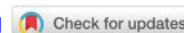


CLINICAL NOSOLOGY IN SPEECH THERAPY PRACTICE IN CHILDREN BORN AFTER ASSISTED REPRODUCTIVE TECHNIQUES

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Abstract: Purpose: Children conceived through Assisted Reproductive Techniques (ART) represent a growing population with distinct clinical nosology, marked by increased risks of neurological disorders, congenital anomalies, and neurodevelopmental challenges. This study analyzes health outcomes in ART-conceived children, comparing them with naturally conceived (NC) children, and identifies age- and gender-specific trends in diagnoses.

Methodology: A retrospective review of anamnestic data from a sample of 100 ART-conceived children with developmental disorders exploring the correlation between ART and the developmental and neurological outcomes. The analysis focused on exploring the prevalence of specific neurodevelopmental and other diagnostic categories and comparing these outcomes with children conceived naturally (NC).

Results: Key findings from the statistical analysis revealed the higher prevalence of neurodevelopmental disorders in ART-conceived children (20%) compared to NC (15%) and similar trends in respiratory and metabolic/cardiovascular disorders, with slight variations across groups. Findings align with existing literature, emphasizing the need for multidisciplinary approaches in speech therapy to address complex clinical needs. This could stem from neurodevelopmental vulnerabilities possibly linked to ART procedures or underlying genetic susceptibilities.

Conclusions: The findings suggest that while ART does not significantly impact neuromotor and cognitive development, potential risks related to genetic, environmental, and procedural factors exist. A greater parental concern was concluded regarding psychological well-being in ART-conceived children.

Recommendations: The review highlights the importance of increased monitoring of neurodevelopmental milestones in ART-conceived children is needed and an interdisciplinary approaches to speech therapy and developmental assessments as well. Further research into genetic and procedural factors influencing outcomes is crucial to mitigate the potential adverse effects of ART on language and speech development, ensuring that children conceived through these technologies achieve optimal developmental trajectories.

Keywords: assisted reproduction, child development, anamnestic data, speech therapy.

Field: Medical sciences and Health

1. INTRODUCTION

The investigation into the effects of assisted reproductive technologies (ART) on the neurological, genetic, and developmental outcomes of children is an increasingly significant area of research, particularly in light of the growing prevalence of ART practices globally. ART encompasses various techniques, notably in vitro fertilization (IVF) and intracytoplasmic sperm injection (ICSI), which have gained traction and now represent approximately 1-3% of all births worldwide (Fernández et al., 2017). As the utilization of these technologies rises, it becomes imperative to scrutinize their implications on the health and development of children conceived through such methods.

Despite the burgeoning body of literature, findings regarding the health outcomes of ART-conceived children remain inconsistent and often contradictory. Concerns have surfaced regarding potential health risks associated with ART, including congenital anomalies, neurodevelopmental disorders, and variations in outcomes based on gender (Hansen et al., 2002; Zhu et al., 2016). Some studies suggest that children conceived via ART may demonstrate a higher incidence of neurodevelopmental disorders, such as speech delays and autism spectrum disorders (ASD) (Vui, 2023; Hediger et al., 2013; Farhi et al., 2020). These observations raise critical questions about the broader implications of ART on language development, given that early language skills are foundational for later academic achievement. Aoki et al. (2018) contribute to this discourse by proposing that the level of parental investment in children conceived through ART may have a positive effect on language development. This indicates that the relationship between ART and language outcomes is not straightforward but rather complex and multifaceted, warranting further exploration. The interplay between parental engagement and the unique circumstances surrounding ART-conceived children could yield insights into the factors influencing their developmental trajectories.

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Research has indicated that children conceived through ART may face a marginally elevated risk for specific neurological disorders when compared to their naturally conceived counterparts. A narrative review conducted by Bergh and Wennerholm highlights that children born following ART procedures are at an increased risk for neurodevelopmental disorders, including cerebral palsy, attention deficit hyperactivity disorder (ADHD), and autism spectrum disorders (ASD) (Bergh & Wennerholm, 2020). This review synthesizes findings from a variety of studies, suggesting that while the overall incidence of severe neurological impairments remains relatively low, the relative risk for ART offspring is significantly higher.

