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INVESTIGATING THE LANGUAGE DEVELOPMENT OF INDIVIDUALS WITH DOWN SYNDROME, AND HIGHLIGHTING THE IMPORTANCE OF SPEECH THERAPY

Dimitra Chaldi[1i],
Antonia Karagiannidou[2]
[1]PhD Candidate,
Faculty of Medicine,
University of Patras,
Greece,
M.ADS, BSc. S-LP Speech - Language Therapist,
Speech Rehabilitation Institute,
Patras, Greece
LSVT-Loud Certified Clinician,
Prompt - Bridging Certified Clinician
[2]MSc. Student at Auditory Processing Disorder-Psychoacoustic Applications,
School of Medicine,
Aristotle University of Thessaloniki,
Greece

Abstract:
Down syndrome is the most common viable numerical chromosomal abnormality, affecting one in every 600 births. It is the most common cause of intellectual disability due to genetic factors. Nearly all individuals with this syndrome have an extra copy of the 21st, leading to cognitive and physical disabilities. Down syndrome can be detected through prenatal screening and is classified into three categories: trisomy 21, mosaicism, and translocation. The main aim of this study is to investigate the linguistic characteristics of people with Down syndrome and demonstrate the value of speech therapy. Statistical analysis shows that the linguistic development of individuals with Down syndrome differs in every subsection from normal development. There are deficiencies not only in their linguistic development (i.e., phonology, morphology, syntax, and pragmatics) but also in many cognitive categories (e.g., memory). Furthermore, this study confirmed the value of speech therapy through personalized intervention. However, we found that the speech therapists who participated in this survey did not have the appropriate expertise. Their knowledge of Down syndrome was good, but they needed a deeper understanding of the syndrome.

[i] Correspondence: email dimitrachaldi.speech@gmail.com

Keywords: Down syndrome, linguistic development, pre-linguistic stage, linguistic mechanisms, speech, and therapy intervention

1. Introduction

Down syndrome (DS) is the most common chromosomal abnormality, with a ratio of approximately 1:600 births worldwide per year. It is a condition characterized by physical, functional, and mental abnormalities resulting from the presence of three copies of chromosome 21, rather than the usual two. DS is divided into 3 types: Trisomy 21, mosaicism, and transposition. More than 300 genes are found on chromosome 21 that encode proteins and cause differentiation in the cells and tissues of the body (Roizen & Patterson, 2003). It is known from the literature that this syndrome is the main cause of intellectual disability, with the largest percentage of these individuals showing a moderate degree of mental retardation (Chapman, 1997). These individuals show some common characteristics due to the extra chromosome 21. However, there are great differences between them in terms of physical and mental characteristics. Additionally, other anatomical abnormalities may be present, which may not impact the individual's functionality. While trisomy 21 is the only viable trisomy during pregnancy, only one-third of these fetuses survive birth. In terms of cognitive development in individuals with DS, it is characterized by fluctuations. Infancy and early childhood show progress in cognitive abilities, whereas a decline begins in adulthood. This decline is attributed to factors such as microencephaly, with reduced activity in the hippocampus, cerebellum, and prefrontal lobe compared to typically developing individuals (Nadel, 2003).

A percentage of individuals with Down Syndrome (DS) display severe mental retardation, with the majority falling within the moderate to severe range, and a smaller segment characterized by borderline intelligence (Pueschel, 2001). When examining the language development in children with DS, it is noted to have a similar organization and structure as typically developing children but progress at a slower rate due to intellectual disability. Factors such as developmental issues with the tongue, hearing problems, and impaired short-term memory contribute to this slower progress (Roizen & Patterson, 2003). Delayed or rapid development of language mechanisms can result in disruptions to the individual's language progression (Paul, 2007). Gillham (1990) notes that in children with DS, the onset of the expressive period is delayed compared to typical development, often not emerging until around 18 months and sometimes not until 5 or 6 years old. The delay can be attributed to reduced hearing ability and skeletal deformities that hinder articulation and speech ability (Dodd & Thompson, 2001). While individual variability is crucial, the language development of individuals with DS displays consistent universal traits. Debates arise regarding whether non-verbal communication is stronger than expressive abilities, and the challenges posed by phonology, syntax, morphology, and certain aspects of pragmatics. To address these debates, a questionnaire was designed to investigate language progression and underscore the importance of speech therapy intervention for individuals with DS.

The work comprises two parts: the theoretical and the research. The theoretical segment delves into an analysis of all concepts related to Down syndrome and the linguistic development of affected individuals. Specifically, it includes a historical review, discussions on the possibilities of its occurrence, and chromosomal changes, and presents various forms and types of the syndrome. Moreover, it details the methods of prenatal diagnosis and their characteristics. The closing section focuses on speech development, particularly the preparatory stage. An in-depth analysis of language mechanisms in individuals with Down syndrome is provided, emphasizing the importance of timely and effective speech therapy intervention. The research conducted was qualitative, with the information gathered being interpretatively analyzed based on impressions or diagnostic criteria. Data were collected from individuals of various ages and both genders working as speech therapists. The questionnaire was distributed electronically to speech therapists via email, which was sourced from the internet between May 23 and July 10. Finally, descriptive statistical processing was carried out using Microsoft Excel.

2. Material and Methods

The primary objective of this study is to investigate the perspectives of speech therapists concerning the language development of individuals with DS. This research was initiated due to the scarcity of Greek research and data concerning the language development of individuals with this syndrome. To gather data, a purposeful sampling method was utilized, targeting speech therapists who met predetermined criteria and practiced in the field. The questionnaire was specifically aimed at speech therapists, irrespective of their location, background, or socio-economic standing. Administered via email, the electronic questionnaire featured concise questions that only required around 10 minutes to completion to enhance cooperation and performance. Developed after an extensive bibliographic review, a 38-item questionnaire created through the Survey Monkey program served as the primary measuring tool for this research. The questionnaire is segmented into three distinct parts for streamlined analysis.

The first section of the questionnaire contains demographic information about the population, including gender, age, level of education, workplace, years of work experience, and questions regarding the DS cases handled by the participants. The second section inquires about language development, challenges in phonology, semantics, syntax, and pragmatics, as well as mental capacity and social interactions. The final part of the questionnaire covers speech therapy intervention inquiries, including assessment tools, duration, goals, intervention methods, and collaboration with other related fields. Each participant was presented with identical questions in a fixed order for consistency. The questionnaire primarily comprises closed-ended questions for efficient completion, with a limited number of open-ended queries to grasp participants' insights and opinions.

3. Results

A total of 64 speech therapists responded to the questionnaire, with only 45 providing answers to all the questions. Only participants who completed 80% (30 questions) of the questionnaire were included in the statistical analysis. Demographic data was collected by asking participants about their gender, age, education, place of work, and previous experience.

These data are presented in Table 1 and Chart 1.

Table 1: Demographic data of speech therapists (N=45)

Variables		Number (N)	Percentage (%)
Gender	i. Male	9	20
	ii. Female	36	80
Age range	i. 20-30	22	48,9
	ii. 31-40	14	31,1
	iii. 41-50	6	13,3
	iv. 51-60	3	6,7
	v. Over 61 years old	0	0,0
Higher education	i. First degree	17	37,8
	ii. Second degree	5	11,1
	iii. Postgraduate	23	51,1
	iv. PhD	0	0
Workplace	i. Private office	36	80
	ii. Hospital	0	0
	iii. Rehabilitation Institute	2	4,4
	iv. Special Needs School	5	11,1
	v. Home-based	8	17,8
	vi. Other	3	6,7
Work experience	i. 0-5 years	19	42,2
	ii. 6-10 years	9	20
	iii. 11-12 years	6	13,3
	iv. 16-20 years	10	22,2
	v. >21 years	1	2,2

The largest proportion of participants were female (80%), with only 20% being male. The majority fell within the age range of 20-30 years (48.9%), followed by 31-40 (31.1%), 41-50 (13.3%), 51-60 (6.7%), and over 61 (0%). In terms of educational background, 51.11% indicated holding a master's degree, 37.8% a bachelor's degree, and 11.1% a second degree, with no respondents reporting having a PhD. Moreover, most speech therapists reported working in a private office (80%), while 17.8% worked from home, 11.1% in a special school, 6.7% in another location such as KEDASY, and 4.4% in a rehabilitation center; no one mentioned working in a hospital. Finally, with regards to work experience, 42.2% mentioned having 0-5 years of experience, 22.2% between 16-20 years, 20% between 6-10 years, 13.3% between 11-12 years, and only 2.2% having more than 21 years of experience.

