The Assisted Reproductive Technology Summary 2013 National Report of Taiwan

Health Promotion Administration
Ministry of Health and Welfare
Novermber, 2015

Guide to the Report

1. The assisted reproduction database of Taiwan was established in 1998 and has been periodically updated by the assisted reproduction (excluding data for artificial insemination using the husband's semen) case data reported by each artificial reproduction institution in Taiwan.

2. This report is based on the results of a statistical analysis conducted on case data received from various artificial reproduction institutions. Details of the report are expressed in graphs with a corresponding text explanation.

3. The term "year" herein refers to the period between January 1st and December 31st in which the case had received reproduction assistance; that is, covering the "date of initiating taking the fertility drug" or the "date of initiating the treatment cycle". The period so defined shall be applied to pregnancy and live birth analyses as well.

4. "Age" statistics in the report refer to the "full age"; that is, a subject who is 34 years and 9 months old shall be categorized and calculated as in the 34 age group.

5. Cycles of "fresh embryos" and "frozen embryos" which are simultaneously transferred shall be categorized and calculated as "fresh embryos" .

6. In addition to this publication, this report is also posted on the Health Promotion Administration, Ministry of Health and Welfare website on which Reports of 1998 to 2013 are also available.
   (website: http://www.hpa.gov.tw)

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Chapter 1 Overview

The Artificial Reproduction Act (ARA) was promulgated and implemented on March 21, 2007 and aimed to perfect the development of assisted reproduction technology and to safeguard the rights of infertile couples, children born under assisted reproduction and donors, as well as to uphold public ethics and health. According to Article 27 of the ARA, artificial reproduction institutions are obliged to report relevant information regarding the number of patients undergoing treatment, success rates, causes of infertility, and the assisted reproduction technology adopted. The competent authority shall establish an assisted reproduction database and periodically conduct statistical analyses as well as publish updated data accordingly.

Laws and regulations governing the management of the practices and database of assisted reproduction in Taiwan region have been prescribed continually since 1995. In early 1998, a total of 48 artificial reproduction institutions were established in Taiwan; by July 2015, the number of licensed medical institutions had reached 78 totally. In accordance with the provisions of the Artificial Reproduction Act, these medical institutions are required to apply for approval from the competent authority before engaging in assisted reproduction treatment practices and the acceptance, storage, or provision of reproductive cell donations. In order to maintain the quality of assisted reproduction technology performed in medical institutions, the Health Promotion Administration, Ministry of Health and Welfare has regularly conducted permit reviews on all licensed artificial reproduction institutions.

This report focuses on the statistical analysis for cases that had been treated in the 73 artificial reproduction institutions in Taiwan (2013). Chapter 1 briefly introduces the assisted reproduction methods and treatment cycles. Chapter 2 presents the statistics for all cycles of treatment, including data for assisted reproduction using fresh non-donor eggs, sperm or embryos and data about the egg/sperm recipients. Chapter 3 conducts an analysis of assisted reproduction using fresh non-donor eggs, sperm or embryos. In order to present the diverse implications of the collected data, this chapter was divided into various sections based on all types of cycles performed on married couples, In Vitro Fertilization (or IVF for short) and fresh non-donor eggs embryo transfer techniques independently performed on married couples, and the transfer of frozen embryos on married couples. Chapter 4 shows the analysis for the age, acceptance rate, and live birth rate of women who accepted donor eggs in assisted reproduction treatment. Chapter 5 presents an analysis of the trends in the practice during the period of 1998 to 2013.

Section 1: Assisted Reproduction Treatment Cycles

As the assisted reproduction process comprises a series of steps taking a period of around two weeks to complete, using “cycle” as the unit will be more appropriate than a single time point when analyzing the data. In the course of statistical analysis conducted under such assessment, a particular couple receiving assisted reproduction treatment may contribute more than one cycle.

The assessment of a cycle begins when the use of oral or injected fertility drugs to stimulate the ovaries to develop eggs starts, or an ovary examination is conducted in preparation for embryo transfer. Cycles either pre-terminated or uncompleted in the treatment are still counted as a case in the statistics.

Section 2: Assisted Reproductive Technology

This section delves into several assisted reproduction methods and micromanipulation techniques used in Assisted Reproductive Technology (ART).

I. Assisted Reproduction Methods

1. IVF/ET: In Vitro Fertilization and embryo transfer, generally referred to as test tube babies.
   Fertilizing extracted eggs and sperm and developing them to an early embryo stage, and then transferring the embryos into the uterus through the uterine cervix.

2. GIFT: Gamete Intra-fallopian Transfer.
   Placing the extracted eggs back into the fallopian tube by laparoscopy and fertilizing them with sperm inside the body.

3. ZIFT/TET: Zygote Intra-fallopian Transfer/Tubal Embryo Transfer.
   Sperm and eggs are fertilized in vitro and then transferred back into the fallopian tube to enable the zygote or embryo to be naturally implanted in the uterus from the fallopian tube.

4. AID: Artificial Insemination Using Donor’s Semen.
   Inject the donor’s sperm directly into uterus, fallopian tube or the follicles.

II. Micromanipulation Technique

1. ICSI: Intra-cytoplasm Sperm Injection.
   Combining and fertilizing the egg and sperm by injecting a single sperm into the egg cytoplasm.

2. Assisted Hatching.
   Punch a hole through the zona pellucid to assist in the hatching and transfer of the embryo.

Except for the provisions prohibiting embryo sexual selection and relevant penalties of such law listed in paragraph 3, Article 16 of the Artificial Reproduction Act, the stipulation of Article 5 in the Artificial Reproduction Act is not applicable to the performance of Artificial Insemination Using Husband's Semen (AIH). As the practice of AIH treatment is not limited to artificial reproduction institutions, these case data are not required to be reported. Hence, the term "assisted reproduction case" stated in this paper and all analytical data does not include assisted reproduction cases using the AIH procedure.

Chapter 2 Overall ART Cycle Statistics

The basis of calculation for all data collection periods of this paper is the starting date of each cycle. All data compiled for analysis came from the regular data received from the 73 artificial reproduction institutions of Taiwan in the year 2013.

Section 1: Cycles and Types of Treatment

I. Number of ART Cycles

A total of 17,393 ART cycles (including cycles without completing egg retrieval or transfer) were conducted in 2013 (Table 1); among which, 919 cycles used donors sperm or eggs, and 16,474 cycles used non-donor sperm or eggs.

Table 1 ART Cycles in Taiwan, 2013

(Unit: Cycle)

Unit: Type of Cycle	Number of ART Cycles
Use of Donor Sperm and Eggs	919
Use of Donor Sperm	298
Use of Donor Eggs	621
Use of Non-donor Sperm, Eggs or Embryos	16,474
Total ART Cycles	17,393

II. Types of ART

Analysis of the types of ART revealed that more than 74.7% of treatments adopted fresh embryos (Figure 1) developed from non-donor sperm and eggs, followed by 20.0% of frozen embryos developed from non-donor sperm and eggs, and 3.0% of ART cycles using fresh embryos developed from donor sperm or eggs; whereas, cycles using frozen embryos developed from donor sperm or eggs accounted for merely 2.3%.

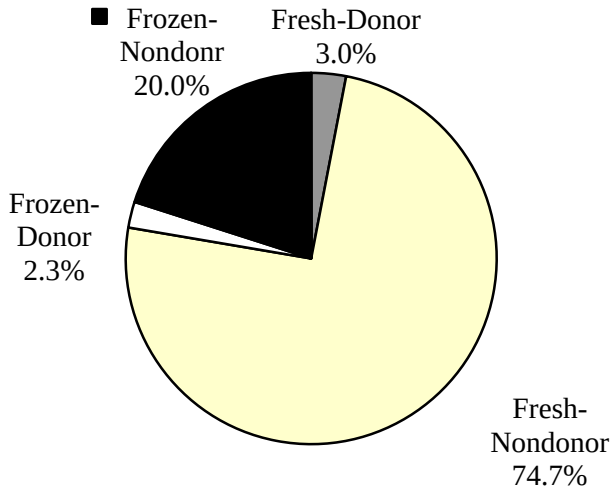

Figure 1 Types of ART Cycles in Taiwan, 2013

Section 2: Ages of Women Receiving ART

Figure 2 shows the age group distribution of women receiving ART. The majority of women receiving this treatment ranged from 31 to 39 years (the accumulate percentages are 25% and 75%, respectively). The peak of the curve in the graph is noted at age 34 and 35 years, indicating that among women receiving the ART cycle the highest number were at age of 34 and 35, accounting for 9.0% of the total ART cycle participants. The second highest percentage was 36-year-old women, accounting for 8.9% of the total participants.

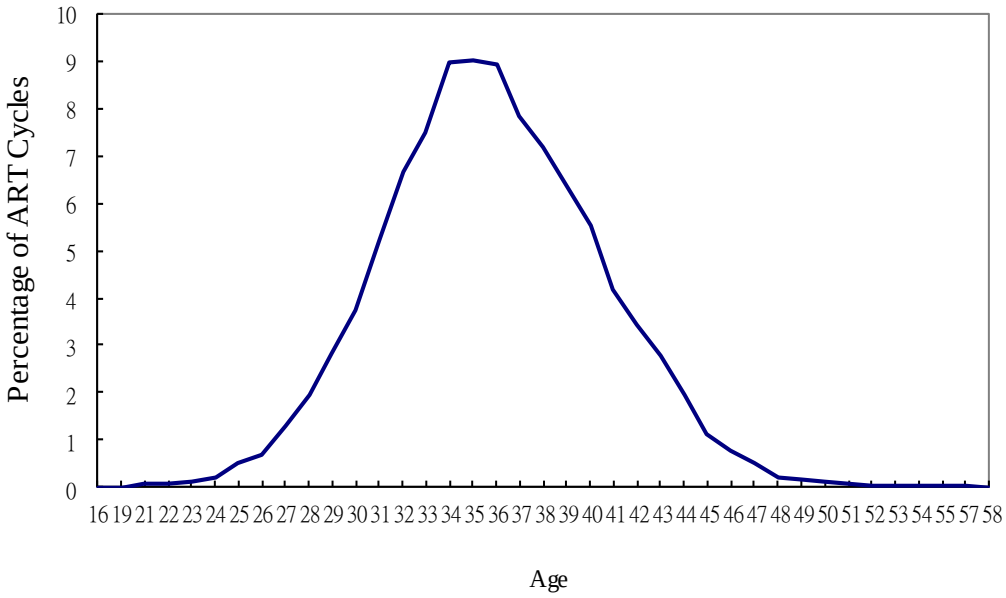

Figure 2 Age Group Distributions of Women Receiving ART in Taiwan, 2013

Section 3: Analysis of the Reasons for Infertility

Figure 3 shows the reasons for infertility of women receiving ART. 43.1% of cases were due to female-related factors unrelated to the fallopian tube, followed by 22.9% of multi-factor. Male-related causes and fallopian tube related factors comprised 18.3% and 11.8%, respectively, ranking third and fourth.

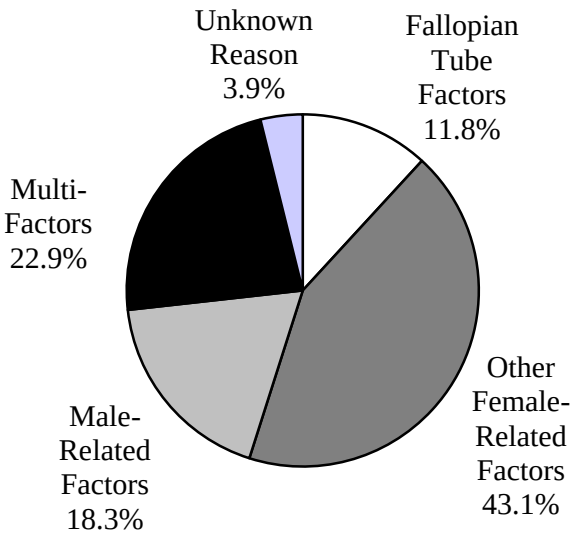

Figure 3 Reasons for Infertility of ART Cases in Taiwan, 2013

Section 4: Types of ART Used

Among the types of ART used, the most popular procedure was the IVF/ET method, taking up 99.0% of the total. Other methods comprised merely 0.8% and the rest of the methods, such as, GIFT, ZIFT/TET, and AID made up less than 1% (Figure 4). A further discussion of the ART procedure selected in multiple cycles of IVF/ET method which focus on the treatment conditions and pregnancy results of IVF/ET treatment cases using eggs, sperm or embryos between spouses will be presented in Section 2 of Chapter 3.

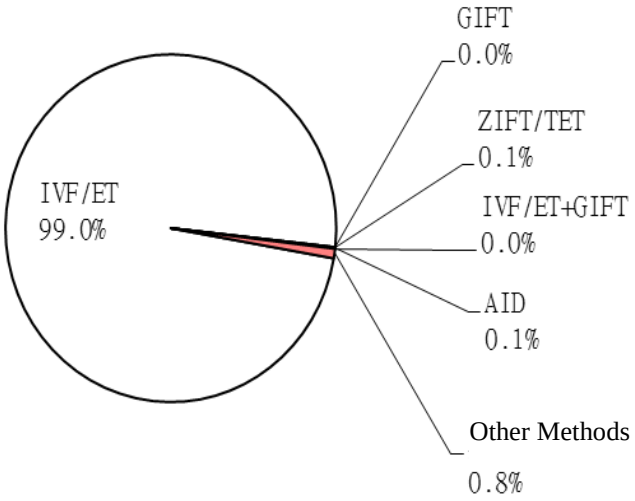

Figure 4 Types of ART Used in Taiwan, 2013

Section 5: Micromanipulation Technique

Table 2 indicates the number of cycles and percentages of ART using the micromanipulation technique. The micromanipulation technique was applied to 74.6% of the 17,393 ART cycles performed in 2013. Among these, cycles using ICSI only accounted for 31.6%; cycles using the assisted hatching technique only took up 16.8%; whereas, cycles jointly using ICSI and assisted hatching technique accounted for 26.0%. The correlation between rates of pregnancies and live births using the ICSI micromanipulation technique is further discussed in Section 7.