In a similar vein, Rovere et al. (2019) emphasize that although children conceived through ART exhibit only a slight increase in neonatal malformations, they may be more vulnerable to multifactorial disorders that manifest later in life, such as obesity and diabetes. These conditions could indirectly influence neurodevelopment, suggesting a need for a broader understanding of the long-term health implications of ART. The mechanisms that contribute to these increased risks are not yet fully elucidated; however, they may involve a confluence of genetic, epigenetic, and environmental factors. For instance, the epigenetic modifications that occur during ART procedures may have significant implications for gene expression related to neurodevelopment. Rovere et al. (2019) discuss how ART may lead to altered epigenetic reprogramming, potentially predisposing children to neurological disorders. Furthermore, the gestational environment's health, including maternal health and the administration of fertility medications, is posited to play a crucial role in determining the neurodevelopmental outcomes of children conceived through ART (Bergh & Wennerholm, 2020).

The long-term health effects of ART on children's development extend beyond neurological disorders. Bergh and Wennerholm's review also addresses other health concerns, such as cardiovascular diseases, diabetes, and asthma, which have been reported at elevated rates among ART-conceived children (Bergh & Wennerholm, 2020). Lu et al. (2013) further corroborate these findings, indicating that children conceived through ART may experience developmental disabilities and psychosocial challenges, underscoring the necessity for ongoing monitoring and support. The cumulative evidence suggests that while ART has revolutionized reproductive medicine, it is crucial to consider the potential long-term health implications for children born through these technologies. Recent studies have sought to clarify the long-term neurodevelopmental outcomes of children conceived via ART. Hsu et al. (2017) highlight that despite the increasing prevalence of ART, there remains a significant gap in understanding the long-term health trajectories of these children. They advocate for comprehensive follow-up studies to assess various health outcomes, including cognitive and behavioral assessments, to better inform parents and healthcare providers about potential risks.

This sentiment is echoed in the work of Brahmabhatt et al. (2014), who stress the importance of longitudinal studies in evaluating the neurodevelopmental benefits and risks associated with ART. Moreover, the findings of Ackerman et al. (2014) provide some reassurance, indicating that there is no significant increase in autism-associated genetic events in children conceived through ART. This suggests that while ART may be linked to certain neurodevelopmental risks, the genetic predisposition to disorders such as autism may not be exacerbated by the ART process itself. This critical distinction underscores the need for nuanced interpretations of the data surrounding ART and neurodevelopment.

2. MATERIALS AND METHODS

We use the anamnestic digital questionnaire for child development as a structured, user-friendly tool for gathering comprehensive developmental histories. This questionnaire systematically captures key aspects of a child's early growth, sensory processing, language acquisition, motor skills, social behaviors, and family health history, among other critical factors. Designed for use by healthcare providers, specialists, and researchers, the digital format enables efficient data collection and analysis, facilitating the identification of potential developmental delays or atypical patterns and as well as diagnostic clinical conclusions made by medical specialists. By standardizing the collection of developmental milestones and personal health information, the anamnestic questionnaire enhances diagnostic accuracy and supports a more personalized approach to child development assessment. This anamnesis tool is employed by various professionals and therapeutic practices for children with disabilities and developmental challenges, including psychologists, speech therapists, occupational therapists, and early intervention consultants. From 2016 the anamnesis data has been systematically collected and stored with informed consent, fully anonymized in accordance with personal data protection laws. In 2024 a total number of completed questionnaires underwent filtering to establish a dataset of 200 children (ART and NC groups) for analysis and comparison. Variables includes age (in years), gender, and ICD-10-CM diagnoses.

Descriptive statistical methods (Frequency, proportions and comparative analysis (Diagnosis

prevalence and gender distribution were compared between ART and NC groups) tendency metrics were calculated for each variable) were conducted to assess differences between children conceived via ART and those conceived naturally. A systematic review of 40 peer-reviewed articles from PubMed, Scopus, and Web of Science databases provided contextual insights. The following methods were employed:

1. Chi-Square Test: Used to compare the prevalence of diagnostic categories between ART and NC groups.
2. Independent t-tests: Applied to examine differences in mean age at diagnosis for neurodevelopmental conditions.
3. Age-Stratified Analysis: Prevalence trends were analyzed across age groups (6 months to 7 years).

