*Original Article*

# Speech Outcomes in Children with Cleft and Palate: Srinagarind Hospital, Khon Kaen University, Thailand

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***Background:*** Speech defects in children with cleft lip and palate are common after cleft repair. Investigation of speech outcomes provides useful information for further intervention planning and protocol reviewing.

***Objective:*** The aim of the present study was to determine speech outcomes in children with CLP, compared to normal children between 6 and 13.

***Materials and Methods:*** This was a cross-sectional study. Fifteen children with cleft palate, with or without cleft lip (CLP) and 15 normal children between 6 and 13 were enrolled. Perceptual assessment via Thai Speech Parameters for Patients with Cleft Palate in a Universal Reporting System for identification and classification speech outcomes was performed by two senior speech and language pathologists by consensus. Descriptive analysis and Wilcoxon Sign Rank Test were used to present the data.

***Results:*** The prevalence of speech abnormalities in primary school-aged children with CLP was high (viz., articulation errors (100%), abnormalities of resonance (hypernasality: 44%), audible nasal emission/turbulence (44 to 60%), voice disorders (27%), intelligibility (36%), less understandability (60%), deviation acceptability (87%). Children with CLP had more speech abnormalities of both types and numbers than normal children (median difference = 9; 95% confident interval = 7, 10).

***Conclusion:*** Speech abnormalities in primary school-aged children with CLP were common, including: CAD, hypernasality, voice disorders, audible nasal emission/turbulence, less understandability, and deviation acceptability.

***Keywords:*** Speech outcomes, Cleft lip and palate, Primary school, Speech abnormality

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Cleft lip and palate (CLP) or orofacial cleft are the most common congenital malformations. In Thailand, the prevalence of CLP ranges between 0.58 and 2.49 per 1,000 live births[1-3] compared to the worldwide incidence that ranges between 0.11 and 2.00[4-10]. The most common stigmas after surgery include various speech abnormalities[11-14], psychological dysorders[10], economic stress[15], educational or literacy deficits[10,16,17], and overall poor quality of life (QoL)[18-22].

After the primary surgery, the common speech defects among children with CLP include: articulation errors and phonological disorders (79.70 to 88.56%)[11,13]; resonance disorders (43 to 69%)[11,13]; voice disorders (12.5 to 19.13)[13,23]; and delayed speech and language disorders (16.33)[13]. Taken together, these errors and disorders result in reduced intelligibility[24] and poorer QoL[25].

The Center of Cleft lip and Cleft Palate and Craniofacial Deformities, Khon Kaen University in association with the Tawanchai Project was established in 2006. The protocol for interdisciplinary approaches in children with CLP includes providing primary surgery for chieloplasty around the age of 3 months and palatoplasty at 1 year[26]. Treatment outcomes are considered from various perspectives so as to achieve the best quality of care for each patient. An investigation of five-year speech outcomes and hearing in children with CLP at the Tawanchai Center has already been done[14,27], so the aim of the current study was to determine speech outcomes in children with CLP compared to normal non-CLP children between 6 and 13.

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## Materials and Methods

### *Study design*

This was a cross-sectional prospective study. The research protocol was reviewed and approved by the Central Research Ethics Committee (CREC Number: CREC038/58BPm, Certificate number: COA-CREC019/2526).

### *Setting*

Speech Clinic, Srinagarind Hospital, Faculty of Medicine, and Nonmuang Primary School, Muang District, Khon Kaen.

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### *Participant selection*

Participants were children with cleft palate, with or without cleft lip (CLP) registered in the Speech Clinic, Srinagarind Hospital, Faculty of Medicine, Khon Kaen University, and normal non-CLP children attending primary school in Khon Kaen province.

#### *Inclusion criteria*

For a comparison of speech outcomes, we included (a) children between 6 and 13 with CLP registered for treatment at the Speech Clinic, Srinagarind Hospital, Faculty of Medicine, Khon Kaen University; and, (b) normal non-CLP children between 6 and 13, in grades between 1 and 6 at Nonmuang Primary School, randomly selected by teachers.

#### *Exclusion criteria*

We excluded children with CLP and normal non-CLP children with health conditions that affected speech and/or language skills (i.e., delayed speech and language development, common cold, any syndrome that negatively affected development like Treacher Collins Syndrome, Global delayed development, Autism, or Attention Deficit Hyperactivity disorders).