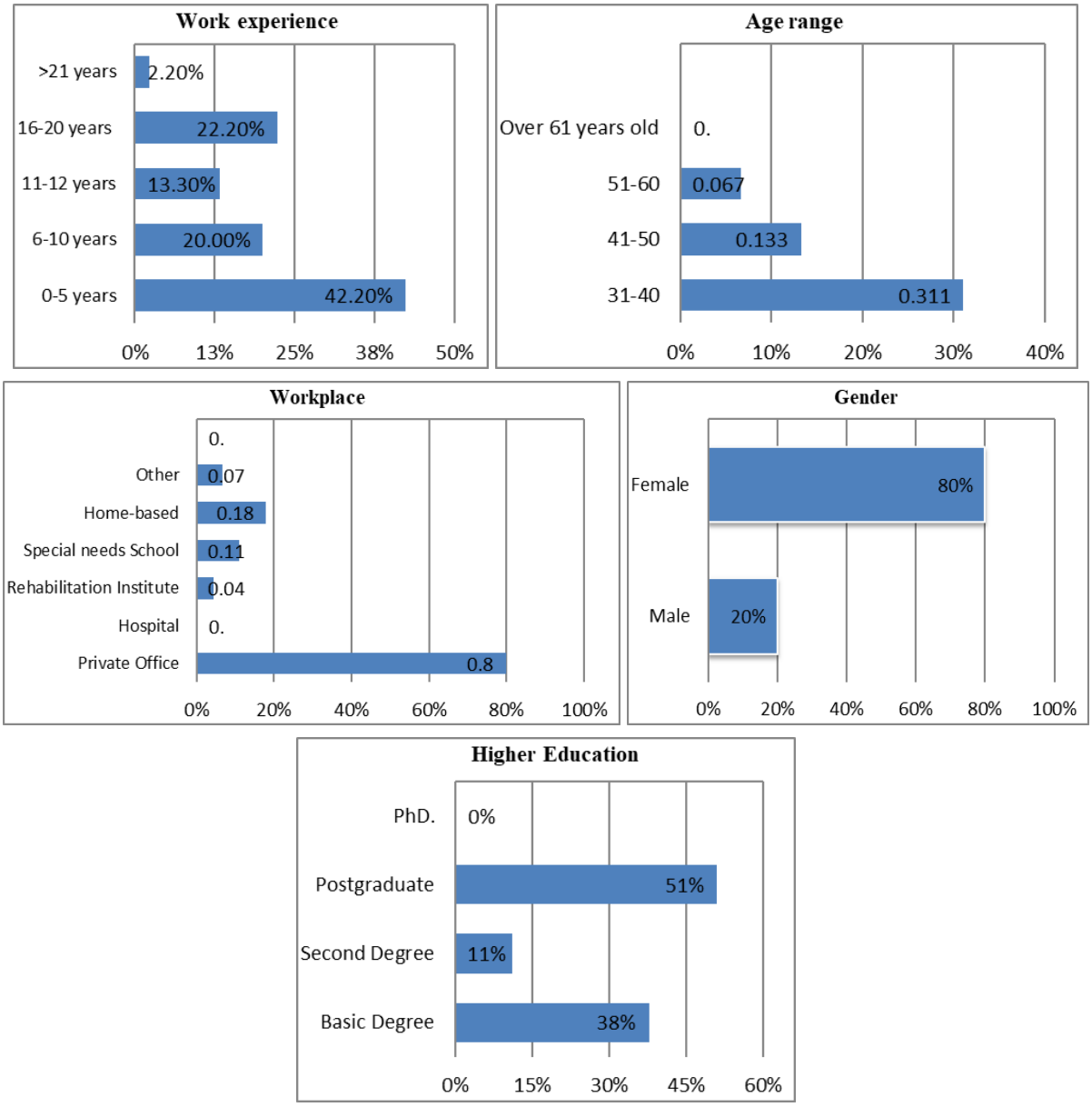

Chart 1: Participant's demographics

The first part of the questionnaire required participants to provide information regarding their target population and caseload management. The responses from speech therapists regarding the cases they handle are presented in Table 2 and Chart 2.

Among the participating speech therapists, all reported that they provide services to preschool and school-age children (100%), with only 37.8% also treating adults. Some therapists indicated they work with both age groups. When asked about the number of Down syndrome (DS) cases they have worked with, the responses varied: 35.6% stated they had experience with 1-3 children, 20% with 11-15 children, another 20% with 16 or more children, 11.1% with 4-6 children, 8.9% with 7-10 children, and finally, a small percentage (4.4%) had not treated any DS cases.

Variable		Number (N)	Percentage (%)
Clinical Population	i. Preschoolers and School-age Children	45	100
	ii. Adults	17	37,8
	iii. Other	0	0
Number of clients with Down Syndrome	i. None	2	4,4
	ii. 1-3	16	35,6
	iii. 4-6	5	11,1
	iv. 7-10	4	8,9
	v. 11-15	9	20
	vi. 16+	9	20

Table 2: Clinical population

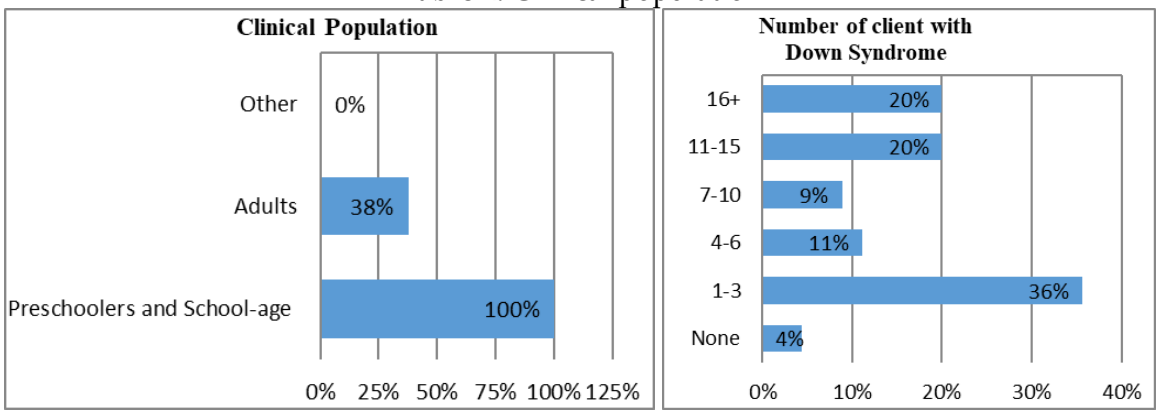

Chart 2: Clinical Population

Listed below are the responses of speech therapists regarding the language development of individuals with Down syndrome and the challenges they encounter in aspects of speech, including phonology, semantics, syntax, and pragmatics. Additionally, an investigation into their cognitive abilities and social engagement is conducted. Nearly all respondents affirmed that the initial vocabulary acquisition in children with DS differs from that of typically developing children (97.8%), with only a marginal 2.2% holding a contrary opinion (refer to Chart 3).

