

Research Article

Global perspectives on tongue-tie assessment of one to ten year-old children in speech-language pathology

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Suggested Citation

Smart, S., et al. (2024). Global perspectives on tongue-tie assessment of one to ten year-old children in speech-language pathology. *International Journal of Orofacial Myology and Myofunctional Therapy*, 50(2), 1-17.

DOI: <https://doi.org/10.52010/ijom.2024.50.2.4>



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RESEARCH ARTICLE

Global Perspectives on Tongue-Tie Assessment of One to Ten Year-Old Children in Speech-Language Pathology

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Purpose: Speech-language pathologists (SLPs) are essential in evaluating tongue structure and function. Due to limited psychometrically validated assessment tools, evidence-based practitioners often rely on clinical expertise to inform their assessment and clinical decision-making. This study aimed to explore how SLPs assess tongue structure and function in children aged 1 to 10 years suspected of having a tongue-tie by examining global practice patterns.

Methods: A total of 194 practicing, English-speaking SLPs participated in a global online survey. The survey gathered information on participant demographics, classification tools used, and methods for assessing tongue structure and function, oral motor function and speech production in children with suspected tongue-tie.

Results: Participants reported using various measures, including case history, oral examination, and clinical assessment. These measures encompassed evaluation of tongue structure, oral motor tasks and functional measures, including observation of speech, feeding, and swallowing. Notably, 40% of participants indicated they did not use any published assessment tool. While over 90% of participants evaluated feeding skills through parent questionnaires, only 55% observed feeding during mealtimes. Additionally, SLPs in the United States reported using different classification tools for tongue-tie compared to their counterparts in Australia, the United Kingdom and other countries.

Conclusion: There is a global trend of limited use of published tongue-tie assessment tools in clinical practice. Most clinicians rely on various measures to evaluate tongue structure and function in children with suspected tongue-tie. These findings highlight the need for a specialized assessment tool that is designed and validated for evaluating tongue structure and function in children beyond infancy.

Keywords: tongue-tie, ankyloglossia, children, paediatrics, assessment, speech-language pathology

INTRODUCTION

Speech-language pathologists (SLPs) play a pivotal role in infant feeding and swallowing to ensure optimal health and well-being in children and promote mealtime participation. Scope of practice guidelines emphasize SLPs' key involvement in assessing, diagnosing, and managing various aspects of feeding, eating, drinking, saliva control, and swallowing over the lifespan (SPA, 2022; ASHA, 2016).

Ankyloglossia, commonly known as tongue-tie (TT) is characterized by a functional restriction of tongue movement from a restricted lingual frenulum (Australian Dental Association (ADA), 2000; Fernando, 1998). Prevalence rates for TT vary, ranging from 0.1% to 32.5% depending on age and diagnostic criteria (Hill, Lee & Pados; 2020; Maya-Enero et al., 2021; Suter & Bornstein, 2009). An

increase in surgical interventions globally over the past two decades correlates with increased breastfeeding rates and heightened awareness of TT (Chinnadurai et al., 2015; Kapoor et al., 2018; Walsh et al., 2017). While most of the literature on TT focuses on infants, untreated TT in children over 1 year of age has been associated with speech sound production difficulties, feeding challenges, orthodontic issues, sleep and breathing disturbances and impairments to activities like licking ice-cream on a cone and kissing (Chinnadurai et al., 2015; Walsh & Benoit, 2019; Yoon et al., 2017).

The definition of ankyloglossia or TT refers to both structure and function, and it is imperative to assess both aspects thoroughly. Therefore, comprehensive case history and thorough assessment of oral structure and function conducted by qualified professionals, including SLPs, are recommended for evaluating TT (Messner & Lalakea, 2002). Various published assessment tools, including classification systems and comprehensive assessment protocols (see Appendices A and B), are available to guide clinical assessment, measuring a broad spectrum of tongue structures and functions. Despite the functional definition of TT emphasizing a restriction in tongue mobility due to a short or restricted frenulum (ADA, 2020), commonly used classification systems often evaluate TT severity

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Edited by Dr. Nancy Pearl Solomon for *Special Issue: Contemporary Approaches to Collaborative Management in Ankylofrenula*

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Received: March 23, 2024; Accepted: September 7, 2024

<https://doi.org/10.52010/ijom.2024.50.2.4>

based on a single structural or functional measure, lacking comprehensive diagnostic capabilities and psychometric data (Kotlow, 1999; Garcia Pola et al, 2020; Ruffoli et al, 2005; Yoon et al, 2017). Comprehensive TT assessment protocols, such as the Lingual Frenulum Protocol, offer a more inclusive evaluation, encompassing both structural and functional aspects (Marchesan, 2012). However, psychometric information for the English version of the LFP is unavailable and validation was conducted with children and adults over 7 years of age in Portuguese (Marchesan, 2012). A systematic review by Suter and Bornstein (2009) highlighted the need for universally accepted diagnostic criteria and measures for TT assessment.

The overarching goal of the current study was to investigate how SLPs assess tongue structure and function in children from 1 to 10 years of age with suspected TT. By exploring practice patterns globally, we aimed to:

1. Explore case history items utilized by SLPs in assessing TT.
2. Evaluate classification systems used by SLPs to categorize the appearance and severity of TT.
3. Identify tools and methodologies employed by SLPs to measure tongue structure.
4. Examine oral motor tasks recommended or prescribed by SLPs as part of TT assessment and management.
5. Identify tools and methodologies that are used to assess functional outcomes and efficacy of different assessments of tongue function in children with TT, including speech production.

Materials and Methods

Ethical clearance was secured from the Curtin University Human Research Ethics Committee (HREC2020-0301) before initiating this study. This research employed an online, descriptive, cross-sectional survey aimed at English-speaking SLPs globally, to explore the clinical assessment practices for 1 to 10 year-old children with suspected TT.