Table 2 Status of Micromanipulation Technique Application in ART Case Cycles in Taiwan, 2013

Cases Using Micromanipulation	Cycles	Percentage (%)
Procedure applied	12,982	74.6
ICSI	5,488	31.6
Assisted hatching	2,930	16.8
ICSI+ Assisted hatching	4,529	26.0
Others	35	0.2
Procedure not applied	4,411	25.4
Total ART cycles	17,393	100.0

Section 6: The Number of Embryos Transferred

In order to provide guidance for artificial reproduction institutions to avoid transferring too many embryos which may result in an increasing probability of twins or multiple births that not only generates a burden on family's economy but also affects the social structure, the government promulgated and implemented the Artificial Reproduction Act in 2007 which specifically limits the maximum number of embryos transferred to be four in each ART. The Act further defines pertinent penalty provisions for the violation of such law.

The statistics on the number of embryos transferred in ART cycles during the year 2013 show that the majority of transfers were 2 embryos, which accounted for 35.3%; while transfers of 3 and 4 embryos were 32.6% and 20.7%, respectively.

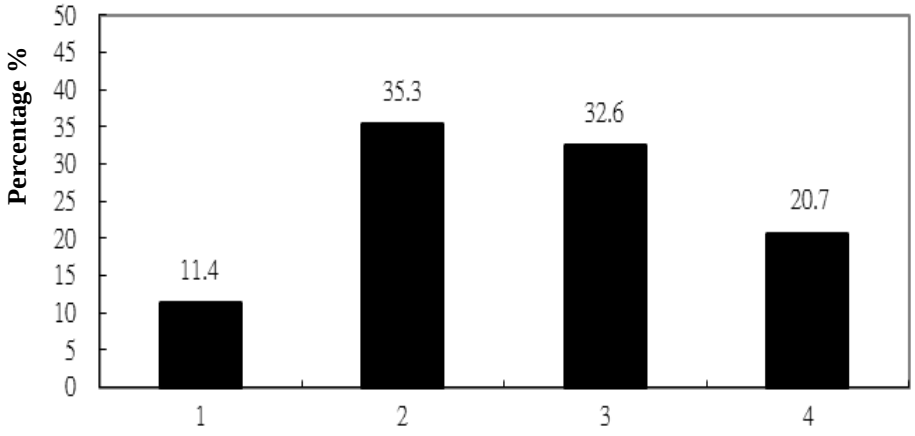

Figure 5 Percentage of Embryo Transfers Performed in ART Cycles in Taiwan, 2013

Section 7: Pregnancies and Live Births

An ART cycle starts when ovulation medicines are given to stimulate ovulation or an ovary examination is conducted for the preparation of embryo transfer, and its final object is the smooth delivery of a healthy infant. However, not all ART cycles are performed successfully with regard to pregnancy and delivery.

Of 17,393 ART cycles in 2013, 6,228 cycles successfully led to pregnancy of which 4,585 cycles resulted in live births. However, owing to multiple births in some cycles, the total number of delivery infants 5,988, is 163 more than the infants that were delivered in 2012.

Analysis of statistics on the correlation of pregnancy rates and live birth rates were conducted based on the age of women receiving ART treatments. In 2013, the pregnancy rate of ART was about 35.8%, while the crude live birth rate accounted for 26.4%. The pregnancy and live birth rates among different age groups are shown in Figure 6. As the number of ART cycles of women “Age under 24” and “age over 44” were too small, the breakdown of ages in these two groups were not carried out and these data were combined in calculations in the statistics. The graph shows that after age 30, pregnancy rates and live birth rates seem to decline following the increase in age of the women receiving the treatments.

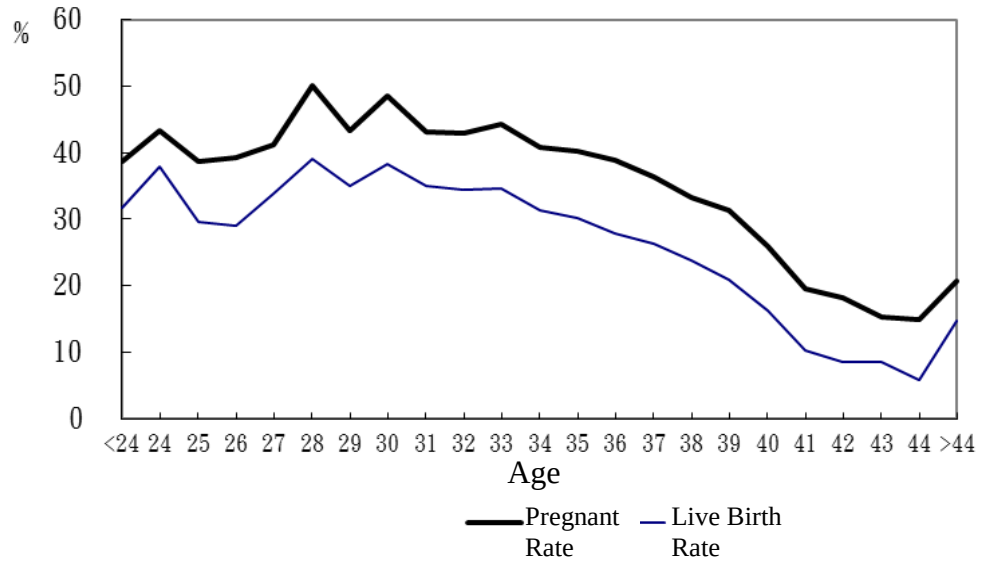

Figure 6 The diagram of relationships of women receiving ART between ages and both of pregnancy rate and live birth rate in Taiwan area in 2013

This section additionally conducts an analysis of the success rates, the dominant results and related problems of ART cycles as follows.

I. Analysis of Success Rates by Six Methods

Figure 7 shows six measures in presenting ART success rates including pregnancy rate of treatment cycle, live birth rate of treatment cycle, live birth rate of egg retrieval cycle, live birth rate of transfer cycle, and single-fetus rate of treatment and transfer cycles as follows:

1. Pregnancy rate of treatment cycle: this rate is generally referred to as the pregnancy rate, which is the percentage of successful pregnancies in ART cycles. Since some pregnancies may be terminated due to miscarriage or dead birth, this rate usually will be higher than live birth rate of treatment cycles. The pregnancy rate of treatment cycle in 2013 was 35.8%.

2. Live birth rate of treatment cycle: this rate is normally referred to as the live birth rate, meaning the percentage of live births in ART cycles (each delivery is counted as one live birth despite the number of infants delivered). This is the ratio that most concerns people because it presents the probability of having a live birth infant by means of ART treatment. The live birth rate of ART cycles in 2013 was 26.4%.

3. Live birth rate of egg retrieval cycle: this rate refers to as the percentage of live birth ART cycles in which an egg retrieval procedure was performed. This rate is generally higher than the live birth rate of the ART cycles because it excludes cycles that were cancelled without retrieving eggs. The live birth rate of egg retrieval cycles in 2013 was 24.7%; whereas, receiving ART treatment but without the egg retrieval procedure accounted for 24.5%.

4. Live birth rate of transfer cycle: this rate is referred to as the percentage of live birth cycles of transfer cycles in the course of the ART process, accounting for 31.7 % in 2013; among which, the live birth rate for fresh embryo transfers was 30.4% and 35.3% for frozen embryos. The transfer cycles of frozen embryos accounted for 25.9% of overall transfer cycles.

5. Single-fetus rate of treatment cycle: This refers to the percentage of singleton live birth cycles in the ART cycles. The singleton live birth is an important measurement for the success rate of the ART because, compared to multiple-fetus births, a delivery of a single-fetus new born infant suffers less health risks such as preterm birth, light body weight, congenital defects and mortality. The single-fetus rate of ART cycles in 2013 was 18.4%.

6. Single-fetus rate of transfer cycle: this refers to as the singleton live birth rate in the ART transfer cycles. This rate in 2013 was 22.1%.

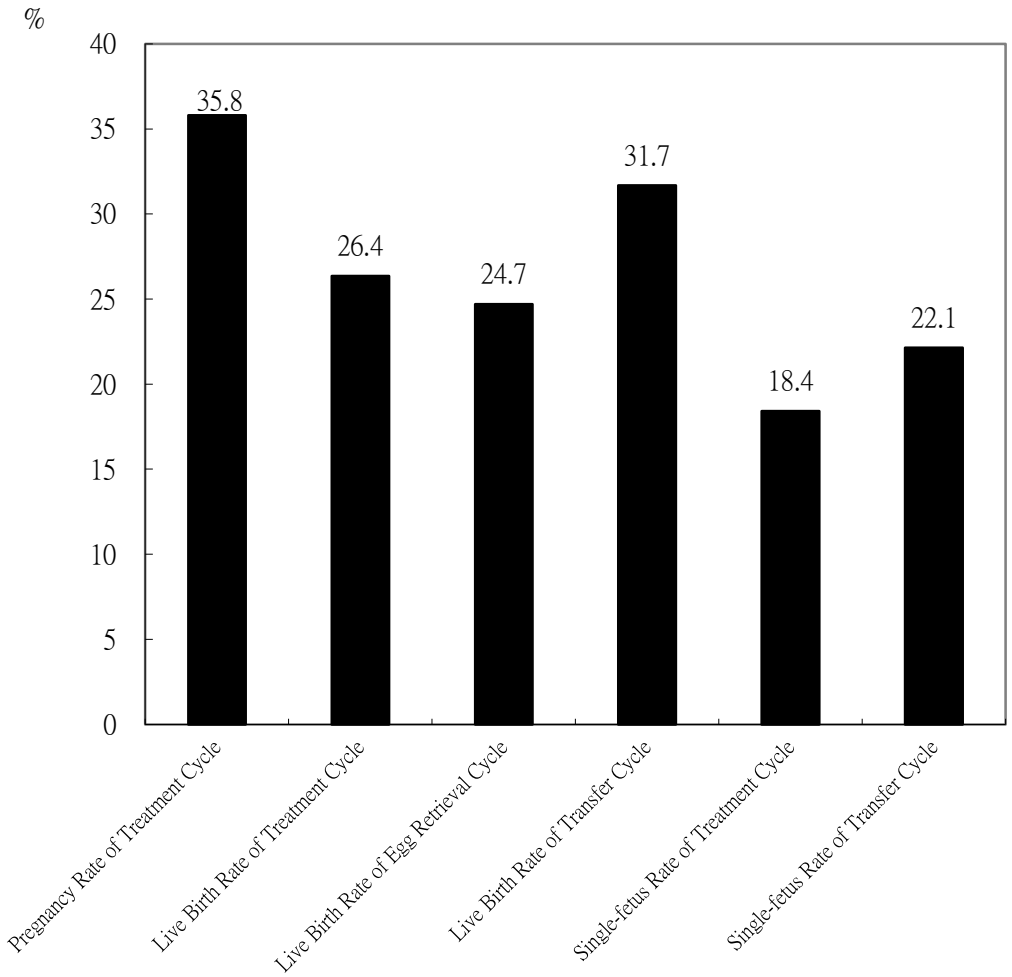

Figure 7 Analysis of Success Rates of ART Performed in Taiwan, 2013

II. Pregnancy Results

Figure 8 presents the pregnancy results of ART in 2013. Singletons were delivered in 51.4% of the pregnancy cycles and twins in 21.8%. However, 26.4% of the pregnancy cycles failed to produce any live births. The next section will analyze pregnancies that failed to result in live births.

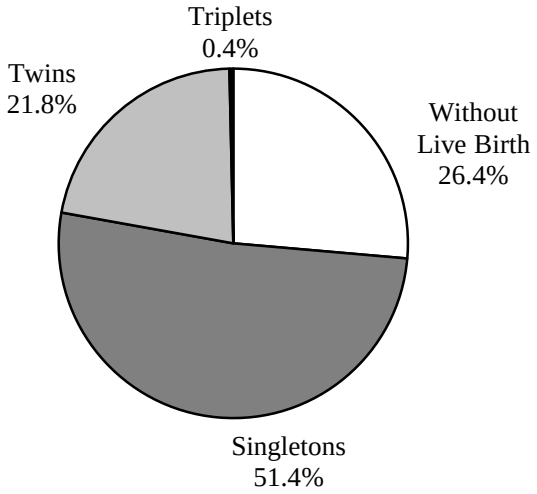

Figure 8 Analyses of Pregnancy Results of ART in Taiwan, 2013

III. Analysis of Pregnancy Cases without Live Births

The majority of the 1,643 pregnancy cases that failed to produce live births during the cycles were due to natural miscarriages, accounting for 62.2%. The second highest factor was induced abortion accounting for 25.4%, followed by ectopic pregnancies, 6.6%, and 4.1% stillbirths, as shown in Figure 9. Some of above cases were reported with additional conditions of natural miscarriage, ectopic pregnancy, and induced abortion, stillbirth during 20-27 weeks or after 28 weeks. As a result, the sum of the percentages is greater than 100; in addition, 62 cycles (3.7%) with unspecified conditions are not listed in the graph.

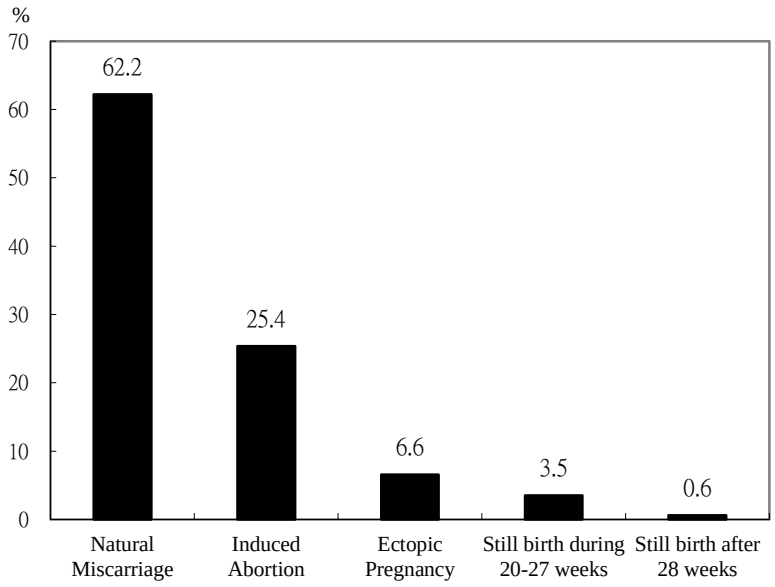

Figure 9 Analysis of Status of Pregnancies without Live Births of ART Cycles in Taiwan, 2013

IV. Correlation between the Pregnancy Rate and Live Birth Rate with/without the application of the ICSI micromanipulation technique

Figure 10 presents the correlation of with/without the application of the ICSI micromanipulation technique with the pregnancy rate and live birth rate. The pregnancy rate using the ICSI micromanipulation technique was 33.9%, which was 1.8% lower than the rate for no micromanipulation technique. For the live birth rate, the rate of using the ICSI micromanipulation technique was 24.6%, the live birth rate without using ICSI micromanipulation technique was 28.8%.

