

Mehmet Ongun, Nebi Mustafa Gumus, Selim Ünsal, Ali Yildirim*, Sevda Yüksel, Mustafa Yüksel and Mehmet Gündüz

Research on articulation problems of Turkish children who have Down syndrome at age 3 to 12

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Abstract

Background: Articulation is a process that allows air to pass through vocal cords and then form words and syllables using the tongue, teeth, mentum and palatine tonsils. A person who has pronunciation problems produces, syllables or words inaccurately so; the auditors have got difficulty to understand what did say, such that the listener has difficulty in understanding what is being said. Due to being genetically different the Down syndrome individual has difficulty with speech due to structural defects in the mouth and problems with the mouth-tongue muscles.

Aim: Here the determination of the articulation (pronunciation) problems and the probable causes of the determined problems have been studied.

Methods: This study involved children without hearing loss problems; 17 females and 23 males who have Down syndrome and were ages between 3 and 12 years. The Ankara articulation test (AAT) was applied to the individuals. The articulation (pronunciation) ages have been determined according to the ATT. By the detailed assessment of the ATT, it was determined which voices were uttered correctly or not. Through a family interview survey, the information that affected the development of the Down syndrome child's speech and academic development was obtained. Through a patient identification survey, the education and health information that may effect the speech development were obtained. Through an oral motor assessment survey, the information regarding the competence of oral motor skills that may effect articulation problems were collected. The data were analyzed. Using a family survey, child identification survey

and an oral motor assessment survey the correlation between articulation age and articulation defects were viewed.

Results: It has been detected that the articulation age of Down syndrome children between 3 and 12 years of age are quite a bit lower when compared to the chronological age according to the ATT. Moreover, in terms of results from the ATT, children with Down syndrome whose chronological age is 8 years 7 months have a 3 year 5 months' articulation age according to the ATT. They have some difficulties with Turkish vowels such as (/a/, /e/, /ı/, /i/). Also they have some difficulties with consonants such as (/r/, /j/, /z/, /ş/, /z/, /l/, /s/, /n/). Articulation defects at various levels have been detected for all Down syndrome children. Articulation (pronunciation) problems were encountered less in children from highly educated and more concerned families. It has been shown that articulation (pronunciation) problems are less children who receive early treatment, therapy and education services.

Conclusion: Significant correlation between the level of articulation usage by individuals and frequency of the articulation problem were detected. For this reason, attaching importance to oral motor studies are considered. Raising parental awareness is required on prenatal diagnosis of Down syndrome. By treating the problems of the speech organs at an early age and including the children who have Down syndrome into the early education programs around 0–3 years and accurate intervention during critical periods, the articulation problems can be reduced. Using a wider age range and having more participants, it is considered that more efficient results may be obtained.

Keywords: articulation problems; Down syndrome; pronunciation problems.

*Corresponding author: Ali Yildirim, Department of speech and language therapy, De Montfort University, The Gateway, Leicester, LE19BH, UK, E-mail: P1204214@myemail.dmu.ac.uk

Mehmet Ongun, Nebi Mustafa Gumus, Selim Ünsal, Sevda Yüksel, Mustafa Yüksel and Mehmet Gündüz: Department of Audiology and speech disorders, Turgut Ozal University, Yenimahalle/Ankara, Turkey

Introduction

Down syndrome (DS) indicates the presence of an extra chromosome, i.e. here are 46 chromosomes instead of

47 chromosomes [1]. An infant with DS has low muscle tone known as hypotonia. This means that individual's muscles are loose and "soft". Low tone usually affects all the muscles in the body. This situation is an obvious physical feature, which mobilizes doctors to search for other signs of Down syndrome. More importantly, low muscle tone affects the movement, strength and development of the individual [2, 3]. While many of the physical characteristics associated with DS do not affect individual growth and learning ability, low muscle tone makes it difficult for all areas of development. For instance, low muscle tone has an impact on rolling on the floor, sitting, standing and walking. Another area that low muscle tone affects the ability of the infant to accept solid foods, because low muscle tone is observed in the mouth muscles [3, 4].

