ISSN 2055-0286
Advances in Social Sciences Research Journal; Vol. 13 No. 01 (2026) (274-286)
https://doi.org/10.14738/assrj.1301.19938

Comparative Study of Language and Communication Skills in Children Conceived by Assisted Reproduction Techniques, In Vitro Fertilization (IVF) and Intracytoplasmic Sperm Injection (ICSI)

Evangelia Neou[1], Maria Vlassopoulos[1], Helen Lazaratou[1], Antonis Galanos[2], Charalabos Papageorgiou[1]

1. 1st Department of Psychiatry, School of Medicine, Eginition Hospital, National and Kapodistrian University of Athens/ School of Medicine, Greece
2. 1st Department of Psychiatry, School of Medicine, Eginition Hospital, National and Kapodistrian University of Athens/ Laboratory for Research of the Musculoskeletal System/ Greece

Abstract: Assisted Reproduction Techniques (ART), such as in vitro fertilization (IVF) and intracytoplasmic sperm injection (ICSI), have been widely applied over the past two decades. However, their association with children's communication development remains insufficiently explored. This study aimed to compare the language and communication skills of 51 children aged 4–8 years, conceived through IVF, ICSI, or natural conception (control group). Groups were matched by age, gender, and birth order. Assessments included standardized language tests and parental questionnaires evaluating emotional and family factors influencing language growth. Results showed that children conceived through IVF achieved significantly higher scores in vocabulary (p=0.003), grammar, syntax (p=0.002), and sentence structure (p=0.003) compared to ICSI and control groups. No significant differences appeared between ICSI and control groups or in articulation scores. These findings suggest that IVF conception may be linked to enhanced language development, possibly due to richer parent-child communication dynamics.

Keywords: Children, Icsi, Ivf, Language, Speech

INTRODUCTION

Reproductive rights are a fundamental component of human rights, recognized and protected in most countries. In modern societies, reproductive challenges remain a significant problem with moral, psychological, and social impact [1]. The growing prevalence of infertility has driven the development and widespread adoption of new technology-assisted reproductive methods [2]. According to the World Health Organization (WHO) about 17,5% of couples globally have infertility problems [3].

Assisted reproduction techniques (ART) include conservative methods of treatment of underlying causes such as treatment of polycystic ovaries, treatment of oligospermia, and intervention techniques when conservative treatments fail to achieve natural fertilization [4]. Frequently used interventional methods include in vitro fertilization (IVF), gametes intrafallopian transfer (GIFT), and intracytoplasmic sperm injection (ICSI) [4]. This research study focuses on IVF and ICSI, as they are among the most reliable and effective ART methods over other approaches [5].

The first successful IVF birth took place in 1978 in England and since then, it has become the most widely used and rapidly evolving assisted reproductive method [6]. Nowadays IVF is frequently utilized in research studies and screening for hereditary diseases and is constantly developing to achieve higher success rates [7]. As with any other medical intervention, IVF carries potential risks and complications. These include a risk of ectopic pregnancy or birth with low-birth-weight baby fetuses caused by high IVF stimulation resulting in high levels of estrogen [8]. Furthermore, the high financial cost and ethical considerations associated with IVF remain significant concerns for many prospective parents [6], [9]. The ICSI method is considered an effective procedure and has been widely used around the world since the early 1990s [10]. The main advantage of this method lies in its effectiveness in cases of severe male infertility [11]. However, its drawbacks include the comparatively higher cost, increased risk of embryo damage, and higher chance of conceiving multiples, twins or triplets, which often face complications in pregnancy and possible birth defects [12]. Since the birth of the first IVF baby, more than 8 million babies have been born through IVF according to the European Society of Human Reproduction and Embryology [13]. In Greece, approximately 15,000 IVF attempts take place every year, while there are over 500,000 in vitro fertilization cycles in Europe comprising 30%IVF and 28% ICSI [14].

Children conceived via IVF and ICSI now constitute a substantial proportion of the population, highlighting the importance of ongoing evaluation of both techniques, particularly in our study evaluation of the risk of speech and language disorders compared to naturally conceived children CG [15]. Speech and language development is a complex process. Speech refers to the actual sounds of the spoken language, and language refers to the content including morphology, semantics, and the use of symbols [16]. Communication is any verbal or non-verbal behavior which can affect interactions between individuals [17], [18]. The first three years of life are crucial for language development of children since during this period most language skills will be acquired [19]. Eventually, most children manage to reach the basic milestones of speech before first grade through a normal rapid acquisition of speech and language skills[18]. However, there are several factors that affect children's language development, categorized as internal such as the history of childbirth and the nutritional intake [20] and external factors, like the domestic environment, where all play a crucial role in language development. Socio-economic and cultural factors, and the existence of a rich linguistic environment may influence language development [21]

Furthermore, cognitive abilities such as attention, memory, and problem-solving skills are closely intertwined with language development [22], [23]. Speech and language disorders are the most common disorders of early childhood affecting 7% of preschoolers and 5-10% of school children [24], If untreated, they can negatively influence behavior, social participation, social anxiety, academic and work outcomes, self-confidence, and reading [25]. While many studies focus on the neurodevelopmental characteristics of ART conceived children [26], their cognitive levels [27], [28], behavior assessment and their neuromotor and language development [29], the findings lack definitive conclusions. Furthermore, the international research community has been concerned with the speech and language development of children born through ART as well as the possibility that they may have a higher predisposition to speech and language disorders [30]. However, existing studies on this issue remain limited and inconclusive, thus prompting researchers to further studies [31], [32].

