Tongue pressures in healthy adults aged sixty to seventy-nine

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Speech Pathology and Audiology

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We recommend that the thesis prepared under our supervision by

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Tongue pressures in healthy adults aged sixty to seventy-nine

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MASTER OF SCIENCE

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Abstract

Background: Tongue pressure is essential to normal tongue function. Tongue pressure influences mastication and swallowing.

Aim: The study investigated the tongue pressure of healthy, English-speaking individuals aged 60 to 79 in the United States to establish an anterior and posterior tongue pressure database. The study examined sex differences in tongue pressure. In addition, the study established an anterior-to-posterior tongue pressure ratio.

Population: Fifty healthy adults aged 60-79, balanced by sex (25 males; $M = 67.48$, $SD = 5.01$, 25 females; $M = 67.84$, $SD = 5.29$).

Method: The Iowa Oral Performance Instrument was used to measure anterior and posterior maximum isometric tongue pressure and to establish an average anterior-to-posterior tongue pressure ratio based on maximum isometric pressure.

Results: Statistical analyses included descriptive statistics, paired t-tests, and a linear regression. The mean MIP for the anterior is 46.48 kPa ($SD = 10.51$) and for the posterior is 48.60 kPa ($SD = 10.49$). Results revealed no statistically significant difference between anterior and posterior maximum isometric pressures ($p = 0.08$) or between sexes for anterior ($p = 0.38$) or posterior ($p = 0.70$) maximum isometric pressures. A linear regression revealed a positive correlation between anterior and posterior tongue pressures per participant ($R^2 = 0.97$). The average anterior-to-posterior tongue pressure ratio is .98 kPa ($SD = 0.17$). A two-tailed t-test yielded no statistical difference in the APTR by sex ($p = 0.32$).
Conclusion: These findings suggest that anterior and posterior regions of the tongue generate similar levels of pressure in this population, with no significant sex differences. Normative anterior and posterior tongue pressure data provides valuable information for evaluating and managing oral function in older adults aged 60-79.

Keywords: tongue, tongue pressure, anterior tongue pressures, posterior tongue pressures, muscle fiber types, aging, sex differences, normative data, Iowa Oral Performance Instrument (IOPI), maximum isometric tongue pressure (MIP), anterior-to-posterior tongue pressure ratio (APTR)
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Introduction

The tongue is a muscular hydrostat that is composed of four intrinsic and four extrinsic muscles. The intrinsic muscles have internal attachments that allow the tongue to change shape (Kayalioglu et al., 2007). The extrinsic muscles have external attachments and allow for gross tongue movements such as protrusion and retraction (Kayalioglu et al., 2007). The tongue performs a role in mastication and swallowing (Stierwalt & Youmans, 2007; VanRaventhorst-Bell et al., 2018).

A primary function of the tongue is mastication and transportation of the bolus from the mouth through the pharynx (Youmans et al., 2008; Gingrich et al., 2012). To accomplish the task, the tongue generates lingual pressure along its anteroposterior length to ensure smooth and efficient movement of saliva, as well as food and liquids (Gingrich et al., 2012). Due to the complex nature and important functions of the tongue, the tongue is composed of various muscle fiber types that contribute to anterior and posterior pressure generation. An understanding of tongue function requires knowledge of muscle fiber types. Such knowledge allows an understanding of the difference between anterior and posterior tongue pressures.

The subdivisions of the tongue are comprised of two main muscle fiber types with the composition changing from the tongue tip to the blade to its base. Sanders et al. (2013) investigated the histology of 6-cadaver tongues. The authors found that the anterior tongue (tip to blade) is composed of 45% type I and 55% type II muscle fibers. The tip to the blade of the tongue is composed of more type II, fast-twitch muscle fibers. Type II muscle fibers allow for short and quick bursts of pressure, permitting the
manipulation and propulsion of boluses during swallowing (VanRavenhorst-Bell et al., 2018; Hsiao et al., 2022). The body of the tongue is composed of 69% type I and 31% type II muscle fibers and the tongue base is predominately composed of 74% type I and 26% type II, slow-twitch muscle fibers. The body and base of the tongue are predominately composed of type I fibers. Type I muscle fibers contract slowly and are relatively fatigue-resistant, allowing for sustained muscle pressure. The type I fibers allow for prolonged activities, such as upper airway closure during mastication (VanRavenhorst-Bell et al., 2018; Hsiao et al., 2022). The study was limited to histological muscle fiber types and did not explore the impact of variation in muscle composition between the anterior and posterior of the tongue on pressure generation, the primary function of the tongue during the oral phase of swallowing in healthy adults.

