



The actual impact of SARS-CoV-2/COVID-19 pandemic on IVF activity: a survey across Italian ART centers

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Abstract

Purpose Since the end of February 2020, SARS-CoV-2 dramatically spread in Italy. To ensure that most of National Health System (NHS) resources were employed to control the pandemic, non-urgent medical procedures (including IVF) were suspended in March 2020. Here, we aimed at assessing the impact of the restrictive measures on Italian IVF activity.

Methods In May 2020, the Italian ART Register launched an online survey (multiple choices and open answers) across ART centers (89.0% response rate; $N = 170/191$) to investigate how they were facing the emergency and estimate the reduction in their activity. In February 2022, the official data of the whole 2020 were published and retrospectively analyzed. The ART cycles conducted in Italy in 2020 (67,928 by 57,423 patients) were then compared to those conducted in 2019 (82,476 by 67,633 patients). The estimates formulated through the survey were compared to the actual reduction.

Results In 2020, 14,548 less IVF cycles were conducted with respect to 2019 (– 17.6% reduction). This led to 2539 fewer live births (– 19.8%) than 2019. If the reduction unveiled by the survey launched in May 2020 (i.e., – 35%) would have persisted throughout 2020, a significantly larger impact was expected (4200 less newborns). Instead, the activity was gradually recovered, and it compensated the months of greatest emergency, thus fulfilling the most optimistic scenario.

Conclusions Italy suffers from the lowest birth rate in Europe, and COVID-19 impact on IVF-derived live births testified how key ART is for Italian demographics. The government should support access to these treatments with dedicated actions.

Keywords ART National Register · Assisted reproductive techniques · Gamete donation · SARS-CoV-2 · COVID-19

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Introduction

Coronavirus disease 2019 (COVID-19) was initially reported in China on the 30th of December 2019, and since then, SARS-CoV-2 has spread worldwide [1]. Specifically, from February to April 2020, Lombardia (Italy) reported the highest numbers of SARS-CoV-2 cases. The first case of evident SARS-CoV-2 transmission emerged on the 20th of February in Codogno (Lombardia). From that date, the number of diagnosed COVID-19 cases increased exponentially, and Lombardia became the area most affected by the pandemic. Given the rapid upsurge of positive cases in the area, regional and local health authorities in strong collaboration with the National Public Health Institute introduced severe restrictions to prevent or at least limit the spread of the infection. Following the increase in numbers and in spatial distribution of the cases detected, on the 8th of March 2020, a regional lockdown was imposed, and the quarantined area was identified as the possible epicenter

of the ongoing outbreak, which was shortly followed by a national lockdown on the 11th of March 2020. Given the provisions issued by the Decree of the Prime Minister and the consequent “Guidelines for the remodulation of deferrable programmed activity during COVID-19 emergencies” issued by the Ministry of Health on the 16th of March 2020, restrictions were also imposed on healthcare activities, suspending “deferrable” and “non-urgent” hospitalizations and outpatient services. In this context, to tackle the rapid expansion of the pandemic, on the 17th of March 2020, the Italian ART National Registry with the National Transplant Center issued a technical note addressed to ART centers, regarding the “measures to prevent the transmission of SARS-CoV-2 infection in Italy, for reproductive cells and IVF treatments.” The recommendations encompassed suspension of new treatments, including induction of ovulation, intrauterine insemination (IUI), and IVF, as well as non-urgent gamete cryopreservation, cancellation of embryo transfers, both fresh and frozen; it also recommended to temporarily suspend gamete donations. Exceptions entailed patients currently “in treatment” or requiring urgent fertility preservation due to gonadotoxic therapies. These restraint measures were aimed at limiting population movements and interactions, avoiding any, though rare, hospitalization of IVF patients, and, most importantly, diverting health personnel towards COVID-19 assistance. ESHRE also issued two statements on the 19th of March 2020 and on the 2nd of April 2020 and recommended postponing IVF treatments, except for urgent fertility preservation in oncologic patients, both as a precautionary measure and to avoid overloading the healthcare systems.

Material and methods

The ART National Registry, established at the National Health Institute (NHI), according to the Article 11, paragraph 1, of Law 40/2004 (G.U. n.45 of February 24, 2004), and to the decree of the 7th of October 2005 signed by the Minister of Health (G.U. n.282 of December 3, 2005), collects data about authorized Italian ART centers. In detail, the report addresses all aspects of ART from the number of cycles per year, pregnancy rate, and live birth rate. Data collection is retrospective and mandatory, and it is performed by filling the required information in a specific database with password-protected access, personalized for each center, on the ART National Registry website (www.iss.it/rpma). Considering the health emergency experienced by our country, the ART National Registry launched a questionnaire on May 2020 to measure the impact of COVID-19 pandemic on ART practice in Italy.

