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CHILDREN BORN AFTER ASSISTED REPRODUCTIVE TECHNOLOGIES: EVIDENCE FROM SPEECH-LANGUAGE THERAPY PRACTICE

CRIANÇAS NASCIDAS APÓS TECNOLOGIAS DE REPRODUÇÃO ASSISTIDA: EVIDÊNCIAS DA PRÁTICA DA TERAPIA DA FALA E DA LÍNGUA

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Abstract
Assisted reproductive technologies (ART) have been increasingly used worldwide over the past decades, raising sustained interest in their potential implications for child development beyond perinatal outcomes. While medical risks associated with ART have been extensively examined, evidence regarding early functional development in real-world clinical contexts remains limited. The present study explores developmental characteristics and referral patterns among children conceived through ART in comparison with naturally conceived peers, using data derived from outpatient speech-language therapy practice. A retrospective descriptive analysis was conducted on 1,661 anonymized anamnestic records collected over a six-year period through a standardized web-based questionnaire completed by caregivers prior to developmental consultation. Children were grouped according to conception method (ART versus natural conception), and descriptive statistical methods were applied to examine demographic characteristics, referral age, developmental milestones, and parent-reported clinical information. Children conceived via ART accounted for 23.2% of the sample. In both groups, referrals were most frequent between 2 and 5 years of age and showed a consistent male predominance. ART-conceived children were referred at a slightly younger age; however, no

Resumo
As tecnologias de reprodução assistida (TRA) têm sido cada vez mais utilizadas em todo o mundo nas últimas décadas, suscitando um interesse sustentado nas suas potenciais implicações para o desenvolvimento infantil para além dos resultados perinatais. Embora os riscos médicos associados às TRA tenham sido amplamente examinados, as evidências relativas ao desenvolvimento funcional precoce em contextos clínicos reais continuam a ser limitadas. O presente estudo explora as características de desenvolvimento e os padrões de encaminhamento entre crianças concebidas através de TRA em comparação com pares concebidos naturalmente, utilizando dados derivados da prática de terapia da fala e linguagem em regime ambulatório. Foi realizada uma análise descritiva retrospectiva de 1.661 registros anamnésicos anônimos coletados ao longo de um período de seis anos por meio de um questionário padronizado online preenchido pelos cuidadores antes da consulta de desenvolvimento. As crianças foram agrupadas de acordo com o método de concepção (ART versus concepção natural) e métodos estatísticos descritivos foram aplicados para examinar características demográficas, idade de encaminhamento, marcos de desenvolvimento e informações clínicas relatadas pelos pais.

clinically meaningful differences were identified between groups in early motor, communicative, or regulatory developmental milestones. A higher proportion of positive family history of hereditary conditions was observed in the ART group. These findings indicate that ART, as a method of conception, is not independently associated with adverse early developmental outcomes and support the use of inclusive, function-oriented developmental monitoring frameworks relevant to clinical practice and public health policy.

Keywords: Assisted Reproductive Technologies, Child Development, Speech-Language Therapy, Early Regulation, Preventive Monitoring.

As crianças concebidas por meio de ART representaram 23,2% da amostra. Em ambos os grupos, os encaminhamentos foram mais frequentes entre 2 e 5 anos de idade e mostraram uma predominância consistente do sexo masculino. As crianças concebidas por ART foram encaminhadas em uma idade ligeiramente mais jovem; no entanto, não foram identificadas diferenças clinicamente significativas entre os grupos nos marcos do desenvolvimento motor, comunicativo ou regulatório precoce. Uma proporção maior de histórico familiar positivo de doenças hereditárias foi observada no grupo ART. Esses achados indicam que a TRA, como método de concepção, não está associada de forma independente a resultados adversos no desenvolvimento inicial e apoiam o uso de estruturas de monitoramento do desenvolvimento inclusivas e orientadas para a função, relevantes para a prática clínica e as políticas de saúde pública.