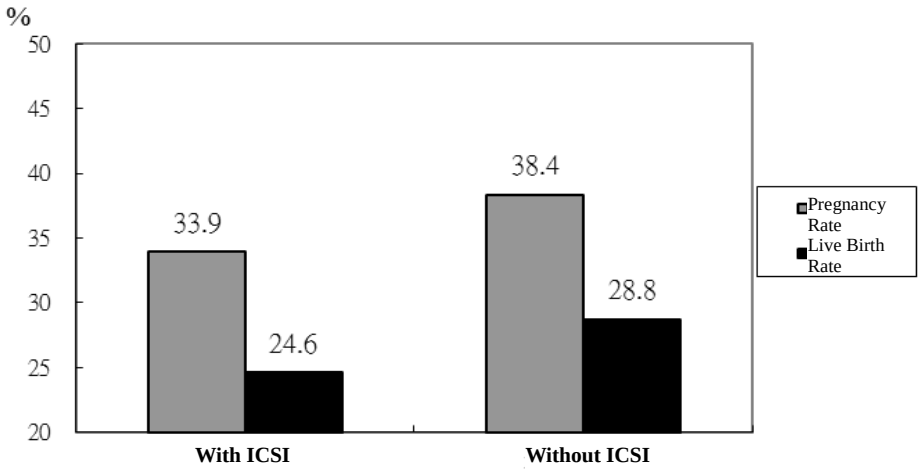

Figure 10 Correlation between the Pregnancy Rate and Live Birth Rate with/without the application of the ICSI micromanipulation technique of the ART Cycles in Taiwan, 2013

Section 8: Status of New-Born Infants

I. Ratio of the Number of Live Birth Deliveries to Sex

Among the 4,585 live birth cycles, 69.9% were singletons; twins were 29.6%, and triplets were 0.5% (Figure 11).

A total of 5,988 infants were born by way of ART in 2013, in which 3,052 infants were boys and 2,936 were girls, a sex ratio of 103.9

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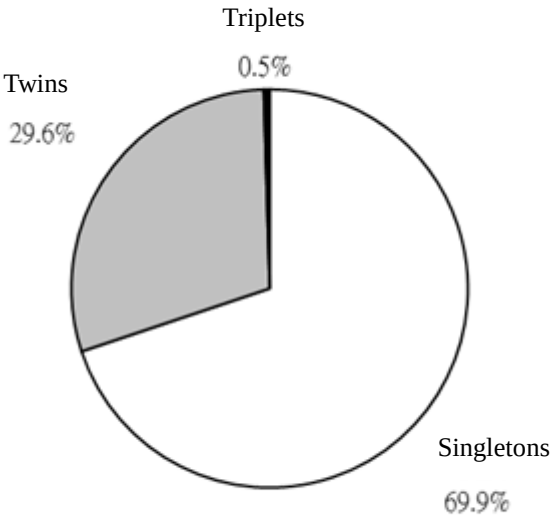

Figure 11 Percentage of the Number of Offspring in the ART Cycles Live Births in Taiwan, 2013

II. Ratio of Live Birth-weight to Congenital-defect

An observation of the 5,988 live birth infants showed that 4.8% of infants were born with body weights under 1,500 gm; 33.7% of infants were born with body weights ranging between 1,500 gm and 2.499 gm; 61.5% of infants were born with body weights more than 2,500 gm, while 0.7% of infants were born with apparent congenital defects, as shown in Table 3.

Table 3 Live Birth Infant Weights and Congenital Defects in Taiwan, 2013

Infant Status	Live Birth Infants	Percentage (%)
Gender		
Male	3052	51.0
Female	2,936	49.0
Weight		
<1500 gm	287	4.8
1500-2499 gm	2,017	33.7
≥2500gm	3,684	61.5
Apparent or visible congenital defects	39	0.7

III. Correlation between the Number of Fetuses and Infant Body Weights

Figure 12 shows the correlation between the number of fetuses and infant body weights. In triplet births, 18.2% of the newborns weighed under 1,000 gm, 27.3% weighed between 1,000 gm and 1,499 gm, 51.5% weighed between 1,500 gm and 2,499 gm, and 3.0% weighed more than 2,500 gm. In the birth of singletons, most newborns weighted more than 2,500 gm which was 87.7%. In twin births, the largest percentage of newborns weighed between 1,500 to 2,499 gm was 61.1%, followed by 32.1% of newborns weighted more than 2,500 gm. The examination results indicate a negative correlation between the number of offspring and infant body weight ($P<0.0001$); in other words, the higher the number of offspring, the lower the body weight of the infant.

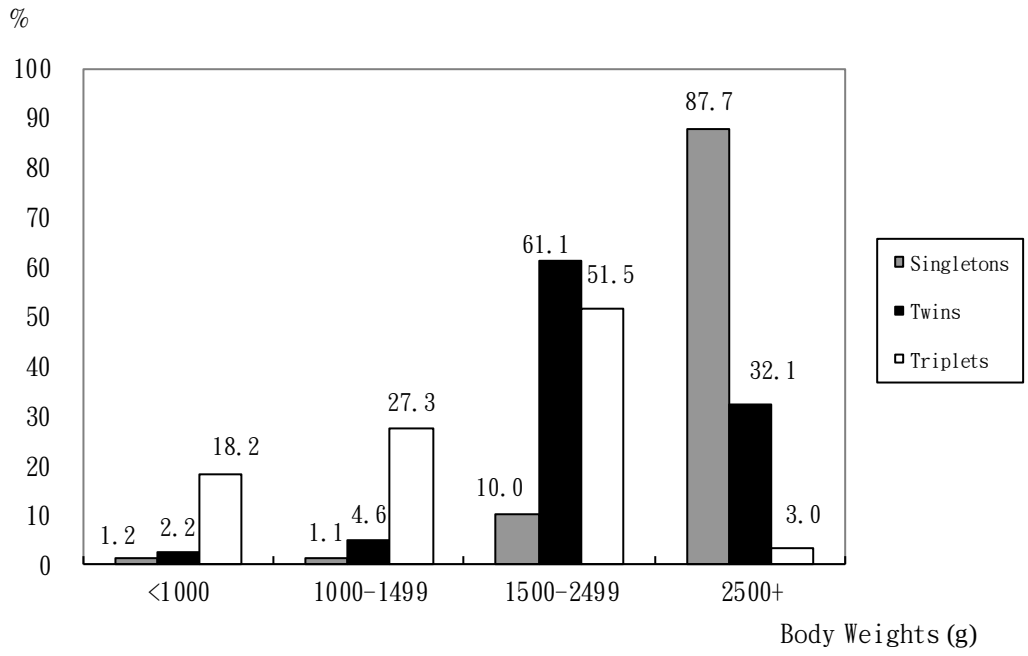

Figure 12 Correlation of Percentages Between the Number of Offspring and Weights of the ART Live Births Cycles in Taiwan, 2013

Chapter 3 ART Cycles Using Fresh Non-donor Eggs, Sperm, or Embryos

Section 1: ART Cycles Using Fresh Non-donor Eggs, Sperm, or Embryos

This section analyses the statistics of various ART cycles implemented through different treatments using non-donor (couple) sperm, eggs or frozen embryos, but AIH excluded.

I. Age Distribution of Women Receiving Treatment

A total of 16,473 ART cycles using fresh non-donor eggs, sperm, or embryos were performed in 2013, accounting for 94.7% of the total ART cycles (including ART cycles using fresh eggs and sperm from donors). Age distribution of women receiving ART is shown in Figure 13, in which the distribution curve is quite similar to the age distribution of all the ART cycles. (Figure 2, page 6)

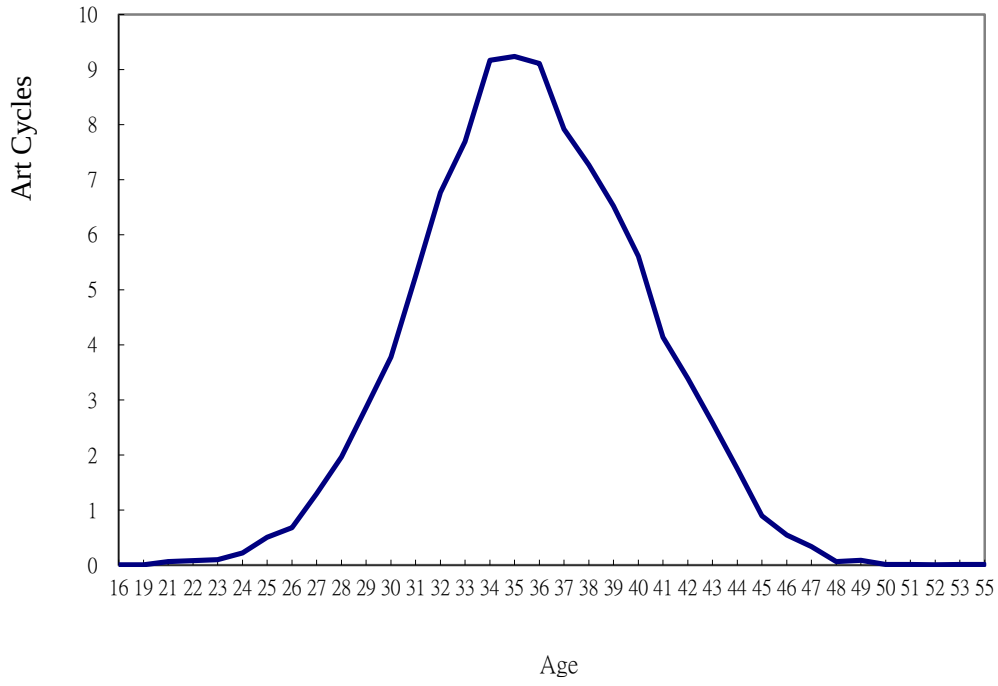

Figure 13 Ages Distribution of Women Receiving ART Cycles Using Fresh Non-donor Eggs, Sperm, or Embryos in Taiwan, 2013

II. Pregnancy Rates and Live Birth Rates among Age Groups

Analysis of statistics on the correlation of pregnancy rates and live birth rates were conducted based on the age of women receiving ART treatments. In 2013, the pregnancy rate of ART using fresh non-donor eggs, sperm, or embryos was about 35.3%, while the crude live birth rate accounted for 25.9%. The pregnancy and live birth rates among different age groups are shown in Figure 14. As the number of ART cycles of women "Age under 24" and "age over 44" were too small, the breakdown of ages in these two groups were not carried out and these data were combined in calculations in the statistics. The graph shows that after age 30, pregnancy rates and live birth rates seem to decline following the increase in age of the women receiving the treatments.

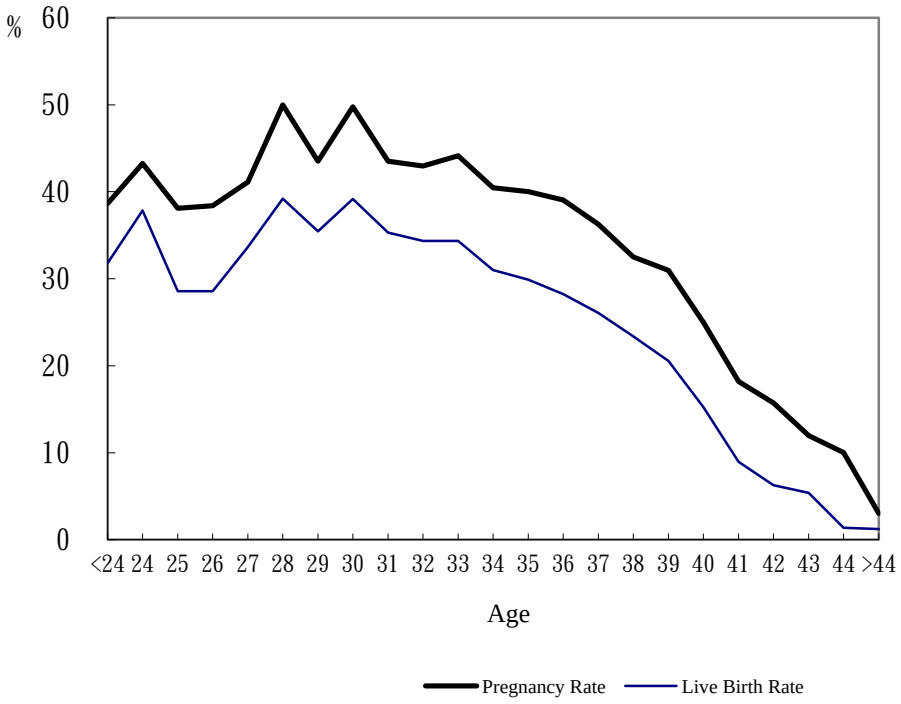

Figure 14 Correlation among the Pregnancy Rates, Live Birth Rates and the Age of Women Receiving ART Cycles Using Fresh Non-donor Eggs, Sperm, or Embryos in Taiwan, 2013

III. The Comparison between the Pregnancy Rates and Live Birth Rates Using Different Types of ART

The success rates of the ART cycles correlate not only to the age of women mentioned above, but also to the types of technology. Generally, the ZIFT/TET procedure which transfers the fertilized embryo into the fallopian tube is more compatible with the principles of natural reproduction; hence, the live birth rate achieved under this procedure is the highest. Figure 15 shows the pregnancy rates and the live birth rates of various types of ART cycles in the 16,472 non-donor (couple) ART cycles performed in year 2013. The graph shows that only 12 cycles used the ZIFT/TET type and only 1 cycle used the GIFT type; whereas, 16,311 cycles used the IVF/ET type, making it the most commonly used procedure.