The Italian centers were asked to specify the treatments being performed and how they adapted the procedures

during the emergency (i.e., modification of standard operating procedures [SOP], management of communication with the patients whose treatment was suspended or postponed). The survey was aimed at assessing the differences between ART centers and at quantifying the cycles suspended and/or postponed, as well as the consequences in terms of hypothetical reduction of live births from these techniques (a translated copy of the questionnaire is provided as [Supplementary Material](#)). Briefly, the questionnaire was based on 3 sections: in the first one, the centers were asked to indicate the activities performed in the first third of 2019 and 2020; the second one investigated the new operating procedures adopted and the number of suspended procedures; the third one was dedicated to donation cycles, to the first medical examination, and to fertility preservation treatments. Within the questionnaire, two different groups of IVF centers were identified depending on whether they had suspended IVF activity or not, during the investigated period.

The questionnaire included 40 questions, most of them with pre-defined responses, others open-ended, or allowing multiple choices to investigate several aspects of ART centers organization. Twenty questions requested specific information on the activity, such as the number of fresh cycles, the number of cycles from thawed embryos and/or oocytes, the number of gamete donation cycles, and the number of embryo transfers and pregnancies achieved.

The survey involved 191 ART centers registered in the ART National Registry at the moment of the survey, who were asked to complete the online questionnaire, accessible from a dedicated section of the registry official website (www.iss.it/rpma). ART center directors were invited to participate to highlight the current and the future impact of COVID-19 pandemic on ART procedures. A FAQ section within the questionnaire was designed to provide more detailed information while completing the questionnaire. The survey was available online for one month. Of the 191 involved centers, 15 (7.9%) did not answer the questionnaire (or wrongly filled it in) and were excluded. Another 6 centers (3.1%) were excluded due to the inconsistencies between the cycles performed in the first third of 2019 (as declared in the survey) and the cycles declared for to the official ART National Registry data collection. A total of 170 clinics (89.0%) were included in this study.

This survey allowed to quantify the activity of Italian ART centers from January to April 2020 versus January to April 2019. To predict the reduction of the activity for the year 2020 compared to 2019, two scenarios were assumed from a range of minimum and maximum values for the initiated cycles/warmings; in the pessimistic scenario, we supposed that the reduction experienced in the first third of 2020 would remain unchanged throughout the year, while in the optimistic scenario, we assumed a recover of ART in the remaining 8 months of 2020. Both estimates were then

compared with the actual IVF activity in 2020 portrayed by the data collected by the ART National Registry and published in February 2022. The estimates on pregnancies and live births for whole 2020 were made assuming that each Italian ART center maintained the same efficacy for the ART techniques as in 2019. For each center, the pregnancy rates (PR) and live birth rates (LBR) per initiated cycle/thawing reported in 2019 were applied at the initiated cycles/thawing estimated for the whole 2020 in both the pessimistic and optimistic scenarios.

A descriptive report of survey responses was provided, including absolute numbers and percentages, and comparing the data across ART centers, assessing also putative differences between public, private, and private accredited by the National Health System (NHS), as well as according to the geographic area (north-west, north-east, center, south, and islands) and size of the centers (small with less than 200 cycles per year, medium with 200–999 cycles per year and large with at least 1000 cycles per year).

All statistical analyses were performed with IBM SPSS software (version 27).

According to current Italian legislation, this study was exempt from ethics committee approval.

Results

Results from the survey issued in May 2020

When the survey was published online, 191 ART centers were active in Italy, 170 of them correctly completed the questionnaire and did not unveil inconsistencies with respect to the activity officially reported (89.0% response rate). The response rate was 100% in 11 regions, including the ones mostly affected by the SARS-CoV-2/COVID-19 spreading (Table 1), and very high at public centers (67 out of 70, 95.7%) (Table 2). In general, though, no significant differences in the response rates were reported.

Due to the re-allocation of health resources and staff members, 21.2% (36 out of 170) of the ART centers were entirely or partially dedicated to COVID-19 patient care. The facilities mostly affected by this re-organization were public centers (43.3%, $N = 29/67$), centers with a medium activity (28.9%, $N = 26/90$) and centers located in the areas mostly affected by the spread of the virus, i.e., the North-Western regions (40.5%, $N = 15/37$).

