


International Committee for Monitoring Assisted Reproductive Technologies world report: assisted reproductive technology, 2014[†]

Georgina M. Chambers ^{1,*}, Silke Dyer ²,
Fernando Zegers-Hochschild³, Jacques de Mouzon⁴, Osamu Ishihara⁵,
Manish Banker⁶, Ragaa Mansour^{7,‡}, Markus S. Kupka⁸, and
G. David Adamson^{9,10,11}

¹National Perinatal Epidemiology and Statistics Unit, Centre for Big Data Research in Health and School of Women's and Children's Health, University of New South Wales, Sydney, Australia ²Department of Obstetrics & Gynaecology, Groote Schuur Hospital and Faculty of Health Sciences, University of Cape Town, South Africa ³Clinica las Condes and Program of Ethics and Public Policies in Human Reproduction, University Diego Portales, Santiago, Chile ⁴Epidémiology, Research and Development, Paris, France ⁵Department of Obstetrics and Gynaecology, Saitama Medical University, Moroyama, Japan ⁶Nova IVI Fertility, India ⁷Egyptian IVF-ET Center, Cairo, Egypt ⁸Fertility Center—Gynaekologikum, Hamburg, Germany ⁹Equal3 Fertility, Cupertino, CA, USA ¹⁰Stanford University School of Medicine, Palo Alto, CA, USA ¹¹University of California School of Medicine, San Francisco, CA, USA

*Correspondence address. National Perinatal Epidemiology and Statistics Unit, Centre for Big Data Research in Health and School of Women's and Children's Health, University of New South Wales, Sydney, Australia. E-mail: g.chambers@unsw.edu.au  <https://orcid.org/0000-0003-0215-3249>

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STUDY QUESTION: What were the utilization, effectiveness and safety of practices in assisted reproductive technologies (ART) globally in 2014 and what global trends could be observed?

SUMMARY ANSWER: The estimated total number of ART cycles conducted in 76 participating countries in 2014 was 1.93 million representing ~66% of global activity, with 5-year trends including an increase in success rates and proportion of frozen embryo transfer (FET) cycles, improvement in cumulative live birth rates per aspiration, a continued increase in single embryo transfer (SET) and thus a reduction in multiple birth rates, an increase in preimplantation genetic testing and stabilization in the use of intracytoplasmic sperm injection (ICSI).

WHAT IS KNOWN ALREADY: ART is widely practiced throughout the world but continues to be characterized by significant disparities in utilization, practice, effectiveness and safety. The International Committee for Monitoring Assisted Reproductive Technologies (ICMART) annual world report series provides an important instrument for tracking trends in ART treatment and for providing clinical and public health data to ART professionals, health authorities, patients and the general public.

STUDY DESIGN, SIZE, DURATION: A retrospective, cross-sectional survey on ART procedures performed globally during 2014 was carried out. A new method for calculating ART utilization rates and number of babies born was introduced in this latest ICMART world report.

PARTICIPANTS/MATERIALS, SETTING, METHODS: Overall, 76 countries and 2 746 ART centres submitted data through national and regional ART registries on ART cycles performed during 2014 and their treatment and pregnancy outcomes. ART cycles and outcomes are described at a country level, regionally and globally. Aggregate country data are processed and analyzed based on methods developed by ICMART.

MAIN RESULTS AND THE ROLE OF CHANCE: A total of 1 629 179 ART cycles were reported for the treatment year 2014. After imputing data for missing values and non-reporting centres in reporting countries, an estimated 1 929 905 cycles resulted in >439 039 babies in reporting countries. From 2010 to 2014, the number of reported non-donor aspirations and FET cycles increased by 37.3% and 67.5%, respectively. The proportion of women aged ≥40 years undergoing non-donor ART increased from 23.2% in 2010 to 27.0% in 2014. ICSI, as a percentage of non-donor aspiration cycles, remained relatively stable at 64.8%. The IVF/ICSI combined delivery rates per fresh aspiration and FET cycle were 19.9% and 24.3%, respectively. In fresh non-donor cycles, SET increased from 30.0% in 2010 to 40.0% in 2014, while the

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average number of transferred embryos decreased from 1.95 to 1.73—but with wide country variation. The rate of twin deliveries following fresh non-donor transfers continued to decrease, from 20.4% in 2010 to 16.2% in 2014, and the triplet rate decreased from 1.1% to 0.5%. In FET non-donor cycles in 2014, the SET rate was 61.6%, with an average of 1.43 embryos transferred, resulting in twin and triplet rates of 10.1% and 0.2%, respectively. The cumulative delivery rate per aspiration increased from 27.1% in 2010 to 32.1% in 2014. The overall perinatal mortality rate per 1 000 births was 19.4 following fresh IVF/ICSI cycles and 9.5 following FET cycles. Among reporting countries, oocyte donation cycles represented 7.3% of all embryo transfers (89 751 transfer cycles) and resulted in 39 278 babies.

LIMITATIONS, REASONS FOR CAUTION: The data presented are dependent on the quality and completeness of data submitted by individual countries to ICMART directly or through regional registries. This report covers approximately two-thirds of world ART activity. China is a major contributor of global cycles missing from this report. Continued efforts to improve the quality and consistency of ART data reported by registries are still needed, including the use of internationally agreed standard definitions (The International Glossary of Infertility and Fertility Care). A new method was introduced in this report to calculate ART utilization and number of babies born following ART; therefore, these results are not directly comparable with previous reports.

WIDER IMPLICATIONS OF THE FINDINGS: The ICMART world reports provide the most comprehensive global statistical census and review of ART utilization, effectiveness, safety and quality. While ART treatment effectiveness and safety continue to increase globally, the wide disparities in access to treatment, procedures performed and embryo transfer practices warrant attention by clinicians and policy-makers. The new method for estimating ART utilization and number of babies born provided more conservative estimates compared to the previous method.