Palavras-chave: *Tecnologias de Reprodução Assistida. Desenvolvimento Infantil. Terapia da Fala e Linguagem. Regulação Precoce. Monitoramento Preventivo.*

1 INTRODUCTION

Over the past five decades, assisted reproductive technologies (ART) have profoundly transformed reproductive medicine and family formation. As outlined by Gardner, Weissman and Howles (2018), advances in assisted reproduction have enabled millions of individuals and couples to achieve parenthood, contributing to a steady increase in ART-conceived births worldwide. Population-based surveillance data further confirm this global trend (Sunderam *et al*., 2017).

As the prevalence of ART continues to rise, increasing attention has been directed toward understanding not only perinatal and obstetric outcomes, but also the longer-term developmental trajectories of children conceived through these technologies. Large-scale cohort studies generally indicate that children conceived via ART demonstrate cognitive, motor, and communicative development comparable to that of naturally conceived peers. However, as emphasized by Bergh and Wennerholm (2020), these findings should be interpreted in relation to specific perinatal and contextual factors rather than ART procedures per se. Similarly, Pinborg, Wennerholm and Bergh (2023) note that developmental differences observed in early childhood are more strongly associated with

prematurity, birth weight, and obstetric variables than with the use of assisted reproductive technologies.

Despite the overall reassuring evidence, the literature consistently highlights the importance of ongoing developmental monitoring, particularly in domains reliant on early neurobiological regulation, such as communication, sensorimotor integration, and psychomotor development (Balayla *et al*., 2017; Hann *et al*., 2018; Sutcliffe *et al*., 2014). These domains form the foundation for later language acquisition, learning, and social participation, underscoring their relevance within preventive and public health–oriented frameworks.

From the perspective of speech-language therapy and related developmental professions, early identification of regulatory and communicative vulnerabilities plays a central role in prevention, timely intervention, and family guidance. In outpatient clinical and community-based practice, anamnestic data obtained from caregivers constitute a key source of information for understanding early developmental patterns, contextual risk factors, and functional difficulties that may not be immediately evident during structured assessment sessions. As demonstrated by Stern *et al*. (2016), systematically collected self-reported parental data can provide reliable insights into reproductive history and early developmental trajectories, particularly when integrated into digitally structured databases.

In recent years, growing interest has emerged in examining ART-related developmental outcomes within real-world clinical and outpatient settings, complementing findings from registry-based and epidemiological studies. Particular attention has been directed toward early regulatory processes, communicative development, and sensorimotor organization, which are foundational for later language and learning outcomes (Novakovic *et al*., 2019; DeAngelis; Martini; Owen, 2018). Although current evidence does not support deterministic associations between ART and adverse developmental outcomes, Pinborg *et al*. (2015) and Iliadou, Janson and Cnattingius (2011) highlight the relevance of epigenetic and imprinting-related mechanisms that may influence early developmental regulation in a subset of children. These findings support developmentally sensitive monitoring approaches rather than pathologizing assumptions regarding ART-conceived children.

Against this background, the present study analyzes a large, digitally organized anamnestic database derived from outpatient speech-language therapy and developmental

consultation practices. By comparing children conceived via assisted reproductive technologies with those conceived naturally, the study aims to identify developmental characteristics, referral patterns, and potential risk markers relevant to early regulation, communication, and psychomotor development. The findings are discussed within a preventive and public health–oriented framework, emphasizing implications for interdisciplinary monitoring, early intervention planning, and child development policies in the context of assisted reproduction.

2 MATERIALS AND METHODS

2.1. Study design

The present study employed a retrospective, descriptive observational design based on secondary analysis of anonymized anamnestic data. The dataset was derived from outpatient speech-language therapy and developmental consultation practices and was collected using a standardized, web-based questionnaire. The study design aimed to identify developmental characteristics and referral patterns in children conceived via assisted reproductive technologies (ART) compared to those conceived naturally.

2.2 Data source and ethical considerations

Anamnestic data were collected over a six-year period through a digital platform designed for use by trained speech-language therapists and developmental specialists. All data were obtained with informed parental consent and were fully anonymized prior to analysis, in accordance with applicable data protection regulations and ethical standards for research involving human participants.