Participants

The target group comprised SLPs proficient in English from any country. Recruitment efforts were made through Speech Pathology Australia (SPA), Speech-Language and Audiology Canada, as well as various professional interest groups with international membership via social media.

Materials

An online survey was generated using Qualtrics software, Version 13 (Qualtrics, 2013). Survey questions were formulated based on outcomes from a literature review of assessment tools and insights from other relevant online surveys (Brinkmann et al.

2004; Richmond, 2019). A total of 15 questions explored participants' utilization of published assessments and the specific structural and functional measures they employed. Table 1 provides an overview of the survey questions. In instances where respondents selected the 'other' option within a multiple-choice question, they were encouraged to provide a detailed description.

Procedure

Before the survey launch, two speech-language pathologists (SLPs) with expertise in survey research reviewed the survey meticulously. Their feedback focused on assessing the survey's structure, clarity, and content. This preliminary review was crucial for refining the instrument and ensuring that it effectively captured the intended information. The online survey was accessible for a duration of 8 weeks, spanning July to September 2020. An information flyer containing a reusable survey link was disseminated through professional organizations and social media channels. Essential participant information and details regarding informed consent were featured on the first landing page of the survey. Participants indicated their informed consent by selecting 'yes' to commence the survey.

Analysis

Data were extracted from Qualtrics into Microsoft Excel and were used to compute response frequencies for multiple-choice questions and rank-order options for questions requiring ranking.

Content analysis was applied to free text responses under the 'other' option for all questions, as well as additional comments provided after the survey following the methodology outlined by O' Cathain and Thomas (2004).

RESULTS

A total of 255 participants from 20 countries consented to participate in the study, 206 respondents answered questions beyond the initial demographic section, and 147 completed the entire survey. Table 2 lists a summary of respondents by question.

Participant details, such as nationality, workplaces and years of experience are detailed in Table 3. The average duration of experience was 12.3 years (SD = 9.1).

Participants reported the frequency with which they assess clients aged 1 to 10 years with TT and whether they typically serve as the initial point of contact for evaluating children in this age range. Responses are documented in Table 4.

Table 1. Online survey questions: speech-language pathologist participant demographics and assessment use for assessing children with suspected tongue-tie.

Question Number	Survey Question
1	Where did you complete your speech pathology training?
2	How many years have you practiced as a speech pathologist?
3	Which of the following best describes your current workplace setting(s)? (Select all that apply)
4	How often (approximately) do you assess a client aged 1 to 10 years of age with tongue-tie?
5	How often are you the first point of contact when assessing a child aged 1 to 10 years for tongue tie?
6	From which of the following sources have you received referrals to assess a child aged 1 to 10 years for tongue tie? Select all that apply.
7	To which of the following professionals do you refer children aged 1 to 10 years with tongue tie? Select all that apply.
8	Which of the following tools or classification systems do you use when assessing a child aged 1 to 10 with tongue-tie? Select all that apply.
9	How long does a typical assessment for a child aged 1 to 10 years with tongue tie take?
10	Which of the following case history items do you consider most important during your assessment of children aged 1 to 10 years with tongue tie? Please drag each sentence to rank order of importance.
11	Which of the following structural features of the tongue do you assess in clients with tongue-tie aged 1 to 10 years? Select all that are relevant.
12	Which of the following oral motor/tongue tasks do you assess with clients with tongue-tie aged 1 to 10 years? Select all that are relevant.
13	Which of the following aspects of speech production do you assess in a client with tongue-tie aged 1 to 10 years? Select all that are relevant.
14	Which of the following functional assessments of tongue function do you assess in a client with tongue-tie aged 1 to 10 years, assuming developmental appropriateness? Select all that are relevant.
15	Would you like to receive a summary of the results of this survey?

Participants were asked to report on the average duration of a typical assessment for a child aged 1 to 10 years with TT, with most reporting it takes less than 15 minutes (Figure 1).

Respondents were prompted to select all applicable options regarding the sources from which they have received referrals to assess children within this age range for TT. Examples of other practitioners from which SLPs received referrals included lactation consultants, paediatricians, bodyworkers (e.g., osteopaths, chiropractors) and neonatologists. Additionally, they were asked to identify the professionals to whom they refer 1 to 10 year-old children with TT. Table 5 provides a comprehensive overview of the sources of referral to SLP services and the recipients of referral from SLPs in this context.

Case History

Participants were requested to discern the case history questions that offered the utmost insights, prioritizing them during the assessment (Table 6).

The three most important case history items were feeding history/current issues, medical history, and breastfeeding history. The three least important case history items were aesthetic concerns, fluency, and social/emotional impacts of TT.

Assessment Tools

Table 7 lists the reported frequency of utilization of published assessment tools, encompassing classification systems, comprehensive assessment protocols, and various instruments. Participants could select all that applied. Interestingly, of the top two assessment tools by geographical region, all countries selected 'None' as one of the top two. In the US, the majority of participants utilize the Merkel-Walsh and Overland (2016) Tethered Oral Tie screening tool (17%), whilst in Australia the second most frequently used assessment is the ATLFF (Hazelbaker, 1999), and of other counties, the Kotlow (1999) and Quick Tongue Tie (Yoon et al, 2017) were the second most frequently reported. A subset of participants (8%) also indicated the use of alternative tools, such as the Nuffield assessment

Table 2. Online survey: speech-language pathologist respondent and attrition rates by question.

