through 2016, the percentage of transfers using elective single embryo transfer (eSET) increased dramatically from about 5% to 43% for patients younger than age 35 and from approximately 3% to 25% for patients aged 35–37 (Figure 51).

The percentage of eSET transfers is the percentage of all transfers in which at least

two embryos are available for transfer but only one embryo is transferred. It does not include cycles in which only one embryo is available. The use of eSET is the most effective way to avoid a multiple-fetus pregnancy and to reduce the risk for poor infant health outcomes such as prematurity and low birth weight.

Figure 51

Percentages of Elective Single Embryo Transfer (eSET) Among All Transfers Using Fresh Embryos from Fresh Nondonor Eggs, by Age Group,* 2007–2016



* All ages older than 40 years are reported together due to the small number of transfers performed with eSET.

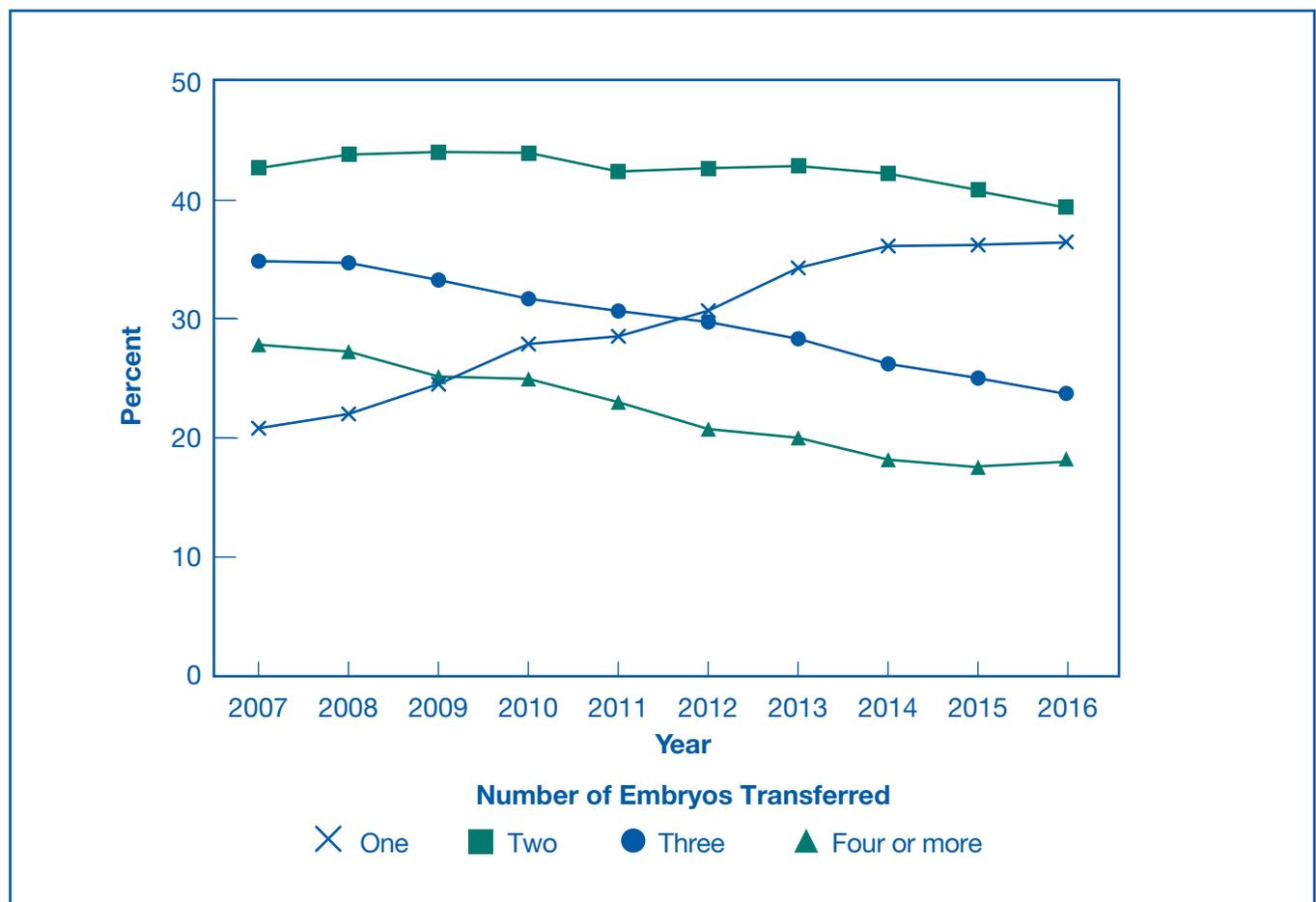
Has the relationship between number of embryos transferred and the percentage of transfers that resulted in live births changed?