Children between 6 and 13 years were enrolled (a) 15 with CLP and (b) 15 normal non-CLP.

After parents gave written consent and the children verbal assent, general characteristics and information were gathered through recorded interviews. An examination of the ears, nose, and throat was performed by an otorhinologist to screen for any diseases that might cause any deviation to normal speech and language outcomes. The Thai Early Language Milestone and the UTAH test for Language Development were used to screen for delayed speech and language development.

Tools for assessment of speech outcomes included the Standard Thai Articulation, Resonation, Nasal Emission and Nasal Turbulence Test. The test was developed by the principle investigators and their colleagues[28].

Each child was asked to name, read, or repeat to an investigator (the corresponding author)'s naming in case of she/he could not name or read pictures of target sounds, both words and sentences test by herself/himself. Two senior speech and language pathologists (SLP), who have experience in CLP more than 30 years, were investigators and independently did perceptual assessment and classified type of articulation errors for cleft speech types. If there was any disagree on perceptual assessment between 2 investigators, child was asked to name or read or repeat to an investigator (corresponding author)'s naming and discussed until having consensus between 2 investigators.

Resonance from the standard test was investigated and classified using universal criteria[28,29] as follows: within normal limits/none or normal resonance = 0; mild = 1; moderate = 2; and severe hypernasality = 3. Audible nasal air emission and/or nasal turbulence were set as: within normal limits – none or no deviation; intermittent or variable – some audible nasal air emission in high oral pressure consonants <4 target sounds; or frequent or pervasive – audible nasal air emission in most of oral consonants ≥4 target sounds. As for intelligibility, understandability, acceptability, and facial grimace, the outcomes were defined by universal parameters[28,29] as follows: intelligibility from conversational speech – good when >75% of conversation understandable; fair – understandable when topic known; or, mean when 50 to 75% of conversation understandable; and, unintelligible when <50% of conversation understood. Speech understandability from conversational speech as follows: good = most always easy to understand; mild = occasionally difficult to understand; moderate = often difficult to understand; and, severe = difficult to understand most or all of the time. Speech Acceptability from whole speech sample: good = normal; mild = mild deviation; moderate = moderate deviation; severe = severe deviation.

Grimacing is an aberrant facial muscle movement and a subconscious attempt to inhibit abnormal nasal airflow by constricting the nares. Facial grimace from a whole speech sample—especially for those with high oral pressure sounds—within normal limits for normal configuration are: ala = 1 – aberrant ala muscle movement; nasal bridge = 2 – aberrant bridge of nasal muscle movement; and, forehead = 3 – aberrant forehead muscle movement.

Descriptive analyses were performed for presenting demographic data. The Wilcoxon Signed Rank Test was used to assess differences among medians vis-a-vis articulation errors. Correlation was used to analyze the relationship among tests.

## Results

The general characteristics of the 15 typical and 15 children with CLP are presented in Table 1. The intra-group characteristics were comparable. Children with CLP had significant abnormalities of the tongue (tied), teeth, and bite (malocclusion) (Angle's Class Malocclusion) more than normal.

As for resonance disorders, normal children had no evidence of resonance abnormality. Children with CLP had both resonance disorders and audible nasal emission (Table 2). The incidence of hypernasality was 43%, most of whom had mild hypernasality (36%). Audible nasal emission was 60%, most of whom were of an intermittent level (50%).

Voice, intelligibility, understandability, acceptability, facial grimace, speech outcomes are presented in Table 2. Twenty-seven percent of children with CLP had voice abnormality; 36% had deviation of intelligibility or intelligibility if the topic of conversation were known; 60% had abnormality of understandability; and 97% of the whole speech sample was unacceptable. Face muscle constriction for facial grimace occurred in 33%. There was no speech abnormality related to voice, intelligibility, understandability, acceptability, or facial grimace among the typical non-CLP children.

