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Association between aspects of clinical assessment of the tongue accomplished in children

Associação entre os aspectos da avaliação clínica da língua realizada em crianças

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ABSTRACT

Purpose: Investigate the possible association between myofunctional aspects of the tongue clinical evaluation. **Methods:** Observational, cross-sectional study conducted with 80 healthy Brazilian schoolchildren aged 8-12 years: 36 (45%) males and 44 (55%) females. The following aspects of the tongue were assessed: morphology, frenulum, mobility, praxis, and force. Association between the aspects of clinical evaluation was obtained considering a statistical significance level of 5%. **Results:** The following associations were observed: between tongue width and height; between frenulum length and the tasks of sucking the tongue on palate, tongue vibration, tongue protrusion/retraction, and touching right and left commissures and upper and lower lips; between frenulum attachment to the floor of the mouth and the tasks of sucking tongue on palate and tongue vibration. In the snap task, tongue apex snap was associated with tongue body snap. Tongue snap (apex or body) was associated with sucking the tongue on palate, tongue vibration, tongue protrusion/retraction, touching right and left commissures and upper and lower lips, and tongue force. Sucking tongue on palate was associated with tongue vibration, tongue protrusion/retraction, touching right and left commissures and upper and lower lips, and tongue force. Tongue vibration was associated with tongue protrusion/retraction and tongue force. Association was also observed between the tongue protrusion/retraction task and touching right and left commissures and upper and lower lips. **Conclusion:** Association between tongue aspects was verified in the clinical evaluation.

Keywords: Tongue; Evaluation; Speech, Language and hearing sciences; Stomatognathic system; Muscle strength

RESUMO

Objetivo: Pesquisar a existência de associação entre os aspectos da avaliação clínica da língua. **Métodos:** Estudo transversal observacional, com 80 crianças brasileiras, saudáveis, faixa etária entre 8 e 12 anos, sendo 36 (45%) do gênero masculino e 44 (55%) do gênero feminino. Foram avaliados aspectos da língua relacionados à morfologia, frênulo, mobilidade, praxias e força. Foram obtidas as associações entre os aspectos da avaliação clínica, considerando nível de significância de 5%. **Resultados:** Houve associação entre largura e altura; entre extensão do frênulo e as provas de sugar a língua no palato, vibrar, protrair/retrair e tocar comissuras direita e esquerda e lábios superior e inferior e entre a fixação do frênulo no assoalho da boca e as provas de sugar a língua no palato e vibrar. A prova de estalar ápice de língua apresentou associação com estalar o corpo. Estalar a língua (ápice ou corpo) apresentou associação com sugar a língua no palato, vibrar, protrair/retrair, tocar comissuras direita e esquerda e lábios superior e inferior e força. A prova de sugar a língua no palato apresentou associação com vibrar, protrair/retrair, tocar comissuras direita e esquerda e lábios superior e inferior e força de língua e a prova de vibrar a língua, com protrair e retrair e força de língua. Também houve associação entre protrair e retrair e tocar comissuras direita e esquerda e lábios superior e inferior. **Conclusão:** Os aspectos da língua na avaliação clínica apresentaram associações entre si.

Palavras-chave: Língua; Avaliação; Fonoaudiologia; Sistema estomatognático; Força muscular

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INTRODUCTION

The tongue is a muscular organ that plays an important role in several functions of the stomatognathic system, such as chewing, swallowing, and speech articulation[1]. During mastication, the tongue assists with the grinding phase[2], keeping the food on the occlusal surfaces, and facilitates formation of the food bolus[2]. In deglutition, food is directed by the tongue into the pharynx[3], whereas in speech it is one of the structures responsible for articulation of phonemes[4]. In addition, the tongue cleans the oral cavity after food consumption[2].

Tongue muscles are responsible for its moving and changes in its shape, and are divided into extrinsic (palatoglossus, genioglossus, hyoglossus, and styloglossus) and intrinsic (superior longitudinal, inferior longitudinal, transversus, and verticalis)[1]. The intrinsic muscles are included in the tongue, whereas the extrinsic muscles are originated from adjacent structures and inserted in the tongue[1]. The intrinsic and extrinsic muscles of the tongue are interdependent because their fibers form a three-dimensional latticework[1,5]. Thus, most movements of the tongue require simultaneous contraction of several muscles, with constant interaction between extrinsic and intrinsic muscles, in the various functions it performs[1,5]. Because of the arrangement of its muscle fibers, which are organized both parallel and perpendicular to the axis, the tongue is considered a muscular hydrostat, being able to change its shape without changing its volume. Thus, any change in one dimension will cause a compensatory change in at least one other dimension[6]. For instance, elongation/tapering is obtained by contraction of the transversus and verticalis, which decreases cross-section; shortening is caused by contraction of the superior and inferior longitudinal muscles; lateral bending is the result of simultaneous contraction of the longitudinal muscles, unilaterally, and of the transversus[6].

