Determining the Validity of the Tongueometer in Comparison to the Iowa Oral Performance Instrument

Nazia Mohsin[1], Rebekah Guastella[2], Stefania Oppedisano[2], Ashwini M. Namasivayam-MacDonald[1]

[1] Rehabilitation Science – Speech-Language Pathology, McMaster University [2] Communication Sciences and Disorders, Adelphi University

BACKGROUND

- To measure tongue strength, tongue pressure manometers measure the maximal voluntary isometric contraction (MVIC) of the tongue[4,5,6].

- MVIC demonstrates strong reliability when assessing muscle strength[3].

- As new tongue pressure manometers come to market it is important that they are validated against the current gold standard, Iowa Oral Performance Instrument (IOPI), prior to being implemented in research and clinical practice.

Figure 2. IOPI bulb[1].

Figure 3. Tongueometer bulb[2].

- Literature indicates that the IOPI demonstrates strong efficacy in measuring tongue strength[4].

- Adams et. al (2012) found that slippage of the IOPI bulb occurs when placed in the oral cavity, potentially impacting accuracy of tongue strength values. As well, posterior tongue and swallowing positions may be prone to artifact movement than the anterior position[4].

- The Tongueometer bulb was designed to mitigate artifact movement by creating a textured surface while the IOPI bulb has a smooth surface.

- **This study investigates the concurrent validity of a new, relatively inexpensive device to measure tongue strength, the Tongueometer, in comparison to the current gold standard tongue pressure manometer, Iowa Oral Performance Instrument (IOPI).**

METHODS

- Data was collected from 45 healthy participants between the ages of 21 to 92 (34 female, M = 46.9 ± 23.3 years) with no prior history of dysphagia.

- Three different tongue pressure measurements were conducted on each participant using the two devices:
    - 1) maximum anterior pressure
    - 2) maximum posterior pressure
    - 3) regular effort saliva swallows

Table 1. Example of how measurements were taken for each participant.

- Three trials were conducted for each type of tongue pressure measurements (anterior, posterior and swallowing).

- The maximum value across three trials for each location was calculated for analysis, given that they correlate with mean tongue pressures[5].

- R was used to conduct statistical analyses and visualize the data.

- Concurrent validity was assessed by determining the Pearson's correlation coefficient for the relationship between the two devices for each of the three tongue pressure measurements.

- Paired t-tests were used to determine if the measures taken by the two devices were similar.

Participant 1		
Device	Tongueometer	IOPI
Max anterior pressure	Trial 1	Trial 1
	Trial 2	Trial 2
	Trial 3	Trial 3
Max posterior pressure	Trial 1	Trial 1
	Trial 2	Trial 2
	Trial 3	Trial 3
Max swallow pressure	Trial 1	Trial 1
	Trial 2	Trial 2
	Trial 3	Trial 3

RESULTS

- Both devices measured anterior pressure similarly (t(69) = -0.16, p = 0.88).

- Anterior tongue pressure measurements for the Tongueometer had a relatively normal distribution while the IOPI measurements were right-skewed.

- Both devices measured posterior (t(69) = -2.48, p = 0.02), and swallowing pressure (t(68) = -2.89, p = 0.01) differently.

- Posterior tongue pressure measurements for the Tongueometer had a bimodal distribution while the distribution for the IOPI were more right-skewed.

- Swallowing tongue measurements for the Tongueometer were left-skewed while the distribution for the IOPI were right-skewed.