A review of the literature reveals no consistent pattern regarding language development in ART-conceived children. Some studies report no significant differences in their language development compared to children of normal conception in all developmental stages [33], [34], [35], [36]. Other studies suggest that poor speech and language outcomes in children of IVF and ICSI seem to be related to immaturity and low birth weight, which are more common due to the increased frequency of twin and multiple pregnancies[37], [38]. In fact, newborns conceived through ART are three times more likely to have low birth weight [39], [40]. Additional findings indicate that these children may experience slight language delays or face a 13% higher risk for developmental disorders and language disorders [41]. Conversely, some researchers report higher verbal IQ, and more advanced verbal abilities among ART-conceived [42], [43].

Given the inconsistency in current findings, the literature suggests that various external factors can influence children's language development, either positively or negatively [21]. Thus, it is essential to examine whether the medicalization of the fertilization process alters the role of the family, impacts the relationship between parents, increases parenting stress, contributes to a predisposition to depression, or affects the quality of parent-child interactions compared to families of natural conception [44]. The success rate of ART methods is approximately 20%, and the psychological burden of this journey can be profound, with long-term consequences for couples [45]. Individuals—whether a couple or a single mother—undergoing this process often experience intense anxiety and financial stress, as each fertilization attempt comes at a high cost[46]. This already heightened psychological strain may, in some cases, intensify under the weight of impending responsibilities [47]. Following successful conception, some parents may withdraw emotionally from their new reality, and as a result, the raising of the children can become an overwhelming challenge (particularly in cases of multiple pregnancies). Anxiety and avoidant behaviors may lead mothers to defensively distance themselves from the demands of motherhood, negatively impacting their child's development [48]

Furthermore, mothers who have undergone IVF are more likely to experience psychosocial distress, depressive symptoms, and anxiety—at rates 10–50% higher than those of naturally conceiving mothers [49]. They also tend to report elevated stress levels, low self-esteem, and a lack of motivation and protectiveness toward their children [50], [51]. In some cases, they develop unrealistic expectations for their special child, fail to provide sufficient language interaction and stimulation, which can negatively impact overall development, particularly language acquisition [47]. Similarly, mothers who have faced infertility challenges sometimes exhibit lower levels of interaction with their children, a factor strongly linked to language delays in their offspring [52].

MATERIALS AND METHODS

The sample comprised ART-conceived children recruited from private IVF clinics in Athens. In accordance with the mandatory European regulation of General Data Protection (GDPR) [52], the research was conducted following approval from the ethics board of “Aiginiteio” hospital (APA: ΩΦΑ646Ψ8Ν2-ΜΟΞ). All methods should respect human rights and conform to bioethics (Law3305/2005, Greece). Written informed consent was obtained from the parents, and all data were collected and processed anonymously. The sample collection was arduous and long in duration because of the COVID-19 pandemic and additionally due to the

reservedness of parents to speak about their ART-conceived children. The actual sample collection began at the end of February 2020, shortly before the pandemic was officially announced worldwide [54]. This resulted in the suspension of the process until a future period, not predictable at that time. The process began again timidly June 2021, still during the pandemic, when a regulatory framework for professional and social operations and contacts had been put in place by the Greek government. Total sample collection lasted approximately 9 months and ended March 2022.

Children who were conceived naturally were randomly selected from schools across the Athens prefecture, the capital of Greece, where half the country's population resides. The initial sample consisted of 92 children. The exclusion criteria were bilingual children, significant low birth weight <2kg, neurodevelopmental disorders and intellectual disability. The inclusion criteria were the child's age, sex, birth order, marital status, educational level of the mother, premature birth, and parental age.

A detailed history was obtained from the parents, including information about demographics, the family's socio-economic level, and the method of conception. Parents completed the Score-15 questionnaire [55] a well-established measure used to assess family functioning and interaction. It measures core aspects such as family values, cooperation among members during challenges, the quality of communication, and the ability to adapt to a new situation[56]. The dass-21 questionnaire [57] as also completed by both parents which measures the emotional states of depression, anxiety, and stress scale [58].

Children were evaluated using specific speech and language assessment tests. Their expressive vocabulary was measured using the Word Finding Test [59]. Furthermore, the Action Pictures Test assessed two key aspects of language: morphosyntax, grammatical accuracy of spoken phrases, pragmatics, and how effectively language was used to convey information [60]. At the same time, their articulation was evaluated with the Phonological Test of Logopedists, created and standardized by the Panhellenic Association of Logopedists which recorded each child's phonetic index and determined whether their phonemes usage was appropriate for their chronological age[61].

STATISTICAL ANALYSES

A priori power analysis was conducted using G*Power (version 3.1.9.7) to determine the required sample size for detecting differences in expressive vocabulary percentile scores among three independent groups. The analysis assumed a minimum meaningful difference of 20 percentile points between groups. To control multiple comparisons, the significance level was adjusted to $\alpha = 0.017$ using the Bonferroni correction for three pairwise comparisons. The analysis indicated that a sample size of **17 participants per group** (total $N = 51$) would provide **90% power** to detect the specified difference at the adjusted significance level. The application of the exclusion criteria, the sample size estimation and the intention for homogenization of the groups resulted in 3 groups of 17 children each: 17 children conceived via IVF (IVF group), 17 children conceived via ICSI (ICSI group) and 17 NC children and their families (Control Group), a total of 51 children. Children in all groups were matched for age, sex and the order of birth. Chi-square tests (x^2) were used for categorical variables, while F-tests (ANOVA) were used for continuous variables to assess differences in means.

