The Assisted Reproductive Technology Summary 2010 National Report of Taiwan

Bureau of Health Promotion, Department of Health, Executive Yuan

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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 Bureau of Health Promotion (BHP) website on which Reports of 1998 to 2009 are also available. (BHP website: http://bhp.doh.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 June 2012, the number of licensed medical institutions had reached 70 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 Bureau of Health Promotion 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 72 artificial reproduction institutions in Taiwan (2010). 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 nondonor eggs, sperm or embryos and data about the egg/sperm recipients. Chapter 3 conducts an analysis of assisted reproduction using fresh nondonor 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 nondonor 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 2010.

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 72 artificial reproduction institutions of Taiwan in the year 2010.

Section 1: Cycles and Types of Treatment

I. Number of ART Cycles

A total of 11,513 ART cycles (including cycles without completing egg retrieval or transfer) were conducted in 2010 (Table 1); among which, 529 cycles used donors sperm or eggs, and 10,984 cycles used nondonor sperm or eggs.

Table 1 ART Cycles in Taiwan, 2010

(Unit: Cycle)

Unit: Type of Cycle	Number of ART Cycles
Use of Donor Sperm and Eggs	529
Use of Donor Sperm	213
Use of Donor Eggs	316
Use of Nondonor Sperm, Eggs or Embryos	10,984
Total ART Cycles	11,513

II. Types of ART

Analysis of the types of ART revealed that more than 82.3% of treatments adopted fresh embryos (Figure 1) developed from nondonor sperm and eggs, followed by 13.1% of frozen embryos developed from nondonor sperm and eggs, and 3.3% 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 1.3%.

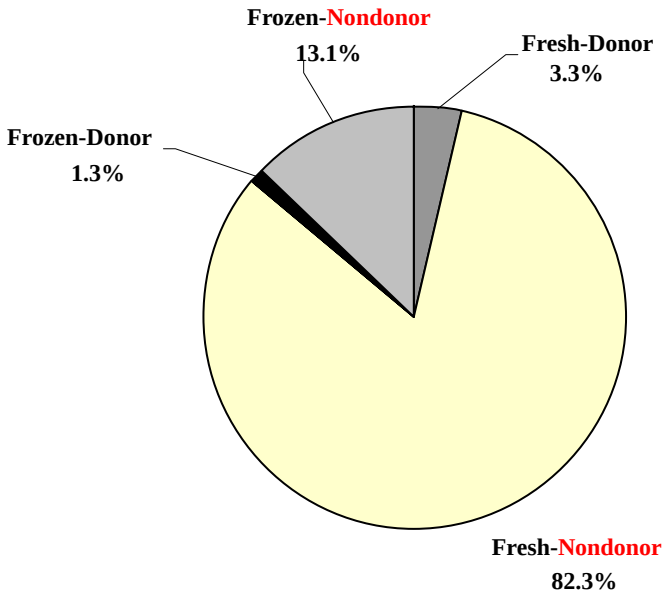

Figure 1 Types of ART Cycles in Taiwan, 2010

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 38 years (the accumulate percentages are 25% and 75%, respectively). The peak of the curve in the graph is noted at age 34 years, indicating that among women receiving the ART cycle the highest number were at age of 34, accounting for 8.7% of the total ART cycle participants. The second highest percentage was 35-year-old women, accounting for 8.5% of the total participants.

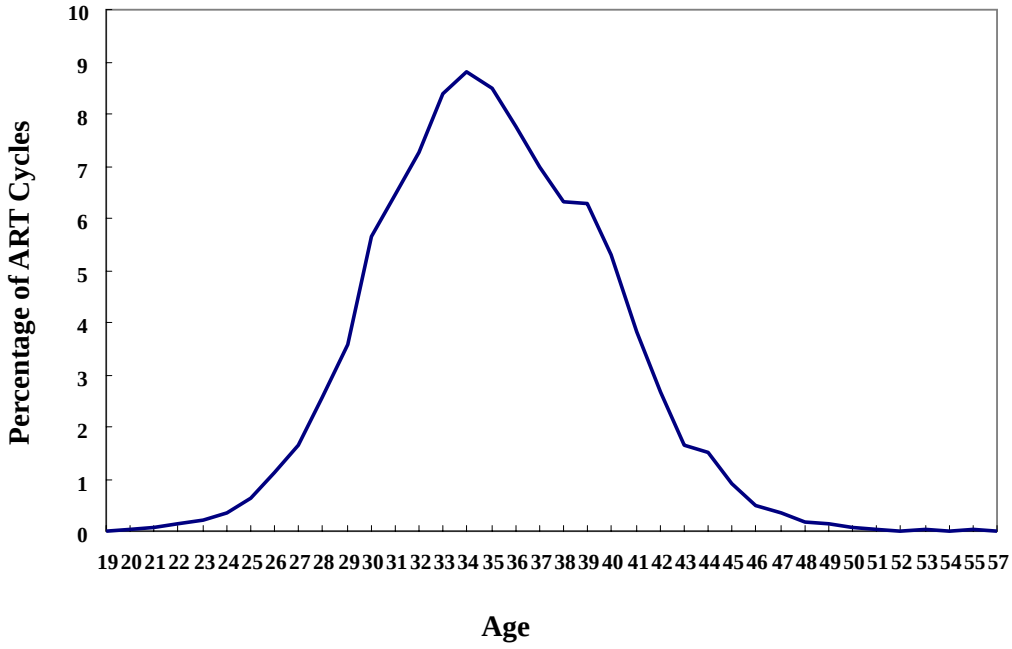

Figure 2 Age Group Distributions of Women Receiving ART in Taiwan, 2010

Section 3: Analysis of the Reasons for Infertility

Figure 3 shows the reasons for infertility of women receiving ART. 35.9% of cases were due to female-related factors unrelated to the fallopian tube, followed by 22.6% of multi-factor. Male-related causes and fallopian tube related factors comprised 22.2% and 15.0%, respectively, ranking third and fourth.

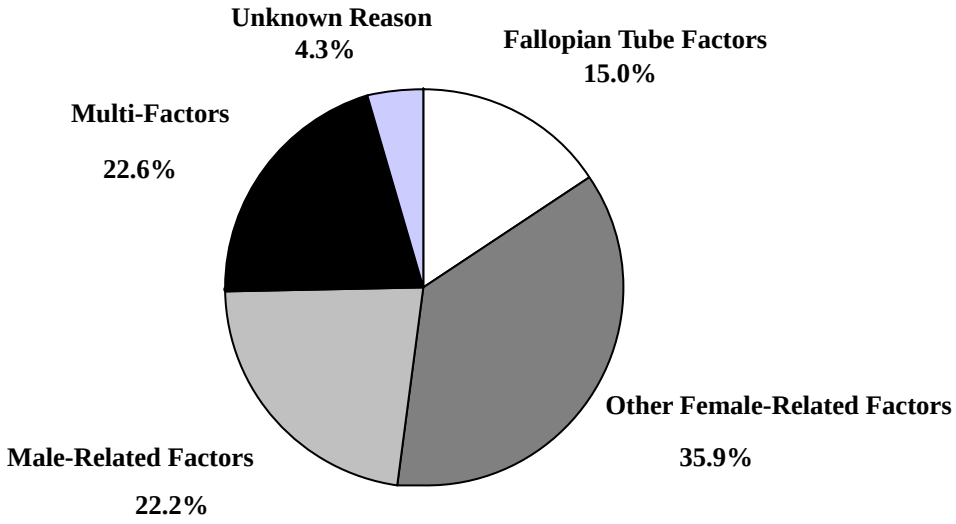

Figure 3 Reasons for Infertility of ART Cases in Taiwan, 2010

Section 4: Types of ART Used

Among the types of ART used, the most popular procedure was the IVF/ET method, taking up 98.6% of the total. Other methods comprised merely 1.0% and the rest of the methods, such as, GIFT, ZIFT/TET, AID, and the combination of IVF/ET and GIFT 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.

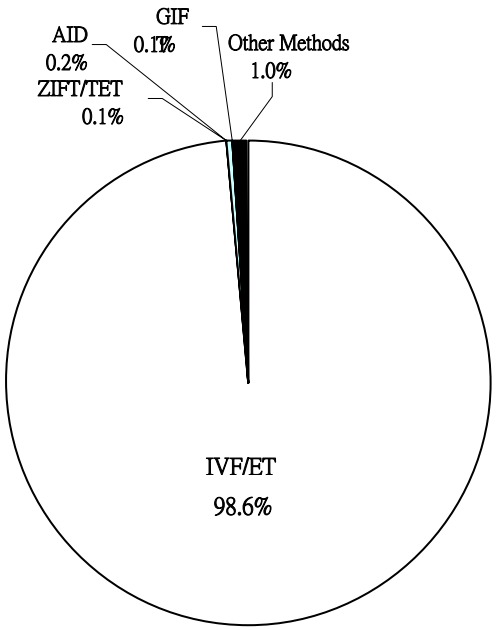

Figure 4 Types of ART Used in Taiwan, 2010

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 69.6% of the 11,513 ART cycles performed in 2010. Among these, cycles using ICSI only accounted for 27.2%; cycles using the assisted hatching technique only took up 14.2%; whereas, cycles jointly using ICSI and assisted hatching technique accounted for 27.7%. 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, 2010

Cases Using Micromanipulation	Cycles	Percentage (%)
Procedure applied	**8,010**	**69.6**
ICSI	**3,134**	**27.2**
Assisted hatching	**1,657**	**14.4**
ICSI+ Assisted hatching	**3,184**	**27.7**
Others	**35**	**0.3**
Procedure not applied	**3,503**	**30.4**
Total ART cycles	**11,513**	**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 2010 show that the majority of transfers were 4 embryos, which accounted for 37.4%; while transfers of 3 and 2 embryos were 31.6% and 21.8%, respectively.

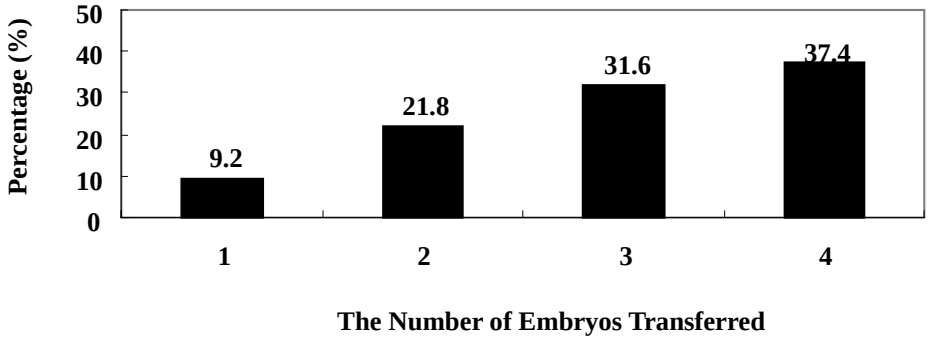

Figure 5 Percentage of Embryo Transfers Performed in ART Cycles in Taiwan, 2010

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 11,513 ART cycles in 2010, 4,144 cycles successfully led to pregnancy of which 3,068 cycles resulted in live births. However, owing to multiple births in some cycles, the number of delivery infants (4,117) is more than the number of live birth cycles. 653 more infants were delivered than in 2009.