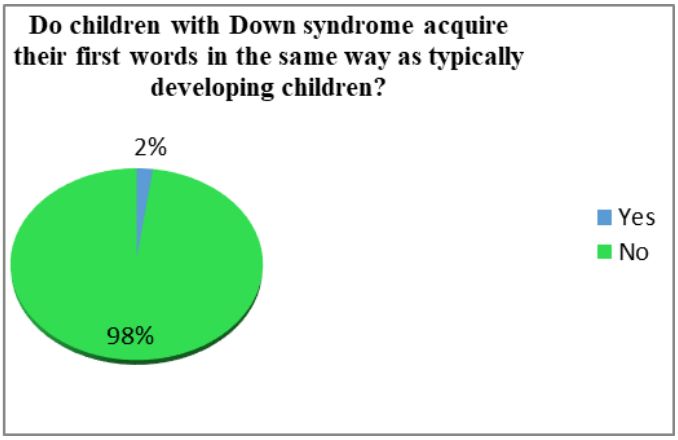

Chart 3: Frequency rates for acquisition of first words

Regarding the onset of consonant and vowel production in children with DS, 95.6% of respondents agreed that it differs from that of typically developing children, with only 4.4% indicating otherwise (see Chart 4).

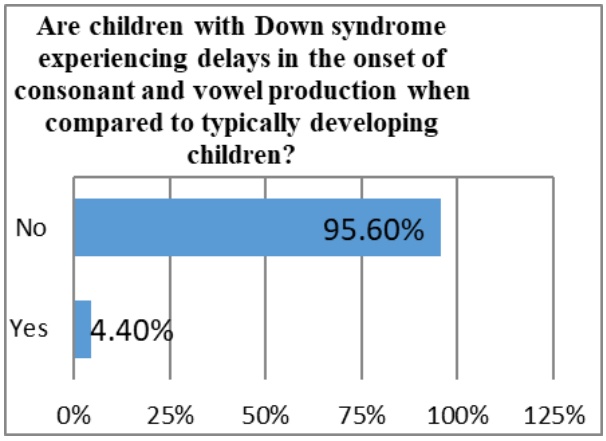

Chart 4: Frequency rates for starting /s/ & /f/ production

Based on the responses of 100 participants, it was found that 93.3% indicated a significant delay in the expressive vocabulary of children with Down syndrome compared to typically developing individuals, while only 6.7% disagreed with this assessment (see Chart 5). The survey methodology included a combination of interviews and questionnaires to gather these insights into language development.

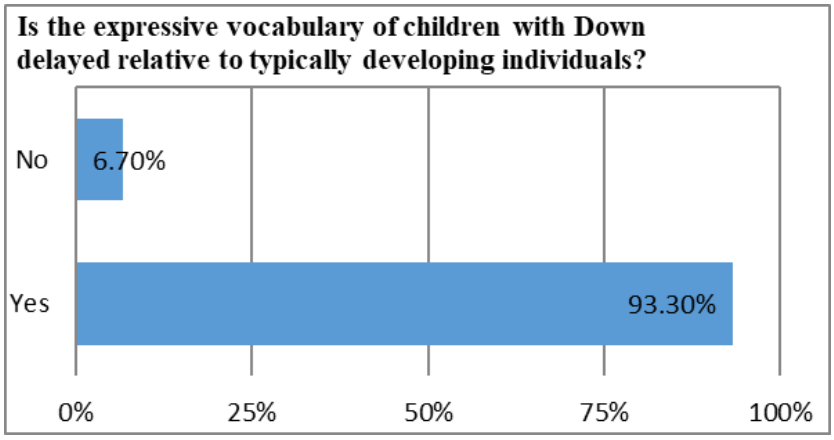

Chart 5: Frequency rates for expressive vocabulary production

Out of all the surveyed speech therapists, 93.3% acknowledged that children with DS face challenges in phonology, while 91.1% cited difficulties in semantics. Another 91.1% pointed out issues with writing, and 80% identified struggles in factuality.

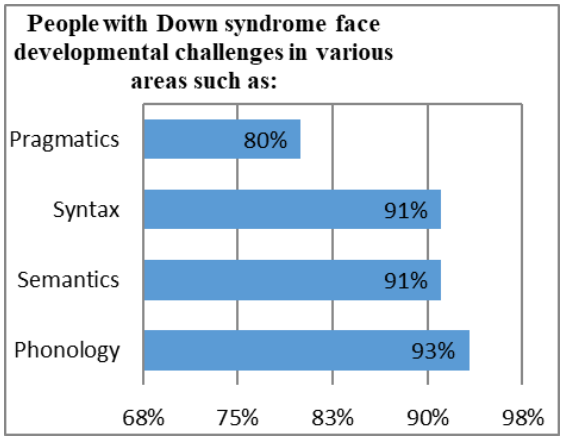

Chart 6: Frequency rates for deficits in language mechanisms in individuals with Down syndrome

According to 93.3% of respondents, children with DS primarily exhibit difficulty in the expressive area. Additionally, 88.9% noted weaknesses in the cognitive-executive domain and visual-motor coordination. 80% indicated challenges with memory, 57.8% with auditory perception, and only 24.4% with visual perception. It is worth mentioning that most participants cited issues in the cognitive-executive domain, expression, memory, and visual-motor coordination as the main areas of concern for these children.

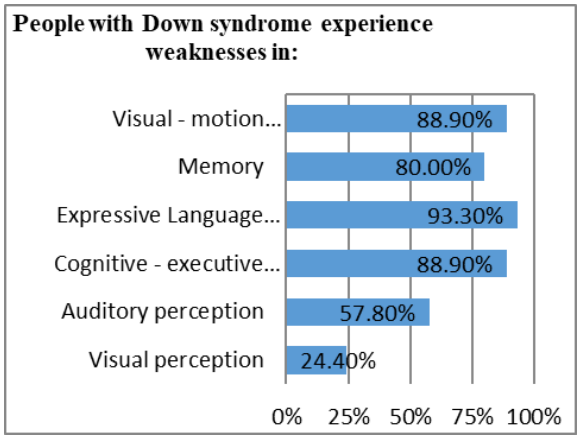

Chart 7: Frequency rates of challenges related to specific cognitive functions across various domains

In terms of speech production difficulties, 82.2% of speech therapists attributed it to a big tongue. Additionally, 77.8% linked it to a small oral cavity. Furthermore, 64.4% identified the presence of dysarthria (difficulty in coordinating articulations) in the child, while 60% associated it with a high, narrow, and arched palate. Only 4.4% mentioned other factors such as low muscle tone. Many participants selected multiple answers for this question, with the most common choice being all four options.

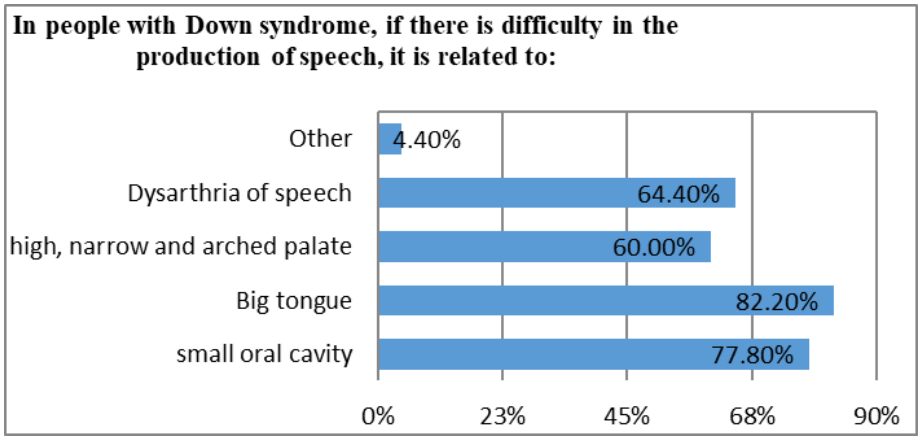

Chart 8: Frequency rates for the cause(s) of difficulty in speech production

Most participating speech therapists stated that children with DS present language deficits, more specifically in production and syntax (95.6%); only 4.4% responded that they do not present difficulties.