The percentage of transfers using fresh embryos from fresh nondonor eggs that resulted in live births increased from 21% in 2007 to 37% in 2016 for the transfer of one embryo (Figure 52). During the same period, the percentage of transfers that resulted in live births decreased overall from 43% to 40% for the transfer of two embryos, from 35% to 24% for the transfer of three embryos, from 28% to 18% for the transfer of four or more embryos.

Interpretation of the relationship between the number of embryos transferred and the percentage of live births over time is affected by several factors. The increase in the percentage of live births among transfers of one embryo is likely due in part to a shift toward eSET among good-prognosis patients and overall improvements in ART practice.

Figure 52

Percentages of Transfers Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Live Births, by Number of Embryos Transferred, 2007–2016



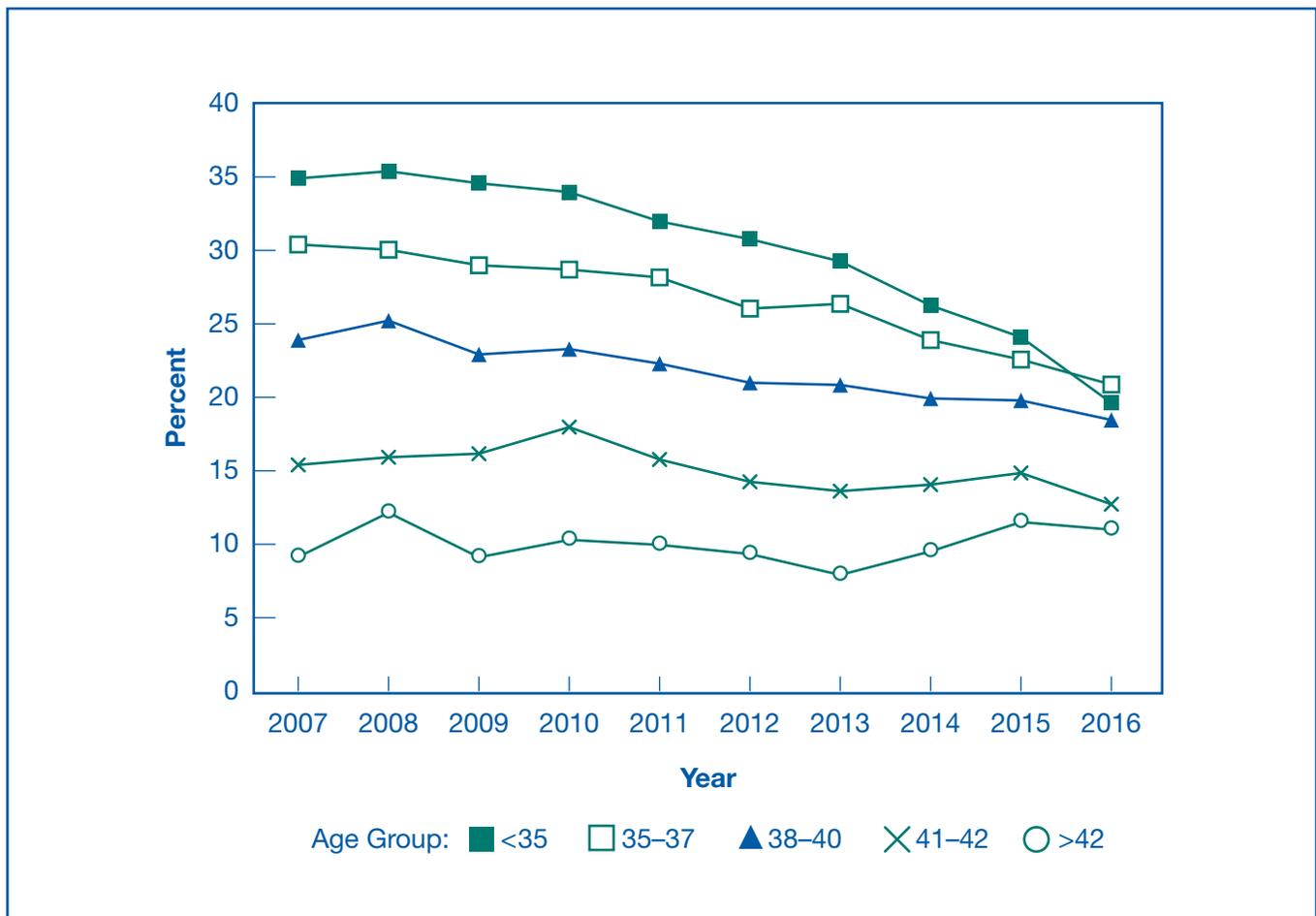
Has the percentage of multiple-infant live births changed?

