Original Article

Cumulative Live Birth Rate per Oocyte Aspiration in Artificial Reproduction Technology: A Retrospective Observational Study of the Association between Maternal Age and the Number of Oocytes Retrieved in an Indian Population

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Abstract

Background: The association between cumulative live birth rate (CLBR) and oocyte aspiration in the context of maternal age is not well understood in the Indian population. **Aims:** To find the relationship between CLBR and a single oocyte aspiration. **Settings and Design:** This is a retrospective study analysing the data of 1989 women who underwent *in vitro* fertilisation (IVF) between January 2015 and December 2019, at Gunasheela Surgical and Maternity Hospital, India. **Materials and Methods:** Participants were divided into two groups based on age: ≤35 (group I, n = 1665) and >35 (Group II, n = 324). CLBR per single oocyte aspiration in fresh and subsequent three frozen embryo transfer cycles was estimated. **Statistical Analysis Used:** Logistic regression analysis was used to show the likelihood of pregnancy rate, and CLBR per aspiration after treatment was represented as odd's ratios (OR) with 95% confidence intervals. **Results:** Maximal CLBR for Groups I and II was 81.25% with >25 oocytes and 75% with 16–20 oocytes, respectively. In the fresh ET cycle, maximal pregnancy and live birth rates were observed in 6–10 oocytes for Group I (54% and 41%) and in 16–20 oocytes for Group II (75% and 75%). The ORs for pregnancy rate (P = 0.01) and CLBR (P = 0.007) increased with an increase in the number of oocytes retrieved. The ORs for pregnancy rate and CLBR for Group II were 0.68 (P = 0.002) and 0.58 (P = 0.00002), respectively as compared to Group I. Optimal oocytes required to achieve positive IVF outcomes in fresh/frozen ET cycles were low in Group I (6–10 oocytes), but higher in Group II (16–20 oocytes). **Conclusion:** Robust positive relationship was observed between the number of oocytes retrieved and CLBR in women of both age groups.

Keywords: *Cumulative live birth rate, in vitro fertilisation/intracytoplasmic sperm injection, maternal age, oocytes retrieval, single oocyte aspiration*

Introduction

In recent times, a shift in child-bearing age to late thirties and early forties has been observed in a greater proportion of women opting to start a family, owing to professional and financial considerations, as well as the availability of effective contraception options. Consequently, the demand for assisted reproductive technology (ART) has risen significantly among women of advanced reproductive age. Among Indian women

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undergoing *in vitro* fertilisation (IVF),[1] the association between cumulative live birth rate (CLBR) and oocyte aspiration in the context of maternal age is not well understood. The landscape of CLBR has changed with the introduction of single ET strategies. Evidently, CLBR from fresh and all frozen embryo transfer (FET) cycles following a single controlled ovarian stimulation (COS) has become an important parameter of success for ART.[2] Consequently, the relationship between the number of oocytes retrieved and CLBR may assist clinicians in accurate individual counselling.

The aim of this study was to present a comparative evaluation of CLBRs per single oocyte aspiration in women from different age groups.

Subjects and Methods

Study design

This retrospective observational study included 1989 women between 20 and 40 years of age undergoing IVF/intracytoplasmic sperm injection (ICSI) cycles between January 2015 and December 2019 at Gunasheela Surgical and Maternity Hospital, India. Data for this study were analysed from the hospital medical records. The study was approved by the Institutional Ethics Committee (study number: EC/QA/17/2020; approved via letter number: IEC/0040/2021). Patient consent was waived as this was a retrospective study. The study adhered to the principles of the Helsinki Declaration (2013).

Eligibility criteria

The subjects were stratified into two groups, based on maternal age (younger [≤35 years] and advanced [>35 years]). Each group was further divided into six subgroups depending on the number of oocytes obtained in a single oocyte aspiration cycle (≤5, 6–10, 11–15, 16–20, 21–24, and >25).

Patients were excluded from the study if they had planned to undergo donor oocyte cycles, *in vitro* maturation cycles, preimplantation genetic screening/diagnosis, embryo pooling cycles and ICSI cycles using testicular sperm aspiration.