- There were significant large positive correlations between the two devices' measurements for all three tongue pressure measures (anterior r = 0.76, posterior r = 0.89, swallowing r = 0.73).
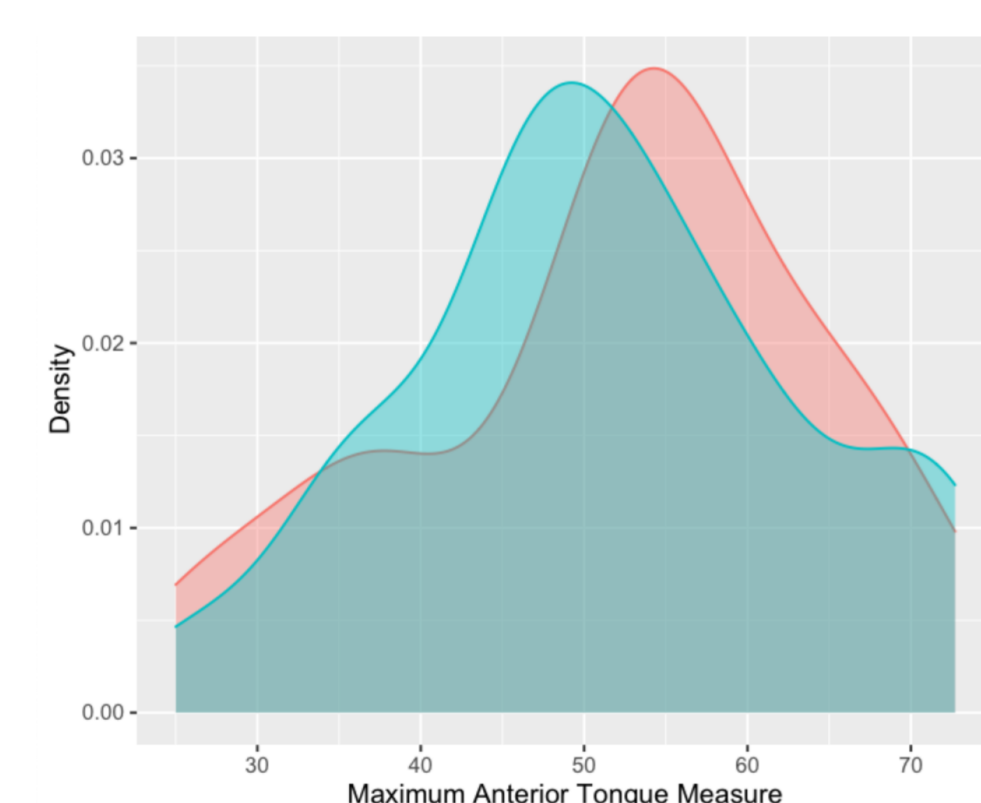
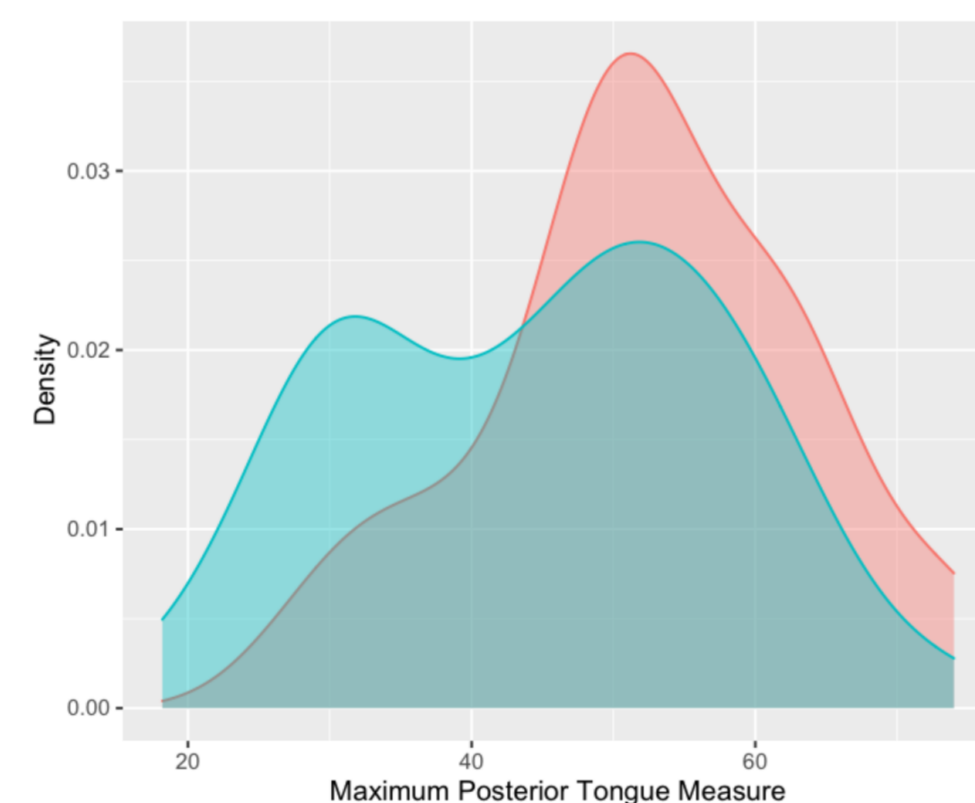**Figure 4.** Distribution of Anterior Tongue Measures.
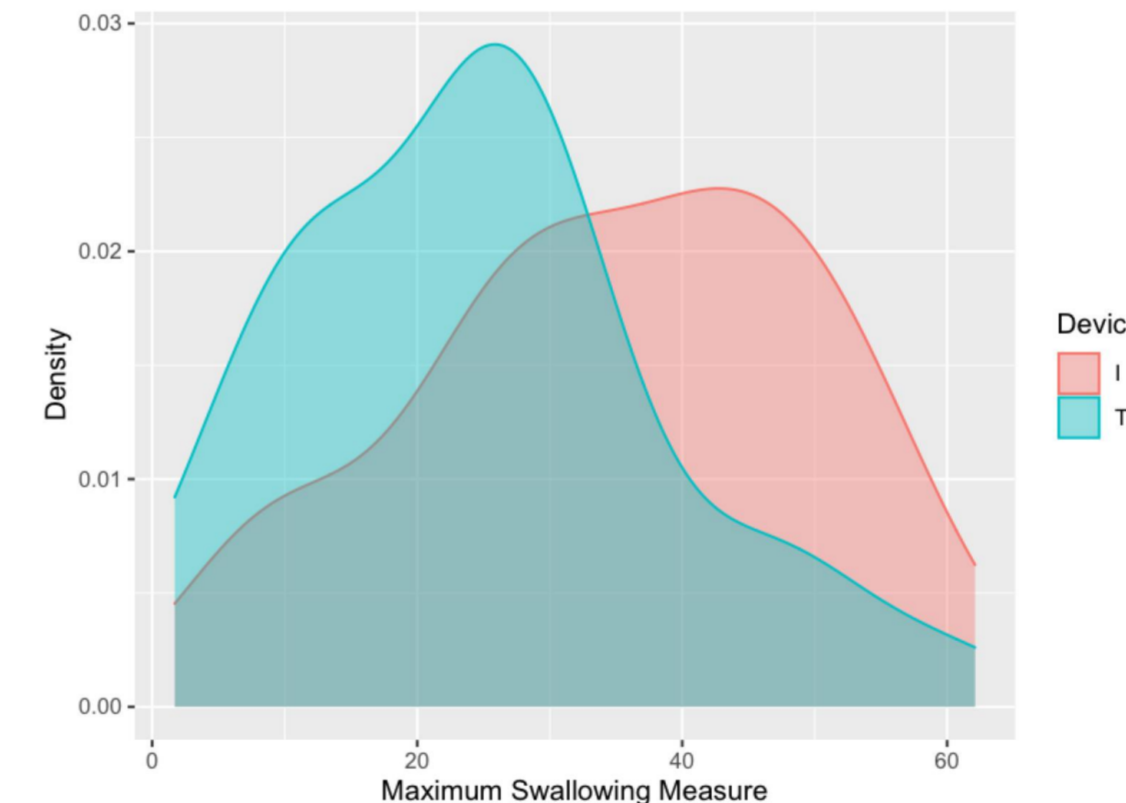
Figure 5. Distribution of Posterior Tongue Measures.
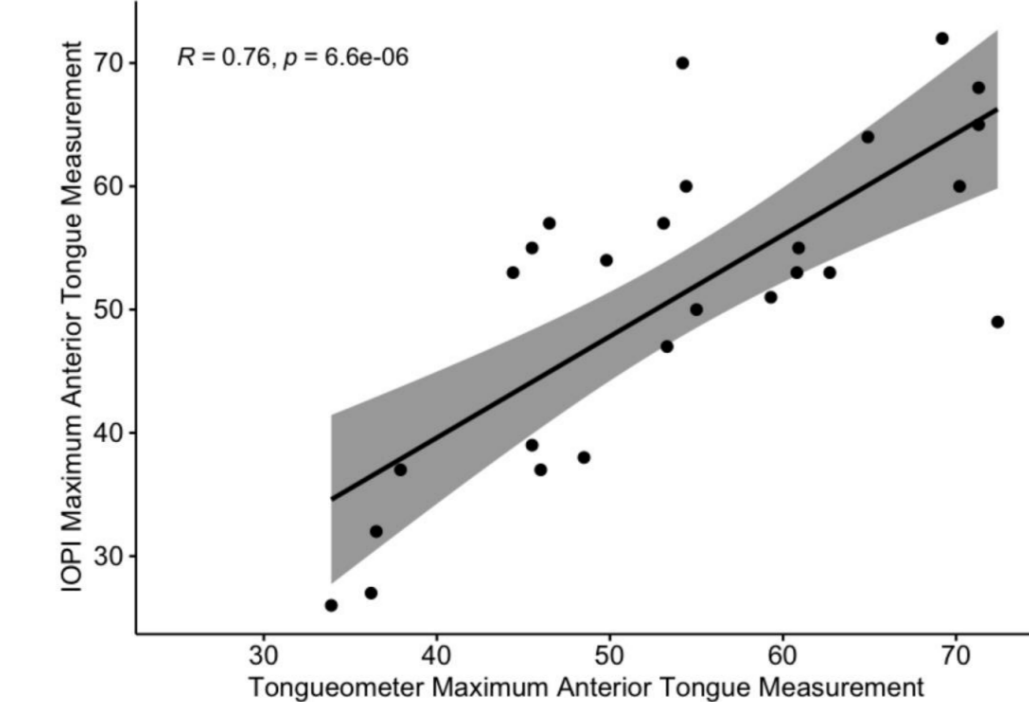
Figure 6. Distribution of Swallowing Tongue Measures.