The pregnancy rates achieved under the different types are: IVF/ET 35.3% (5,761/16,311), 0.0% for GIFT, 25.0% for ZIFT/TET (3/12), and 38.8% (57/147) for other types. The live birth rates are: IVF/ET 26.0% (4,233/16,311), GIFT 0.0%, ZIFT/TET 8.3% (1/12), and 26.5% (39/147) for the other types.

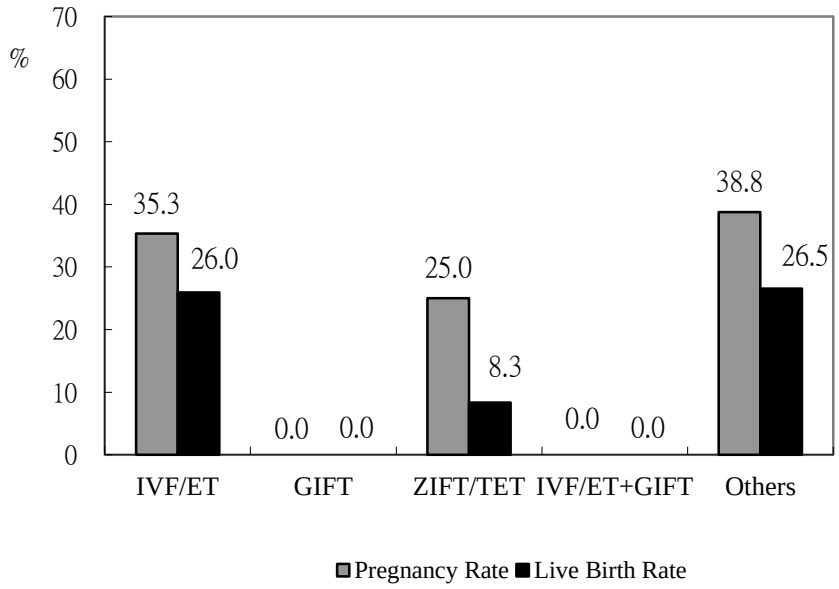

Figure 15 Correlation between Pregnancy Rates and Live Birth Rates of Various Types of ART Cycles Using Fresh Non-donor Eggs, Sperm, or Embryos in Taiwan, 2013

Note: Since GIFT was administered with only one cycle, the limited number of available samples may result in statistical bias of the success rate.

Section 2: In Vitro Fertilization

Among various treatment methods of the assisted reproductive technologies, the “In Vitro Fertilization and embryo transfer (IVF/ET)” method, generally called the test tube baby, accounted for 99.0% of total methods, making it the most commonly used procedure. This section delves into the conditions of non-donor IVF/ET cycles. The statistics are based on the individual IVF data of the couples. IVF/ET treatments using donor sperm or eggs and IVF/ET+GIFT procedures were not included in the statistics.

I. Pregnancy Rates and Live Birth Rates

In 2013, a total of 16,311 ART cycles using fresh non-donor eggs, sperm, or embryos used the IVF/ET procedure. The pregnancy rate was 35.3% with a 26.0% live birth rate (Figure 15), in which the percentage of singleton deliveries was 70.2%, twins 29.3%, and triplets 0.5%.

For women under 35 years old, the pregnancy rate might reach 42.9% if cases of male infertility are excluded. The live birth rate was raised to 33.4%.

II. Number of Embryos Transferred and Live Birth Rates

Usually, the more embryos are transferred, the higher the proportion of live births infants more than twins. From Figure 16, it is apparent that the live birth rate of transferring two embryos could reach 30.0% or higher; however, relatively, the chance of producing more fetuses in these live birth cycles would reach as high as 37.8 % (Figure 17). Figure 18 shows the distribution of the numbers of embryos transferred using the IVF procedure in ART cycles between spouses. Among all the live birth cycles, the 2-embryo transfer had the highest ratio, 37.5% of the cycles.

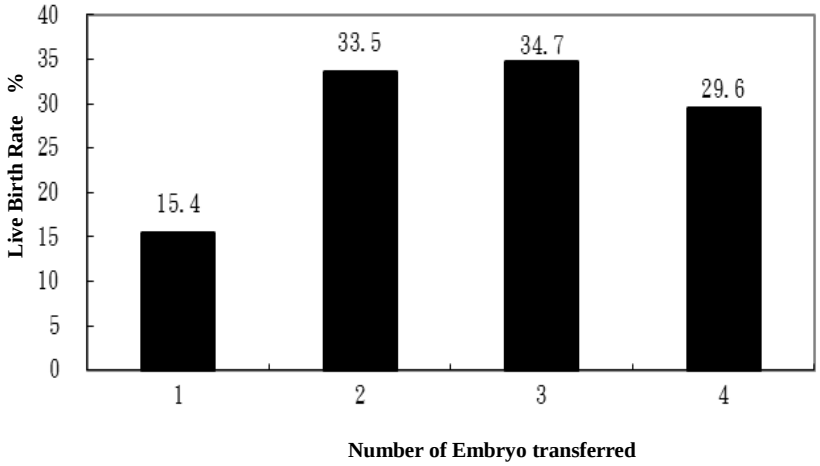

Figure 16 Correlation between Numbers of Embryos Transferred by IVF and Live Birth Rates in ART Cycles Using Fresh Non-donor Eggs, Sperm, or Embryos in Taiwan, 2013

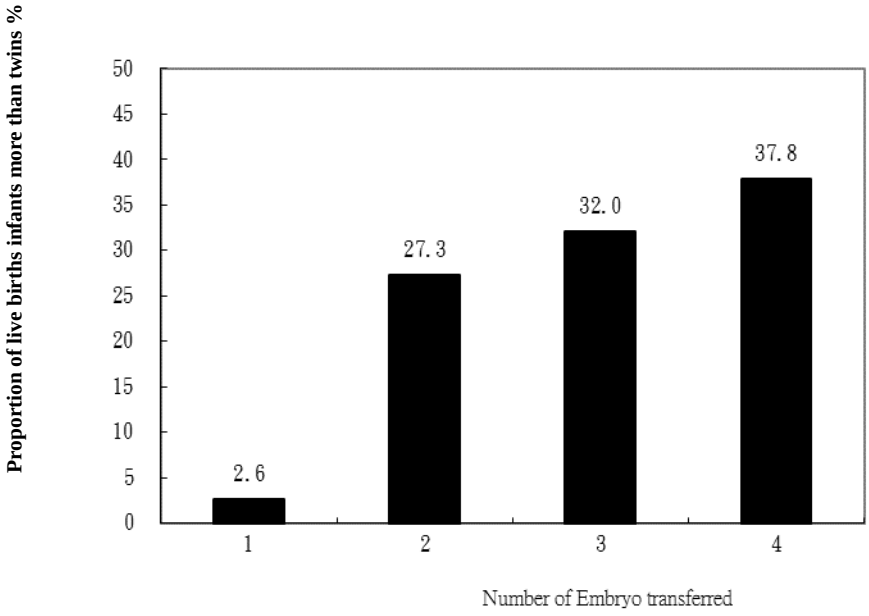

Figure 17 Proportions of Multiple-Infant Live Births More than Twins Using IVF Embryo Transfers to Overall Live Birth Cycles in ART Cycles Using Fresh Non-donor Eggs, Sperm, or Embryos in Taiwan, 2013

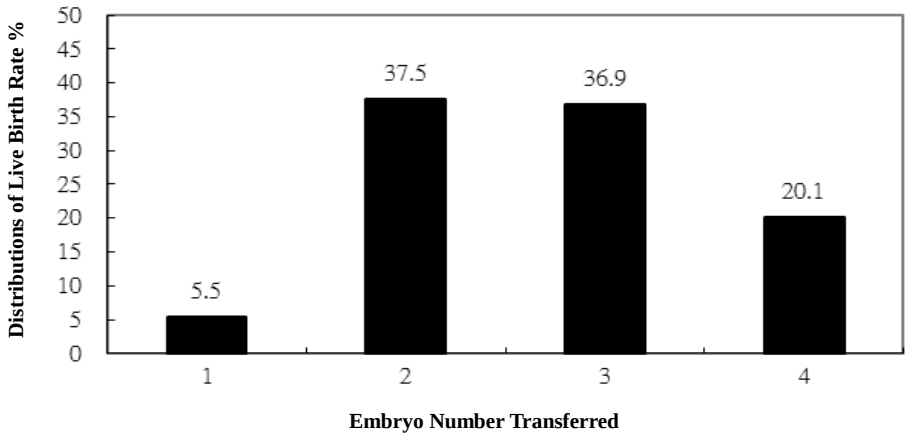

Figure 18 Distributions of Embryo Numbers Transferred by IVF in the ART Live Birth Cycles That Using Fresh Non-donor Eggs, Sperm, or Embryos in Taiwan, 2013

III. ICSI Micromanipulation Technique

In 2013, a total of 9,538 cycles using ICSI micromanipulation technique to aid pregnancy accounted for 58.5% of overall IVF treatment cycles. The pregnancy rate with the aid of the ICSI technique was 33.9%; whereas the pregnancy rate without the aid of the ICSI technique was 37.3%. On the other hand, the live birth rate with the aid of the ICSI technique was 24.6%, while the live birth rate without the aid of the ICSI technique was 27.9%.

Section 3: Status of ART Using Fresh Non-donor Embryos Transfers

This section analyses the statistics of the 10,388 cycles using fresh non-donor embryo transfers in ART cycles, which means that the transferred embryos were entering into the embryo transfer stage and neither of them was developed from donor sperm or eggs nor from frozen ones. As the assessment methods for pregnancy rate and live births rate used in this section are different from previous sections, mainly studying cycles where fresh embryos are developed from the sperm and eggs of spouses, the pregnancy and live birth success rates under assessment are the pregnancy rates of transfer cycles and the live birth rates of transfer cycles.

I. Ages and Success Rates

Pregnancy and live birth rates were significantly related to the ages of women receiving ART, particularly women over 40 years old having a low success rate. The pregnancy rate of transfer cycles for women under the age of 35 was 50.6%; but the average rate of women above the age of 40 (ages 41 – 53) dropped to 16.6%. Moreover, the difference is even more significant in the live births rate of transfer cycles; dropping from 40.3% for women under the age of 35 to 6.7% for women over the age of 40. (Figure 19)

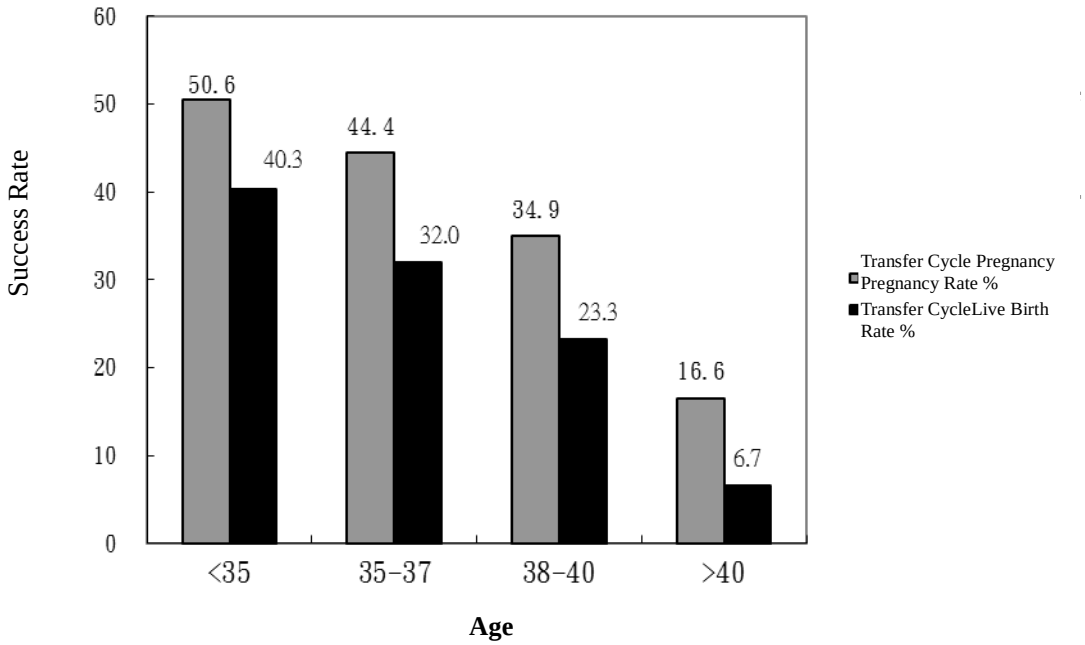

Figure 19 Pregnancy Success Rate of Fresh Embryos Transferred of Women Age at or over 40 Years in ART Cycles Using Fresh Non-donor Eggs, Sperm, or Embryos in Taiwan, 2013

Figure 20 shows the success rates of transfer cycles for women at or over the age of 40. The pregnancy rate of transfer cycles for women at the age of 40 was 28.0%, however, their live birth rate of transfer cycles dropped to 16.9%. In the cycles of women at or over the age of 42, an apparent drop was noted in the success rate of transfer cycles, and in the cycles of women at or over the age of 43 (ages 44 – 53), the pregnancy rate of transfer cycles was 10.8% (68/632) and live birth rate of transfer cycles dropped to 3.5% (22/632).