Treatment protocol

Control ovarian stimulation and ovum-pickup

Patients received daily injections of recombinant human follicle-stimulating hormone (*r*-hFSH-alfa [Gonal-f®, Merck Healthcare KGaA, Darmstadt, Germany]) starting on day 3 of their menstrual cycle based on age, anti-mullerian hormone (AMH), antral follicle count (AFC) and body mass index (BMI). Depending on the ovarian response, human menopausal gonadotropin (hMG/IVF-M™; Cipla, LG Chem Ltd, Korea) was added. Further doses were tailored for each patient post day 6 of stimulation based on serum estradiol (E_2) levels and follicular sizes were screened using a transvaginal ultrasound (TVS). On dominant follicles reaching >14 mm diameter or E_2 >250 pg/mL, a gonadotropin-releasing hormone (GnRH) antagonist was started (Ganirelix 0.25 mg SC; Orgalutran, N.V. Organon, The Netherlands) and continued till the ovulation trigger. Serum hormone levels (E_2), luteinising hormone (LH) and follicular size were monitored. Ovulation was triggered when 3–4 follicles in each ovary reached >17 mm diameter with either recombinant human choriogonadotropin alfa (*r* DNA hCG) (ovitrelle, 250 µg SC; Merck Serono Modugno, Bari, Italy) or injecting GnRH agonist trigger (leuprolide acetate, [Luprofact™4 Zydus Cadila Healthcare Ltd, Ahmedabad, India]) in case of hyper response. The ovum pick-up (OPU) procedure was performed 36 h post-trigger using TVS, under general anaesthesia. A 16 G single-lumen OPU needle (Cooks Medical®, Ovum Aspiration Single Lumen Needle) was used to aspirate follicles from the ovaries with the suction pressure maintained at 100 mmHg.

In vitro fertilisation/intracytoplasmic sperm injection and fresh embryo transfer

Collected oocytes were inseminated by conventional IVF or ICSI with semen collected from partner and embryos were cultured up to day 5 (blastocyst stage). In patients with no risk of hyperstimulation, a fresh ET was performed and the surplus embryos were cryopreserved. In case of patients at risk with hyperstimulation (≥15 eggs and high oestrogen levels >2500 pg/mL on the day of final oocyte maturation triggering), all embryos were frozen and transferred in subsequent FET cycles.

Endometrial preparation in frozen embryo transfer

Patients received E_2 valerate (2 mg, Progynova, Bayer HealthCare Pharmaceuticals LLC, Berlin, Germany) tablets starting from day 3 of their menstrual cycle and increased serially up to 8 mg/day to induce endometrial growth, which was monitored by ultrasound scanning. When the optimal thickness of the endometrium of 8 mm was reached, thawing and transferring of frozen blastocysts were carried out. Vaginal progesterone (Progesterone Soft Gelatin Capsules 400 mg, Gestone, Ferring Pharmaceuticals, Saint-Prex, Switzerland) was given for luteal support.

Outcome measures

The primary outcome was to calculate CLBR per single oocyte aspiration in fresh and subsequent three FET cycles performed in all subgroups. The secondary outcome was to estimate the optimal number of oocytes required for a successful live birth in younger and older women.

Statistical analysis

The potential predictors considered for the analysis were mean age, mean BMI, mean AMH, mean AFC, mean follicle-stimulating hormone (FSH), mean LH, mean gonadotropin dose, mean days of stimulation, peak E_2 on the day of trigger, mean mature eggs (M2), maturation rate, fertilisation rate, cleavage rate, mean number of embryos/fresh ET, mean number of frozen embryos, cumulative pregnancy rate, CLBR and abortion rate/transfer. Variables showing a significant association with the outcome were considered for the final regression model.

All the continuous variables were expressed as mean and the categorical variables as count and percentage. Pregnancy rates, live birth rates, CLBR, total pregnancies and live births were calculated and expressed as percentages. Logistic regression analysis was performed to identify the likelihood of pregnancy rate and CLBR per aspiration after treatment was represented as odds ratios (ORs) with 95% confidence intervals (95% CI). *P* values were calculated using two-sided tests and $P < 0.05$ was considered to be statistically significant. The distribution of oocyte yield and positive pregnancy in each cycle was calculated in different age groups. Data were consolidated using MS Excel software and all statistical analyses were carried out using R-statistical software, version 4.0.2, R Foundation for Statistical Computing, Vienna, Austria.

Results

Patient baseline characteristics

Following the planned inclusion and exclusion criteria, 1989 women were included in the analysis. Baseline characteristics, summarised in Table 1, were comparable with respect to age, BMI, fertilisation rate, number of mature eggs, abortion rate and other clinical parameters. Patients (n = 1989) categorised into age groups ≤35 years (Group I, n = 1665) and >35 years (Group II, n = 324) were stratified into ≤5, 6–10, 11–15, 16–20, 21–25 and >25 oocyte subgroups. The mean age of women commencing ART treatment ranged between 28 and 30 years in Group I and 37 and 38 years in Group II. Fresh ETs were observed in all oocyte subgroups except >25 oocyte subgroup in Group I and 21–25 oocyte subgroup in Group II. Gonadotropin dose was considerably higher in women under Group II as compared to Group I [Table 1]. Miscarriage rates were the highest in Group II across all the oocyte subgroups when compared to Group I [Table 1].