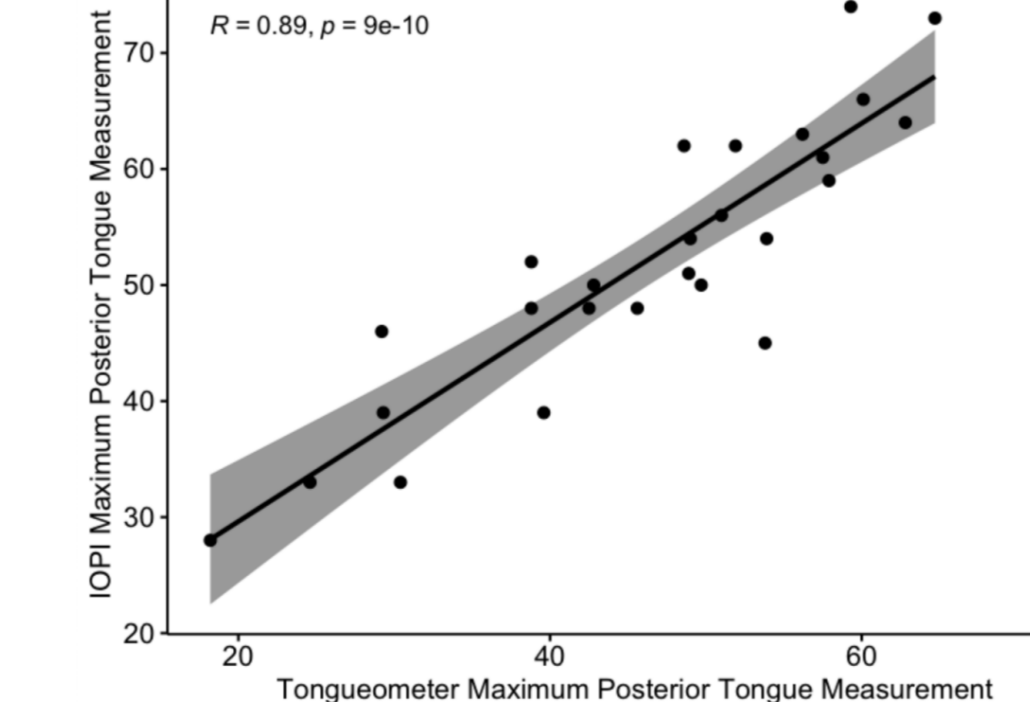**Figure 7.** Tongueometer vs. IOPI Anterior Tongue Measurement