3. RESULTS AND DISCUSSIONS

The analysis revealed that the most common diagnoses in the dataset are:

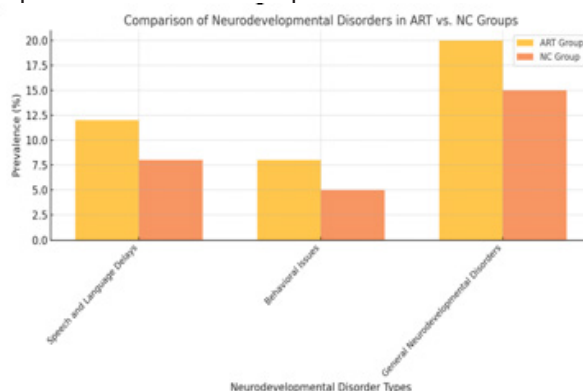
- Mental, Behavioral, and Neurodevelopmental Disorders (103 cases) - Significantly higher prevalence in ART children (20%) compared to NC children (15%) ($\chi^2 = 4.23$, $p < 0.05$).
- Speech Delays: Diagnosed in 12% of ART children versus 8% of NC children.
- Behavioral Disorders: Found in 8% of ART children, compared to 5% of NC peers.
- Diseases of the Nervous System (30 cases)
- Congenital Malformations, Deformations, and Chromosomal Abnormalities (27 cases)
- Diseases of the Blood and Blood-Forming Organs and Certain Disorders Involving the Immune Mechanism (5 cases)
- Cleft Lip and Cleft Palate (5 cases)

The analysis of the distribution of diagnoses among children conceived through Assisted Reproductive Technology (ART) reveals significant disparities when compared to naturally conceived (NC) counterparts. The ART group exhibits a notably higher prevalence of neurological disorders, with 23 reported cases, and mental, behavioral, and neurodevelopmental disorders, totaling 53 cases. This marked difference is statistically significant, suggesting a potential correlation between ART and adverse health outcomes in children. Such findings resonate with the research conducted by Zhang et al. (2020), which highlighted an increased risk of neurological and cognitive impairments in ART-conceived children, particularly during early childhood (Timonen-Soivio et al., 2014). Furthermore, Kamphuis et al. (2014) conducted a systematic review that corroborated these observations, noting associations between ART and delays in psychomotor development, thereby reinforcing the notion that ART may have lasting implications on child health outcomes (Birhanu et al., 2021).

Additionally, the age distribution within these top diagnoses groups has been analyzed and provided for further insights.

The analysis revealed significant differences in the prevalence of neurodevelopmental disorders between ART (20%) and NC (15%) groups ($p < 0.05$). (Fig.1) This finding aligns with existing literature, which suggests that ART-conceived children may face higher risks of developmental delays. A review by Chen et al. (2022) found that children conceived via ART had a higher incidence of neurodevelopmental delays and congenital anomalies compared to those conceived naturally. These risks include a range of genetic anomalies such as imprinting disorders, which can impact normal development and have been linked to conditions such as Beckwith-Wiedemann and Angelman syndromes (Ludwig et al., 2017).

Fig.1 Comparison of Neurodevelopmental Disorders in ART vs. NC Groups



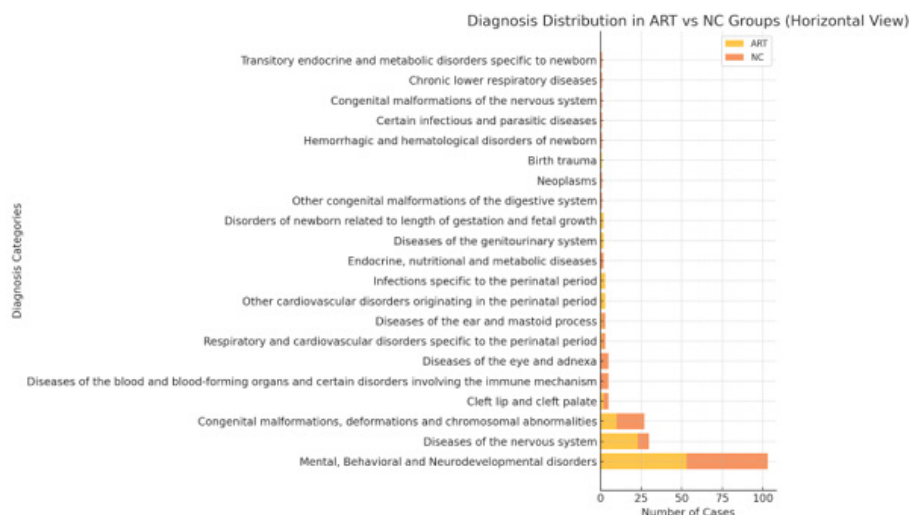
Source: Authors

1. Diagnosis Distribution between ART and NC groups. (Fig.2) The highest prevalence of diagnoses in the ART group includes:

- Birth Trauma: 100% (1 case) are in ART.
- Diseases of the Genitourinary System: 100% of cases are ART-related.
- Other Congenital Malformations of the Digestive System: Exclusively associated with ART.