Survey Question	Number of Respondents
Where did you complete your speech pathology training?	232
How many years have you practiced as a speech pathologist?	226
Which of the following best describes your current workplace setting(s)? (Select all that apply)	224
How often (approximately) do you assess a client aged 1 to 10 years of age with tongue-tie?	206
How often are you the first point of contact when assessing a child aged 1 to 10 years for tongue tie?	206
From which of the following sources have you received referrals to assess a child aged 1 to 10 years for tongue tie? Select all that apply.	206 (422 responses)
To which of the following professionals do you refer children aged 1 to 10 years with tongue tie? Select all that apply.	206 (374 responses)
Which of the following tools or classification systems do you use when assessing a child aged 1 to 10 with tongue-tie? Select all that apply.	195 (361 responses)
How long does a typical assessment for a child aged 1 to 10 years with tongue tie take?	147
Which of the following case history items do you consider most important during your assessment of children aged 1 to 10 years with tongue tie? Please drag each sentence to rank order of importance.	147
Which of the following structural features of the tongue do you assess in clients with tongue-tie aged 1 to 10 years? Select all that are relevant.	147 (741 responses)
Which of the following oral motor/tongue tasks do you assess with clients with tongue-tie aged 1 to 10 years? Select all that are relevant.	147 (1185 responses)
Which of the following aspects of speech production do you assess in a client with tongue-tie aged 1 to 10 years? Select all that are relevant.	144 (499 responses)
Which of the following functional assessments of tongue function do you assess in a client with tongue-tie aged 1 to 10 years, assuming developmental appropriateness? Select all that are relevant.	142 (737 responses)
Would you like to receive a summary of the results of this survey?	141

Table 3. Demographic characteristics of participants) by nationality, workplace context and years of experience.

Participant Demographics (N = 206)	N (%)
Nationality (N = 206)	
United States of America	102 (49.5%)
Australia	61 (29.6%)
United Kingdom	16 (7.8%)
Other*	27 (13.1%)
Workplace Context (N = 205)	
Private Practice	100 (36.4%)
Hospital	46 (16.7%)
Education	45 (16.4%)
Community Health	41 (14.9%)
Disability	15 (5.5%)
Teaching/Research	10 (3.6%)
Other	25 (9.1%)
Total responses	275
Years of Experience (N = 205)	
Up to 5 years	48 (23.3%)
5 years or more	157 (76.2%)

*Belgium (N = 1), Canada (N = 4), Iceland (N = 1), India (N = 4), Iran (N = 1), Ireland (N = 1), Jordan (N = 1), Lebanon (N = 1), Malaysia (N = 1), Netherlands (N = 2), New Zealand (N = 1), Pakistan (N = 2), Portugal (N = 1), Slovakia (N = 1), South Africa (N = 3), Spain (N = 1), Sweden (N = 1)

Table 4. Frequency of assessment and initial contact role in tongue-tie evaluation for children aged 1 to 10 years (N = 206).

Participant Responses	N (%)
Frequency of Assessment	
More than one a month	64 (31.1%)
Every 1-3 months	56 (27.2%)
Every 3-6 months	20 (9.7%)
Every 6-12 months	21 (10.2%)
Less than once a year	40 (19.4%)
Other	5 (2.4%)
Initial Contact Role	
Always	4 (1.9%)
Most of the time	35 (35.0%)
About half the time	27 (13.1%)
Sometimes	83 (40.3%)
Never	20 (9.7%)

(Williams & Stephens, 2004), resources from Pamela Marshalla (Marshalla Speech & Language, 2024), and the Beckman Oral Motor Evaluation Protocol (Beckman, 1986).

Measures of Tongue Structure

The use of measures of tongue structure is outlined in Table 8. Ninety percent of participants reported assessing tongue tip appearance in both elevated (n = 133) and protruded tongue positions (n = 132). The other most reported measures included lingual frenulum appearance (n = 128) and measuring lingual frenulum length (n = 110). When analysed by geographical region, the top three items reported by participants from the United States (n = 418), Australia (n = 221), United Kingdom (n = 29) and other countries combined (n = 62) were 'tongue tip appearance when elevated', 'tongue tip appearance when protruded', and 'lingual frenulum appearance.'

Oral Motor Tasks

A summary of assessments of oral motor tasks as reported by participants by geographical area is provided in Table 9. Other measures included suction of the tongue onto the palate (n = 8), dissociation of tongue and jaw movements (n = 3), tremors (n = 1), coordination (n = 1), tongue tip sweep of teeth (n = 1) and licking of hard palate front to back (n = 1). Three participants noted difficulty eliciting oral motor tasks due to the age of their clients. There was significant overlap of oral motor tasks by country, with all countries reporting 'tongue tip elevation (when mouth is opened as wide as possible)' as the top item assessed in the United States (n = 72), Australia (n = 40), United Kingdom (n = 7) and other countries combined (n = 13). The full distribution of tasks by country is outlined in Table 9.

Table 5. Sources of referrals to and from speech-language pathologists by participants when assessing children aged 1 to 10 years with suspected tongue-tie (N = 206).

Source of Referrals	N (%)
To Speech-Language Pathology (N = 422)*	
General Practitioner	92 (21.8%)
Allied health professional	69 (16.4%)
Dentist and dental surgeon	68 (16.1%)
Nurse or child health nurse	43 (10.2%)
School	40 (9.5%)
Surgeons (e.g., ENT)	31 (7.3%)
Other	79 (18.7%)
From Speech-Language Pathology (N = 374)*	
Dentist and dental surgeon	132 (35.3%)
Surgeons (e.g., ENT)	100 (26.7%)
General Practitioner	54 (14.4%)
Allied health professional	42 (11.2%)
Other	46 (12.3%)

* Participants could select more than one option.