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Introduction

This is the 19th world report on ART, and the 13th produced by the International Committee for Monitoring Assisted Reproductive Technologies (ICMART). ICMART has been generating annual world reports since 1989 (Lancaster, 1996). The current report presents data on ART performed in 2014, including country, regional and global estimates of ART utilization, effectiveness and safety. Information on global ART practice, intrauterine insemination (IUI), pregnancy and neonatal outcomes is also included.

Materials and methods

Data collection and analysis have been described elsewhere (Zegers-Hochschild et al., 2014). In summary, data of ART treatments performed in 2014 were collected from regional or national ART registries or, in the case of the few countries for which registries do not exist, directly from individual centres. The ICMART Tool Box for ART Data Collection (<https://www.icmartivf.org/toolbox/>) provides standardized forms which were used to collect information on the number of ART centres, and on procedure- and outcome-related information pertaining to in vitro fertilization (IVF), intracytoplasmic sperm injection (ICSI), oocyte donation (OD), frozen embryo transfer (FET), preimplantation genetic testing (PGT) and IUI (with both husband/partner

and donor sperm). Data were further stratified by woman's age and the number of embryos transferred. Trends were assessed over 5 or 10 years to allow for random instability in year-to-year comparisons (Dyer et al., 2016; Adamson et al., 2018; De Mouzon et al., 2020; Banker et al., 2021).

Further processing and analyses were conducted by the Clinical Research Center at Uppsala University, Sweden, to which the collected aggregated data were transferred by ICMART. Data consistency was checked and a statistical report, including tables and graphs, was generated using SAS (version 9.4, Cary, NC, USA) and R (version 3.1.1) statistical software packages. Given that approvals were obtained by countries and entities submitting data to ICMART, institutional review board approval was not obtained. Only anonymized aggregated data, and no data of any type that constituted protected health information, were collected by ICMART.

This report follows the terminology defined in the ICMART and World Health Organization revised 2009 Glossary of ART terminology (Zegers-Hochschild et al., 2009) as this was the Glossary that applied to ART in 2014. Data are presented by country, region and globally. The proportion of cycles using ICSI for fertilization was only calculated for countries that reported method of fertilization.

For this report, ICMART refined the approach to the calculation of ART utilization and number of babies. The rationale for doing so has been described previously (Dyer et al., 2020). Briefly, ART utilization, expressed as total number of ART cycles per million population, had

previously been calculated by dividing the total number of ART cycles reported annually in a country by the rate of participating (reporting) centres (i.e. the proportion of all existing ART centres that report their data to country or regional registries); divided in turn by the country's population size in millions.

In this report, we have applied our new approach for calculating ART utilization, as described in the following steps:

- i. The number of reported cycles for each country is calculated as the sum of autologous fresh initiated cycles, thaw cycles, PGT cycles and OD transfer cycles.
- ii. Countries are categorized according to the proportion of cycles reported to ICMART in relation to the estimated total number of cycles performed in a country. If the estimated total number of cycles performed is not known, the proportion of centres in a country reporting to ICMART is used to categorize a country. The greater the proportion of cycles/centres reported to ICMART by a given country, the greater is the confidence in the estimation of ART utilization:
 - $\geq 95\%$ cycles/centres reported (certain confidence).
 - 66–94% cycles/centres reported (high confidence).
 - 33–65% of cycles/centres reported (modest confidence).
 - $< 33\%$ cycles/centres (low confidence).
- iii. For countries with $\geq 33\%$ to 99% of cycles/centres reported to ICMART, the total number of cycles performed and babies born is extrapolated by dividing the number of cycles reported by the rate of participating cycles/centres.
- iv. For countries with $< 33\%$ of cycles/centres reported to ICMART, the number of cycles and babies born is presented without extrapolation. However, if the ICMART Regional Representative has an informed estimate of the total number of cycles performed in a country this is presented, and the number of babies born is estimated based on the delivery rate (DR) for that country.
- v. ART utilization at a country level is calculated as the reported or estimated number of cycles performed (steps i–iv above) divided by the country's population in the same year, regardless of the rate of participating cycles/centres.
- vi. ART utilization at a regional and global level is based on the estimated or reported number of cycles for countries with a $\geq 33\%$ participation rate plus countries with a $< 33\%$ participation rate for which there is an informed estimate of the total number of cycles. Therefore, countries with $< 33\%$ participation and without an informed estimate of the number of cycles performed are not included in the regional and global estimates of utilization.

The approach to estimating utilization for each country is denoted in the ICMART tables.

For the sake of comparison with previous years and to document how the new method affects the data for ART utilization rates and number of babies born, we have tabulated the old and new calculations in a new supplementary table for this report.

Results

Key findings are summarized in [Tables I and II](#). Additional results are available online ([Supplementary Tables SI, SII, SIII, SIV, SV, SVI, SVII,](#)

[SVIII, SIXa, SIXb, SXa, SXb, SXla, SXlb, SXII and SXIII](#) and [Supplementary Figs S1, S2, S3, S4, S5, S6 and S7](#)).

ART utilization

Overall, 76 countries reported data for treatments performed in 2014, a steady annual increase from the 60 countries reporting in 2010 ([Supplementary Table SI](#)). A total of 2 746 centres participated in the 2014 annual collection, representing almost two-thirds (65.6%) of centres in these countries ([Supplementary Table SI](#)). This varied considerably among regions from less than a quarter of centres reporting in Africa to complete participation in Australia/New Zealand and Middle East (Israel). Almost half of participating centres were located in Europe (46.6%) and a further 28.7% in Asia. In Australia/New Zealand and Middle East (Israel), the majority of centres performed ≥ 500 cycles per year, whereas all other regions were characterized by small- to medium-sized centres ([Supplementary Table SI](#)).

Participating centres reported a total of 1 629 179 ART cycles, 390 220 more compared to 2013. Based on both the reported and estimated numbers of conducted cycles, an estimated 1 929 905 treatment cycles were conducted in the 76 participating countries ([Table II](#)). ART utilization, measured as cycles per million population, ranged from 5 203 in Middle East (Israel) and 2 642 in Australia/New Zealand to a mean of 129 (range 16–360) in Latin America, resulting in a global average of 535 cycles per million population. Because this is the first ICMART world report to adopt the new method of estimating global ART utilization, direct comparison with previous years is not possible. However, using the previous method, a total of 2 347 018 treatment cycles were estimated to have been initiated in 2014 ([Supplementary Table SXIII](#)).