Figure 53 shows that the percentage of live births that resulted in multiple infants born decreased over time in younger age groups among cycles using fresh embryos from fresh nondonor eggs. From 2007 through 2016, the percentage of multiple-infant live births decreased from 35% to 20% for women younger than age 35, from

30% to 21% for women aged 35–37, from 24% to 18% for women aged 38–40, and from 15% to 13% for women aged 41–42. During the same time period, the percentage of multiple-infant live births ranged from approximately 8% to 12% for women older than age 42.

Figure 53

Percentages of Live Births Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Multiple Infants Born, by Age Group, 2007–2016



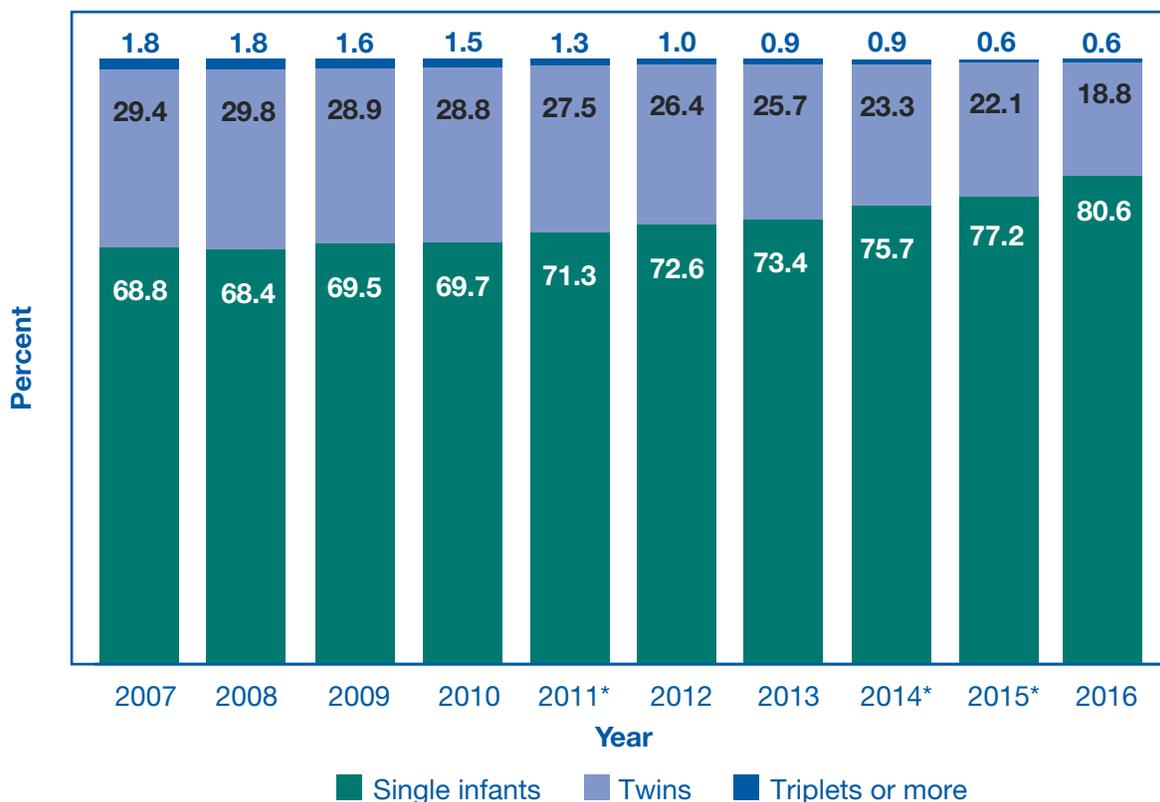
Has the percentage of single infants, twins, and triplets or more changed for transfers that resulted in live births?