The anterior tongue contains a high concentration of muscle fibers resistant to fatigue/slow twitch (Type I) and of fast contraction/fast twitch (Type IIa). This composition provides structural support for the anterior tongue to perform rapid, repetitive, low-force movements during speech production. Type IIb fibers are located on the tongue base. They produce rapid but more forceful actions needed during swallowing. The high bioenergetic capacity for adenosine triphosphate (ATP) production of Type I and IIa fibers, which are predominant in the tongue, make it resistant to muscle fatigue[7].

Not only does muscle fiber type differ between the regions of the tongue, but also the concentrations of tissues. Greater connective tissue concentration occurs in the anterior tongue compared with that in the medial and posterior regions. The connective tissue provides the resistance and flexibility necessary for the rapid sequence of movements and changes in tissue shape performed by the anterior tongue during speech production[8]. Another factor responsible for the fine and accurate movements of the anterior third of the tongue is the higher concentration of motor units in this region. In contrast, the posterior tongue has a higher concentration of muscle tissue and a larger fiber bundle diameter, favoring movements that require force[8]. Owing to the complex organization of its muscle fibers and to the large number of motor neurons that compose the cranial nerve XII, which is responsible for its motor innervation, the tongue performs several movements in short periods of time[9].

Muscle and anatomical aspects of the tongue, such as force, mobility, praxis, posture, morphology and frenulum, should be in harmony so that the stomatognathic functions can be performed adequately. When there is suspicion of impairments, each aspect should be assessed thoroughly and separately[10]. The clinical assessment of the tongue is the most commonly used, but it is limited because of its perceptive nature, and the diagnosis can vary between speech-language pathologists[11]. Even with the development and use of objective evaluation tools, which have grown in this research area[12-14], qualitative clinical evaluation is still the most used method in practice. However, association between the tongue aspects obtained in qualitative clinical assessment is still little studied. A previous study[15] investigated the association between the aspects of tongue clinical evaluation in healthy young adults and verified that the level of force influences lingual praxis performance. The authors also observed that changes in the vibration task tended to be accompanied by other difficulties, such as in tongue snap and elevation. Another survey, which assessed the tongue of 120 preschoolers, found normal tongue tonus in children with normal praxis and altered tongue tonus in children with altered praxis[10].

Considering that most speech-language therapy patients are children, it is important to observe and understand the relationships between the clinical aspects of the tongue in this population. Some authors showed that orofacial myofunctional aspects have been poorly addressed in children[16]. Thus, studies addressing these aspects could assist speech-language pathologists with performing more accurate diagnoses in the field of orofacial motricity and proposing suitable therapeutic plans. In this context, this study aimed to investigate the possible association between aspects of clinical assessment of the tongue in children; such association is believed to exist.

METHODS

This observational, cross-sectional study was conducted at the Integrated Health Clinics of the *Centro Universitário Metodista Izabela Hendrix*, the Universidade Federal de Minas Gerais (UFMG), and in a public school of Belo Horizonte, Minas Gerais state, Brazil. The study was approved by the Research Ethics Committees of the aforementioned Institutions under the respective protocol numbers: 2.141.922; 692.875; CAAE - 67187417.5.0000.5149.

Study sample

Eighty healthy schoolchildren aged 8-12 years (mean=10.52 years; standard deviation=1.4 years), 36 (45%) males and 44 (55%) females, composed the study sample.

Inclusion criteria were as follows: being within the established age group; absence of glossectomy, pelvectomy, or tongue paralysis; absence of diagnosis of pervasive developmental disorder; absence of diagnoses of neurological or syndromic diseases; absence of diagnosis of hearing loss. Exclusion criteria comprised children who were unable to understand the tasks requested in the assessment, who were unable to complete all the stages of the clinical evaluation, and who showed lack of agreement between the examiners in the clinical assessment of the tongue.