RESULTS

There was Homogeneity between the 3 groups in relation to gender (p=0.183), birth order (p=0.100) and age (p=0.135) (Table 1).

Table 1: Homogeneity test between the 3 groups

		Conception						p-value
		ICSI (n=17)		IVF (n=17)		CG (n=17)		
		N	%	N	%	N	%	
Sex	**Men**	8	47,1%	13	76,5%	9	52,9%	183
	Women	9	52,9%	4	23,5%	8	47,1%	
Birth order	**1st**	13	76,5%	13	76,5%	17	100,0%	100
	2nd	4	23,5%	4	23,5%	0	0%	
Age (mv±SD)		5.23±0.73		5.37±0.92		5.84±1.02		135

N: Number of participants, n: Group size, mv: mean value, SD: Standard deviation, ICSI: Intracytoplasmic Sperm Injection, IVF: In Vitro Fertilization, CG: Control group – natural conception

Significant difference was observed in the Vocabulary competence between the IVF group and ICSI group [23,53(6,92 / 40,14) p=0.005] as well as between IVF and the CG group [15,30(0,53 / 30,06) p=0.041], There was no significant difference between ICSI group and CG [7,65(12,9 /28,2) p=0.63,4] (Table 2).

Regarding grammar and syntax competence, a significant difference was found between IVF and ICSI group [22,95(5,23 / 40,65) p=0.010]. The mean difference between the IVF and CG approached statistical significance [12,94(-1,26 / 27,14) p=0.079], while no significant difference was found between ICSI group and CG [10,59(-8,80 /29,97) p=0.382] (Table 2).

In terms of Informational competence, there is a statistically significant difference between the IVF and ICSI group [23,53 (7,61/ 39,45) p=0.003] and between the group IVF and CG group [10,00(-4,10 /24,10) p=0.199]. No significant difference was observed between ICSI and CG [13,53 (-5,60 / 32,66) p=0.207] (Table 2).

Table 2: Comparison of variables between groups

	ICSI (n=17)	IVF (n=17)	CG (n=17)	F Welcht test	p-value
Vocabulary competence score	51,76±26,75	74,71±11,25	59,41±21,64	7.21	3
Grammatical competence score	48,82±24,97	72,35±10,91	59,41±20,76	7.5	2
Informational competence score	47,06±24,18	70,59±9,66	60,59±21,06	7.5	3

All values are presented as mean ± standard deviation. n: Group size, ICSI: Intracytoplasmic Sperm Injection, IVF: In Vitro Fertilization, CG: Control group – Natural Conception

There were no significant differences between all the groups for the indicators of Articulation as a category (p=0.726), correct Articulation of "s" (p=0.703), correct Articulation of "r" (p=0.862), correct Articulation of "δ" (p=1.000), correct Articulation of "v" (p=0.801), correct Articulation of "f" (p=0.125), correct Articulation of "th" (p=0.412) and the indicator Articulation as a score (p=0.853) (Table 3)

Table 3: Comparison of articulation, intelligence, and behavior between groups

	ICSI (n=17)	IVF (n=17)	CG (n=17)	X^2	p-value
Articulation n (%) Normal/ Abnormal	9(53%)/8(47%)	11(64,7%)/6(35,3%)	9(52,9%)/8(47,1%)	0,64	0,726
s, n(%) Articulate/ non articulate	10(58,8%)/ 7(41,2%)	12(70,6%)/ 5(29,4%)	12(70,6%)/ 5(29,4%)	0,71	0,703
r, n(%) Articulate /non-Articulate	14(82,4%)/ 3(17,6%)	15(88,2%)/ 2(11,8%)	14(82,4%)/ 3(17,6%)	0,30	0,862
δ, n(%) Articulate/non-Articulate	14(82,4%)/ 3(17,6%)	14(82,4%)/ 3(17,6%)	14(82,4%)/ 3(17,6%)	0,00	1,000
v, n(%) Articulate/non-Articulate	16(94%)/ 1(6%)	15(88,2%)/ 2(11,8%)	15(88,2%)/ 2(11,8%)	0,44	0,801
f, n(%) Articulate/non-Articulate	17(100%)/ 0(0%)	17(100%)/ 0(0%)	15(88,2%)/ 2(11,8%)	4,16	0,125
th, n(%) Articulate/ non-Articulate	16(94%)/ 1(6%)	16(94%)/ 1(6%)	14(82,4%) /3(17,6%)	1,77	0,412
	ICSI (n=17)	IVF (n=17)	CG (n=17)	F	p-value
Articulation, mv±SD	0,88±1,27	0,76±1,48	1,06±1,78	0,16	0.853

Chi-square and F tests. n: Group size, ICSI: Intracytoplasmic Sperm Injection, IVF: In Vitro Fertilization, CG: Control group – natural conception.