This section 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 6 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 ACT 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 2010 was 36.0%.

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 2010 was 26.6%.

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 2010 was 26.7%; whereas, receiving ART treatment but without

the egg retrieval procedure accounted for 17.2%.

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 29.7 % in 2010; among which, the live birth rate for fresh embryo transfers was 29.3% and 31.6% for frozen embryos. The transfer cycles of frozen embryos accounted for 15.5% 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 2010 was 17.7%.

6. Single-fetus rate of transfer cycle: this refers to as the singleton live birth rate in the ART transfer cycles. This rate in 2010 was 19.7%.

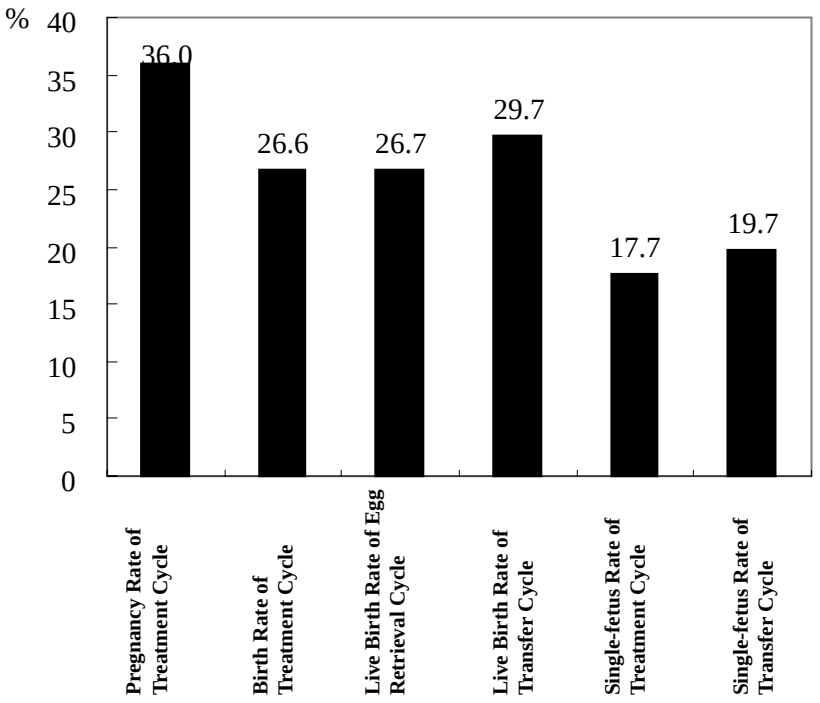

Figure 6 Analysis of Success Rates of ART Performed in Taiwan, 2010

II. Pregnancy Results

Figure 7 presents the pregnancy results of ART in 2010. Singletons were delivered in 49.1% of the pregnancy cycles and twins in 24.5%. However, 26.0% of the pregnancy cycles failed to produce any live births. The next section will analyze pregnancies that failed to result in live births.

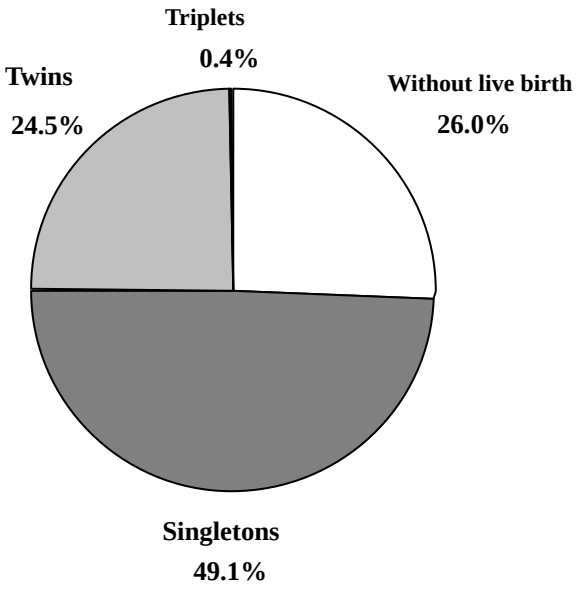

Figure 7 Analyses of Pregnancy Results of ART in Taiwan, 2010

III. Analysis of Pregnancy Cases without Live Births

The majority of the 1,076 pregnancy cases that failed to produce live births during the cycles were due to natural miscarriages, accounting for 55.1%. The second highest factor was induced abortion accounting for 29.8%, followed by ectopic pregnancies, 10.7%, and 4.7% stillbirths, as shown in Figure 8. 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, cases with unspecified conditions (1.1%) are not listed in the graph.

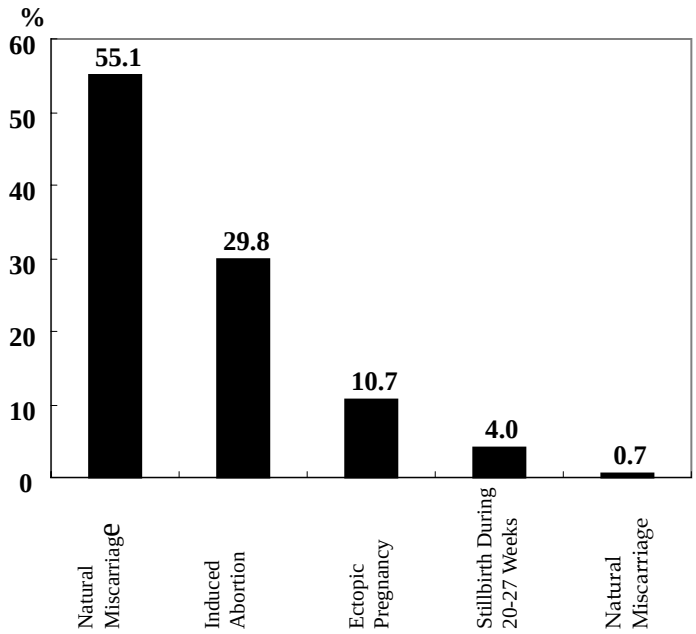

Figure 8 Analysis of Status of Pregnancies without Live Births of ART Cycles in Taiwan, 2010

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

Figure 9 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 36.5%, which was 1.1% higher than the rate for no micromanipulation technique. For the live birth rate, the rate of using the ICSI micromanipulation technique was 0.8% higher than that for no ICSI micromanipulation technique, 27.0% and 26.2%, respectively.

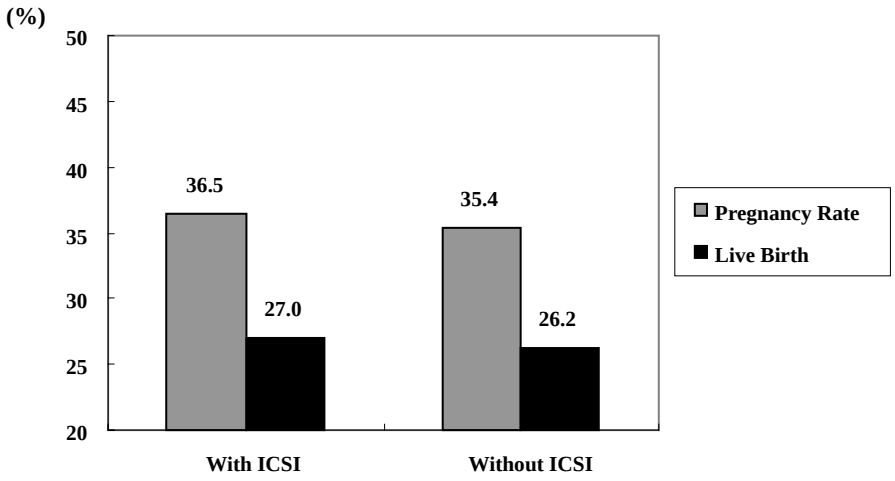

Figure 9 Correlation between the Pregnancy Rate and Live Birth Rate with/without the application of the ICSI micromanipulation technique of the ART Cycles in Taiwan, 2010

Section 8: Status of New-Born Infants

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

Among the 3,068 live birth cycles, 66.3% were singletons; twins were 33.2%, and triplets were 0.5% (Figure 10).

A total of 4,117 infants were born by way of ART in 2010, in which 2,078 infants were boys and 2,039 were girls, a sex ratio of 101.9 which showed significant improvement over the 119.2 ratio of 2009.

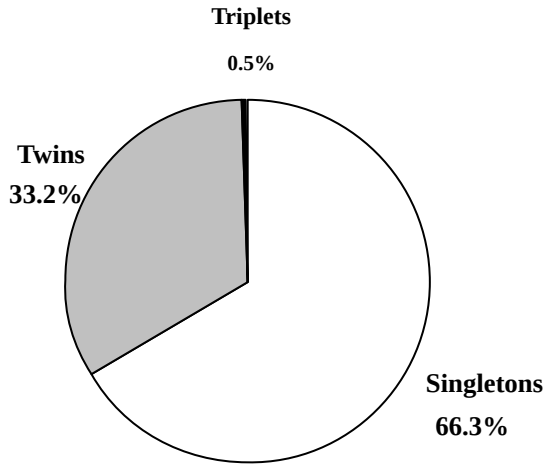

Figure 10 Percentage of the Number of Offspring in the ART Cycles Live Births in Taiwan, 2010

II. Ratio of Live Birth-Weight to Abnormalities

An observation of the 4,117 live birth infants showed that 6.1% of infants were born with body weights under 1,500 gm; 35.5% of infants were born with body weights ranging between 1,500 gm and 2,499 gm; 58.4% of infants were born with body weights more than 2,500 gm, while 1.2% of infants were born with apparent congenital defects, as shown in Table 3.

Table 3 Live Birth Infant Weights and Rates of Abnormalities of ART Cycles in Taiwan, 2010

Infant Status	Live Birth Infants	Percentage (%)
Gender		
Male	2,078	50.5
Female	2,039	49.5
Weight		
<1500 gm	252	6.1
1500-2499 gm	1,462	35.5
≥2500gm	2,403	58.4
Apparent or visible congenital defects	49	1.2

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

Figure 11 shows the correlation between the number of fetuses and infant body weights. In triplet births, 8.4% of the newborns weighed under 1,000 gm, 45.8% weighed between 1,000 gm and 1,499 gm, 45.8% weighed between 1,500 gm and 2,499 gm, and no infants weighed more than 2,500 gm. In the birth of singletons, most newborns weighted more than 2,500 gm which was 86.7%. In twin births, the largest percentage of newborns weighed between 1,500 to 2,499 gm was 61.1%, followed by 31.4% 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.