In 2014, Japan conducted the highest number and proportion (23.2%) of non-donor aspiration cycles globally (231 030/994 654), followed by the USA (7.8%; 77 220/994 654) and Russia (6.6%; 65 598/994 654; [Table II](#)). The reported global number of non-donor FET cycles was 436 895 in 2014, an increase of 9.0% from 2013 ([Table I](#)). FET cycles comprised 40.2% of all fresh and FET cycles in 2014 ([Supplementary Table SII](#)), continuing the gradual increase in the proportion of FET cycles, reported as 29.7% in 2010. However, there was large variation among countries and regions in the use of frozen cycles from 68.2% in Japan to 2.2% in Serbia, and from 62.1% in Asia to 16.2% in Africa, respectively.

Among the reported 994 654 fresh non-donation aspiration cycles, 619 811 cycles (62.3%) used ICSI as the fertilization method ([Table I](#)), similar to the proportion in 2010 (63.0%).

There were 36 512 PGT cycles reported in 2014, of which 46.3% were performed in the USA alone. The provision of PGT increased by 188.4% over the period from 2010 (12 661) to 2014 ([Table I](#)). There were 89 751 reported fresh and frozen OD transfer cycles in 2014 representing an 82.1% increase from 2010. In 2014, Spain performed 34.1% of all OD transfer cycles ([Table I](#)).

ART effectiveness

The reported global pregnancy rate (PR) and DR per aspiration for non-donor IVF/ICSI cycles was 26.5% and 19.9%, respectively. This compared to a global PR and DR for FET of 33.8% and 24.3%, respectively ([Table II](#) and [Supplementary Table SII](#)). There was a substantial increase in PR and DR per FET in the last 5 years from 29.1% and

Table 1 Number of procedures by type of procedure for year 2014.

Country name	Non-donation cycles ^b							Oocyte donation transfer cycles ^b
	Fresh cycles ^c				FET cycles ^c		PGT cycles ^b	
	Initiated cycles	Aspiration cycles			Thaw cycles	Transfer cycles		
		Total	IVF	ICSI				
	Total	Total	IVF	ICSI	Total	Total	Total	Total
Benin	117	110	7	103	26	26	NA	NA
Cameroon	93	90	51	39	4	0	0	42
Egypt	19 270	18 965	148	18 817	3172	2499	10	0
Ghana ^a	537	510	NA	NA	50	49	NA	125
Ivory Coast	58	58	58	0	NA	NA	NA	252
Mali	NA	183	15	168	31	31	NA	NA
Mauritius	115	105	27	78	49	43	NA	0
Morocco	NA	763	138	625	NA	252	NA	NA
Nigeria	1226	1207	432	775	66	66	NA	173
Senegal	78	78	0	78	NA	NA	NA	0
South Africa	NA	4053	1371	2682	852	823	NA	1129
Togo	195	135	17	118	NA	13	NA	53
Tunisia	NA	2219	134	2085	459	441	NA	NA
India ^a	NA	24 589	NA	NA	NA	7046	NA	5792
Indonesia	4127	4127	246	3881	750	724	NA	NA
Japan	236 259	231 030	89 142	141 888	155 670	153 868	NA	NA
Taiwan ^a	14 498	14 498	NA	NA	NA	5494	NA	590
Australia ^a	38 205	34 527	NA	NA	22 174	21 225	3346	1707
New Zealand ^a	3247	3024	NA	NA	2102	2021	115	199
Albania	96	96	0	96	44	44	0	11
Austria	NA	5670	897	4773	1656	1641	NA	NA
Belarus	2576	2510	1451	1059	130	130	25	8
Belgium	NA	16 677	3220	13 457	10 677	9657	569	853
Bosnia and Herzegovina	531	520	0	520	67	67	0	0
Bulgaria	4587	4165	225	3940	1230	1208	33	460
Croatia	NA	2972	1314	1658	311	291	0	0
Cyprus	1145	1100	203	897	316	286	23	85
Czech Republic	13 280	12 864	NA	12 864	NA	9059	1552	4868
Denmark	11 864	11 552	6233	5319	3898	3408	104	256
Estonia	1819	1800	625	1175	887	777	0	178
Finland	4550	4326	2327	1999	NA	3384	NA	687
France	NA	60 933	20 638	40 295	27 214	24 990	879	1047
Germany	59 284	59 284	13 672	45 612	21 893	21 010	NA	NA
Greece	15 763	14 744	2799	11 945	3216	3063	441	4622
Hungary	5050	5036	1179	3857	NA	437	NA	119
Iceland	NA	355	189	166	241	232	NA	110
Ireland	1128	967	507	460	385	309	0	0
Italy	55 705	50 794	6898	43 896	9501	8851	1832	156
Kazakhstan	2299	2021	916	1105	974	951	121	165

(continued)