Clinical evaluation

Study participants were selected in the waiting rooms of the Integrated Health Clinics of the *Centro Universitário Metodista Izabela Hendrix* and of the Speech-language Pathology Outpatient Clinic of UFMG, and in a public school in Belo Horizonte. All participants were informed about the purposes and methods of the research. All participants, as well as their parents and/or legal guardians, signed an Informed Consent Form (ICF) prior to study commencement. The schoolchildren were submitted to clinical assessment of the tongue performed by two speech-language pathologists (one of them specialized in orofacial motricity), or by a speech-language pathologist specialized in orofacial motricity and a senior student of the Speech-language Pathology (SLP) course of the *Centro Universitário Metodista Izabela Hendrix*, previously trained on the clinical assessment of the tongue. In total, five examiners participated in the data collection: three speech-language pathologists and two senior SLP undergraduate students. The three speech-language pathologists that performed the clinical evaluation had experience in orofacial motricity of one, 10 and 23 years. The diagnoses were reached by consensus and, when there was disagreement between evaluations of the two examiners, the individual was excluded from the sample.

Clinical assessment of the tongue was performed through anthroposcopy and lasted approximately 20 min. Five aspects were evaluated: morphology, frenulum, mobility, praxis, and force[17].

Assessment of the morphological aspects observed the width and height of the tongue and classified them as normal or altered. In the lingual frenulum evaluation, participants were asked to elevate the tongue inside the oral cavity without touching the palate, and the attachments of the frenulum were observed on the floor of the mouth and on the tongue. It was also observed whether frenulum length was adequate, short or long[17]. Cases with a history of previous frenotomy or frenectomy were recorded.

In the mobility assessment, participants were requested to perform movements of snapping the apex and body of the tongue, sucking the tongue on hard palate, sucking the tongue on hard palate for 5s, and vibrating it[15]; the model was provided by the examiners. Each of these tasks was classified as normal, altered, or absent.

In the praxis (coordination) assessment, using the model provided by the examiners, participants were asked to alternate between lingual protrusion and retraction and sequentially touch the apex of the tongue on the right and left commissures and upper and lower lips[15]. This task was considered altered when the participant could not perform these movements adequately. All tasks of mobility and praxis in which there was presence of associated movements of the mandible and perioral musculature were noted, with unexpected contractions of the lips and mandible movements during the accomplishment of the tongue tasks considered as associated movements.

In order to investigate tongue force, participants were requested to keep the tongue in protrusion and push it against a tongue depressor, which was positioned vertically a few centimeters away from the mouth, performing the task of counter-resistance, for a few seconds[15]. Tongue force was classified as normal when protrusion against the resistance offered by the depressor was maintained without trembling and/or deformation; it was considered reduced when the musculature showed slight resistance against the depressor and tremors and deformation were observed; it was classified as reduced at the apex when only the tongue apex showed deformation and/or tremors.

Data analysis

Aiming to describe the sample, measurements of central tendency (mean) and variability (standard deviation) were performed for the continuous variables, whereas frequency analysis was conducted for the categorical variables. The Chi-squared and Fisher's exact tests were applied to evaluate the association between the variables force, mobility, praxis, morphology, and frenulum. A significance level of 5% was adopted for all statistical analyses. Data were processed in IBM SPSS software.

RESULTS

Eighty schoolchildren, 36 (45%) males and 44 (55%) females, were evaluated. Age distribution of the participants was as follows: 12 (15%), 8 years; 7 (8.8%), 9 years; 13 (16.3%), 10 years; 23 (28.7%), 11 years; 25 (31.3%), 12 years.

Regarding the morphological aspects of the tongue, 77 (96.3%) of the participants presented adequate height and 71 (88.8%) had adequate width; 69 (86.3%) showed adequate frenulum length and 10 (12.5%) presented short frenulum; 71 (89.9%) showed frenulum attachment to the tongue at midline, 3 (3.8%) at the apex, and 5 (6.3%) between midline and apex; 64 (81%) had frenulum attachment to the floor of the mouth visible from the caruncles and 15 (6.3%) visible from the alveolar crest. One of the participants had previously undergone frenectomy and, therefore, did not participate in the assessment of this aspect.

With respect to mobility, 68 (85%) participants adequately snapped the apex of the tongue, 69 (86.3%) snapped the body of the tongue; 68 (85%) properly sucked the tongue on palate; 62 (77.5%) showed correct tongue vibration.