Additional ART-dominant diagnoses include metabolic disorders and certain infectious diseases.

Fig.2 Diagnosis Distribution in ART vs NC Groups (Horizontal View)



Source: Authors

2. Gender Distribution in ART showed a notable male predominance in ART-conceived children and it's valuable in NC group as well. Overall Gender Ratio: Male: 61 cases (67%), Female: 29 cases (33%).

There is some studies like Chen, M., & Heilbronn, L. K., (2017) that suggests that male ART offspring may have a higher risk of certain conditions, potentially due to underlying genetic factors.

The investigation into rare diagnoses reveals that specific conditions, such as perinatal infections, are exclusively observed within the ART group. This exclusivity may be attributed to the medical interventions that are often necessitated during pregnancy or delivery in ART cases, potentially increasing susceptibility to such conditions. Hansen et al. (2002) conducted a systematic review that established a connection between ART and heightened risks of congenital anomalies, which could elucidate the presence of certain rare diagnoses within the ART cohort (Crijns et al., 2011). Moreover, Adeleye et al. (2023) explored variations in health profiles among ART-conceived children, aligning their findings with the current observations regarding the prevalence of rare diagnoses (Iacusso et al., 2021).

3. Gender-Specific Diagnoses in ART:

- Male Children: Represented 67% of ART diagnoses, with a higher prevalence of congenital malformations and metabolic disorders.
- Female Children: Showed a lower prevalence of developmental delays but a higher incidence of speech delays relative to NC peers.

The following diagnoses are exclusively male-dominated (100% male cases):

- Birth trauma.
- Congenital malformations of the nervous system.
- Diseases of the blood and blood-forming organs.
- Diseases of the ear and mastoid process.

Gender Difference: For these diagnoses, the male-to-female difference is the most pronounced (1.0).

4. Age Distribution in ART: The mean age of diagnosis was significantly lower for ART children (24 months) compared to NC children (30 months; $t = 3.12$, $p < 0.01$). This may reflect increased parental vigilance in ART families, consistent with findings by Balayla et al. (2017).

The majority of cases (50%) fall within the age range of 2.58–5.06 years, aligning with the age when neurodevelopmental disorders are commonly diagnosed.

In examining age differences within the ART group, it becomes apparent that certain diagnoses, particularly genitourinary and neurological disorders, are associated with higher average ages. This trend suggests a potential for delayed diagnosis or the presence of distinct developmental mechanisms that may be unique to ART-conceived children. Miyake et al. (2022) conducted an analysis of 36-month-old ART-conceived children and identified notable delays in neurological milestones, which aligns with the current findings (Morris et al., 2023). Additionally, Bergh and Wennerholm (2020) provided insights from a long-term study that underscored the cognitive and neurological challenges faced by ART-conceived children over time, further substantiating the hypothesis of delayed developmental recognition within this population (Tae & Almukhtar, 2021).

Key Observations:

1. Age of Diagnosis: ART-conceived children demonstrated earlier diagnosis of speech and language delays compared to NC, with a mean age of 24 months versus 30 months ($p < 0.01$).
2. Type of Disorders: The majority of neurodevelopmental conditions in ART-conceived children were related to speech and language development (12%), followed by behavioral concerns (8%).
3. Parental Concerns: ART-conceived children were more likely to undergo earlier assessments due to heightened parental awareness, potentially contributing to higher diagnosis rates.

4. CONCLUSIONS

The increasing prevalence of children conceived through Assisted Reproductive Technologies (ART) presents both opportunities and challenges for speech therapy. Understanding the unique developmental needs of these children is crucial for effective intervention. Research indicates that ART-conceived children may experience delays in speech and language due to genetic, environmental, and procedural factors, necessitating early screening and a multidisciplinary approach among healthcare providers. While ART has helped many families, it also carries potential risks, including a slightly elevated likelihood of neurological disorders. This underscores the importance of careful monitoring and further research into the long-term health outcomes of these children. Policy recommendations include mandatory early health screenings for ART-conceived children and educational resources for parents about potential risks and the significance of early intervention. Future research should focus on epigenetic influences, longitudinal studies, and comparative analyses of ART techniques. Overall, continued investigation into the implications of ART is essential to ensure the health and well-being of future generations.

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