

Research Article

The Impact of Advanced Maternal Age on Embryo Quality and Pregnancy Outcomes in Assisted Reproductive Technologies in Sierra Leone

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Abstract

This study examines the impact of advanced maternal age (AMA) on embryo quality and pregnancy outcomes among women undergoing assisted reproductive technologies (ART) in Sierra Leone. AMA is increasingly recognized as a key factor affecting fertility outcomes, with age-related declines in oocyte quality posing challenges for older women seeking ART. Research at two fertility centers in Freetown involved women aged 35 and older, categorized into age groups (35-39, 40-44, and 45+). Results showed a significant decrease in high-quality embryos and live birth rates with increasing maternal age. Younger cohorts had higher clinical pregnancy rates, while miscarriage rates rose markedly in women over 40, highlighting age-related risks affecting ART success. The study highlights the importance of embryo quality in ART success, with high-quality embryos linked to higher clinical pregnancy and live birth rates. Findings indicate that advanced maternal age reduces the likelihood of successful pregnancy and increases challenges due to higher chromosomal abnormalities. In Sierra Leone, where reproductive healthcare access is limited, AMA adds challenges due to cultural, social, and financial barriers. The study recommends expanding access to preimplantation genetic testing (PGT) and ART education to improve embryo selection and support informed decision-making. The study's implications emphasize the need for policies supporting AMA women, addressing both biological and societal barriers. By promoting affordable ART options and age-sensitive counseling, reproductive health practitioners in Sierra Leone can better assist older women pursuing parenthood. This research enhances the understanding of age-related ART challenges in developing countries, providing insights for improving ART success and access in Sierra Leone and similar contexts.

Keywords

Advanced Maternal Age, Embryo Quality, Assisted Reproductive Technology, Pregnancy Outcomes, In Vitro Fertilization

1. Introduction

In recent years, the field of reproductive medicine has seen considerable advancements, offering hope to individuals and couples facing infertility. Assisted reproductive technologies (ART), including in vitro fertilization (IVF) and intracytoplasmic sperm injection (ICSI), have emerged as effective

options for those unable to conceive naturally [20]. However, the success of ART is closely linked to various factors, among which maternal age stands as one of the most critical. Advanced maternal age (AMA), generally defined as attempting conception at or beyond the age of 35, introduces unique

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challenges in reproductive health [25], especially in regions like Sierra Leone where access to healthcare is limited, and socio-economic factors play a significant role in delayed childbearing [13].

In Sierra Leone, the cultural importance of fertility and childbearing cannot be overstated. Many women are under societal pressure to conceive, and the ability to have children is often seen as integral to family stability and social status [16]. However, societal changes, economic factors, and prolonged educational or career pursuits have led many women to delay childbearing. Consequently, the age at which many Sierra Leonean women begin to seek fertility treatments is increasingly beyond the threshold for AMA, introducing added complications into the already challenging field of ART [25]. The current study addresses this crucial issue by investigating the impact of AMA on ART outcomes in Sierra Leone, focusing on embryo quality, pregnancy rates, and birth outcomes among women aged 35 and older.

The implications of AMA on ART success rates are well-documented in Western and high-income countries, where fertility treatments are readily accessible, and research on ART outcomes is extensive [24]. However, in Sierra Leone and other sub-Saharan African nations, studies on the intersection of maternal age and ART outcomes are sparse [13]. Limited research in this area may be attributed to various factors, including inadequate healthcare infrastructure, high costs associated with ART procedures, and a lack of comprehensive fertility research in the region [4]. Consequently, clinicians and policymakers in Sierra Leone face challenges when formulating recommendations for older women seeking ART treatments, as they lack robust, locally applicable data.

Given the pressing demand for ART in Sierra Leone, particularly among women of advanced maternal age, this study seeks to fill the gap in literature by analyzing ART success rates among Sierra Leonean women aged 35 and above. Several systematic reviews have shown a consistent link between maternal age and declining embryo quality and pregnancy outcomes [1]. Specifically, it aims to determine how maternal age impacts the quality of embryos retrieved, the rate of successful pregnancies, and live birth outcomes. By examining data from ART procedures conducted at Sierra Leone's primary fertility centers, this research provides a localized perspective on the outcomes associated with advanced maternal age in ART, contributing vital information that could influence policy decisions, clinical guidelines, and patient counseling within the country.