Most ART centers (78.2%, $N = 133/170$) reported they had suspended all activities, without starting new cycles and only completing the ongoing treatments with oocytes/embryos cryopreservation or embryo transfer; 20.0% ($N = 34/170$) of the ART centers suspended all activities, except for consultations and exams prescription. Only three centers, although reporting a reduction, did not suspend

Table 1 Geographic distribution of participating centers and corresponding response rates

Region or geographical area	No. of invited centers		Responding centers	
	<i>N</i>		<i>N</i>	% of invited centers
Piemonte	12		12	100
Valle d'Aosta	1		1	100
Lombardia	24		22	91.7
Liguria	2		2	100
North West	39		37	94.9
Bolzano	3		3	100
Trento	1		1	100
Veneto	18		18	100
Friuli-Venezia Giulia	3		3	100
Emilia-Romagna	15		14	93.3
North East	40		39	97.5
Toscana	15		12	80.0
Umbria	2		2	100
Marche	3		2	66.7
Lazio	25		22	88.0
Center	45		38	84.4
Abruzzo	3		2	66.7
Molise	1		1	100
Campania	24		23	95.8
Puglia	11		9	81.8
Basilicata	1		1	100
Calabria	5		4	80.0
Sicilia	19		13	68.4
Sardegna	3		3	100
South and Islands	67		56	83.6
Total	191		170	89.0

Table 2 Setting of participating centers with corresponding response rates

	Invited centers		Responding centers	
	No	% of centers	No	% of invited center
Center setting				
Public	70	36.6	67	95.7
Private accredited by the NHS	17	8.9	13	76.5
Private	104	54.5	90	86.5
Total	191	100.0	170	89.0
Number of cycles per year, 2019				
< 200 (small center)	78	40.8	65	83.3
200–999 (medium center)	98	51.3	90	91.8
≥ 1000 (large center)	15	7.8	15	100.0
Total	191	100.0	170	89.0

their activity during the lockdown and started new IVF treatments.

In the period between the 22nd of February and the 11th of April 2020, many ART centers ($N=21$) suspended their activity on the 9th of March 2020, when the Decree of Italian Prime Minister requested the postponement of all non-urgent outpatient healthcare activities. Already before this date, 16.2% ($N=27/167$) of the Italian ART centers had made this decision, while about 60% of them ($N=102/167$) suspended their activity only after the 17th of March 2020, when a Technical Note was issued by the National ART Registry and the National Transplant Center (Fig. 1).

The decision to suspend the activity was taken mainly by the clinical directors, based on the recommendations of National and International Scientific Societies, at both private clinics (66.7%, $N=60/90$) and private clinics accredited by the NHS (61.5%, $N=8/13$), whereas in public centers, the decision was taken mainly by the hospital's Health director (65.7%, $N=44/67$).

The couples undergoing an IVF treatment were informed of its suspension mainly by the clinical director at private centers (75.6%, $N=68/90$), mainly by any clinician of the team in private centers accredited by the NHS (76.9%, $N=10/13$), and almost equally by the medical or nursing/midwifery staff (56.7%, $N=38/67$) and by the clinical directors (58.2%, $N=39/67$) at public centers.

At 79.4% of the centers ($N=135/170$), the couples whose treatment had been suspended were also contacted to further discuss any concern they might have regarding the emergency. This service was provided mainly at private centers (83.3%, $N=75/90$), especially if located in central regions