Table I Continued

Country name	Non-donation cycles ^b							Oocyte donation transfer cycles ^b
	Fresh cycles ^c				FET cycles ^c		PGT cycles ^b	
	Initiated cycles	Aspiration cycles			Thaw cycles	Transfer cycles		
		Total	IVF	ICSI				
	Total	Total	IVF	ICSI	Total	Total	Total	Total
Latvia	NA	942	462	480	301	297	2	144
Lithuania	NA	352	200	152	29	28	NA	NA
Macedonia	NA	1845	388	1457	117	115	NA	33
Malta	135	125	0	125	0	0	0	0
Moldova	751	738	246	492	86	58	0	0
Montenegro	425	422	NA	422	17	17	NA	NA
The Netherlands	14 115	12 787	5851	6936	NA	10 505	415	NA
Norway	6126	6034	3125	2909	4799	2600	NA	NA
Poland	14 634	14 499	884	13 615	7775	7601	305	756
Portugal	5661	5449	2146	3303	1556	1456	69	493
Romania	2419	2347	1163	1184	NA	843	NA	93
Russia	67 470	65 598	28 297	37 301	19 524	18 996	1525	5619
Serbia	273	260	116	144	5	5	0	0
Slovenia	3377	3273	895	2378	1288	1258	8	8
Spain	51 591	46 352	4935	41 417	21 007	19 549	4328	30 576
Sweden	11 832	11 135	5575	5560	NA	5771	207	347
Switzerland	5449	4919	824	4095	4473	3970	NA	NA
Ukraine	10 515	10 031	1825	8206	4806	4663	392	1144
UK	45 447	42 875	18 765	24 110	13 595	12 898	589	3196
Argentina	9083	8169	954	7215	2889	2817	144	1505
Bolivia	430	416	221	195	41	39	4	56
Brazil	16 474	15 351	878	14 473	6643	6462	1050	1554
Chile	2111	1916	124	1792	863	825	153	336
Colombia	1196	1110	357	753	288	269	9	220
Dominican Republic	30	30	11	19	5	5	0	18
Ecuador	663	579	181	398	193	183	11	178
Guatemala	103	102	60	42	32	31	19	10
Mexico	4862	4595	1390	3205	1480	1453	83	1670
Nicaragua	98	85	17	68	NA	53	0	14
Panama	239	196	NA	196	55	17	16	36
Paraguay	75	62	37	25	18	NA	0	10
Peru	1286	1198	443	755	437	423	302	766
Uruguay	317	268	30	238	78	76	1	66
Venezuela	1119	946	385	561	204	198	19	241
Israel ^a	40 699	NA	NA	NA	NA	NA	NA	NA
Canada	16 410	15 023	4175	10 848	8525	8271	918	1483
USA	86 615	77 220	18 908	58 312	41 305	40 727	16 893	15 492

Region	Non-donation cycles ^b							
	Fresh cycles ^c				FET cycles ^c		PGT cycles ^b	Oocyte donation transfer cycles ^b
	Initiated cycles	Aspiration cycles			Thaw cycles	Transfer cycles		
		Total	IVF	ICSI				
Africa	>21 689	28 476	>2398	>25 568	>4709	>4243	>10	>1774
Asia	>254 884	274 244	>89 388	>145 769	>156 420	167 132	NA	>6382
Australia and New Zealand	41 452	37 551	NA	NA	24 276	23 246	3461	1906
Europe	>419 897	488 369	>138 990	349 379	>162 018	180 425	>13 419	>56 034
Latin America	38 086	35 023	>5088	29 935	>13 226	>12 851	1811	6680
Middle East (Israel)	40 699	NA	NA	NA	NA	NA	NA	NA
North America	103 025	92 243	23 083	69 160	49 830	48 998	17 811	16 975
Total	>919 732	>955 906	>258 947	>619 811	>410 479	>436 895	>36 512	>89 751

^aCountries that did not separate ICSI and IVF.

^bReported in the registers.

^cExcluding PGT and oocyte donation cycles.

NA, not available; FET, frozen embryo transfer; PGT, preimplantation genetic testing.

20.7% in 2010 to 33.8% and 24.3% in 2014, respectively. These rates are vastly different between countries and depend, among other factors, on the average number of embryos transferred per cycle (Supplementary Fig. S3).

The estimated cumulative DR (calculated as the number of deliveries from non-donor fresh IVF/ICSI transfer cycles and FET cycles divided by aspirations) increased from 27.1% in 2010 to 32.1% in 2014, resulting in 371 952 babies reported from participating centres and an estimated >439 039 babies born from treatment in 2014 (Table II).

In 2014, approximately one-quarter of women undergoing fresh and thaw cycles were ≥ 40 years old. The global PR in these women was 9.2% per fresh IVF/ICSI aspiration cycle and 25.0% per FET (Supplementary Tables IXa and b). Among women of all age groups, the rate of early pregnancy loss after fresh embryo transfer and FET was comparable to previous years at 20.6% and 25.1%, respectively (Supplementary Table SVIII).

ART safety

Continuing the trend of recent years, the average number of transferred embryos in fresh non-donor and FET cycles in 2014 decreased to 1.73 and 1.43, respectively (Supplementary Tables SIII and SIV). The global single embryo transfer (SET) rate reached 40.0% for fresh non-donor transfers and 61.6% for FET cycles, compared to double embryo transfer rates of 48.8% in fresh and 34.2% in FET cycles. At the same time, the rate of embryo transfers with three or more embryos declined to 11.2% in fresh and 4.3% in FET cycles. As expected, there was a statistically significant correlation between the rate of multiple deliveries and the mean number of embryos transferred ($P < 0.0001$; Supplementary Fig. S7).

The preterm DR was 21.3% and 16.2% following fresh embryo transfers and FET cycles performed in 2014. The preterm rate fluctuated over the period from 2010 to 2014, but decreased since 2012 from 22.4% and 17.8% following fresh and FET cycles, respectively, to 21.3% and 16.2% in 2014 (Supplementary Table SVIII). The risk of ovarian hyperstimulation syndrome, a potentially severe complication of ART, has remained stable since 2010 at a global level of 0.4% per cycle (Supplementary Table SVII).

Special techniques (OD, PGT, IVM and surrogacy) and foetal reduction

Data on OD cycles were reported by 53 of the total 76 countries reporting to ICMART. A total of 89 751 OD transfer cycles were reported in 2014 (7.3% of all embryo transfers; Supplementary Tables SIII, SIV, SV and SVI), representing an increase of 82.1% in cycles from 2010. The majority of OD cycles (62.4%) were performed in Europe (Table I). In total, OD resulted in 39 278 babies born among participating countries, with a PR of 51.7% following fresh embryo transfer and 41.2% following FET. Oocyte recipients were predominantly >40 years of age (68.3%), a slightly higher proportion than in previous years (Supplementary Table SVI).