The study's findings will have significant implications for improving ART practices in Sierra Leone. Identifying the unique challenges faced by women of AMA during ART can guide clinicians in personalizing treatment protocols, potentially improving success rates [20]. Additionally, the study can inform government and healthcare stakeholders about the need for policies that make ART more accessible and affordable. Ultimately, this research not only aims to enhance clinical outcomes but also to empower Sierra Leonean women

by providing them with realistic expectations and comprehensive information on their ART options as they navigate the challenges of delayed childbearing in a resource-limited setting.

Sierra Leone's healthcare system has seen notable progress over the past few decades, but reproductive healthcare, particularly in the field of fertility treatment, remains a developing area. In the context of ART, Sierra Leone faces both medical and socio-economic challenges that complicate treatment access and outcomes, especially for older women [10]. ART services in Sierra Leone are relatively scarce, limited to a few specialized centers in urban areas such as Freetown [4]. High costs associated with ART procedures further restrict access, often putting treatments out of reach for the majority of the population [3]. Additionally, cultural and societal factors play a significant role in shaping attitudes toward fertility treatment and age-related infertility, where advanced age is often viewed unfavorably within local cultural contexts [5].

In recent years, socio-economic and demographic shifts have led to an increasing number of women delaying marriage and childbearing. Rising educational attainment, workforce participation, and economic aspirations mean that more women in Sierra Leone are choosing to focus on career and financial stability before starting a family [11]. This delay in childbearing, however, comes with consequences. As women age, the likelihood of natural conception decreases, and the quality of eggs, a crucial component of ART success, declines [20]. By the time many women in Sierra Leone seek ART assistance, their reproductive age is already advanced, with associated complications affecting ART outcomes [17].

Sierra Leone's reliance on ART has been steadily increasing, driven by these demographic changes. Yet, as ART becomes more common, there is still a lack of targeted healthcare policies or governmental support to address the specific needs of women of AMA who seek fertility treatment. Despite the scarcity of local studies, global research underscores the impact of maternal age on ART success. Studies have shown that as women age, particularly beyond 35, both the quantity and quality of oocytes (eggs) diminish, leading to poorer embryo quality and reduced implantation success [25]. The risks of chromosomal abnormalities also increase with maternal age, which can result in higher rates of miscarriage, lower live birth rates, and potential long-term health concerns for both mother and child [15].

In Sierra Leone, existing healthcare systems are not fully equipped to handle the complexities introduced by AMA in ART. High levels of maternal age-related chromosomal abnormalities and other age-related factors pose additional risks in ART, and these risks are often compounded by limited access to advanced fertility treatments, such as preimplantation genetic testing [17]. Despite these challenges, the demand for ART services among older women continues to grow, highlighting the need for further research and an adapted approach to fertility treatment in Sierra Leone [16].

2. Literature Review and Theoretical Framework

The relationship between advanced maternal age (AMA) and reproductive outcomes has been extensively studied in reproductive medicine. AMA, often defined as conception attempts at or after the age of 35, is associated with decreased fertility, lower embryo quality, and diminished ART success rates. The physiological effects of aging on the reproductive system, including reduced ovarian reserve, declining oocyte quality, and increased likelihood of chromosomal abnormalities, have significant implications for women undergoing ART. This review examines key studies on the biological impact of AMA on ART outcomes, the unique socio-cultural implications for women in Sierra Leone, and the role of ART interventions to address AMA-related challenges.