Cognitive development of individuals with DS is slow compared to individuals with normal development. While delays in cognitive development affect other skills, it also has an impact on the infant's language skills [4]. Articulation disorders of children with Down syndrome occurs based on the incorrect coordination of the movements of lips, tongue, velum (soft palate), jaw or pharynx or a mistake in the placement, timing, direction, pressure and of speech [5].

Young children with DS have difficulty in both articulation and phonology. The possibility of progress in phonology becomes more and more possible through the treatment and practice of learning more about correct and incorrect sound patterns. Articulation, on the other hand, is more difficult as it depends on anatomical and physiological factors (such as lower teeth being ahead of the upper teeth or the difficulty in coordinating muscles) and it becomes even more complicated with oral motor and motor planning difficulties [6].

Anatomical and physiological differences are the foremost underlying factors which cause problems that make it difficult to articulate speech for individuals with DS [7] (see Table 1). Articulation disorders definitely affect speech intelligibility [8]. Articulation is a serious problem for children with DS. Analysis of the underlying cause of these problems was the main goal of this research.

Table 1: Participants' physiotherapy, speech and language, and oral motor training status.

	Involved (%)	Not involved (%)
Physiotherapy	16 children (40)	24 children (60)
Speech and language	10 children (25)	30 children (75)
Oral motor	8 children with DS (20)	32 children (80)

Methods

A mixed method research design was used in this study. Forty individuals with DS (16 female, 24 male) aged between 3 and 12 years (see Table 2) who receive care from special education and rehabilitation centers in Istanbul participated in this research. Hearing tests were performed.

Those who are in 500–4000 Hz pure tone audiometry average in the range of 0–15 dB, whose middle ear pressure is ± 50 daPa and have type A tympanogram, ipsilateral and contralateral reflex thresholds in the range of 85–90 dB were involved in the study. The Ankara articulation test (AAT) was used to measure the articulation levels of the children. Based on the AAT results (see Table 3), their articulation age was determined.

With the AAT's detailed evaluation options, which sound was uttered correctly or not was identified. As there is no rating for ATT vocal sounds, vocal sound were evaluated separately. For this purpose, children were shown pictures describing the vocal sounds at the beginning, in the middle and at the end of the assessment. For each sound, word initial, syllable initial, vowel in the middle, final syllable and final word assessments were realized. To do so, specific pictures showing each sound's position were chosen.

The inability to pronounce sounds correctly and no pronunciation was accepted as there being no sound. With the help of family interview surveys, the child identification questionnaire, and the oral motor assessment questionnaire, information which may affect the individual's articulation problems, were collected. Research questionnaires were adapted from the questions of previous questionnaires used by language and speech therapists, which might affect articulation. The family questionnaire (see Table 4), child identification questionnaire, and oral motor assessment questionnaire (see Table 5) data was used in identifying the correlation between articulation age and articulation disorders.

Findings

This study primarily focuses on 3- to 12-year-old children diagnosed with DS. The reason for starting with 3 year olds is that Smith et al. [9] suggest that the utterance of the first word of individuals with DS starts at the age of 2–3 years.

Twenty-three of the participants were male (57%) and 17 of them were female (43%). Sounds with experienced articulation disorder between the genders were contrasted statistically and there were no significant relationships between the genders.

Table 2: Age of participants.

	3–6 Years	6–12 Years
n	12	28
%	30	70
Min	38 months	76 months
Max	67 months	136 months
Med.	60 months ± 1.23	120 months ± 1.91

Table 3: Assessment of vowels and consonants in initial, middle and final positions.