The questionnaire was completed by caregivers prior to the initial consultation and covered multiple domains of early development, including pregnancy and birth history, early regulatory behaviors, communication, play, feeding, sensorimotor development, and psychomotor milestones. The use of digitally structured anamnestic instruments enabled systematic data aggregation and reduced variability associated with unstructured clinical interviews.

2.3 Variables and measures

The anamnestic questionnaire comprised approximately 250 items organized into 80 questions, including single-choice, multiple-choice, Likert-scale, and open-ended response formats. For the purposes of the present analysis, selected variables were grouped into the following domains:

- Demographic characteristics: child age and sex;
- Conception method: ART versus natural conception;
- Clinical information: parent-reported diagnoses and hereditary conditions;
- Early developmental milestones: age of attainment for key motor, communicative, and regulatory behaviors;
- Regulatory and sensorimotor indicators: sleep, feeding, communication, and early interaction patterns.

Age-related developmental milestones were operationalized using predefined age ranges corresponding to widely accepted developmental norms. Milestone attainment was categorized into four levels based on age-related expectations reported in the anamnestic questionnaire:

(1) typical (achievement within the expected age range),

(2) at risk (achievement within an extended age range or with emerging difficulties),

(3) delayed (achievement beyond the expected age range), and

(4) not yet achieved at the time of referral.

Open-ended responses related to clinical diagnoses and hereditary conditions were manually reviewed and categorized into predefined diagnostic groups to ensure consistency across records.

2.4 Data processing and statistical analysis

As of April 2023, the database contained 2,017 successfully completed questionnaires. After applying inclusion criteria and data quality checks, 1,661 records were retained for analysis. Records for children older than 13 years were excluded. Data preprocessing included verification of numerical fields, manual review of text-based entries, and categorical harmonization of key variables. Descriptive statistical analyses

were conducted to summarize distributions across demographic characteristics, conception method, and developmental indicators.

Results were presented using absolute frequencies, percentages, and graphical visualizations. Comparative analyses focused on identifying patterns and trends rather than inferential statistical testing, in line with the descriptive and exploratory nature of the study.

All analyses were conducted using standard statistical procedures appropriate for observational descriptive research.

3 RESULTS

3.1 Sample characteristics and grouping

Following application of the inclusion criteria, a total of 1,661 anamnestic records were included in the final analysis. Sample characteristics by conception method are presented in Table 1.

Table 1

Sample characteristics by conception method (n = 1,661)

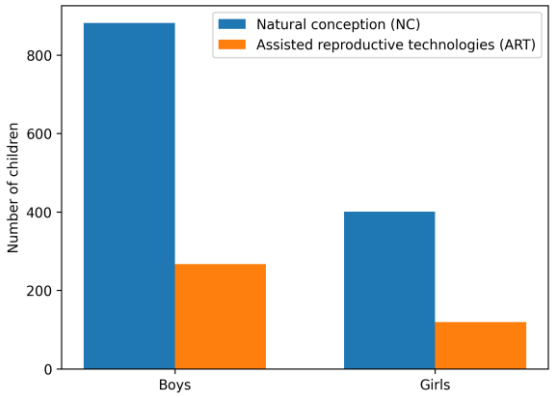
Characteristic	ART (n = 386)	Natural conception (NC) (n = 1,275)	Total (n = 1,661)
Sex			
Boys, n (%)	269 (69.7)	874 (68.5)	1,143 (68.8)
Girls, n (%)	117 (30.3)	401 (31.5)	518 (31.2)
Age at referral			
Most frequent age range	2–5 years	2–5 years	2–5 years
Clinical diagnosis at referral			
No formal diagnosis, n (%)	270 (69.9)	893 (70.0)	1,163 (70.0)
Hereditary conditions reported			
Presence of hereditary conditions, n (%)	127 (32.9)	293 (23.0)	420 (25.3)

ART: assisted reproductive technologies; NC: natural conception. Age refers to age at referral for outpatient developmental consultation. Percentages may not total 100 due to rounding.