During the past 10 years, the percentage of transfers using fresh embryos from fresh nondonor eggs that resulted in single-infant live births increased from about 69% to 81%; twin births decreased from approximately 29% to 19%; and triplets or more births decreased from about 2% to less than 1% (Figure 54).

Infants born from multiple-infant births, including twins, are at greater risk of poor outcomes, including low birth weight, preterm birth, neurological impairments such as cerebral palsy, and death, compared with infants born from single-infant births.

Figure 54

Percentages of Single Infants, Twins, and Triplets or More Among ART Transfers Using Fresh Embryos from Fresh Nondonor Eggs That Resulted in Live Births, 2007–2016

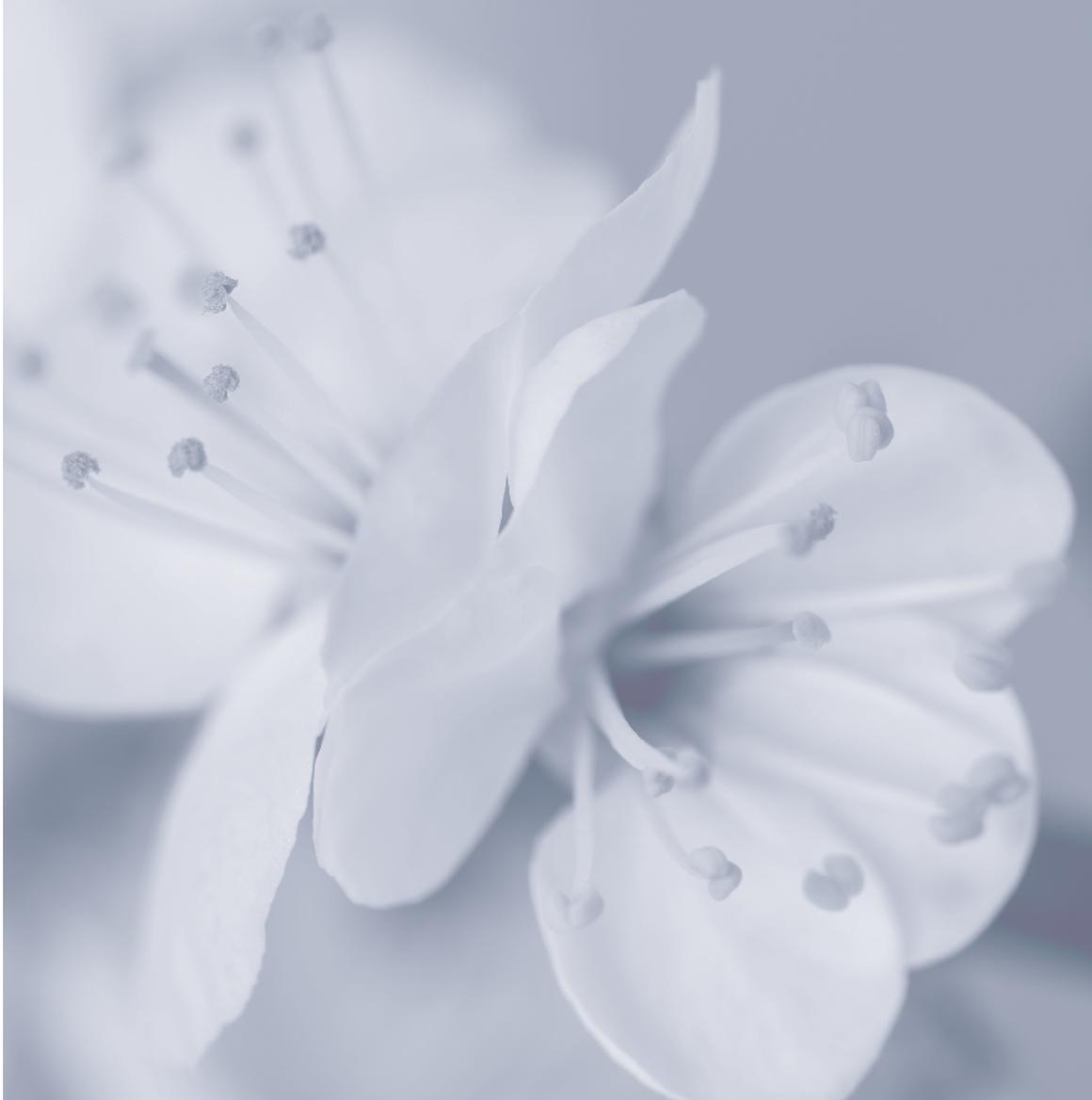


* Totals do not equal 100% due to rounding.

2016

Appendix A

Glossary of Terms



APPENDIX A: GLOSSARY OF TERMS

American Society for Reproductive Medicine (ASRM). Professional society whose affiliate organization, the Society for Assisted Reproductive Technology (SART), is composed of clinics and programs that provide ART.

ART (assisted reproductive technology). All treatments or procedures that include the handling of human eggs or embryos to help a woman become pregnant. ART includes but is not limited to in vitro fertilization (IVF), gamete intrafallopian transfer (GIFT), zygote intrafallopian transfer (ZIFT), tubal embryo transfer, egg and embryo cryopreservation, egg and embryo donation, and gestational surrogacy.

ART cycle. An ART cycle starts when a woman begins taking fertility drugs or having her ovaries monitored for follicle production. If eggs are produced, the cycle progresses to egg retrieval. Retrieved eggs are combined with sperm to create embryos. If fertilization is successful, at least one embryo is selected for transfer. If implantation occurs, the cycle may progress to clinical pregnancy and possibly live birth. ART cycles include any process in which (1) an ART procedure is performed, (2) a woman has undergone ovarian stimulation or monitoring with the intent of having an ART procedure, or (3) frozen embryos have been thawed with the intent of transferring them to a woman.