Regarding the parents there was homogeneity between the 3 groups in relation to Marital Status (p=0.150), Educational Level (p=0.183), Type of Delivery (p=0.594), Mother's Age (p=0.063), Father's Age (p=0.155), while there is a difference, as expected, with Pregnancy (p<0.005) and Attempts (Table 4)

Table 4: Social factors between the three groups

		Conception			p-value
		ICSI (n=17)	IVF (n=17)	CG (n=17)	
Marital status	married	14(82.4%)	17(100%)	16(94.1%)	0.15
	divorced	3(17.6%)	0(0%)	1(5.9%)	
Educational level	Secondary education	0(0%)	3(17.6%)	3(17.6%)	0.183
	Post secondary	17(100%)	14(82.4%)	14(82.4%)	
Birth	premature birth	1(5.9%)	0(0%)	0(0%)	0.594
	Normal birth	16(94.1%)	17(100%)	17(100%)	
Mother's age	mv±SD	43.65±5.22	41.18±4.39	40.18±3.0	0.063
Father's age	mv±SD	45.29±6.61	43.82±5.00	41.76±3.73	0.155

SD: Standard deviation, mv: mean value, n: Group size, ICSI: Intracytoplasmic Sperm Injection, IVF: In Vitro Fertilization, CG: Control group – natural conception.

Psychological and family functioning indicators showed no significant differences between the groups; Anxiety (p=0.311), Stress (p=0.421), Family adaptability (p=0.210), Family strengths (p=0.210) and family communication (p=0.210). However, a significant difference was observed in Depression levels (p=0.046). Pairwise comparisons for the Depression indicator revealed a difference between the CG group and the ICSI (p=0.051) and IVF (p=0.034) groups. CG group reported lower depression level (Table 5).

Table 5: Comparison according to DASS- 21 questionnaire

	ICSI (n=17)	IVF (n=17)	CG (n=17)	X2	p-value Kruskal Wallis
Anxiety	5,00±3.03	3.59±3.34	4.41±3.69	2.33	0,311
Depression	2.35a±2.64	2.06b±2.16	0.82±1.59	6.16	0,046
Stress	6.00±5.11	3.35±2.52	4.76±4.44	1.73	0,421
Family adaptability	2,59±0,89	2,33±0,80	2,15±1,05	3.12	0,210
Family strengths	2,57±1,00	2,27±0,90	2,10±1,00	2.44	0,295
Family communication	4,25±0,92	4,22±0,81	3,86±0,84	2.26	0,323

Variables are described as mean ± standard deviation. The differences do not apply if we calculate the Bonferroni correction (p-value new =0.017). a: p=0,051 vs CG, b: p=0,034 vs CG. n: Group size, ICSI: Intracytoplasmic Sperm Injection, IVF: In Vitro Fertilization, CG: Control group – natural conception.

DISCUSSION

Our research focused on the language development of children born through ART specific IVF and ICSI. The aim was to investigate whether there is an influence in the language development of these children because of the different methods of conception. Analysis of the data indicated that children conceived through IVF have statistically significant differences across all vocabulary, grammar and giving information tests, compared with children conceived through ICSI or naturally. Thus, our study showed that IVF children demonstrated increased verbal ability, better expressive vocabulary, better grammatical structure level, better expressive language informational level in comparison with ICSI and children conceived naturally. Existing literature suggests that children conceived via IVF may have a slight advantage in early language development, specifically vocabulary, compared to those conceived through unplanned pregnancies [37], [62], [63]. IVF children develop their first language faster and more effectively than children conceived naturally [63], [64], [65]

The differential aspect of the language profile between the assisted reproductive techniques may exist the fact that the two procedures may be associated with distinct parental, biological, and psychosocial profiles, each of which has the potential to influence developmental outcomes in offspring (Hart & Norman, 2013). Notably, some studies have reported a modest advantage in early vocabulary development among children conceived via IVF compared to those conceived through ICSI [67].

Furthermore, crucial factors for the development of a child's speech are the environment and–their interaction with the parents [7], [50], [68], [69]. Parents of IVF children tend to be more engaged with their children and spend more quality time with their children, which may explain the observed differences in verbal abilities [70].

Regarding the evaluation of the articulation of these children, there is currently insufficient research that allows for direct comparison for children 4-8 years conceived through ART. Most existing studies focus on general language development and communication rather than articulation specifically. In our research, our participants do not seem to present any heterogeneity in terms of the normal articulation of phonemes. The phonemes evaluated were /r/, /f/, /th/, /v/, /d/, /s/ which are among the most common speech sounds that children in this age group tend to have difficulty with.

Our study examined whether parents who have children conceived through ART exhibit higher levels of depression. It also explored potential differences in their interactions, communication quality, and whether these factors vary across different conception methods, influencing children's language development. We found no statistically significant differences in anxiety or stress levels between IVF, ICSI and naturally conceiving parents. Previous literature also indicates that family environment, and particularly the interaction of children with their parents, plays a decisive role in their language development [71], [72]. While no group exhibited language delay or severe impairments, children conceived through IVF showed comparatively higher rates of language ability. This may be attributed to the fact that these parents tend to spend more quality time with their children, providing a rich language environment. Furthermore, the differing patterns of depression in the IVF and ICSI groups do not appear to affect parental involvement or interaction with their children, nor do they impact the children’s language development. Previous research indicated that parents experiencing depressive symptoms tend to interact

less with their children, a factor that has been associated with lower levels of language development. Although individuals undergoing in vitro fertilization (IVF) may exhibit transient depressive symptoms, primarily due to the psychological stress associated with the procedure, the findings of the present study suggest that, despite this potential risk, the strong desire for parenthood and the significant effort invested in achieving it often result in increased parental involvement in both the care of and interaction with their children. The parents usually had been trying to conceive for a long time. A strong desire for parenthood therefore seems to be associated with high-quality parenthood (Lazaratou Helen, 2014)

In conclusion, the factors assessed such as anxiety, stress, depression and parental communication—do not appear to affect children's language development or lead to language disorder in agreement with previous studies (Cummings & Davies, 1994; Roy et al., 2022). In addition, the results of this study indicated that children conceived through IVF demonstrate better language development compared to those conceived via ICSI or natural conception. This difference appears to be linked to better parent-child interaction and communication within the IVF group.