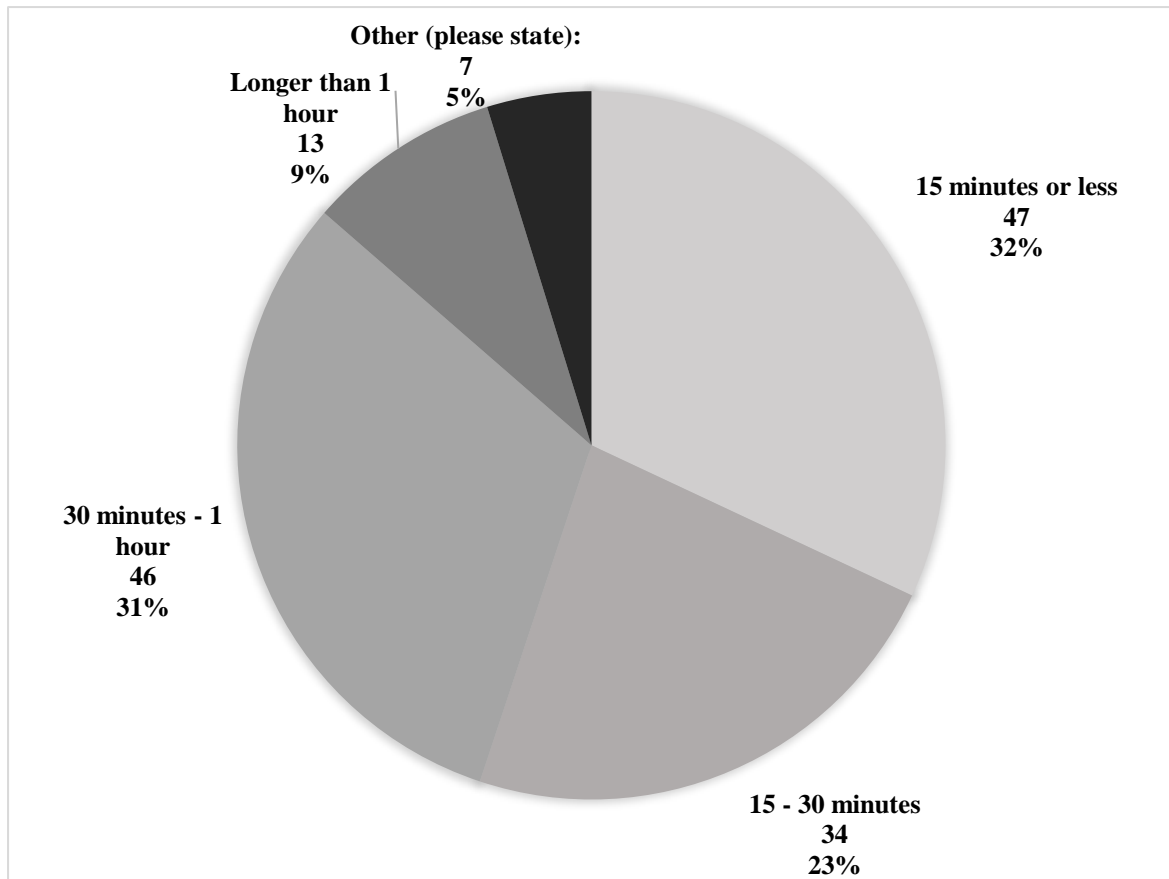


Figure 1. Average duration of tongue tie assessment by participants for children aged 1 to 10 years (N = 147).

Table 6. Participant prioritization of case history questions in tongue-tie assessment (N = 147).

Case History Item	Most Important	Top Three Most Important	Bottom Three Least Important
Medical history	40 (27%)	79 (54%)	0 (0%)
Feeding history/current issues	35 (24%)	95 (65%)	0 (0%)
Breastfeeding history	16 (11%)	82 (56%)	1 (1%)
Breathing, sleep, and snoring history/issues	16 (11%)	42 (29%)	4 (3%)
Speech development/issues	13 (9%)	36 (24%)	1 (1%)
Prior diagnosis of TT	11 (7%)	45 (31%)	2 (1%)
Parent concerns	9 (6%)	17 (12%)	34 (23%)
Dental and orthodontic history/issues	3 (2%)	27 (18%)	0 (0%)
Family history of TT	1 (1%)	7 (5%)	2 (1%)
Language development/issues	0 (0%)	4 (3%)	31 (12%)
Social/emotional impacts of TT	0 (0%)	4 (3%)	13 (9%)
Fluency	0 (0%)	0 (0%)	49 (33%)
Aesthetic concerns	0 (0%)	0 (0%)	65 (44%)
Voice issues	0 (0%)	0 (0%)	55 (37%)
Muscular pain	0 (0%)	0 (0%)	57 (39%)
Other	3 (2%)	3 (2%)	141 (96%)

Table 7. Assessment or classification systems used by participants when assessing children aged one to 10 years with tongue-tie by country (n = 147).

Assessment Tools**	Ages Range	United States (%)		Australia (%)		United Kingdom (%)		Other (%)		Total
		N	(%)	N	(%)	N	(%)	N	(%)	
Coryllos (2004) classification	> 18 mo	10	6%	2	3%	1	8%	1	4%	14
Fernando (1998) Tongue Assessment Protocol (TAP)	9 mo – 29 yr	7	4%	5	7%	0	0%	1	4%	13
Kotlow (1999) free tongue measurement and classification system	18 mo – 14 yr	16	9%	3	4%	1	8%	3	13%	23
Kotlow (1999) criteria for normal tongue mobility	18 mo – 14 yr	12	7%	2	3%	0	0%	0	0%	14
Ferres-Amat et al (2016) classification system	4 – 14 yr	2	1%	0	0%	0	0%	0	0%	2
Hazelbaker (1993) Assessment Tool for Lingual Frenulum Function (HATLFF)	< 12 mo	13	8%	16	21%	1	8%	1	4%	31
Ito et al.& (2015) protocol	3 – 8 yr	0	0%	1	1%	0	0%	0	0%	1
Marchesan (2012) Lingual Frenulum Protocol	7.2 – 11.6 yr	14	8%	4	5%	0	0%	2	9%	20
Martinelli (2015) Neonatal Tongue Screening Test	< 3 mo	12	7%	6	8%	1	8%	1	4%	20
Merkel-Walsh and Overland (2016) Tethered Oral Tie screening tool	All ages	28	17%	3	4%	1	8%	2	9%	34
Quick Tongue Tie Assessment Tool (QTT)	6 – 70 yr	19	11%	6	8%	0	0%	3	13%	28
Ruffoli et al (2005) classification system using maximal incisor opening (MIO)	6 – 12 years	1	1%	1	1%	0	0%	0	0%	2
Yoon et al. (2017) classification system using maximal incisor opening (MIO)	6 – 70 yr	6	4%	2	3%	1	8%	1	4%	10
None		22	13%	22	29%	3	23%	7	30%	54
Other		7	4%	3	4%	4	31%	1	4%	15
TOTAL		169		76		13		23		281