With respect to sex distribution, the sample demonstrated a clear male predominance across both groups. Overall, 1,143 children (68.8%) were male and 518 children (31.2%) were female. This distribution remained consistent within the ART and naturally conceived groups, with approximately twice as many male referrals compared to female referrals (Figure 1).

Figure 1

Distribution of children by sex and method of conception.



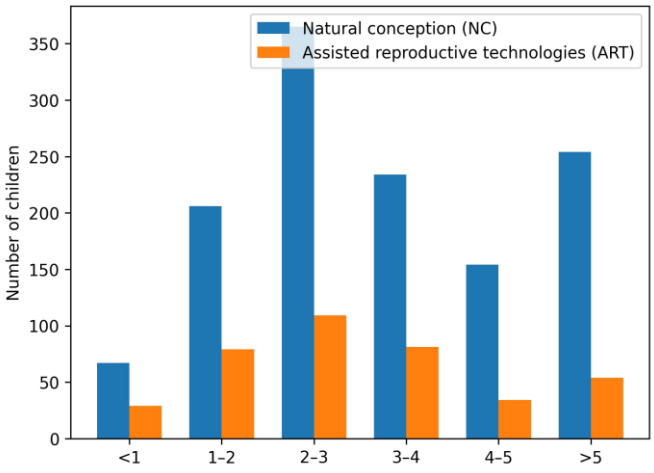
Distribution of boys and girls among children conceived via assisted reproductive technologies (ART) and natural conception (NC). Percentages are calculated within each conception group.

3.2 Age distribution

Referrals to developmental specialists were most frequent between 2 and 5 years of age in both conception groups. In the natural conception group, the highest number of referrals was observed in the 2–3-year age range (n = 365), followed by 3–4 years (n = 234) and 4–5 years (n = 154). A similar pattern was observed in the ART group, with the highest referral frequency between 2–3 years (n = 109) and 3–4 years (n = 81). Children conceived via ART were referred at a slightly younger age overall, as reflected by higher proportions of referrals before the age of three (Figure 2).

Figure 2

Age distribution at referral to developmental specialists by method of conception.



Records of children older than 13 years were excluded from the analysis.

3.3 Hereditary conditions

Parent-reported hereditary conditions were present in approximately one quarter of the analyzed sample. Within this subgroup, approximately 33% of children conceived via ART and 23% of children conceived naturally were reported to have a positive family history of hereditary conditions.

These data reflect parent-reported information collected through the anamnestic questionnaire.

3.4 Developmental milestones

Developmental milestone attainment was analyzed across 11 key indicators encompassing early social responsiveness, gross motor development, and expressive language abilities. Each milestone was categorized as typical development, at risk, delayed, or not yet achieved. Across both conception groups, the largest proportion of atypical findings was observed in expressive language milestones, including first syllables, first words, and two- to three-word utterances. Gross motor milestones showed comparatively smaller proportions of delay.

Comparative analysis demonstrated only minor quantitative differences between ART and NC groups across most milestones. Slightly higher frequencies of delayed attainment were noted in the ART group for milestones related to independent walking and early speech production. However, the overall developmental profiles across social, motor, and communicative domains remained broadly similar between the two groups (Table 2).

At the time of data collection, approximately 70% of the children had not yet received a formal clinical diagnosis. Among cases with reported diagnoses, the most frequently documented categories included autism spectrum disorder, neurodevelopmental disorders, genetic or neurological conditions, expressive language delay, and allergic conditions.

3.4.1 Early motor and social developmental milestones

Early motor and social developmental milestones by conception method and sex are presented in Table 2A. Across both conception groups, a substantial proportion of children were classified as *at risk* or *delayed* for several early motor and social milestones at the time of referral. This pattern was observed consistently among boys and girls.