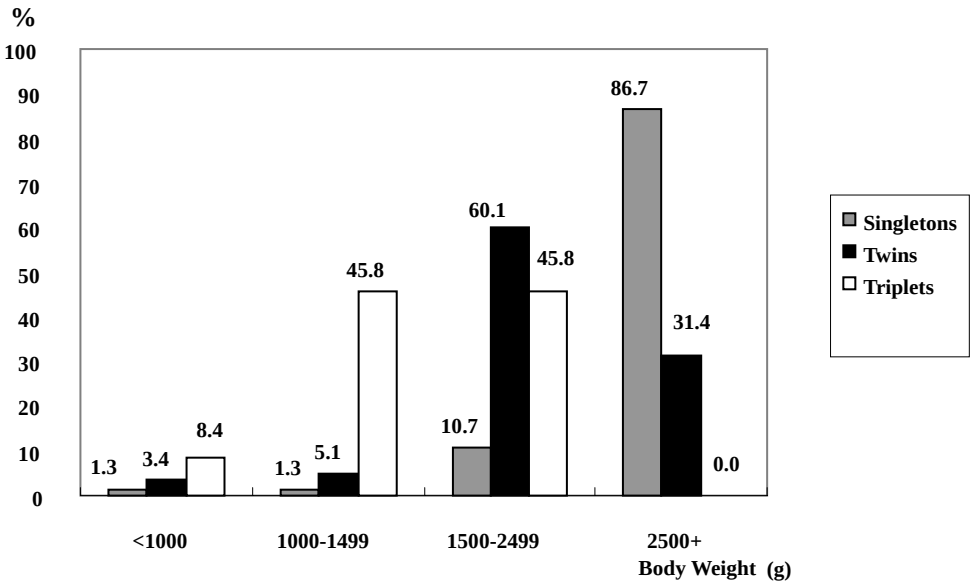

Figure 11 Correlation of Percentages Between the Number of Offspring and Weights of the ART Live Births Cycles in Taiwan, 2010

Chapter 3 ART Cycles Using Fresh Nondonor Eggs, Sperm, or Embryos

Section 1: ART Cycles Using Fresh Nondonor Eggs, Sperm, or Embryos

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

I. Age Distribution of Women Receiving Treatment

A total of 10,984 ART cycles using fresh nondonor eggs, sperm, or embryos were performed in 2010, accounting for 95.4% 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 12, in which the distribution curve is quite similar to the age distribution of all the ART cycles. (Figure 2, page 6)

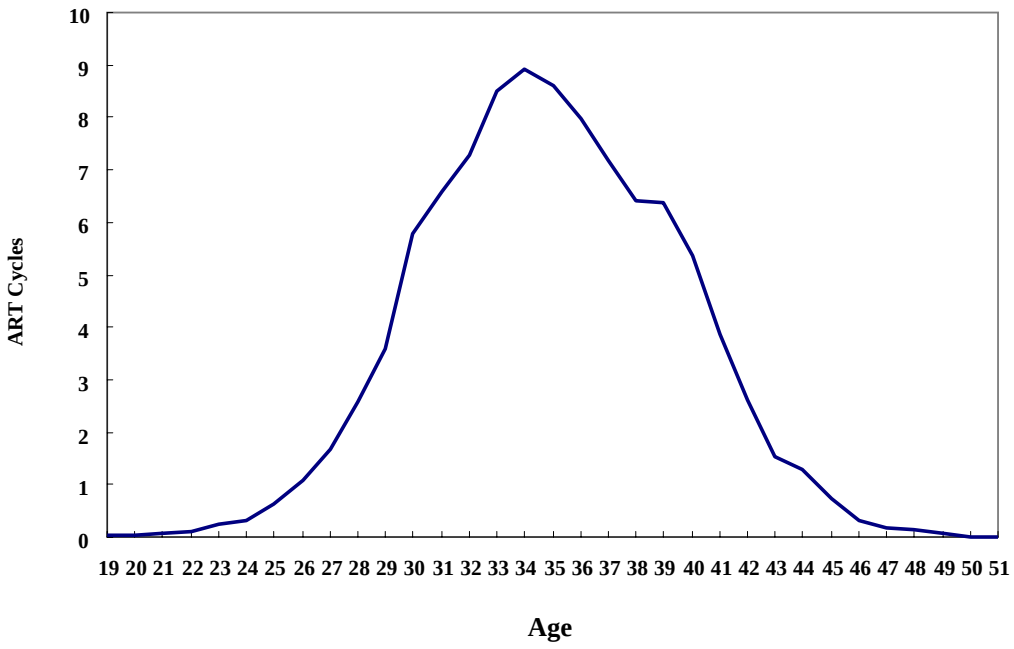

Figure 12 Ages Distribution of Women Receiving ART Cycles Using Fresh Nondonor Eggs, Sperm, or Embryos in Taiwan, 2010

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 2010, the pregnancy rate of ART using fresh nondonor eggs, sperm, or embryos was about 35.3%, while the crude live birth rate accounted for 26.0%. The pregnancy and live birth rates among different age groups are shown in Figure 13. As the number of ART cycles of women “Age under 24” and “age older than 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 29, pregnancy rates and live birth rates seem to decline following the increase in age of the women receiving the treatments.

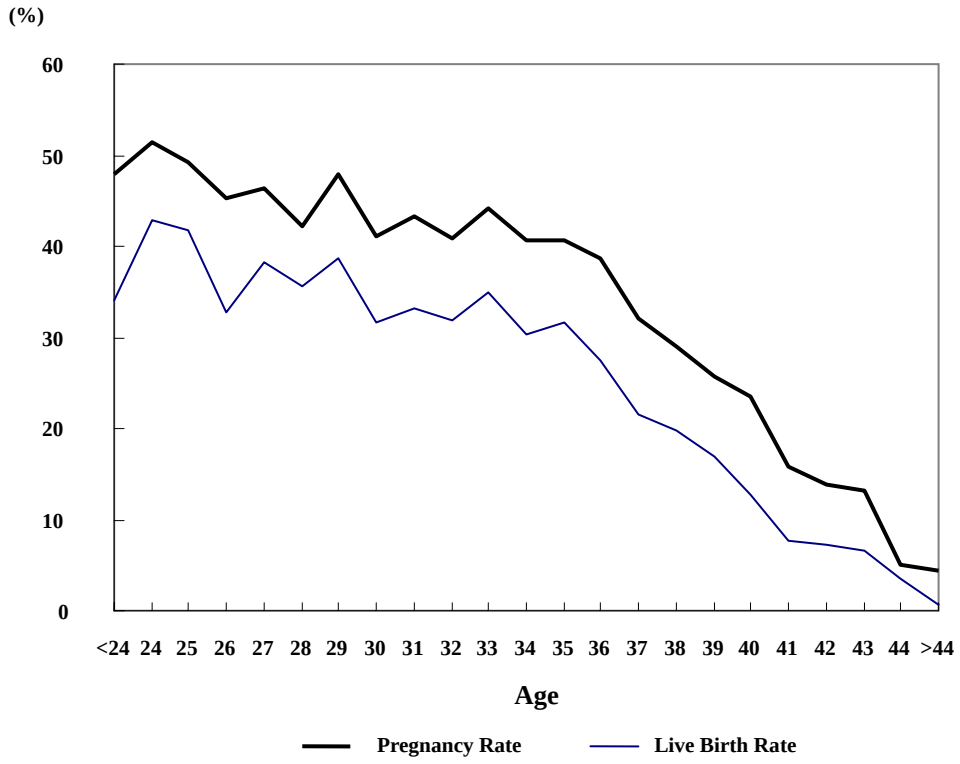

Figure 13 Correlation among the Pregnancy Rates, Live Birth Rates and the Age of Women Receiving ART Cycles Using Fresh Nondonor Eggs, Sperm, or Embryos in Taiwan, 2010

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 14 shows the pregnancy rates and the live birth rates of various types of ART cycles in the 10,984 nondonor (couple) ART cycles performed in year 2010. The graph shows that only 13 cycles used the ZIFT/TET type and only 4 cycles used the GIFT type; whereas, 10,862 cycles used the IVF/ET type, making it the most commonly used procedure.

The pregnancy rates achieved under the different types are: IVF/ET 35.4% (3,841/10,862), 25.0%（1/4）for GIFT, 38.5% for ZIFT/TET（5/13）, and 27.6% (29/105) for other types. The live birth rates are: IVF/ET 26.0% (2,828/10,862), GIFT 0.00%（0/4）, ZIFT/TET 15.4%（2/13）, and 22.9%(24/105) for the other types.

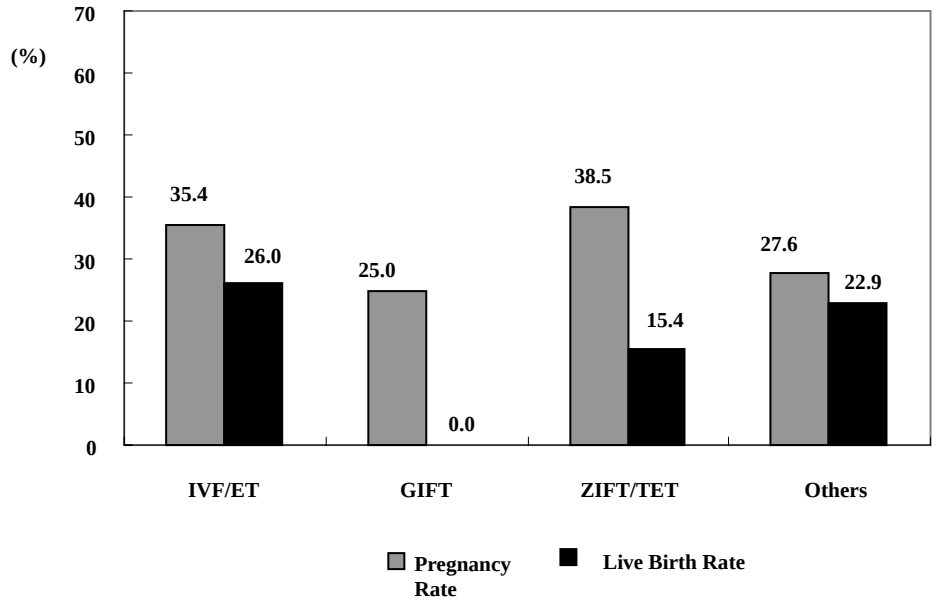

Figure 14 Correlation between Pregnancy Rates and Live Birth Rates of Various Types of ART Cycles Using Fresh Nondonor Eggs, Sperm, or Embryos in Taiwan, 2010

Note: Since GIFT was administered with only four cycles, 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 98.9% of total methods, making it the most commonly used procedure. This section delves into the conditions of nondonor 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 2010, a total of 10,862 ART cycles using fresh nondonor eggs, sperm, or embryos used the IVF/ET procedure. The pregnancy rate was 35.4% with a 26.0% live birth rate (Figure 14), in which the percentage of singleton deliveries was 66.4%, twins 33.1%, and triplets 0.5%.