Tongue pressure is a product of the amount of force produced by the tongue and is influenced by muscle fiber type (Stierwalt & Youmans, 2007; Clark & Solomon, 2011; Adams et al., 2013; VanRavenhorst-Bell et al., 2018). Due to the difference in muscle fiber type composition between the anterior and posterior tongue; it is anticipated that the force generation of the locations would differ.

Historically, speech-language pathologists subjectively measured tongue pressure by asking a patient to protrude their tongue and push against a tongue depressor. Research indicates subjective measures are unreliable and invalid (Clark et al., 2003). Objective measurements can provide accurate and valid tongue pressures. Baseline data can be collected to quantify treatment progress across time (Youmans & Stierwalt, 2006). There are commercially available devices to objectively measure tongue pressure. The Iowa Oral Performance Instrument (IOPI) is the gold standard device to objectively
assess tongue pressure. IOPI objectively measures pressures in kilopascals (kPa). Tongue pressure can be measured in kPa, which allows a clinician to obtain quantitative data that can be compared to normative data. Normative data allows comparisons across age groups and assists in identifying patients with diminished tongue pressures.

Studies have been conducted to determine the normal variation of non-swallowing isometric tongue function in healthy individuals. Using IOPI, Crow and Ship (1996) examined tongue pressure across age and sex. The study included 99 healthy participants aged 19-96 years (52 males, 47 females). The male group had a mean tongue pressure of 74.8 kPa (SD = 18.9). The female group had a mean tongue pressure of 64.7 kPa (SD = 19.6). Females exhibited lower tongue pressures than males (p = .01). The study also reported results by age. Of particular interest, the older group consisted of 43 participants aged 60-79 years. The older group had a mean tongue pressure of 69.5 kPa (SD = 17.3). The younger group consisted of 16 total participants aged 19-39 years. The younger group exhibited greater tongue pressure with a mean of 75.7 kPa (SD = 17.3).

Youmans et al. (2008) examined maximum isometric tongue pressure and swallowing pressures using IOPI in healthy adults to assess the potential decline of tongue strength with age. The study included 96 participants that were divided into three age groups- (youngest: 20-39 years, middle: 40-59 years, oldest: 60-79 years). The maximum isometric pressure of the oldest age group, consisting of 30 participants balanced by sex, is of particular interest to the present study. The male group of the oldest adults had a mean tongue pressure of 62.69 kPa (SD = 13.04). The female group of the oldest adults had a mean tongue pressure of 57.56 kPa (SD = 12.73). The results indicated no significant sex differences across the oldest group (p = 0.25). Alternatively, they did
find a statistically significant difference in tongue pressure across age. The youngest
group ($p < 0.0001$); and the middle group ($p = 0.008$) exhibited greater maximum
isometric tongue pressure when compared to the oldest group.