	Initial		Middle		Final	
	Sound available	Sound unavailable	Sound available	Sound unavailable	Sound available	Sound unavailable
a	39	1	39	1	39	1
e	36	4	33	7	32	8
ı	27	13	26	14	26	14
i	31	9	30	10	29	11
o	30	10	29	11	29	11
ö	27	13	27	13	27	13
u	30	10	28	12	28	12
ü	27	13	25	15	26	14
b	37	3	33	7	–	–
c	13	27	12	28	–	–
ç	21	19	22	18	–	–
d	35	5	32	8	–	–
f	23	17	23	17	23	17
g	21	19	13	27	–	–
ğ			12	18	10	30
h	23	17	19	21	16	24
j	5	35	9	31	5	35
k	26	14	22	18	22	18
l	26	14	26	14	25	15
m	36	6	32	8	28	12
n	28	12	30	10	30	10
p	18	22	18	22	22	18
r	6	34	6	34	8	32
s	29	11	26	14	24	16
ş	9	31	11	29	16	24
t	23	17	23	17	22	18
v	12	28	13	27	12	28
y	25	15	24	16	24	16
z	14	26	12	28	15	24

Table 4: Participants' parents educational status.

	Illiterate (%)	Elementary-middle school (%)	High school (%)	University (%)
Mother	4 (10)	20 (50)	12 (30)	4 (10)
Father	–	16 (40)	14 (35)	10 (25)

We compared articulation disorders of those who are involved and not involved in physiotherapy and no meaningful correlation was found. It was found out that children with DS who are involved in speech and language therapy experienced less articulation disorders. We compared articulation disorders of those who are involved and not involved in oral motor therapy and a meaningful correlation was found.

Articulation disorders of children of mothers who are elementary-middle school graduates were contrasted statistically and it was found that children of mothers who are illiterate and elementary-middle school graduates experience more articulation disorders.

The children of families who work on oral motor practices experience less articulation disorders.

Findings of test method

Participants' articulation age identification analysis

The articulation age averages of 3–6-year-old children with DS were 2:0–2:11 months (2 years, 6 months to 2 years, 11 months), and articulation age averages of 6–12-year-old children with DS were 3:0–3:11 months (3 years to 3 years, 11 months).

Vowels and consonants assessment tables

There is no statistically meaningful correlation among the initial, middle and final positions of all sounds in

Table 5: Participants' oral motor assessment statistics.

	Did (%)	Partially Did (%)	Did not Do (%)
Pursing	15 (37)	19 (48)	6 (15)
Pursing the lips to make a kiss	14 (35)	11 (27)	15 (38)
Puffing out the cheeks	11 (27)	13 (33)	16 (40)
Upper lip licking	14 (35)	21 (52)	5 (13)
Lower lip licking	14 (57)	10 (25)	7 (18)
Circular licking lips	4 (10)	17 (42)	17 (42)
Touching tongue to upper palate	10 (25)	10 (25)	20 (50)
Tongue snapping by sticking it to palate	1 (2)	16 (40)	23 (58)
Putting out the tongue and moving it up and down	4 (10)	20 (50)	16 (40)
Putting out the tongue and moving it left and right	18 (45)	11 (27)	11 (28)
Opening and closing jaw rapidly	19 (47)	14 (35)	7 (18)
Holding breath and breathing out interruptedly	11 (27)	8 (20)	21 (53)
Correct use of breath	6 (15)	–	34 (85)

Table 6: The most problematic to the least problematic ranking in consonant sounds.

Male	Female
The most problematic articulation sounds in initial sound position /j/, /r/, /ʃ/, /c/, /v/, /z/, /k/	/r/, /j/, /ʃ/, /v/, /z/, /y/, /p/, /g/
The most problematic articulation sounds in middle sound position /r/, /j/, /c/, /z/, /v/, /ʃ/, /ğ/, /g/	/ğ/, /j/, /r/, /ʃ/, /z/, /g/, /v/, /c/
The most problematic articulation sounds in final sound position /j/, /r/, /v/, /ğ/, /h/, /z/, /ʃ/	/j/, /r/, /ğ/, /z/, /v/, /ʃ/, /y/

Table 7: The most problematic to the least problematic ranking in vowel sounds.

