

The status of assisted reproductive technology in Korea in 2012

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Objective: This study was designed to report the status of assisted reproductive technology (ART) therapy in South Korea between January 1, 2012 and December 31, 2012.

Methods: A localized online survey, originally developed by the International Committee Monitoring Assisted Reproductive Technologies, was first launched and provided to all available ART centers via email in 2015. Fresh embryo transfer (FET) cases were categorized as standard *in vitro* fertilization, intracytoplasmic sperm injection (ICSI), or half-ICSI. Thawed embryo transfer (TET) and other related procedures, including surgical sperm retrieval, were surveyed.

Results: Data from 33,956 ovum pick-up procedures were provided by 75 clinics in 2012. Of the 33,088 cycles in which ova were retrieved, a complete transfer was performed in 90.5% (29,932 cycles). In addition, 10,079 FET cycles were confirmed to have resulted in clinical pregnancy, representing a pregnancy rate of 30.5% per ovum pick-up and 33.7% per ET. The most common number of embryos transferred in FET was 2 (41.6%), followed by 3 (34.0%), and non-elective single ETs (10.0%). Of the 10,404 TET cycles in which transfer was completed, 3,760 clinical pregnancies (36.1%) were confirmed by ultrasonography.

Conclusion: The overall clinical pregnancy rate for FET and TET cycles in 2012 was higher than in 2011 (33.7% vs. 33.2% and 36.1% vs. 31.1%, respectively). The most common number of embryos transferred in FET cycles was 2, unlike in 2011.

Keywords: Assisted reproductive techniques; Surveys

Introduction

Subfertility is being overcome through advancements in fertility treatment, including controlled ovarian stimulation, intrauterine insemination, and *in vitro* fertilization (IVF). Since the first IVF baby was born in South Korea (hereafter Korea) in 1985, the use of assisted reproductive technology (ART) to overcome infertility has dramatically

increased, along with the number of fertility centers and live births of ART-conceived infants. The most recent national statistics indicate that 2.83% of all births in 2011 were associated with financial support from the National Supporting Program for the Subfertile administered by the Korean Ministry of Health and Welfare (KMHW).

The Korean Society of Obstetrics and Gynecology collected ART data and published their first report in 1992, and the Korean Society of Assisted Reproduction (KSAR) took over that role in 2013. Although the data collection forms are based on the International Committee Monitoring Assisted Reproductive Technologies Tool Box for Data Collection forms, they have been revised to collect a few additional pieces of information starting in 2014; however, the forms were kept similar in order to allow the comparison of results from previous years.

The primary objective of this database was to facilitate a collabora-

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tion between the Committee for ART Statistics and fertility centers in Korea and to obtain an overall national picture of fertility treatments based on data from all ART clinics in Korea that voluntarily provided data on procedures performed between January 2012 and December 2012.

Methods

1. Subjects

Of the 188 ART clinics that were invited to input their data into the module created by the Committee of Statistics of the KSAR, 75 reported their outcomes (return rate, 39.8%). The complete list of the ART clinics that participated in this survey is listed by region in Supplement 1.

2. Methods

A revised Korean-language online survey was provided by email to all ART clinics registered with the KMHW. Responses were collected online (<http://www.ivfkorea.or.kr>). The survey was originally based on the International Committee Monitoring Assisted Reproductive Technologies Tool Box for Data Collection forms (Supplement 2).

The IVF data were also categorized according to outcomes after embryo transfer (ET) in fresh cycles, after thawed ET, and in association with other related procedures, as in the previous survey. Thereafter, the data were subclassified according to the IVF method, such as conventional IVF, intracytoplasmic sperm injection (ICSI), and half-ICSI.

All data reflected treatment cycles that took place in 2012. However, the precise characteristics of the starting and ending day of the data submitted (ovum pick-up day or controlled ovarian stimulation day) were left to the clinic's discretion, thereby resulting in a mixed dataset. Clinical pregnancy was defined as the presentation of an intrauterine gestational sac on ultrasound examination. Cases of biochemical pregnancy were excluded if elevated serum beta-human chorionic gonadotropin was the only sign of pregnancy. Live birth delivery was defined as the birth of one or more live infants, with the delivery of multiple infants counting as a single live-birth delivery.

Table 2. The number of fresh ET and thawed ET cycles by age group

Age group (yr)	Fresh ET		Thawed ET	
	2012	2011	2012	2011
≤ 29	1,848 (6.2)	1,946 (7.1)	803 (7.7)	717 (8.4)
30–34	11,573 (38.7)	10,416 (38.0)	4,817 (46.3)	3,802 (44.5)
35–39	10,782 (36.0)	10,029 (36.6)	3,718 (35.7)	3,039 (35.6)
≥ 40	5,713 (19.1)	5,002 (18.3)	1,066 (10.2)	978 (11.5)
Total	29,916 ^{a)} (100.0)	27,396 (100.0)	10,404 ^{a)} (100.0)	8,536 (100.0)

Values are presented as number (%).
ET, embryo transfer.