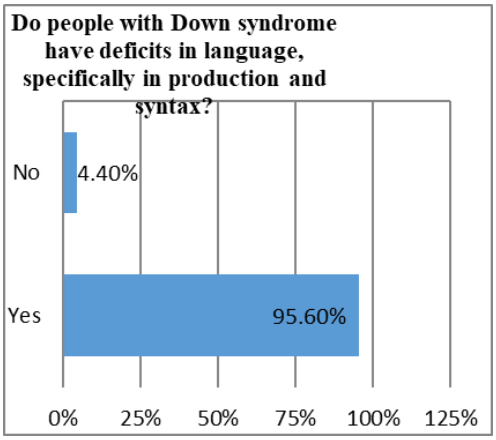

Chart 9: Frequency rates for production and writing difficulties

All participants (100%) claimed that individuals with Down syndrome exhibit phonological errors during early education settings. For example, they may struggle with producing certain sounds accurately.

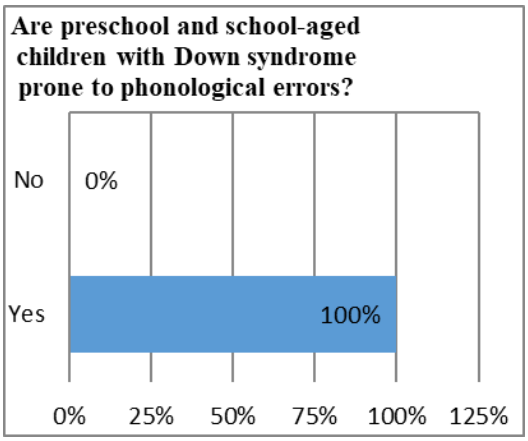

Chart 10: Frequency rates for phonology errors at preschool and school age

Among speech therapists, 97.8% believe that expressive language skills are less developed in these individuals compared to receptive skills, with only 2.2% holding a contrasting view.

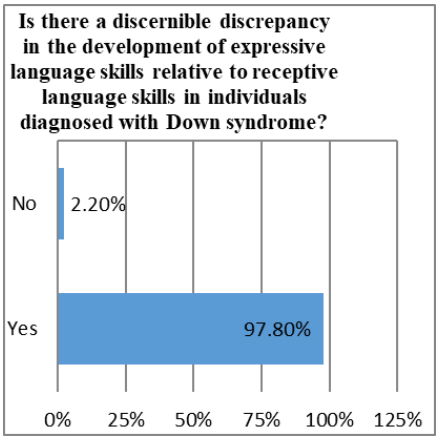

Chart 11: Frequency rates related to the development of expressive language skills

When it comes to their communication skills, 84.4% of participants believe they excel, particularly in areas such as articulation, listening, and conveying ideas effectively. In contrast, 15.6% indicated that they do not feel as confident in their speech production.

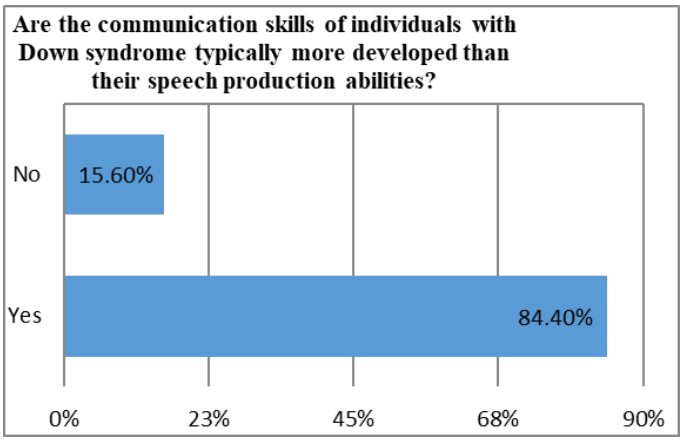

Chart 12: Frequency rates for communication skills among individuals with Down syndrome

The study found that 84.4% of the respondents believed that individuals with Down syndrome do not exhibit typical intelligence levels, while only 15.6% had a different viewpoint.

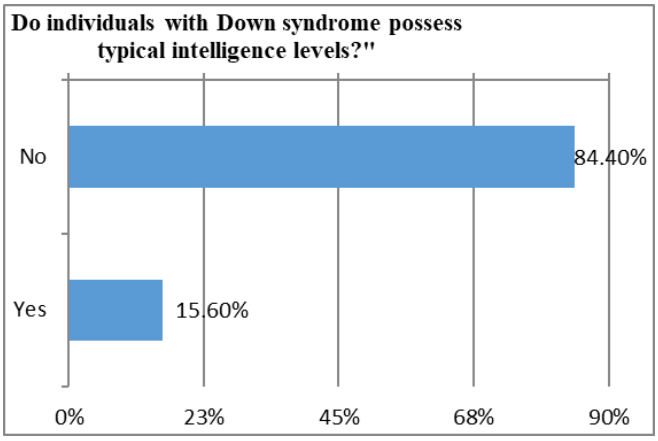

Chart 13: Frequency percentages for the intelligence of children with Down syndrome

According to the surveyed speech therapists, 77.8% indicated that individuals with DS experience challenges in maintaining eye contact. Conversely, 22.2% reported no difficulties in this aspect. This data sheds light on the varied perspectives within the professional community regarding eye contact in individuals with DS.

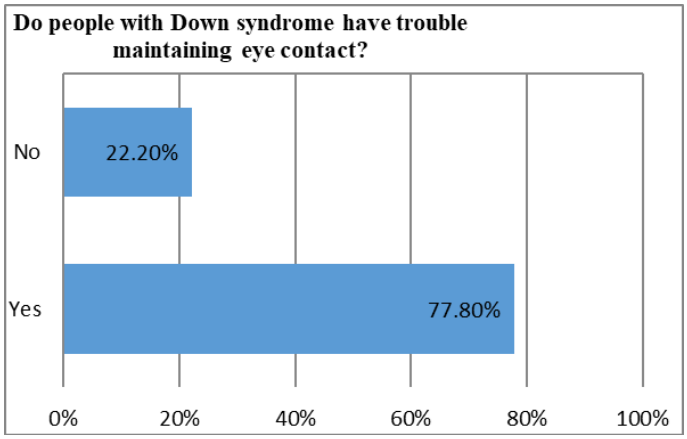

Chart 14: Frequency rates for eye contact among individuals with Down syndrome

Based on the participants' responses, most speech therapists (51.1%) mentioned that individuals with Down syndrome face challenges in short-term memory. Furthermore, 44.5% of respondents highlighted difficulties in both long-term and short-term memory. Only one participant (2.2%) indicated issues specifically with long-term memory, while another (2.2%) stated that memory is not a problem for individuals with Down syndrome.

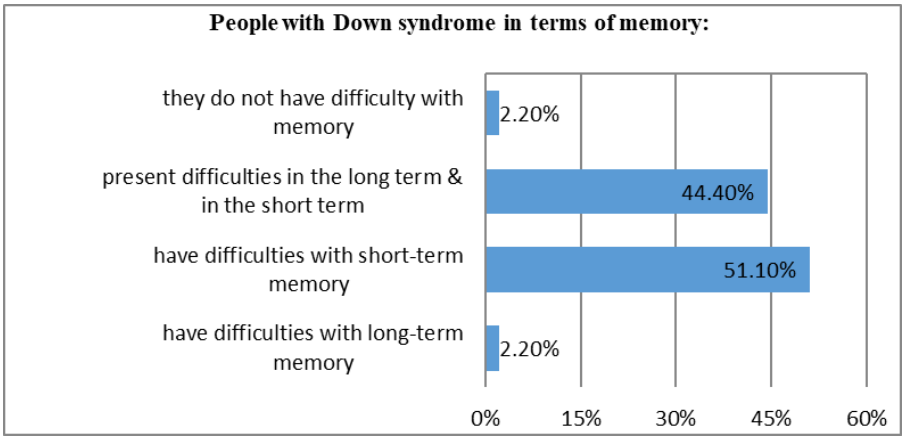

Chart 15: Frequency percentages for the memory of people with Down syndrome

91.1% of participants in the sample reported that individuals with Down syndrome experience challenges with visual-spatial concepts. In contrast, 8.9% of respondents indicated the opposite regarding visual-spatial abilities in individuals with DS.