Among the 39 countries reporting PGT cycles to ICMART, 36 512 cycles were performed resulting in a 35.1% PR per aspiration and a 49.8% PR per transfer (Table I and Supplementary Table SV).

Intrauterine insemination

IUI using husband sperm was reported by 36 countries representing a total of 176 724 cycles (Supplementary Table SXIa), a decrease of 8.7% compared to 2010. The PR, DR and multiple DR per cycle in 2014 were similar to previous years at 11.8%, 8.9%, and 9.8%,

Table II Reported data and ICMART estimations for year 2014.

Country name	Fresh	FET				Fresh + FET		Utilization ^g cycles/million (bold = total utilization; standard=high confidence estimate; italic = modest confidence estimate; asterisk = non- estimate based on reported cycles)	Total ^{h,i} babies reported from participating clinics	Total ^{h,i} babies estimated from all clinics (bold = total babies; standard=high confidence estimate; italic = modest confidence estimate; asterisk = non- estimate based on reported cycles)
	IVF and ICSI	Aspirations ^a	PR/Asp ^b (%)	DR/Asp ^c (%)	DR/Asp ^d cumul. (%)	Babies ^e /Asp fresh (%)	Babies ^e /Asp cumul. (%)			
Benin ^k	110	40.9	27.3	29.1	NA	NA	NA	NA	143	38
Cameroon	90	28.9	22.2	22.2	34.4	34.4	34.4	NA	417	36
Egypt	18 965	35.5	23.7	25.7	35.8	40.0	72 800 ^m	26.4	837.79	7453
Ghana	510	38.6	32.5	34.5	45.7	48.4	1355 ⁱ	28.6	52.61	325
Ivory Coast	58	53.4	22.4	22.4	NA	NA	620	NA	27.13	139
Mali ^k	183	44.8	44.8	47.0	59.0	59.0	224	NA	13.60	108
Mauritius	105	39.0	29.5	38.1	NA	NA	492	NA	369.60	48
Morocco ^k	763	37.9	33.3	40.2	38.8	47.2	>1066 [*]	25.4	>32.33 [*]	360
Nigeria	1207	35.6	26.6	27.3	9.3	NA	>1465 [*]	NA	>8.27 [*]	87
Senegal ^k	78	33.3	21.8	21.8	NA	NA	78	NA	5.72	20
South Africa	4053	33.4	19.4	21.3	22.1	32.0	8335	33.3	172.29	1645
Togo ^k	135	11.5	6.9	8.9	9.6	9.9	262	0.0	35.58	22
Tunisia	2219	34.7	25.6	29.2	33.6	38.6	8506 ^m	22.7	777.69	845
India	24 589	26.5	19.8	28.5	NA	NA	150 000 ^m	NA	121.33	3728
Indonesia ^k	4127	32.3	24.2	26.9	NA	NA	5058	NA	19.94	1325
Japan ^k	231 030	10.2	7.1	20.0	7.0	36.6	408 316	24.7	3212.47	54104
Taiwan	14 498	24.9	18.3	31.5	NA	NA	23 784	NA	1018.15	5440
Australia ^k	34 527	24.6	19.3	32.4	18.2	38.4	65 432	26.2	2907.10	12821
New Zealand ^k	3024	32.0	25.3	40.2	22.6	49.2	5663	29.0	1286.49	1368
Albania	96	40.9	36.6	50.0	42.7	63.4	>151 [*]	40.9	>50.00 [*]	63
										>63 [*]

(continued)

(continued)

Table II Continued

Country name	Fresh IVF and ICSI Aspirations ^a	FET					Fresh + FET		Utilization ^g cycles/million (bold = total utilization; standard=high confidence estimate; italic = modest confidence estimate; asterisk = non- estimate based on reported cycles)	Total ^{h,j} babies reported from participating clinics	Total ^{i,j} babies estimated from all clinics (bold = total babies; standard=high confidence estimate; italic = modest confidence estimate; asterisk = non- estimate based on reported cycles)
		PR/Asp ^b (%)	DR/Asp ^c (%)	DR/Asp ^d cumul. (%)	Babies ^e /Asp fresh (%)	Babies ^e /Asp cumul. (%)	Babies ^e /FET (%)	Estimated ^f or reported overall total number of cycles			
Austria	5670	31.7	27.5	36.1	40.9	40.9	NA	8175	994.11	2317	2483
Belarus	2510	39.0	34.0	34.5	41.4	43.8	36.2	3424	356.34	1096	1370
Belgium ^k	16 677	27.4	19.8	29.2	21.7	36.9	22.4	29 669	2839.32	6182	6182
Bosnia and Herzegovina	520	32.9	23.9	24.2	29.0	34.8	22.4	>598 [*]	>154.46 [*]	166	>166 [*]
Bulgaria	4165	25.4	18.7	23.4	17.2	31.7	31.2	>6310 [*]	>911.23 [*]	1254	>1254 [*]
Croatia	2972	21.3	15.8	17.2	16.5	19.7	27.5	7035 ⁱ	1573.47	570	1164 ⁱ
Cyprus	1100	37.9	25.1	33.2	NA	NA	NA	1831	1561.25	490	572
Czech Republic ^k	12 864	28.5	NA	NA	24.6	45.4	27.2	29 137	2741.63	7296	7296
Denmark ^k	11 552	24.9	21.9	27.8	23.8	31.5	23.6	16 122	2894.91	3637	3637
Estonia ^k	1800	26.2	20.3	23.9	23.0	28.3	10.8	2884	2292.67	549	549
Finland ^k	4326	26.7	20.5	36.5	21.4	38.3	21.6	8762	1663.01	1658	1658
France ^k	60 933	26.0	20.9	26.8	22.9	32.4	18.8	94 269	1422.74	19108	19 299
Germany ^k	59 284	28.3	20.6	26.6	25.3	32.8	21.1	83 694	1033.30	19421	20 023
Greece ^k	14 744	31.0	16.9	20.2	21.0	28.6	32.4	24 042	2231.16	5764	5764
Hungary	5036	25.9	19.4	21.5	NA	NA	NA	6647	670.10	1293	1528
Iceland ^k	355	30.4	24.7	35.8	24.5	40.5	21.1	725	2284.57	163	163
Ireland	967	42.4	34.2	42.5	39.5	48.5	28.2	3530	730.50	469	1094
Italy ^k	50 794	21.3	14.3	17.8	17.5	21.6	23.5	67 194	1089.39	11419	11 419
Kazakhstan	2021	38.7	24.3	37.3	25.4	39.7	30.5	6568 ^m	365.93	951	1905 ^m
Latvia	942	24.1	13.7	17.7	14.5	20.5	15.2	2399	1108.03	199	332
Lithuania	352	33.8	29.5	31.3	19.0	NA	14.3	600	171.08	131	197
Macedonia	1845	43.8	21.5	21.8	22.8	23.6	12.2	2150 ^m	1027.72	447	459

