Effect of Maternal Aging on Fertility Outcomes in Assisted Reproductive Technology: A Study of Autologous and Donor Oocyte Cycles

Ibinabo Fubara Bob-Manuel, Henry Ajulor Amadi-Ikpa, Gospel Uchechukwu Collins

Department of Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, Rivers State, Nigeria.

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ABSTRACT

With increasing numbers of women delaying childbearing, age-related declines in fertility have become a significant concern, often necessitating the use of assisted reproductive technologies (ART). Although ART has enabled many individuals and couples to achieve pregnancy, evidence shows that conceptions through ART carry higher risks of adverse outcomes. This study aimed to investigate the impact of female aging on reproductive outcomes in ART cycles, comparing outcomes between autologous and donor oocytes across different age groups. A retrospective design was employed, using medical records from two fertility clinics in Port Harcourt, Nigeria. Data on age, weight, number of oocytes retrieved, embryo quality, and IVF cycle outcomes were analyzed, and the Chi-square test was used to examine associations between variables. Among 120 donor oocyte cycles, the highest positive IVF outcomes were observed in women aged 36–39 years (n = 11, 52.38%), followed by those aged 31–35 years (n = 10, 50%), 40–44 years (n = 11, 31.43%), ≤30 years (n = 9, 39.13%), and ≥45 years (n = 5, 23.81%). In the 120 autologous cycles, success rates declined progressively with age: ≤30 years (n = 15, 55.56%), 31–35 years (n = 10, 42.67%), 36–39 years (n = 6, 25%), 40–44 years (n = 2, 8.33%), and ≥45 years (n = 0, 0%). Chi-square analysis demonstrated a significant association between age and IVF outcome in autologous cycles, whereas no significant association was observed in donor cycles. These findings highlight the influence of maternal age on IVF success when using autologous oocytes and underscore the ability of donor oocytes to mitigate age-related declines in reproductive potential.

Keywords: Female Ageing, Assisted Reproduction Technology, Donor Oocytes, Autologous Oocytes

INTRODUCTION

Reproduction is essential to species survival, and female ageing remains one of the most significant factors influencing human fertility. As women age, particularly beyond 35 years, fertility declines due to reductions in oocyte quantity and quality, leading to diminished ovarian reserve, increased aneuploidy, and lower success rates in assisted reproductive technologies (ART) such as in vitro fertilization (IVF) (1, 2). Oocytes from older women exhibit higher rates of chromosomal abnormalities, resulting in implantation failure, miscarriage, and increased risk of chromosomally abnormal offspring (3). These changes are largely linked to age-related alterations in the ovarian microenvironment and mitochondrial dysfunction.

To address age-related infertility, assisted reproductive technologies, including IVF and intracytoplasmic sperm injection (ICSI), increasingly rely on donor oocytes, which are typically sourced from younger, fertile women. Donor oocytes offer significantly higher success rates than autologous oocytes in older women, with evidence showing that women aged 40–44 achieve live birth rates similar to younger women when donor oocytes are used (4). However, the choice between donor and autologous oocytes is complex and shaped by psychological, ethical, and emotional considerations, including concerns about genetic relatedness and parent– child bonding (5, 6).

Despite extensive global research on ART outcomes, there is limited evidence from Port Harcourt, Nigeria, on how female aging influences reproductive success, particularly regarding differences between autologous and donor oocyte cycles. With increasing trends of delayed childbearing in the region, this knowledge gap contributes to uncertainty in managing age-related infertility. Therefore, this study aims to address this gap by evaluating

the impact of female aging on reproductive outcomes in Port Harcourt, comparing success rates between cycles using autologous and donor oocytes.

Objectives of the Study

The objectives of the study include to:

i. Characterise and evaluate the descriptive attributes and clinical success rates of oocytes utilised in assisted reproductive procedures among women across different age groups in Port Harcourt.
ii. Determine the association between oocyte age groups and in vitro fertilization (IVF) cycle outcomes.
iii. Compare the success rates of IVF cycles employing autologous oocytes versus donor oocytes in order to elucidate differences in reproductive performance.