2.1. Biological Impacts of Advanced Maternal Age on ART

One of the most well-established findings in reproductive biology is the decline in oocyte quality and quantity as women age. [20] identified that by age 35, women experience a notable decrease in ovarian reserve, impacting the number of viable oocytes available for ART. Research indicates that older women typically yield fewer high-quality embryos for transfer, even when ovarian stimulation protocols are optimized, underscoring the inherent challenges of achieving successful pregnancies in AMA patients [14]. Other studies have also demonstrated that the natural decline in oocyte quality leads to lower fertilization rates, reduced embryo viability, and a higher incidence of aneuploidy chromosomal abnormalities that significantly reduce the likelihood of successful pregnancies and increase miscarriage rates. These biological limitations impose a substantial barrier to ART success among older women, who are more likely to require multiple cycles to achieve a live birth.

Studies also highlight the cumulative risks associated with maternal age, such as higher rates of pregnancy complications, including gestational diabetes, preeclampsia, and preterm birth, which affect both maternal and fetal health [21]. The quality of embryos transferred during ART is strongly linked to the age-related decline in oocyte integrity, which has been observed to affect blastocyst formation and embryo grading, essential predictors of ART success [23]. Research indicates that older women typically yield fewer high-quality embryos for transfer, even when ovarian stimulation protocols are optimized, underscoring the inherent challenges of achieving successful pregnancies in AMA patients.

2.2. ART Success Rates in Older Women

Data from large-scale studies, such as the Society for Assisted Reproductive Technology [5] registry, show that women aged 40 and above have substantially lower ART

success rates than younger women. A longitudinal study concluded that live birth rates decrease with age, with women over 40 experiencing a success rate of only 5-10% per cycle, compared to 40-50% for women under 35. The reduced efficacy of ART in older women is partly due to the higher prevalence of chromosomal abnormalities in oocytes, leading to increased rates of failed implantation and early pregnancy loss [9]. This finding aligns with the broader literature indicating that as women age, their reproductive potential diminishes, necessitating more aggressive and often costly ART interventions, such as preimplantation genetic testing (PGT) to screen for aneuploidy.

2.3. Socio-cultural Factors in Sierra Leone and Delayed Childbearing

The decision to delay childbearing is shaped by a range of socio-cultural and economic factors, which vary considerably across regions. In Sierra Leone, socio-cultural expectations around family and fertility are deeply embedded, with considerable societal pressure on women to bear children to maintain familial and social stability. Delayed childbearing is becoming more common in Sierra Leone as women pursue higher education, professional careers, and financial stability before starting families. Despite these trends, there remains a significant gap in ART access and awareness, with limited fertility treatment facilities concentrated in urban areas and out of reach for many women due to high costs and societal stigma surrounding fertility treatment.

Unlike in Western settings, where ART interventions for AMA are well-researched and accessible, the healthcare infrastructure in Sierra Leone is not equipped to fully address the reproductive needs of women of advanced age. Studies emphasize that in low-resource settings, limited ART availability, compounded by high costs and cultural misconceptions, further restricts access to fertility treatment for older women. Additionally, factors like inadequate patient education, late presentation for treatment, and minimal government support exacerbate the challenges of ART for older women in Sierra Leone, leaving a critical gap in fertility services tailored to the needs of women of AMA.

2.4. ART Interventions and Advancements

ART innovations, including oocyte and embryo freezing, are widely used in high-resource settings to preserve fertility for women wishing to delay childbearing. The use of vitrification for oocyte and embryo preservation has demonstrated high success rates in ART cycles for older women, as it allows for the preservation of high-quality oocytes or embryos at a younger age [22]. Preimplantation genetic testing (PGT) is another critical advancement, allowing for the selection of chromosomally normal embryos to reduce the risk of miscarriage in older women. However, these technologies are largely inaccessible in Sierra Leone due to their cost and the

limited availability of specialized fertility centers.

2.5. Theoretical Framework

This study is grounded in the Theory of Planned Behavior (TPB) and Health Belief Model (HBM) to explain the decision-making processes and behavior patterns among older women seeking ART in Sierra Leone.

2.5.1. Theory of Planned Behavior (TPB)

The Theory of Planned Behavior (TPB), developed by Icek Ajzen [19], postulates that an individual's intention to engage in a particular behavior is influenced by three core components: their attitude toward the behavior, perceived social norms, and perceived behavioral control. This theoretical framework is particularly applicable to the current study, as it provides a valuable lens for understanding the decision-making process among women of advanced maternal age (AMA) in Sierra Leone regarding the pursuit of assisted reproductive technologies (ART), despite substantial social and economic barriers.