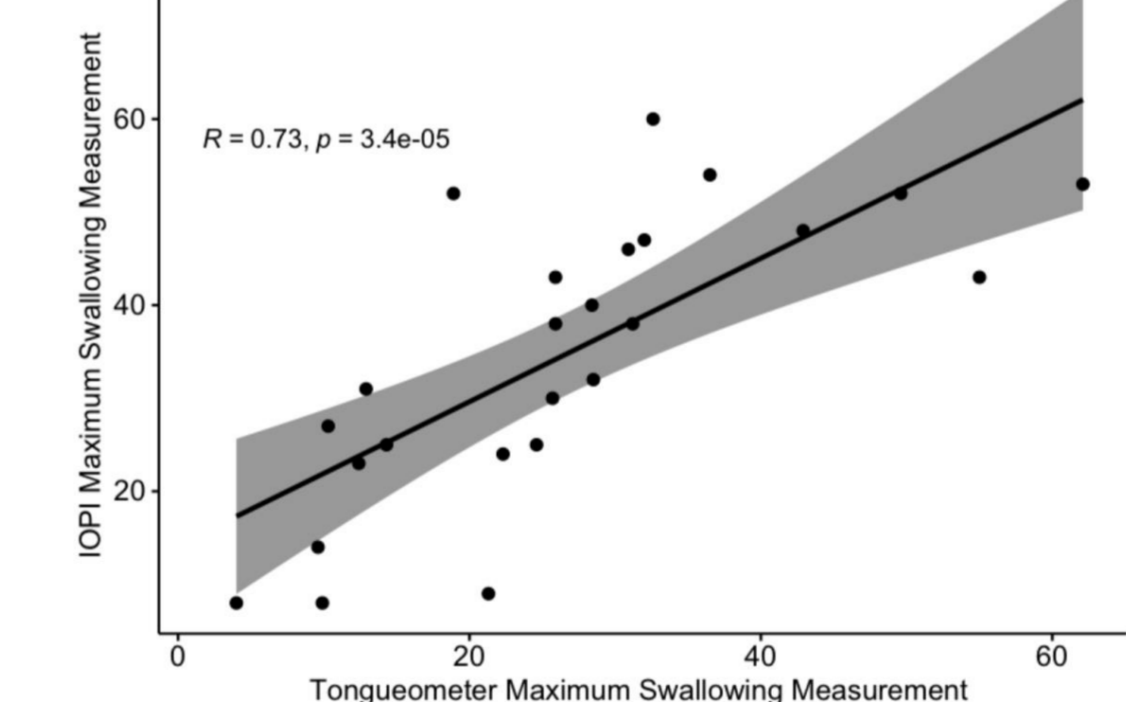**Figure 8.** Tongueometer vs. IOPI Posterior Tongue Measurement.

