

POSEIDON group prevalence in assisted reproductive technology cycles: A retrospective analysis from an Indian tertiary assisted reproductive technology center

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Abstract

Objectives: The aim of the study was to assess the prevalence of “low prognosis” patients using POSEIDON criteria undergoing *in vitro* fertilization (IVF) cycle in Indian population. **Study Design:** This is a retrospective cohort study. **Period of Study:** It included data from the recruitment period from January 1, 2018 to December 31, 2021. **Study Settings:** The study was conducted at the Center for IVF and Human Reproduction, Sir Gangaram Hospital, New Delhi. **Methodology:** Out of the 3032 IVF stimulation cycles with oocyte aspirations, 596 cycles were excluded based on the exclusion criteria. The study focused on 2436 IVF/ICSI (Intracytoplasmic sperm injection) stimulation cycles that met inclusion criteria. Each cycle was categorized into one of the four groups defined by the POSEIDON criteria along with a fifth non-POSEIDON group. Prevalence was observed for each POSEIDON group and the non-POSEIDON group. **Results:** Out of the analyzed cycles, 1210 were classified under POSEIDON groups, representing a prevalence of 49.67%. The distribution of cycles in POSEIDON groups 1, 2, 3, and 4 was 31.4, 23.2, 19.17, and 26.19%, respectively. **Conclusion:** Low prognosis patients based on POSEIDON criteria, represented about half of the population.

Keywords: POSEIDON, low prognosis, poor responder, IVF, ICSI

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INTRODUCTION

In assisted reproductive technology (ART), prioritizing key practices is crucial. This involves evaluating a couple’s fertility, providing personalized treatments, offering clear counseling, and creating effective, safe, time-limited treatment plans that respect patients’ values.

In the last two decades, there has been a surge in couples seeking ART. As women age, their ovarian reserve

diminishes, affecting both egg quality and quantity. This often leads to fewer eggs during stimulation, classifying them as “poor responders”.^[1] Historically, poor responder definitions varied. The Bologna criteria defined the poor responders by considering factors such as age, prior responses, and low ovarian reserve.^[2] The Bologna criteria, while helpful, have limitations, including heterogeneity and neglecting age and oocyte quality. To address this, the POSEIDON criteria emerged in 2016,

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categorizing patients by age, reserve, and prior responses. It shifts the focus from “poor ovarian response” to “low prognosis,” aiding those with lower pregnancy odds.^[3-6]

Our study assessed low-prognosis patients using POSEIDON criteria in the Indian population seeking *in vitro* fertilization (IVF) at a tertiary IVF center. This research emphasizes the importance of POSEIDON criteria in shaping ART practices and improving patient care.

ETHICS

Ethical clearance was given by the Independent Ethics Committee, F.1/IEC/IFS/2022No.28 2022. This article does not contain any studies involving animals performed by any of the authors.

STUDY DESIGN

Data Collection

Retrospective data were collected from January 1, 2018, to December 31, 2021, at the Center for IVF and Human Reproduction at Sir Ganga Ram Hospital. The study focused on women with primary and secondary infertility who underwent IVF cycles and met the inclusion and exclusion criteria.

Study Participants

A total of 3032 IVF stimulation cycles that underwent aspiration were considered during the recruitment period. After excluding 596 cycles that did not meet the criteria, 2436 IVF/ICSI cycles were included. These cycles were categorized into POSEIDON and non-POSEIDON groups based on age, ovarian reserve parameters, and the number of oocytes retrieved.

Data Collection

Patient data included age, type and duration of infertility, and cause of infertility. Ovarian reserve was assessed using serum AMH (Anti-Mullerian Hormone) or AFC (Antral follicle count).

The study’s inclusion criteria encompassed women aged 23 to 45 years who had been diagnosed with either primary or secondary infertility and had opted for self-oocyte retrieval. Ovarian stimulation was performed using various suitable conventional antagonist protocols at our center. Tables 1–3

In contrast, the exclusion criteria comprised individuals younger than 23 years or older than 45 years of age, donor-recipient cycles, surrogacy, oocyte cryopreservation.

IVF/ICSI Procedures

Oocyte aspiration was performed under sedation, and the number of retrieved oocytes was recorded.

POSEIDON Stratification

Cycles were categorized into POSEIDON groups based on age, prestimulation ovarian reserve testing, and the number of oocytes retrieved. Five groups were formed, and they are as follows:

- (1) GROUP 1: POSEIDON 1 à Age <35 years with good ovarian reserve (AMH ≥1.2 ng/mL and/or AFC ≥ 5) with an unexpected poor or suboptimal ovarian response
 - (a) 1a: less than four oocytes
 - (b) 1b: four to nine oocytes retrieved
- (2) GROUP 2: POSEIDON 2 à Age ≥35 years with good ovarian reserve (AMH ≥1.2 ng/mL and/or AFC ≥5) with an unexpected poor or suboptimal ovarian response

Table 1: POSEIDON Group and non-POSEIDON Group Distribution.