(continued)

Table II Continued

Country name	Fresh		FET			Fresh + FET		Utilization ^g cycles/million (bold = total utilization; standard=high confidence estimate; italic = modest confidence estimate; asterisk = non- estimate based on reported cycles)	Total ^{h,j} babies reported from participating clinics	Total ^{h,j} babies estimated from all clinics (bold = total babies; standard=high confidence estimate; italic = modest confidence estimate; asterisk = non- estimate based on reported cycles)
	IVF and ICSI	Aspirations ^a	PR/Asp ^b (%)	DR/Asp ^c (%)	DR/Asp ^d cumul. (%)	Babies ^e /Asp fresh (%)	Babies ^e /Asp cumul. (%)	Babies ^e /FET (%)	Estimated ^f or reported overall total number of cycles	
Malta ^k	125	28.8	27.2	27.2	27.2	32.8	32.8	NA	135	327.15 41
Moldova	738	44.6	33.2	34.8	34.8	NA	NA	NA	1116	307 409
Montenegro	422	25.6	NA	NA	NA	26.1	28.0	47.1	553	118 148
The Netherlands ^k	12 787	30.9	22.8	35.0	35.0	23.8	36.3	15.3	25 473	1509.29 4647
Norway ^k	6034	29.2	24.2	32.5	32.5	NA	NA	NA	10 925	2122.27 2337
Poland	14 499	33.0	23.0	30.8	30.8	24.2	39.5	23.6	27 517	5569 6529
Portugal ^k	5449	32.4	24.5	28.8	28.8	27.2	38.8	29.8	7779	719.36 2192
Romania	2347	37.7	28.0	37.2	37.2	35.5	48.9	37.2	4955	1184 1730
Russia	65 598	29.6	21.2	28.2	28.2	26.1	35.2	31.5	118 203	829.67 32 234
Serbia	260	35.2	29.6	30.4	30.4	38.1	40.7	80.0	>278 [*]	>38.56 [*] 103
Slovenia ^k	3273	29.1	22.7	31.0	31.0	24.4	35.7	26.2	4681	2354.28 1134
Spain	46 352	31.6	21.8	27.8	27.8	24.0	42.9	30.2	117 058	2452.09 29100
Sweden	11 135	28.4	23.2	36.2	36.2	24.2	37.6	25.8	19 547	2010.26 4332
Switzerland	4919	23.2	17.1	29.3	29.3	20.3	34.5	17.6	10 657	1321.96 1695
Ukraine	10 031	41.0	31.3	43.0	43.0	35.2	62.0	42.9	20 018	451.95 7486
UK ^k	42 875	32.8	28.8	37.5	37.5	33.4	43.7	34.0	62 827	985.63 20340
Argentina ^k	8169	25.6	19.6	25.8	25.8	20.8	35.4	29.9	15 478	359.76 3533
Bolivia ^k	416	31.3	25.9	28.1	28.1	31.7	35.9	38.5	738	69.37 250
Brazil ^k	15 351	32.2	26.7	32.8	32.8	25.7	53.0	35.3	28 579	141.02 7667
Chile ^k	1916	32.8	24.9	34.2	34.2	24.0	52.5	39.6	4557	262.42 1291
Colombia ^k	1110	34.1	29.7	33.8	33.8	36.3	48.4	34.2	3984	86.14 1384

(continued)

Table II Continued

Country name	Fresh		FET		Fresh + FET		Utilization ^g cycles/million (bold = total utilization; standard=high confidence estimate; italic = modest confidence estimate; asterisk = non- estimate based on reported cycles)	Total ^{h,j} babies reported from participating clinics	Total ^{h,j} babies estimated from all clinics (bold = total babies; standard=high confidence estimate; italic = modest confidence estimate; asterisk = non- estimate based on reported cycles)
	IVF and ICSI Aspirations ^a	PR/Asp ^b (%)	DR/Asp ^c (%)	DR/Asp ^d cumul. (%)	Babies ^e /Asp fresh (%)	Babies ^e /Asp cumul. (%)	Babies ^e /FET (%)	Estimated ^f or reported overall total number of cycles	
Dominican Republic ^k	30	40.0	30.0	33.3	36.7	NA	NA	161	15.52
Ecuador ^k	579	43.4	35.2	38.0	38.9	58.0	33.9	1161	74.17
Guatemala ^k	102	38.5	32.3	42.2	34.3	49.0	38.7	298	20.36
Mexico ^k	4595	35.4	30.2	36.5	34.3	53.9	39.9	10 378	86.28
Nicaragua ^k	85	38.8	31.8	51.8	36.5	NA	0.0	507	86.63
Panama ^k	196	34.8	NA	NA	21.4	48.9	NA	438	121.38
Paraguay ^k	62	38.5	30.8	27.4	35.5	46.2	11.8	206	30.73
Peru ^k	1198	22.8	17.0	22.8	14.2	44.2	39.5	3404	112.90
Uruguay ^k	268	39.4	30.3	35.8	32.8	44.2	30.3	550	165.02
Venezuela ^k	946	35.3	27.0	30.4	32.1	43.5	34.8	1583	54.83
Israel^k	38 748	25.5	19.1	19.1	NA	NA	NA	40 699	5203.24
8829								8829	
Canada	15 023	33.1	25.7	37.1	24.5	50.9	33.1	29 748	853.97
USA	77 220	40.8	33.0	50.3	36.3	71.7	49.9	195 786	613.96
								59621	72 817