Justification

This study seeks to make a meaningful difference in the lives of women and families grappling with agerelated infertility by clarifying how maternal age affects oocyte quality and ART outcomes. By directly comparing IVF success with autologous versus donor oocytes across age groups, the research gives clinicians clearer guidance and patients better, more compassionate counselling so difficult choices are met with solid evidence rather than uncertainty. Beyond improving clinical decision-making and resource use, the study is intended to reassure and empower couples and individuals pursuing parenthood later in life, helping them navigate treatment options with dignity, hope, and realistic expectations.

Research Questions

1. How do the descriptive characteristics and clinical success rates of oocytes used in assisted reproductive technology vary across different maternal age groups in Port Harcourt?
2. What is the relationship between the age group of the oocytes and the resulting in vitro fertilization (IVF) cycle outcomes?
3. How do IVF success rates differ between cycles utilizing autologous oocytes and those utilizing donor oocytes among women of varying age groups?

Research Hypothesis

$H1_o$: Oocyte age has no significant association with in vitro fertilization outcomes

H1: Oocyte age is significantly associated with in vitro fertilization outcomes.

$H2_o$: There is no significant difference in reproductive success rates between IVF cycles using donor oocytes and those using autologous oocytes, regardless of maternal age group.

H2: In vitro fertilization cycles utilizing donor oocytes achieve significantly higher reproductive success rates than cycles utilizing autologous oocytes across all maternal age groups.

Definition of Key TermsIn Vitro Fertilization (IVF): In vitro fertilization is an assisted reproductive technology in which oocytes are retrieved from a woman's ovaries and fertilized with sperm outside the body, typically in a controlled laboratory environment. The resulting embryos are cultured and subsequently transferred into the uterus to achieve pregnancy.

Donor Oocytes: These are mature oocytes obtained from a different woman.

Autologous Oocytes: Autologous oocytes are a woman's own oocytes retrieved from her ovaries and used in her assisted reproductive treatment (7, 8)

LITERATURE REVIEW

The global rise in maternal age at first birth has coincided with an increasing reliance on assisted reproductive technologies (ARTs) (9).). Although ART has enabled many individuals and couples to achieve pregnancy,

evidence shows that conceptions through ART carry higher risks of adverse outcomes such as stillbirth, preeclampsia, preterm delivery, low birth weight, and congenital anomalies. These risks persist even among singleton pregnancies and are not fully explained by unmeasured confounding, suggesting that both ARTrelated factors and underlying infertility may contribute (10, 11, 12). At the same time, infertility affects approximately 8–10% of people of reproductive age globally, reinforcing the importance of ART as a vital option for families experiencing reproductive challenges (13). With ART now accounting for an estimated 8% of births in some regions, though influenced by national regulations, its relevance in modern fertility care continues to expand (14, 15).

Shifts in demographic patterns have also contributed to delayed childbearing, with many women postponing pregnancy into their mid-thirties and beyond. This trend is driven by widespread contraceptive use and broader socioeconomic changes, including women's increasing educational and professional opportunities, economic instability, and evolving family structures (16, 17). The biological decline in female fertility typically begins around age thirty and becomes more pronounced between thirty-five and forty (18, 19). Both ovarian and endometrial aging are recognized contributors to reduced pregnancy success. Endometrial alterations related to age may account for a large proportion of implantation failures, and premature endometrial aging has been linked to recurrent implantation failure (20, 19) Concurrently, ovarian aging leads to fewer available oocytes and increased aneuploidy, further compromising embryo viability (21, 22, 19). Tinelli et al., 2023; To counter these challenges, strategies such as early oocyte cryopreservation, preimplantation genetic testing for aneuploidy, and the use of donor oocytes have been adopted to improve the likelihood of transferring chromosomally healthy embryos (23, 18,19).