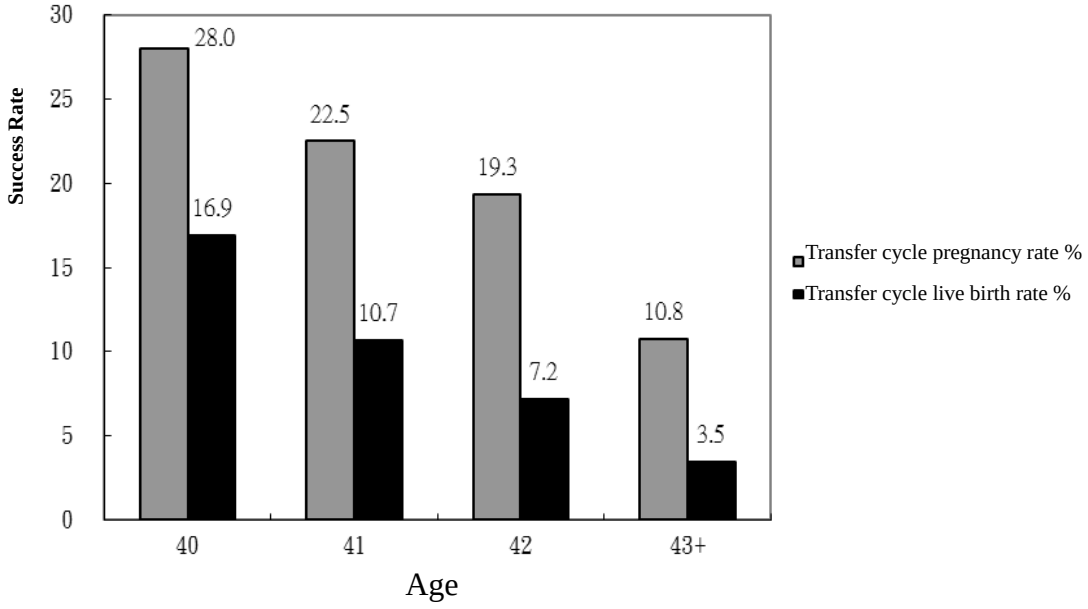

Figure 20 Pregnancy Success Rate of Fresh Embryos Transferred of Women Age at or over 40 Years in ART Cycles Using Fresh Nondonor Eggs, Sperm, or Embryos in Taiwan, 2013

II. Miscarriage Rate

Figure 21 presents the correlation between the age of pregnant women adopting fresh non-donor embryo transfers under ART treatment and the rate of natural miscarriages. The natural miscarriage rates for the pregnant women age between 19-24 were 3.6%, for pregnant women under the age of 38 were less than 20.0%; however, the miscarriage rates of women aged 40 or above increased with age, the average rate of miscarriage for women aged 40 or above was 40.6%.

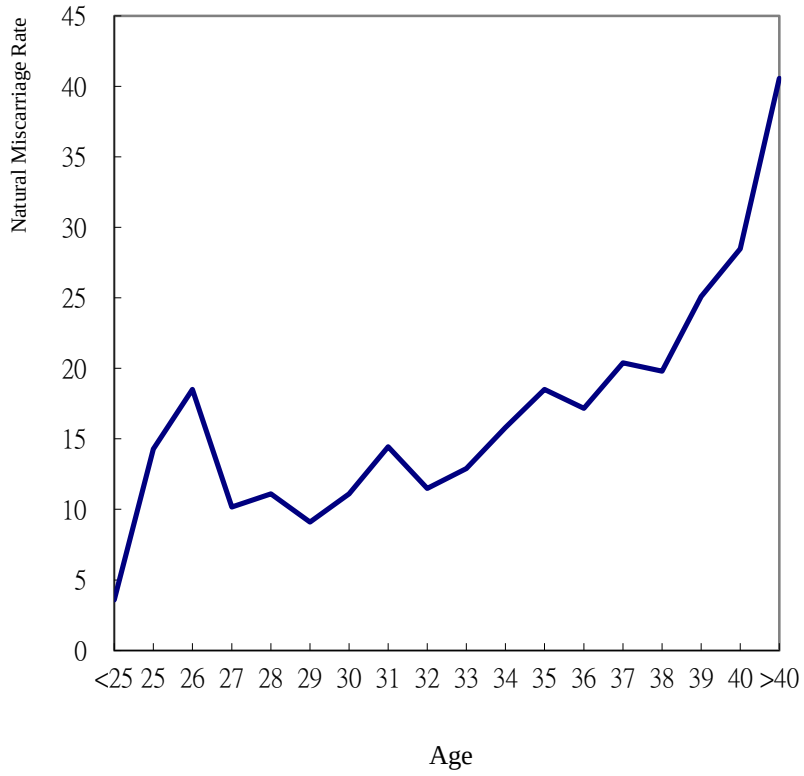

Figure 21 Natural Miscarriage Rate by Women's Age Using Fresh Embryos Transfers in ART Cycles Using Fresh Non-donor Eggs, Sperm, or Embryos in Taiwan, 2013

Section 4: Status of ART Using Frozen Non-donor Embryo Transfers

Figure 22 shows a comparison of the pregnancy rates and live birth rates and transfers of frozen and fresh embryos of ART Cycles in 2013. The pregnancy rate for frozen embryo transfer cycles was 45.9%, significantly different from the 41.1% pregnancy rate for fresh embryo transfer cycles (P=0.000001). At the same time, compared with the 34.1% live birth rate of fresh embryo transfer cycles, the 30.1% live birth rate for frozen embryo transfer cycles was significant as well (P=0.000001).

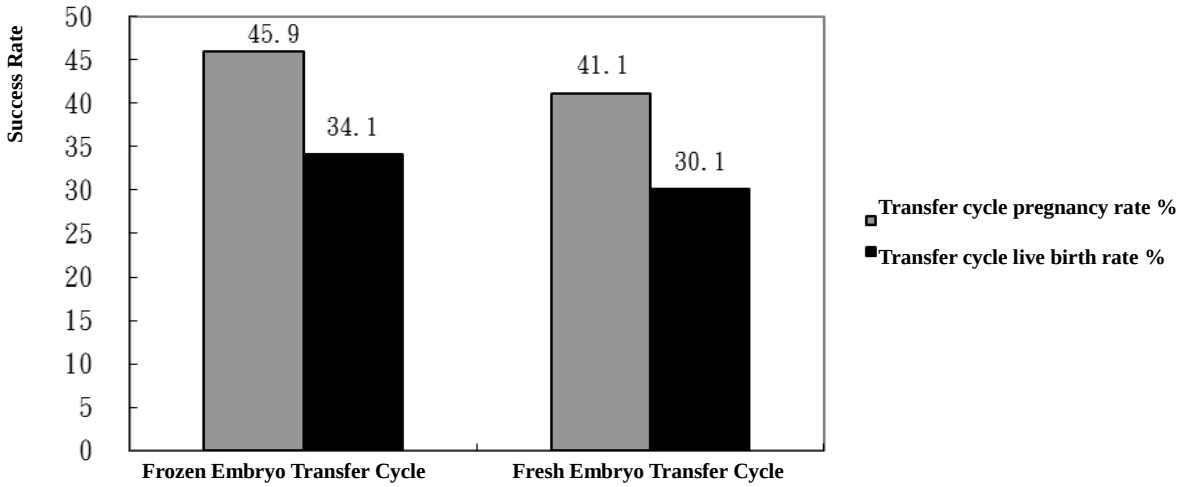

Figure 22 Comparison of Success Pregnancy Rates and Live Birth Rates between Transfers of Frozen Embryo and Fresh Embryo of ART Cycles in Taiwan, 2013

Chapter 4 ART Cycles Using Donor Eggs

Women using donor eggs face more factors affecting their pregnancies and live birth conditions than women using their own eggs in the treatment. Hence, this chapter delves into the treatment conditions for women who underwent ART cycles using donor eggs. As the effects of sperm on the pregnancy and live birth conditions are minimal, this aspect will not be discussed in this chapter regardless whether they were from donors or nondonros (couples).

Section 1 Age and Acceptance Rate

In 2013, a total of 621 cycles accepted donor eggs, and the acceptance rate increased following the increase of women's ages. Only 5.2% of the women under the age of 42 accepted donor eggs; however, after the age of 43, following the women's age increases, a corresponding rise in the indices was noted (Figure 23). In the age group of women above the ages of 45, an average of 38.2% of them received donor eggs.

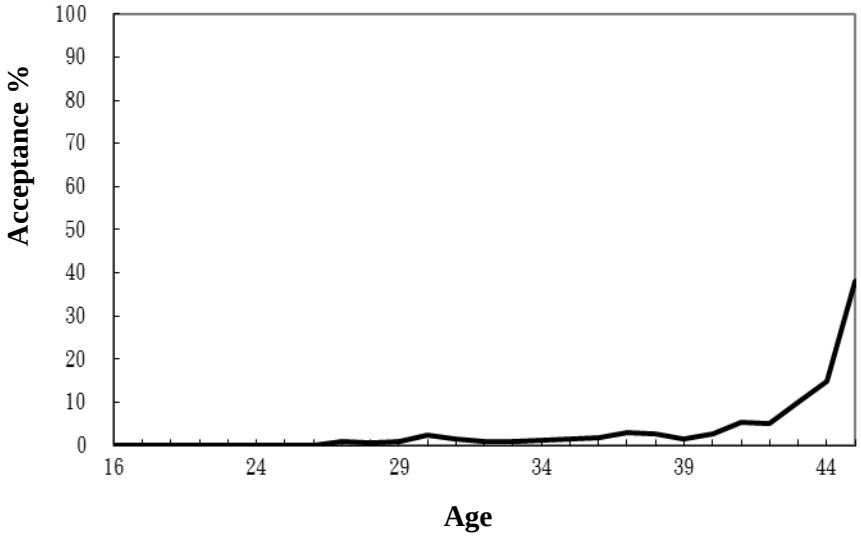

Figure 23 Correlation between the Age and Acceptance Rate of Women Receiving Donor Eggs in ART Cycles in Taiwan, 2013

Section 2: Live Birth Rate

Disregarding the effects of the frozen process on the live birth rate, this section focuses on the sources of eggs to compare the live birth rates of transfers. Based on Figure 24, the live birth rate of embryo transfer cycles seemed to be more related to the producer of the eggs. The Artificial Reproduction Act requires that the age of egg donors should be between the years of 20 and 40. While women using their own eggs came from a variety of age groups, such condition results in the difficulty to trace the fluctuations of the live birth rate of fresh embryos developed from donor eggs in various age groups. On the contrary, as the women's ages increased, a steady decline was noted in the live birth rate of transfers using fresh embryos developed from the women's own eggs.

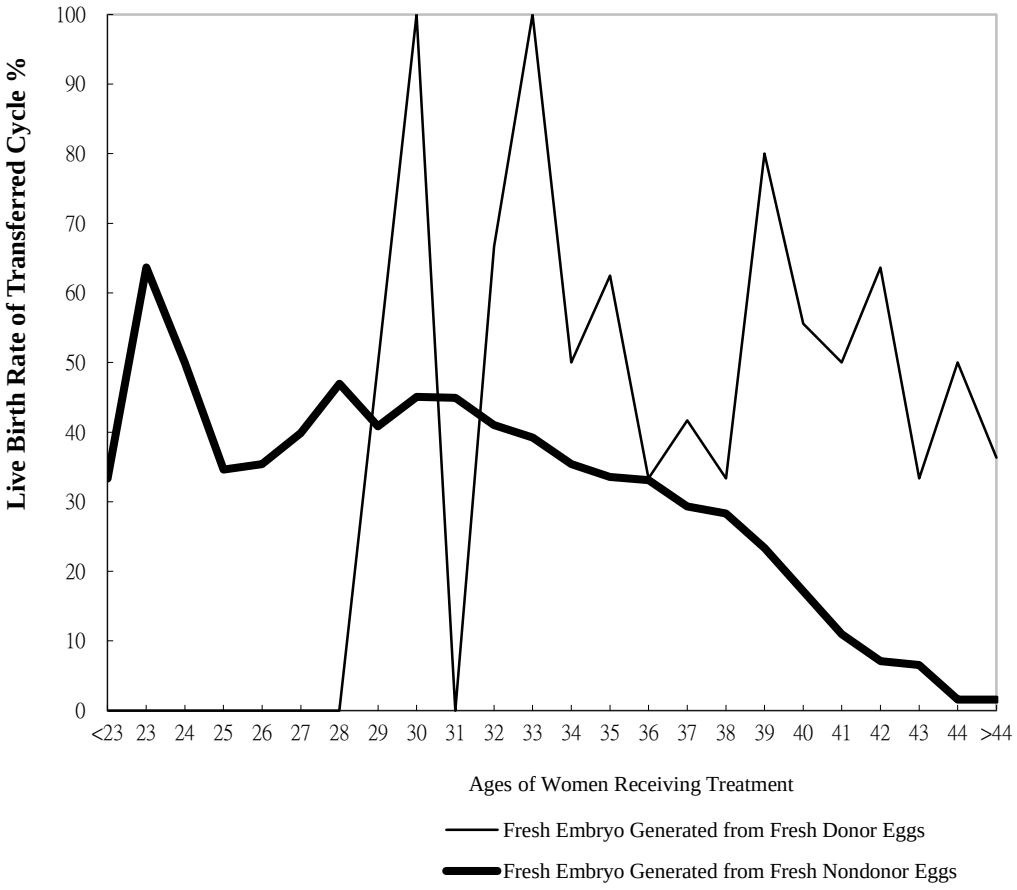

Figure 24 Correlation between the Live Birth Rate of Transfer Cycles and the Ages of Women Developing Fresh Embryos by Receiving Donor Eggs and Non-donor Eggs in ART Cycles in Taiwan, 2013

Chapter 5 Trends in ART (1998 – 2013)

This chapter analyzes trends in ART acceptance in Taiwan since 1998. Section 1 analyzes the annual statistics for treatment cycles, live birth cycles, and numbers of live born infants of ART. Section 2 analyzes the trends in live birth rates resulting from fresh embryos developed from non-donor eggs and sperm, frozen embryos developed from non-donor eggs and sperm, fresh embryos developed from donor eggs and sperm and frozen embryos developed from donor eggs and sperm. Section 3 analyzes the conditions about the live birth rate of transfer cycles conducted annually based on the age groups of participants. Section 4 delves into trends in the rate of multiple births.

Section 1: Trends of ART Cycles

1. Statistics of Treatment Cycles, Live Birth Cycles, and the Number of Live Born Infants

Figure 25 shows the number of ART cycles, live birth cycles, and live born infants during the period from 1998 to 2013. The number of ART cycles in 2003 may have been affected by the Severe Acute Respiratory Syndrome (SARS) pandemic which resulted in an apparent drop in the number of ART cycles. From 2001 to 2004, the number of treatments averaged between 6,500 and 6,700 cycles. In the years following 2005, the number exceeded 7,200 cycles and increased gradually. In 2013, it increased 8.4% to 17,393 cycles compared to 16,041 cycles in 2012.

The number of live birth cycles before 2004 ranged between 1,500 cycles and 1,800 cycles; however, in 2005, the number soared to over 2,000 cycles. This growth may be due to the increase in the acceptance for ART cycles starting in 2005 and the maturity of the technology in Taiwan. The number of live born infants maintained a stable growth; that is, an annual average of around 2,400 to 2,600 infants was born under the treatment in the period from 2001 to 2004. After 2005, around 2,800 infants were born each year. The 3,093 infants were born in 2008; and the 5,988 infants of 2013 showed an increase of 163 over the 5,825 infants of 2012.