* Participants could select more than one option

Percentages reported out of total participants who completed the question

Table 8. Measures of Tongue Structure Tools Used by Participants to Assess Children Aged One to 10 Years of Age with Tongue-Tie by Country (N= 147).

Assessment of Tongue Structure **	United States		Australia		United Kingdom		Other		Total
	n	(%)	n	(%)	n	(%)	n	(%)	
Tongue tip appearance when elevated	73	17%	42	19%	5	17%	10	16%	130
Tongue tip appearance when protruded	73	17%	42	19%	7	24%	11	18%	133
Mid-tongue appearance when retracted	53	13%	25	11%	4	14%	6	10%	88
Lingual frenulum appearance	71	17%	39	18%	5	17%	11	18%	126
Lingual frenulum length (by observation)	59	14%	31	14%	4	14%	11	18%	105
Lingual frenulum length (direct measurement or proxy measurement e.g. MOTTIP)	21	5%	7	3%	0	0%	4	6%	32
Lingual frenulum insertion points into tongue and/or floor of mouth	58	14%	29	13%	2	7%	9	15%	98
None	0	0%	1	0%	0	0%	0	0%	1
Other (please state):	10	2%	5	2%	2	7%	0	0%	17
TOTAL	418		221		29		62		730

* Participants could select more than one option.

Percentages reported out of total participants who completed the question

Assessment of Speech Production

The utilization of measures related to speech production is outlined in Table 10. Other measures included tongue placement during speech, tongue and jaw movement during speech, phonetic inventory, articulation of vowels, fluency, placement analysis, compensations, and syllable structures which were reported by one participant for each of these items. Participants from the United States, Australia and the United Kingdom all reported the same top three assessment tasks for assessing speech production, including assessing intelligibility, articulation of alveolar and palatal-alveolar sounds, and assessment of phonological processes. The third item reported by the other countries was 'percentage phonemes/consonants correct' instead of assessment of phonological processes.

Assessment of Tongue Function

Table 11 outlines measures of functional assessments of tongue function. Ninety percent of participants reported providing a parent questionnaire or screening questions regarding eating and swallowing issues (n = 132), observation of oral cavity hygiene (n = 103), and observations of cup drinking (n = 95) and straw drinking (n = 85). Other measures included breastfeeding-related measures (n=4), volitional wet swallow (n=2), facial

muscle activation while drinking (n=1), time taken to orally break down foods (n=1), and where food is broken down in the mouth (n=1). Participants from all countries reported the same top two assessment tasks for assessing tongue function, including, parent questionnaire or screening questions about eating and swallowing issues, observation of oral cavity and hygiene, and cup drinking.

Years of Experience and Assessment Tool Used

A chi-square test of independence was conducted to examine the relationship between years of experience and the type of assessment tool used. The data were categorized into five experience ranges: 0 – 5 years, 6 – 10 years, 11 – 15 years, 16 – 20 years, and >21 years. The assessment tools included Hazelbaker's (1993) HATLFF, Quick Tongue Tie Assessment Tool (QTT), Kotlow's (1999), Coryllos' (2004) classification, Fernando's (1998) Tongue Assessment Protocol (TAP), Marchesan's (2012) Lingual Frenulum Protocol, Merkel-Walsh and Overland's (2016) Tethered Oral Tie screening tool, and "None."

The chi-square test indicated that there was no significant association between years of experience and the type of assessment tool used, $\chi^2(20, N = 100) = 10.50, p = .953$. This result suggests that the choice of assessment tool does not significantly depend on

Assessment of Oral Motor Skills **	United States		Australia		United Kingdom		Other		Total
	N	(%)	N	(%)	N	(%)	N	(%)	
Tongue strength	27	4%	16	5%	4	7%	6	6%	53
Tongue position at rest	70	11%	35	10%	5	8%	10	9%	120
Tongue protrusion	69	10%	36	11%	6	10%	11	10%	122
Tongue tip elevation (when mouth is opened as wide as possible)	72	11%	40	12%	7	11%	13	12%	132
Tongue retraction	52	8%	25	7%	5	8%	9	8%	91
Movement of mid-tongue when tongue elevated or retracted	45	7%	11	3%	4	7%	5	5%	65
Movement of floor of mouth when tongue elevated	51	8%	12	4%	3	5%	10	9%	76
Licking lips	43	7%	35	10%	5	8%	10	9%	93
Tongue movement left and right	65	10%	37	11%	7	11%	9	8%	118
Tongue tip reaching up towards nose/down towards chin	50	8%	37	11%	5	8%	10	9%	102
Mobility of sides of tongue (e.g. cupping)	49	7%	17	5%	3	5%	7	6%	76
Tongue tip able to touch inside of cheeks or molars	56	8%	33	10%	5	8%	8	7%	102
None	0	0%	1	0%	0	0%	0	0%	1
Other (please state):	12	2%	2	1%	2	3%	1	1%	17
TOTAL	661		337		61		109		1168

* Participants could select more than one option.

