RESEARCH ARTICLE
DOI: 10.26650/Tr-ENT.2024.1598499
The Turkish Journal of Ear Nose and Throat 2024;34(4):115-123

Relationship between Anatomical and Physiological Problems with Speech Problems in Turkish-Speaking Children with Cleft Lip and Palate*

Namık Yücel Birol[1,2], Özlem Ünal Logacev[3]

[1]İstanbul Medipol University, Graduate School of Health Sciences, Department of Speech and Language Therapy, İstanbul, Türkiye
[2]Tarsus University, Faculty of Health Sciences, Department of Speech and Language Therapy, Mersin, Türkiye
[3]İstanbul Medipol University, Faculty of Health Sciences, Department of Speech and Language Therapy, İstanbul, Türkiye

ORCID ID: N.Y.B. 0000-0001-7155-3591; Ö.Ü.L. 0000-0002-5509-5655

Citation: Birol NY, Ünal Logacev Ö. Relationship between Anatomical and Physiological Problems with Speech Problems in Turkish-Speaking Children with Cleft Lip and Palate. Tr-ENT 2024;34(4):115-123. https://doi.org/10.26650/Tr-ENT.2024.1598499

ABSTRACT

Objective: The aim of this study was to describe the speech and resonance characteristics of Turkish-speaking children with cleft lip and palate (CLP) and to investigate the relationship between oral anatomical-physiological problems and speech-resonance problems.
Materials and Methods: 40 Turkish-speaking children with CLP between the ages of 3 and 15 underwent oral-motor evaluation, nasometric evaluation (The Nasometric Assessment Tool-Turkish), articulation evaluation (sentence repetition test), and perceptual resonance evaluation.
Results: The most common speech errors seen in the participants were backing, differentiation of glides, voicing errors, labialisation, nasalisation, palatalisation, dentalisation and lateralisation. 35% of the participants had normal resonance, while the remaining 65% had resonance-airflow problems. A significant relationship was found between hypernasality and nasalisation, weak articulation, and double articulation. A significant relationship was found between class III malocclusion and dentalisation, lateralisation, bilabialisation; crossbite and lateralisation; missing teeth and dentalisation, palatalisation, fronting.
Conclusion: There is a relationship between dental and occlusal anomalies and speech errors and between hypernasality and speech errors. In addition to articulation errors, phonological processes may also be present in Turkish-speaking children with CLP. The results of this study can be taken into consideration by speech and language therapists while conducting assessments and providing interventions for Turkish-speaking children with CLP.
Keywords: Cleft palate, speech disorders, speech sound disorder

INTRODUCTION

In humans, cleft lip and palate (CLP) is the most prevalent orofacial abnormality (1). CLP was the second most common major congenital anomaly after central nervous system anomalies in a study conducted in Türkiye (2). The prevalence of CLP in Türkiye has been reported as 8.11 per 10 000 live births (3).

Individuals with CLP may have structural and physiological problems in the oral-facial structures such as the jaw, teeth, nose, lips and palate (4). These problems can lead to various challenges, including speech deficits, feeding issues, hearing issues, and dental malformations (5). CLP can cause speech sound disorders and resonance problems (6). There are studies investigating the articulation and phonological characteristics of children with CLP who speak languages such as English, Swedish, Hebrew, Portuguese, and Arabic (7-11). Information about CLP speech characteristics in less assessed languages can teach researchers and clinicians more about universal CLP speech disorders. In addition, because each language has a different phonological system, the identification of language-specific CLP speech errors may enable the development or adaptation of interventions for that language.

There are very few studies describing the speech characteristics of Turkish-speaking children with CLP (12–14). Tezel evaluated

* This study was completed within the scope of the first author's Master's Thesis at the İstanbul Medipol University.

Corresponding Author: Namık Yücel Birol **E-mail:** namikyucelbirol@tarsus.edu.tr
Submitted: 09.12.2024 • **Revision Requested:** 21.12.2024 • **Last Revision Received:** 22.12.2024 • **Accepted:** 23.12.2024 • Published Online: 31.12.2024

the speech characteristics of five Turkish-speaking monolingual children aged 3.5-6.5 years with cleft palate (12). The most common speech errors in Tezel's study were nasalisation, backing, differentiation of glides, fricativisation, and voicing errors. Because phonological delays were observed in all participants in Tezel's study, Tezel stated that phonological problems were considered caused by phonetic errors. Dinsever-Eliküçük et al. evaluated the speech of 87 Turkish-speaking CLP children between the ages of 6-18 and found pharyngeal fricatives, posterior nasal fricatives/stop production, glottal stop production, middorsal palatal stop production, nasal frictional production, posterior nasal frictional production/phoneme specific nasal emission, use of nasal consonants for oral consonants, and replacement of trills consonant production errors (14). Dinsever-Eliküçük et al. focused on compensatory articulation errors in their study. Ünal-Logacev et al. assessed the speech problems of 35 children aged 0-18 years who grew up in a Turkish-speaking environment and found nasalisation, weak articulation, double articulation, differentiation of glides, labialisation, fronting, active nasal fricatives, lateralisation, voicing errors, dentalisation and palatalisation speech errors, with backing being the most common (13). In general, studies of CLP speech features in the Turkish literature are controversial and limited.