Fresh pregnancy rates and live birth rates in study participants

Overall, 1221 women in Group I and 247 women in Group II underwent fresh ET. Positive pregnancies observed in Group I and Group II were 602 (49.30%) and 103 (41.70%) while, live births were found to be 453 (37.10%) and 65 (26.32%), respectively. The highest pregnancy rates for Group I were observed to be 54% (6–10 oocyte subgroup) and for Group II were 75% (16–20 oocyte subgroup). Similarly, the highest live birth rate (41%) was observed in the 6–10 oocyte subgroup of Group I and 75% in 16–20 oocyte subgroup for Group II. However, no positive pregnancies and live birth rates were reported in the >25 oocyte subgroup of Group I and from 21 to 25 oocyte subgroups in Group II as none of the women had undergone fresh ET cycle. There were no patients who produced >25 oocytes in Group II [Table 2].

Cumulative live birth rate in study participants

CLBR in 1665 patients of Group I who had fresh/frozen ET was observed to be 47.45%. In Group II, 324 patients had fresh/frozen ET and CLBR was observed to be 32.72%, which was lower than Group I. Highest CLBR for Group I was observed to be 81% for >25 oocyte subgroup and 75% in Group II for the 16–20 oocyte subgroup. An increase in CLBR with the retrieval of additional oocytes was observed in women under Group I. In the case of women under Group II, an increase in CLBR was observed up to 16–20 oocyte subgroup followed by a reduction in the higher oocyte subgroups [Figures 1 and 2]. CLBR was not recorded in >25 oocyte subgroup of Group II as none of the patients produced >25 oocytes.

Logistic regression analysis

In the multivariate regression model, a significant increase in pregnancy rate and CLBR per aspiration was observed in the oocyte subgroups. For analysis, the ≤5 oocyte subgroup was used as a reference. OR for pregnancy rate significantly increased from 1.66 (95% CI 1.34 to 2.04; P = 0.000002) to 2.11 (95% CI 1.61–2.76; P = 0.00000005), 2.89 (95% CI 1.89–4.54; P = 0.000001), 3.16 (95% CI 1.51–7.25; P = 0.003) to 4.64 (95% CI 1.48–20.36; P = 0.01) in the oocyte subgroups 6–10, 11–15, 16–20, 21–25 and > 25 respectively.

The ORs for CLBR significantly increased from 1.45 (95% CI 1.17–1.79; P = 0.0006) to 1.77 (95% CI 1.36–2.30; P = 0.00002), 2.21 (95% CI 1.48–3.33; P = 0.0001), 3.63 (95% CI 1.78–7.84; P = 0.0005) to 4.82 (95% CI 1.66–17.42; P = 0.007) in the oocyte subgroups 6–10, 11–15, 16–20, 21–25 and >25, respectively. The ORs of pregnancy