As for praxis, 72 schoolchildren (90%) adequately performed the task of tongue protrusion/retraction and 71 (88.8%) sequentially touched the apex of the tongue on the right and left commissures and upper and lower lips correctly. Associated movements of lips and/or tongue were only noticed in the praxis tasks: in the tongue protrusion/retraction task, one participant showed lip compensation and in the task of touching the right and left commissures and upper and lower lips, one participant presented lip compensation and two participants showed mandible compensation.

Concerning tongue force, 35 (43.8%) participants showed adequate force, 21 (12.5%) had reduced force at the apex, and 24 (30%) presented reduced force in the whole tongue.

Regarding association between tongue width and height and other variables of interest, association was found only between the height and width variables themselves, indicating that individuals with altered width also tended to show changes in tongue height (Table 1).

As for association between frenulum length and attachment to the tongue and other variables of interest, associations were found between frenulum length and the tasks of touching the right and left commissures and upper and lower lips, tongue protrusion/retraction, tongue vibration, and sucking the tongue on palate, as well as between frenulum attachment to the floor of the mouth and the tasks of sucking the tongue on palate and tongue vibration, indicating that individuals with altered frenulum showed difficulties in mobility and lingual praxis (Table 2).

With respect to association between tongue apex snap and tongue body snap and other variables of interest, significant associations were observed between tongue apex snap and tongue body snap, as well as between tongue snap (body or apex) and the tasks of sucking the tongue on palate, tongue vibration, tongue protrusion/retraction, touching the commissures and lips, and tongue force (Table 3).

With regards to association between sucking the tongue on palate and tongue vibration and other variables of interest, significant associations were found between sucking the tongue on palate and the tasks of tongue vibration, tongue protrusion/retraction, touching the right and left commissures and upper and lower lips, and tongue force, as well as between tongue vibration and the tasks of tongue protrusion/retraction and tongue force (Table 4).

As for association between the tasks of tongue praxis and other variables of interest, association was observed only between tongue protrusion/retraction and touching the right and left commissures and upper and lower lips (Table 5).

Table 1. Association between tongue width and height and other variables of interest

Task	Tongue width					Tongue height				
	Normal		Altered		*p*-value	Normal		Altered		*p*-value
	n	%	n	%		n	%	n	%	
Tongue height										
Normal	70	90.9	7	9.1	0.002**	-	-	-	-	-
Altered	1	33.3	2	66.7		-	-	-	-	-
Frenulum length										
Adequate	62	89.9	7	10.1	0.366*	66	95.6	3	4.3	0.508*
Short	8	80	2	20		10	100	0	0	
Frenulum attachment to the tongue										
At midline	65	91.5	6	8.5	0.337*	69	97.2	2	2.8	0.237*
Between midline and apex	4	80.0	1	20.0		5	100	0	0	
At the apex	1	33.3	2	66.7		2	66.7	1	33.3	
Frenulum attachment to the floor of the mouth										
Visible from the caruncles	58	90.6	6	9.4	0.249**	64	100.0	0	0	0.237**
Visible from the crest	12	80.0	3	20.0		12	80.0	3	20	
Tongue apex snap										
Adequate	59	86.8	9	13.2	0.185*	65	95.6	3	4.41	0.465*
Altered	6	100.0	0	0		6	100.0	0	0	
Absent	6	100.0	0	0		6	100.0	0	0	
Tongue body snap										
Adequate	60	87.0	9	13.0	0.208*	66	95.6	3	4.35	0.487*
Altered	5	100.0	0	0		5	100	0	0	
Absent	6	100.0	0	0		6	100	0	0	
Sucking the tongue on palate										
Adequate	59	86.8	9	13.2	0.185*	65	95.6	3	4.4	0.465*
Altered	7	100.0	0	0		7	100.0	0	0	
Absent	5	100.0	0	0		5	100.0	0	0	
Tongue vibration										
Adequate	55	88.7	7	11.3	0.983*	61	98.4	1	1.61	0.063*
Altered	9	81.8	2	18.2		10	90.9	1	9.1	
Absent	7	100.0	0	0		6	85.7	1	14.3	
Tongue protrusion/retraction										
Adequate	67	88.2	9	11.8	0.471*	73	96.0	3	3.95	0.690*
Altered	3	100.0	0	0		3	100.0	0	0	
Lip movement	1	100.0	0	0		1	100.0	0	0	
Touching the right and left commissures and upper and lower lips										
Adequate	62	87.3	9	12.7	0.263*	68	95.8	3	4.2	0.536*
Altered	6	100.0	0	0		6	100.0	0	0	
Lip movement	1	100.0	0	0		1	100.0	0	0	
Mandible movement	2	100.0	0	0		2	100.0	0	0	

*Chi-squared test; **Fisher's exact test

Subtitle: n = number of individuals; p = level of significance

Table 1. Continued...