Groups	Frequency	Prevalence (%)
POSEIDON	1210	49.67
Non-POSEIDON	1226	50.33
Total	2436	100.00

Table 2: POSEIDON Group Distribution.

POSEIDON Groups	Frequency	Prevalence (%)
Group 1	380	31.4
Group 2	281	23.2
Group 3	232	19.17
Group 4	317	26.19

Table 3: POSEIDON Subgroup and Non-POSEIDON Group Distribution.

Group Distribution Numbers (Prevalence)	Major Group Numbers (Prevalence)	Subgroup
POSEIDON: 1210 (P = 49.67%)	1: 380 (15.60%)	1A: 45 (1.85%)
		1B: 335 (13.75%)
	2: 281 (11.54%)	2A: 45 (1.85%)
		2B: 236 (9.69%)
	3: 232 (9.52%)	-
Non-POSEIDON: 1226 (P = 50.33%)	4:317 (13.01%)	-
	5: 1226 (50.33%)	-

- (a) 2a: less than four oocytes
- (b) 2b: four to nine oocytes retrieved
- (3) GROUP 3: POSEIDON 3 à Age <35 years with poor ovarian reserve prestimulation parameter (AMH <1.2 ng/mL and/or AFC <5)
- (4) GROUP 4: POSEIDON 4 à Age ≥35 years with poor ovarian reserve prestimulation parameter (AMH <1.2 ng/mL and/or AFC <5)
- (5) GROUP 5: Non-POSEIDON group adequate ovarian reserve (AMH ≥1.2 ng/mL and/or AFC ≥5) and optimal ovarian response (≥10 oocytes retrieved)

Outcome Measures

Prevalence of different POSEIDON groups was observed among patients undergoing IVF cycles at a tertiary ART center.

Statistical Analysis

Categorical variables were expressed as numbers and percentages, while quantitative data were presented as means with standard deviations or as medians with interquartile ranges (25th and 75th percentiles), depending on the normality of the data determined using the Kolmogorov–Smirnov test. Nonparametric tests were applied for non-normally distributed data. Qualitative variable comparisons were conducted using the chi-square test, with Fisher’s exact test employed when expected cell values were less than 5. For quantitative variables, analysis of variance followed by the Bonferroni correction was utilized for normally distributed data, while the Mann–Whitney Test and Independent *t* test were employed for non-normally and normally distributed data, respectively. Data were entered into Microsoft Excel and analyzed using IBM’s Statistical

Package for Social Sciences (SPSS) software, version 25.0, and statistical significance was defined as a *P*-value less than 0.05.

RESULTS

Prevalence of POSEIDON group was found to be 49.67%, while the remainder classified as non-POSEIDON group which comprises 50.33% of the total population. Thus, POSEIDON group comprises quite a large proportion, almost half of the population attending ART clinic for IVF.

In POSEIDON group, group 1 had greatest number of IVF cycles followed by group 4 and then groups 2 and 3. Among “low prognosis” patients according to POSEIDON criteria, prevalence was 31.4% in group 1, 23.2% in group 2, 19.17% in group 3, and 26.19% in group 4.

The overall prevalence of different subgroups in the whole population is 15.60, 11.54, 9.52, and 13.01% for groups 1 to 4, respectively.

Characteristics of the patients is described in the Table 4.

DISCUSSION

This study aims to determine the prevalence of POSEIDON groups in the Indian population within a tertiary ART center. It covers data from January 2018 to December 2021, involving 2436 IVF/ICSI cycles. Out of these, 1210 cycles were categorized under POSEIDON groups, indicating a prevalence of 49.67% [confidence interval (CI) = 48.34–52.32%]. Tables 5–8

Table 4: Descriptive Data in POSEIDON and Non-POSEIDON Group.

	POSEIDON (n = 1210)	Non-POSEIDON (n = 1226)	Total	P Value
Age (mean ± SD)	34.39 ± 4	31.97 ± 3.81	33.17 ± 4.09	<0.0001 [†]
Primary infertility	695 (57.44%)	762 (62.15%)	1457 (59.81%)	0.018 [†]
Secondary infertility	515 (42.56%)	464 (37.85%)	979 (40.19%)	0.018 [†]
Years of infertility (mean ± SD)	3.93 ± 2.42	3.84 ± 2.19	3.88 ± 2.31	0.962 [‡]

SD = standard deviation.

Table 5: Descriptive Data in POSEIDON and Non-POSEIDON Subgroups.