^{a)}The patient's age was missing for 16 fresh ET cycles and 45 thawed ET cycles.

3. Analysis

The contribution of ART to each outcome was calculated by dividing the total number of outcomes by the number of ovum pick-ups and the number of ETs. All data were analyzed using PASW ver. 18.0 (SPSS Inc., Chicago, IL, USA).

Results

1. Overview

1) Data provided by the fertility clinics

Seventy-five centers reported 33,956 ovum pick-up cycles that were initiated in 2012. In total, 41,995 ET cycles were reported.

2) Types of ART procedures

Fresh ET was used in approximately 71.3% (n=29,932) of the 41,995 ART cycles that were reported. ART cycles that used frozen embryos were the next most common type of procedure, accounting for approximately 24.9% of the total ART cycles (n=10,449). The less common procedures were natural-cycle IVF (n=747), *in vitro* maturation (n=414), preimplantation genetic diagnosis (n=311), and the surgical retrieval of sperm (Table 1).

3) Trends by age

Women 30 to 34 years of age comprised the majority (38.7%) of all fresh ET cycles performed in 2012. The age distribution among patients who received fresh ET cycles was as follows: 36.0% among

Table 1. The number of cycles for each ART procedure

Type of ART procedure	No. of cycles in 2012	No. of cycles in 2011
Fresh ET	29,932 (71.3)	27,683 (74.8)
Thawed ET	10,449 (24.9)	8,826 (23.9)
Others ^{a)}	1,614 (3.8)	481 (1.3)
Total	41,995 (100.0)	36,990 (100.0)

Values are presented as number (%).

ART, assisted reproductive technology; ET, embryo transfer.

^{a)}The category of "others" includes preimplantation genetic diagnosis/screening, natural *in vitro* fertilization, ovum donation, and *in vitro* maturation cycles.

those 35 to 39 years of age, 19.1% among those over 40 years of age, and 6.2% among those 25 to 29 years of age. Similarly, women aged 30 to 34 years of age comprised the largest group of women who underwent thawed ET cycles, accounting for 46.3% of those cycles. Women 35 to 39 years of age comprised the next most common age group (Table 2).

4) Clinical pregnancy according to age

Among the patients from whom ova were retrieved ($n = 33,088$), 90.5% ($n = 29,932$) successfully transferred their embryos in 2012. Of the 29,916 cycles for which the patient's age was reported, 10,079 patients were confirmed to have achieved clinical pregnancy. Among the patients who underwent thawed ET ($n = 10,404$), 3,760 patients were confirmed to have achieved clinical pregnancy, representing a 36.1% clinical pregnancy rate per ET cycle. The clinical pregnancy rate per ET of fresh cycles was higher among patients 34 years of age or younger than the corresponding clinical pregnancy

rate per ET for thawed ET cycles (Table 3).

5) Live deliveries by treatment type

Although many of the clinics that participated in this study may not have been able to follow their pregnant patients through the actual delivery, live births were reported for a total of 5,467 patients. However, several clinics did not report the number of live births or whether they were accomplished by IVF, ICSI, half-ICSI, or thawed ET in 2012 (Table 4).

2. Fresh cycles

1) Clinical pregnancy by fertilization method

Of the 29,932 fresh ET cycles, 34.5% used embryos obtained by IVF, 45.6% by ICSI, and 20.0% by half-ICSI.

Among the cycles in which embryos were successfully transferred, the clinical pregnancy rate was 36.9%, 28.7%, and 39.7% among those who underwent IVF, ICSI, and half-ICSI procedures, respectively (Table 5).

Table 3. Clinical outcomes by age group

Outcome	Fresh cycle (yr)				All	Thawed cycle (yr)				All
	≤ 29	30–34	35–39	≥ 40		≤ 29	30–34	35–39	≥ 40	
ET cycles (n)	1,848	11,573	10,782	5,713	29,916	803	4,817	3,718	1,066	10,404
Clinical pregnancy (n)	834	4,782	3,543	920	10,079	356	1,884	1,273	247	3,760
Delivery reported (n)	337	1,973	1,386	295	3,991	159	773	518	73	1,523
CPR per ET (%)	45.1	41.3	32.9	16.1	33.7	44.3	39.1	34.2	23.2	36.1

ET, embryo transfer; CPR, clinical pregnancy rate.

Table 4. Live births by fertilization method

Fertilization method	Singleton	Twin delivery	Triplet delivery	Quadruplet or more delivery	Total
IVF	1,007	331	1	0	1,339
ICSI	1,274	409	9	0	1,692
Half-ICSI	642	265	4	0	911
Thawed ET	1,116	398	11	0	1,525
Total	4,309	1,403	25	0	5,467

Values are presented as number.