The anatomical features, physiological processes, and speech problems of children with CLP should be identified by speech and language therapists (SLTs). In addition, SLTs must demonstrate how speech problems relate to these structures and functions. As a result, the SLT's understanding of which anatomical and physiological issues are related to speech problems is important for making a differential diagnosis about the speech problem, guiding the child correctly and implementing effective intervention methods (4).

The aim of this study was to describe the oral anatomy-physiology and speech characteristics of Turkish-speaking children with cleft lip and palate and to examine the relationship between the anatomical-physiological problems and speech-resonance problems of these children. While this study primarily focuses on the relationship between articulation-phonological errors and anatomical-physiological problems in CLP participants, nasalance scores compared based on nasality judgments are included because they are significant from a clinical standpoint. The research questions of this study are as follows:

- What are the oral anatomical-physiological problems and speech-resonance characteristics of Turkish-speaking children with CLP?
- What is the relationship between the oral anatomical-physiological problems and the speech-resonance characteristics of Turkish-speaking children with CLP?
- Is there a statistically significant difference between the nasalance scores and the perceived resonance and nasal airflow of Turkish-speaking children with CLP?

MATERIALS AND METHODS

Participants

This cross-sectional study described the oral anatomical and physiological problems of Turkish children with cleft lip and palate between the ages of 3 and 15 years, using the Cleft Lip and Palate Assessment Form and the Nasality Microphone, and examined the relationship between these anatomical-physiological problems and speech-resonance problems.

This study was conducted on participants with cleft lip and palate who applied for speech and language assessment at the Medipol Language, Speech and Swallowing Therapy and Innovative Technologies Research and Application Centre (MEDKOM). Data were collected before the COVID-19 pandemic.

The criteria for inclusion in the study are as follows:

- Presence of cleft lip and palate, isolated cleft palate, submucous cleft, occult submucous cleft, or velopharyngeal insufficiency not attributable to any cause
- 3;0 - 18;0 years of age,
- Turkish mother tongue,
- Ability to cooperate in the assessment process (allowing oral-motor assessment, repetition of speech stimuli),
- Normal hearing, determined based on the caregiver/family report during the evaluation process,
- No behavioural disorder to an extent that would interfere with the assessment.

A total of 67 participants were assessed. 12 participants were excluded from the study because they did not meet the age criteria and 15 participants were excluded because they did not wish to participate in speech-related tasks, such as repeating speech stimuli. As a result, the study was completed with 40 participants who met the inclusion criteria.

The mean age of the participants was 5.4±1.45 years. Of the participants, 50% were girls and 50% were boys. The age distribution revealed that 62.5% of the participants were in the 3;0-6;11 age range, 35% were in the 7;0-12;11 age range, and 2.5% were in the 13;0-17;11 age range. Regarding syndromic conditions, 82.5% of the participants had no syndrome, while 17.5% had a syndrome. Distribution by cleft type showed that 32.5% had unilateral primary secondary complete cleft, 22.5% had bilateral primary secondary complete cleft, 10% had secondary complete cleft, 12.5% had secondary incomplete cleft, 20% had submucous cleft, and 2.5% had velopharyngeal insufficiency. In terms of palate surgery history, 12.5% had no prior surgeries, 55% had undergone one surgery, 22.5% had undergone two surgeries, and 10% had undergone three surgeries. Regarding speech and language therapy history, 80% of the participants had no prior therapy experience, while 20% had received therapy previously.

Data collection tools

The Cleft Lip and Palate Assessment Form and the Nasometric Assessment Tool (NADA) were administered to the participants (13, 15). The Cleft Lip and Palate Evaluation Form is a Turkish assessment tool designed to evaluate individuals with CLP or craniofacial anomalies according to a specific protocol. The subtests of the Cleft Lip and Palate Assessment Form are the CLP Family Interview Form, the CLP Oral Peripheral Assessment Form, and the CLP Speech and Resonance Assessment Form. The CLP Family Interview Form subtest was used to explore possible genetic and environmental factors underlying cleft lip and palate or craniofacial anomalies and to obtain information about the child's prenatal, perinatal and postnatal history, general health and development. The CLP Oral Peripheral Assessment Form subtest includes items to help associate anatomical and physiological problems with speech disorders and peripheral assessment items. This subtest includes items that provide structural and functional assessment of malocclusion of the teeth, tooth structure, and presence and location of fistula, tongue, uvula, velum, and nasopharynx. The CLP Speech and Resonance Assessment Form subtest contains speech stimuli that can be used to assess speech and resonance in people with CLP. The speech assessment section of this subtest consists of a Sentence Repetition Test. In the Sentence Repetition section, there is a target sentence for each consonant in Turkish to determine the individual's speech errors.