For women under 35 years old, the pregnancy rate might reach 41.7% if cases of male infertility are excluded. The live birth rate was raised to 32.1%.

II. Number of Embryos Transferred and Live Birth Rates

Usually, the more embryos are transferred, the higher the ART success rate; however, the probability of bearing two or more fetuses would be accordingly higher. From Figure 15, it is apparent that the live birth rate of transferring three embryos could reach 30% or higher; however, relatively, the chance of producing more fetuses in these live birth cycles would reach as high as 35.5 % (Figure 16). Figure 17 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 4-embryo transfer had the highest ratio, 42.4% of the cycles.

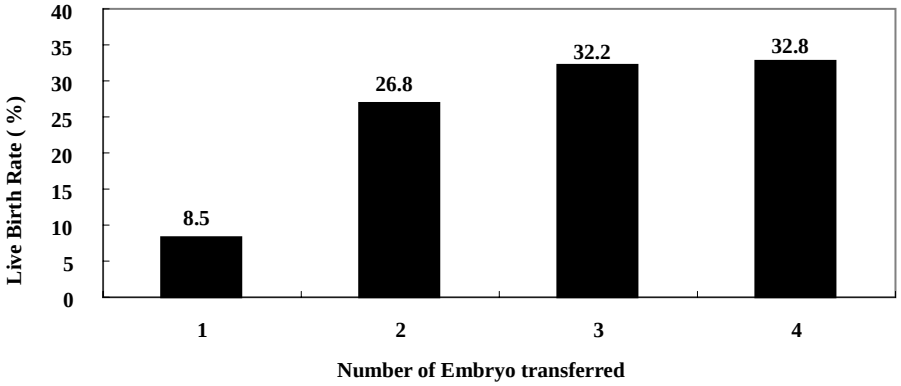

Figure 15 Correlation between Numbers of Embryos Transferred by IVF and Live Birth Rates in ART Cycles Using Fresh Nondonor Eggs, Sperm, or Embryos in Taiwan, 2010

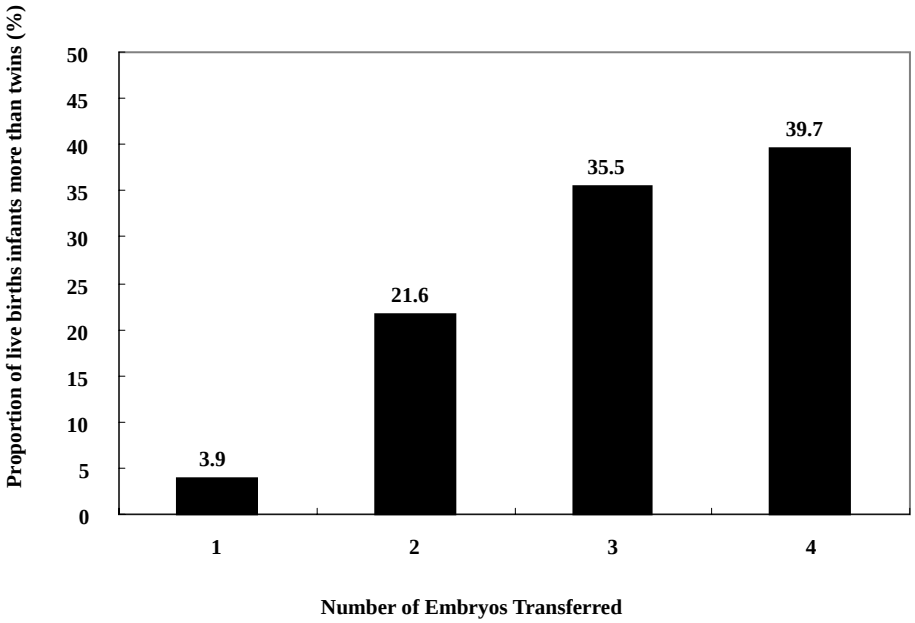

Figure 16 Proportions of Multiple-Infant Live Births More than Twins Using IVF Embryo Transfers to Overall Live Birth Cycles in ART Cycles Using Fresh Nondonor Eggs, Sperm, or Embryos in Taiwan, 2010

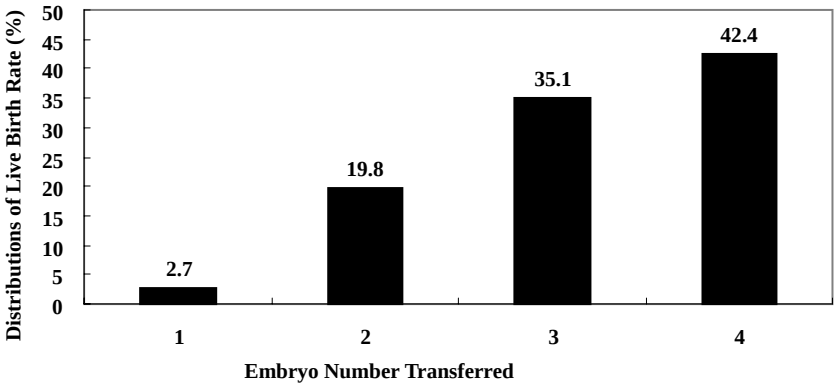

Figure 17 Distributions of Embryo Numbers Transferred by IVF in the ART Live Birth Cycles That Using Fresh Nondonor Eggs, Sperm, or Embryos in Taiwan, 2010

III. ICSI Micromanipulation Technique

In 2010, a total of 6,018 cycles using ICSI micromanipulation technique to aid pregnancy accounted for 55.4% of overall IVF treatment cycles. The pregnancy rate with the aid of the ICSI technique was 35.9%; whereas the pregnancy rate without the aid of the ICSI technique was 34.7%. On the other hand, the live birth rate with the aid of the ICSI technique was 26.4%, while the live birth rate without the aid of the ICSI technique was 25.5%.

Section 3: Status of ART Using Fresh Nondonor Embryos Transfers

This section analyses the statistics of the 6,475 cycles using fresh nondonor 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 47.3%; but the average rate of women above the age of 40 (ages 41 – 50) dropped to 13.8%. Moreover, the difference is even more significant in the live births rate of transfer cycles; dropping from 36.6% for women under the age of 35 to 6.7% for women over the age of 40. (Figure 18)

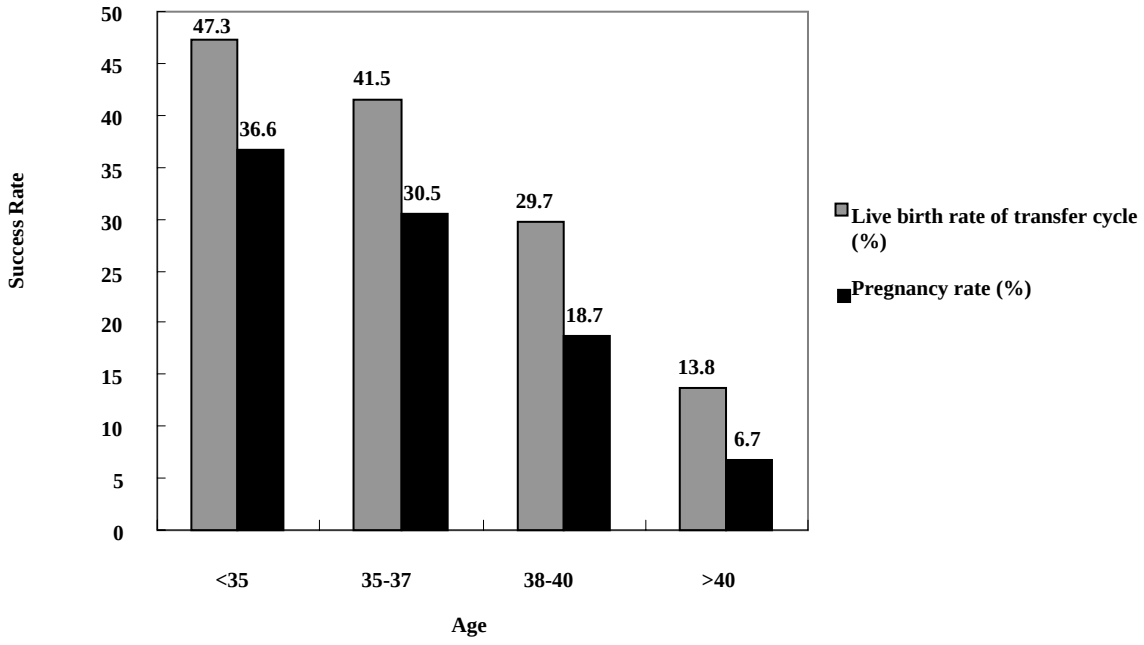

Figure 18 Pregnancy Success Rates of Fresh Embryos Transferred of Women Age Groups in ART Cycles Using Fresh Nondonor Eggs, Sperm, or Embryos in Taiwan, 2010

Figure 19 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 27.1%, however, their live birth rate of transfer cycles dropped to 14.0%. 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 43 – 51), the pregnancy rate of transfer cycles was 9.0% (11/214) and live birth rate of transfer cycles dropped to a mere 4.4% (4/214).

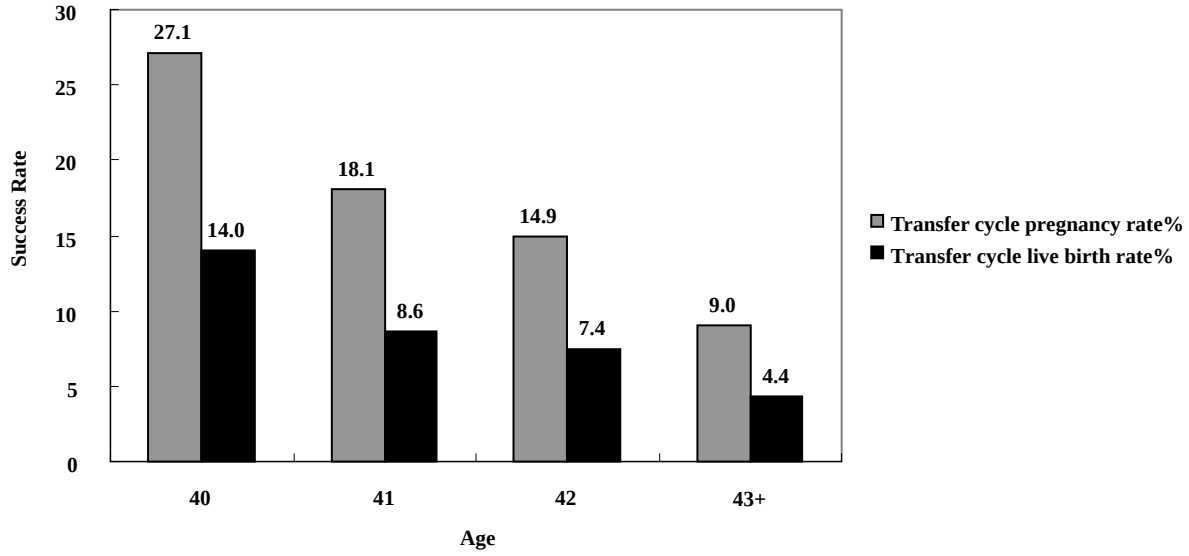

Figure 19 Pregnancy Success Rate of Fresh Embryos Transferred of Women Age at or over 40 Years in ART Cycles Using Fresh Nondonor Eggs, Sperm, or Embryos in Taiwan, 2010

II. Miscarriage Rate

Figure 20 presents the correlation between the age of pregnant women adopting fresh nondonor embryo transfers under ART treatment and the rate of natural miscarriages. Except for the 20.4% miscarriage rates of women under the age of 31, natural miscarriage rates 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 is 29.5%.