Task	Tongue width					Tongue height				
	Normal		Altered		*p*-value	Normal		Altered		*p*-value
	n	%	n	%		n	%	n	%	
Tongue force										
Adequate	33	94.3	2	5.7	0.171*	33	94.3	2	5.7	0.421*
Reduced	18	85.7	3	14.3		20	95.2	1	4.8	
Reduced at the apex	20	83.3	4	16.7		24	100.0	0	0	

*Chi-squared test; **Fisher's exact test
Subtitle: n = number of individuals; p = level of significance

Table 2. Association between frenulum length and attachment to the tongue and other variables of interest

Task	Frenulum length					Frenulum attachment to the tongue							Frenulum attachment to the floor of the mouth				
	Adequate		Short		*p*-value	At midline		Between midline and apex		At the apex		*p*-value	Visible from the caruncles		Visible from the crest		*p*-value
	n	%	n	%		n	%	n	%	n	%		n	%	n	%	
Frenulum attachment to the tongue																	
At midline	63	88.7	8	11.3	0.139	-	-	-	-	-	-	-	-	-	-	-	-
Between midline and apex	3	60.0	2	40.0		-	-	-	-	-	-		-	-	-	-	
At the apex	3	100.0	0	0		-	-	-	-	-	-		-	-	-	-	
Frenulum attachment to the floor of the mouth																	
Visible from the caruncles	58	90.6	6	9.4	0.071	60	93.7	3	4.7	1	1.6	0.285	-	-	-	-	-
Visible from the crest	11	73.3	4	26.7		11	73.3	2	13.3	2	13.3		-	-	-	-	
Tongue apex snap																	
Adequate	61	91.0	6	9.0	0.065	61	91.0	4	6.0	2	3.0	0.224	56	83.6	11	16.4	0.173
Altered	4	66.7	2	33.3		6	100.0	0	0	0	0		5	83.3	1	16.7	
Absent	4	66.7	2	33.3		4	66.6	1	16.7	1	16.7		3	50.0	3	50.0	
Tongue body snap																	
Adequate	61	89.7	7	10.3	0.119	62	91.2	4	5.9	2	2.9	0.226	56	82.4	12	17.6	0.457
Altered	4	80	1	20		5	100.0	0	0	0	0		5	100.0	0	0	
Absent	4	66.7	2	33.3		4	66.6	1	16.7	1	16.7		3	50.0	3	50.0	
Sucking the tongue on palate																	
Adequate	61	91.0	6	9.0	0.019	60	89.5	4	6.0	3	4.5	0.233	55	82.1	12	17.9	0.028
Altered	6	85.7	1	14.3		7	100.0	0	0	0	0		7	100.0	0	0	
Absent	2	40.0	3	60.0		4	80.0	1	20.0	0	0		2	40.0	3	60.0	
Tongue vibration																	
Adequate	56	91.8	5	8.2	0.028	56	91.8	3	4.9	2	3.3	0.276	53	86.9	8	13.1	0.014
Altered	9	81.8	2	18.2		10	90.9	1	9.1	0	0		9	81.8	2	18.2	
Absent	4	57.1	3	42.9		5	71.4	1	14.3	1	14.3		2	28.6	5	71.4	
Tongue protrusion/retraction																	
Adequate	67	89.3	8	10.7	0.021	67	89.3	5	6.7	3	4.0	0.420	61	81.3	14	18.7	0.757
Altered	1	33.3	2	66.7		3	100	0	0	0	0		2	66.7	1	33.3	
Lip movement	1	100.0	0	0		1	100	0	0	0	0		1	100.0	0	0	
Touching the right and left commissures and upper and lower lips																	
Adequate	64	91.4	6	8.6	0.002	63	90.0	4	5.7	3	4.3	0.724	57	81.4	13	18.6	0.796
Altered	2	33.3	4	66.7		5	83.3	1	16.7	0	0		4	66.7	2	33.3	
Lip movement	1	100	0	0		1	100	0	0	0	0		1	100.0	0	0	
Mandible movement	2	100	0	0		2	100	0	0	0	0		2	100.0	0	0	
Tongue force																	
Adequate	34	97.1	1	2.9	0.063	34	97.1	1	2.9	0	0	0.192	30	85.7	5	14.3	0.348
Reduced	18	78.3	5	21.7		20	87.0	1	4.3	2	8.7		17	73.9	6	26.1	
Reduced at the apex	17	80.9	4	19.1		17	80.9	3	14.3	1	4.8		17	80.9	4	19.1	