Clark and Solomon (2011) examined age and sex differences in maximum
pressure of anterior versus posterior tongue strength using IOPI. The study included 171
total participants, 88 males and 83 females aged 18-89 years. The results were reported
by sex and age. The male group had a mean anterior tongue pressure of 57.50 kPa ($SD =$
15.10) and posterior tongue pressure of 52.0 kPa ($SD = 15.20$). In comparison, the female
group had a mean anterior tongue pressure of 56.50 kPa ($SD = 13.60$) and posterior
tongue pressure of 53.60 kPa ($SD = 14.20$). Males and females had no significant
difference in tongue pressures in the anterior ($p = .329$) or posterior ($p = .253$) locations.
To examine age differences, the investigation included three age groups: young (18-29
years, $n = 68$, 25 males, 43 females, $M = 22.9$, $SD = 3.5$), middle (30-59 years, $n = 60$, 35
males, 25 females, $M = 44.7$, $SD = 8.8$); and old (60-89 years, $n = 43$, 28 males, 15
females, $M = 70.8$, $SD = 7.1$). The older group had a mean anterior tongue pressure of 51
kPa ($SD = 15$) and a mean posterior tongue pressure of 47.40 kPa ($SD = 16.7$). The
middle group had a mean anterior tongue pressure of 62.80 kPa ($SD = 13$) and a mean
posterior tongue pressure of 57.90 kPa ($SD = 14$). The young group had a mean anterior
tongue pressure of 55.8 kPa ($SD = 13.5$) and a mean posterior tongue pressure of 52.30
kPa ($SD = 13.2$). A significant age effect was observed with the older group exhibiting
lower pressures compared to the younger and middle groups in the anterior ($p = 0.000$)
and posterior ($p = 0.008$) locations.
Peladeau-Pigeon and Steele (2017) used IOPI to collect data on anterior and posterior isometric tongue pressures including healthy male and female participants aged 60-69 years \((n = 6)\) and 70-79 years \((n = 6)\). The male group aged 60-69 years had a mean anterior tongue pressure of 45.84 kPa \((SD = 12.87)\) and a mean posterior tongue pressure of 40.27 kPa \((SD = 22.05)\). The male group aged 70-79 years had a mean anterior tongue pressure of 47.69 kPa \((SD = 15.80)\) and a mean posterior tongue pressure of 38.79 kPa \((SD = 9.84)\). The female group aged 60-69 years had a mean anterior tongue pressure of 52.71 kPa \((SD = 14.44)\) and a mean posterior tongue pressure of 52.94 kPa \((SD = 11.43)\). The group of females aged 70-79 years had a mean anterior tongue pressure of 42.00 kPa \((SD = 11.09)\) and a mean posterior tongue pressure of 45.18 \((SD = 11.97)\). The main purpose of this study was to investigate a cyclic spatiotemporal index of differences based on age and sex. Consequently, there was no statistical analysis regarding age and sex differences concerning tongue strength. However, the mean values provide information concerning the age and sex differences between tongue locations.

Using IOPI, Galek et al. (2021) examined the difference in oral pressures between healthy individuals and poststroke individuals who report functional swallowing abilities. The study included 36 total participants \((14\ M\ and\ 22\ F)\), balanced by poststroke and healthy individuals with a mean age of 67 years. The anterior and posterior tongue pressures of healthy individuals are of particular interest to the present study. The healthy individuals had a mean anterior tongue pressure of 42.0 kPa \((SD = 11.16)\) and a mean posterior tongue pressure of 39.7 kPa \((SD = 10.12)\). In many studies, anterior and posterior tongue pressures are collectively reported (Crow & Ship, 1996; Youmans et al., 2008; Adams et al., 2013; VanRavenhorst-Bell et
al., 2018). However, the existing literature suggests slightly greater tongue pressure values for the anterior tongue as compared to the posterior tongue (Clark & Solomon; 2012; Adams et al., 2013). Anterior and posterior tongue pressure vary between 40-80 kPa in healthy adults aged 18-59 years (Crow & Ship, 1996; Clark & Solomon, 2011; Adams et al., 2013; VanRavenhorst-Bell et al., 2018) and declines 10-15 kPa in healthy older adults (Crow & Ship, 1996; Clark & Solomon, 2011; Adams et al., 2013; VanRavenhorst-Bell et al., 2018). Additionally, the literature demonstrates an inconsistency in normative tongue pressures for healthy adults aged 60-79 years, with tongue pressures varying between 40-75 kPa with the older literature showing greater MIPs and the most recent literature showing lower MIPs (Crow & Ship, 1996; Youmans et al., 2008; Clark & Solomon, 2011; Peladeau-Pigeon & Steele; 2017; Galek et al., 2021).