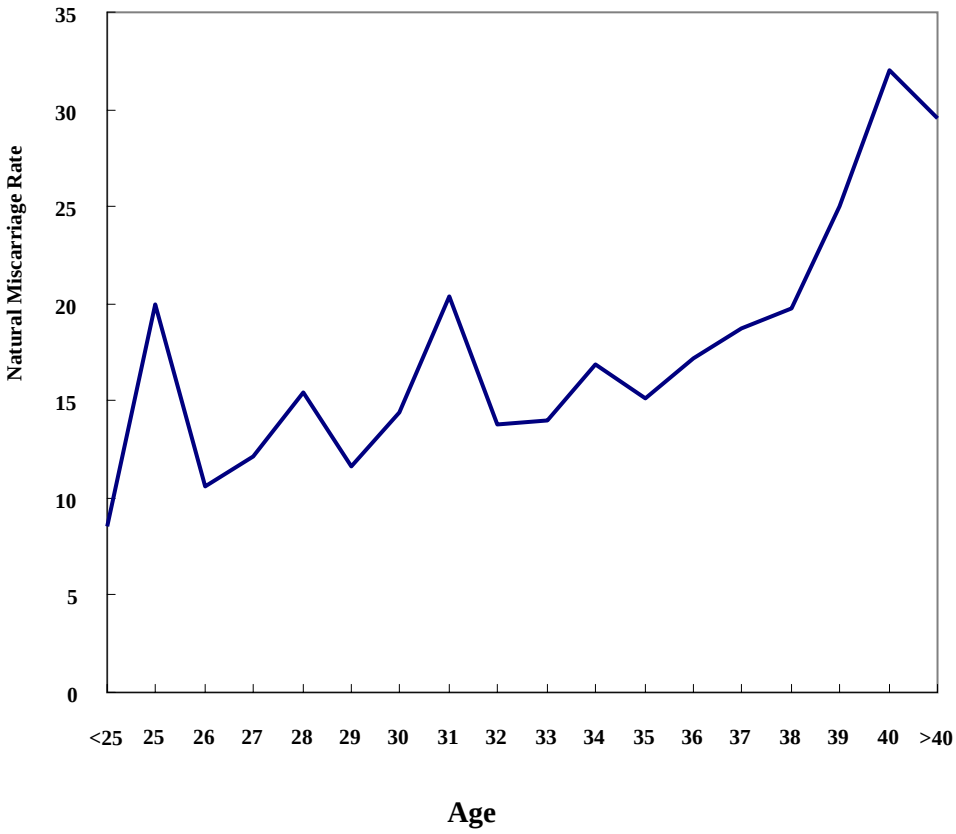

Figure 20 Natural Miscarriage Rate by Women's Age Using Fresh Embryos Transfers in ART Cycles Using Fresh Nondonor Eggs, Sperm, or Embryos in Taiwan, 2010

Section 4: Status of ART Using Frozen Nondonor Embryo Transfers

Figure 21 shows a comparison of the pregnancy rates and live birth rates and transfers of frozen and fresh embryos of ART Cycles in 2010. The pregnancy rate for frozen embryo transfer cycles was 40.5%, not significantly different from the 39.2% pregnancy rate for fresh embryo transfer cycles (P=0.3520). At the same time, compared with the 30.4% live birth rate of fresh embryo transfer cycles, the 28.8% live birth rate for frozen embryo transfer cycles was not significant different either (P=0. 2103).

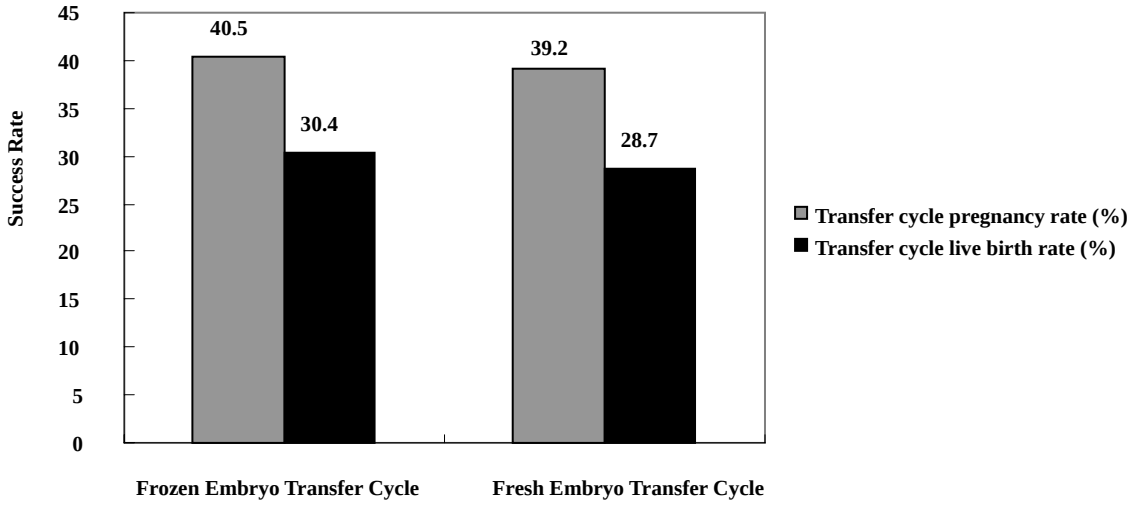

Figure 21 Comparison of Success Pregnancy Rates and Live Birth Rates between Transfers of Frozen Embryo and Fresh Embryo of ART Cycles in Taiwan, 2010

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 2010, a total of 316 cycles accepted donor eggs, and the acceptance rate increased following the increase of women's ages. Only a small group of 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 22). In the age group of women between the ages of 45 and 57, an average of 38.0% of them received donor eggs.

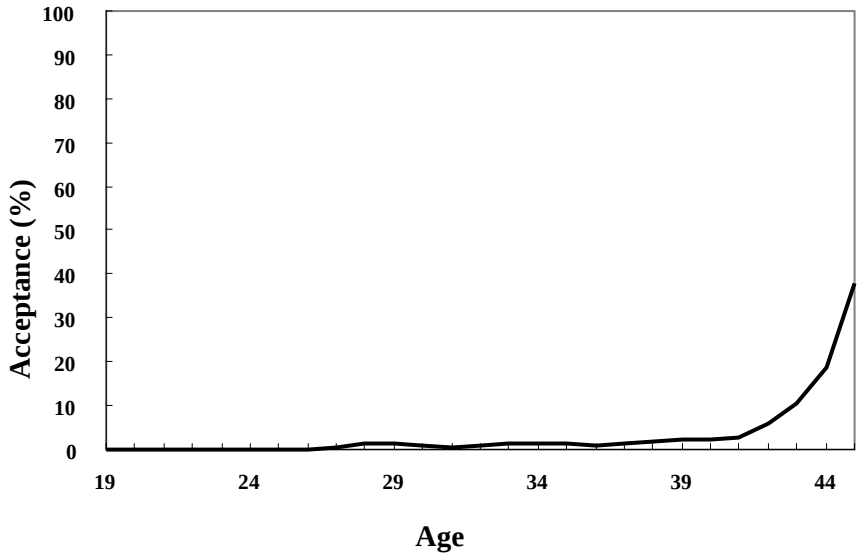

Figure 22 Correlation between the Age and Acceptance Rate of Women Receiving Donor Eggs in ART Cycles in Taiwan, 2010

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 23, 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.

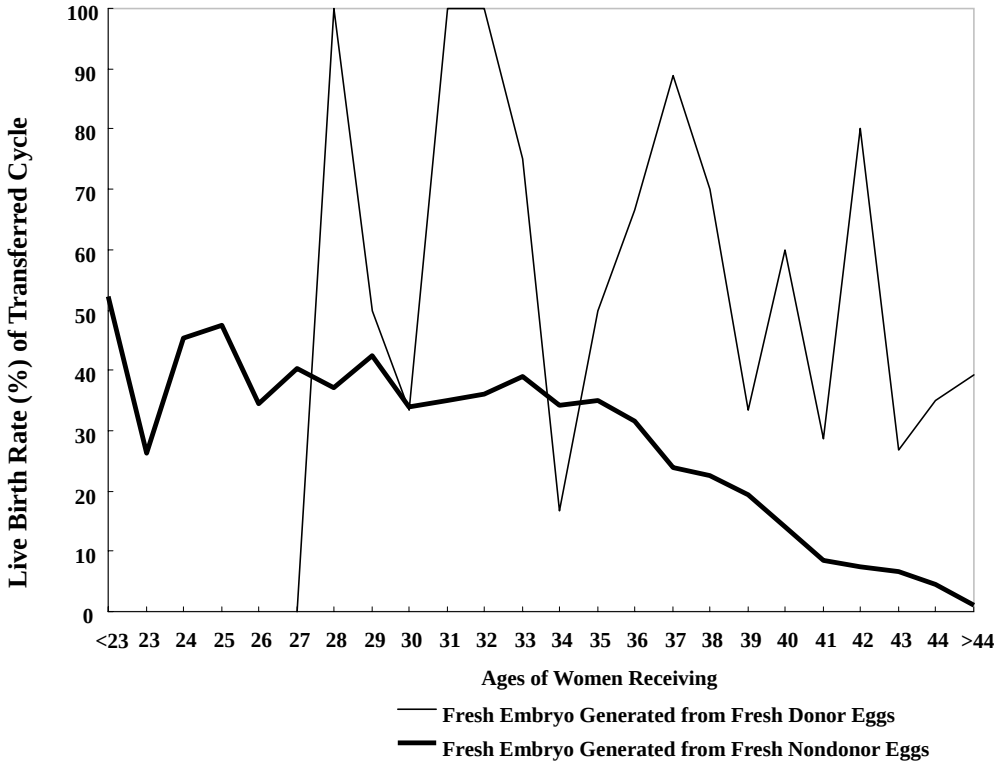

Figure 23 Correlation between the Live Birth Rate of Transfer Cycles and the Ages of Women Developing Fresh Embryos by Receiving Donor Eggs and Nondonor Eggs in ART Cycles in Taiwan, 2010

Chapter 5 Trends in ART (1998 – 2010)

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 nondonor eggs and sperm, frozen embryos developed from nondonor 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 24 shows the number of ART cycles, live birth cycles, and live born infants during the period from 1998 to 2010. 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 2010, it increased 24.2% to 11,513 cycles compared to 9,266 cycles in 2009.