Canceled cycle. An ART cycle in which ovarian stimulation was performed but the cycle was stopped before eggs were retrieved or, in the case of frozen embryo cycles, before embryos were transferred. Cycles are canceled for many reasons: eggs may not develop, the patient may become ill, or the patient may choose to stop treatment.

Cryopreservation. The practice of freezing eggs or embryos from a patient's ART cycle for potential future use.

Diminished ovarian reserve. This diagnosis means that the ability of the ovary to produce eggs is reduced. Reasons include congenital, medical, or surgical causes.

Donor egg cycle. An ART cycle in which an embryo is formed from the egg of one woman (the donor) and then transferred to another woman (the recipient). Sperm from either a female patient's partner, a male patient, or a sperm donor may be used.

Donated embryo cycle. An ART cycle in which an embryo that is donated by a patient or couple who previously underwent ART treatment and had extra embryos available is transferred to another woman (the recipient).

Ectopic pregnancy. A pregnancy in which the fertilized egg implants in a location outside of the uterus—usually in the fallopian tube, the ovary, or the abdominal cavity. Ectopic pregnancy is a dangerous condition that must receive prompt medical treatment.

Egg. A female reproductive cell, also called an oocyte or ovum.

Egg or embryo banking cycle. An ART cycle started with the intention of freezing (cryopreserving) all resulting eggs or embryos for potential future use.

Egg retrieval (also called oocyte retrieval). A procedure to collect the eggs contained in the ovarian follicles.