The number of articulation errors was counted at both the word and sentence levels. In case there was any sound that had the same error at both the word and sentence

**Table 1.** Characteristics

| Variables | Normal | | Children with CLP | |
|---|---|---|---|---|
| | Number | % | Number | % |
| Sex | | | | |
| Male | 7 | 46.67 | 6 | 40 |
| Female | 8 | 53.33 | 9 | 60 |
| Age | | | | |
| Mean (SD) | 8.33 (1.632) | | 9 (1.9639) | |
| Cleft type | | | | |
| Rt. CLP | - | - | 3 | 20 |
| Bilateral CLP | - | - | 6 | 40 |
| Lt. CLP | - | - | 2 | 1.33 |
| CP | - | - | 4 | 26.67 |
| Occlusion** | | | | |
| Normal | 13 | 92.85 | - | - |
| Malocclusion class | - | - | - | - |
| Class I | - | - | - | - |
| Class II | 1 | 6.67 | - | - |
| Class III | - | - | 13 | 100 |
| N/A@ | 1 | - | 2 | - |
| Home language | | | | |
| Central or official | 6 | 40 | - | - |
| Northeast | 6 | 40 | 15 | 100 |
| Northeast & central or official | 3 | 20 | - | - |
| Tongue | | | | |
| Normal | 15 | 100 | 13 | 86.67 |
| Tongue tied | - | - | 2 | 13.33 |
| Teeth | | | | |
| Missing upper teeth | 4 | 26.67 | 1 | 6.67 |
| Open bite | 3 | 20 | 3 | 20 |
| Cross bite | 1 | 6.67 | - | - |
| Missing upper teeth & open bite | - | - | 11 | 73.33 |
| Normal | 7 | 46.67 | - | - |

@ Children with cleft lip and palate whose mother had right cleft lip, ** Angle's Class Malocclusion, # of missing upper front teeth
Rt. CLP = Right cleft lip and palate; Lt. CLP = Left cleft lip and palate; Bilat. CLP = Bilateral cleft lip and palate

levels, it was counted as a articulation error. The types of articulation errors are presented in Figure 1. Children with CLP had more articulation defects than normal children.

The type of articulation errors in children with CLP and normal children were classified per standard guidelines[28,29]. Similar to the number of articulation errors, the types of articulation errors were classified as word and sentence levels. If a child had the same type of articulation error in both word and sentence levels, it was considered one type (e.g., if a child had [$tc^h$], [$k^h/t^h$] at word level it was a velar type; vs. [$tc^h$], [$k^h/tc^h$] at sentence level it was a velar type. The type of articulation error was classified to be a velar type).

Classification of the types of articulation errors in children with CLP and normal children are presented in Table 3. The Velar and Trill error were the most common patterns in both children with CLP and normal children. Two of the normal children had only an articulation type of functional articulation disorder: trill error.

Comparison of the number of articulation errors between children with CLP and normal children was done using the Wilcoxon Sign Rank Test. Children with CLP were poorer than normal children. Children with CLP had significantly more articulation errors than normal children (i.e., the relative proportion of articulation errors in children with CLP to normal children was 10 to 1 and the mean difference was 9; the 95% confidence interval was 7, 10).

## Discussion

The children studied—those with CLP and normal children—had a similar background, sex, and age (Table 1). Two children (13.3%) were tongue tied. All of the children with CLP and a half of the normal children had an abnormality of teeth and malocclusion, which agrees with previous reports that children with CLP had a high risk for malocclusion and teeth abnormalies[30,31].

Perceptual assessment for resonance (Table 2) revealed the prevalence of resonance disorders in children with CLP both at the word and sentence levels was 43% compared to none in normal children. This finding underscores the high risk for velopharyngeal insufficiency (VPI) and supports a previous reports that found the prevalence of hypernasality after palatoplasty in Thailand ranged between 37.5 and 43.3%[13,32,33]. Audible nasal emission prevalence (i.e., 60% at the word level and 45% at the sentence level): was higher than hypernasality. Audible nasal emission is the abnormal passing of oral air through a palatal cleft, or from some other type of velopharyngeal inadequacy (VPI). For example, during the production of a consonant a buildup of oral air pressure is required for proper pronunciation (e.g., /p/ or /s). Nasal turbulence, also called a nasal rustle, is due to air pressure being forced through a small velopharyngeal opening. As the air pressure goes through, there is friction and bubbling of secretions above the opening. Our data show that audible nasal emission or nasal turbulence can occur without hypernasality.