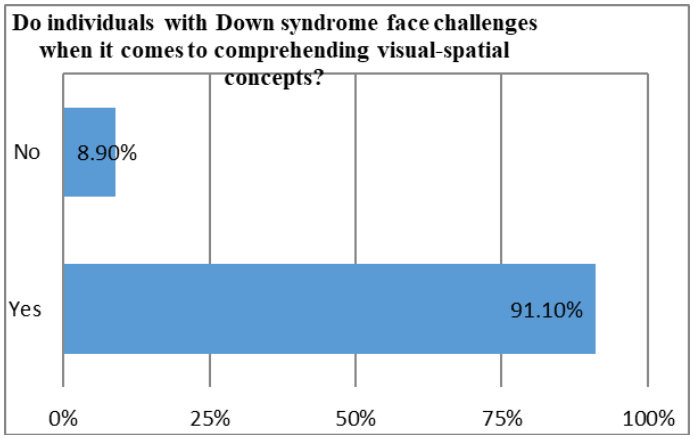

Chart 16: Frequency rates for difficulties in visual-spatial concepts

All speech therapists unanimously confirmed that the individuals in question are experiencing difficulties with reading. However, further evaluation and assessment may be necessary to fully understand the extent and nature of their challenges.

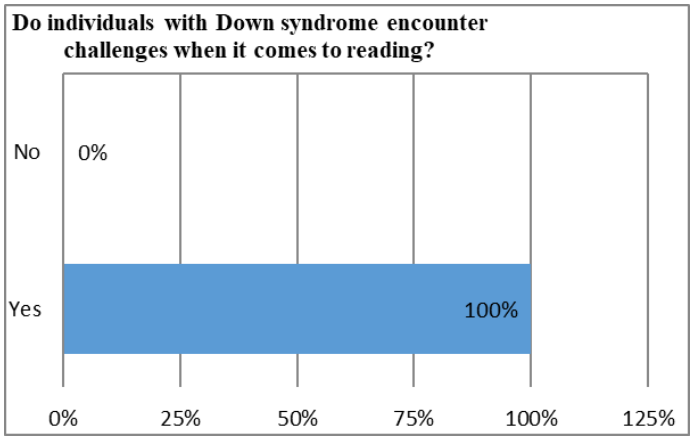

Chart 17: Frequency rates of reading ability among individuals with Down syndrome

According to the results, the largest percentage of speech therapists (66.7%) who participated in the research answered that children with this syndrome cannot start a conversation and maintain its topic, while 33.3% stated that they have this ability.

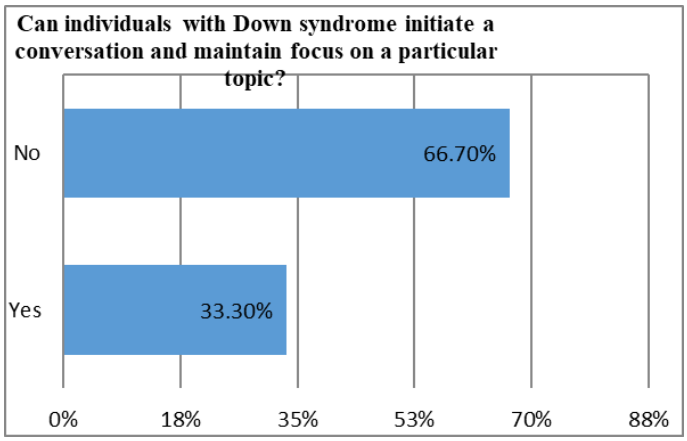

Chart 18: Frequency percentage data indicates the conversational ability of individuals with Down syndrome

Among the total sample of participants, 62.2% believed that individuals with DS are incapable of recounting information or narratives, while 37.8% answered the opposite.

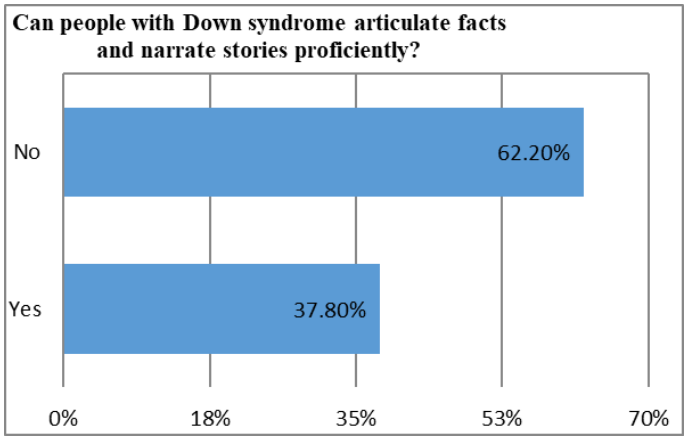

Chart 19: Frequency percentages for the ability to tell stories in people with Down syndrome

Among speech therapists surveyed, 95.6% stated that they face challenges with complex grammar skills, while only 4.4% reported no difficulties in this area.

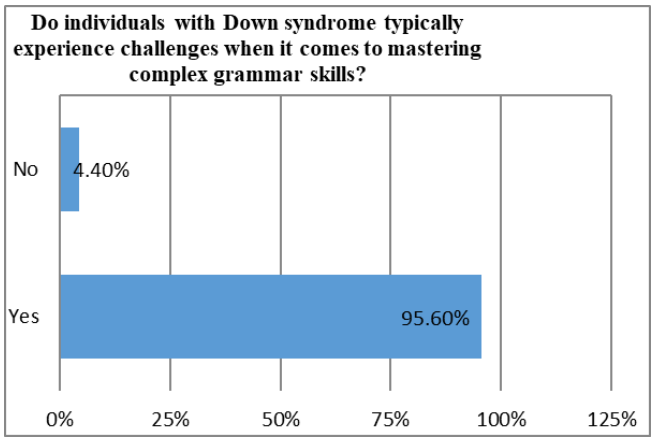

Chart 20: Frequency rates for complex grammar skills in individuals with Down syndrome

In a survey among speech therapists, 75.6% indicated that social interaction among individuals with Down syndrome is average, 22.2% rated it as good, and only 2.2% considered it bad.

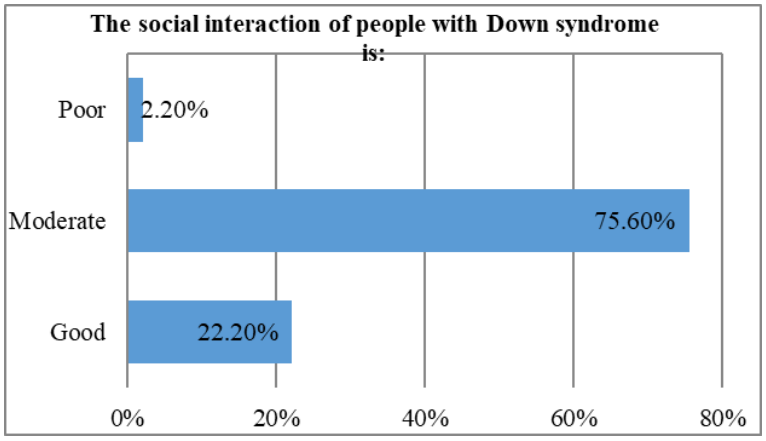

Chart 21: Frequency rates for the social interaction of people with Down

In a study on the behavior of individuals with Down syndrome (DS), 77.8% of the surveyed speech therapists noted that they do not exhibit aggression or antisocial behavior, while 22.2% had an opposing view.