Table 2A

Distribution of early motor and social developmental milestones by conception method and sex

Milestone	Category	NC Boys	NC Girls	ART Boys	ART Girls
Social smile	Typical	129	52	35	18
At risk	146	62	48	21	
Delayed	599	287	186	78	
Response to voice	Typical	430	187	129	56
At risk	198	85	53	30	
Delayed	246	129	87	31	
Goal-directed reaching toward objects or people	Typical	380	180	116	62
At risk	235	114	70	21	
Delayed	259	107	83	34	
Pointing	Not yet achieved	143	84	43	29
Typical	384	179	130	50	
At risk	43	15	12	4	
Delayed	304	123	84	34	
Independent sitting	Not yet achieved	18	25	11	7
Typical	331	150	94	26	
At risk	226	94	69	30	

Delayed	299	132	95	54	
Crawling	Not yet achieved	133	84	46	14
Typical	472	218	148	61	
At risk	92	43	31	16	
Delayed	177	56	44	26	
Pulling to stand	Not yet achieved	29	38	18	7
Typical	238	118	72	29	
At risk	153	53	43	23	
Delayed	454	192	136	58	
Independent walking	Not yet achieved	48	56	26	21
Typical	681	283	183	74	
At risk	44	21	24	8	
Delayed	101	41	36	14	

For social smile and response to voice, delayed performance represented the most frequent category in both ART- and naturally conceived children, with higher absolute numbers observed among boys in both groups. Similarly, for reaching for an object or person, delayed attainment was common across sexes and conception methods, while typical performance accounted for a smaller proportion of cases.

Regarding postural and locomotor milestones, including independent sitting, crawling, and pulling to stand, a considerable number of children were classified as delayed, particularly among boys. The category *not yet achieved* was present across all milestones but was more frequently observed in earlier motor skills, such as sitting and crawling. For independent walking, although typical attainment was the most frequent category overall, a notable number of children in both conception groups remained classified as delayed or at risk at the time of assessment.

Across all motor and social milestones, the distribution patterns were broadly comparable between children conceived via ART and those conceived naturally, with sex-related differences showing a consistent predominance of boys among delayed and at-risk categories.

3.4.2 Early communicative and language milestones

Early communicative and language developmental milestones are summarized in Table 2B. Across both conception groups, delays in early speech and language milestones were frequently reported, particularly for later-emerging communicative skills. For first syllables, delayed attainment constituted the largest category among both boys and girls, regardless of conception method. A similar distribution was observed for first words, with

delayed performance predominating across all subgroups, while typical attainment was reported less frequently.

The most pronounced delays were observed for two- to three-word utterances, where *not yet achieved* and *delayed* classifications together accounted for the majority of cases in both ART and naturally conceived children. This pattern was evident for both sexes, with higher absolute numbers among boys.

Overall, the distribution of communicative and language milestones revealed comparable profiles between conception groups, characterized by a high prevalence of delayed or not yet achieved milestones at referral, particularly for expressive language measures.

Table 2B

Distribution of early communicative and language milestones by conception method and sex

Milestone	Category	NC Boys	NC Girls	ART Boys	ART Girls
First syllables	Not yet achieved	43	25	12	8
Typical	174	96	67	32	
At risk	64	36	18	6	
Delayed	593	244	172	71	
First words	Not yet achieved	163	76	51	33
Typical	143	87	46	27	
At risk	36	21	10	4	
Delayed	532	217	162	53	
Two- to three-word utterances	Not yet achieved	421	198	120	72
Typical	65	48	16	13	
At risk	41	24	8	6	
Delayed	347	131	125	26	

NOTE: ART- assisted reproductive technologies; NC- natural conception. Developmental milestones were classified as typical, at risk, delayed, or not yet achieved based on age-appropriate expectations reported in the anamnestic questionnaire. Data are presented as absolute frequencies.

3.5 Summary of observed patterns

Overall, the descriptive analysis revealed:

- a stable male predominance in referrals across both conception groups;
- a peak referral period between 2 and 5 years of age;
- similar distributions of early developmental milestone attainment between ART and naturally conceived children;
- a higher proportion of parent-reported hereditary conditions in the ART group.