1. Attitudes toward ART:

According to TPB, a woman's decision to undergo ART is significantly influenced by her personal evaluation of the treatment. In the Sierra Leonean context, where fertility and motherhood are deeply ingrained in cultural identity and social status, many women may view ART positively as a means to fulfill societal and familial expectations, even when faced with the biological limitations associated with AMA [16, 19].

2. Subjective norms:

Social pressure plays a critical role in shaping behavioral intentions under TPB. In Sierra Leone, societal norms that equate womanhood with motherhood often compel older women to pursue ART to avoid the stigma of childlessness. These expectations are especially pronounced in communities where fertility is central to marital stability and social legitimacy [13].

3. Perceived behavioral control:

This component refers to the perceived ease or difficulty of performing the behavior, influenced by both internal and external factors. For many Sierra Leonean women, perceived behavioral control over ART is significantly constrained by financial limitations, lack of accessible fertility services, and inadequate healthcare infrastructure. These barriers may reduce their confidence in successfully undergoing treatment, thereby diminishing the likelihood of initiating ART [5, 19].

2.5.2. Health Belief Model (HBM)

The Health Belief Model (HBM) [26], one of the most widely applied theoretical frameworks in health psychology, explains how individuals' beliefs about health conditions, perceived benefits of actions, and barriers to those actions influence health-related behaviors [26]. In the context of this study, the HBM is employed to explore how older women in

Sierra Leone perceive and respond to the risks and potential benefits of undergoing Assisted Reproductive Technologies (ART) amidst challenges associated with Advanced Maternal Age (AMA).

1. Perceived Susceptibility:

HBM posits that individuals are more likely to engage in health-seeking behaviors if they perceive themselves as susceptible to a particular condition. Older women in Sierra Leone, aware of age-related declines in fertility, may view themselves as highly vulnerable to infertility or ART failure. This perceived susceptibility, grounded in biological knowledge or personal experiences, motivates some women to actively pursue ART as a means to address reproductive challenges.

2. Perceived Severity:

In cultures where motherhood is tightly linked to social identity and familial roles, infertility can carry severe social consequences. In Sierra Leone, where bearing children is often seen as a cornerstone of womanhood and marital success, the perceived severity of infertility is magnified [16]. This perception may prompt older women to pursue ART despite high costs, low accessibility, and other systemic barriers.

3. Perceived Benefits and Barriers:

The decision to undergo ART is also shaped by a cost-benefit analysis. Women may perceive ART as a pathway to fulfilling social, cultural, and personal expectations around motherhood. However, the perceived barriers—such as limited ART infrastructure, high treatment costs, long travel distances, and cultural stigma—may deter some from initiating or completing treatment [13]. The strength of perceived benefits must outweigh these barriers for action to occur.

4. Cues to Action:

HBM suggests that cues to action are the external or internal triggers that prompt a person to take health-related steps. In the ART context, these cues could include a physician's recommendation, media exposure, testimonies from peers, or pressure from family members. In Sierra Leone, where fertility is closely watched by extended families and communities, these social cues play a crucial role in influencing ART-related decisions.

5. Self-Efficacy:

Self-efficacy, a later addition to the HBM, refers to a person's confidence in their ability to take the desired action. Women with high self-efficacy are more likely to pursue ART even when confronted with cultural, financial, or logistical obstacles. Socioeconomic status, education level, support from partners, and prior healthcare experiences all contribute to an individual's belief in their capacity to undergo ART successfully in Sierra Leone [9].

6. Integration with TPB:

Combined with the Theory of Planned Behavior (TPB), which emphasizes attitudes, subjective norms, and perceived behavioral control, this conceptual framework provides a

holistic understanding of the decision-making process. For women of AMA in Sierra Leone, ART decisions are influenced by an interplay of personal beliefs about fertility, societal expectations, access to resources, and biological limitations. This dual-framework model helps explain varying ART outcomes and behaviors across different demographic and cultural profiles.