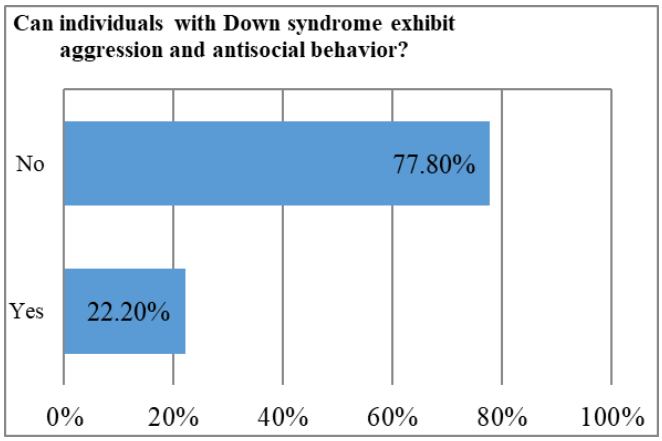

Chart 22: Frequency percentages regarding the behavior of individuals with Down's Syndrome

In the survey, 51.1% of the sample reported using weighted physical tools, such as scales or weighted blankets, to assess children with Down syndrome, while 48.9% indicated the use of informal methods like observation and parent interviews.

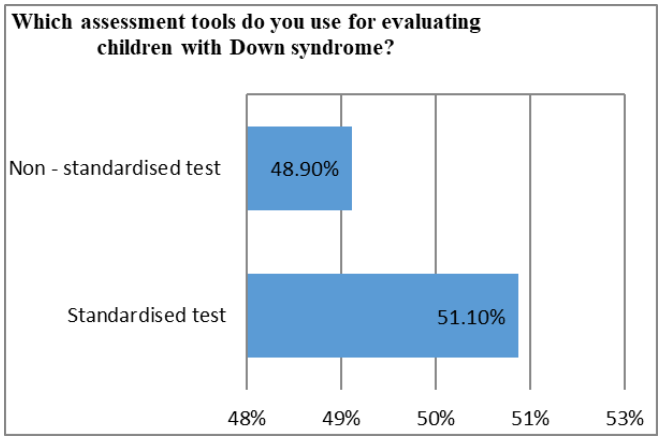

Chart 23: Frequency rates of assessment tools used by speech therapists for evaluating language development in children with Down syndrome

Speech therapists use a variety of tools, both weighted and non-weighted, to assess speech disorders. Most therapists primarily use tools such as articulation tests, language assessments, and fluency evaluations to evaluate their patients.

Standardised Tests

Articulation Assessment	MetaPhon Test	Test of Pragmatic Language	Wisc-V (psychometric test)
Action Picture Test	Derbyshire Language Scheme	Celf pre-school	
Word Finding Vocabulary Test	Language Comprehension and Expression Test	Life orientation test-revised (LOT-R) (Psychometric test)	

Non-standardised Tests

Picture description activities	Tacting, categorization, and use (semantics) of objects
Activities for phonological awareness	Memory activities

A survey conducted among a group of speech therapists revealed that 73.3% of respondents recommend starting intervention for children with this syndrome during preschool age, while 26.7% suggest beginning in infancy. Interestingly, none of the therapists indicated that intervention should commence during school age. The insights provided by these professionals highlight the importance of early intervention for children with this syndrome and underscore the value of starting therapy during the formative years of development.

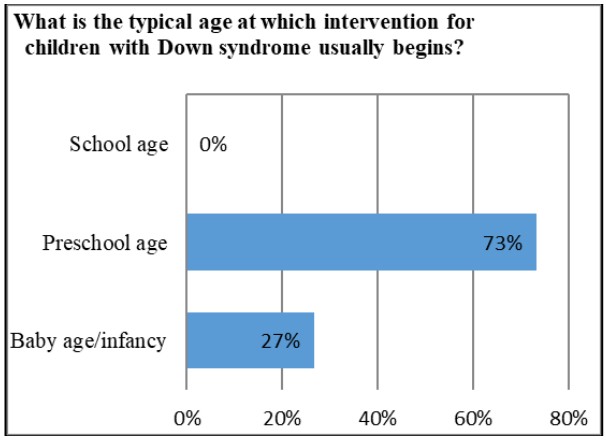

Chart 24: Frequency rates of therapy sessions during the intervention period for children with Down syndrome

Most speech therapists (80%) agreed on the importance of collaborating with a physical therapist, occupational therapist, social worker, special educator, and psychologist for the optimal treatment of children. An additional 20% stressed the need for cooperation with an occupational therapist, while 11.1% highlighted the significance of working with a psychologist. Moreover, 8.9% acknowledged the value of collaboration with a physical therapist and a special educator. Interestingly, none mentioned partnering with a social worker, but some responses suggested the involvement of a physiotherapist, occupational therapist, and psychologist for comprehensive treatment.

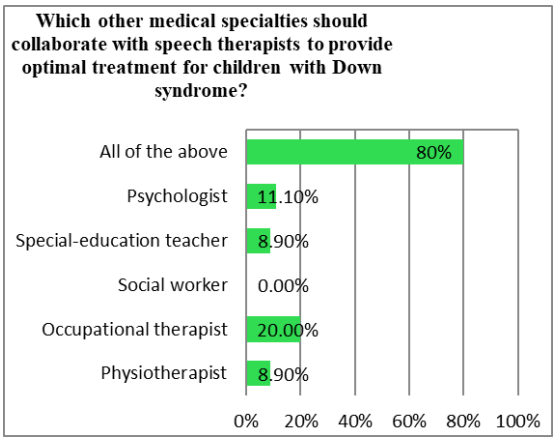

Chart 25: Frequency rates of collaboration between speech therapists and other specialties

Based on participant responses, most speech therapists (68.9%) believe that interventions for preschool-aged children with DS should prioritize social skills. Similarly, 57.8% suggested a focus on language development, while 13.3% highlighted the importance of addressing phonology and articulation. It is worth noting that many responses included more than one area of focus, with the most common combination being social skills and language development.

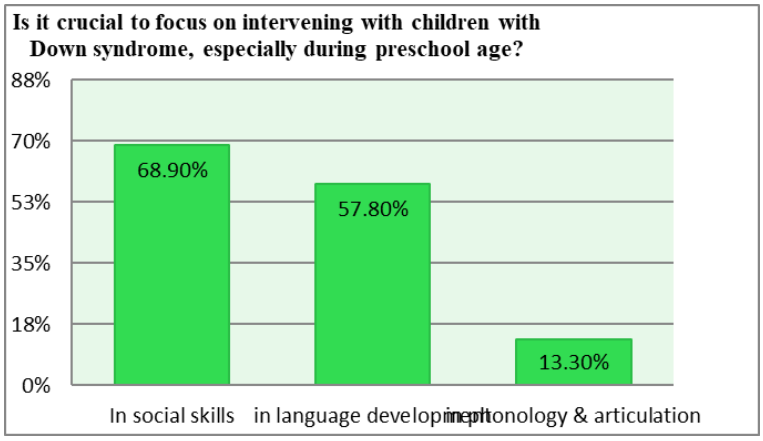

Chart 26: Frequency rates for achieving the initial goal of speech therapy intervention in children with Down syndrome

In relation to speech therapy intervention, 77.8% of the participants indicated that they initiated an intervention for children with Down syndrome (DS) with the aim of improving social communication skills, while the remaining 22.2% stated that behavioral improvement is not the primary objective.