Age (years)	1 (n = 380)	2 (n = 281)	3 (n = 232)	4 (n = 317)	5 (n = 1226)
Age (mean ± SD)	30.98 ± 2.53	37.32 ± 2.1	31.5 ± 2.24	37.99 ± 2.31	31.97 ± 3.81
Primary infertility	248 (65.26%)	148 (52.67%)	155 (66.81%)	144 (45.43%)	762 (62.15%)
Secondary infertility	132 (34.74%)	133 (47.33%)	77 (33.19%)	173 (54.57%)	464 (37.85%)
Years of infertility (mean ± SD)	3.82 ± 2.14	4.42 ± 2.58	3.37 ± 2.12	4.03 ± 2.7	3.84 ± 2.19
Body mass index (kg/m ²) Mean ± SD	25.69 ± 4.03	26.36 ± 4.61	26.12 ± 4.24	26.4 ± 4.3	26.15 ± 4.19

SD = standard deviation.

Table 6: Distribution of Ovarian Reserve Markers: AMH (ng/mL) and AFC in POSEIDON subgroups and non-POSEIDON group.

	1A (n = 45)	1B (n = 335)	2A (n = 45)	2B (n = 236)	3 (n = 232)	4 (n = 317)	5 (n = 1226)
AMH (ng/mL)							
Mean ± SD	2.93 ± 2.38	2.49 ± 1.24	1.95 ± 0.77	2.59 ± 1.98	0.74 ± 0.29	0.69 ± 0.3	3.99 ± 2.32
AFC							
Mean ± SD	9.69 ± 2.54	7.99 ± 1.51	8.13 ± 1.83	7.96 ± 1.66	6.07 ± 3.55	5.08 ± 3.16	16.96 ± 6.47

SD = standard deviation.

Table 7: Distribution of Response to Ovarian Stimulation: Serum E2 (pg/mL) on the Day of Trigger, Number of Oocytes in POSEIDON Subgroups and Non-POSEIDON Group.

	1A (n = 45)	1B (n = 335)	2A (n = 45)	2B (n = 236)	3 (n = 232)	4 (n = 317)	5 (n = 1226)
Serum E2 (pg/mL) on the day of trigger							
Mean ± SD	1454.33 ± 1218.95	1768.64 ± 954.17	1174.93 ± 693.19	1902.84 ± 1104.22	1301.66 ± 824.68	1124.54 ± 795.64	3052.12 ± 1831.41
Number of oocytes							
Mean ± SD	2.11 ± 1.05	7.08 ± 1.58	1.98 ± 1.08	6.79 ± 1.6	5.9 ± 3.73	4.81 ± 3.41	16.96 ± 6.47

SD = standard deviation

Table 8: Comparative Distribution of the Prevalence of POSEIDON Groups in Other Studies.

Author	Group 1 (%)	Group 2 (%)	Group 3 (%)	Group 4 (%)
Present study	31.4	23.2	19.17	26.19
Vargas <i>et al.</i> ^[10]	20.4	31.5	14.8	33.3
Levi-Setti <i>et al.</i> ^[13]	6.9	19.8	11.7	61.5
Shi <i>et al.</i> ^[11]	24.9	13.7	24.3	37.1
Li <i>et al.</i> ^[12]	60.9	24.5	3.4	11.2
Esteves <i>et al.</i> ^[9]	44.2	36.1	5.2	14.4

The study's prevalence aligns with Conforti's (2019) 47%, while Seven *et al.* reported 52.6%, and Esteves *et al.* estimated 43.0%.^[7-9] Some studies found lower prevalence, such as Vargas at 13.1%. However, variations may be due to patient demographics and donor egg use.^[10] Shi *et al.* reported 24.5% and Li *et al.* found 31.5% using POSEIDON criteria.^[11,12]

This study shows clinical differences between POSEIDON and non-POSEIDON patients. POSEIDON patients were older with lower AMH and AFC but had a similar body mass index. The mean number of oocytes in groups 1 and 2 was higher than that in group 3 and 4. Unexplained infertility was the primary reason for IVF in both groups.

CONCLUSION

In conclusion, addressing the challenges of low-prognosis women in fertility treatments requires tailored clinical assessment. The POSEIDON criteria effectively categorize these women into distinct groups. Our study determined the prevalence of these groups, with nearly half of the patients fitting the criteria. Managing these cases remains complex due to limited understanding of underlying mechanisms. Moving forward, refining poor responder management is crucial. Conducting well-

designed clinical research within this population is imperative. Future studies should focus on formulating effective strategies for poor responders, considering pregnancy outcomes in the four POSEIDON-defined groups.

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Conflicts of interest

There are no conflicts of interest

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