Egg transfer (also called oocyte transfer). The transfer of retrieved eggs into a woman's fallopian tubes through laparoscopy. This procedure is used only in GIFT.

Embryo. An egg that has been fertilized by a sperm and has then undergone one or more cell divisions.

Embryo transfer. Placement of embryos into a woman's uterus through the cervix after IVF: in ZIFT, zygotes are placed in a woman's fallopian tube.

Endometriosis. A medical condition that involves the presence of tissue similar to the uterine lining in abnormal locations.

eSET (elective single embryo transfer). Elective single embryo transfer is a procedure in which one embryo, selected from a larger number of available embryos, is placed in the uterus or fallopian tube. The embryo selected for eSET might be a frozen (cryopreserved) embryo from a previous IVF cycle or a fresh embryo selected from a larger number of fresh embryos yielded during the current IVF cycle.

Female factor infertility. Infertility due to ovulatory disturbances, diminished ovarian reserve, pelvic abnormalities affecting the reproductive tract, or other abnormalities of the reproductive system.

Fertility Clinic Success Rate and Certification Act of 1992 (FCSRCA). Law passed by the United States Congress in 1992 requiring all clinics performing ART in the United States to annually report their success rate data to CDC.

Fertility preservation. A cycle started with the intent to freeze all resulting eggs or embryos for 12 months or longer in order to preserve future fertility.

Fertilization. The penetration of the egg by the sperm and the resulting combining of genetic material that develops into an embryo.

Fetus. The unborn offspring from the eighth week after conception to the moment of birth.

Follicle. A structure in the ovaries that contains a developing egg.

Fresh eggs, sperm, or embryos. Eggs, sperm, or embryos that have not been frozen.

Fresh embryo cycle. An ART cycle in which fresh (never frozen) embryos are transferred to the woman. The fresh embryos are conceived with fresh eggs and fresh or frozen sperm.

Frozen egg cycle. An ART cycle in which frozen (cryopreserved) eggs are thawed, fertilized, and then the resulting fresh embryo is transferred to the woman. Frozen and thawed eggs may be fertilized with either fresh or frozen sperm.

Frozen embryo cycle. An ART cycle in which frozen (cryopreserved) embryos are thawed and transferred to a woman. Frozen embryos may have been conceived using fresh or frozen eggs and fresh or frozen sperm.

Gamete. A reproductive cell, either a sperm or an egg.

Gestational age. The deviation of time from estimated last menstrual period (LMP) to birth. LMP is estimated using the date of retrieval or transfer.

Gestational carrier (also called a gestational surrogate). A woman who gestates, or carries, an embryo that was formed from the egg of another woman with the expectation of returning the infant to its intended parents.

Gestational sac. A fluid-filled structure that develops within the uterus early in pregnancy. In a normal pregnancy, a gestational sac contains a developing fetus.

GIFT (gamete intrafallopian transfer). An ART procedure that involves removing eggs from the woman's ovary and using a laparoscope to place the unfertilized eggs and sperm into a woman's fallopian tube through small incisions in her abdomen.

ICSI (intracytoplasmic sperm injection). A procedure in which a single sperm is injected directly into an egg; this procedure is commonly used to overcome male infertility problems.

Implantation rate. A measurement of ART success when the ART cycle results in an intrauterine clinical pregnancy, defined as the larger of either the number of maximum fetal hearts by ultrasound or maximum infants born, including live births and stillbirths, out of the total number of embryos transferred.

Induced or therapeutic abortion. A procedure used to end a pregnancy.

Infertility. In general, infertility refers to the inability to conceive after 12 months of unprotected intercourse. Female patients aged 35 and older unable to conceive after 6 months of unprotected intercourse generally are considered infertile for the purpose of initiating medical treatment.

IUI (intrauterine insemination). A medical procedure that involves placing sperm into a woman's uterus to facilitate fertilization. IUI is not considered an ART procedure because it does not involve the manipulation of eggs.

IVF (in vitro fertilization). An ART procedure that involves removing eggs from a woman's ovaries and fertilizing them outside her body. The resulting embryos are then transferred into a woman's uterus through the cervix.