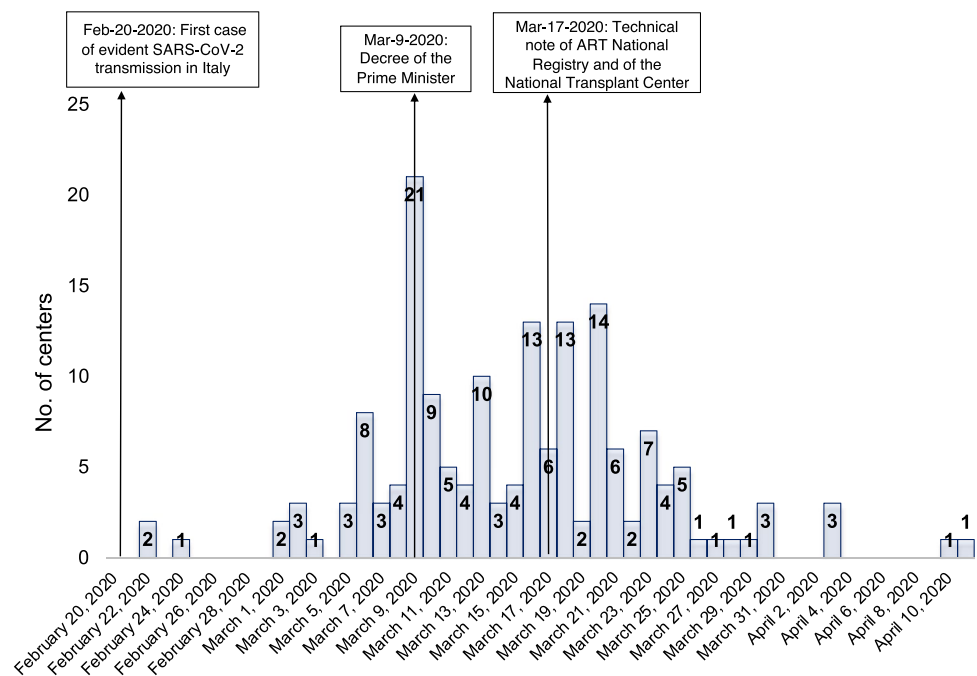
of Italy (92.1%, $N=35/38$). These couples were contacted mainly by the clinical director (61.5%, $N=83/135$) or other clinicians of the team (55.6%, $N=75/135$). At 25 centers (18.5%), the psychologists together with other staff members counseled the couples, while at 4 centers only the psychologist communicated the interruption of IVF activity to the couples.

The first consultation, which was still conducted as outpatient activity at 66 centers out of 170 (38.8%), was aimed at outlining the main cause of infertility and it accounted for a total of 1423 couples counseled during the lockdown. The continuity of service was ensured mainly at private centers (51.1%, $N=46/90$) and at private centers accredited by the NHS (46.2%, $N=6/13$), especially those located in the central regions of Italy (50%, $N=19/38$), and among larger centers (53.3%, $N=8/15$).

Importantly, counseling and gamete cryopreservation procedures for fertility preservation purposes in oncologic patients were never suspended, as recommended by all national and international scientific societies in the field of reproductive medicine and by the Technical Note of the ART National Registry as well. Out of 112 centers that offer fertility preservation, 52 (46.4%) reported they in fact treated cancer patients during the period investigated by this survey. Public centers were the ones mostly active to this end (80.4%, $N=41/51$), followed by North-Western regions (65.2%, $N=15/23$) and larger centers (61.5%, $N=8/13$).

Most of the 86 ART centers that already offered IVF treatments with donor gametes before the pandemic postponed these cycles (53.5%, $N=46/86$), 22.1% ($N=19/86$) had no couples in-treatment for this practice, while 18.6%

Fig. 1 Distribution of the ART centers between the 22nd of February and the 11th of April 2020 according to the day they suspended IVF activity



($N=16/86$) concluded the ongoing treatments until embryo transfer.

During the period under investigation, 70.6% ($N=120/170$) of the centers interrupted treatments before ovarian stimulation, 34.7% ($N=59/170$) after ovarian stimulation (by performing oocyte cryopreservation), and 72.9% ($N=124/170$) postponed the scheduled thawing cycles.

The 170 centers performed 77,287 fresh/frozen IVF cycles in 2019, corresponding to 93.7% of the overall IVF activity performed in Italy. When comparing the period January–April 2020 with the same period in 2019, a reduction of 9,578 IVF cycles was reported, corresponding to an overall reduction of -34.8% of the IVF activity. Specifically, there was a -46.4% reduction of cycles with cryopreserved oocytes, -34.1%, of fresh IVF cycles, -33.7% of cycles with cryopreserved embryos, and -39.2% of donor cycles (Fig. 2, Table 3).

The greatest activity reduction was registered at private centers accredited by the NHS (-37%), in North-Western regions (-40.4%), i.e., the areas mostly affected by SARS-CoV-2/COVID-19 virus pandemic, at medium and large centers (-36.4% and -36%, respectively), and at centers directly involved in the creation of a department dedicated to COVID-19 patients care (-37.7%) (Table 3).