Advancing maternal age also directly affects the biological quality of oocytes, with reductions in both quantity and functional competence becoming more evident after the age of thirty-five (17) Age-related declines in ovarian reserve, increased chromosomal abnormalities, and mitochondrial dysfunction contribute to lower fertilization rates, higher miscarriage rates, and decreased success in ART cycles. Conversely, oocytes obtained from younger donors generally exhibit superior developmental potential, which is reflected in higher pregnancy and live birth rates among older recipients. Previous studies have demonstrated that donor oocytes substantially improve outcomes compared to autologous oocytes in older women. Despite this, the use of donor oocytes may influence the emotional and psychological experience of pregnancy and parenting, highlighting the multifaceted nature of ART decisions. Overall, ART remains a critical medical intervention for addressing infertility across diverse clinical contexts (17, 24, 19).

METHODOLOGY

Study Design

This was a retrospective, cross-sectional comparative study, designed to investigate the influence of maternal age on reproductive outcomes in assisted reproductive technology (ART) cycles in Port Harcourt. Women were stratified by age and by oocyte type (autologous or donor) to examine outcomes.

Study Area

The study was carried out in two purposively selected assisted reproductive technology (ART) clinics in Port Harcourt, Nigeria, recognized for their comprehensive in vitro fertilization (IVF) programs and diverse patient populations. These clinics provide a representative setting for evaluating reproductive outcomes across different maternal age groups and oocyte sources.

Methods of Data Collection

Data were retrospectively extracted from patient records and systematically organized according to relevant clinical and laboratory variables. Patients and donor were health individuals.

1. Patient age
2. Donor age
3. Patient weight (reported as mean ± standard deviation for each age group)
4. Embryo quality score

Number of oocytes retrieved

1. Positive outcome: Defined as a clinical pregnancy confirmed by ultrasound
2. Negative outcome: Defined as failure to achieve clinical pregnancy

Outcome rates were summarized as frequency counts and percentages for each maternal age group and oocyte type (autologous or donor)

Sampling Technique

A purposive sampling technique was employed. A total of 240 in vitro fertilization cycles were included, comprising 120 cycles using autologous oocytes and 120 cycles using donor oocytes. Patients were stratified by maternal age into five groups: ≤30, 31–35, 36–39, 40–44, and ≥45 years. Inclusion criteria were availability of complete medical records and at least one completed in vitro fertilization cycle. Only healthy patients and donors were used. Records that lacked essential information required for analysis were excluded.

Data Analysis

Descriptive statistics were used to summarize the sample: means and standard deviations for continuous variables, and frequencies and percentages for categorical variables. To evaluate the association between maternal age group and in vitro fertilization outcome, the Chi-square test of independence was performed. An alpha level of 0.05 was set a priori; p-values less than 0.05 were considered statistically significant. All analyses were conducted using standard statistical software.

Ethical Consideration

The study protocol was approved by the Ethics Committee of the University of Port Harcourt. To protect participant privacy, all data were anonymized prior to analysis and handled in accordance with ethical standards for retrospective research.

RESULT

The results of the study were presented in tables, as follows;

Table 1: Descriptive statistics of IVF outcome using donor eggs

Age Groups	N	Mean ± SD			IVF cycle outcome	
		Weight (kg)	NRO	QE	Positive [N (%)]	Negative [N(%)]
≤30	23	74.74 ± 17.79	17.30 ± 10.19	3.57 ± 0.79	9 (39.13)	14 (60.87)
31 -35	20	73.20 ± 13.70	15.70 ± 4.72	3.50 ± 0.61	10 (50)	10 (50)
36 -39	21	77.00 ± 11.75	17.00 ± 12.08	3.76 ± 0.99	11 (52.38)	10 (47.62)
40- 44	35	84.14 ± 15.19	17.00 ± 8.29	3.77 ± 0.88	11 (31.43)	24 (68.57)
≥45	21	78.52 ± 11.47	14.52 ± 5.75	3.81 ± 0.69	5 (23.81)	16 (76.19)