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 3,464 infants of 2009 showed an increase of 653 over the 4,117 infants of 2010.

Table 4 Numbers of Treatment Cycles, Live Birth Cycles, and Live Birth Infants of ART in Taiwan, 1998-2010

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
Total	98,554	25,655	35,892

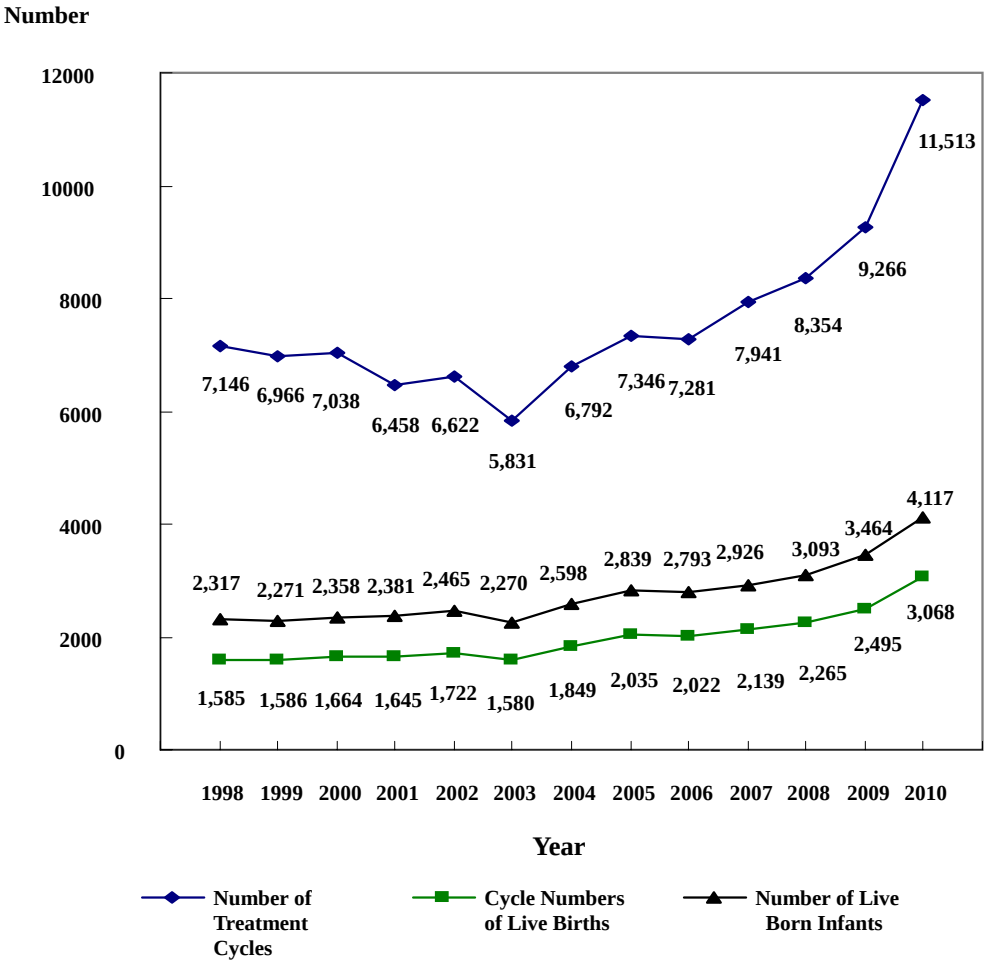

Figure 24 Numbers of ART Cycles, Live Birth Cycles, and Live Birth Infants in ART Cycles in Taiwan, 1998 - 2010

II. Pregnancy Rates and Live Birth Rates

Figure 25 illustrates the pregnancy rates and live birth rates of the ART from 1998 to 2010. 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 2010, the pregnancy rate was 36.0%. On the other hand, the live birth rate increased annually from 22.2% in 1998 and peaked at 27.8% in 2006; in 2010, the rate was 26.6%.

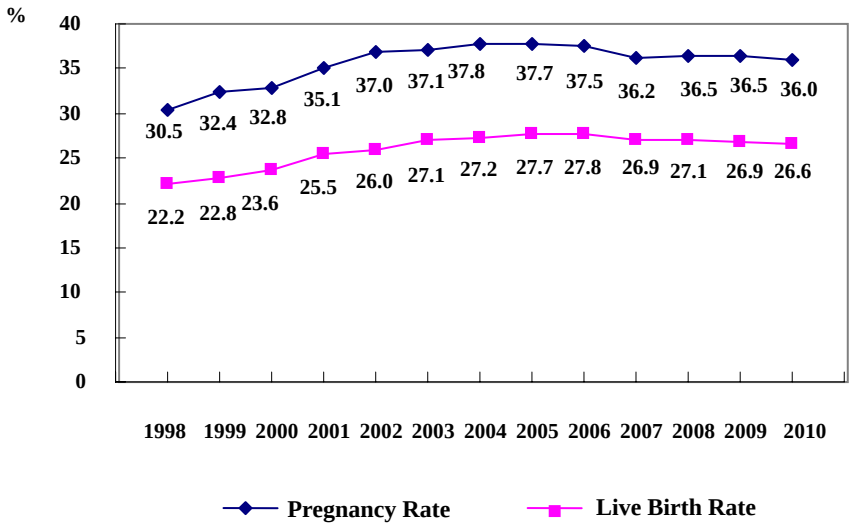

Figure 25 Pregnancy Rates and Live Birth Rates of ART Cycles in Taiwan, 1998-2010

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

I. Live Birth Rates of Transfer Cycles

Figures 26 and Figure 27 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 nondonors and from donors) in the period from 1998 to 2010.

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 nondonor 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 2009 was 28.7%. Fluctuation of the live birth rates of transfer cycles in ART using frozen nondonor 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 2010 was 30.4% which is 0.4% lower than the 30.8 % of 2009 (Figure 26).

The live birth rate of transfer cycles using fresh embryos developed from donor sperm or eggs was 46.1% in 2008 which had increased by 18.6% compared with 27.5% in 1998. The frozen embryos developed from donor sperm or eggs transferred were used in 62 cycles in 2008, 101 cycles in 2009 and 148 cycles in 2010 with a live birth cycle rate of 43.9% (Figure 27).

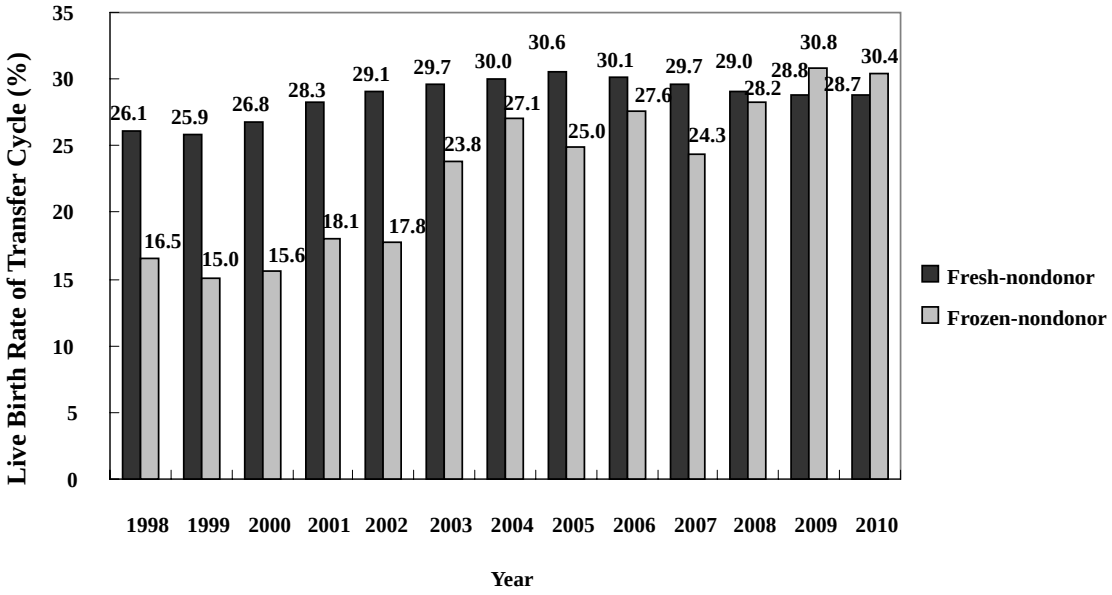

Figure 26 Live Birth Rates of Transfer Cycle Using Fresh Embryos and Frozen Embryos Made from Nondonor Sperm and Eggs in Taiwan, 1998-2010

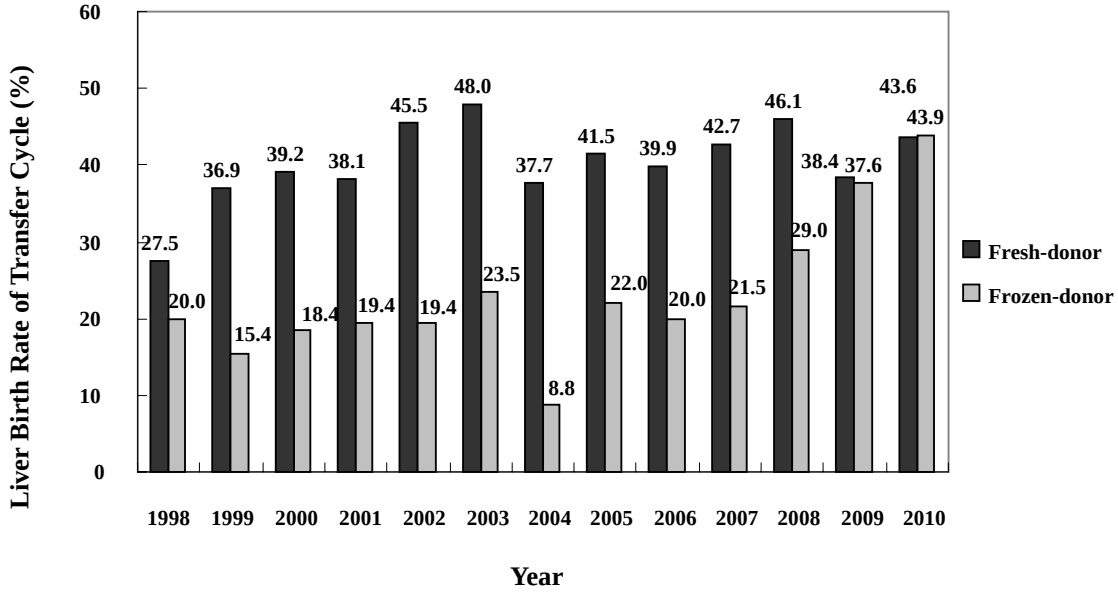

Figure 27 Live Birth Rates of Transfer Cycle Using Fresh Embryos and Frozen Embryos Made from Donor Sperm or Eggs in Taiwan, 1998-2010

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 28 and 29 show separately the singleton rates for the four types of ART cycles in the period from 1998 to 2010; that is, the fresh and frozen embryos from eggs and sperm from nondonors and from donors.