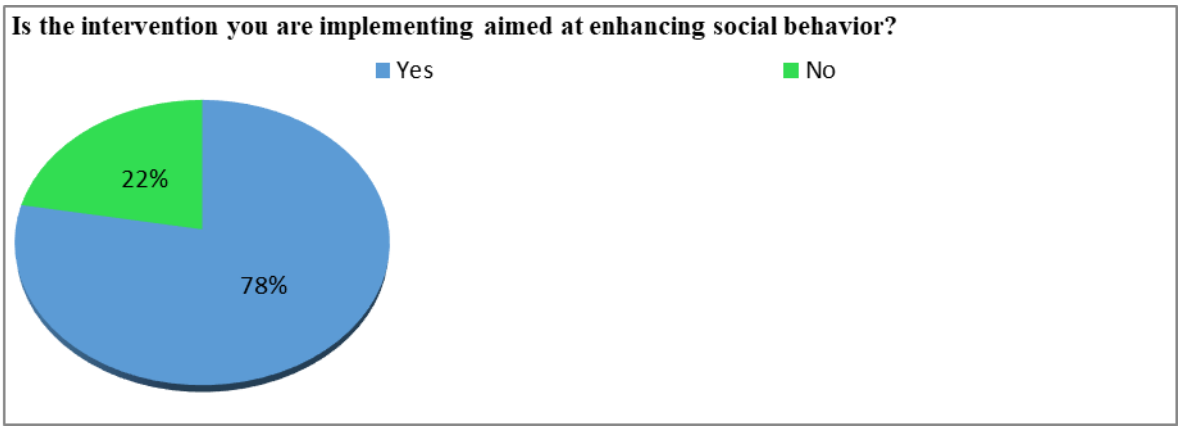

Chart 27: Frequency rates of improvements in targeted social behaviors as a primary goal in speech therapy interventions for children with Down syndrome

From the analysis of the responses to this specific question, it emerged that the main cause of unacceptable behavior in children with DS is communication problems, whether verbal or not, as stated by most respondents (75.6%). Accordingly, 57.8% answered that they are due to the existence of stereotypes and obsessions, 46.7% to an inability to understand social norms, and only 2.2% attributed the behaviour to a lack of discipline. Many of the responses included more than one reason for the behavior.

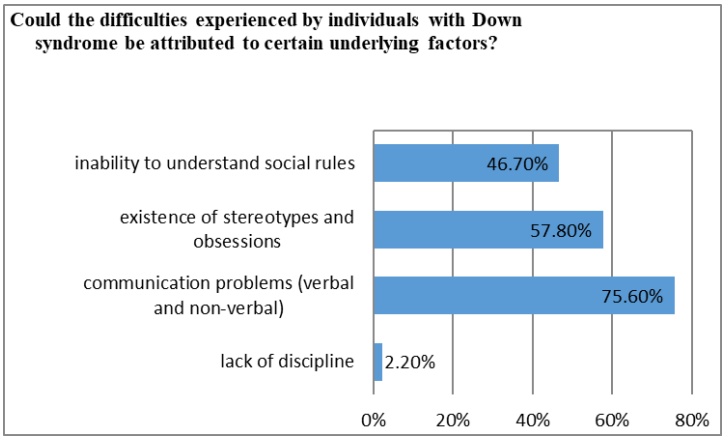

Chart 28: Frequency rates for the causes of unacceptable behavior in Down syndrome

Among participants, the majority (82.2%) identified the development of oral language as a key goal of intervention, with 80% also emphasizing enriching the vocabulary of children with DS. A smaller percentage mentioned addressing articulatory and phonological errors (31.1%), as well as promoting phonological awareness (31.1%). Notably, some responses highlighted a combination of oral language development and vocabulary enrichment, while others encompassed all four goals simultaneously.

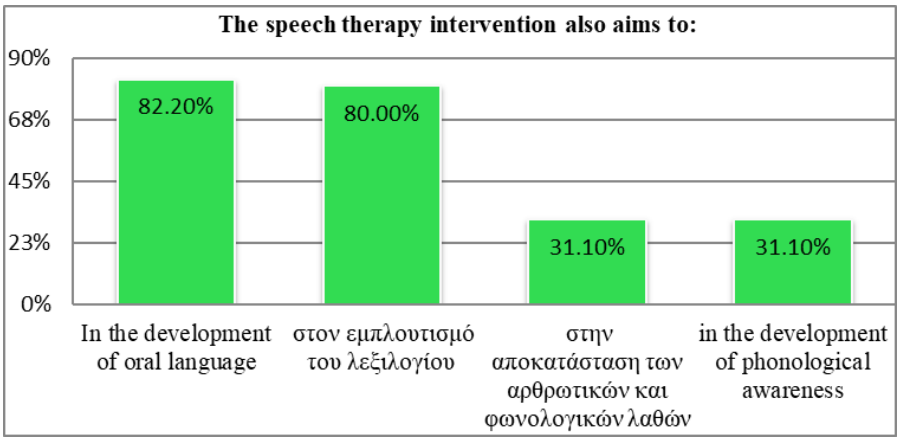

Chart 29: Frequency rates for specific goals targeted in speech therapy interventions for children with Down syndrome

Nearly all the speech therapists interviewed (97.8%) believe that learning concepts and communication skills contribute to the language development of these individuals. Only one participant (2.2%) expressed a differing view. Out of a total of 45 participants interviewed, these results were observed.

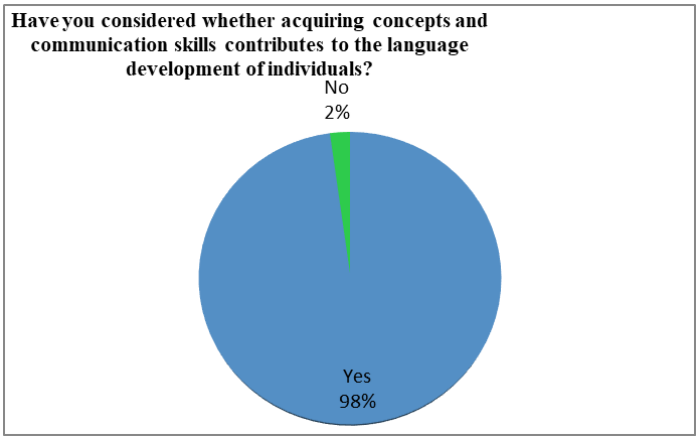

Chart 30: Frequency rates for learning concepts and communication skills in children with Down syndrome

When considering the generalization of acquired knowledge and behaviors across different environments, a vast majority of speech therapists (97.8%) agreed that it is essential to do so, while a small percentage (2.2%) expressed that they did not believe it to be necessary.

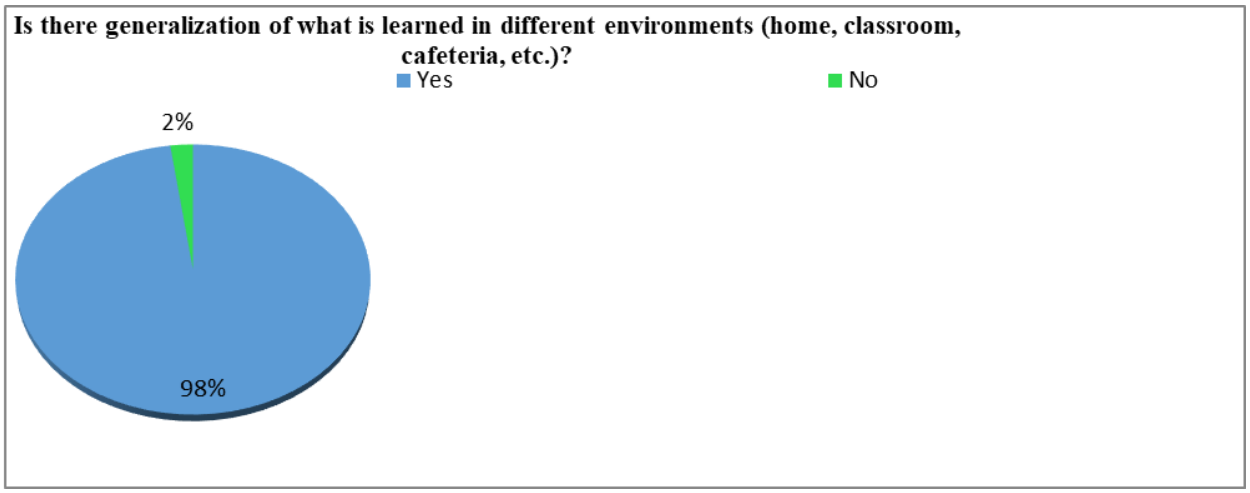

Chart 31: Frequency rates of the generalization of acquired knowledge and behaviors in children with Down syndrome

Every speech therapist in the study reported introducing other family members to the speech therapy intervention for children with Down syndrome.