N= Sample Size; kg= Kilogram; SD= Standard Deviation; NRO= Number of Retrieved Oocyte; QE= Quality of Embryo; IVF= In vitro Fertilization; %= Percentage

Table 2: Descriptive statistics of IVF outcome using autologous eggs

Age Groups	N	Mean ± SD			IVF cycle outcome	
		Weight (kg)	NRO	QE	Positive [N(%)]	Negative [N(%)]
≤30	27	81.67 ± 12.90	16.33 ± 6.23	3.22 ± 0.42	15 (55.56)	12 (44.44)
31 -35	24	81.00 ± 4.15	9.00 ± 7.47	4.25 ± 3.34	10 (42.67)	14 (58.33)
36 - 39	24	79.17 ± 10.15	18.17 ± 13.38	4.50 ± 2.58	6 (25)	18 (75)
40- 44	24	96.50 ± 15.87	13.75 ± 5.51	4.50 ± 0.51	2 (8.33)	22 (91.67)
≥45	21	98.33 ± 12.08	23.33 ± u.50	3.67 ± 0.48	0 (0)	21 (100)

N= Sample Size; kg= Kilogram; SD= Standard Deviation; NRO= Number of Retrieved Oocyte; QE= Quality of Embryo; IVF= In vitro Fertilization; %= Percentage

Table 3. Test for association between IVFoutcomes and age groups using donor oocytes

Age Groups	IVF Cycle Outcome		Calculated X^2	df	Critical X^2 at α=0.05	p-value	Inference
	Positive [frequency]	Negative [Frequency]					
≤30	9	14	4.96	4	9.49	p>0.05	NS
31 -35	10	10					
36 - 39	11	10					
40- 44	11	24					
≥45	5	16					

X^2= Chi-Square value; df= Degree of Freedom; NS= Not Significant

Table 4. Test for association betweenIVF outcomes and age groups using autologous oocytes

Age Groups	IVF Cycle Outcome		Calculated X^2	df	Critical X^2 at α=0.05	p-value	Inference
	Positive [frequency]	Negative [Frequency]					
≤30	15	12	27.27	4	9.49	P<0.05	S
31 -35	10	14					
36 - 39	6	18					
40- 44	2	22					
≥45	0	21					

X^2= Chi-Square value; df= Degree of Freedom; S= Significant

Table 5: Comparison between autologous and donor oocytes positive outcomes.

Age Group	Positive Outcome of Autologous Oocytes (%)	Positive Outcome of Donor Oocytes (%)
≤30	55.6	39.1
31–35	42.7	50.0
36–39	25.0	52.4
40–44	8.3	31.4
≥45	0	23.8

Autologous oocyte cycles exhibited a statistically significant age-related decline in IVF success ($p < 0.05$). In contrast, donor oocyte cycles showed no significant association between age group and treatment outcome ($p > 0.05$). Across all age categories, donor cycles also yielded higher numbers of retrieved oocytes and superior embryo quality scores compared with autologous cycles.

DISCUSSION

The present study evaluated the impact of female age on reproductive outcomes in assisted reproduction cycles using both donor and autologous oocytes. Across donor oocyte cycles, pregnancy rates varied by age group, with women aged 36–39 years achieving the highest positive outcome (52.38%), followed closely by the 31– 35 year group (50%). Conversely, women aged ≥45 years exhibited the lowest success rate (23.81%), highlighting a decline in outcomes even when high-quality donor oocytes were used (Table 1). The relative consistency in embryo quality scores across donor oocyte groups suggests that the observed reduction in pregnancy rates among older recipients may be influenced more by uterine or systemic factors associated with maternal age rather than by oocyte quality.