Percentages reported out of total participants who completed the question

Table 10. Assessments of speech production used by participants when assessing children aged one to 10 years with tongue-tie by country (N = 144).

Assessment - Speech Production **	United States		Australia		United Kingdom		Other		Total
	n	(%)	n	(%)	n	(%)	n	(%)	
Intelligibility rating	5	2%	5	3%	0	0%	0	0%	10
Articulation of alveolar and palatal-alveolar sounds i.e. /t, d, l, th, ch/	64	23%	35	22%	6	27%	8	20%	113
Phonological processes	71	26%	36	23%	7	32%	13	32%	127
Percentage phonemes/consonants correct	41	15%	26	16%	4	18%	6	15%	77
Speech rate	20	7%	19	12%	1	5%	7	17%	47
Diadochokinetic rate	23	8%	10	6%	2	9%	2	5%	37
Acoustic analysis	24	9%	18	11%	1	5%	4	10%	47
Voice	9	3%	3	2%	0	0%	0	0%	12
None	13	5%	2	1%	0	0%	1	2%	16
Other	8	3%	4	3%	1	5%	0	0%	13
TOTAL	278		158		22		41		499

* Participants could select more than one option.

Percentages reported out of total participants who completed the question

the years of experience of the practitioners. Table 12 outlines the frequency of assessment tool usage by years of experience.

DISCUSSION

The current study aimed to investigate how SLPs assess tongue structure and function in children aged 1 to 10 years with a suspected TT, and explored a range of items, including case history items, classification systems, tools and methodologies to measure tongue structure, oral motor tasks and functional outcomes and efficacy of different assessments of tongue function in children with TT, including speech production, amongst clinicians globally.

Key Measures

The results demonstrated extensive utilization of measures across all assessment areas. Between 63% to 91% of participants assessed tongue elevation, protrusion, lateral movements, retraction, licking of lips, tongue resting position and touching of molars with tongue tip. Eighty-seven percent of survey participants assessed articulation of alveolar (tongue-tip to superior alveolar ridge) and palatal-alveolar (mid-tongue approximation with hard palate) speech sounds, whilst 79% assessed intelligibility, and 54% assessed phonological processes. There was limited reported assessment of rate (26%) and voice (11%) during the assessment of TT. Feeding history and current issues (65%), medical history (54%) and breastfeeding history (56%) were rated in the top three case history priorities by participants. Interestingly, over 90% of respondents reported investigating feeding issues through parent questionnaires or screening questions; 54% to 66% of participants reported direct observation of eating and drinking during oral trials with various textures, cups/straws and mealtimes.

The widespread assessment of feeding issues reported by participants supports Chinnadurai et al.'s (2015) recommendations for more research into the impacts of TT on feeding and swallowing. Management of feeding and swallowing difficulties in children is within the scope of practice for SLPs in Australia and the United States, however, we are aware of no studies that reported on the confidence and competence of SLPs in making differential diagnoses for children with TT (SPA, 2012). Recruitment targeted interest groups related to pediatric dysphagia, but the survey did not ask participants to indicate their skills in this practice area. Participants outside of this practice area may account for the reduced use

Table 11. Functional assessment of tongue function used by participants when assessing children aged one to 10 years with tongue-tie by country (N = 142).

Assessment of Tongue Function**	United States		Australia		United Kingdom		Other		Total
	N	(%)	N	(%)	N	(%)	N	(%)	
None	7	1%	3	1%	0	0%	1	2%	11
Parent questionnaire or screening questions about eating and swallowing issues	132	18%	42	20%	7	23%	13	21%	194
Observation of oral cavity hygiene	103	14%	32	15%	6	20%	9	14%	150
Bottle drinking	81	11%	21	10%	3	10%	6	10%	111
Straw drinking	85	12%	19	9%	3	10%	6	10%	113
Cup drinking	95	13%	24	12%	4	13%	7	11%	130
Dry swallow observing maturity of swallowing pattern	65	9%	19	9%	2	7%	7	11%	93
Oral trials with varying food textures	84	11%	19	9%	3	10%	7	11%	113
Mealtime observation	77	10%	24	12%	2	7%	7	11%	110
Other (please state):	8	1%	4	2%	0	0%	0	0%	12
TOTAL	737		207		30		63	737	1037

*Participants could select more than one option; * Percentages reported out of total participants who completed the question. Note. Dry swallow refers to swallowing saliva only. Case history refers to participants investigating feeding and swallowing difficulties through parent questionnaire or case history interview.

Table 12. Assessment tool usage by years of clinical experience (N = 218).

Years of Experience	Hazelbaker (1993) ATLFF	Quick Tongue Tie Assessment Tool (QTT)	Kotlow (1999) Classification	Coryllos (2004) classification	Fernando (1998) TAP	Marchesan (2012) Lingual Frenulum Protocol	Merkel-Walsh and Overland (2016) tool	Other	TOTAL
0-5 years	10	12	8	7	10	5	4	3	59
6-10 years	8	6	7	9	6	3	8	5	52
11-15 years	5	4	5	8	7	3	6	4	42
16-20 years	6	3	4	7	5	5	4	2	36
21+ years	8	2	3	5	4	2	4	1	29
TOTAL	37	27	27	36	32	18	26	15	218

of direct observation measures compared to case history questions, and the lack of use of published feeding and swallowing assessment tools. Alternatively, participants may use case history questions for all participants but did not report using observational measures as they only use these when the case history warrants further investigation.