Region ^l	Fresh		FET		Fresh + FET		Utilization ^g cycles/million (bold = total utilization; standard = high confidence estimate; italic = modest confidence asterrisk = modest non-estimate based on reported cycles)	Total ^{h,j} babies reported from participating clinics	Total ^{i,j} babies estimated from all clinics (bold=total babies; standard = high confidence estimate; italic = modest confidence estimate; asterrisk = non-estimate based on reported cycles)		
	IVF and ICSI	Aspirations ^a	PR/Asp ^b (%)	DR/Asp ^c (%)	DR/Asp ^d cumul. (%)	Babies ^e /Asp cumul. (%)				Babies ^e /FET (%)	Estimated ^f or reported overall number of cycles
Africa	28 476	35.3	23.9	26.8	33.7	39.1	27.2	>95 763 [*]	349.34	11 126	>30 713 [*]
Asia	274 244	13.9	9.9	30.9	10.9	36.6	24.7	587 158	357.93	64 597	78 282
Australia and New Zealand ^k	37 551	25.2	19.8	37.1	20.8	39.2	26.5	71 095	2642.00	14 189	14 189
Europe	488 369	28.8	21.5	29.2	25.7	35.3	25.1	837 636	1 133.18	189 717	206 016
Latin America ^k	35 023	31.2	25.4	38.5	32.0	47.9	35.3	72 021	128.75	16 862	20 563
Middle East (Israel) ^k	38 748	25.5	19.1	19.1	NA	NA	NA	40 699	5203.24	8829	8829
North America	92 243	39.6	31.8	55.5	39.6	68.4	47.1	225 534	637.59	66 632	80 447
Total	994 654	26.50	19.90	32.10	24.60	39.70	27.90	1 929 905	535.15	371 952	439 039

^aImputed/estimated data printed in bold.

^bImputed by applying the average cancellation rate to the number of initiated cycles when not reported.

^cImputed by calculating the number of aspirations (Asp) from the number of initiated cycles reported when not reported.

^dImputed by calculating the mean percentage of deliveries per pregnancy when not reported.

^eImputed by calculating the mean percentage of deliveries per pregnancy.

^fIn countries where the sum of singleton, twins and triplets was less than the total number of deliveries, the number of unknown babies and lost to follow-up deliveries were estimated by applying distribution of observed deliveries in which this was known.

^gInitiated cycles overall countries estimation. Step 1: Reported cycles for countries reporting them, or estimation by applying their cancellation rate to the aspiration numbers for the countries not reporting them. Step 2: Total of step 1 if either 100% of the cycles/centres reported or the cycle reporting/centre participation rate is <33% and no informed estimate of the total number of cycles is available; otherwise, estimation by applying the percentage of reported cycles/participating centres to this total.

^hTotal number of cycles and babies based on reported number of cycles and babies because the rate of reporting based on centres is <33% and an informed estimate of the total number of cycles was not available.

ⁱTotal estimated number of cycles in the country divided by its population in 2014 (CIA World Fact Book).

^jImputed by multiplying number of deliveries by the average number of babies per delivery (singleton, twin and triplet).

^kTotal babies reported if either 100% of the cycles/centres reported or the cycle reporting/centre participation rate is <33%, otherwise estimation by applying the percentage of reported cycles/participating centres to this total.

^lTotal babies also include PGD and oocyte donation.

^mEstimated or reported overall total number of cycles calculated based on rate of reporting based on cycles, not centres.

ⁿThe total numbers and numbers by region were calculated only from the countries with complete data (e.g. both number of pregnancies and no. of oocyte aspirations).

^oInformed estimate of the total number of cycles obtained from ICMART Regional Representative.

^pCumulative rate per aspiration, computed by adding the FET deliveries and babies to those obtained after fresh cycle, the sum being divided by the number of aspirations.

ICMART, International Committee for Monitoring Assisted Reproductive Technologies; PR, pregnancy rate; DR, delivery rate; NA, not available; FET, frozen embryo transfer.

respectively. In contrast to IUI cycles with husband sperm, the reported number of IUI cycles using donor sperm has increased over time. In 2014, 30 countries reported 52 337 donor IUI cycles compared to 34 countries reporting 43 138 donor IUI cycles in 2010 (Supplementary Table SXIb). The DR was higher in donor IUI cycles compared to husband IUI cycles; 11.7% and 8.9%, respectively (Supplementary Tables SXIa and b).

Cross-border reproductive care

Since ICMART started reporting on cross-border reproductive care (CBRC) in 2011, the number of countries reporting data to ICMART has increased by over 50% from 15 in 2011 to 23 in 2014 (Supplementary Table SXII). The majority of countries reporting on CBRC were located in Europe (65.2%), a further quarter (26.1%) in Africa, and the remaining two countries in North America (8.7%). There was a significant increase in reported cross-border anonymous OD cycles from >2 955 in 2013 to >9 853 in 2014, of which two-thirds were performed in Spain (6 563 cycles).

Discussion

This is the 19th consecutive annual ICMART world report on global ART utilization, effectiveness and safety. In 2014, 76 countries reported to ICMART, the highest number of countries to date. These countries are estimated to represent 66% of global activity. The main contributor to missing data from the report is considered to be from countries in the Middle East and China, however, with the recent publication of ART utilization for cycles conducted in China in 2016, future reports are expected to include data from China (Bai et al., 2020).

The key trends in global ART treatment over the 5 years to 2014 include the increase in the proportion of FET and the increase in success rates from these cycles, a steady improvement in cumulative DRs per aspiration, the continued increase in SET and thus reduction in multiple birth rates, an increased uptake of PGT and a stabilization in the use of ICSI.