These findings provide a descriptive overview of developmental characteristics and referral patterns in children conceived via assisted reproductive technologies within outpatient speech-language therapy and developmental consultation settings.

4 DISCUSSION

The present study examines early developmental characteristics in children conceived via assisted reproductive technologies (ART) using a large anamnestic database derived from outpatient speech and language therapy practice. Based on an analytical sample of 1,661 children, including 386 conceived via assisted reproductive technologies and 1,275 conceived naturally, the present findings demonstrate comparable developmental profiles across conception groups. The sex distribution revealed a stable male predominance in both groups (882 boys vs. 401 girls in the NC group; 267 boys vs. 119 girls in the ART group), reflecting referral patterns commonly observed in outpatient developmental services.

Analysis of age at referral demonstrated a clear concentration of consultations between 2 and 5 years of age in both groups. Notably, ART-conceived children were more frequently referred before the age of three, with 109 referrals between 2 and 3 years compared to 365 in the NC group, supporting the interpretation of earlier parental engagement rather than increased developmental pathology.

Children conceived via ART were referred at a mean age approximately six months earlier than their naturally conceived peers. Importantly, this earlier referral was not associated with higher rates of diagnosed developmental disorders, as approximately 70% of children in both groups had no formal clinical diagnosis at the time of assessment. This pattern supports the interpretation that earlier referral among ART-conceived children is more likely related to increased parental vigilance following infertility treatment rather than to increased developmental pathology. Similar trends have been reported in population-based studies examining parent–child dynamics and service utilization following medically assisted reproduction (Goisis; Palma, 2021).

Analysis of clinical nosology further reinforces this interpretation. Among children with documented diagnoses, the most frequently reported conditions included autism spectrum disorder, congenital and malformative syndromes, generalized developmental disorders, expressive language delay, genetic and neurogenic diagnoses,

and allergic conditions. The distribution of diagnostic categories was comparable between ART and naturally conceived children, indicating no overrepresentation of specific developmental disorders associated with ART conception in this outpatient sample. These findings are consistent with large-scale cohort and longitudinal studies reporting no clinically meaningful differences in neurodevelopmental outcomes between ART and naturally conceived children, particularly in singleton pregnancies (Roychoudhury *et al*., 2021; Pinborg *et al*., 2023).

Previous research emphasizes that genetic background and epigenetic mechanisms may influence postnatal development independently of the reproductive technology used (Vrooman; Bartolomei, 2017). The present results align with this perspective and underscore the importance of distinguishing between treatment-related effects and pre-existing familial factors.

The most detailed insights emerge from the analysis of 11 developmental milestones across motor, social, and communicative domains, summarized by conception method and sex in Tables 2A and 2B. The data demonstrate that, in both conception groups, expressive language milestones (first syllables, first words, and two- to three-word utterances) accounted for the highest proportion of delayed or at-risk classifications. Gross motor milestones such as independent sitting, crawling, and walking showed comparatively smaller proportions of delay. While minor quantitative differences were observed—particularly with respect to independent walking and early speech production—the overall developmental profiles of ART and naturally conceived children remained broadly similar across domains.

These findings are of particular relevance to clinical and policy-related debates. The data do not support deterministic narratives that position ART-conceived children as inherently developmentally vulnerable. Instead, they point to a pattern of functional variability that mirrors that observed in naturally conceived children referred for developmental consultation. Systematic reviews in this field similarly report heterogeneous and often non-significant associations between ART and long-term developmental outcomes, emphasizing the role of environmental, familial, and regulatory factors rather than reproductive technology per se (Burgio *et al*., 2022).

From a public health and legal perspective, the present results argue against the classification of ART-conceived children as a distinct high-risk group requiring exceptional regulatory measures. Rather, they support integrated developmental

surveillance models applicable to all children, irrespective of conception method, while remaining responsive to individual risk profiles such as prematurity, perinatal complications, and hereditary background. Such an approach is consistent with principles of proportionality, non-discrimination, and the child's right to timely developmental support.