Table 4 Numbers of Treatment Cycles, Live Birth Cycles, and Live Birth Infants of ART in Taiwan, 1998-2013

Year	Treatment Cycle (Unit: Cycle)	Live Birth Cycle (Unit: Cycle)	Live Birth Infant (Unit: Infant)
1998	7,146	1,585	2,317
1999	6,966	1,586	2,271
2000	7,038	1,664	2,358
2001	6,458	1,645	2,381
2002	6,622	1,722	2,465
2003	5,831	1,580	2,270
2004	6,792	1,849	2,598
2005	7,346	2,035	2,839
2006	7,281	2,022	2,793
2007	7,941	2,139	2,926
2008	8,354	2,265	3,093
2009	9,266	2,495	3,464
2010	11,513	3,068	4,117
2011	14,645	4,060	5,486
2012	16,041	4,394	5,825
2013	17,393	4,585	5,988
Total	146,633	38,694	53,191

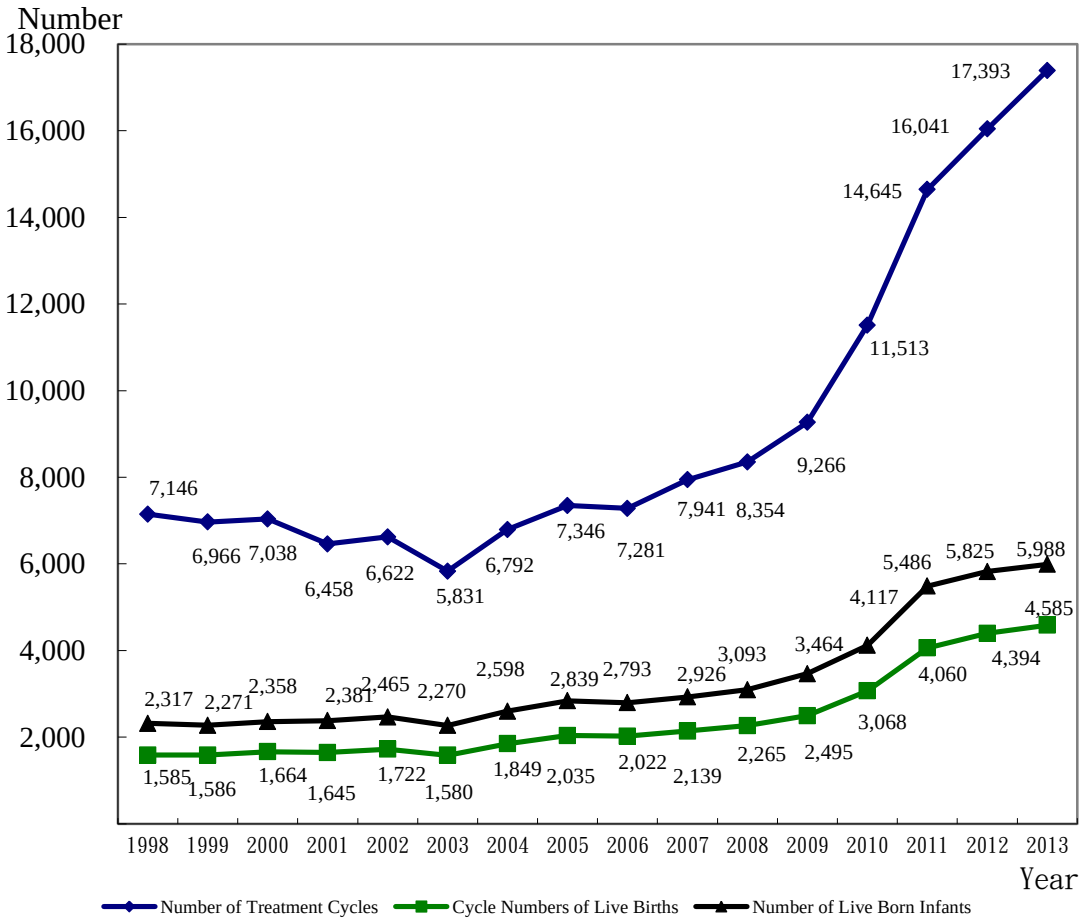

Figure 25 Numbers of ART Cycles, Live Birth Cycles, and Live Birth Infants in ART Cycles in Taiwan, 1998 - 2013

II. Pregnancy Rates and Live Birth Rates

Figure 26 illustrates the pregnancy rates and live birth rates of the ART from 1998 to 2013. With the exception of the slight decline in 2007, both the pregnancy and live birth rates for the rest of the years were comparatively stable. In 1998, the pregnancy rate was 30.5%; until 2002 the pregnancy rates had exceeded 37.0%. In 2013, the pregnancy rate was 35.8%. On the other hand, the live birth rate increased annually from 22.2% in 1998 and peaked at 27.8% in 2006; in 2013, the rate was 26.4%.

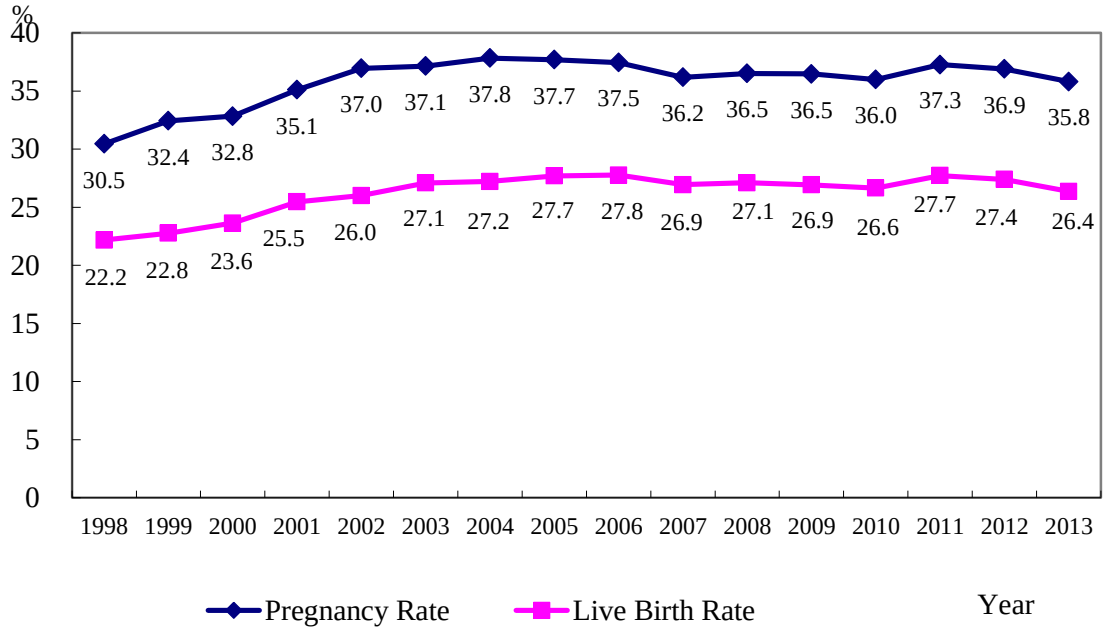

Figure 26 Pregnancy Rates and Live Birth Rates of ART Cycles in Taiwan, 1998-2013

Section 2: The Trend of Success Rates by Four Types of Transfer Cycles

I. Live Birth Rates of Transfer Cycles

Figures 27 and Figure 28 illustrate the transfer cycle live birth rates of ART using the four types of embryos (i.e., fresh and frozen embryos from eggs, and sperm both from non-donors and from donors) in the period from 1998 to 2013.

Starting from 1999, a growth trend was noted that every year in the live birth rate of transfer cycles in ART that were using fresh non-donor embryo; the live birth rate rose from 26.1% in 1998 to 30.1% in 2006. A slight drop was noted in 2007 to a rate of 29.7% which was 0.4% less than the 2006 rate. The rate in 2008 was 29.0% which was 0.7% slightly lower than the rate of 2007. The rate in 2009 was 28.8% which was 0.2% lower than the rate in 2008, the rate in 2013 was 25.0%. Fluctuation of the live birth rates of transfer cycles in ART using frozen non-donor embryos was noted in the past few years; however, after 2003, a significant growth was noted in the rate. The live birth rate of transfer cycles for 2013 was 34.1% which is 1.5% higher than the 32.6 % of 2012 (Figure 27).

The live birth rate of transfer cycles using fresh embryos developed from donor sperm or eggs was 41.9% in 2013 which had increased by 14.4% compared with 27.5% in 1998. The frozen embryos developed from donor sperm or eggs transferred were used in 272 cycles in 2012, 377 cycles in 2013 with a live birth cycle rate of 45.9% which is 1.8% higher than 44.1% in 2012 (Figure 28).

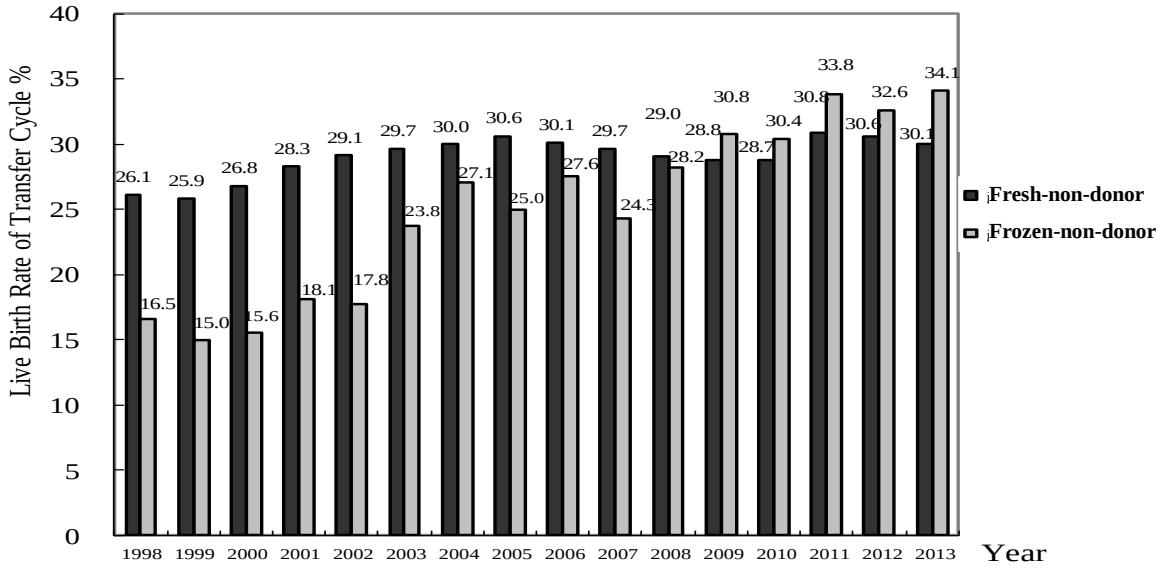

Figure 27 Live Birth Rates of Transfer Cycle Using Fresh Embryos and Frozen Embryos Made from Non-donor Sperm and Eggs in Taiwan, 1998-2013

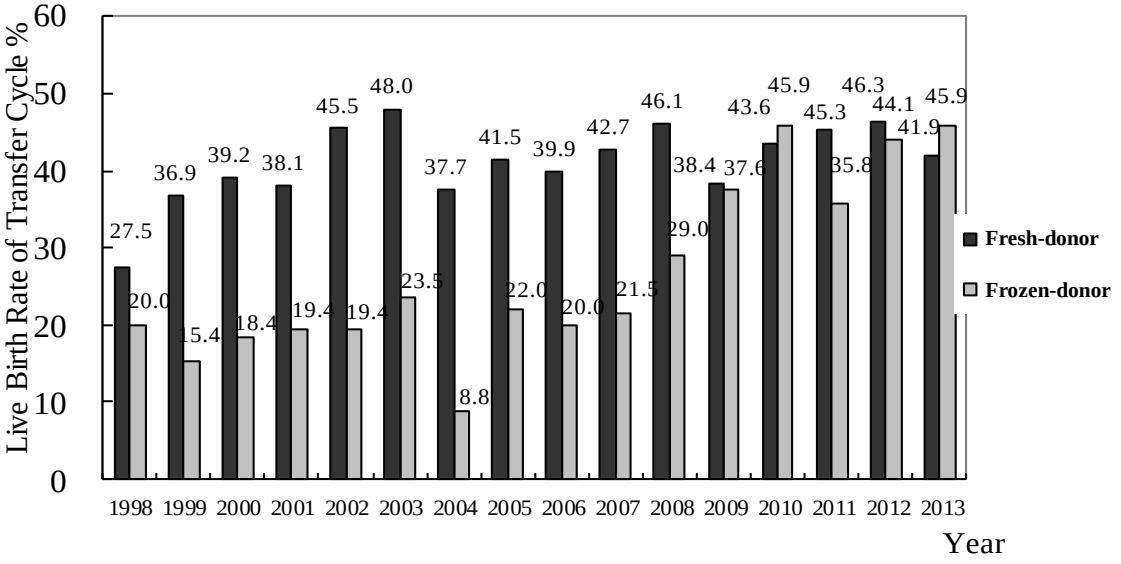

Figure 28 Live Birth Rates of Transfer Cycle Using Fresh Embryos and Frozen Embryos Made from Donor Sperm or Eggs in Taiwan, 1998-2013

II. Single-Birth rate of Transfer Cycles

Single-birth rate is a very important index in the measurement of success. Compared with multiple birth deliveries, the singleton rate involves lower childbirth risks such as premature birth, underweight, congenital defects, and stillbirth. Figure 29 and 30 show separately the singleton rates for the four types of ART cycles in the period from 1998 to 2013; that is, the fresh and frozen embryos from eggs and sperm from non-donors and from donors.

The singleton rates of ART transfer cycles using fresh non-donor embryos showed an annually growing trend starting from 1998; the rate reached 15.1% in 1998 and 21.0% in 2013. The singleton rates of Art transfer cycles using frozen non-donor embryos showed the significant increased to 19.6% in 2004. In 2013, the rate was 24.4% (Figure 29). However, a fluctuating trend was noted in the singleton rate of transfer cycles using fresh embryos and frozen embryos developed from donor sperm and eggs (Figure 30).