Table 1: Baseline characteristics of study participants

Parameter	Oocyte subgroups										
	Group I						Group II				
	<5	6-10	11-15	16-20	21-25	>25	<5	6-10	11-15	16-20	21-25
n	509	695	309	103	33	16	131	130	49	12	2
Mean age (years)	30.68	29.93	30.16	29.73	28.91	29.81	38.19	37.90	37.24	37.17	38.00
Mean AMH (ng/ml)	2.80	4.00	4.93	6.62	7.14	7.96	1.51	2.35	3.30	4.36	4.52
Mean BMI (kg/m^2)	25.74	26.02	26.69	25.95	25.79	26.00	27.15	27.13	26.40	28.72	22.05
Mean FSH (IU/ml)	6.96	5.99	5.69	5.28	4.90	5.13	6.97	6.25	5.53	5.14	2.31
Mean LH (IU/ml)	4.90	5.23	5.51	5.76	5.93	11.04	4.42	4.36	4.69	4.12	0.82
Peak E_2 (pg/ml)	1280.65	1811.61	2219.39	2959.43	2896.81	2636.13	303.89	1784.40	2339.89	2497.64	14.50
Mean AFC (mm)	6.38	7.98	10.61	13.30	15.52	15.88	5.15	5.32	7.83	13.55	18.00
Mean Gn dose (IU daily)	2169.42	1925.85	1809.44	1579.21	1885.94	1289.03	3131.39	2506.29	2058.89	2271.59	2975.00
Mean days of stimulation	8.54	8.13	8.04	7.52	7.67	7.56	8.89	8.49	7.73	7.42	8.50
Mean M2 eggs	3.59	7.89	12.67	17.54	22.70	29.69	2.71	7.68	12.39	17.33	22.50
Maturation rate (%)	59.64	74.67	80.62	79.53	84.92	84.97	71.86	80.24	80.83	84.21	78.94
Fertilization rate (%)	78.51	71.56	67.87	63.81	62.08	62.32	88.73	68.87	69.85	51.92	88.89
Cleavage rate (%)	97.77	97.66	97.74	97.05	98.28	96.62	30.19	97.24	95.05	96.29	40
Mean number of embryos/fresh ET	1.77	1.84	1.68	1.25	1.40	NA	0.95	1.90	1.86	1.75	NA
Mean number of frozen embryos	0.90	2.80	5.30	7.61	9.64	12.31	0.61	2.14	4.86	7.33	9.50
Cumulative pregnancy rate (%)	48.33	66.04	72.17	76.70	84.85	93.75	49.62	43.85	59.18	100	50
CLBR (%)	36.74	49.21	53.07	57.28	75.76	81.25	33.59	26.15	36.73	75	50
Abortion rate/transfer (%)	9.63	13.67	13.59	15.53	6.06	6.25	13.74	15.38	20.41	16.67	0

Group I: ≤35 years age, Group II: >35 years age. AFC=Antral follicle count, AMH=Anti-Müllerian hormone, BMI=Body mass index, E_2=Estradiol, FSH=Follicle stimulating hormone, Gn=Gonadotropin, LH=Luteinizing hormone, *n*=number of participants, CLBR=Cumulative live birth rate, ET=Embryo transfer, NA=No fresh ET, M2=Mature eggs

Table 2: Association of fresh pregnancy rate and livebirth rate with number of oocytes retrieved and age

Number of oocyte retrieved (subgroups)	Pregnancy rate (%)		Live birth rate (%)	
	Group I	Group II	Group I	Group II
≤5	42	39	32	55
6-10	54	37	41	24
11-15	52	62	39	34
16-20	46	75	25	75
21-25	20	0	20	0
>25	0	0	0	0

Group I: ≤35 years age, Group II: >35 years age

rate and CLBR for Group II were lower compared to Group I (0.68 [95% CI 0.54–0.87; P = 0.002] and 0.58 (95% CI 0.45–0.75; P = 0.00002]) when Group I was used as reference [Table 3].

Distribution of oocyte yield

The distribution of the number of oocytes retrieved differed between age groups I and II. Table 3 shows the distribution of oocytes yield and the distribution of aspirated oocytes is graphically depicted in Figure 3. The median number of matured oocytes retrieved was higher in Group I (8 oocytes) as compared to Group II (6 oocytes). The frequency of distribution of mature oocytes was also significantly higher in women under Group I (maximal frequency >150) as compared to that of Group II (maximal frequency >35) [Figure 3].

The highest positive pregnancy was observed in fresh ET followed by FET 1 cycle in both age groups. In Group I, FET 1 cycle had higher positive pregnancy in women with 11 up to >25 oocytes as compared to women in the same subgroups with fresh ET. Women in both age groups had low positive pregnancy in FET 3 and FET 4 cycles with no pregnancy in most of the oocyte subgroups. No positive pregnancies were reported from FET 3 cycle onwards in women in Group II, which could be attributed to the low number of patients in this group, and hence, cannot be accurately commented up on. Overall positive pregnancy for women under age groups I and II was 602 and 104 in fresh ET, 438 and 61 in FET cycles, respectively [Table 4].

Cumulative pregnancies and live births in fresh and frozen embryo transfer

Women in both groups underwent fresh and subsequent FET in terms of three different patterns and reported differential percentages of cumulative pregnancies and live births. In Pattern I, women in both groups did not undergo fresh ET but, subsequently underwent FETs. In Pattern II, women in both Groups I and II underwent fresh ET which resulted in negative pregnancies and so underwent subsequent FETs. According to Pattern III, women in both groups underwent fresh ET, which resulted in positive pregnancies but resulted in