The Nasality Microphone is a handheld, portable device used to measure nasality during speech production. It consists of a plate placed between the upper lip and the nose, with microphones above and below the plate to capture acoustic energy from the nasal and oral cavities. The device calculates a nasal balance score by dividing the nasal acoustic energy by the total nasal and oral acoustic energy, providing a numerical representation of nasality. After proper placement, the device is operated using software to record the speech sample. The Simplified Nasometric Assessment Procedures Revised (SNAP-R) test, which is used to assess resonance and velopharyngeal function, has been phonetically adapted to Turkish under the name Nasometric Assessment Tool (NADA), and normative studies have been conducted for individuals aged 4 to 18 years (15, 16). According to normative data, high nasality scores are compatible with hypernasality and low scores are compatible with hyponasality. The NADA consists of three subtests: the Syllable Repetition/Prolonged Sound Subtest, the Picture-Cued Subtest, and the Reading Subtest. The Syllable Repetition/Prolonged Sound Subtest consists of syllables and extended sounds. The Picture Cued Subtest consists of five different sentence sets. The Reading Subtest consists of two easy-to-read paragraphs, one with five nasal sounds and a weighted of plosive sounds, and the other with no nasal sounds and a weighted of fricative sounds. As the NADA standards are set for the Nazometer II: Model 6450, it was used in this study only for data collection and not for diagnosis.

Procedure

Families who applied to MEDKOM for speech and language evaluations related to cleft lip and palate were informed about the study and invited to participate. Families meeting the eligibility criteria and agreeing to participate signed an informed consent form before the evaluation, which was conducted in the assessment and phoniatry rooms at MEDKOM.

The Cleft Lip and Palate Assessment Form was administered to the family and child. During the medical history assessment of children under seven years of age, a speech and language therapy graduate student engaged the child with games to prevent boredom during the family interview. Before the speech and resonance assessment, the participants underwent an oral motor assessment, including structural and functional evaluations of the occlusion pattern, teeth, tongue, velum, uvula, nasopharynx, and fistula (location and size) using a light source.

Participants repeated sentences targeting consonant phonemes from the Cleft Lip and Palate Speech and Resonance Assessment Form subtest after the evaluator. Children under seven were encouraged to imitate a parrot to facilitate sentence repetition, and a speech sample was taken. For children who forgot the sentence, the evaluator prompted them by saying one word at a time (e.g., the evaluator says "Baba," and the child repeats "Baba"). Phonemes requiring clarification were elicited with the /ʌ/ sound (e.g., pʌpʌpʌ for /p/, sʌsʌsʌ for /s/). When necessary, the participants produced the target phoneme along with minimal pairs for further analysis. For those with extreme hypernasality, some sentences were spoken with the nose closed to better identify phonemes. All assessments were conducted under the supervision of a CLP-specialised speech therapist with 10 years of experience and two graduate students.

Participants underwent the Straw Test and the Resonance Assessment Test, which are subtests of the Cleft Lip and Palate Speech and Resonance Assessment Form, to evaluate resonance. In the Resonance Assessment Test, participants opened and closed their nose while saying a long /i/ and non-nasal words if hypernasality was suspected, or a long /m/ and nasal words if hyponasality was suspected. The resonance type was marked based on changes observed with nose opening and closing. In the Straw Test, a flexible straw was used to detect the airflow and resonance type by placing one end in the participant's nostril and the other in the assessor's ear during high-pressure sound repetitions.

For instrumental assessment, participants completed the NADA using the nasal microphone. Initially, the Picture Cued Subtest was administered, with the Syllable Repetition Subtest used for those requiring simpler stimuli. Nasalance scores were calculated for utterances with high-pressure phonemes. Because children under 4 years of age could not undergo nasometric evaluation, nasalance scores were obtained from 22 participants. Each assessment took approximately 10 minutes.

Phonetic transcription, oral-peripheral assessment and resonance-nasal airflow assessment of the speech stimuli were carried out in consensus with a CLP specialised speech and language therapist who has ten years of experience in working with children with CLP and two graduate speech and language therapy students. Speech and resonance assessments were videotaped using a Canon Legria HF R806 camera. In cases where there was no consensus between the assessors on the phonetic transcription and perceived resonance- nasal airflow type, video recordings were used.

Ethics

Ethical approval was obtained from the İstanbul Medipol University Non-Interventional Clinical Research Ethics Committee (Date: 30.11.2018 No: 703). Institutional approval was obtained from the İstanbul Medipol University Institute of Health Sciences to conduct the study at MEDKOM. Families who agreed to participate in the study were given detailed information about the study and signed an "Informed Consent Form." The names of the participants were kept completely confidential and coded with specific letters and numbers.

Table 1: Oral anatomical and physiological characteristics of the participants

	n	%
Occlusion type		
Normal occlusionun	18	45
Class II malocclusion	6	15
Class III malocclusion	16	40
Anterior open bite		
Yes	2	5
No	38	95
Posterior open bite		
Yes	1	2.5
No	39	97.5
Supernumerary teeth		
Yes	2	5
No	38	95
Missing teeth		
Yes	21	52.5
No	19	47.5
Crossbite		
Yes	9	22.5
No	31	77.5
Fistula		
Yes	12	30
No	28	70
Fistula position		
Anterior fistula	8	66.7
Posterior fistula	4	33.3
Fistula size		
≤ 2 mm	3	25
3–5 mm	4	33.3
6–8 mm	4	33.3
9 mm ≥	1	8.3

Data analysis

Statistical data analysis was performed using IBM SPSS Statistics 29.0. Descriptive statistics were used for the demographic data, speech and resonance characteristics, and oral anatomical-physiological characteristics of the participants. Means and standard deviations were calculated for continuous variables and proportions and percentages for categorical data. The Shapiro-Wilk normality test, skewness-kurtosis values and graphs were used to determine whether the data conformed to the normal distribution. As the data followed the normal distribution, the one-way ANOVA test, one of the parametric methods, was used to analyse the data. The chi-square test was used for the relational analysis of the categorical data, and the Phi correlation coefficients were calculated. In this study, the interpretation of the Phi correlation coefficient was based on the study of (17). Statistically, a value of $p<0.05$ was considered statistically significant.