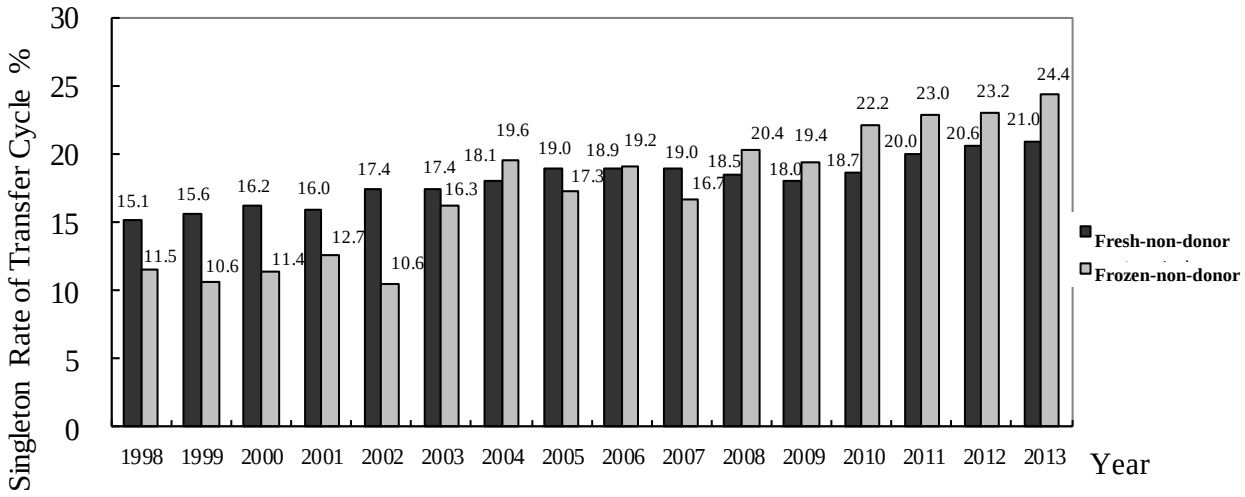

Figure 29 Singleton Rates of Transfer Cycle Using Fresh Embryos and Frozen Embryos Made from Non-donor Sperm and Eggs in Taiwan, 1998-2013

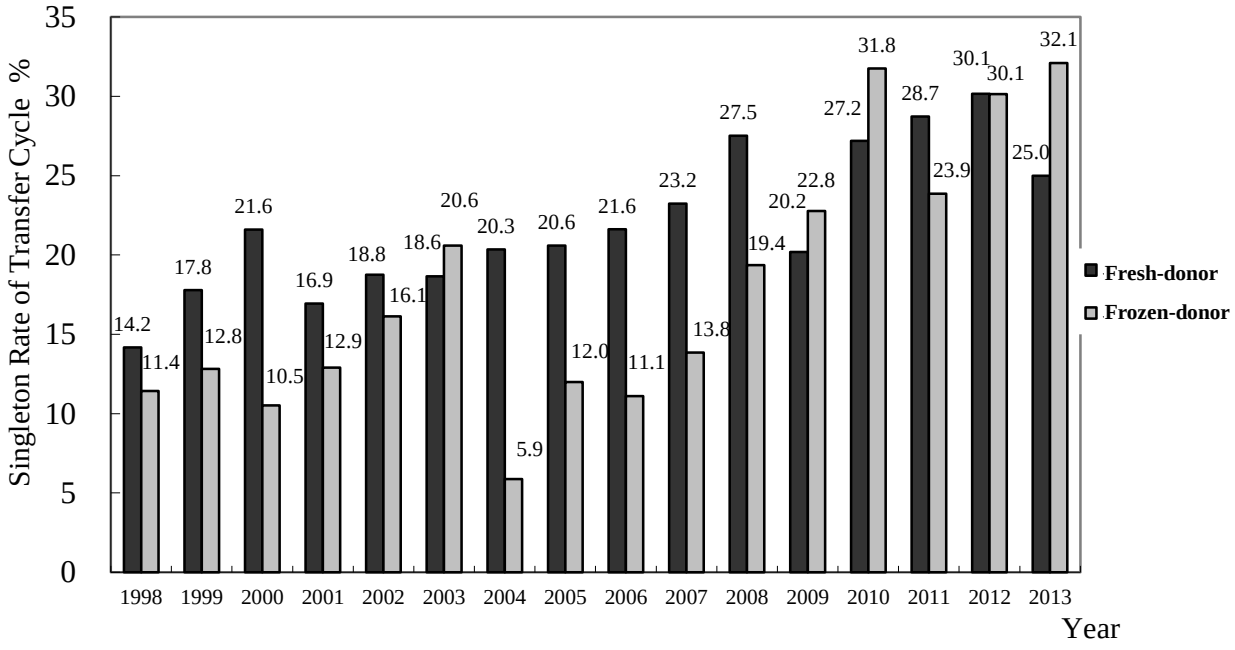

Figure 30 Singleton Rates of Transfer Cycle Using Fresh Embryos and Frozen Embryos Made from Donor Sperm and Eggs in Taiwan, 1998-2013

Section 3: Success Rates of Transfer Cycles of Various Age Groups

Figure 31 shows the live birth rate of ART transfer cycles using fresh non-donor embryos conducted in the period from 1998 to 2013 which was based on the ages of the women receiving the treatment. During this period, the live birth rate of the transfer cycles for women under 35 years old increased by 11.1%, from 29.2% in 1998 to 40.3% in 2013. In the same period, the live birth rate of the transfer cycles for women between the aged of 35 and 37 increased by 7.6%, for women between the age of 38 and 40 years old the rate increased by 6.2%, and between the aged of 41 and 42 years old the rate increase by 1.3%; however, for women aged over 42 years, live births rate declined by 2.4%.

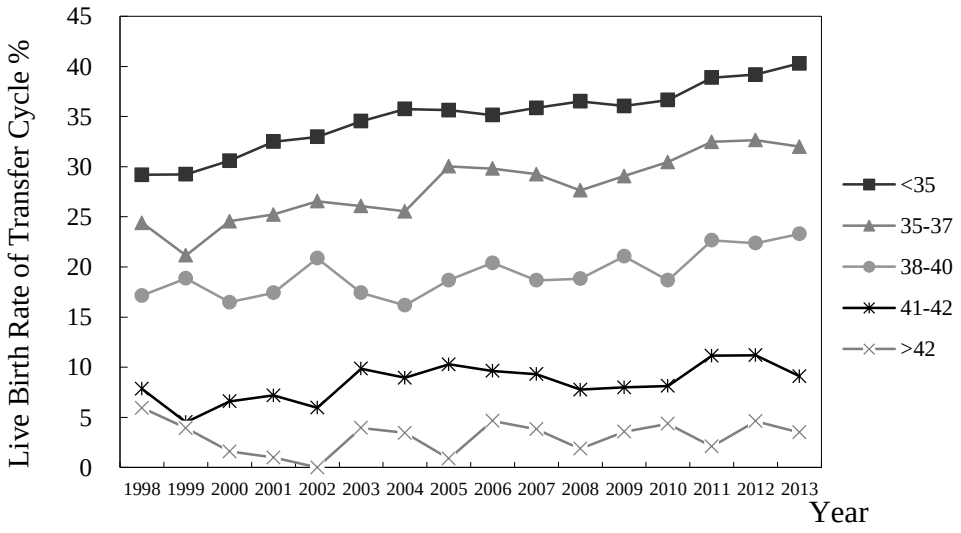

Figure 31 Live Birth Rate of Transfer Cycle Using Fresh Non-donor Embryos in Taiwan, 1998-2013 (By Ages Groups of Treated Women)

Figure 32 shows the single-fetus rate of ART transfer cycles using fresh non-donor embryos conducted in the period from 1998 to 2013 based on the ages of the women receiving the treatment. During this period, the singleton rate of the transfer cycles by women 35 years or under rose by 10.2%, from 15.9% in 1998 to 26.1% in 2013. In the same period, the singleton rate of the transfer cycles by women between the aged of 35 and 37 rose by 6.3%, women aged between 38 and 40 raised by 6.9%, and that of women aged between 41 and 42 rose by 2.0%. However, the singleton rate of women aged over 42 declined by 2.7%.

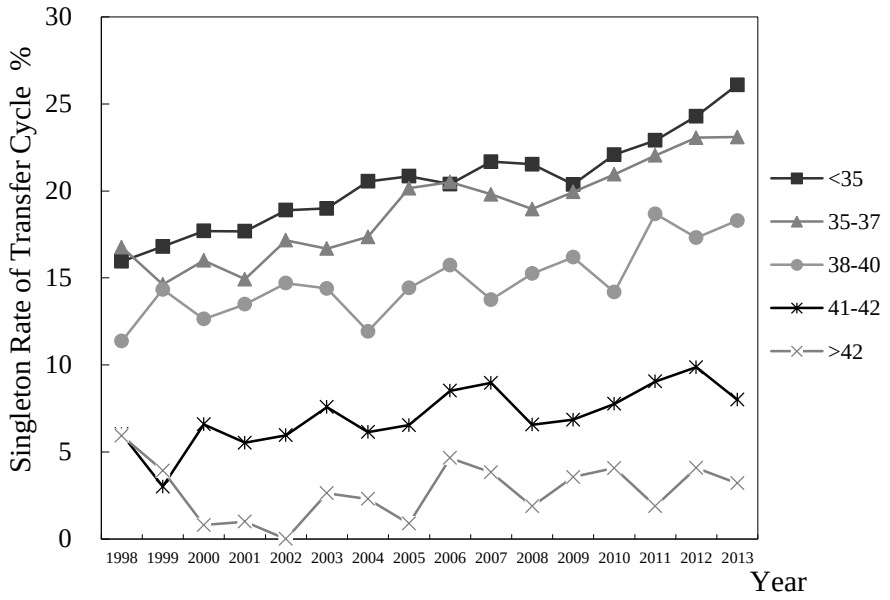

Figure 32 Singleton Rate of Transfer Cycle Using Fresh Non-donor Embryos in Taiwan, 1998-2013 (By Ages Groups of Treated Women)

Section 4: Trends for Multiple Birth Rates

Multiple birth deliveries bring higher risks to both mother and infants in terms of caesarean sections, premature births, underweight, congenital defects of infants, and stillbirths. Figures 33 and Figure 34 separately show the ratio of multiple birth rates in the live birth cycles of the four types of ART cycles; that is, ART transfer cycles using fresh embryos and frozen embryos made from non-donor sperm and eggs and the transfer cycles using fresh embryos and frozen embryos made from donor sperm and eggs.

As shown in Figures 33 and Figure 34, it is evident that a stable rate around 40% was maintained in the multiple birth rates of the live birth cycles of ART transfer cycles using fresh non-donor embryos in the period from 1998 to 2004; however, a declining trend was noted after 2004. The rate of 35.1% in 2011 was 0.2% lower than the rate in 2010, and the rate of 32.5% in 2012 was 2.6% lower than that for 2011. The rate of 30.3% in 2013 was 2.3% lower than 2012. Compared with the rate in 1998, the multiple birth rates of the live birth cycles of ART transfer cycles using fresh non-donor embryos in 2013 dropped by 11.7% (from 42.0% of 1998 to 30.3% of 2013). Fluctuations in the other three types were more significant; the multiple birth rate of the live birth cycles of ART transfer cycles using frozen non-donor embryos was 28.5% in 2013, 0.5% lower than the rate in 2012; whereas, the multiple birth rate of the live birth cycles using frozen embryos that were made from donor sperms or egg was 40.3% in 2013 which was 8.1% less than 48.4% of 1998, also a 5.5% more than the 34.8% in 2012; the multiple birth rate of the live birth cycles of ART transfer cycles using frozen embryos made from donors sperm and eggs was 30.1% in 2013 which was 12.8% less than the 42.9% of 1998.

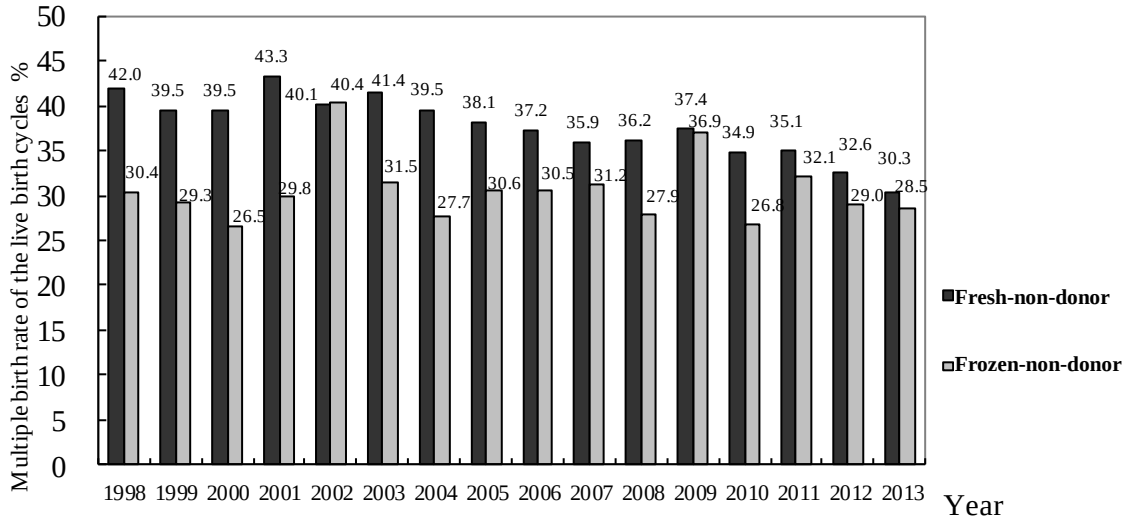

Figure 33 Multiple Births Rate of Live Birth Cycle Using Fresh Embryos and Frozen Embryos from Non-donor Sperm and Eggs in Taiwan, 1998-2013.