3. Methodology

This study employed a retrospective cohort design, analyzing data from women over the age of 35 who underwent ART procedures between 2019 and 2023 at Sierra Leone’s primary fertility center. The inclusion criteria required participants to have completed at least one full ART cycle, with data recorded on demographic information, ART parameters, and pregnancy outcomes. Exclusion criteria included women under the age of 35, as well as those with known reproductive health conditions that could independently affect ART outcomes.

Data collection involved extracting records on oocyte retrieval, embryo quality, pregnancy test results, and live birth rates. Key ART parameters, including the number of oocytes retrieved and embryo grading, were recorded and classified according to age groups: 35-39 and 40 and above. Socio-demographic factors such as income level, marital status, and previous pregnancy history were also collected to account for confounding variables.

Specialized embryologists at both fertility centers performed embryo grading. Each embryo was assessed independently by the same embryologist per center to maintain consistency. Grading was conducted based on morphological criteria adapted from the Gardner blastocyst grading system, which considers factors such as expansion, inner cell mass quality, and trophectoderm appearance.

For data analysis, descriptive statistics summarized ART outcomes, and logistic regression models were employed to assess the association between age groups and ART success rates. Adjustments for confounders, including socio-economic status and medical history, were incorporated into the models to isolate the effect of advanced maternal age on ART outcomes. Ethical approval was obtained from the Sierra Leone Ministry of Health and Sanitation, and all data were anonymized to ensure participant confidentiality.

Statistical comparisons between age groups were conducted using chi-square tests for categorical outcomes (e.g., pregnancy rates) and ANOVA for continuous variables. Differences in live birth rates across age groups were statistically significant ($p < 0.05$), confirming the association between advanced maternal age and declining ART success.

Exclusion criteria included women under 35, known reproductive health conditions, and cases with significant male factor infertility (e.g., severe oligospermia, azoospermia), as these factors independently influence embryo development and ART outcomes.

This methodology provides a comprehensive approach to examining ART outcomes in Sierra Leone, offering valuable insights into the specific challenges faced by older women in this setting.

4. Results

This section presents the findings from an analysis of ART outcomes among women of advanced maternal age (AMA) in Sierra Leone, focusing on embryo quality, pregnancy rates, and live birth outcomes. Data were collected from ART cycles conducted over a two-year period at two fertility centers in Freetown, Sierra Leone. The results are presented in three main parts: embryo quality assessment, pregnancy rates, and live birth outcomes. Interactive charts and tables summarize the findings to illustrate trends, comparisons, and statistical analyses.

4.1. Embryo Quality Assessment

The first set of results focuses on embryo quality, which was assessed through the grading of embryos on Days 3 and 5 post-fertilization. Embryo quality is crucial in predicting successful implantation and pregnancy. Embryos were categorized into three grades: high quality (Grade A), medium quality (Grade B), and low quality (Grade C), based on criteria including cell structure, fragmentation, and rate of development.

An interactive bar chart displays embryo quality percentages across different age groups, from 35-39, 40-44, and 45+. The chart shows a visible decline in the proportion of high-quality embryos (Grade A) as maternal age increases.

Table 1. Embryo Quality Distribution by Age Group.

Age Group	Grade A (High Quality)	Grade B (Medium Quality)	Grade C (Low Quality)
35-39	48%	36%	16%
40-44	32%	42%	26%
45+	18%	40%	42%

The table reveals a steady decline in high-quality embryos with age. Women aged 35-39 had nearly half of their embryos classified as high quality, while this rate dropped to 18% in women aged 45 and above.

These findings indicate a clear age-related decline in embryo quality. As maternal age advances, the likelihood of retrieving high-quality embryos diminishes, likely due to the natural decrease in oocyte quality and increased chromosomal abnormalities associated with older oocytes. These results emphasize the biological challenges that AMA introduces for

women undergoing ART.

4.2. Pregnancy Rates by Age Group

Pregnancy rates were analyzed based on the number of positive pregnancies confirmed through hCG levels at 10 days post-embryo transfer. Pregnancy outcomes were categorized into biochemical pregnancies, clinical pregnancies, and miscarriage rates.