RESULTS

Anatomical problems that may affect articulation and resonance, such as occlusion types, dental characteristics, presence, location, and size of the fistula, are listed in Table 1.

Among the children who participated in the study, 45% had normal occlusion and 40% had class III malocclusion. Anterior open bite was present in 5% of the participants, posterior open bite in 2.5%, and overbite in 2.5%. In total, 52.5% of the participants had missing teeth, 22.5% had crossbite, and 30% had fistula. Of the participants with fistula, 66.7% had fistula in the anterior region. The fistula size of 66.6% of the participants with fistula was between 3 and 8 mm (Table 1).

The articulation and phonological errors determined by transcribing the participants' speech data are shown in Figure 1.

Backing was found in 55% (n=23) of the children, differentiation of glides in 57% (n=23), voicing errors in 45% (n=18), labialisation in 42.5% (n=17), nasalisation in 27.5% (n=11), palatalisation in 25% (n=10), dentalisation in 25% (n=10), lateralisation in 22.5% (n=10), weak articulation in 17.5% (n=7), double articulation in 10% (n=4), fronting in 10% (n=4), active nasal fricatives in 5% (n=2). 37.5% (n=15) had other errors such as stopping, fricativisation, retracted articulation.

The resonance and nasal airflow characteristics of the participants as judged by perceptual evaluation are shown in Figure 2.

Hypernasality (n=10, 25%), nasal turbulence (n=11, 27.5%), and normal resonance (n=14, 35%) were found in most participants (Figure 2).

Table 2: Comparison of participants' nasalance scores according to perceived resonance type

	Variable			n	Mean	SD
Resonance and Nasal airflow error type	(1) Hypernasality and nasal emission			7	52.11	7.38
	(2) Nasal turbulence			8	35.30	12.01
	(3) Normal resonance			7	24.68	9.11
	Total			22	37.27	14.66
Source of the variance	KT	SD	KO	F	p	Difference (Scheffe)
Between groups	2681.242	2	1340.621	13.868	**0.000***	**1-2**** **1-3*****
Within groups	1836.750	19	96.671			
Total	4517.992	21				

KT: Sum of squares, SD: Degrees of Freedom, KO: Mean Square, F: F-Test Value, *p<0.05, **: Significant difference between hypernasality and nasal emission and Nasal turbulence, ***: Significant difference between hypernasality and nasal emission and normal resonance

Table 3: Relationship between resonance-nasal airflow and speech errors

	Backing	Nasalisation	Weak articulation	Double articulation
Hypernasality	0.107 (p=0.499)	**0.624* (p=0.000)**	**0.453* (p=0.004)**	**0.355* (p=0.025)**
Nasal turbulence	0.107 (p=0.499)	-0.254 (p=0.108)	-0.136 (p=0.389)	-0.205 (p=0.194)
Normal resonance	-0.234 (p=0.140)	**-0.361* (p=0.022)**	-0.221 (p=0.162)	-0.086 (p=0.586)

*: P<0.05

Table 2 shows the nasalance values of the participants and the resonance types and nasal airflow errors judged by the perceptual evaluation of the participants with nasalance scores.

When the distribution showing the one-way analysis of variance comparison of perceived resonance type and nasalance scores was analysed, a significant difference was found between perceived resonance type and nasalance scores (F= 13.868, p<0.05). Scheffe's multiple comparison test was used to determine between which resonance-airflow types the significant difference was found. According to the Scheffe test results, the nasalance scores of the participants with hypernasality and nasal emission were significantly higher than the nasal scores of the participants with nasal turbulence or normal resonance (p<0.05) (Table 2, Figure 3).

Table 3 shows the relationship between the perceived resonance-nasal airflow and the speech errors.

To examine the relationship between the participants' perceived resonance-nasal airflow and speech errors, the chi-square test was applied and the phi (Φ) correlation coefficient was calculated. A very strong positive correlation was found between the presence of hypernasality and nasalisation (r=0.624, p=0.000); hypernasality and weak articulation (r=0.453, p=0.004); and hypernasality and double articulation (r=0.355, p=0.025). A very strong negative correlation was found between the presence of normal resonance and nasalisation (r=-0.361, p=0.022).

Table 4 shows the relationship between oral anatomical-physiological problems and speech errors.