Further scientific research is required to gain a deeper understanding of the speech and language development of children conceived through assisted reproductive technologies, particularly through IVF and ICSI, in relation to their parental environment. The present findings showed better language development among IVF-conceived children compared to those conceived through ICSI or natural conception, may reflect the complex interaction between biological, psychosocial, and environmental factors. One possible explanation is that parents who conceived through IVF often demonstrate heightened emotional investment, verbal interaction, and cognitive stimulation toward their children, possibly due to the prolonged anticipation and effort preceding conception. However, differences in parental age, education, socioeconomic status, and prenatal or perinatal conditions may also contribute to this pattern. Future longitudinal and interdisciplinary studies are essential to disentangle these mechanisms and to determine whether the observed cognitive advantages are transient or persist throughout development. Early identification and guidance can thus facilitate optimal language outcomes for all children, regardless of conception method.

The limitation of this study was the small sample size due to the restrictions already mentioned. Expanding the sample in future studies would enhance the generalizability and validity of the findings. Preliminary results of this study were presented as a conference abstract in International Congress of Speech and Language Therapy(Neou, et al.2021)

In accordance with the policies of the journal the authors disclose the following information regarding potential financial conflicts of interest: The authors declare that they have no known financial interests, personal relationships, or affiliations that could have influenced the work reported in this manuscript. No financial support, grants, consulting fees, honoraria, stock ownership, or other financial relationships exist that could be perceived as potential conflicts of interest.

REFERENCES

[1] C. Onwuachi-Saunders, Q. P. Dang, and J. Murray, "Reproductive Rights, Reproductive Justice: Redefining Challenges to Create Optimal Health for All Women.," *J. Healthc. Sci. Humanit.*, vol. 9, no. 1, 2019.

[2] H. M. W. Bos and F. B. Van Rooij, "The influence of social and cultural factors on infertility and new reproductive technologies," 2007. doi: 10.1080/01674820701447439.

[3] W. Ombelet, "WHO fact sheet on infertility gives hope to millions of infertile couples worldwide.," *Facts Views Vis. Obgyn*, vol. 12, no. 4, 2020.

[4] M. Jain and M. Singh, *Assisted Reproductive Technology (ART) Techniques*. 2025.

[5] V. Q. Dang *et al.*, "The effectiveness of ICSI versus conventional IVF in couples with non-male factor infertility: study protocol for a randomised controlled trial.," *Hum. Reprod. Open*, vol. 2019, no. 2, p. hoz006, 2019, doi: 10.1093/hropen/hoz006.

[6] P. C. Steptoe and R. G. Edwards, "Birth after the reimplantation of a human embryo," 1978. doi: 10.1016/s0140-6736(78)92957-4.

[7] G. W. Evans, "The environment of childhood poverty.," *Am. Psychol.*, vol. 59, no. 2, pp. 77–92, Jan. 2004, doi: 10.1037/0003-066X.59.2.77.

[8] T. A. Gelbaya, "Short and long-term risks to women who conceive through in vitro fertilization.," *Hum. Fertil. (Camb).*, vol. 13, no. 1, pp. 19–27, Mar. 2010, doi: 10.3109/14647270903437923.

[9] K. G. Fulda and K. Lykens, "Ethical issues in predictive genetic testing: a public health perspective.," *J. Med. Ethics*, vol. 32, no. 3, pp. 143–7, Mar. 2006, doi: 10.1136/jme.2004.010272.

[10] "Intracytoplasmic sperm injection (ICSI)," *Fertil. Steril.*, vol. 90, no. 5 SUPPL., Nov. 2008, doi: 10.1016/j.fertnstert.2008.08.045.

[11] J. Xu, Y. Yu, M. Xue, and X. Lv, "Intracytoplasmic Sperm Injection Improves Normal Fertilization Rate and Clinical Pregnancy Rate in Male Infertility," *Contrast Media Mol. Imaging*, vol. 2022, 2022, doi: 10.1155/2022/1522636.

[12] J. P. Alukal and D. J. Lamb, "Intracytoplasmic Sperm Injection (ICSI) – What are the risks?," *Urol Clin North Am*, vol. 35, no. 2, pp. 277–288, 2008, doi: 10.1016/j.ucl.2008.01.004.

[13] M. Banker *et al.*, "International Committee for Monitoring Assisted Reproductive Technologies (ICMART): world report on assisted reproductive technologies, 2013," *Fertil. Steril.*, vol. 116, no. 3, 2021, doi: 10.1016/j.fertnstert.2021.03.039.

[14] C. De Geyter *et al.*, "European IVF-monitoring consortium (EIM) for the European Society of Human Reproduction and Embryology (ESHRE)," *Hum Reprod*, vol. 33, no. 9, 2018.