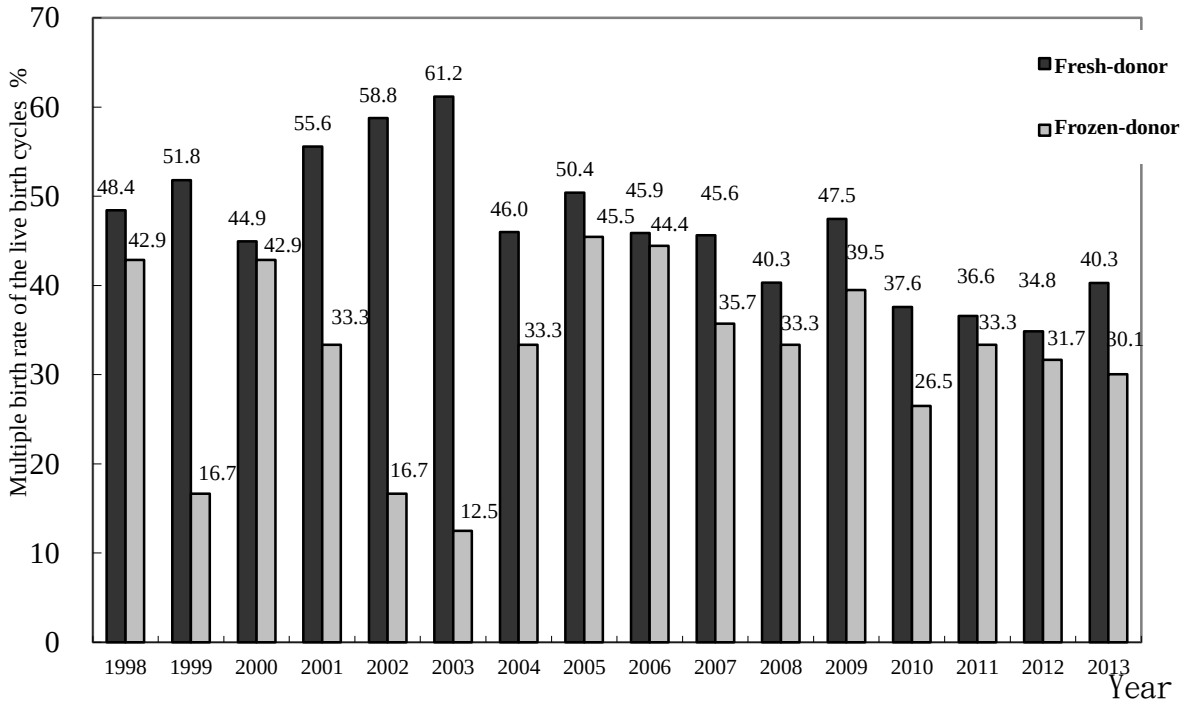

Figure 34 Multiple-Infant Live Birth Rates Using Fresh Embryos and Frozen Embryos from Donor Sperm and Eggs in Taiwan, 1998-2013

Figure 35 compares the percentages of multiple births rates of the live birth cycles in ART cycles using fresh non-donor embryos from the years 1998 to 2013. In the live birth cycles, rates of triplets or more dropped from 4.6% in 1998 to 0.5% in 2013; however, rates of twins dropped from 37.4% in 1998 to 29.7% in 2013.

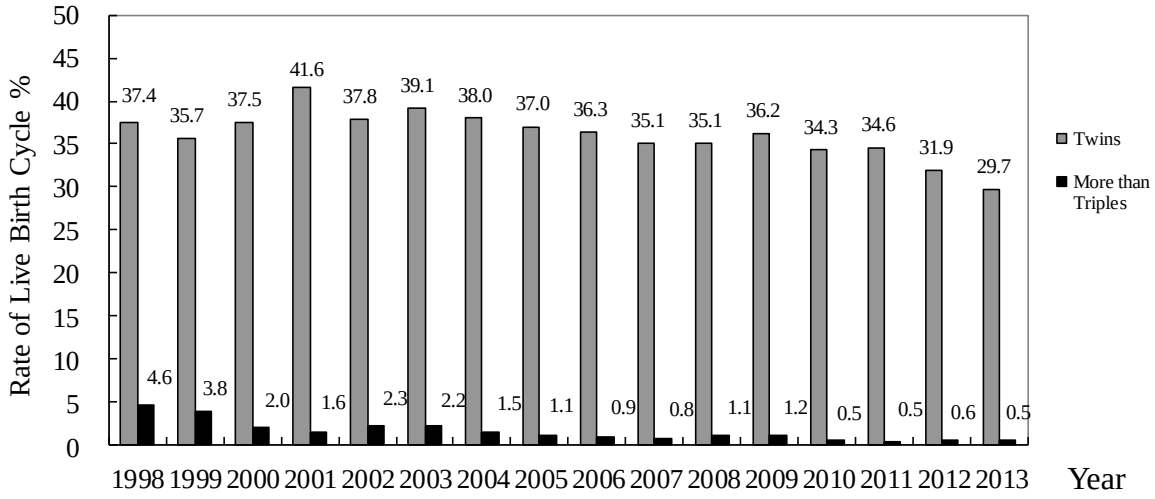

Figure 35 Twins and Triplet Birth Rate of Live Birth Cycle Using Fresh Non-donor Embryos in Taiwan, 1998-2013

Reference Websites

1. Health Promotion Administration, Ministry of Health and Welfare
   http://www.hpa.gov.tw
2. Taiwanese Society for Reproductive Medicine: http://www.tsrm.org.tw/
3. American Society for Reproductive Medicine: http://www.asrm.org/
4. Center for Disease Control and Prevention: http://www.cdc.gov/

Appendix Statistical Summary of Assisted Reproduction in 2013

Summary

Type of ART		Procedural Factors		Causes of Infertility	
IVF/ET	99%	Using ICSI	58%	Fallopian tube factor	13%
GIFT	<1%	Un-stimulated conducted	18%	Other female factors	43%
ZIFT/TET	<1%			Male factor	18%
AID	<1%			Multiple factors	23%
IVF/ET+GIFT	<1%			Unknown reasons	4%
Other Methods	<1%				

Pregnancy Success Rates

Type of Treatment Cycle	Age of Woman			
Fresh embryos of ART Cycles	**<35**	**35-37**	**38-40**	**41-42**
Total Number of Treatment Cycles	5,188	3,434	2,673	1,128
Percentage of pregnancy cycles	41.5	36.8	27.7	16.3
Percentage of live birth cycles	33.1	26.5	18.5	7.6
Live birth rate of egg retrieval cycles	33.7	27.1	19.0	7.6
Number of transfer cycles	4,246	2,822	2,096	838
Live birth rate of transfer cycles	40.4	32.2	23.6	10.3
Single-fetus live birth rate of transfer cycles	26.1	23.2	18.4	8.6
Percentage of cancellation	18.7	18.3	22.1	26.2
Average number of embryos transferred	2.6	2.7	2.8	2.7
Percentage of multiple births in live birth cycles	35.4	27.9	22.2	16.3

Frozen embryos of ART Cycles	**<35**	**35-37**	**38-40**	**41-42**
Total Number of Treatment Cycles	1,733	1,044	640	196
Percentage of pregnancy cycles	49.3	44.4	42.2	33.7
Percentage of live birth cycles	37.9	33.7	29.7	20.4
Live birth rate of egg retrieval cycles	14.3	45.5	14.3	0.0
Number of transfer cycles	1,668	1,018	616	189
Live birth rate of transfer cycles	39.4	34.6	30.8	21.2
Single-fetus live birth rate of transfer cycles	26.4	24.7	26.0	19.0
Percentage of cancellation	99.7	99.0	99.4	98.5
Average number of embryos transferred	2.4	2.5	2.6	2.4
Percentage of multiple births in live birth cycles	32.9	28.7	15.8	10.0

Fresh embryos of non-donor eggs	**<35**	**35-37**	**38-40**	**41-42**
Total Number of Treatment Cycles	5,148	3,380	2,636	1,091
Percentage of pregnancy cycles	49.3	44.4	42.2	33.7
Percentage of live birth cycles	33.1	26.5	18.3	7.0

Live birth rate of egg retrieval cycles	33.7	27.1	18.8	7.2
Number of transfer cycles	4,224	2,793	2,073	821
Live birth rate of transfer cycles	40.3	32.1	23.3	9.3
Single-fetus live birth rate of transfer cycles	26.0	23.2	18.3	8.0
Percentage of cancellation	18.4	17.7	21.7	24.9
Average number of embryos transferred	2.6	2.7	2.8	2.7
Percentage of multiple births in live birth cycles	35.4	27.8	21.3	13.2

Frozen embryos of non-donor eggs	**<35**	**35-37**	**38-40**	**41-42**
Total Number of Treatment Cycles	1,691	1,007	603	162
Percentage of pregnancy cycles	49.4	44.5	40.6	25.9
Percentage of live birth cycles	38.1	33.8	28.4	14.2
Live birth rate of egg retrieval cycles	14.3	45.5	0.0	0.0
Number of transfer cycles	1,636	983	580	155
Live birth rate of transfer cycles	39.4	34.6	29.5	14.8
Single-fetus live birth rate of transfer cycles	26.4	24.8	25.0	14.2
Percentage of cancellation	99.7	99.0	99.5	98.1
Average number of embryos transferred	2.4	2.5	2.6	2.5
Percentage of multiple births in live birth cycles	32.9	28.2	15.2	4.3

Fresh embryos of non-donor sperms	**<35**	**35-37**	**38-40**	**41-42**
Total Number of Treatment Cycles	5,062	3,392	2,645	1,116
Percentage of pregnancy cycles	41.6	36.7	27.6	16.3
Percentage of live birth cycles	33.2	26.4	18.5	7.5
Live birth rate of egg retrieval cycles	33.7	27.0	19.0	7.5
Number of transfer cycles	4,153	2,794	2,072	828
Live birth rate of transfer cycles	40.4	32.1	23.6	10.1
Single-fetus live birth rate of transfer cycles	26.2	23.2	18.3	8.6
Percentage of cancellation	18.3	18.1	22.0	26.3
Average number of embryos transferred	2.6	2.7	2.8	2.7
Percentage of multiple births in live birth cycles	35.2	27.8	22.5	15.5

Frozen embryos of non-donor sperms	**<35**	**35-37**	**38-40**	**41-42**
Total Number of Treatment Cycles	1,684	1,025	625	195
Percentage of pregnancy cycles	49.2	44.4	41.9	33.3
Percentage of live birth cycles	37.6	33.9	29.4	20.0
Live birth rate of egg retrieval cycles	14.3	45.5	14.3	0.0
Number of transfer cycles	1,621	999	601	188
Live birth rate of transfer cycles	39.0	34.7	30.6	20.7
Single-fetus live birth rate of transfer cycles	26.0	24.7	26.0	18.6
Percentage of cancellation	99.7	99.0	99.4	98.5
Average number of embryos transferred	2.4	2.5	2.6	2.5
Percentage of multiple births in live birth cycles	33.3	28.8	15.2	10.3

Fresh embryos between spouses	**<35**	**35-37**	**38-40**	**41-42**
Total Number of Treatment Cycles	5,022	3,338	2,608	1,079
Percentage of pregnancy cycles	41.6	36.8	27.5	15.8
Percentage of live birth cycles	33.2	26.5	18.3	6.9
Live birth rate of egg retrieval cycles	33.7	27.1	18.8	7.1
Number of transfer cycles	4,131	2,765	2,049	811
Live birth rate of transfer cycles	40.3	32.0	23.3	9.1
Single-fetus live birth rate of transfer cycles	26.1	23.1	18.3	8.0
Percentage of cancellation	18.0	17.5	21.6	25.0
Average number of embryos transferred	2.6	2.7	2.8	2.7
Percentage of multiple births in live birth cycles	35.3	27.6	21.6	12.2

Frozen embryos between spouses	**<35**	**35-37**	**38-40**	**41-42**
Total Number of Treatment Cycles	1,642	988	588	161
Percentage of pregnancy cycles	49.3	44.4	40.3	25.5
Percentage of live birth cycles	37.8	33.9	28.1	13.7
Live birth rate of egg retrieval cycles	14.3	45.5	0.0	0.0
Number of transfer cycles	1,589	964	565	154
Live birth rate of transfer cycles	39.0	34.8	29.2	14.3
Single-fetus live birth rate of transfer cycles	26.0	24.9	25.0	13.6
Percentage of cancellation	99.7	99.0	99.5	98.1
Average number of embryos transferred	2.4	2.5	2.6	2.5
Percentage of multiple births in live birth cycles	33.4	28.4	14.5	4.5

	All Ages Combined	
Donor eggs	**Fresh Embryos**	**Frozen Embryos**
Numbers of transfer cycles	172	295
Percentage of live birth cycles in transfer cycles	46.5	46.4
Average number of embryos transferred	2.5	2.0

Donor sperms	**Fresh Embryos**	**Frozen Embryos**
Numbers of transfer cycles	160	82
Percentage of live birth cycles in transfer cycles	36.9	43.9
Average number of embryos transferred	2.8	2.1

Between Spouses	**Fresh Embryos**	**Frozen Embryos**
Numbers of transfer cycles	10,388	3,374
Percentage of live birth cycles in transfer cycles	30.1	34.1
Average number of embryos transferred	2.7	2.5

The Number of Embryos Transferred and the Live Rate of Singleton

Age below 35	Number of embryos			
	1	2	3	4
The number of transferred cycles	488	2,557	1,966	897
The rate of transferred cycles	7	37	28	13
The pregnancy rate of transferred cycles	38	53	52	49
The singleton rate of fetal heart sound	88	65	60	54
The live birth rate of singletons	99	69	60	54

Age 35 to 37	Number of embryos			
	1	2	3	4
The number of transferred cycles	408	1,215	1,455	762
The rate of transferred cycles	9	27	32	17
The pregnancy rate of transferred cycles	25	46	49	47
The singleton rate of fetal heart sound	85	72	68	61
The live birth rate of singletons	96	75	71	62

Age 38 to 40	Number of embryos			
	1	2	3	4
The number of transferred cycles	320	745	844	801
The rate of transferred cycles	10	22	25	24
The pregnancy rate of transferred cycles	18	35	42	43
The singleton rate of fetal heart sound	84	75	80	67
The live birth rate of singletons	98	83	82	70

Age above 40	Number of embryos			
	1	2	3	4
The number of transferred cycles	429	596	450	530
The rate of transferred cycles	16	22	17	20
The pregnancy rate of transferred cycles	15	28	26	25
The singleton rate of fetal heart sound	85	57	69	51
The live birth rate of singletons	100	68	80	75

Numbers of assisted reproduction institutions for data reporting: 73