Live birth. The delivery of one or more infants with any signs of life.

Male factor infertility. Any cause of infertility due to low sperm count or problems with sperm function that makes it difficult for a sperm to fertilize an egg under normal conditions.

Miscarriage (also called spontaneous abortion). A pregnancy ending in the spontaneous loss of the embryo or fetus before 20 weeks of gestation.

Multifetal pregnancy reduction. A procedure used to decrease the number of fetuses a woman carries and improve the chances that the remaining fetuses will develop into healthy infants. Multifetal reductions that occur naturally are referred to as spontaneous reductions.

Multiple factor infertility, female and male. A diagnostic category used when one or more female cause of infertility and male factor infertility are diagnosed.

Multiple factor infertility, female only. A diagnostic category used when more than one female cause of infertility but no male factor infertility is diagnosed.

Multiple-fetus pregnancy. A pregnancy with two or more fetuses, determined by the number of fetal hearts observed on an ultrasound.

Multiple-infant birth. A pregnancy that results in the birth of more than one infant.

NASS (National ART Surveillance System). Web-based data collection system used by all ART clinics to report data for each ART procedure to CDC.

Nondonor cycle. An ART cycle in which an embryo is formed from the egg of a female patient and either partner or donor sperm and then transferred back to the patient.

Oocyte. The female reproductive cell, also called an egg.

Other causes of infertility. These include immunological problems, chromosomal abnormalities, cancer chemotherapy, and serious illnesses.

Ovarian hyperstimulation syndrome. A possible complication of ovarian stimulation or ovulation induction that can cause enlarged ovaries, a distended abdomen, nausea, vomiting or diarrhea, fluid in the abdominal cavity or chest, breathing difficulties, changes in blood volume or viscosity, and diminished kidney perfusion and function.

Ovarian monitoring. The use of ultrasound, or blood or urine tests to monitor follicle development and hormone production.

Ovarian stimulation. The use of drugs (oral or injected) to stimulate the ovaries to develop follicles and eggs.

Ovulatory dysfunction. A diagnostic category used when a woman's ovaries are not producing eggs normally. It is usually characterized by irregular menstrual cycles reflective of ovaries that are not producing one mature egg each month. It includes polycystic ovary syndrome and multiple ovarian cysts.

PGD/PGS (preimplantation genetic diagnosis or screening). Techniques performed on embryos prior to transfer. PGD is for detecting specific genetic conditions to reduce the risk of passing inherited diseases to children. PGS screens embryos for an abnormal number of chromosomes, which is of special value for patients with advanced age, recurrent miscarriages, or prior failed IVF.

Pregnancy (clinical). A pregnancy documented by ultrasound that shows a gestational sac in the uterus. For ART data reporting purposes, pregnancy is defined as a clinical pregnancy rather than a chemical pregnancy (that is, a positive pregnancy test).

Singleton. A single infant.

Society for Assisted Reproductive Technology (SART). An affiliate of ASRM composed of clinics and programs that provide ART.

Sperm. The male reproductive cell.

Spontaneous abortion. See Miscarriage.

Stillbirth. The birth of an infant that shows no sign of life after 20 or more weeks of gestation.

Stimulated cycle. An ART cycle in which a woman receives oral or injected fertility drugs to stimulate her ovaries to develop follicles that contain mature eggs.

Thawed embryo cycle. Same as frozen embryo cycle.

Tubal factor infertility. A diagnostic category used when the woman's fallopian tubes are blocked or damaged, making it difficult for the egg to be fertilized or for an embryo to travel to the uterus.

Ultrasound. A technique used in ART for visualizing the follicles in the ovaries, the gestational sac, or the fetus.