To comprehensively assess the actual reduction of IVF activity due to the pandemic, a comparison of whole 2020 versus whole 2019 data was needed. Although, this would involve at minimum 1-year wait. Therefore, to provide a tentative snapshot of the consequences of the pandemic on IVF, the survey requested the number of fresh, frozen, and donor cycles from the 1st of January to the 30th of April 2019 and 2020. Based on these data, two assumptions on IVF activity reduction were formulated, aiming at identifying a

range of values for the remaining 8-month period from May to December 2020, within which the real reduction values could fall:

- The first scenario assumed that the reduction observed in the first 4 months would remain unchanged throughout the calendar year. This would lead to an estimated decrease of 26,880 cycles and 4265 live births.
- The second scenario assumed a smaller reduction (-15%), due to a resumption of the activity during the remaining eight months of 2020, estimating a decrease of 15,581 cycles and 2447 live births.

Importantly, after the lockdown, starting from June 2020, despite the gradual resumption, several regions underwent multiple suspensions of the IVF activity, especially in public facilities, due to the fluctuations in the spreading of the infection and the numerous hospitalizations.

Results from the ART National Registry data collection officially published in February 2022

In February 2022, the Report of the Minister of Health was delivered, which reports the data collected between May and December 2021 from the ART National Registry about the IVF activity in Italy for the whole year 2020 (in press). Finally, it was possible to verify the hypotheses sustained by our survey. A reduction of 14,548 IVF cycles (-17.6%) was observed with respect to the IVF activity in 2019 (<https://bit.ly/3zCeCOD>), which is significantly smaller compared to the -34.8% assumed in the first scenario of our survey, but very close to the estimate in the second scenario. The recovery of activity after the first third

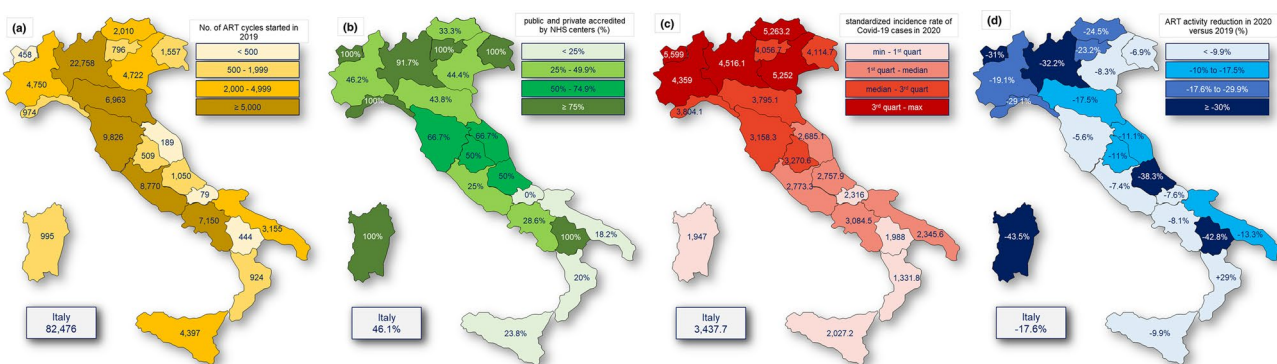


Fig. 2 Impact of SARS-CoV-2/COVID-19 pandemic on Italian IVF activity. **a** Total number of ART cycles started in 2019 in each region (data collected through the mandatory data submission to the National ART Registry). **b** Ratio of public centers and private centers accredited by NHS active in 2019 and 2020. **c** Standardized cumulative incidence rate of COVID-19 cases per 100,000 inhabitants in 2020* (Standard Population Italy Census 2011). **d** Absolute reduc-

tion of IVF activity in the comparison between full year 2019 versus 2020 (data collected through the mandatory data submission to the National ART Registry). *Source: Istat e Istituto Superiore di Sanità. Impatto dell'epidemia COVID-19 sulla mortalità totale della popolazione residente—anno 2020. https://www.istat.it/it/files/2021/03/Report_ISS_Istat_2020_5_marzo.pdf

Table 3 Cycles and reduction of the IVF activity, for third I (data collected through the survey) and full year (data collected through the mandatory data submission to the National ART registry), reported according to IVF technique, center setting, and geographical area (comparison 2019–2020)