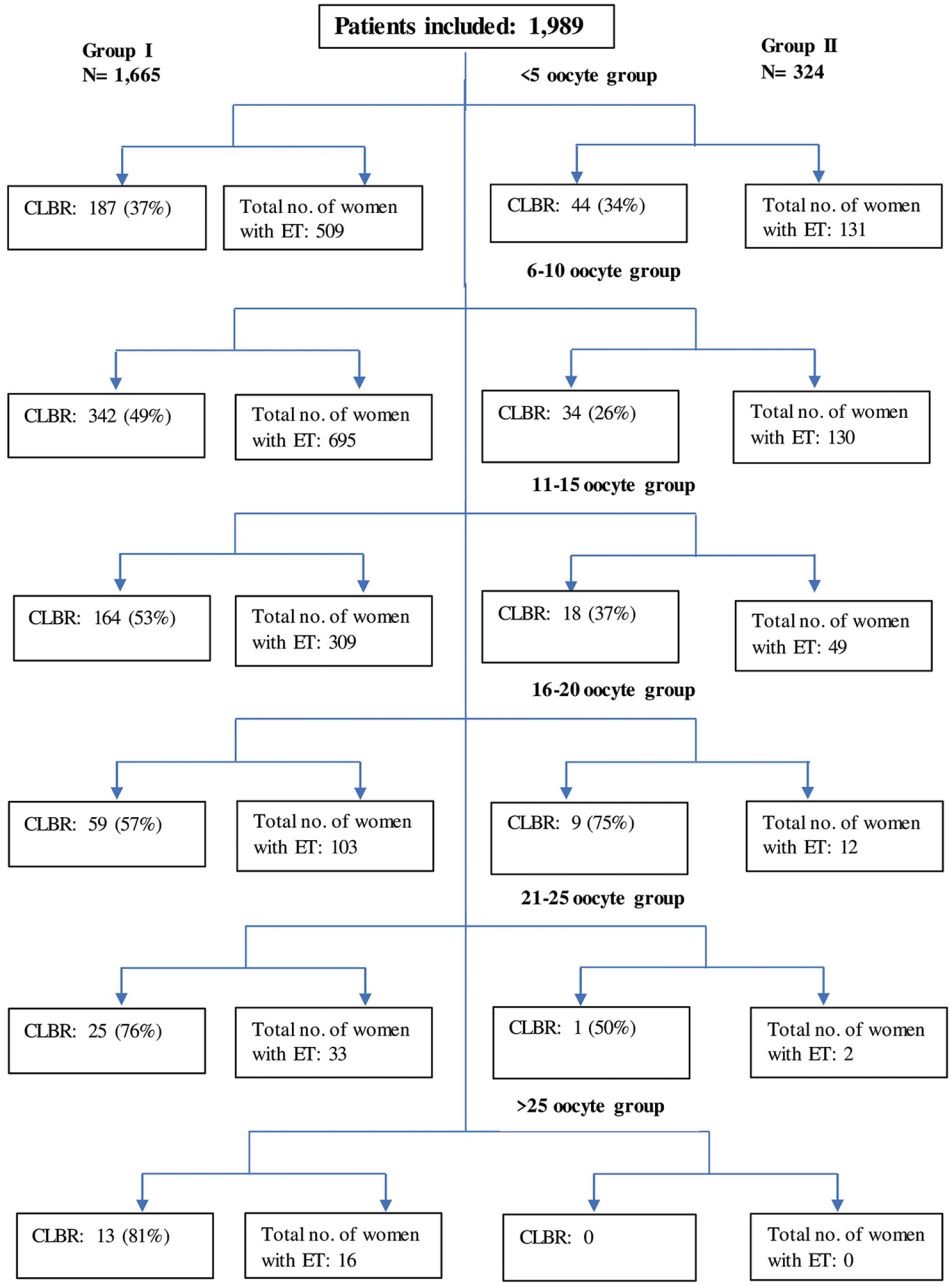

Figure 1: Flowchart of association of CLBR (both fresh ET and FET) with number of oocytes retrieved and age. ET = Embryo transfer; Group I: ≤35 years age; Group II: >35 years age, CLBR = Cumulative live birth rate, FET = Frozen embryo transfer

negative live births. Therefore, they had undergone FET cycles.

Women in Groups I and II reported the highest cumulative pregnancies (81% at >25 oocyte subgroup and 88% at 16–20 oocyte subgroup) and live births (75% at 21–25 oocyte subgroup and 63% in 16–20 oocyte subgroup), respectively in Pattern I. None of the women in Group II produced >25 oocyte. In Pattern II, women in Groups I and II reported maximal cumulative pregnancies (50% at >25 oocyte subgroup and 100% at 16–20 oocyte subgroup) and live births (38% and 100% in 16–20 oocyte subgroup), respectively. Cumulative pregnancy rates were 100% in women in Groups I and II in Pattern III (≤5–16–20 oocyte subgroups and ≤5–11–15 oocyte subgroups) and live birth rates were 13% (11–15 oocyte subgroup and 6–10 oocyte subgroup), respectively.