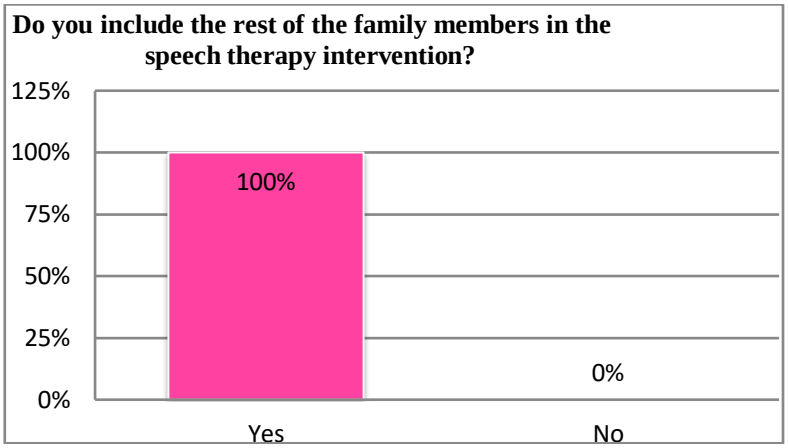

Chart 32: Frequency rates of family member involvement in speech therapy interventions

4. Discussion

The research findings highlighted a significant lack of knowledge and experience among speech therapists in working with individuals with Down syndrome. Most of the speech therapists (42.2%) involved in the study have 0-5 years of experience, predominantly working in private practices (80%), with over half (51.1%) holding postgraduate qualifications. Participants had varying degrees of exposure to Down syndrome cases, with a majority (35.6%) handling 1-3 instances and some having no prior encounters with this condition. Moreover, a prevailing trend indicated that speech therapists primarily focus on preschool and school-aged children.

To initiate the analysis, the vast majority (97.8%) correctly identified delays in consonants and vowels production initiation and first words acquisition in children with Down syndrome compared to typically developing children. Similarly, a high percentage (93.3%) recognized delays in expressive vocabulary among these children, consistent with existing literature (Bleile & Schwartz, 1984). The onset of the expressive period for children with Down syndrome was found to span from 1 to 6 years, influenced by factors such as reduced hearing ability and facial skeletal deformities.

Furthermore, participants displayed an awareness of the challenges related to language mechanisms, cognitive domains, and perception in individuals with Down syndrome, as illustrated in Figures 6 and 7. However, they inaccurately attributed speech production difficulties to a singular oral-facial anomaly, as highlighted in the options provided in Diagram 8. Dodd and Thompson (2001) stated that musculoskeletal abnormalities of the face lead to difficulties in coordinating joint movements, in addition to reduced hearing ability. Furthermore, when it comes to the production and writing abilities of individuals with DS, 95.6% of speech therapists acknowledged their challenges. Fowler (1990) highlighted how children with DS struggle with combining words and forming simple sentences compared to typically developing peers. They often use shorter and less complex expressions, alongside non-verbal communication skills. Phonological errors are also common in preschool and school-aged children with DS, as identified by all speech therapists in the study sample. In terms of the expressive domain,

it was observed that communication skills, such as gestures, excel in children with DS while speech production lags, with about 90% of respondents agreeing. Chapman (1997) emphasized that DS is a prevalent cause of intellectual disability, with 77.8% recognizing difficulties in maintaining eye contact.

The literature review on pragmatics in DS revealed challenges in mastering components of joint attention, like mutual eye contact (Abbeduto *et al.*, 2007). Memory plays a crucial role in knowledge acquisition, yet DS poses specific hurdles, particularly in short-term memory as highlighted by Buckley (1986). It is important to recognize these nuances, as almost half of speech therapists are unaware of the distinct difficulties DS individuals face in short-term memory compared to long-term memory. When considering reading ability, discussing, and narrating skills among individuals with Down syndrome (DS), deficiencies exist as highlighted by Martin *et al.* (2009), which are recognized by most speech therapists (100% for discussion, 66.7% for narration). These challenges are also evident in the complex grammar skills affected by limited mental development in children with DS (Fowler *et al.*, 1994), acknowledged by 95.6% of participants. Various assessment tools are used, with a preference for weighted (51.1%) or informal (48.9%) methods, particularly focusing on language skills using tools like Action Pictures, the METAPHON test, and the Language Perception and Expression Test among others. Additionally, some therapists utilize psychometric assessment tools like the weighted LOT-R and Wisc-V.

In speech therapy interventions, most therapists begin their work during preschool years (73.3%) and collaborate with a range of specialists including occupational therapists, physical therapists, social workers, special educators, and psychologists to address primarily social skills improvement (68.9%) and language development (57.8%). These professionals work collectively (80%) recognizing the social deficits in children with DS without signs of aggression (77.8%). Verbal and non-verbal communication problems (75.6%) along with potential stereotypical behaviors and obsessions (57.8%) contribute to unacceptable behaviors in these individuals (Martin *et al.*, 2009). Furthermore, speech therapists advocate for additional goals such as oral language development (82.2%) and vocabulary enrichment (80%) to enhance overall communication skills. It is crucial to highlight that 97.8% of individuals showed improvement when generalizing social skills across different environments. Furthermore, parental involvement in speech therapy interventions (100%) and adherence to therapist instructions to support the child's progress are essential. In conclusion, a small portion of the sample population exhibited insufficient knowledge regarding language development characteristics and the goals of speech therapy intervention in individuals with Down syndrome.

4.1 Research limitations

The present research, like most studies based on a questionnaire, faced challenges due to deviations from reality. This was largely influenced by the small percentage of speech therapists who participated, many of whom had limited work experience. As a result,

this study is vulnerable to potential reliability issues, particularly in the realm of data accuracy and trustworthiness.

Conflict of interest statement

The authors whose names are listed below immediately certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

All authors have participated in (a) conception and design, or analysis and interpretation of the data; (b) drafting the article or revising it critically for important intellectual content; and (c) approval of the final version. The Article I have submitted to the journal for review is original, has been written by the stated authors and has not been published elsewhere. The Figures that I have submitted to the journal for review are original, were taken by the stated authors, and have not been published elsewhere. This manuscript has not been submitted to, nor is under review at, another journal or other publishing venue. The authors have no affiliation with any organization with a direct or indirect financial interest in the subject matter discussed in the manuscript

Corresponding author

Name: Dimitra Chaldi, BSc. S-LP, M.ADS, PhD Student
Affiliation: PhD Student, Department of Otorhinolaryngology-Head and Neck Surgery, University of Patras, School of Medicine, Patras, Greece
Address: University of Patras, University Campus, 26504, Patras, Greece.
Email: dimitrachaldi.speech@gmail.com

About the Author(s)

Dimitra Chaldi, PhD Candidate, Faculty of Medicine, University of Patras, Greece; M.ADS (Specialization in Applied Behavior Analysis), BSc. S-LP; Speech - Language Therapist at Speech Rehabilitation Institute, Patras, Greece; LSVT-Loud Certified Clinician; Prompt - Bridging Certified Clinician; Hanen - It Takes Two to Talk Certified S-LP.

Antonia Karagiannidou, MSc. Student at Auditory Processing Disorder-Psychoacoustic Applications, School of Medicine, Aristotle University of Thessaloniki, Greece; Speech - Language Therapist at Everybody Talks, Komotini, Greece.

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