For other speech outcomes (Table 2), voice disorders in CLP was 27% (3 in 11) compared to none in normal children. In previous studies, this rate ranged between 5.5 and 43%[13,33-37] vs. none in normal children, supporting the theory that voice disorders or hoarseness is laryngeal compensation for abnormal velopharyngeal valving. VPI causes difficulty with articulation of specific consonants owing to the inability to build sufficient air pressure in the oral cavity. Compensatory mechanisms to increase air flow to correct articulation—in particular for stops, fricatives, sibilants, and affricates—is implicated in vocal cord abnormalities and voice disturbances. A more recent study, however, did not find any relationship between hoarseness in patients with cleft palate and VPI, calling into question the theory of laryngeal compensation as the source of hoarseness[38]. There is no identified definitive cause of hoarseness, suggesting its cause is multifactorial or attributable

**Table 2.** Resonance and speech outcomes based on a perceptual assessment among CLP

| No. | Hypernasality | | Audible nasal emission Nasal turbulence | | Voice** | Intelligibility* | Understandability* | Acceptability** | Facial grimace |
|---|---|---|---|---|---|---|---|---|---|
| | Words | Sentences | Word | Sentence | | | | | |
| 1) | Mild | Mild | WNL | WNL | WNL | WNL | WNL | WNL | None |
| 2) | Mild | Mild | Invasive | Invasive | Abnormal | If topic is know | Mild | Mild | Ala |
| 3) | WNL | WNL | N/A | N/A | N/A | WNL | Mild | Mild | None |
| 4) | WNL | WNL | N/A | N/A | Abnormal | If topic is know | Severe | Severe | None |
| 5) | Moderate | Moderate | WNL | WNL | WNL | If topic is know | Moderate | Moderate | Nasal bridge |
| 6) | WNL | WNL | Intermittent | WNL | N/A | N/A | Moderate | Moderate | None |
| 7) | WNL | WNL | Intermittent | WNL | N/A | WNL | Mild | Mild | None |
| 8) | Mild | Mild | N/A | Intermittent | WNL | If topic is know | Mild | Mild | None |
| 9) | WNL | WNL | WNL | WNL | WNL | If topic is know | Mild | Mild | None |
| 10) | Mild | Mild | Intermittent | Intermittent | WNL | WNL | Mild | Mild | Ala |
| 11) | WNL | Mild | Intermittent | Intermittent | WNL | WNL | WNL | WNL | None |
| 12) | WNL | WNL | WNL | WNL | WNL | WNL | WNL | Mild | None |
| 13) | WNL | WNL | N/A | N/A | WNL | WNL | WNL | Mild | Nasal bridge |
| 14) | Mild | WNL | Intermittent | Intermittent | N/A | WNL | WNL | Mild | Ala |
| 15) | N/A | N/A | N/A | N/A | Abnormal | WNL | WNL | Mild | None |
| Total | | | | Total | | | | | |
| Mild | 5 (36%) | 5 (36%) | | WNL/None | 8 (73%) | 9 (64%) | 6 (40%) | 2 (13%) | 10 (67%) |
| Moderate | 1 (7%) | 1 (7%) | | Abnormality/ If topic known | 3 (27%) | 5 (36%) | | | |
| Intermittent | | | 5 (50%) | 4 (36%) N/A | 4 | 1 | | | |
| Invasive | | | 1 (10%) | 1 (9%) -Mild/ala | | | 6 (40%) | 10 (67%) | 3 (20%) |
| WNL | 8 (57%) | 8 (57%) | 4 (40%) | 6 (55%) -Moderate/ nasal bridge | | | 2 (13%) | 2 (13%) | 2 (13%) |
| N/A | 1 | 1 | 5 | 4 -Severe | | | 1 (7%) | 1 (7%) | - |

WNL = Within normal limit; N/A = Not available
* Assessment from conversational speech; ** Assessment from whole speech sample