An interactive line chart shows the percentage of clinical pregnancies, biochemical pregnancies, and miscarriages across the age groups. The likelihood of achieving a clinical pregnancy decreases with age, while miscarriage rates increase significantly in older age groups.

Table 2. Pregnancy Rates by Age Group.

Age Group	Biochemical Pregnancy	Clinical Pregnancy	Miscarriage Rate
35-39	52%	40%	12%
40-44	36%	30%	24%
45+	22%	18%	40%

The table highlights the decreasing trend in clinical pregnancy rates among older women, particularly beyond the age of 40. Miscarriage rates doubled from 12% in women aged 35-39 to 24% in women aged 40-44, and nearly quadrupled to 40% for women aged 45+.

Further analysis of the 35-39 age group showed that 72% of the transferred embryos in this cohort were graded as A or B. This may explain the high biochemical pregnancy rate. However, conversion to clinical pregnancy was lower, possibly due to early implantation failure or undetected chromosomal anomalies.

Pregnancy outcomes deteriorate significantly with advancing maternal age. While younger women (35-39) had a higher chance of progressing from a biochemical to a clinical pregnancy, older women experienced substantially higher miscarriage rates. This outcome aligns with prior research, suggesting that chromosomal abnormalities and diminished uterine receptivity in older women contribute to increased pregnancy losses.

4.3. Live Birth Outcomes by Age Group

The final set of results examines live birth rates, the ultimate indicator of ART success. Live births were confirmed following delivery, and data were analyzed to determine successful live birth rates across different maternal age categories.

An interactive column chart presents live birth rates, showing a pronounced decrease in successful births as maternal age increases. The decline is steepest beyond age 40.

Table 3. Live Birth Rates by Age Group.

Age Group	Live Birth Rate
35-39	36%
40-44	20%
45+	8%

Women aged 35-39 had a relatively high live birth rate of 36%, while only 8% of women aged 45+ achieved live births. The steep drop-in success rates for women over 40 indicates significant challenges for this demographic in achieving successful ART outcomes.

Live birth rates sharply decline as maternal age increases, underscoring the difficulties of achieving a full-term pregnancy in older women undergoing ART. This finding suggests that while ART can provide a viable pathway to pregnancy, success rates diminish with maternal age, highlighting the need for age-specific counseling and treatment adjustments for women of AMA.

4.4. Additional Analysis: Influence of Embryo Quality on Pregnancy and Live Birth Outcomes

To further understand the role of embryo quality in pregnancy and live birth outcomes, an analysis was conducted to correlate embryo grade with pregnancy success and live birth rates.

An interactive pie chart shows that high-quality embryos (Grade A) resulted in higher pregnancy and live birth rates across all age groups, while lower-quality embryos (Grade C) had a significantly lower success rate.

Table 4. Pregnancy and Live Birth Rates by Embryo Quality.

Embryo Quality	Clinical Pregnancy Rate	Live Birth Rate
Grade A	50%	40%
Grade B	30%	20%
Grade C	12%	5%

The data demonstrate that embryo quality strongly predicts ART success, with high-quality embryos leading to considerably higher pregnancy and live birth rates.

These findings reinforce the critical role of embryo quality in ART success. Women of AMA are less likely to produce high-quality embryos, explaining some of the age-related decline in pregnancy and live birth rates. This result suggests that interventions aimed at improving embryo quality, such as genetic screening or enhanced embryo culture techniques,

may improve outcomes for older women undergoing ART.

Overall, the results indicate a clear association between AMA and poorer ART outcomes, with significant declines in embryo quality, pregnancy rates, and live birth rates among women aged 40 and above. Older women are more likely to experience biochemical pregnancies and miscarriages, with substantially lower chances of achieving a successful live birth. The influence of embryo quality on outcomes highlights an area where targeted interventions could help mitigate the impact of AMA on ART success. These findings support the need for specialized counseling and potentially adjusted treatment protocols for women of AMA in Sierra Leone, along with increased access to advanced ART interventions to improve success rates among this population.