In Pattern III, women who underwent fresh/frozen ET cycles in both groups reported maximal cumulative pregnancies; however, owing to the smaller sample size, no definite conclusions could be drawn. Maximal cumulative live births were reported in Pattern I in both groups who underwent FET cycles [Table 5].

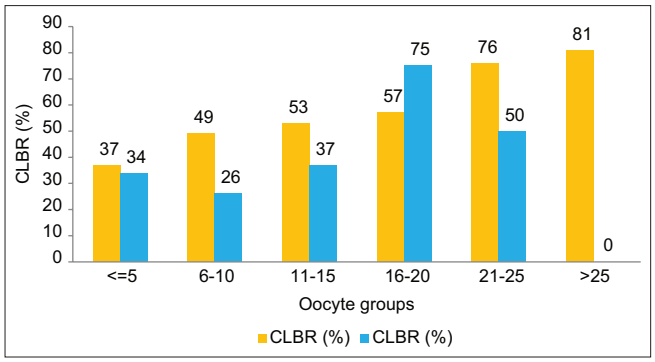

Figure 2: Association of CLBR with number of oocytes retrieved and age. CLBR = Cumulative live birth rate

Table 3: Correlation between pregnancy rates and cumulative live birth rate with number of oocytes retrieved and age, and distribution of oocyte yield

Predictors	OR	95% CI	*P*
Pregnancy rate logistic regression analysis			
Oocyte subgroups			
≤5	1		
6-10	1.6552	1.3434-2.0411	0.000002*
11-15	2.1051	1.6126-2.757	0.00000005*
16-20	2.8947	1.8865-4.5382	0.000001*
21-25	3.1631	1.5101-7.2528	0.003*
>25	4.6336	1.475-20.3648	0.01*
Age group			
Group I	1		
Group II	0.6822	0.535-0.8695	0.002*
CLBR logistic regression analysis			
Oocyte subgroups			
≤5	1		
6-10	1.4477	1.1706-1.7923	0.0006*
11-15	1.7688	1.3587-2.3047	0.00002*
16-20	2.2131	1.4797-3.3275	0.0001*
21-25	3.6263	1.7813-7.8443	0.0005*
>25	4.8217	1.6564-17.4165	0.007*
Age group			
Group I	1		
Group II	0.5808	0.4491-0.7473	0.00002*
Distribution of oocyte yield statistics (M2)			
Age group (years)	***n***	**Median**	**IQR**
≤35	1665	8	6
>35	324	6	7

*Significant results. Group I: ≤35 years age, Group II: >35 years age. CI=Confidence intervals, IQR=Interquartile range, M2=Mature oocytes, *n*=Number of patients, OR=Odds ratio, CLBR=Cumulative live birth rate

Discussion

In the current retrospective study, we sought to establish the impact of the number of oocytes retrieved on pregnancy rate, live births and CLBR in women undergoing ART stratified according to age. During the 5-year study duration, a total of 1989 women who underwent fresh/FETs were screened for positive IVF outcomes. The study demonstrates a robust positive relationship between the number of oocytes retrieved and pregnancy rates, live births and CLBR in women undergoing IVF/ICSI cycles.

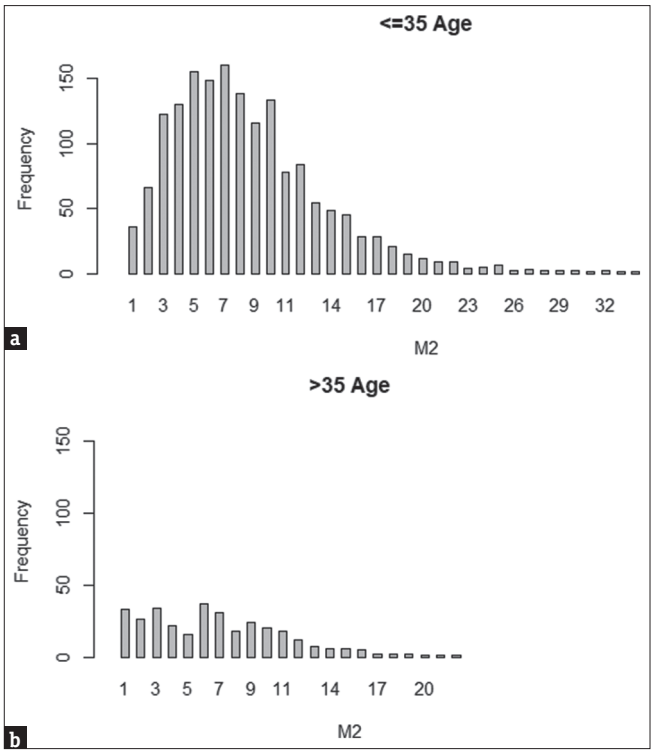

Figure 3: Distribution of oocyte yield in age groups (a) Group I (b) Group II

Following are the key findings of this study:

i. Cumulative pregnancy and live birth rates in fresh/FET were higher for women ≤35 years (Group I) when compared to women >35 years (Group II), indicating a positive association between maternal age and outcomes of ART
ii. Increase in the number of oocytes retrieved significantly increased the pregnancy rate (P = 0.018) and CLBR (P = 0.007) in >25 oocytes subgroup, establishing a positive association of both CLBR and pregnancy rates with the number of oocytes retrieved
iii. CLBR increased with every additional oocyte among women of Group I compared to Group II.

A consistent increase in the pregnancy rate was observed in Group I (≤35 years of age) with an increase in oocyte number up to 6–10 oocytes, following which a reduction in pregnancy rate was observed in cycles with fresh ET. However, this pattern was different in Group II showing a linear increase in pregnancy rate with each additional oocyte retrieval in cycles with fresh ET. This points to the linear association between the number of oocytes

Table 4: Pregnancy count in each cycle in age Groups I and II

Number of oocyte retrieved (subgroups)	Positive pregnancy in fresh ET		Positive pregnancy in FET1		Positive pregnancy in FET2		Positive pregnancy in FET3		Positive pregnancy in FET4	
	Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II
≤5	188	41	49	19	8	5	1	0	0	0
6-10	306	41	118	15	30	1	4	0	1	0
11-15	96	18	101	10	23	1	3	0	0	0
16-20	11	3	52	7	16	1	0	1	0	0
21-25	1	1	22	1	5	0	0	0	0	0
>25	0	0	1	0	4	0	0	0	0	0

Group I: ≤35 years age, Group II: >35 years age. ET=Embryo transfer, FET=Frozen ET

retrieved and pregnancy rate with advanced maternal age. In this study, pregnancy rates obtained were higher than in other studies, even for advanced maternal age. Studies by Vaughan *et al*.[3] included women up to the age of 46 years and showed a pregnancy rate of 41.3% in ≥15 oocyte subgroup. Previous studies.[4,5] had shown that the pregnancy rates doubled when women produced >25 oocytes compared to women with <5 oocytes.

A decrease in live birth rate in fresh ET cycle in subgroups beyond 6–10 retrieved oocytes among women under 35 years of age may be a result of detrimental effects on endometrial receptivity and the inclination towards FET cycles at higher oocyte yields. Peak live birth rate in women older than 35 years of age was observed in the 16–20 oocytes subgroup. In subgroups with higher oocytes, none of the women underwent fresh ET. A similar association of retrieved oocytes with rates of live birth has been reported in a systematic review of observational studies on fresh ET outcomes.[6] The decline in live birth rates has previously been reported in the 15–20 oocyte subgroup in women aged between 18 and 40 years undergoing fresh ET or FET,[7-9] whereas Drakopoulos *et al*.[10] reported maximal live birth rate of 31.4% in 10–15 oocyte subgroup in women <40 years of age. In this study, we observed a decline in live births (39%) for fresh ET cycles in the 11–15 oocyte subgroup in women ≤35 years of age, which is in accordance with previous reports.

In this study, CLBR followed a steadily increasing trend with every additional oocyte retrieved in women under ≤35 years of age. Maximum CLBR observed in >35 years peaked at 75% (16–20 oocyte subgroup), following which a decline was observed. This may have been due to a lower sample size (n = 2) of women producing >25 oocytes. Compared to CLBR rates in previous reports (61.7%, Ji *et al*.; 61.5%, Drakopoulos *et al*. and 34.1%, Toftager *et al*.),[8,10,11] higher CLBR rates were obtained in this study. Yin *et al*.[12] reported 2.7% CLBR per oocyte retrieval in advanced-age women >40 years. Coupled with enhanced post-warming survival rates caused by vitrification,[13] a greater number of oocytes could contribute to an increased CLBRs after using all cryopreserved embryos. Our results suggest a similar positive association between oocyte yield and CLBR.