There was limited indication that participants used objective measures or validated tools to assess tongue structure, oral motor skills or feeding skills. Only 23% measured 'Maxillary Incisive Papillae at Room of Mouth' (MOTTIP), and only 16% used the Quick Tongue-Tie (QTT) tool, which is a specialised instrument used to measure free-tongue measurement, lingual frenulum length, tongue protrusion and/or tongue elevation. This may be due to a lack of awareness, use of estimation or anatomical reference points instead of objective measurement, intolerance of measurement procedures by younger children, or lack of fit of tools to the needs of clinicians. For example, clinical assessment tools such as the Test of Masticating and Swallowing Solids (TOMASS) were developed for healthy adults from 20 to 80 years of age, and were later modified and a normative database was established for 638 children from 4 to 18 years of age in two commercially available crackers in four countries, and then for 2 to 4 year-old children in Australia (Huckabee et al., 2018; Frank et al., 2019; Porter et al., 2024). The TOMASS was not identified or may not have been widely adopted for clinical use at the time of survey completion.

The results from this survey do not specifically indicate which of the measures selected were considered primary diagnostic indicators for TT and which were part of routine, comprehensive or exclusionary assessment procedures. Several participants commented that diagnosis of TT is typically not the focus of clinical assessment and that the measures they reported using were part of a routine comprehensive assessment of a child's speech, language, and swallowing skills. This reflects comments by Walsh and Tunkel (2017) that simplistic TT diagnostic frameworks do not reflect the complexities of speech and feeding mechanisms and tongue development, and thus do not explain the subsequent variability in presentation and treatment outcomes for children with TT.

Published Assessment Tools

The most frequently used published assessment tools in this survey were Kotlow's (1999) classification, the Lingual Frenulum Protocol (LFP), and the Tongue Assessment Protocol (TAP) (Fernando, 1998; Kotlow, 1999; Marchesan, 2012). Forty percent of survey participants reported using

no published assessment tool. This reflects trends identified by Richmond (2019) and Marchesan (2012) against using published assessment tools to assess oral motor skills or to diagnose TT. The limited use of published assessment tools in clinical practice may indicate a lack of awareness, or that these tools do not meet clinical requirements for efficient, comprehensive, age- and ability-appropriate tools that allow for baseline measurement of treatment goals (Arvedson et al., 2020).

There were also geographic disparities for classification systems used by participants when evaluating children aged with suspected tongue-tie across different countries. Notably, the Merkel-Walsh and Overland (2016) Tethered Oral Tie screening tool was most frequently used in the United States (17%) compared to other countries. The Hazelbaker (1993) Assessment Tool for Lingual Frenulum Function (ATLFF) was commonly utilized in Australia (21%), whereas the Quick Tongue Tie Assessment Tool (QTT) was prominently used in the United States (11%) and other regions (13%). Some tools, like the Ferres-Amat et al. (2016) classification system, had limited use, with no participants reporting their use in Australia, the United Kingdom, and other regions. The "None" category indicated a significant portion of participants not using any specific tool, especially in Australia (29%) and other regions (30%). Overall, there is considerable variation in the use of tongue-tie assessment tools across different countries.

Concerningly, participants most often reported using assessment tools designed for use with infants up to 12 months of age, including the Assessment Tool of Lingual Frenulum Function (ATLFF), and the Neonatal Tongue Screening Test (12%) (Hazelbaker, 1993; Martinelli, 2015). These tools are not validated for use with children over 1 year of age and do not assess functional activities including speech and mature swallowing. Merkel-Walsh and Overland's (2016) Tethered Oral Tissues protocol was used by 21% of participants, which is a tool available online, through workshops and in a published book; however, psychometric data have not been reported for this tool.

Participants reported assessing a wider range of structural and functional measures than is included in any published tool. However, without the use of a published protocol, it is unknown how clinicians weigh these factors. Survey results suggest that SLPs prioritize speech and feeding impacts over impairments to structure or non-speech oral motor skills. Therefore, a diverse range of measures are used in clinical practice to assess the impact of TT on tongue structure and function in children aged 1 to 10 years, but with limited use of published assessment measures. The duration of assessment

can indeed vary depending on the tool used. Some tools are consistently associated with shorter durations (e.g., Quick Tongue Tie Assessment Tool (Yoon et al, 2017), while others, such as Hazelbaker's (1993) ATLFF and Fernando's (1998) TAP are used across a wider range of durations. The "None" category indicates that in many cases, no specific tool was applied, potentially affecting the duration of the assessment. This variability suggests that the choice of assessment tool may impact the time required for an evaluation.

Limitations of the study included recruitment of English-speaking SLPs only, and attrition during survey completion. Non-English speaking SLPs were excluded, including clinicians and researchers from South America and Europe, where clinical awareness of TT is generally considered to be strong.

CONCLUSION

This study aimed to explore the assessment practices of SLPs and their assessment of tongue structure and function in 1 to 10 year-old children with suspected TT. The results revealed widespread use of measures across structural, functional, and feeding assessment areas by participants, as well as geographic disparities. The study highlighted limitations in the use of validated or objective tools, with a low percentage of participants employing specific instruments. The findings also underscored the complexity of diagnosing TT, and the need to include a range of measures from comprehensive case history, oral examinations of tongue structure, oral motor tasks, speech and feeding functions. Of concern, is the use of assessment tools designed for infants up to 12 months of age, suggesting a gap or lack of awareness in age-appropriate tools for older children. This study emphasised the need for more comprehensive, age-appropriate and clinically efficient tools to assess tongue structure and function in the differential diagnosis of TT in older children.

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Funding Source: none

Author Contributions: All authors contributed to conceptualization, study design, data collection, data analysis and interpretation, and manuscript preparation. Dr. Smart managed critical revisions and re-analysis of data for this manuscript.

Data availability statement: The data sets generated and analysed during the current study are available from the corresponding author upon reasonable request.