Chi-squared test
Subtitle: n = number of individuals; p = level of significance

Table 3. Association between tongue apex snap and tongue body snap

Task	Tongue apex snap							Tongue body snap						
	Normal		Altered		Absent		*p*-value	Normal		Altered		Absent		*p*-value
	n	%	n	%	n	%		n	%	n	%	*n*	%	
Tongue body snap														
Adequate	67	97.1	2	2.9	0	0	<0.001	-	-	-	-	-	-	-
Altered	1	20.0	4	80.0	0	0		-	-	-	-	-	-	
Absent	0	0	0	0	6	100		-	-	-	-	-	-	
Sucking the tongue on palate														
Adequate	61	89.7	5	7.4	2	2.9	0.005	63	92.7	3	4.4	2	2.9	<0.001
Altered	5	71.4	1	14.3	1	14.3		4	57.1	2	28.6	1	14.3	
Absent	2	40.0	0	0	3	60.0		2	40.0	0	0	3	60.0	
Tongue vibration														
Adequate	57	91.9	3	4.8	2	3.2	0.001	57	91.9	3	4.8	2	3.2	0.006
Altered	8	72.7	2	18.2	1	9.1		9	81.8	1	9.1	1	9.1	
Absent	3	42.9	1	14.3	3	42.9		3	42.9	1	14.3	3	42.9	
Tongue protrusion/retraction														
Adequate	68	89.5	4	5.3	4	5.3	<0.001	69	90.8	3	3.9	4	5.3	<0.001
Altered	0	0	1	33.3	2	66.7		0	0	1	33.3	2	66.7	
Lip movement	0	0	1	100.0	0	0		0	0	1	100.0	0	0	
Touching the right and left commissures and upper and lower lips														
Adequate	64	90.1	3	4.2	4	5.6	<0.001	64	90.1	3	4.2	4	5.6	0.004
Altered	2	33.3	2	33.3	2	33.3		3	50.0	1	16.7	2	33.3	
Lip movement	0	0	1	100.0	0	0		0	0	1	100.0	0	0	
Mandible movement	2	100.0	0	0	0	0		2	100.0	0	0	0	0	
Tongue force														
Adequate	35	100.0	0	0	0	0	0.001	35	100	0	0	0	0	0.001
Reduced	15	62.5	3	12.5	6	25.0		15	62.5	3	12.5	6	25.0	
Reduced at the apex	18	85.7	3	14.3	0	0		19	90.5	2	9.5	0	0	

Chi-squared test
Subtitle: n = number of individuals; p = level of significance

Table 4. Association between sucking the tongue on palate and tongue vibration and other variables of interest

Task	Sucking the tongue on palate							Tongue vibration						
	Normal		Altered		Absent		*p*-value	Normal		Altered		Absent		*p*-value
	n	%	n	%	n	%		n	%	n	%	n	%	
Tongue vibration														
Adequate	57	91.9	4	6.5	1	1.6	0.001	-	-	-	-	-	-	-
Altered	8	72.7	2	18.2	1	9.1		-	-	-	-	-	-	
Absent	3	42.9	1	14.3	3	42.9		-	-	-	-	-	-	
Tongue protrusion/retraction														
Adequate	66	86.8	7	9.2	3	4.0	0.045	61	80.3	9	11.8	6	7.9	0.009
Altered	1	33.3	0	0	2	66.7		1	33.3	1	33.3	1	33.3	
Lip movement	1	100.0	0	0	0	0		0	0	1	100.0	0	0	
Touching the right and left commissures and upper and lower lips														
Adequate	63	88.7	5	7.0	3	4.2	0.008	57	80.3	8	11.3	6	8.4	0.097
Altered	4	66.7	0	0	2	33.3		3	50.0	2	33.3	1	16.7	
Lip movement	1	100.0	0	0	0	0		0	0	1	100.0	0	0	
Mandible movement	0	0	2	100.0	0	0		2	100	0	0	0	0	
Tongue force														
Adequate	35	100	0	0	0	0	0.001	31	88.6	3	8.6	1	2.9	**0.037**
Reduced	14	58.3	6	25.0	4	16.7		14	58.3	5	20.8	5	20.8	
Reduced at the apex	19	90.5	1	4.8	1	4.8		17	80.9	3	14.3	1	4.8	