Maternal age is one of the key modifiers of the association between the number of oocytes retrieved and IVF outcomes. The optimum number of oocytes retrieved would depend upon the maternal age, where the expected difference in the probability of achieving positive IVF outcomes per aspiration is reduced with advancing age. The probabilities of obtaining a higher number of euploid embryos in fresh or FET cycles are more with higher oocyte yields[14] but as the quality of oocytes is intrinsically related to maternal age,[15] it is probable that the correlation between oocyte yield and live births or CLBR may not be the same for all ages. Fertility decreases significantly after 35 years of age.[16] It is probable that women with <35 years of age have a higher proportion of euploid embryos which are more likely to result in a successful live birth.[14,17] At advanced reproductive ages of over >35 years, the probability of a euploid embryo is small, as is the possibility of high oocyte yields, which may be the reason for a decline in positive IVF outcomes in spite of additional oocytes. Although the number of oocytes retrieved is positively associated with outcomes, the rate of increase in positive outcomes per additional oocyte retrieved may differ between age groups, with women aged >35 years deriving comparatively less benefit from COS with the rise in oocyte retrieval. Therefore, this might be the reason for maximal CLBR at lower oocyte yields in Group II than in Group I.

Our results suggest that optimal oocyte retrieval for achieving positive IVF outcomes in fresh/frozen ET cycles appears to be minimal in younger women (≤35 years) but maximum in older women (>35 years). Furthermore, mature oocytes appear to be significantly more abundant in younger women (≤35 years) which could result in maximal outcomes at higher oocyte retrieval as opposed to older women (>35 years).

Table 5: Cumulative pregnancies and live births in all three patterns in age Groups I and II

Number of oocyte retrieved (subgroups)	Pattern I		Pattern II				Pattern III			
	Cumulative pregnancy (%)	Cumulative live birth (%)	Cumulative pregnancy (%)				Cumulative live birth (%)		Cumulative pregnancy (%)		Cumulative live birth (%)	
	Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II
≤5	46	48	44	37	7	11	5	10	100	100	4	7
6-10	60	40	50	20	20	7	15	3	100	100	7	13
11-15	77	50	63	40	16	0	11	0	100	100	13	0
16-20	70	88	57	63	46	100	38	100	100	0	0	0
21-25	79	50	75	50	50	0	25	0	0	0	0	0
>25	81	0	75	0	0	0	0	0	0	0	0	0

Group I: ≤35 years age, Group II: >35 years age. Pattern I: No fresh ET but FET, Pattern II: Fresh ET resulting in negative pregnancy then underwent FET, Pattern III: Fresh ET resulting positive pregnancy but negative live birth then underwent FET. ET=Embryo transfer, FET=Frozen ET

Our study indicates that younger-aged women attained positive IVF outcomes in terms of cumulative pregnancies and live births all at lower oocyte retrieval in fresh ET cycles compared to advanced maternal-aged women. In contrast, two randomised trials with participants aged <41 years[18] and 30–31 years,[18] reported 15%–30% higher pregnancy rates after FET cycles than fresh ET cycles. Women with polycystic ovary syndrome, ovarian hyperstimulation syndrome and certain pregnancy complications are more likely to benefit from FET strategy.[19] These could be the contributing factors which led to different results among the two groups of the present study, wherein women in Group I favoured fresh ET cycles while Group II favoured FET cycles.

The strength of the present study is the inclusion of complete data on all fresh and frozen IVF cycles, with no patients undergoing COS and oocyte retrieval being excluded. The findings of this study can therefore be extrapolated within the age range to the general population seeking ART treatment. Non-inclusion of all FET cycles, the unequal sample size in all groups that could affect the success rate of outcomes, non-calculation of power of the study and chances of additional births due to cryopreserved embryos are some of the limitations of the study. The present study focuses only on pregnancy rate, live birth and CLBR per stimulated cycle and does not consider additional issues such as cost, treatment complexity, patient burden and pregnancy complications that might also be of interest to clinicians and patients.[20]

Conclusion

The key to success in IVF is selecting good-quality embryos for transfer. However, we need a balanced approach to maximise IVF outcomes by retrieving a reasonable number of oocytes without distressing the patient. The results of this study indicate that higher CLBR is associated with an increased number of oocytes retrieved. Maximising the number of oocytes retrieved can therefore be a potential strategy for clinicians and patients who wish to achieve a live birth. However, one must keep in mind the role of increasing maternal age on the quality of oocytes obtained.

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Conflicts of interest

There are no conflicts of interest.

Data availibity statement

All data pertaining to this study are contained and presented in this article.

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