In autologous cycles, a clear age-dependent decline in IVF success was observed, with women ≤30 years demonstrating the highest pregnancy rate (55.56%). Pregnancy rates decreased progressively with advancing age, dropping to 25% in the 36–39 year group, 8.33% in the 40–44 group, and 0% in women aged ≥45 years (Table 2). These findings are consistent with previous literature demonstrating the effect of maternal aging on

ovarian reserve and oocyte competence (17, 24, 19). The absence of positive outcomes among women ≥45 years, despite relatively high oocyte retrieval numbers, underscores that oocyte quantity alone cannot compensate for the decline in oocyte quality associated with advanced maternal age.

The Chi-square analysis revealed no statistically significant association between age and pregnancy outcome in donor oocyte cycles ($\chi^2 = 4.96$, $p > 0.05$), indicating that donor eggs mitigate the effects of maternal age on reproductive outcomes (Table 3). In contrast, autologous cycles showed a strong age-related association ($\chi^2 = 27.27$, $p < 0.05$), reflecting the significant influence of maternal age on IVF success when women use their own oocytes (Table 4). Comparative analysis further revealed that donor cycles outperformed autologous cycles in nearly all age categories, particularly in women aged ≥36 years (Table 5). These results support the use of donor oocytes as an effective strategy to overcome age-related declines in ovarian reserve and oocyte competence, particularly in women of advanced reproductive age.

The observed decline in autologous IVF outcomes aligns with findings by Sebastian-Leon et al. (19),), who reported that live birth rates decreased from 45.8% to 32.7% between ages 40 and 50, while implantation failure and pregnancy loss rates increased significantly after age 40. Their analysis, accounting for patient baseline characteristics such as BMI and IVF cycle variables, confirmed that these declines were largely attributable to maternal age rather than other confounding factors. Similarly, Pathare et al. (17)) highlighted that aging negatively affects endometrial biology at molecular, cellular, and histological levels, impairing receptivity and increasing the risk of implantation failure and pregnancy loss. These age-related changes include cellular senescence, chronic low-grade inflammation, tissue fibrosis, and epigenetic modifications, all of which may contribute to reduced success in autologous cycles.

Further support for the observed patterns comes from Yurchuk et al. (25) , who emphasized that reproductive decline in advanced maternal age is driven by both ovarian and systemic factors, including reduced sensitivity to gonadotropins, accumulated negative changes in the oocyte genome, and mitochondrial dysfunction. These alterations compromise oocyte quality, fertilization potential, and embryo development, thereby reducing the likelihood of successful implantation and healthy live birth. Taken together, these findings underscore the multifactorial nature of age-related infertility, highlighting that both gamete quality and endometrial environment contribute to reduced ART success in older women.

CONCLUSION

This study demonstrates that female age has a significant impact on reproductive outcomes in assisted reproductive technology (ART) cycles, particularly when autologous oocytes are used, with pregnancy rates declining sharply in women over 35 years and reaching zero in those aged ≥45 years. In contrast, donor oocyte cycles largely mitigate the effects of maternal age, producing higher and more consistent pregnancy rates across all age groups, especially in women over 36 years. These findings highlight the critical role of oocyte quality in determining IVF success and indicate that age-related declines in fertility are influenced not only by ovarian reserve but also by uterine and systemic factors. Clinically, the results support the use of donor oocytes as an effective strategy to improve reproductive outcomes in older women and underscore the importance of incorporating maternal age and oocyte source into personalized ART planning to optimize the likelihood of conception and live birth.

RECOMMENDATIONS

For women of advanced maternal age or with low ovarian reserve, fertility clinics should offer donor oocyte IVF as the preferred option, while also providing personalized protocols for those using their own eggs. Comprehensive counselling should be included to help women understand their options, the likely outcomes, and any emotional or ethical considerations, ensuring informed decisions and the best possible chances of success.

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Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request. All relevant datasets were generated and analyzed during the current research and can be provided for academic or research purposes.

Conflict Of Interest

The authors declare no conflicts of interest related to this study.

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