Chi-squared test
Subtitle: n = number of individuals; p = level of significance

Table 5. Association between the tasks of tongue praxis and other variables of interest

Task	Tongue protrusion/retraction						*p*-value	Touching the right and left commissures and upper and lower lips								*p*-value
	Normal		Altered		Absent			Normal		Altered		Lip movement		Mandible movement		
	n	%	n	%	n	%		N	%	n	%	n	%	n	%	
Touching the right and left commissures and upper and lower lips																
Adequate	71	100	0	0	0	0	<0.001	-	-	-	-	-	-	-	-	-
Altered	3	50.0	3	50.0	0	0		-	-	-	-	-	-	-	-	
Lip movement	0	0	0	0	1	100.0		-	-	-	-	-	-	-	-	
Mandible movement	2	100.0	0	0	0	0		-	-	-	-	-	-	-	-	
Tongue force																
Adequate	35	100	0	0	0	0	0.072	34	97.1	1	2.9	0	0	0	0	0.466
Reduced	22	91.7	2	8.3	0	0		21	87.5	2	8.3	0	0	1	4.2	
Reduced at the apex	19	90.5	1	4.8	1	4.8		16	76.2	3	14.3	1	4.8	1	4.8	

Chi-squared test

Subtitle: n = number of individuals; p = level of significance

DISCUSSION

This study investigated the aspects of morphology, frenulum, mobility, praxis, and force of the tongue in schoolchildren aged 8-12 years. This age group was chosen because the motor development of the tongue undergoes little variation in this phase. The diameter and myelination of the axons of the corticobulbar tract, which controls tongue movement, undergoes a rapid and non-linear increase until approximately 8 years of age. After this age, they continue to increase, but more gradually, towards the end of childhood and adolescence[18]. A survey that measured the tongue force of children and adolescents described a rapid increase from 3 to 8 years of age, and showed that after the age of 8 years, force continued to increase, but more gradually, until reaching a peak at the age of approximately 16 years[18].

Tongue height was the aspect that had the smallest number of individuals considered as altered, whereas tongue force was the aspect with the largest number of altered individuals. A previous study that addressed the clinical assessment of the tongue in healthy young adults[15] showed that force was also a variable with a large number of altered individuals (62.5% of the sample), and in another survey that investigated the prevalence of SLP disorders in children, the authors observed that 67.4% of orofacial myofunctional impairments were associated with the force of the structures evaluated[16]. A previous research[10] suggested that muscle strength interferes with the capacity of the tongue to perform sequential movements. This association is in agreement with the findings of the present study, which shows that individuals with decreased tongue force also present difficulty in performing tongue praxes. An explanation for this finding is that the amount of force that the tongue is able to exert depends not only on muscle tissue concentration, diameter, and type of muscle fibers, but also on neural activation, that is, the number of motor units recruited in the muscle contraction, speed, and coordination of recruitment of the motor units[7]. Therefore, inadequate neural activation may be associated with decreased force, coordination, and precision of movements.

In the present study, association was found between the morphological aspects of tongue width and height. A previous investigation reported that tongue width is often altered in oral breathers[19] due to the lowered posture that the tongue assumes to allow passage of air through the oral cavity, and it may be a result of weakness of the transversus. In contrast, tongue height is associated with the verticalis. Together, the transversus and the verticalis perform tongue tapering[6], which was evaluated in the task force in this study. However, no association between these variables and tongue force was observed, suggesting that the changes between tongue width and height of the individuals of this study are probably individual anatomical variations, and not a result of changes in force. Increased tongue volume, both in width and height, has been associated with accumulation of fat in the tongue, a condition found in individuals with obstructive sleep apnea[20]; however, this condition was not investigated in the present study.