[15] Y. Lu, N. Wang, and F. Jin, "Long-term follow-up of children conceived through assisted reproductive technology.," *J. Zhejiang Univ. Sci. B*, vol. 14, no. 5, pp. 359–71, May 2013, doi: 10.1631/jzus.B1200348.

[16] A. K. Namasivayam, D. Coleman, A. O'Dwyer, and P. van Lieshout, "Speech Sound Disorders in Children: An Articulatory Phonology Perspective," 2020. doi: 10.3389/fpsyg.2019.02998.

[17] S. Noori, L. Nedaeifard, Z. Agarasouli, J. Koohpaiehzadeh, R. M. Kermani, and A. S. Fazeli, "Prelinguistic behavior of infants of assisted reproductive techniques.," *Iran. J. Pediatr.*, vol. 22, no. 4, pp. 535–8, Dec. 2012.

[18] H. M. Sharp and K. Hillenbrand, "Speech and language development and disorders in children.," *Pediatr. Clin. North Am.*, vol. 55, no. 5, pp. 1159–73, viii, Oct. 2008, doi: 10.1016/j.pcl.2008.07.007.

[19] J. Coplan, "Normal speech and language development: an overview.," *Pediatr. Rev.*, vol. 16, no. 3, pp. 91–100, Mar. 1995, doi: 10.1542/pir.16-3-91.

[20] J. Y. Bang, A. S. Adiao, V. A. Marchman, and H. M. Feldman, "Language nutrition for language health in children with disorders: A scoping review," *Pediatr. Res.*, vol. 87, no. 2, p. 300, Jan. 2019, doi: 10.1038/S41390-019-0551-0.

[21] A. E. Geers, “Factors influencing spoken language outcomes in children following early cochlear implantation.,” *Adv. Otorhinolaryngol.*, vol. 64, pp. 50–65, Jan. 2006, doi: 10.1159/000094644.

[22] J. Gervain, “Typical language development,” *Handb. Clin. Neurol.*, vol. 173, pp. 171–183, Jan. 2020, doi: 10.1016/B978-0-444-64150-2.00016-2.

[23] A. L. Baylis, B. Munson, and K. T. Moller, “Factors affecting articulation skills in children with velocardiofacial syndrome and children with cleft palate or velopharyngeal dysfunction: a preliminary report,” *Cleft Palate Craniofac J*, vol. 45, no. 2, pp. 193–207, 2008, doi: 10.1597/06-012.1.

[24] L. I. Black, A. Vahratian, and H. J. Hoffman, “Communication Disorders and Use of Intervention Services Among Children Aged 3-17 Years: United States, 2012,” *NCHS Data Brief*, no. 205, 2015.

[25] P. A. Prelock, T. Hutchins, and F. P. Glascoe, “Speech-Language Impairment: How to Identify the Most Common and Least Diagnosed Disability of Childhood.,” 2008.

[26] M. Bonduelle *et al.*, “A multi-centre cohort study of the physical health of 5-year-old children conceived after intracytoplasmic sperm injection, in vitro fertilization and natural conception.,” *Hum. Reprod.*, vol. 20, no. 2, pp. 413–9, Feb. 2005, doi: 10.1093/humrep/deh592.

[27] L. Leunens, S. Celestin-Westreich, M. Bonduelle, I. Liebaers, and I. Ponjaert-Kristoffersen, “Cognitive and motor development of 8-year-old children born after ICSI compared to spontaneously conceived children,” *Human Reproduction*, vol. 21, no. 11, pp. 2922–2929, Nov. 2006, doi: 10.1093/humrep/del266.

[28] Z. Papaligoura, O. Panopoulou-Maratou, M. Solman, K. Arvaniti, and J. Sarafidou, “Cognitive development of 12 month old Greek infants conceived after ICSI and the effects of the method on their parents.,” *Hum. Reprod.*, vol. 19, no. 6, pp. 1488–93, Jun. 2004, doi: 10.1093/humrep/deh270.

[29] F. Olivennes, S. Golombok, C. Ramogida, J. Rust, and Follow-Up Team, “Behavioral and cognitive development as well as family functioning of twins conceived by assisted reproduction: findings from a large population study.,” *Fertil. Steril.*, vol. 84, no. 3, pp. 725–33, Sep. 2005, doi: 10.1016/j.fertnstert.2005.03.039.

[30] K. Thorpe, M. Rutter, and R. Greenwood, “Twins as a natural experiment to study the causes of mild language delay: II: Family interaction risk factors,” *J. Child Psychol. Psychiatry*, vol. 44, no. 3, 2003, doi: 10.1111/1469-7610.00126.

[31] E. Basatemur and A. Sutcliffe, “Follow-up of children born after ART,” *Placenta*, vol. 29 Suppl B, pp. 135–140, 2008, doi: 10.1016/j.placenta.2008.08.013.

[32] M. J. Faddy, M. D. Gosden, and R. G. Gosden, “A demographic projection of the contribution of assisted reproductive technologies to world population growth,” *Reprod. Biomed. Online*, vol. 36, no. 4, pp. 455–458, Apr. 2018, doi: 10.1016/j.rbmo.2018.01.006.

[33] Ø. Lidegaard, A. Pinborg, and A. N. Andersen, “Imprinting diseases and IVF: Danish National IVF cohort study,” *Human Reproduction*, vol. 20, no. 4, 2005, doi: 10.1093/humrep/deh714.