Table 4: Relationship between oral anatomical-physiological problems and speech errors

	Backing	Dentalisation	Lateralisation	Palatalisation	Bilabialisation	Fronting
Fistula	0.263 (p=0.096)	0.252 (p=0.111)	0.039 (p=0.804)	0.000 (p=1.000)	-0.011 (p=0.944)	-0.218 (p=0.168)
Class III malocclusion	0.203 (p=0.204)	**0,622* (p=0.000)**	**0.318* (p=0.047)**	0.260 (p=0.104)	**0.793* (p=0.000)**	0.080 (p=0.617)
Crossbite	-0.235 (p=0.138)	-0.35 (p=0.827)	**0.427* (p=0.007)**	-0.173 (p=0.274)	0.142 (p=0.368)	0.220 (p=0.165)
Missing teeth	0.045 (p=0.775)	**0.434* (p=0.006)**	0.033 (p=0.835)	**0.318* (p=0.044)**	0.210 (p=0.184)	**0.317* (p=0.045)**

*: P<0.05

To examine the relationship between the participants' oral anatomical-physiological problems and speech errors, the chi-square test was applied and the phi (Φ) correlation coefficient was calculated. A very strong positive correlation was found between the presence of class III malocclusion and dentalisation (r=0,622, p=0,000); class III malocclusion and lateralisation (r=0.318, p=0.047); class III malocclusion and labialisation (r=0.793, p=0.000); crossbite and lateralisation (r=0.427, p=0.007); missing teeth and dentalisation (r=0.434, p=0.006); missing teeth and palatalisation (r=0.318, p=0.044); missing teeth and fronting (r=0.317, p=0.045).

DISCUSSION

This study described the oral anatomical-physiological and speech-resonance characteristics of children with CLP. It examined the relationship between the perceived resonance-airflow and speech errors. Additionally, the relationship between oral anatomical-physiological problems and speech errors was analysed. Finally, the perceived resonance-airflow types were compared with the nasalance scores.

Among the participants in our study, class III malocclusion, missing teeth, fistula (particularly anterior fistula), and crossbite were the most prevalent oral anatomical and physiological problems. In line with our findings, Ünal-Logacev et al. found that in children with CLP, there were 59% missing teeth, 29% class III malocclusion, and 23% crossbite (13). Similar to our study, it has been documented in the literature that people with craniofacial anomalies and cleft palates have an increased frequency of dental and occlusal defects compared with the non-cleft population (18). According to the incidence of oronasal fistula varies between 3.4% and 78% in the literature, meta-analyses have reported the incidence of oronasal fistula between 6.4% and 8.6% (19-22). Ünal-Logacev et al. also reported fistula in 26% of children with CLP in Türkiye with similar percentages to our study (13).

The most common speech errors observed in the participants were backing, differentiation of glides, voicing errors, labialisation, nasalisation, palatalisation, dentalisation, lateralisation and weak articulation. In the literature, backing is among the most common speech errors in Turkish-speaking children with CLP (12, 13). In our study, phonological processes such as the differentiation of glides were also detected in children with CLP in addition to articulatory errors. Similarly, phonological processes have been reported in Turkish-speaking children with CLP in the literature (12, 13). The reason why the differentiation of glides was observed in 57% of the participants in our study may be because the differentiation of glides is the phonological process that is eliminated at the latest in children with typical development in Turkish (23). In our study, in contrast to Tezel's study, dentalisation, palatalisation, lateralisation and labialisation speech errors were also reported in Turkish-speaking children with CLP (12).