	Cycles started Jan–Apr 2019	Cycles started Jan–Apr 2020	Reduction of cycles Jan–Apr I third (%)	Cycles started in 2019	Cycles started in 2020	Actual reduction in 2020 versus 2019 (%)
Total	27,489	17,911	– 34.8	82,476	67,928	– 17.6
IVF techniques						
Fresh	16,512	10,879	– 34.1	50,324	38,728	– 23.0
Embryo thawing	7575	5020	– 33.7	21,796	19,314	– 11.4
Oocyte thawing	783	420	– 46.4	1361	1099	– 19.3
Donor Gametes	2619	1592	– 39.2	8995	8787	– 2.3
Center setting						
Public	10,476	7056	– 32.6	29,501	20,891	– 29.2
Private accredited by the NHS	6840	4312	– 37.0	22,473	17,778	– 20.9
Private	10,173	6543	– 35.7	30,502	29,259	– 4.1
Geographic area						
North West	10,076	6003	– 40.4	28,940	20,271	– 30.0
North East	5740	3694	– 35.6	16,048	13,647	– 15.0
Center	6091	4090	– 32.9	19,294	18,011	– 6.6
South and Islands	5582	4124	– 26.1	18,194	15,999	– 12.1

of 2020 was variable according to the setting of care. Private centers were able to recover the number of IVF cycles, registering at the end only a –4.1% reduction with respect to 2019. Private centers accredited by the NHS suffered an overall –20.9% loss of IVF cycles, whereas public ones a –29.2% decrease (Table 3). Perhaps, the limited access to the IVF facilities throughout the period of main spread of Sars-CoV-2 infection is at the roots of this difference. Regarding the geographic distribution of the centers, the North-Western centers registered a –30% reduction, followed by the North-Eastern ones with a –15% reduction and by the centers located in the South and Islands where a –12% reduction was reported. The IVF activity in central regions registered only a –6.6% reduction (Table 3). The greatest reduction characterized fresh IVF cycles with a –23% decrease, followed by a –19.3% decrease in cycles with cryopreserved oocytes and –11.4% decrease in the cycles with cryopreserved embryos. The decrease in IVF cycles with donated gametes was milder (–2.3%) (Table 3). These observed reduction of treatment cycles has brought to 3325 fewer pregnancies (–18.7%) and to 2539 fewer live births (–19.8%). The percentage reduction of births is not homogeneous according to IVF techniques (ranging from –5.5% in cycles with cryopreserved embryos to –36.9% in fresh cycles) and to center setting and to geographical area (Table 4). It should be added that the lower births from ART techniques in 2020 are also due to the observed reduction in multiple births.

Figure 2 summarizes in a single panel the size and setting of Italian ART centers in each region, along with the incidence of COVID-19 cases and the actual reduction of IVF activity throughout 2020 versus 2019.

Discussion

The results of the survey demonstrated the importance of efficient and consolidated systems of national surveillance on IVF treatments, as the IVF National Registry established by the Italian NHI (www.iss.it/rpma). The data flow of the Registry was key to provide immediate response also in this critical situation. The IVF centers demonstrated an excellent compliance, replying in a short timeframe (1 month) with a high response rate (89.0%) even during an emergency.

There was a great heterogeneity in the results among different geographical areas, imputable to the different impact of the pandemic. Also, the patterns in the resumption of IVF activity were different depending on the spread of the infection. Public centers and private centers accredited by NHS suffered greater reduction in their activity; moreover, public centers had also to struggle more with the subsequent recovery. Reassuringly, the reduction in terms of IVF treatments and the consequent decrease in the number of live births for 2020 was closer to the more optimistic scenario we initially hypothesized through the survey, mostly due to the greater recovery of activity especially at private centers and in central regions of Italy. Of note, Italian

Table 4 Pregnancies obtained, live birth and reduction of the IVF activity, for full year (data collected through the mandatory data submission to the National ART registry), reported according to IVF technique, center setting, and geographical area (comparison 2019–2020)

	Pregnancies obtained in 2019	Pregnancies obtained in 2020	Actual reduction in 2020 versus 2019 (%)	Live birth in 2019	Live birth in 2020	Actual reduction in 2020 versus 2019 (%)
Total	17,787	14,462	−18.7	12,797	10,258	−19.8
IVF techniques						
Fresh	7753	5197	−33.0	5797	3660	−36.9
Embryo thawing	6758	6096	−9.8	4637	4382	−5.5
Oocyte thawing	242	210	−13.2	173	153	−11.6
Donor Gametes	3034	2959	−2.5	2190	2063	−5.8
Center setting						
Public	5336	3518	−34.1	4064	2616	−35.6
Private accredited by the NHS	4907	3920	−20.1	3737	2915	−22.0
Private	7544	7024	−6.9	4996	4727	−5.4
Geographic area						
North West	6307	4589	−27.2	4842	3413	−29.5
North East	3415	2747	−19.6	2635	2080	−21.1
Center	4048	3624	−10.5	2732	2505	−8.3
South and Islands	4017	3502	−12.8	2588	2260	−12.7