[34] J. Nekkebroeck, W. Van Den Broeck, S. Desmyttere, I. Ponjaert-Kristoffersen, and M. Bonduelle, “The mental, motor, socio-emotional and language development of 2-year-old twins born after PGD/PGS and parental well-being,” 2012. doi: 10.1093/humrep/der352.

[35] I. Place and Y. Englert, “A prospective longitudinal study of the physical, psychomotor, and intellectual development of singleton children up to 5 years who were conceived by intracytoplasmic sperm injection compared with children conceived spontaneously and by in vitro fertilization,” *Fertil. Steril.*, vol. 80, no. 6, 2003, doi: 10.1016/j.fertnstert.2003.06.004.

[36] M. Bonduelle *et al.*, “Prospective follow-up study of 423 children born after intracytoplasmic sperm injection.,” *Hum. Reprod.*, vol. 11, no. 7, pp. 1558–64, Jul. 1996.

[37] U. B. Wennerholm and C. Bergh, “Perinatal outcome in children born after assisted reproductive technologies,” 2020. doi: 10.1080/03009734.2020.1726534.

[38] C. Bergh and U. B. Wennerholm, “Long-term health of children conceived after assisted reproductive technology,” 2020. doi: 10.1080/03009734.2020.1729904.

[39] M. Dehghan *et al.*, “Speech and Language Development of Children Born Following Assisted Reproductive Technologies,” *Int. J. Pediatr. Otorhinolaryngol.*, p. 110060, Apr. 2020, doi: 10.1016/j.ijporl.2020.110060.

[40] C. V. Bellieni, F. Bagnoli, M. Tei, M. De Filippo, S. Perrone, and G. Buonocore, “Increased risk of brain injury in IVF babies,” *Minerva Pediatr.*, vol. 63, no. 6, 2011.

[41] J. Squires, A. Carter, and P. Kaplan, “Developmental monitoring of children conceived by intracytoplasmic sperm injection and in vitro fertilization [3],” Feb. 01, 2003, *Elsevier Inc.* doi: 10.1016/S0015-0282(02)04685-X.

[42] A. Pinborg, A. Loft, L. Schmidt, and A. N. Andersen, “Morbidity in a Danish National cohort of 472 IVF/ICSI twins, 1132 non-IVF/ICSI twins and 634 IVF/ICSI singletons: Health-related and social implications for the children and their families,” *Human Reproduction*, vol. 18, no. 6, 2003, doi: 10.1093/humrep/deg257.

[43] E. D’Haeseleer *et al.*, “Language development of children born following intracytoplasmic sperm injection (ICSI) combined with assisted oocyte activation (AOA),” *Int. J. Lang. Commun. Disord.*, vol. 49, no. 6, 2014, doi: 10.1111/1460-6984.12100.

[44] M. L. Puglisi, C. Hulme, L. G. Hamilton, and M. J. Snowling, “The Home Literacy Environment Is a Correlate, but Perhaps Not a Cause, of Variations in Children’s Language and Literacy Development,” *Scientific Studies of Reading*, vol. 21, no. 6, 2017, doi: 10.1080/10888438.2017.1346660.

[45] J. Wang and M. V Sauer, “In vitro fertilization (IVF): a review of 3 decades of clinical innovation and technological advancement.,” *Ther. Clin. Risk Manag.*, vol. 2, no. 4, pp. 355–64, Dec. 2006.

[46] P. Malekpour, R. hasanzadeh, M. Javedani Masroor, R. Chaman, and Z. Motaghi, “Effectiveness of a mixed lifestyle program in couples undergoing assisted reproductive technology: a study protocol,” *Reprod. Health*, vol. 20, no. 1, 2023, doi: 10.1186/s12978-023-01652-6.

[47] Hélène Lazaratou and Bernard Golse, “From Desire to Reality: Children Produced through Medically Assisted Reproduction (MAR),” *La psychiatrie de l’enfant. Presses Universitaires de France*, vol. 49, p. 573 to 599, 2006.

[48] A. S. Hel Lazaratou, DC Anagnostopoulos, K Magganari, G Zellios, Achristofoulou, “The participation of biological and social factors in the manifestation of learning disorders,” *Encephalos Journal*, 2025.

[49] S. C. Klock and D. A. Greenfeld, “Psychological status of in vitro fertilization patients during pregnancy: a longitudinal study.,” *Fertil. Steril.*, vol. 73, no. 6, pp. 1159–64, Jun. 2000.

[50] F. L. Gibson, J. A. Ungerer, C. A. McMahon, G. I. Leslie, and D. M. Saunders, “The mother-child relationship following in vitro fertilisation (IVF): infant attachment, responsivity, and maternal sensitivity.,” *J. Child Psychol. Psychiatry*, vol. 41, no. 8, pp. 1015–23, Nov. 2000.

[51] Q. Zhan, P. Pan, X. Xu, H. Lou, Y. Lou, and F. Jin, “An overview of studies on psychological well-being in children born following assisted reproductive technologies.,” *J. Zhejiang Univ. Sci. B*, vol. 14, no. 11, pp. 947–60, Nov. 2013, doi: 10.1631/jzus.B1300101.

[52] M. Cornock, “General Data Protection Regulation (GDPR) and implications for research.,” May 2018, *Ireland*. doi: 10.1016/j.maturitas.2018.01.017.