Figure 9. Tongueometer vs. IOPI Swallowing Tongue Measurement.

Table 2. Summary of mean values, standard deviation and comparisons between devices with healthy data.

	Maximum Anterior Tongue Measure (kPa)		Maximum Posterior Tongue Measure (kPa)		Maximum Swallowing Tongue Measure (kPa)	
	Tongueometer	IOPI	Tongueometer	IOPI	Tongueometer	IOPI
Mean ± SD	51.2 ± 12.1	51.7 ± 12.5	44.7 ± 13.2	52.5 ± 11.4	24.8 ± 14.0	35.0 ± 14.8
Paired t-test P-value	0.876		0.016		0.005	
Pearson's R	0.76		0.89		0.73	

DISCUSSION

- Overall, the Tongueometer is a low-cost tool that demonstrates strong concurrent validity across anterior, posterior, and swallowing measures when compared to the IOPI.

- The two devices took very similar anterior tongue pressure measurements but measured posterior and swallow pressures differently. This could be due to differences in bulb shape, material and volume between the devices.

- The left-skewed Tongueometer data suggests that the device may have reduced sensitivity.

- Previous studies have found that posterior tongue and swallowing positions are more prone to artifact movement than the anterior position[4].

FUTURE DIRECTIONS

- Given that there is contrasting evidence regarding the magnitude of age-related differences in tongue pressures [4,5], further analyses of tongue pressure measures between the devices by age group may be beneficial.

- An increased sample size may also provide greater insight as to why devices take certain measures differently or potentially demonstrate similar measurements in posterior tongue and swallowing pressures.

REFERENCES

[1] Sentient Healthcare. (n.d.). [Photograph]. https://sentient-healthcare.ie/product/iopi-system/[4]

[2] E2 Scientific Corp. (n.d.). [Photograph]. https://e2scientific.com/wp-content/uploads/2018/12/rsz_bulb2.png

[3] Lee, S. Y., & Jo, M. E. (2016). Comparison of maximum voluntary isometric contraction of the biceps on various posture and respiration conditions for normalization of electromyography data. *Journal of physical therapy science, 28*(11), 3007-3010. IOPI Medical LLC. (n.d.). [Photograph]. https://iopimedical.com/

[4] Adams, V., Mathisen, B., Baines, S., Lazarus, C., & Callister, R. (2013). A systematic review and meta-analysis of measurements of tongue and hand strength and endurance using the Iowa Oral Performance Instrument (IOPI). *Dysphagia, 28*(3), 350-369.

[5] Youmans, S. R., & Stierwalt, J. A. (2006). Measures of tongue function related to normal swallowing. *Dysphagia, 2*1(2), 102-111.

[6] Hori, K., Taniguchi, H., Hayashi, H., Magara, J., Minagi, Y., Li, Q., ... & Inoue, M. (2013). Role of tongue pressure production in oropharyngeal swallow biomechanics. *Physiological reports, 1*(6), e00167.