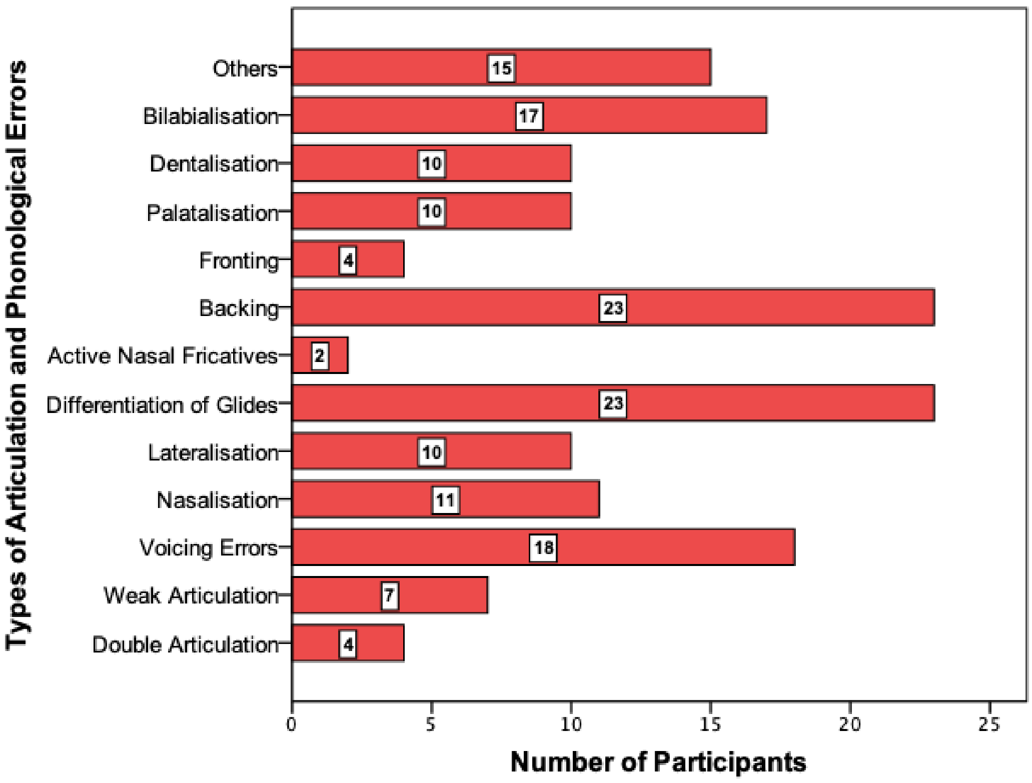

Figure 1: Distribution of participants' articulation and phonological errors

In this study, a strong positive correlation was found between hypernasality and nasalisation, weak articulation, and double articulation. In the literature, hypernasality, weak articulation, nasalisation, backing and double articulation are reported among the speech and resonance features in children with CLP (4). The results of our study support the literature and show a direct relationship between hypernasality and these speech errors.

In our study, a strong positive significant relationship was found between class III malocclusion and dentalisation, lateralisation and bilabialisation; between crossbite and lateralisation; between missing teeth and dentalisation, palatalisation and fronting. These findings highlight specific speech errors associated with dental and occlusal anomalies, providing further clarity to the existing literature. Class III malocclusion was strongly linked to labialisation, which may result from the misalignment of the upper and lower jaws affecting the ability to achieve proper lip closure. In Class III malocclusion, the mandible is positioned anteriorly relative to the maxilla, which can make it challenging for the lower lip to come into contact with the maxillary incisors—a critical movement for producing labiodental sounds such as /f/ and /v/. Instead, to compensate for this misalignment, these sounds may be articulated bilabially, where both lips come together to create the sound. This compensatory strategy alters the typical production mechanism, leading to labialisation. The relationship between class III malocclusion and dentalisation and lateralisation observed in our study can be explained by the altered positioning of the mandible and tongue. In class III malocclusion, the mandible and consequently the tongue are positioned anteriorly relative to the alveolar ridge. This misalignment creates challenges in producing sibilant and lingual-alveolar sounds, which require the tongue tip to be correctly positioned beneath the alveolar ridge. If the tongue maintains its natural position within the mandible during the production of these sounds, the result is often perceived as dentalisation. Alternatively, if the tongue retracts to compensate for the forward positioning of the mandible, the dorsum of the tongue may make contact with the palate, leading to lateral distortion by disrupting the airflow. Similarly, missing teeth were found to significantly contribute to dentalisation and palatalisation, likely due to the altered tongue placement and airflow required for accurate articulation. The relationship between missing teeth and fronting may result from protruding the tongue to compensate for the missing teeth in the anterior region when producing sibilant and linguo-alveolar sounds. The strong relationship observed between crossbite and lateralisation in our study can be explained by compensatory tongue movements. If the tongue moves back to compensate for the crossbite, the dorsum of the tongue may articulate against the palate instead of achieving the typical alveolar or dental placement. This compensatory movement can disrupt the central airflow path required for accurate articulation, causing lateral distortion by redirecting the airflow to one or both sides. These results are consistent with the findings of speech errors in dental and occlusal anomalies in the literature (4,18). Speech production can be affected by anomalies such as cleft lip and palate that affect the connection between the maxilla and mandible (18). The results of our study show that there is a direct relationship between dental and occlusal anomalies and speech errors.

In this study, it was found that the nasalance scores of participants with hypernasality-nasal emission were significantly higher than those with nasal turbulence and normal resonance. In this study, the concordance of nasalance scores with perceptual resonance-airflow results may be due to the fact that a speech and language therapist with 10 years of experience specialising in CLP was involved in the study. Similar to our study results, it is reported in the literature that the reliability of perceptual resonance-airflow judgments is high with clinical experience (24). In this study, no significant difference was found between the nasalance scores of participants with perceptual nasal turbulence and those with normal resonance. This may be due to the inconsistent occurrence of nasal turbulence (6).