The strengths of this study include its large sample size and the use of systematically collected anamnestic data reflecting real-world outpatient practice. However, limitations must be acknowledged, including reliance on parent-reported information and the descriptive nature of the analysis. Future research incorporating standardized developmental assessments and longitudinal follow-up would further elucidate long-term developmental trajectories following assisted reproduction.

4.1 Policy and clinical relevance

The findings of the present study carry important implications for public health policy and clinical practice in the fields of early childhood development and speech-language therapy. The absence of marked developmental differences between children conceived via assisted reproductive technologies and those conceived naturally suggests that ART status alone should not constitute a basis for differential access to diagnostic, therapeutic, or educational services. From a policy perspective, this supports the need for equitable, needs-based allocation of early intervention resources, grounded in functional developmental profiles rather than conception history.

At the clinical level, the high prevalence of delayed or at-risk communicative milestones across both conception groups underscores the importance of universal developmental screening and early referral pathways within primary healthcare and community-based services. Speech-language therapy services should be integrated into multidisciplinary early childhood monitoring frameworks, with particular attention to expressive language development during the preschool years. These findings reinforce existing recommendations for proactive surveillance and timely intervention, regardless of reproductive background, while also highlighting the necessity of informed, non-stigmatizing communication with families of children conceived through ART.

In the context of healthcare regulation and child development policy, the results argue against the introduction of ART-specific risk labeling in developmental monitoring

protocols. Instead, policies should emphasize longitudinal, function-oriented assessment models aligned with international frameworks such as the International Classification of Functioning, Disability and Health (ICF). Such approaches promote a biopsychosocial understanding of child development, support family-centered care, and reduce the risk of over-medicalization or unwarranted anxiety related to assisted conception.

5 CONCLUSION

The present study provides an empirical analysis of early developmental characteristics in children conceived via assisted reproductive technologies based on a large anamnestic database derived from outpatient speech and language therapy practice. The findings indicate that assisted reproductive technologies, as a method of conception, are not independently associated with increased rates of early developmental disorders when compared to natural conception.

Across a sample of 1,661 children, developmental profiles related to early regulation, psychomotor development, and communication showed substantial overlap between ART and naturally conceived children. Although children conceived via ART were referred for developmental consultation at a slightly younger age, this earlier referral was not accompanied by higher rates of clinical diagnoses. Instead, it appears to reflect increased parental sensitivity and proactive help-seeking behavior following infertility treatment.

The analysis of developmental milestones demonstrated that expressive language delays constituted the most frequent area of concern in both groups, while gross motor development followed comparable trajectories. Minor quantitative differences observed in selected milestones, such as independent walking and early speech production, did not alter the overall similarity of developmental patterns between conception groups.

From a broader perspective, the results challenge deterministic or stigmatizing assumptions regarding the developmental vulnerability of ART-conceived children. Rather than supporting the classification of these children as a distinct high-risk group, the data emphasize the importance of individualized developmental monitoring based on functional indicators, perinatal history, and familial context.

These findings support integrative, non-discriminatory approaches to early developmental surveillance and reinforce the role of outpatient speech and language

therapy services as key settings for early identification, prevention, and family-centered guidance.

5.1 Ethical considerations

The study was conducted in accordance with ethical standards for non-interventional research involving human subjects. All anamnestic data were collected with informed parental consent and processed in an anonymized form, in compliance with applicable national regulations on personal data protection. The digital data collection platform ensured restricted access exclusively for trained professionals through individual accounts. The analysis was performed on aggregated data and did not involve any intervention, clinical decision-making, or modification of therapeutic procedures.

Special consideration was given to the ethical implications of research on children conceived via assisted reproductive technologies. The study design and interpretation explicitly avoid stigmatization, medicalization, or discriminatory framing, adhering to principles of proportionality, respect for family autonomy, and the child's right to appropriate developmental support.

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Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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