IVF, *in vitro* fertilization; ICSI, intracytoplasmic sperm injection; ET, embryo transfer.

Table 5. Clinical pregnancies according to fertilization method in fresh cycles

Outcome	IVF	ICSI	Half-ICSI	All
ET, n (%)	10,319 (34.5)	13,635 (45.6)	5,978 (20.0)	29,932 (100.0)
Clinical pregnancy (n)	3,804	3,918	2,375	10,097
CPR per ET (%)	36.9	28.7	39.7	33.7

IVF, *in vitro* fertilization; ICSI, intracytoplasmic sperm injection; ET, embryo transfer; CPR, clinical pregnancy rate.

Table 6. Clinical pregnancies by the number of transferred embryos in fresh cycles

Outcome	No. of embryos transferred							Total
	1		2	3	4	5	6 or more	
	Non-eSET	eSET						
ET cycles (n, %)	3,004 (10.0)	1,499 (5.0)	12,457 (41.6)	10,180 (34.0)	2,469 (8.2)	303 (1.0)	20 (0.1)	29,932 (100.0)
Clinical pregnancy (n)	596	324	4,715	3,409	775	54	4	9,877
CPR per ET (%)	19.8	21.6	37.9	33.5	31.4	17.8	20	32.9
Two or more gestational sacs (n)	6	5	1,288	992	256	15	2	2,564
MPR per ET (%)	0.2	0.3	10.3	9.7	10.2	5	10	8.6

eSET, elective single embryo transfer; ET, embryo transfer; CPR, clinical pregnancy rate; MPR, multiple pregnancy rate.

2) Clinical pregnancy by the number of transferred embryos

Of the 29,932 fresh embryo cycles, 75.6% were 2-ET or 3-ET cycles (2-ET, 41.6%; 3-ET, 34.0%), and 15.0% were single ETs (elective single ET, 5.0%; non-elective single ET, 10.0%). Overall, the clinical pregnancy rate per ET was 37.9% for 2-ET cycles and 33.5% for 3-ET cycles.

The multiple pregnancy rate per ET was the highest among women who underwent 2-ET cycles (10.3%), followed by women who underwent 4-ET cycles (10.2%) (Table 6).

3. Thawing cycles

1) Clinical pregnancy by fertilization method

Of the 10,408 thawed ET cycles, 44.5% used IVF and 55.5% used ICSI or half-ICSI. The clinical pregnancy rate was 35.8% for the IVF group, and 36.4% for the half-ICSI group (Table 7).

2) Clinical pregnancy by the number of transferred embryos

Of the 10,430 thawed ET cycles, 76.0% were 2-ET or 3-ET cycles (2-

Table 7. Clinical pregnancies by the fertilization method in frozen-thawed ET cycles

Outcome	Thawed ET		
	IVF	ICSI	Total
ET cycles (n, %)	4,633 (44.5)	5,775 (55.5)	10,408 (100.0)
Clinical pregnancy (n)	1,657	2,103	3,760
CPR per ET (%) ^{a)}	35.8	36.4	36.1

ET, embryo transfer; IVF, *in vitro* fertilization; ICSI, intracytoplasmic sperm injection; CPR, clinical pregnancy rate.

^{a)}The total number of thawed ET cycles was 10,449. Data on the fertilization method were missing for 41 patients.

Table 8. Clinical pregnancies by the number of transferred embryos in frozen-thawed ET cycles

Outcome	No. of frozen-thawed embryos transferred						Total
	One	Two	Three	Four	Five	Six or more	
ET cycles, n (%) ^{a)}	1,718 (16.5)	5,132 (49.2)	2,797 (26.8)	718 (6.9)	58 (0.6)	7 (0.1)	10,430 (100.0)
Clinical pregnancy (n)	420	1,972	1,079	279	21	2	3,773
CPR per ET (%)	24.4	38.4	38.6	38.9	36.2	28.6	36.2
Two or more gestational sacs (n)	16	547	379	94	4	1	1,041
MPR per ET (%)	0.9	10.7	13.6	13.1	6.9	14.3	10

ET, embryo transfer; CPR, clinical pregnancy rate; MPR, multiple pregnancy rate.

^{a)}The total number of thawed ET cycles was 10,449. Data on the number of frozen thawed ET were missing for 19 patients.

Table 9. Outcomes of the surgical retrieval of sperm

Technique	OPU cycle	Transfer cycle	Clinical pregnancy	Live birth	CPR per ET (%)
PESA	53	49	14	2	28.6
TESE	1,119	782	248	119	31.7
Total	1,172	831	262	121	31.5

Values are presented as number unless otherwise indicated.