The singleton rates of ART transfer cycles using fresh nondonor embryos showed an annually growing trend starting from 1998; the rate reached 18.1% in 2004 and 18.7% in 2010. The singleton rates of Art transfer cycles using frozen nondonor embryos showed the significant increased to 19.6% in 2004. In 2010, the rate was 22.2% (Figure 28). 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 29).

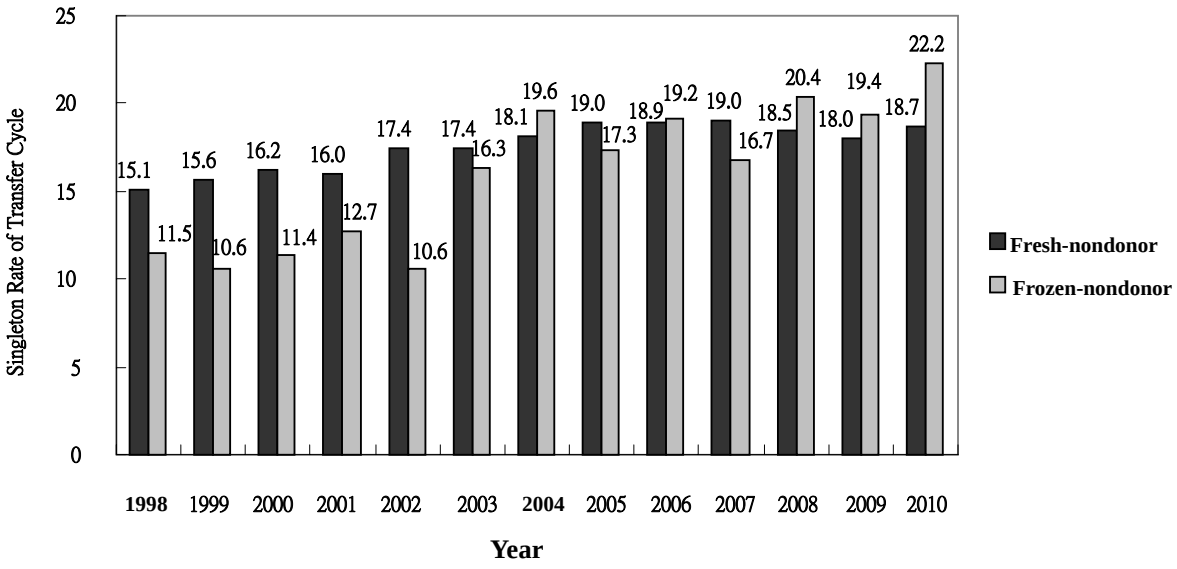

Figure 28 Singleton Rates of Transfer Cycle Using Fresh Embryos and Frozen Embryos Made from Nondonor Sperm and Eggs in Taiwan, 1998-2010

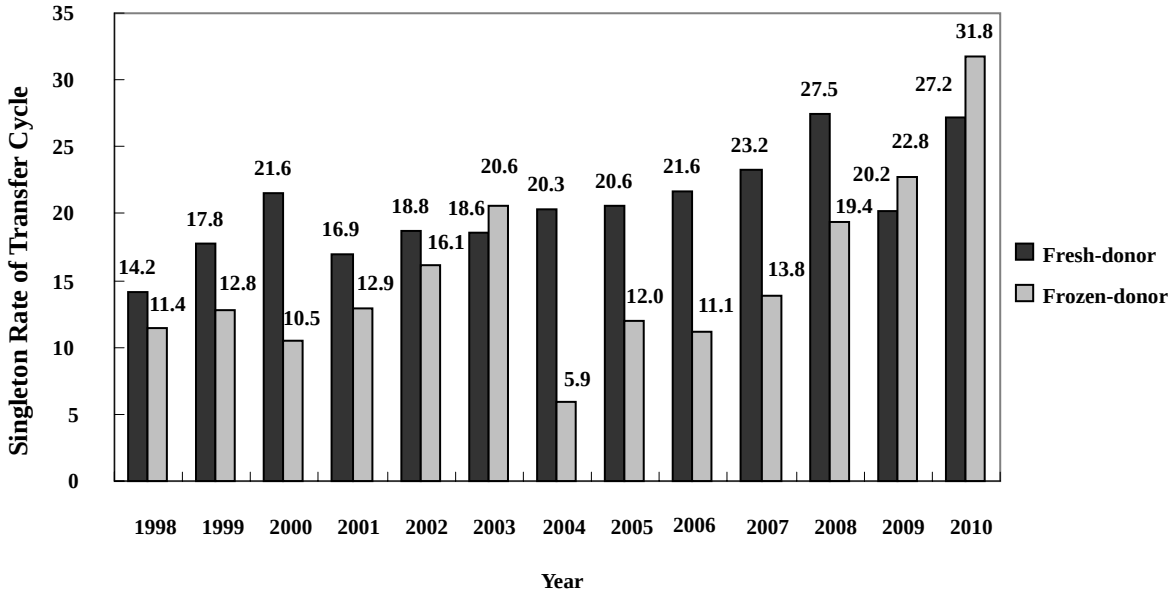

Figure 29 Singleton Rates of Transfer Cycle Using Fresh Embryos and Frozen Embryos Made from Donor Sperm and Eggs in Taiwan, 1998-2010

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

Figure 30 shows the live birth rate of ART transfer cycles using fresh nondonor embryos conducted in the period from 1998 to 2010 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 less than 35 years old increased by 7.4%, from 29.2% in 1998 to 36.6% in 2010. In the same period, the live birth rate of the transfer cycles for women between the aged of 35 and 37 increased by 6.1%, for women between the age of 38 and 40 years old the rate increased by 1.6%, and between the aged of 41 and 42 years old the rate increase by 0.3%; however, for women aged older than 42 years, live births rate declined by 1.5%.

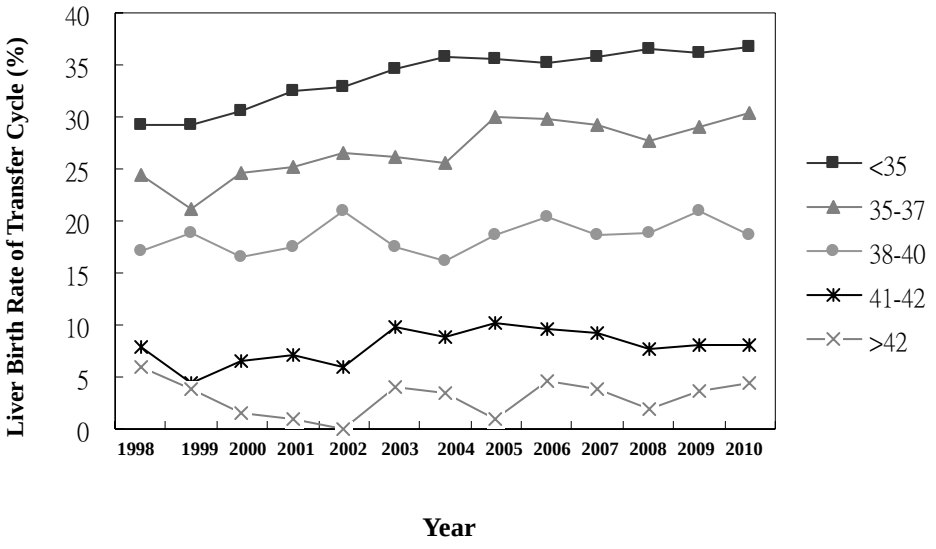

Figure 30 Live Birth Rate of Transfer Cycle Using Fresh Nondonor Embryos in Taiwan, 1998-2010
(By Ages Groups of Treated Women)

Figure 31 shows the single-fetus rate of ART transfer cycles using fresh nondonor embryos conducted in the period from 1998 to 2010 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 6.2%, from 15.9% in 1998 to 22.1% in 2010. In the same period, the singleton rate of the transfer cycles by women between the aged of 35 and 37 rose by 4.2%, women aged between 38 and 40 rose by 2.8%, and that of women aged between 41 and 42 rose by 1.8%. However, the singleton rate of women aged greater than 42 declined by 1.8%.

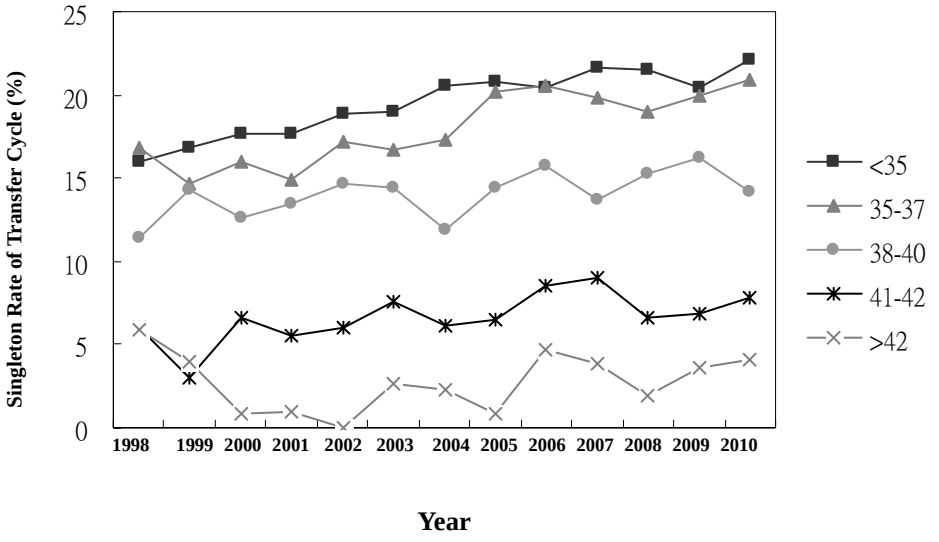

Figure 31 Singleton Rate of Transfer Cycle Using Fresh Nondonor Embryos in Taiwan, 1998-2010

(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 32 and Figure 33 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 nondonor sperm and eggs and the transfer cycles using fresh embryos and frozen embryos made from donor sperm and eggs.