| Patient Number | Children with CLP | Number of Articulation errors | Normal | Number of Articulation errors |
|---|---|---|---|---|
| 1 | [f,h/$p^h$] [s,$t^h$/$tɕ^h$] [$t^h$/$k^h$] [$tɕ^h$/s] [p/f] [p,$p^h$/b] [t,?,tɕ/d] [tɕ,?/t] [k/tɕ] [l/r] [-p/-t] | 11 | [l/r] | 1 |
| 2 | [s/$t^h$,$tɕ^h$] [tɕh/$k^h$,s] [m,$p^h$/b] [ŋ,n/d] [p,?,k,/p] [$t^?$,?,k/t] [tɕ?,?/tɕ] [?/k] [ŋ/m,n] [l/r] | 10 | [l/r] | 1 |
| 3 | [$t^h$/$p^h$] [s/$tɕ^h$] [$tɕ^h$/s] [w/f] [p/b,k] [t/d,p] [k/tɕ] [d/n] [tɕ/j] [l/r] [-p/-t] | 11 | [l/r] | 1 |
| 4 | [t,k,$k^h$/$p^h$] [$k^h$,k/$t^h$] [$k^h$/$tɕ^h$] [k/s,d,t,tɕ] [kw,pk/f] [p/b] [ŋ/n] [ŋ,l,j/r] [-p/-t] [-k/-t] [-ŋ/-n] [-m/-ŋ] | 12 | [l/r] | 1 |
| 5 | [$t^h$/$k^h$] [m/b] [n/d,w] [p?/p] [?,k/t] [?/tɕ,k] [ŋ/n] [l/r] | 8 | [l/r] | 1 |
| 6 | [$p^h$,$k^h$/$t^h$], [s/$tɕ^h$], [$k^h$,$tɕ^h$/$k^h$], [$k^h$/s] ,[p/f], [n/b] [tɕ,k,kŋ/d] ,[k/t,tɕ], [ŋ/n] [n/l], [ŋ,d,ŋk/r] ,[-k/-t] | 12 | [l/r] | 1 |
| 7 | [$k^h$/$t^h$] [k/d] [k,tk/t] [b/m] [$t^h$,l/r] [-k/-t] | 6 | [l/r] | 1 |
| 8 | [$t^h$/$p^h$] [$k^h$/$t^h$,$tɕ^h$] [k/s,d,t] [k,w/f] [k,ktɕ/tɕ] [ŋ/n,l,j] [l,ŋ/r] [-k/-t] [-ŋ/-n] [-n/-ŋ] | 10 | [l/r], [s/$tc^h$] | 2 |
| 9 | [?,b/$p^h$] [$k^h$,?/$t^h$] [?/$k^h$] [k,l,$tɕ^h$,$tɕ^h$l/s] [w,$p^h$/f] [p/b] [k,dk/d] [b/p] [?/k] [ŋ/n] [l/r] [k/?] [O/-k,-n,-ŋ] [-k/-t] | 14 | [l/r] | 1 |
| 10 | [$k^h$/$p^h$,$t^h$] [$t^h$,$k^h$/$tɕ^h$] [tɕ,k/s] [k/f] [m/b] [n,k,kŋ/d] [?/p] [k,?/t] [?,d,j/tɕ] [?,k?/k] [b/m] [ŋ/n] [?w/w] [n,l/j] [l/r] [-m/-ŋ] | 16 | [l/r] | 1 |
| 11 | [$k^h$/$t^h$] [l/r] | 2 | [l/r] | 1 |
| 12 | [$k^h$/$t^h$],[s/$tɕ^h$],[$tɕ^h$/$k^h$],[k ŋ/d],[$t^h$,?/t],[?/ tɕ],[?/k],[kl/l],[O/-k],[l/r],[-k/-p] | 11 | [l/r] | 1 |
| 13 | [l/$t^h$],[l/s],[w/f],[?/b],[k/d],[k/t],[ng/n],[l/r] | 8 | [l/r] | 1 |
| 14 | [s/$tɕ^h$],[$tc^h$/$k^h$],[kd/d],[k,kt/d],[ŋ/n],[l/r] | 6 | [s/$tɕ^h$],[$t^h$/s], [h,?/$p^h$], [$k^h$/$t^h$], [p/b], [l/r] | 6 |
| 15 | [$p^h$,$k^h$/th],[w/f],[ng/n],[ng/l],[l/r],[$k^h$/h] | 6 | [l/r] | 1 |

**Figure 1.** Number of articulation errors.

to some other under-recognized factor. Some patients with hoarseness and cleft palate are treated with voice therapy and anti-reflux treatment, the benefit of these interventions is also unknown[36].