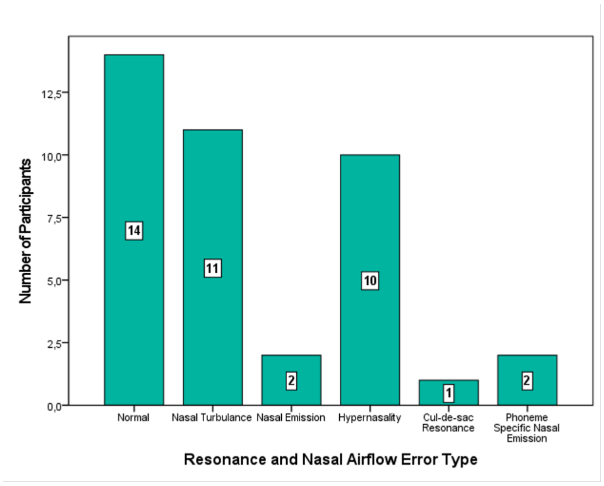

Figure 2: Participants' perceived resonance and nasal airflow types

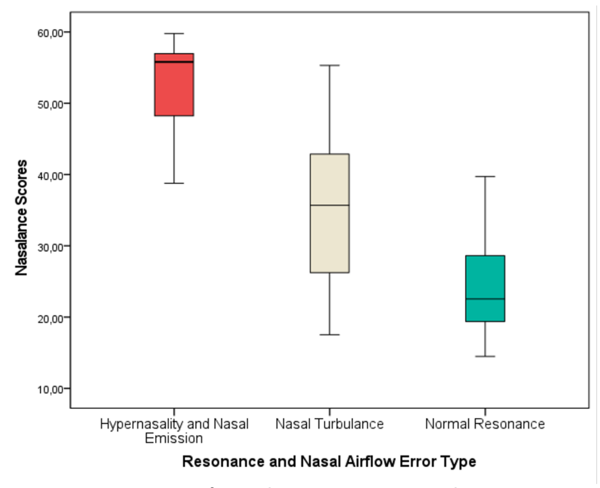

Figure 3: Participants' nasalance scores according to perceived resonance types and nasal airflow errors

Our findings have significant clinical implications for the assessment and intervention of Turkish-speaking children with cleft lip and palate (CLP). The observed relationships between specific dental-occlusal anomalies and articulation errors highlight the necessity for speech and language therapists (SLTs) to consider these structural factors during evaluation. For instance, the strong link between class III malocclusion and labialisation indicates that compensatory articulatory strategies may arise from mandibular misalignment, directly influencing speech production. Similarly, the association between missing teeth and dentalisation underscores the importance of evaluating the dental status when diagnosing speech errors. These insights can guide SLTs in tailoring intervention strategies. Furthermore, understanding the clinical significance of resonance issues, such as hypernasality associated with weak articulation, enables a more comprehensive approach to intervention, combining perceptual and instrumental assessments. Our study emphasises the need for multidisciplinary collaboration, involving dental specialists and SLTs, to address both structural and functional contributors to speech disorders in children with CLP.

There are some limitations of this study. First, the majority of the participants in our research were younger than six years old, which posed challenges during the sentence repetition test as pictorial cues were not provided to facilitate their understanding of the stimuli. Additionally, participants younger than four years of age could not undergo nasometric evaluation, resulting in the absence of nasalance scores for this age group. This limitation may have influenced the comprehensiveness of our findings regarding the resonance assessment. Second, the evaluation was completed in a single day, which might have reduced the participants' cooperation and attention towards the end of the assessment process. Third, the rare oral anatomical and physiological problems observed in a few participants were excluded from the statistical analyses due to their low frequency, potentially limiting the generalizability of our results. Addressing these limitations in future research, such as incorporating age-appropriate tools, extending evaluation durations, and including larger sample sizes, could enhance the robustness of the findings.

We have some suggestions for further research on this subject. The evaluation of speech errors can be supported by objective methods such as ultrasound and electropalatography. In this way, speech errors such as double articulation, which are difficult to evaluate perceptually, can be assessed. Using a sentence repetition test with picture cues for speech assessment and perceptual resonance assessment may increase children's interest in the test. Evaluating each participant individually will ensure that rare anatomical and physiological features that may affect speech are considered.

CONCLUSION

The most common speech errors in Turkish-speaking children with CLP were the backing and differentiation of glides. Phonological disorders may be observed in Turkish-speaking children with CLP. There is a very strong relationship between hypernasality and nasalisation, backing, weak articulation and double articulation. Dental and occlusal anomalies are very strongly associated with dentalisation, lateralisation and labialisation, palatalisation and fronting. These relationships should be considered in the assessment and intervention of children with CLP by speech and language therapists. Perceptual resonance-airflow assessment performed in highly clinically experienced hands supports instrumental nasometric assessments.

Ethics Committee Approval: This study was approved by the İstanbul Medipol University Non-Interventional Clinical Research Ethics Committee (Date: 30.11.2018 No: 703).

Informed Consent: Families meeting the eligibility criteria and agreeing to participate signed an informed consent form before the evaluation, which was conducted in the assessment and phoniatry rooms at MEDKOM.

Peer Review: Externally peer-reviewed.

Author Contributions: Conception/Design of Study- N.Y.B., Ö.Ü.L.; Data Acquisition- N.Y.B., Ö.Ü.L.; Data Analysis/ Interpretation- N.Y.B.; Drafting Manuscript- N.Y.B., Ö.Ü.L.; Critical Revision of Manuscript- Ö.Ü.L., N.Y.B.; Final Approval and Accountability- N.Y.B., Ö.Ü.L.; Technical or Material Support - N.Y.B.; Supervision- Ö.Ü.L.

Acknowledgements: We would like to thank the speech and language therapists Özlem Ergüvenli and Fatma Nerse for their support during the assessments.