Regarding the lingual frenulum, changes in the tasks of mobility and praxis were found in individuals with altered frenulum, with significant association between frenulum length and the tasks of mobility and praxis and between frenulum attachment to the floor of the mouth and tongue mobility. A previous study reported that individuals with frenulum changes are more likely to present changes in tongue mobility[21]. The same research also indicated that 35% of the individuals with altered frenulum presented altered mobility, whereas only 15% of the individuals with normal frenulum showed altered mobility. Another survey found that lingual mobility may be impaired when there is a change in the lingual frenulum[22]. In another article, the authors also observed that individuals with short and anteriorized frenulum presented greater changes in the upper direction praxes and vibration[23], and that the task of sucking the tongue on palate was altered in individuals with short and anteriorized frenulum. The present study confirmed that changes in the length and attachment of the frenulum to the floor of the mouth may generate impairments in tongue mobility. This is due to the fact that the lingual frenulum has a large number of collagen Type I fibers, which are resistant to traction, possibly justifying tongue movement restriction[24]. A participant who had previously undergone frenectomy was not excluded from the study, only from the lingual frenulum assessment, thus participating in the evaluation of the other aspects, because it was considered important to investigate the schoolchildren regardless of impairments or complaints, previous or current, associated with the tongue or oral functions. The exclusion of participants with impairments would limit the range of performance obtained, as noted in a previous research conducted with adults[15].

The associations found in the tasks of mobility and praxis are in agreement with the literature. A study reported that individuals with impairment in praxis have difficulty in tongue vibration and sucking the tongue on palate[25]. In another survey conducted with adults[15], tongue snap showed association with tongue vibration and both tasks were associated with tongue force classification, showing the relationship of these tasks with tongue force, corroborating the findings of the present study.

With respect to praxis, association was observed between tongue protrusion/retraction and touching the commissures and lips, but no association with tongue force was found. This finding is in disagreement with a study conducted with pre-school children, in which decreased tongue force was observed in participants with difficulties in performing tasks of non-verbal lingual praxis[10]. Few individuals showed associated movements of lips and/or mandible during the praxis tasks. Other authors also observed low occurrence of associated movements of lips and increased occurrence of associated movements of mandible, but in a higher proportion (18.8%)[15] compared with those of this research (2.5%). Participants with associated movements of the lips had difficulty in tongue snap (apex and body) and tongue vibration, whereas participants with associated movements of mandible showed difficulty sucking the tongue on palate. In addition, participants with associated movements of lips and/or mandible presented reduced tongue force. Therefore, such unexpected contractions seemed to be compensations to assist with the movement because of the difficulty in tongue force or mobility.

In view of these findings, it was verified that the myofunctional aspects of tongue in the clinical evaluation performed in schoolchildren presented several associations. Speech-language pathologists should, therefore, be attentive during the evaluation process. Interdependence between the changes may influence prognosis, and when there are several altered aspects, a concomitant approach of two or more aspects may be necessary in the therapy.

Qualitative evaluation of the tongue, although a routine in SLP practice, especially in the field of orofacial motricity, is still little studied, mainly regarding the performance of children[16]. Different studies addressing specific tongue tasks such as force[26], mobility[27], praxis[14,28,29], and frenulum[22] have been conducted with individuals with varied clinical conditions. However, the present study innovates by investigating the association between the different tasks of tongue assessment. Such knowledge is important to assist professionals with the evaluation process, enabling a different view from the performance of patients in each assessment task. A careful clinical evaluation is important for therapeutic success.

A limitation to this study was that some important aspects of the tongue were not evaluated, such as tongue tremor, habitual posture, symmetry, and mucosa. The assessments were conducted by pairs of examiners, concomitantly, and not always by the same evaluators, since five examiners participated in the data collection. In addition, two of these examiners were senior SLP undergraduate students, which is another limitation to this study, although all of them were previously trained in the classification criteria of each task. The functions of the stomatognathic system were not evaluated either. It is worth emphasizing that there are difficulties inherent in the subjectivity of clinical evaluation and, in order to minimize them, assessment was always performed by two examiners. It is suggested that further research be conducted to investigate orofacial functions, associating them with the tasks of clinical evaluation, since it is still unknown to what extent the performance of the tongue in isolated tasks is associated with its performance in the functions.

CONCLUSION

Association between the following aspects was verified in the clinical assessment of the tongue: tongue width and height; frenulum length and sucking the tongue on palate, tongue vibration, tongue protrusion/retraction, touching the right and left commissures and upper and lower lips; frenulum attachment to the floor of the mouth and sucking the tongue on palate and tongue vibration; tongue apex snap and tongue body snap; tongue snap (body or apex) and sucking the tongue on palate, tongue vibration, tongue protrusion/retraction, touching the right and left commissures and upper and lower lips, and tongue force; sucking the tongue on palate and tongue vibration, tongue protrusion/retraction, touching the right and left commissures and upper and lower lips, and tongue force; tongue protrusion/retraction and tongue force; tongue protrusion/retraction and touching the right and left commissures and upper and lower lips.

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