Sixty percent of children with CLP had less understandability of conversations, and 87% of them had deviation in acceptability of whole speech. These data suggest that even with a high percentage of deviation of

**Table 3.** Type of articulation disorder

| Type of articulation disorder | Children with CLP | | Normal | |
|---|---|---|---|---|
| | Number | % | Number | % |
| Within normal limit | 1 | 1.61 | 3 | 17.56 |
| Pharyngeal | 1 | 1.61 | - | - |
| Glottal | 5 | 8.06 | - | - |
| Mid-dorsal palatal | 0 | 0 | - | - |
| Velar | 14 | 22.58 | - | - |
| Phoneme specific | - | - | - | - |
| Not Phoneme specific | - | - | - | - |
| Nasal consonant for oral pressure consonant | 3 | 4.83 | - | - |
| Nasalized pressure consonant | 4 | 6.45 | - | - |
| Weak oral pressure | - | - | - | - |
| Developmental articulation | 1 | 1.61 | - | - |
| Phonological error | - | - | - | - |
| Functional/other oral misarticulation | 11 | 17.74 | 2 | 11.75 |
| Dental lisping | - | - | - | - |
| Organic articulation disorder | - | - | - | - |
| Co-articulation | 7 | 11.29 | - | - |
| Trill | 12 | 19.35 | 12 | 7.58 |
| Gliding | 2 | 3.23 | - | - |
| Lateralize | 1 | 1.61 | - | - |

speech acceptability, whole conversation understandability was fair; due to factors such as context, topic, and/or environment.

As for the number of articulation errors (Figure 1), children with CLP had significantly more articulation defects than normal children [median difference = 9; 95% confident interval = 7, 10;]. These results confirmed the occurrence of compensatory articulation disorders due to VPI or anatomical defects. Compensatory articulation disorders (CAD) are learned articulation errors. They are errors in place of articulation or direction of airflow; due to the inability to generate adequate intra-oral air pressure for consonant production, anterior structural anomalies, abnormal auditory–perceptual learning, or due to the anatomical inability to close the VP port, which can persist even after successful physical management of the VP mechanism or other factors. Regarding the type of articulation errors (Table 3), the velar type was the most common in children with CLP as was reported study[39]. Besides functional articulation, other oral articulations and trill, our results are similar to a previous finding, which found glottal and pharyngeal productions were the latter common CAD. Meanwhile, the current study revealed that glottal, nasalized voice pressure consonants, and nasal for oral pressure consonants were common. These results also supported a previous study, which proposed that the productive phonological processes were consonant backing, final consonant deletion, gliding, and stopping[40]. Interestingly, trill and functional articulation disorders were more prevalence in children with CLP as with previous studies[13,33,39,41,42]. They might reflect that Thai school might focus less on trill or flap. The current study also revealed that children with CLP had significantly more articulation errors than normal children. This finding agrees with previous studies and the theory of the compensatory mechanism of air leakage into nasal cavity result in CAD and other speech abnormalities.

Taken together, the prevalence of speech abnormalities in children with CLP remains high including articulation error (100%), resonance disorders (hypernasality: 44%), audible nasal emission/turbulence (44 to 60%), voice disorders (27%), intelligibility (36%), less understandability (60%), and deviation acceptability (87%). This information might prove useful for further research and protocol review[14].

## Conclusion

Speech abnormalities—including CAD, hypernasality, audible nasal emission/ turbulence, less understandability, and deviation acceptability—remain common such that critical speech intervention and review protocols are needed for better speech outcomes and improved quality of life.

## What is already known on this topic?

Speech abnormalities are common among children with CLP after chielolasty and palatoplasty. The prevalence of which various between centers, institutions, and nations. Studies on speech defects among children with CLP in primary school in Thailand need to be done.

## What this study adds?

Primary school-aged children with CLP had high CAD, hypernasality, audible nasal emission/ turbulence, less understandability, and deviation acceptability.

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## Potential conflicts of interest

The authors declare no conflicts of interest.