[53] “ΝΟΜΟΣ 3305/2005 | ΦΕΚ Α 17-2005 | σελίδα 1 | nomoi.info.” Accessed: Feb. 17, 2016. [Online]. Available: https://nomoi.info/ΦΕΚ-Α-17-2005-σελ-1.html

[54] “COVID-19.” Accessed: Jul. 16, 2025. [Online]. Available: https://www.ecdc.europa.eu/en/covid-19

[55] P. Stratton, “SCORE-15 Index of Family Functioning and Change.” [Online]. Available: https://www.aft.org.uk/page/scoreNo Title

[56] J. Kleif and I. Gögenur, “Severity classification of the quality of recovery-15 score—An observational study,” *Journal of Surgical Research*, vol. 225, pp. 101–107, May 2018, doi: 10.1016/j.jss.2017.12.040.

[57] George N. Lyrakos et all, “DAS S 21.” [Online]. Available: https://algologia.org/pdf/Main/EEAS/DASS21_Greek.pdf

[58] A. Osman, J. L. Wong, C. L. Bagge, S. Freedenthal, P. M. Gutierrez, and G. Lozano, “The Depression Anxiety Stress Scales-21 (DASS-21): Further Examination of Dimensions, Scale Reliability, and Correlates,” *J. Clin. Psychol.*, vol. 68, no. 12, 2012, doi: 10.1002/jclp.21908.

[59] Volindroukas et al, *Picture Word Finding Test*. Glafki, 2009.

[60] Vogindroukas et.al, *Greek version of Action Picture Test*. Glagki, 2010.

[61] Panhellenic Association of Logopedists, *Phonetic and Phonological Articulation Test*. 1995.

[62] R. J. Hart and L. A. Wijs, “The longer-term effects of IVF on offspring from childhood to adolescence,” 2022. doi: 10.3389/frph.2022.1045762.

[63] A. Barbuscia and M. C. Mills, “Cognitive development in children up to age 11 years born after ART - A longitudinal cohort study,” *Human Reproduction*, vol. 32, no. 7, 2017, doi: 10.1093/humrep/dex102.

[64] Martin Beckford, “IVF children have bigger vocabulary than unplanned babies,” 2011.

[65] Dana AL Madanat, “The first language development in IVF children compared to spontaneous conception children,” *British Jouirnal of Humanities and Social Sciences*, vol. 16, 2017.

[66] R. Hart and R. J. Norman, “The longer-term health outcomes for children born as a result of ivf treatment: Part i-general health outcomes,” *Hum. Reprod. Update*, vol. 19, no. 3, 2013, doi: 10.1093/humupd/dms062.

[67] M. Bonduelle *et al.*, “Neonatal data on a cohort of 2889 infants born after ICSI (1991-1999) and of 2995 infants born after IVF (1983-1999),” *Human Reproduction*, vol. 17, no. 3, 2002, doi: 10.1093/humrep/17.3.671.

[68] A. L. Baylis, B. Munson, and K. T. Moller, “Factors affecting articulation skills in children with velocardiofacial syndrome and children with cleft palate or velopharyngeal dysfunction: a preliminary report.,” *Cleft Palate. Craniofac. J.*, vol. 45, no. 2, pp. 193–207, Mar. 2008, doi: 10.1597/06-012.1.

[69] M. E. Hayiou-Thomas, “Genetic and environmental influences on early speech, language and literacy development,” *J. Commun. Disord.*, vol. 41, no. 5, p. 10.1016/j.jcomdis.2008.03.002, Sep. 2008, doi: 10.1016/J.JCOMDIS.2008.03.002.

[70] L. Owen and S. Golombok, “Families created by assisted reproduction: parent-child relationships in late adolescence.,” *J. Adolesc.*, vol. 32, no. 4, pp. 835–48, Aug. 2009, doi: 10.1016/j.adolescence.2008.10.008.

[71] C. S. Hahn, “Review: Psychosocial well-being of parents and their children born after assisted reproduction,” 2001. doi: 10.1093/jpepsy/26.8.525.

[72] H. Colpin, K. Demyttenaere, and L. Vandemeulebroecke, “New reproductive technology and the family: the parent-child relationship following in vitro fertilization.,” *J. Child Psychol. Psychiatry*, vol. 36, no. 8, pp. 1429–41, Nov. 1995.

[73] L. H, “Les bébés de la procréation médicalement assistéeNo Title,” *Elsevier Masson*, pp. 339, 90–101, 2014.

[74] R. Roy, M. Chakraborty, K. Bhattacharya, T. Roychoudhury, and S. Mukherjee, “Impact of perinatal maternal depression on child development,” *Indian J. Psychiatry*, vol. 64, no. 3, 2022, doi: 10.4103/indianjpsychiatry.indianjpsychiatry_1318_20.

[75] E. M. Cummings and P. T. Davies, “Maternal Depression and Child Development,” *Journal of Child Psychology and Psychiatry*, vol. 35, no. 1, 1994, doi: 10.1111/j.1469-7610.1994.tb01133.x.

[76] M. Neou, E., Lazaratou, E., Papageorgiou, X., & Vlassopoulos, “Comparative study of language and communication skills of children conceived through assisted reproduction techniques (IVF-ICSI): Quality of parental relationships, and their emotional scales as factors affecting speech and language developmentNo Title,” 2021.