OPU, ovum pick-up; CPR, clinical pregnancy rate; ET, embryo transfer; PESA, percutaneous sperm aspiration; TESE, testicular sperm extraction.

ET, 49.2%; 3-ET, 26.8%), and 16.5% were single ETs. Overall, the clinical pregnancy rate per ET was 38.4% for 2-ET cycles and 38.6% for 3-ET cycles.

The multiple pregnancy rate per ET was the highest among women who underwent 6+ET cycles (14.3%), followed by women who underwent 3-ET cycles (13.6%) (Table 8).

4. Other related procedures

1) Surgical retrieval of sperm

A total of 1,172 cases of surgical sperm retrieval were reported to have successfully progressed to the ET stage. The overall clinical pregnancy rate per ET was 31.5% (Table 9).

2) Preimplantation genetic diagnosis and preimplantation genetic screening

Of the 311 cycles of preimplantation genetic diagnosis that were planned, a total of 42 cases successfully progressed to clinical pregnancy after ET (283 cycles). In 2012, a total of 2,438 embryos were examined at the preimplantation stage, and 1,157 of these embryos were diagnosed as normal.

Of the 24 cycles of preimplantation genetic screening that were planned, nine cases successfully progressed to clinical pregnancy after ET (21 cycles). In 2012, a total of 185 embryos were examined at the preimplantation stage, and 65 of these embryos were diagnosed as normal.

3) Ovum cryopreservation and ovum donation

In 2012, ovum cryopreservation was carried out in 111 cycles. Forty cycles were reported to be planned for medical causes and 44 cycles

for social causes. In 2012, ovum donation was performed in 480 cycles. Of these, 418 cycles were successfully transferred, resulting in clinical pregnancy in 87 cycles and live births in 35 cycles.

4) *In vitro* maturation

A total of 414 cycles using *in vitro* maturation were reported in 2012. From these cycles, 131 clinical pregnancies and 70 live births were reported.

5) Natural-cycle IVF

A total of 747 cycles using natural-cycle IVF were reported in 2012. Of these, 43 clinical pregnancies and 18 live births were reported after ET (387 cycles).

6) Selective fetal reductions

In 2012, 255 selective fetal reductions were reported. The majority of selective fetal reductions were performed in triplet pregnancies, resulting in twin pregnancies (168 cases).

5. Intrauterine insemination

Of the 29,144 cycles of intrauterine inseminations, 3,434 cases successfully progressed to clinical pregnancy (11.7% per cycle).

Discussion

Since the first report was issued in 1995, the number of ART procedures and the pregnancy rate have increased annually in Korea. Although the clinical pregnancy rate per ET in fresh IVF cycles slightly increased from 2011 (33.3%) to 2012 (33.7%), these figures should not be applied to a particular couple without considering all of the relevant factors.

The 40,320 ET cycles performed in 2012 resulted in 3,991 live births from 29,916 fresh ET cycles and 1,523 live births from 10,404 thawed ET cycles (including data on embryos that might have been frozen in 2011, but were thawed and transferred in 2012).

This survey suggests that factors relating to the infertile couples (e.g., the woman's age) and procedural factors (e.g., the number of embryos transferred) played an important role in the success of ART treatments. However, the findings in this report are subject to some serious limitations. First, the data submitted were reported by each ART clinic voluntarily and were not validated by any third parties.

Furthermore, the definitions of infertility and subfertility may vary from clinic to clinic [1]. Second, data about patient demographics, medical history, and infertility diagnoses were absent. Third, these data were not linked to the individual patients in whom the procedures were performed. The data do not indicate whether cycles were performed in women receiving ART treatment for the first time or in women who had previously undergone an unsuccessful ART cycle.

In this survey of voluntarily submitted data from 2012, we report the national trends in ART centers in Korea. We hope that this information will reduce the informational gap between infertile couples and ART clinics and serve as a reference for quality control and the self-promotion of ART centers in Korea.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Acknowledgments

We are deeply grateful to those who contributed to the development of this report and helped collect the 2012 ART data. We believe that their assistance in developing this report will be greatly appreciated by future patients who consider undergoing an ART procedure (Supplement 1).

Supplementary materials

Supplement 1. Seventy-five *in vitro* fertilization centers participated in the 2012 survey. Supplemental data can be found at: <http://ecerm.org/src/sm/cerm-44-47-s001.pdf>.

Supplement 2. The revised Korean-language online survey form used in 2012. Supplemental data can be found at: <http://ecerm.org/src/sm/cerm-44-47-s002.pdf>.

Reference

1. Zegers-Hochschild F, Adamson GD, de Mouzon J, Ishihara O, Mansour R, Nygren K, et al. International Committee for Monitoring Assisted Reproductive Technology (ICMART) and the World Health Organization (WHO) revised glossary of ART terminology, 2009. *Fertil Steril* 2009;92:1520-4.