Conflict of Interest: The authors have no conflict of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Martinelli M, Palmieri A, Carinci F, Scapoli L. Non-syndromic Cleft Palate: An Overview on Human Genetic and Environmental Risk Factors. Front Cell Dev Biol 2020;8:592271.
2. Tomatir AG, Demirhan H, Sorkun HC, Koksal A, Ozerdem F, Cilengir N. Major congenital anomalies: a five-year retrospective regional study in Turkey. Genet Mol Res 2009;8(1):19-27.
3. Türkbay D, Canpolat FE, Derme T, Altuğ N, Yılmaz Y. The birth prevalence of selected major congenital anomalies: Six-year's experience in a tertiary care maternity hospital. Türk Pediatri Arşivi 2020;55(4):393-400.
4. Pereira VJ, Sell D. How differences in anatomy and physiology and other aetiology affect the way we label and describe speech in individuals with cleft lip and palate. Int J Lang Commun Disord 2024;59(6):2181-96.
5. Alighieri C, Haeghebaert Y, Bettens K, Kissel I, D'haeseleer E, Meerschman I, et al. Peer attitudes towards adolescents with speech disorders due to cleft lip and palate. Int J Pediatr Otorhinolaryngol 2023;165:111447.

6. Kummer AW. Cleft palate and craniofacial conditions: a comprehensive guide to clinical management. Fourth edition. Burlington, MA: Jones & Bartlett Learning; 2020. 629 p.
7. Chacon A, Parkin M, Broome K, Purcell A. Australian children with cleft palate achieve age-appropriate speech by 5 years of age. Int J Pediatr Otorhinolaryngol 2017;103:93-102.
8. Albustanji YM, Albustanji MM, Hegazi MM, Amayreh MM. Prevalence and types of articulation errors in Saudi Arabic-speaking children with repaired cleft lip and palate. Int J Pediatr Otorhinolaryngol 2014;78(10):1707-15.
9. Klintö K, Salameh EK, Lohmander A. Phonology in Swedish-speaking 5-year-olds born with unilateral cleft lip and palate and the relationship with consonant production at 3 years of age. Int J Speech Lang Pathol 2016;18(2):147-56.
10. Nachmani A, Masalha M, Kassem F. Phonological Profile of Patients With Velopharyngeal Dysfunction and Palatal Anomalies. J Speech Lang Hear Res 2021;64(12):4649-63.
11. Scherer N, Yamashita R, Fukushiro A, Oliveira D, Keske-Soares M, Ingram D, et al. Assessment of early phonological development in children with clefts in Brazilian Portuguese. In: Under-Reported Monolingual Child Phonology. Bristol, UK: Multilingual Matters; 2020. p. 400–21.
12. Tezel Ö. Yarık damaklı türk çocuklarının sesletim, işitsel ayrımlaştırma ve sesbilgisel özelliklerinin belirlenmesi. Master's Thesis. Anadolu University; 2004. https://www.proquest.com/dissertations-theses/yarık-damaklı-türk-çocuklarının-sesletim-işitsel/docview/2607558993/se-2
13. Ünal-Logacev Ö, Kazanoğlu D, Balo E, Nemutlu A. Cleft Lip and Palate Assessment Form: Medical History, Oral-peripheral Characteristics, Speech Problems. Turk J Plast Surg 2018;26(4):156-68.
14. Dinsever Eliküçük Ç, Kulak Kayıkcı ME, Esen Aydınlı F, Çalış M, Özgür FF, Öztürk M, et al. Investigation of the speech results of posterior pharyngeal wall augmentation with fat grafting for treatment of velopharyngeal insufficiency. J Cranio-Maxillofac Surg 2017;45(6):891-6.
15. Ünal–Logacev Ö, Kummer AW, Çetin C, Topbaş S. Nasometric evaluation of resonance disorders: A norm study In Turkish. Int J Pediatr Otorhinolaryngol 2020;131:109888.
16. MacKay I, Kummer A. The MacKay-Kummer SNAP Test-R Simplified Nasometric Assessment Procedures (Revised 2005). Instruction manual: Nasometer Model 6450. Kay Elemetrics Corp; 2005.
17. Akoglu H. User's guide to correlation coefficients. Turk J Emerg Med 2018;18(3):91–3.
18. Mason KN. The Effect of Dental and Occlusal Anomalies on Articulation in Individuals With Cleft Lip and/or Cleft Palate. Perspect ASHA Spec Interest Groups 2020;5(6):1492-504.
19. Buller M, Jodeh D, Qamar F, Wright J, Halsey J, Rottgers S. Cleft Palate Fistula: A Review. Eplasty 2023;1(23):e7.
20. Bykowski MR, Naran S, Winger DG, Losee JE. The rate of oronasal fistula following primary cleft palate surgery: a meta-analysis. Cleft Palate Craniofac J 2015;52(4):e81-7.
21. Hardwicke JT, Landini G, Richard BM. Fistula incidence after primary cleft palate repair: a systematic review of the literature. Plast Reconstr Surg 2014;134(4):618e-27e.
22. Jodeh DS, Nguyen ATH, Rottgers SA. Outcomes of Primary Palatoplasty: An Analysis Using the Pediatric Health Information System Database. Plast Reconstr Surg 2019;143(2):533-9.
23. Topbaş S. Turkish Speech Acquisition. In: International Guide to Speech Acquisition. Clifton Park, NY, USA: Thomson Delmar Learning; 2007. p. 566-79.
24. Bruneel L, Alighieri C, D'haeseleer E, Kissel I, Adriaansen A, Sseremba D, et al. Reliability results of perceptual ratings of resonance, nasal airflow and speech acceptability in patients with cleft palate by Ugandan speech-language pathologists following a two-day workshop. Int J Pediatr Otorhinolaryngol 2020;136:110191.