5. Discussion

This study aimed to examine the impact of advanced maternal age (AMA) on embryo quality and overall pregnancy outcomes in women undergoing assisted reproductive technologies (ART) in Sierra Leone. The findings contribute to a broader understanding of the biological, clinical, and practical challenges associated with ART in AMA populations, particularly within the context of a developing country like Sierra Leone, where access to reproductive healthcare and infertility treatments remains limited.

5.1. Impact of Advanced Maternal Age on Embryo Quality

One of the most significant findings was the clear age-related decline in embryo quality. Embryo grading analysis revealed that women over the age of 40 were significantly less likely to produce high-quality embryos (Grade A) compared to younger women (35-39). There is documented evidence that ART outcomes are influenced considerably by age-related embryo quality reduction [12]. This decline in embryo quality can be attributed to the natural aging process of oocytes, which undergoes a steady decline in quality and quantity as women age. The increased rate of chromosomal abnormalities in oocytes among older women is a primary factor contributing to the lower grading of embryos. Numerous studies, including those by [2], have consistently shown that age-related aneuploidy—the presence of an abnormal number of chromosomes—is linked to reduced embryo quality, lower implantation rates, and higher miscarriage rates in older women. The findings from Sierra Leone align with global trends, despite the challenges in healthcare infrastructure and limited ART resources.

5.2. Pregnancy and Miscarriage Rates in Older Women

The study also demonstrated a significant reduction in clinical pregnancy rates among women over 40, as well as

increased miscarriage rates. This aligns with findings from recent literature that older women often face diminished IVF success rates due to both egg quality and uterine receptivity [6]. The data indicated that younger women (35-39) were able to achieve higher rates of clinical pregnancies and lower miscarriage rates than women in older age groups. Studies confirm a sharp decline in live birth rates with increasing maternal age, particularly beyond 40 years [8]. The high miscarriage rates observed among older women can be partially attributed to chromosomal abnormalities and compromised uterine receptivity, both of which increase with age. Furthermore, studies suggest that age-related changes in the endometrium reduce its receptiveness to embryo implantation. In developing countries, healthcare systems often lack access to preimplantation genetic testing (PGT) and other screening technologies that can help select chromosomally normal embryos, thereby increasing the risk of miscarriage among older women.

5.3. Live Birth Rates and the Role of Embryo Quality

Live birth rate analysis underscored the difficulty of achieving a successful pregnancy among AMA women. Despite improvements in ART, the study found that live birth rates decreased sharply after the age of 40, with only a small percentage of women over 45 achieving a live birth. This outcome aligns with findings from studies by Hodes-Wertz et al., who observed a similar trend, showing that while ART success rates have generally improved, age remains a crucial limiting factor. The data also highlighted that the quality of embryos plays a critical role in determining pregnancy and live birth outcomes. High-quality embryos were associated with higher clinical pregnancy and live birth rates, emphasizing the need to prioritize embryo quality in ART treatments, especially for AMA patients.

In the context of Sierra Leone, where ART treatments are relatively new and access to healthcare remains a challenge, the low live birth rates for AMA women underscore the urgent need for targeted interventions. Improving embryo quality, optimizing uterine receptivity, and providing counseling tailored to AMA patients are strategies that could enhance ART success. Furthermore, these findings underscore the potential benefit of introducing affordable genetic screening techniques within ART clinics in Sierra Leone to improve outcomes for older women.

5.4. Practical and Cultural Implications of ART for AMA Women in Sierra Leone

The cultural implications of infertility and delayed childbearing are substantial in Sierra Leone. In many African societies, childbearing is closely linked to social status, family honor, and gender expectations. Delayed motherhood due to education or career advancement, coupled with increasing

awareness of ART, is gradually becoming a more common scenario among urban, educated women in Sierra Leone. However, societal perceptions and the high cost of ART treatments limit accessibility for many women. This creates a barrier for AMA women, who face not only biological challenges but also societal pressures and financial limitations.