## References

1. Chowchuen B, Thanaviratananich S, Chichareon KA, Auvichipotchana C, Godfrey K. Multi-center study of oral clefts and associated abnormalities in Thailand: the epidemiologic data and need of health care service. Paper presented at The 10th International Congress on Cleft palate and Related Craniofacial Anomalies; September 4-8, 2005; Durban, South Africa.
2. Chuangsuwanich A, Aojanepong C, Muangsombut S, Tongpiew P. Epidemiology of cleft lip and palate in Thailand. Ann Plast Surg 1998;41:7-10.
3. Ruangsitt C, Prasertsang P, Banpho Y, Lamduan W, Giathamnuay S, Nuwantha A. Incidence of cleft lip and palate in three hospitals in Khon Kaen. Khon Kaen: Department of orthodontics, Faculty of Dentistry, Khon Kaen University; 1993.
4. Eshete M, Butali A, Deressa W, Pagan-Rivera K, Hailu T, Abate F, et al. Descriptive epidemiology of orofacial clefts in Ethiopia. J Craniofac Surg 2017;28:334-7.
5. Hobbs CA, Hopkins SE, Simmons CJ. Sources of variability in birth defects prevalence rates. Teratology 2001;64 Suppl 1:S8-13.
6. Natsume N, Tolarova MM. Epidemiology ofcleft lip and palate. Nagoya: Neomedix; 2006.
7. IPDTOC Working Group. Prevalence at birth of cleft lip with or without cleft palate: data from the International Perinatal Database of Typical Oral Clefts (IPDTOC). Cleft Palate Craniofac J 2011;48:66-81.
8. Waitzman NJ, Romano PS, Scheffler RM. Estimates of the economic costs of birth defects. Inquiry 1994;31:188-205.
9. Watkins ML, Edmonds L, McClearn A, Mullins L, Mulinare J, Khoury M. The surveillance of birth defects: the usefulness of the revised US standard birth certificate. Am J Public Health 1996;86:731-4.
10. Tillman KK, Hakelius M, Hoijer J, Ramklint M, Ekselius L, Nowinski D, et al. Increased risk for neurodevelopmental disorders in children with orofacial clefts. J Am Acad Child Adolesc Psychiatry 2018;57: 876-83.
11. Alfwaress FSD, Khwaileh FA, Rawashdeh MA, Alomari MA, Nazzal MS. Cleft lip and palate: demographic patterns and the associated communication disorders. J Craniofac Surg 2017;28:2117-21.
12. Bispo NH, Whitaker ME, Aferri HC, Neves JD, Dutka JC, Pegoraro-Krook MI. Speech therapy for compensatory articulations and velopharyngeal function: a case report. J Appl Oral Sci 2011;19:679-84.
13. Prathanee B, Thanawirattananit P, Thanaviratananich S. Speech, language, voice, resonance and hearing disorders in patients with cleft lip and palate. J Med Assoc Thai 2013;96 Suppl 4:S71-80.
14. Prathanee B, Pumnum T, Seepuaham C, Jaiyong P. Five-year speech and language outcomes in children with cleft lip-palate. J Craniomaxillofac Surg 2016;44:1553-60.
15. Poenaru D, Lin D, Corlew S. Economic valuation of the global burden of cleft disease averted by a large cleft charity. World J Surg 2016;40:1053-9.
16. Chokbundit N, Prathanee B. Prevalence and oral reading problems in students with cleft palate, grade 6-8. Khon Kaen: Fcaulty of Education, Khon Kaen University; 2016.
17. Ingkapak P, Prathanee B. Prevalence of oral reading problems in Thai students with cleft palate, grades 3-5. J Med Assoc Thai 2016;99 Suppl 5:S9-14.
18. Antoun JS, Fowler PV, Jack HC, Farella M. Oral health-related quality of life changes in standard, cleft, and surgery patients after orthodontic treatment. Am J Orthod Dentofacial Orthop 2015;148:568-75.
19. Aravena PC, Gonzalez T, Oyarzun T, Coronado C. Oral health-related quality of life in children in Chile treated for cleft lip and palate: a case-control approach. Cleft Palate Craniofac J 2017;54:e15-e20.
20. Augsornwan D, Namedang S, Pongpagatip S, Surakunprapha P. Quality of life in patients with cleft lip and palate after operation. J Med Assoc Thai 2011;94 Suppl 6:S124-8.
21. Farinha FT, Banhara FL, Bom GC, Kostrisch LMV, Prado PC, Trettene ADS. Correlation between religiosity, spirituality and quality of life in adolescents with and without cleft lip and palate. Rev Lat Am Enfermagem 2018;26:e3059.
22. Klassen AF, Tsangaris E, Forrest CR, Wong KW, Pusic AL, Cano SJ, et al. Quality of life of children treated for cleft lip and/or palate: a systematic review. J Plast Reconstr Aesthet Surg 2012;65:547-57.
23. Hocevar-Boltezar I, Jarc A, Kozelj V. Ear, nose and voice problems in children with orofacial clefts. J Laryngol Otol 2006;120:276-81.
24. Safaiean A, Jalilevand N, Ebrahimipour M, Asleshirin E, Hiradfar M. Speech intelligibility after repair of cleft lip and palate. Med J Islam Repub Iran 2017;31:85.
25. Aslan BI, Gulsen A, Tirank SB, Findikcioglu K, Uzuner FD, Tutar H, et al. Family functions and life quality of parents of children with cleft lip and palate. J Craniofac Surg 2018;29:1614-8.
26. Prathanee B. Development of interdisciplinary approaches for cleft lip and palate in Thailand. In: Prathanee B, editor. Cleft lip and palate: speech problems