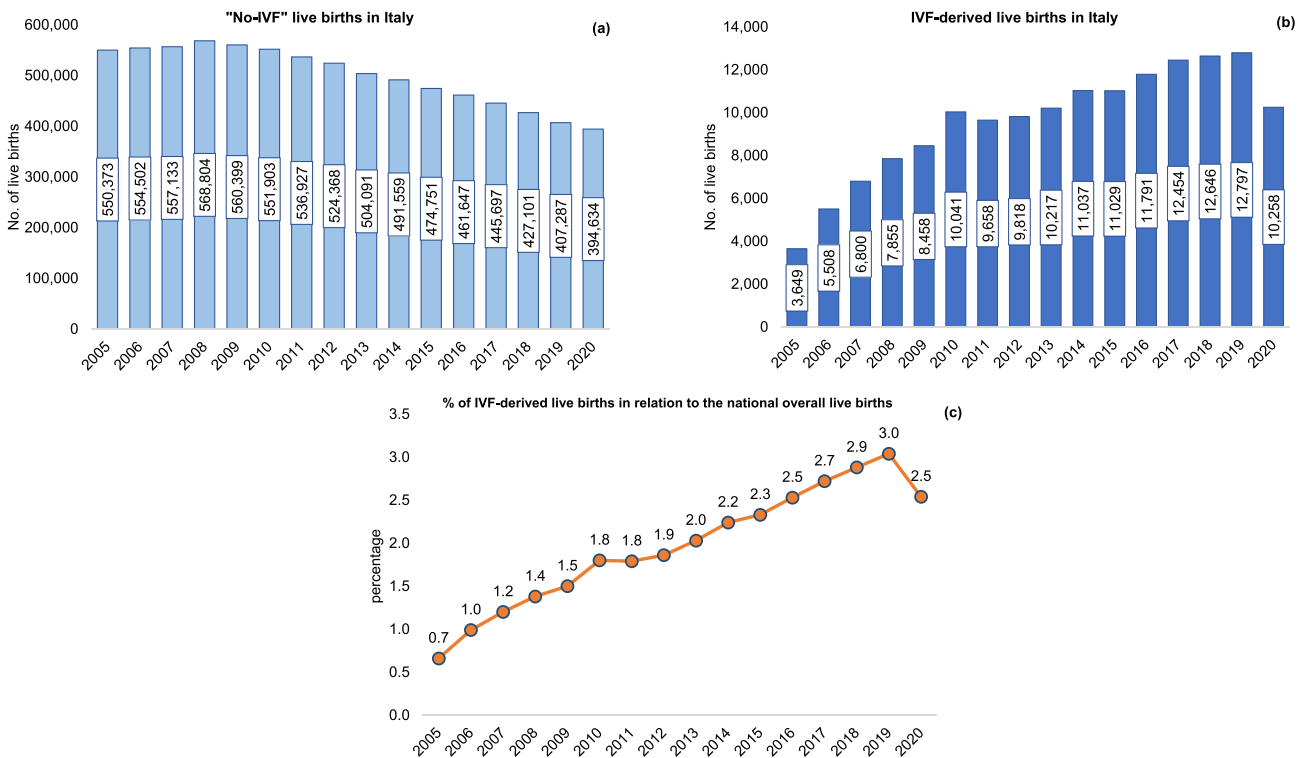


Fig. 3 Distribution of Italian live births from 2005 to 2020. **a** Annual trend of the total number of “no-IVF” live births*. **b** Annual trend of the total number of IVF-derived live births (data collected through the mandatory data submission to the National ART Registry). **c**

Annual trend of the IVF-derived live births’ ratio with the respect to the total number of live births in Italy. *Source: Istat. <https://demo.istat.it/index.php>

ART centers were very resilient to the pandemic and demonstrated great skills in promptly adapting to the new requirements by efficiently re-organizing patient care activities, as well as clinical and laboratory management. During the critical phase of the lockdown, in fact, several Italian experts and national scientific societies published guidelines and position statements to help IVF professionals facing the emergency, by applying safe protocols in a safe work environment, by adopting failure modes and effects analysis (FMEA) to outline the main risks and failure modes along the clinical workflow requiring specific corrective measures, or by outlining population of patients who should be prioritized for urgent treatments because time-sensitive [2–11]. This great contribution of the Italian scientific community possibly supported the great recover in the number of treatments experienced in the last part of 2020.