Appendix A

Description of Classification Systems

Classification system	Measure and classification ranges	Recommended diagnostic guidelines
Ferrés-Amat et al. (2016)	Based on percentage of elevation achieved at MIO: Degree 1 – 100% (no abnormality) Degree 2 – 75% (mild TT) Degree 3 – 50% (moderate TT) Degree 4 – 25% (severe TT) Degree 5 – 10% (serious TT)	Surgery recommended for Degrees 4 and 5.
Garcia Pola et al. (2002)	Based on TRMR (ratio of MOTTIP/MIO): LI – 51% to 100% LII – 31% to 50% LIII – <30%	Surgery conducted on all participants with LII and LIII.
Kotlow (1999)	Based on FTM (distance between tongue tip and insertion of lingual frenulum into tongue): No abnormality – >16mm Class I – 12mm to 16mm (mild TT) Class II – 8mm to 11mm (moderate TT) Class III – 3mm to 7mm (severe TT) Class IV – <3mm (ankyloglossia - complete TT)	Surgery recommended for all Class III and IV, and Class II with fatigue or functional impacts.
Ruffoli et al. (2005)	Classification A based on lingual frenulum length: No abnormality – >2cm Mild TT – 1.6cm to 1.9cm Moderate TT – 0.8cm to 1.5cm Severe TT – <0.7cm Classification B based on interincisal distance at MOTTIP: No abnormality - >2.3cm Mild TT – 1.7cm to 2.2cm Moderate TT – 0.4 to 1.6cm Severe TT – <0.3cm	None given. Authors recommended using Classification B. Decreased tongue mobility and speech abnormalities only detected in participants with moderate to severe TT.
Yoon et al. (2017)	Based on TRMR (ratio of MOTTIP/MIO): Grade 1 – >80% Grade 2 – 50% to 80% Grade 3 – 25% to 50% Grade 4 – <25%	None given. TRMR of 46% equates to the 10 th percentile.

Appendix B

Description of Comprehensive Assessment Protocols

Protocol	Measures of tongue structure	Oral motor tasks	Measures of functional activity	Recommended diagnostic guidelines
Tongue Assessment Protocol (TAP)	<p>Cosmetic appearance item (5-point rating scales):</p> <ul style="list-style-type: none"> - Tongue appearance at rest and when moving - Lingual frenulum tightness 	<p>Lingual movement item (5-point rating scales):</p> <ul style="list-style-type: none"> - Tongue protrusion downwards, upwards and horizontally - Licking of lips - Lateral movements - Tongue retraction <p>Oral kinaesthesia items (two 5-point rating scales):</p> <ul style="list-style-type: none"> - Diadochokinetic syllable rate - Ability to hold air in cheeks and pop <p>Ability to complete a series of tongue protrusion movements into cheeks and out of mouth</p>	<p>Feeding skills item (5-point rating scales):</p> <ul style="list-style-type: none"> - Feeding rate - Ability to lick - Chewing ability - Impaired swallowing - Breastfeeding history <p>Speech item (5-point rating scale):</p> <ul style="list-style-type: none"> - Severity rating based on age-appropriate articulation test using connected speech sample. <p>Emotional status item (5-point rating scale):</p> <ul style="list-style-type: none"> - behaviour and emotional status 	<p>Surgery recommended for total score of 15/28 or less, or for patients with one high-scoring item elevating total score above 15/28.</p>
Assessment Tool for Lingual Frenulum Function (ATLFF)	<p>Appearance items (3-point rating scales):</p> <ul style="list-style-type: none"> - Tongue tip shape when tongue is elevated - Lingual frenulum length when tongue is elevated - Lingual frenulum insertion into tongue - Lingual frenulum insertion into floor of mouth - Lingual frenulum elasticity 	<p>Function items (3-point rating scales):</p> <ul style="list-style-type: none"> - Tongue lateralisation - Tongue elevation - Tongue protrusion (extension) - Spread of anterior tongue - Cupping - Peristalsis 	<p>Function item (3-point rating scale):</p> <ul style="list-style-type: none"> - Snapback while breastfeeding. 	<p>Function scores above 12/14 accepted regardless of appearance score.</p> <p>A function score of 11/14 is acceptable if the appearance score is 10/10.</p> <p>Surgery recommended if function score is below 11/14 or appearance score is under 8/10.</p>

Protocol	Measures of tongue structure	Oral motor tasks	Measures of functional activity	Recommended diagnostic guidelines
Ito et al.'s (2015) protocol	3-point rating scales for: <ul style="list-style-type: none"> - Tongue tip shape when tongue is elevated - Lingual frenulum insertion into tongue - Lingual frenulum insertion into floor of mouth 	3-point rating scale for: <ul style="list-style-type: none"> - Tongue protrusion 	3-point rating scale for: <ul style="list-style-type: none"> - Speech sound errors 	AG diagnosed when the total score was under 8/10.
Lingual Frenulum Protocol (LFP)	General tests (2 or 3-point rating scales): <ul style="list-style-type: none"> - Tongue tip shape when tongue is elevated - Lingual frenulum insertion into tongue - Lingual frenulum insertion into the floor of mouth - Lingual frenulum length when tongue is elevated (four categories) Functional tests (4-point rating scale): <ul style="list-style-type: none"> - Tongue position at rest 	General test (2-point rating scale) <ul style="list-style-type: none"> - TRMR. Functional tests (3-point rating scales): <ul style="list-style-type: none"> - Ability to protrude tongue upwards - Tongue retraction - Lateral movements of tongue - Ability to touch tongue tip to upper and lower molars - Vibration of tongue apex - Ability to suck tongue against palate 	Functional tests (2 or 3-point rating scales): <ul style="list-style-type: none"> - Informal speech sound assessment - Speech sound errors - Facial movements during speech - Speech speed - Speech precision - Voice 	Frenulum considered altered when general test score is greater than 2/8, or when functional score is greater than 24/40.