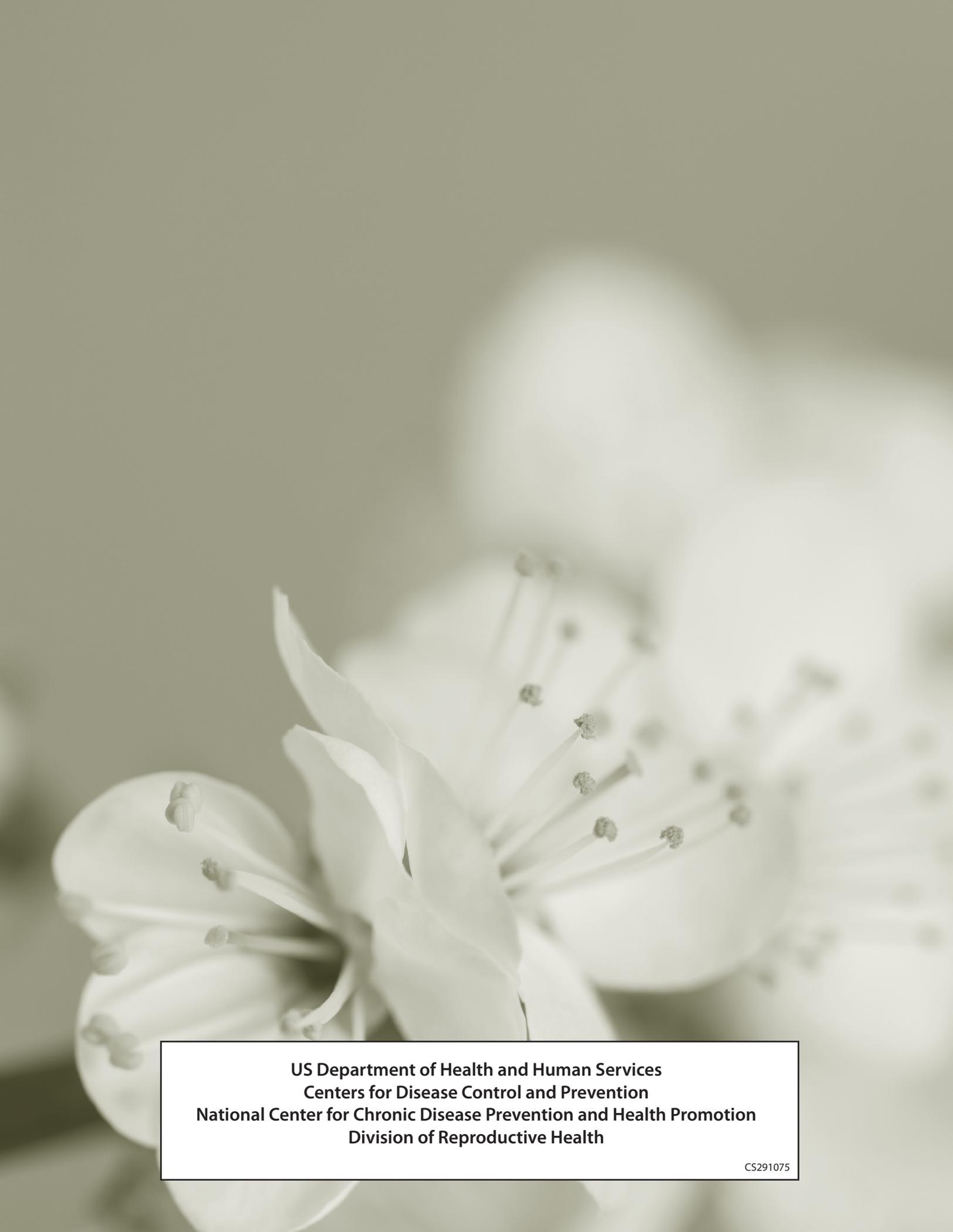
Unknown cause of infertility. A diagnostic category used when no cause of female or male infertility is found.

Unstimulated cycle. An ART cycle in which the woman does not receive drugs to stimulate her ovaries to produce more follicles and eggs. Instead, follicles and eggs develop naturally.

Uterine factor infertility. A structural or functional disorder of the uterus that results in reduced fertility.

ZIFT (zygote intrafallopian transfer). An ART procedure in which eggs are collected from a woman's ovary and fertilized outside her body. A laparoscope is then used to place the resulting zygote into a woman's fallopian tube through a small incision in her abdomen.

Zygote. A fertilized egg before it begins to divide.



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Division of Reproductive Health**