Male	Female
The most problematic articulation sounds in initial sound position /ü/, /ö/, /ı/, /u/, /o/, /i/, /e/, /a/	/ö/, /ü/, /ı/, /u/, /o/, /i/, /e/, /a/
The most problematic articulation sounds in middle sound position /ü/, /ö/, /ı/, /i/, /u/, /o/, /e/, /a/	/ı/, /ü/, /u/, /ö/, /o/, /i/, /e/, /a/
The most problematic articulation sounds in final sound position /ü/, /ö/, /ı/, /i/, /o/, /u/, /e/, /a/	/u/, /ö/, /ü/, /o/, /ı/, /i/, /e/, /a/

the perceptions of the 40 male and female children with DS aged 3–12 years ($p \geq 0.05$). Table 3 shows the most problematic sounds, which children with DS make mistakes.

Regarding the articulation disorders with vowel sounds, the least problem are experienced with /a/, /e/, and /i/ sounds while the most problem are experienced with /ü/ and /ö/ sounds. There is no significant difference between male and female children with DS ($p \geq 0.05$).

Discussion

The number of articulation problem cases of individuals with DS is very high. Researchers found that almost 95%

of children with DS experience articulation problems [10, 11]. Individuals with DS make more mistakes with consonants compared to vowels. When adolescents with DS are articulating consonant sound in different words, they make more mistakes compared to adolescents with other mental disabilities [11] (see Tables 6 and 7).

A research on children with DS revealed that 90% of sound mistakes were related to consonant sounds [11]. In the same research, children with DS did not have any difficulty in uttering vowel sounds. In this research, articulation disorders were encountered with l, r, t, d, c, and j sounds which are uttered by the contact of the tongue to the palate. In his study, Beck associated this problem with the different nature of the palate of children with DS [12].

In their study, Bunton et al. observed articulation disorders depending on the articulation position (back or front) of vowel sounds [10]. In our study, even though there was no significant difference between the positions of vowel sounds, a meaningful correlation was found with rounded and unrounded vowels. More articulation problems were encountered with rounded vowels (o, ö, u, ü). In the same research, Bunton et al. met some contrasts in the positions (initial, middle, final) of sounds. A sound, which was pronounced correctly in the initial position, was articulated incorrectly in the final position.

This study assessed the sounds with their different initial, middle and final positions (see Table 3). Although we have experienced contrasting situations in the initial, middle, and final positions, we generally observed that the sound with articulation disorder was problematic in all positions. Sommers et al. stated that the most commonly mispronounced sounds are (in descending order): /s/, /d/, /t/, /r/, /z/, /l/, /s/, /r/, /n/, and /v/ [13]. Unlike the findings of Sommers's study, our research revealed that /n/, /d/ and /t/ sounds were removed from this list and /j/, /ğ/, /c/, and /g/ sound were added to it (see Table 6).

All of the 40 participants in this study experienced articulation disorders. They mostly had difficulty in complex (hard to articulate) and voiced sounds. Rounded vowels were more problematic among the vowel sounds. Kumin [6] found in his study that children with DS had speech disorders due to oral motor impairment.

Only eight of our research participants received articulator development support therapy and 10 of them worked with a language and speech therapist. We see that the children who get oral motor skills development and articulation therapy experience less articulation problems. Pueschel's study shows that children with DS benefit to a large extent from sensory and cognitive stimulus, gross and fine motor skills practices, and speech therapy [14]. If children with DS have muscle tone in the tongue and cheek that is weak, speech and language pathologists must provide support for these individuals to improve the individual's muscle tone and coordination [4]. It is important to conduct more research on whether children with DS have delayed or regular phonological development [15]. According to Kumin, in order to minimize individuals with DS articulation disorders, to solve unidentified or untreated medical problems of individuals with DS, and to help these children articulate those sounds, it is of great significance that they must make use of their tongue, lips, cheeks, chin, throat, and diaphragm to their full potential [4].

In his study on children aged 2–8 years, Topbaş [16] lists early adopted phonemes as follows: “nasal sounds>labial plosive sounds>liquid approximates>lateral approximates>stop fricative>fricative>tap”. Generally, voice sounds are acquired in the initial word position, while voiceless sounds are obtained in the final word position, and word position is the determining factor in the acquisition of phonemes. In the 8th International Transcription Alphabet, nasal sounds are /m/, /n/; labial plosive sounds are /p/, /b/; approximate sounds are /l/, /r/, /y/, and fricative sounds are /s/, /z/, /v/ and /c/ [16].