Conclusions

Italy is one of the countries mostly affected by a decline in birth rates. It figures among the nations with the lowest fertility rate in Europe (1.27 per woman in 2019 — source: Eurostat year 2019), with a constantly decreasing trend every year. In this context, the contribution of ART is essential. Since the introduction of the ART National Register in 2005, the contribution of ART to the overall number of live births continuously grew from 0.7 to 3.0% in 2019 but then slightly declined to 2.5% in 2020 (Fig. 3). Across 2020–2021, the pandemic has registered several periods of increase in the prevalence of infections, thereby leading, in different regions, to a reduction in the accessibility to ART that persists in 2022. The National ART Register will therefore continue monitoring this phenomenon in the upcoming years. The impact of a global pandemic upon ART, displayed here, provides valuable and documented data and represents a solid background for health authorities and healthcare professionals to research effective preventative and corrective measures to face future emergencies.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10815-022-02600-2>.

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Author contribution GS designed the study. RDL, RS, and VV designed the survey, collected, and analyzed the data. GS, RDL, DC, RS, and VV drafted the manuscript. All authors contributed to the discussion of the results.

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

Declarations

Conflict of interest The authors declare no competing interests.

References

1. Wu F, Zhao S, Yu B, Chen YM, Wang W, Song ZG, et al. A new coronavirus associated with human respiratory disease in China. *Nature*. 2020;579(7798):265–9. <https://doi.org/10.1038/s41586-020-2008-3>.
2. Vaiarelli A, Bulletti C, Cimadomo D, Borini A, Alviggi C, Ajossa S, et al. COVID-19 and ART: the view of the Italian Society of Fertility and Sterility and Reproductive Medicine. *Reprod Biomed Online*. 2020. <https://doi.org/10.1016/j.rbmo.2020.04.003>.
3. De Santis L, Anastasi A, Cimadomo D, Klinger FG, Licata E, Pisaturo V, et al. COVID-19: the perspective of Italian embryologists managing the IVF laboratory in pandemic emergency. *Hum Reprod*. 2020;35(4):1004–5. <https://doi.org/10.1093/humrep/deaa074>.
4. La Marca A, Niederberger C, Pellicer A, Nelson SM. COVID-19: lessons from the Italian reproductive medical experience. *Fertil Steril*. 2020. <https://doi.org/10.1016/j.fertnstert.2020.03.021>.
5. Scarica C, Parmegiani L, Rienzi L, Anastasi A, Cimadomo D, Klinger FG, et al. SARS-CoV-2 persistence at subzero temperatures. *J Assist Reprod Genet*. 2021;38(4):779–81. <https://doi.org/10.1007/s10815-021-02094-4>.
6. Vajta G, Scarica C, Parmegiani L. Risk of contamination with SARS-CoV-2 in ART. *Hum Reprod*. 2022. <https://doi.org/10.1093/humrep/deac053>.
7. Maggiulli R, Giancani A, Fabozzi G, Dovere L, Tacconi L, Amendola MG, et al. Assessment and management of the risk of SARS-CoV-2 infection in an IVF laboratory. *Reprod Biomed Online*. 2020;41(3):385–94. <https://doi.org/10.1016/j.rbmo.2020.06.017>.
8. Alteri A, Pisaturo V, Somigliana E, Vigano P. Cryopreservation in reproductive medicine during the COVID-19 pandemic: rethinking policies and European safety regulations. *Hum Reprod*. 2020;35(12):2650–7. <https://doi.org/10.1093/humrep/deaa210>.
9. Alviggi C, Esteves SC, Orvieto R, Conforti A, La Marca A, Fischer R, et al. COVID-19 and assisted reproductive technology services: repercussions for patients and proposal for individualized clinical management. *Reprod Biol Endocrinol*. 2020;18(1):45. <https://doi.org/10.1186/s12958-020-00605-z>.
10. Hickman C, Rogers S, Huang G, MacArthur S, Meseguer M, Nogueira D, et al. Managing the IVF laboratory during a pandemic: international perspectives from laboratory managers. *Reprod Biomed Online*. 2020;41(2):141–50. <https://doi.org/10.1016/j.rbmo.2020.05.006>.
11. Corona G, Baldi E, Isidori AM, Paoli D, Pallotti F, De Santis L, et al. SARS-CoV-2 infection, male fertility and sperm cryopreservation: a position statement of the Italian Society of Andrology and Sexual Medicine (SIAMS) (Societa Italiana di Andrologia e Medicina della Sessualita). *J Endocrinol Invest*. 2020;43(8):1153–7. <https://doi.org/10.1007/s40618-020-01290-w>.

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