As shown in Figures 32 and Figure 33, 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 nondonor embryos in the period from 1998 to 2004; however, a declining trend was noted after 2004. The rate of 36.2% in 2008 was 0.3% higher than the rate in 2007, and the rate of 37.4% in 2009 was 1.2% higher than that for 2008. The rate of 34.9% in 2010 was 2.5% lower than 2009. Compared with the rate in 1998, the multiple birth rates of the live birth cycles of ART transfer cycles using fresh nondonor embryos in 2010 dropped by 7.1% (from 42.0% of 1998 to 34.9% of 2010). Fluctuations in the other three types were more significant; the multiple birth rate of the live birth cycles of ART transfer cycles using frozen nondonor embryos was 26.8% in 2010, 10.1% lower than the rate in 2009; whereas, the multiple birth rate of the live birth cycles using frozen embryos that were made from donor sperms or egg was 37.6% in 2010 which was10.8% less than 48.4% of 1998, also a 9.9% less than the 47.5% in 2009; the multiple birth rate of the live birth cycles of ART transfer cycles using frozen embryos made from donors sperm and eggs was 27.7% in 2010 which was 15.2% less than the 42.9% of 1998, and dropped 11.8% compared with 39.5% in 2009.

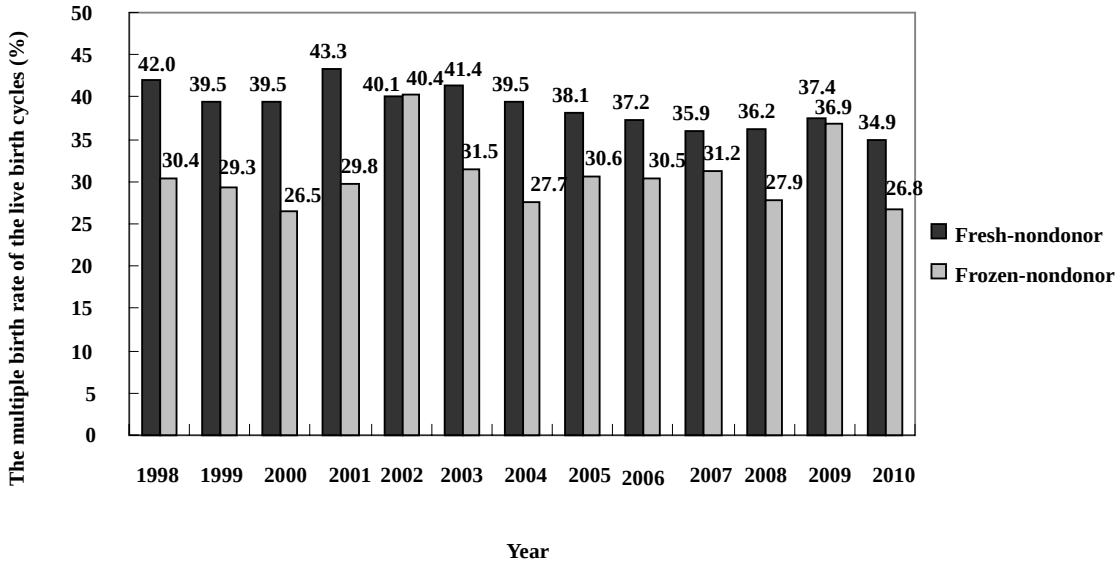

Figure 32 Multiple Births Rate of Live Birth Cycle Using Fresh Embryos and Frozen Embryos from Nondonor Sperm and Eggs in Taiwan, 1998-2010.

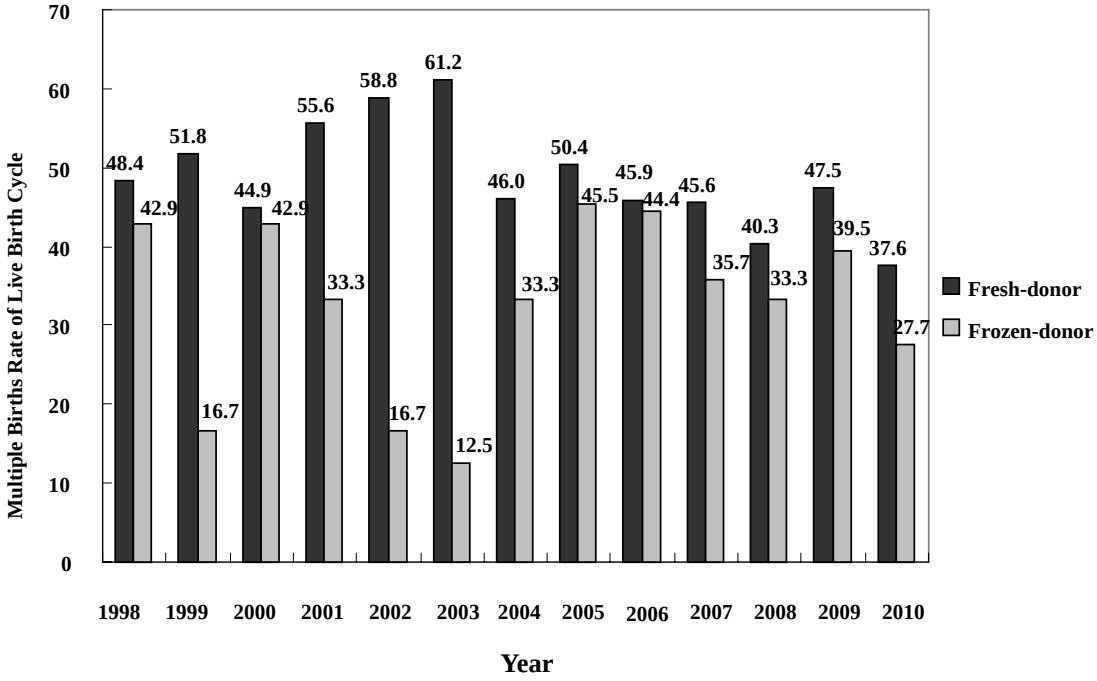

Figure 33 Multiple-Infant Live Birth Rates Using Fresh Embryos and Frozen Embryos from Donor Sperm and Eggs in Taiwan, 1998-2010

Figure 34 compares the percentages of multiple births rates of the live birth cycles in ART cycles using fresh nondonor embryos from the years 1998 to 2010. In the live birth cycles, rates of triplets or more dropped from 4.6% in 1998 to 0.5% in 2010; however, rates of twins remained above 34%, at 37.4% in 1998 and 34.3% in 2010.

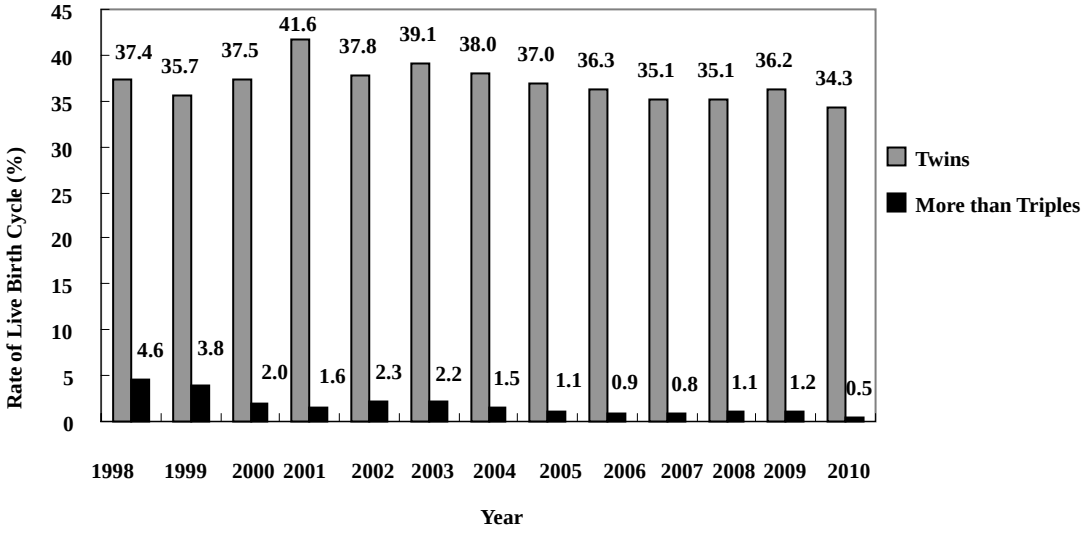

Figure 34 Twins and Triplet Birth Rate of Live Birth Cycle Using Fresh Nondonor Embryos in Taiwan, 1998-2010

Reference Websites

1. Bureau of Health Promotion, Department of Health, Executive Yuan: http://www.bhp.doh.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 2010

Summary

Type of ART		Procedural Factors		Causes of Infertility	
IVF/ET	99%	Using ICSI	55%	Fallopian tube factor	15%
GIFT	<1%	Un-stimulated conducted	12%	Other female factors	36%
IVF/ET+GIFT	0%			Male factor	22%
ZIFT/TET	<1%			Multiple factors	23%
AID	<1%			Unknown reasons	4%

Pregnancy Success Rates

Type of Treatment Cycle	Age of Woman			
Fresh embryos from Non-donor eggs	**<35**	**35-37**	**38-40**	**41-42**
Total Number of Cycles	4,475	2,283	1,789	649
Percentage of pregnancy cycles	43.2	37.3	25.8	14.0
Percentage of live birth cycles	33.5	27.4	16.3	6.8
Percentage of live birth in egg retrieval cycles	34.3	28.1	16.8	7.1
Percentage of live birth in transfer cycles	36.8	30.5	19.0	8.1
Percentage of singleton live births in transfer cycles	22.3	20.9	14.4	7.7
Percentage of cancellations	9.6	10.4	14.5	16.0
Average number of embryos transferred	3.1	3.1	3.0	2.7
Percentage of multiple births in live birth cycles	39.4	31.5	24.1	4.6
Frozen embryos from nondonor eggs				
Number of transfer cycles	834	353	221	63
Percentage of live birth cycle in transfer cycles	36.2	26.4	22.2	15.9
Average number of embryos transferred	2.9	2.7	2.7	2.6

	All Ages Combined	
Donor eggs	**Fresh Embryos**	**Frozen Embryos**
Numbers of transfer cycles	179	112
Percentage of live birth cycles in transfer cycles	48.6	44.6
Average number of embryos transferred	3.0	2.8

Numbers of assisted reproduction institutions for data reporting: 72