The easiest sounds articulated by research participant children with DS are nasal sounds and plosive stop sounds. It requires a good skill of managing tongue, lips, cheeks, jaw, cheek articulators, and breathing, which are articulation elements, in order to pronounce the phonemes correctly. Considering the low hypotonic muscle and slowness in motor skills of children with DS, these children use articulators much less and they experience less problems with tongue and unrounded vowel phonemes.

Repeatedly experiencing upper respiratory tract infections might result in hearing loss of children with DS. According to Kumin (2006) [17], various hearing losses at different levels were encountered in children with DS. Hearing loss leads to articulation disorders. However, as observed by Vicari (2006) [18], “There is no conclusive evidence regarding the fact that speech disorder of individuals with DS is the result of hearing loss”. In this study, parents of children with DS expressed that their children got upper respiratory tract infections more than four times a year. In another question that we asked the families, only 13 out of 40 families stated that they made their children with DS have a hearing test in the last 2 years. This shows that health facilities have problems regarding patient monitoring and redirection [4].

There is no significant difference in terms of phoneme acquisition between male and female children with DS. It was found that female children acquire g/ y /ş, /ç /j phonemes 6 months earlier than male children [4]. This study did not study the phoneme acquisition ages of male and female children with DS. However, it was observed that the most problematic sounds for children with DS are the ones that are consequently acquired (j, r, g, v, z, ş, ç) [4].

A huge proportion of research participant children with DS are receiving or have received psychotherapy. Considering the frequency of articulation problems of children with DS who are getting and not getting psychotherapy, there is no meaningful correlation between these variables. This makes us infer that psychotherapists do not study oral language, lips, cheeks, jaw, and diaphragm

or they do not have adequate equipment to do so. When families were asked, they said that psychotherapists focus only on gross motor skills. Family and child centered education is the most common education model in training children with special needs [19]. Family and children are always the center of this education process. Experts suppose that when shown how to, mothers, fathers and other family members, who spend most of their time with children with DS, can be more effective in training these children. While mothers are the prominent parent in the education of children with normal development, they are also to the fore in guiding children with DS.

It is obvious that when a disciplined education and health regimen is ensured for children with DS in the 0–3 years and 3–6 year age groups by their mothers and fathers, children's speech disorders will surely decrease to a minimum. It is also essential to inform families more about DS by involving them in training. This study has revealed that the families who seek more information about their children's education and health status can minimize articulation problems compared to those who do not research about their children's disorders. It was found that when the families have only primary school education level, the total number of sounds which cannot be articulated by the children with DS increases. Additionally, when fathers are involved in the education process, children have even less articulation problems.

Results

In Turkey, the number of speech and language therapist is very limited. Children with special needs, particularly individuals with DS can only benefit from language and speech therapy services. The National Education Ministry and Health Ministry must work towards a solution to this critical issue.

Hypotonic muscle in DS children plays a preventive role on both motor skills development and as well as language development. Nevertheless, with certain exercises and long lasting therapy to especially improve oral muscles, it is possible to minimize the impact of this disorder even though it is almost impossible to overcome this problem.

At this point, expert educators and educational institutions specialized in this field must take the initiative on this topic. Although individuals with DS experience difficulties in articulating most of the phonemes because of genetic problems, it is predicted that they can minimize their articulation disorders with the help of effective language and speech therapy in the very critical periods.

In our country, most of the children with DS get psychotherapy due to low muscle tone. However, studies on oral motor muscles is limited. It is thought that psychotherapists must specialize more on this issue. It is obvious that when a disciplined education and health regimen is ensured for children with DS in the 0–3 years and 3–6 years by their mothers and fathers, children's speech disorders will surely decrease to minimum. It is also necessary to inform families more about DS by involving them in training. DS clinics must be opened up throughout the country and follow-up and controlling mechanisms must be prepared for the children and families upon once DS is diagnosed. It is significant to note that there is little that individuals with DS cannot achieve when their health problems are kept to a minimum.

This study shows that by more participation and much more detailed research more vital data can be gathered on this issue.

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