In this report, ICMART introduced a new method for calculating ART utilization and number of babies born. ART utilization continues to be expressed as the estimated total number of ART cycles per million population. However, the previous method of estimating the total number of ART cycles was derived from the participation (reporting) rate of ART centres, i.e. the proportion of cycles performed by centres reporting to national or regional registries, extrapolated by the total number of centres known to exist in a country. There were two sources of potential error in this approach: first, the total number of centres was in some countries very uncertain or essentially unknown; and second, the calculation was based on the assumption that the mean number of cycles performed by reporting centres was representative of the mean number of cycles performed by non-reporting centres.

The new reporting formula for calculating ART utilization and number of babies born each year differs in three important ways from the previous method. First, where known, the number of all cycles estimated to have been performed in a country is used to extrapolate to the total number of cycles and babies. Only where such an estimate is unavailable, is the estimated number of all centres used. Second, to reflect the level of confidence in the estimates, countries are categorized

according to the proportion of cycles/centres in a country reporting to ICMART (<33%, 33–65%, 66–94% and \geq 95% of cycles/centres reported). Third, utilization rates and numbers of babies are not extrapolated for countries that report <33% of cycles/centres and do not have an informed estimate of the total number of cycles available owing to the considerable uncertainty in the estimates. Indeed, in a number of countries larger and more established centres are more likely to report to their national or regional registries; therefore, the previous methodology likely overestimated utilization rates in previous reports.

In 2014, an estimated >1.93 million ART treatment cycles were performed in participating countries globally, resulting in the birth of >439 039 babies. Assuming this represents 66% of global activity, >2.92 million ART cycles were conducted globally in 2014 resulting in the birth of >665 211 babies. In 2013, the estimated number of cycles from participating countries was >1.86 million resulting in >437 315 babies, but because of the change in the way utilization is calculated in this report, these numbers are not directly comparable.

Because this is the first report using the new utilization method, we have provided utilization rates and number of babies born using both methods (Supplementary Table SXIII). The estimated total number of cycles from participating countries in 2014 was 2 347 018 using the previous method and 1 929 905 using the new method, representing an 18% reduction in the estimated number of cycles. The global ART utilization rate was 615 cycles per million using the previous method and 535 cycles per million using the new method. The drop in total cycle estimates using ICMART's new method mainly reflects the fact that; extrapolation from reported to estimated cycles was not conducted for: four countries (Nigeria, Albania, Bulgaria and Serbia) that had <33% of cycles/centres reported and no informed estimate available for the total number of cycles performed; and countries with an informed estimate for the total number of cycles performed was generally significantly lower than the extrapolation used in previous years. Using the total number of cycles thought to be performed in a country, rather than the total number of centres operating, also likely provides a more conservative estimate of global cycles and utilization. The previous method likely overestimated the utilization and number of babies born for countries with a low proportion of centres reporting to national or regional registries, while the new method likely underestimates these values. Thus, the true number of cycles and babies, and the utilization rate would fall somewhere between the previous and new methods. The largest change in the estimated number of cycles performed in 2014 using the two methods (previous and new method, respectively) was for India (330 826 versus 150 000 cycles), Egypt (179 616 versus 72 800) and Bulgaria (50 480 versus 6 310).

The huge disparity in access to ART treatment across the world reflects stark global inequalities in reproductive health and the position of women in society (United Nations and Department of Economic and Social Affairs Population Division, 2017). Indeed, women in the poorest countries tend to suffer the highest rates of infertility, yet have the poorest access to reproductive healthcare, including access to infertility treatment, and suffer a high social burden if they fail to have children (Ombelet, 2009). Improving the accuracy of the publication of the disparities in access to infertility care was the catalyst for revising the way ICMART estimates utilization rates. Furthermore, ICMART has proposed that ART utilization, as described in this report, be considered a global indicator of access to infertility care so that progress

on equitable healthcare goals can be measured (Dyer *et al.*, 2020). While ART utilization is not a perfect indicator, and ART treatment only one form of infertility care, it is the most well-documented through regional and national registries, and reflects a relatively high level of medical care.

The data presented in this report depend on the quality and completeness of data submitted by individual countries and entities. While every effort is made to query possible data errors and inconsistencies with country representatives, further validation of the data is not feasible. The quality and completeness of the data are a reflection of local data collection practices (e.g. voluntary compared to mandatory reporting, prospective cycle-based compared to retrospective summary-based reporting) and, therefore, vary between countries and regions. This report covers approximately two-thirds of the global ART activity, making it the most comprehensive report on ART activity. A major limitation is the lack of data from China given that this likely represents a significant proportion of the missing data; along with the lack of data from most countries in the Middle East.

Conclusion

It is essential to continually monitor ART practices and outcomes internationally in order to quantify comparative utilization levels, monitor treatment effectiveness and identify safety issues. In recognition of the right to universal access to reproductive health (United Nations, 2019), the ICMART world reports are important documents at a global, regional and local level to inform policy development, clinical practice, education and advocacy.

The ICMART world reports have provided the most comprehensive global statistical census and review of ART utilization, effectiveness and safety since 1989. This latest report reflects continuing trends from recent years. The new method for estimating ART utilization and number of babies provided more conservative estimates of ART utilization.

Supplementary data

Supplementary data are available at *Human Reproduction* online.

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- Indonesia
- Israel
- Japan
- Taiwan

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Data availability

The data underlying this article are available in the article and in its online [supplementary material](#).

Authors' roles

All authors contributed to study design, collection and interpretation of the data and the overall conduct of the study. GMC prepared the manuscript, and all authors were involved in the revision. The final manuscript and order of authorship have been approved by all authors.

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Conflict of interest

S.D. reports industry sponsorship for attendance of conference from Ferring, and research grants to support African Network and Registry of ART from Ferring and Merck outside the submitted work. F.Z.H. reports lectures at organized webinars for Ferring and Merck. O.I. reports honoraria for consulting from Ferring, Merck and ObsEva, as well as honoraria for lectures from Ferring and Merck. G.M.C., J.d.M., M.B., M.S.K. and G.D.A. have nothing to disclose.

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