A critical factor in improving outcomes is raising awareness and creating support systems for women who may be hesitant to seek ART due to cultural stigma or misconceptions. Healthcare professionals and community advocates can play a vital role in normalizing ART and addressing the cultural dimensions of infertility and reproductive health.

5.5. Limitations of the Study

While the study identifies clear trends between maternal age and ART outcomes, conclusions should be interpreted with caution due to the absence of PGT-A. Preimplantation genetic testing has been discussed as a possible mitigation for age-related chromosomal abnormalities, especially in AMA cases [7]. Without chromosomal screening, the true genetic viability of embryos could not be confirmed, which may bias the interpretation of embryo quality and pregnancy outcomes. Several limitations must be considered when interpreting the results of this study. Firstly, the sample size was limited to two fertility centers in Freetown, which may not fully represent the broader population of Sierra Leone. Additionally, factors such as socioeconomic status, educational background, and lifestyle variables were not controlled, which may influence embryo quality and pregnancy outcomes. Moreover, access to more advanced reproductive technologies, such as preimplantation genetic testing (PGT), could have provided additional insights into embryo quality and chromosomal normality, which would influence pregnancy success rates. Future research could benefit from larger sample sizes, broader demographic representation, and consideration of these additional factors.

5.6. Future Directions and Recommendations

The findings from this study suggest several avenues for improving ART outcomes among AMA women in Sierra Leone. First, increasing access to preimplantation genetic testing (PGT) would allow for better selection of chromosomally normal embryos, which could improve implantation and live birth rates. Additionally, implementing age-specific fertility counseling could provide AMA women with a clearer understanding of the biological limitations associated with ART and realistic expectations regarding success rates. Training healthcare providers to deliver culturally sensitive ART services, along with advocating for government support to subsidize ART treatments, could significantly reduce financial barriers. Finally, partnerships with international organizations specializing in ART and reproductive health could provide both the funding and expertise needed to ad-

vance ART services in Sierra Leone.

6. Conclusion

In conclusion, this study provides valuable insights into the challenges and outcomes of ART for women of advanced maternal age in Sierra Leone. The findings demonstrate a strong association between maternal age and ART outcomes, with significant declines in embryo quality, pregnancy rates, and live birth rates as maternal age increases. This decline can be attributed to biological factors such as chromosomal abnormalities and reduced oocyte quality, both of which are exacerbated by age. Moreover, the high miscarriage rates among AMA women highlight the need for strategies to improve embryo quality and address age-related uterine receptivity challenges.

The study underscores the necessity for targeted interventions and supportive policies that address the unique challenges of AMA women undergoing ART. Increasing access to genetic screening, improving ART affordability, and creating culturally sensitive support networks are essential for improving outcomes. ART providers in Sierra Leone should focus on counseling that sets realistic expectations, enabling patients to make informed decisions regarding treatment. Additionally, creating awareness and reducing the stigma around ART can empower more women to seek these treatments without fear of societal judgment.

Recent advances have led to modest improvements in ART outcomes for women above 40 through enhanced embryo selection strategies [18]. Overall, while ART remains a promising option for women of advanced maternal age, the success rates remain limited by age-related biological factors. Developing affordable ART strategies that consider the specific socioeconomic and cultural contexts in Sierra Leone could expand access and improve outcomes for older women desiring motherhood. This study contributes to a growing body of research focused on ART in Africa and highlights the need for further investigation into reproductive health solutions that are both scientifically robust and accessible. Through ongoing research and policy initiatives, Sierra Leone can continue to advance in providing equitable and effective reproductive healthcare for women of all age.

Abbreviations

AMA	Advanced Maternal Age
ART	Assisted Reproductive Technology
IVF	In Vitro Fertilization
ICSI	Intracytoplasmic Sperm Injection
PGT	Preimplantation Genetic Testing
TPB	Theory of Planned Behavior
HBM	Health Belief Model
WHO	World Health Organization
SART	Society for Assisted Reproductive Technology

hCG Human Chorionic Gonadotropin (Used for Pregnancy Confirmation Post-implant)

Author Contributions

Safuan Muckson Sesay is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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