and multidisciplinary approches 1. Khon Kaen: Khon Kaen University Print; 2014. p. 28-51.
27. Thanawirattananit P, Prathanee B. Five-year hearing outcomes in children with cleft lip/palate. J Med Assoc Thai 2016;99 Suppl 5:S92-6.
28. Prathanee B, Lorwatanapongsa P, Anantapong D, Buakanok N. Thai speech parameters for patients with cleft palate in a universal reporting system. Asia Pac J Speech Lang Hear 2011;14:31-49.
29. Henningsson G, Kuehn DP, Sell D, Sweeney T, Trost-Cardamone JE, Whitehill TL. Universal parameters for reporting speech outcomes in individuals with cleft palate. Cleft Palate Craniofac J 2008;45:1-17.
30. Montes ABM, de Oliveira TM, Gaviao MBD, de Souza BT. Occlusal, chewing, and tasting characteristics associated with orofacial dysfunctions in children with unilateral cleft lip and palate: a case-control study. Clin Oral Investig 2018;22:941-50.
31. Rullo R, Festa VM, Rullo R, Addabbo F, Chiodini P, Vitale M, et al. Prevalence of dental anomalies in children with cleft lip and unilateral and bilateral cleft lip and palate. Eur J Paediatr Dent 2015;16:229-32.
32. Kaewkumsan N, Chowchuen B, Prathanee B. Clinical outcomes of primary palatoplasty in preschool-aged cleft palate children in Srinagarind Hospital and comparison with other standard cleft centers. J Med Assoc Thai 2014;97 Suppl 10:S37-48.
33. Prathanee B, Makarabhirom K, Jaiyong P, Pradubwong S. Khon Kaen: a community-based speech therapy model for an area lacking in speech services for clefts. Southeast Asian J Trop Med Public Health 2014;45:1182-95.
34. Brondsted K, Liisberg WB, Orsted A, Prytz S, Fogh-Andersen P. Surgical and speech results following palatopharyngoplasty operations in Denmark 1959-1977. Cleft Palate J 1984;21:170-9.
35. Grunwell P, Brondsted K, Henningsson G, Jansonius K, Karling J, Meijer M, et al. A six-centre international study of the outcome of treatment in patients with clefts of the lip and palate: the results of a cross-linguistic investigation of cleft palate speech. Scand J Plast Reconstr Surg Hand Surg 2000;34:219-29.
36. Robison JG, Otteson TD. Prevalence of hoarseness in the cleft palate population. Arch Otolaryngol Head Neck Surg 2011;137:74-7.
37. Timmons MJ, Wyatt RA, Murphy T. Speech after repair of isolated cleft palate and cleft lip and palate. Br J Plast Surg 2001;54:377-84.
38. Hamming KK, Finkelstein M, Sidman JD. Hoarseness in children with cleft palate. Otolaryngol Head Neck Surg 2009;140:902-6.
39. Prathanee B, Pumnum T, Seepuaham C. Types of articulation errors in individuals with cleft lip and palate. J Med Assoc Thai 2013;96 Suppl 4:S81-90.
40. 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;78:1707-15.
41. Prathanee B, Pumnum T, Jaiyong P, Seepuaham C, Xayasin V. Satisfaction of speech and treatment for children with cleft lip/palate in Lao People's Democratic Republic. J Med Assoc Thai 2011;94 Suppl 6:S40-4.
42. Prathanee B, Seephuaham C, Pumnum T. Articulation disorders and patterns in patients with cleft. Asian Biomed 2014;8:699-706.