    The literature is inconsistent concerning sex differences associated with tongue pressure. Some studies have reported that men have significantly greater maximum tongue pressures than women (Crow & Ship, 1996; Youmans & Stierwalt, 2006; Stierwalt & Youmans, 2007). More recent studies have found little variability between sexes and tongue pressure (Youmans et al., 2008; Clark & Solomon, 2011; Peladeau-Pigeon & Steele, 2017).

    Methodological discrepancies, such as instrumentation, sample variability, working bulb placement definitions, and the stimuli can lead to inconsistent interpretation of results (Gingrich et al., 2012). Additionally, the lack of investigation between anterior and posterior isometric pressures limits a comprehensive understanding of pressure generation by muscle fiber types. The differences between anterior and posterior
isometric pressure are crucial to understanding tongue pressure and its impact on everyday tasks. At present, no literature exists regarding the quantification of an anterior-to-posterior isometric tongue pressure ratio.

Given the current gaps in the literature, the aims of the study are to:

- Establish normative data for anterior and posterior tongue pressures of English-speaking, monolingual individuals aged 60 to 79 years in the United States
- Examine sex differences in tongue pressure
- Establish an anterior-to-posterior tongue pressure ratio for 60- to 79-year-old males and females collectively and by sex that can be used to examine the influence of muscle fiber types in a clinical assessment.

**Method**

The procedures, instrumentation, and dependent measures in this study closely align with those used in the investigation by Youmans et al. (2008). Independent of the methodology used by Youmans et al. (2008), the study will not include boluses or measures related to swallow pressures. Before the investigation, all proposed procedures were submitted to the Institutional Review Board and approved (Proposal Number: 2064314-5).

**Participants**

Fifty participants (25 males; $M = 67.48$ years, $SD = 5.01$, 25 females; $M = 67.84$ years, $SD = 5.29$) aged 60-79 years participated in the investigation. Stratified sampling ensured a balance between sex groups. Inclusion criteria required the participants to be within the age group 60-79 years of age, by self-report in good general health, have an
oral mechanism judged to be within structural and functional normal limits (refer to Appendix A), and be a monolingual speaker of English. Participants were excluded if they self-reported histories of impairments or diagnoses that can impact tongue function, such as swallowing, respiratory, speech, or neurologic impairments, as well as those with a history of head or neck cancer.

**Instrumentation**

The Iowa Oral Performance Instrument (IOPI) Pro Model 3.1, an FDA-approved device created by IOPI Medical LLC, obtained all tongue pressure scores. The IOPI is a handheld portable device that can assess lip and tongue pressures. The tongue bulb is approximately 3.5 cm in length and 4.5 cm in diameter and is attached to the pressure transducer with an 11.5 cm connecting tube (Youmans et al., 2008). The measurement of peak tongue pressure captured kilopascals (kPa) digitally on a liquid crystal display.

**Procedures**

Participants were informed of the study’s purpose, procedures, possible risks, and potential benefits. An oral mechanism examination ruled out structural and functional abnormalities. Participants who met the inclusion criteria were seated in a comfortable chair in an upright position. The investigator began training by placing the bulb with care given to maintain the bulb on the anterior and posterior lingual surface for each trial. The specific definitions (Robbins et al., 2007, Galek et al., 2021) for the anterior placement included situating the bulb approximately 10 mm posterior to the tongue tip. The blue bulb seal lay flat against the blade of the tongue behind the central incisors. Posterior placement (Robbins et al., 2007, Galek et al., 2021) included situating the bulb approximately 10 mm anterior to the most posterior circumvallate papilla. Additionally,
the tubing rested between the central incisors for anterior and posterior placement (Robbins et al., 2007). After displaying appropriate tongue positioning, the participant practiced a “push and release” of the tongue against the bulb for five training repetitions. A one-minute rest allowed the participant to prepare for the initiation of the tongue function task. The investigator held and placed the bulb in a predetermined, a priori randomized anterior or posterior location to counterbalance. Data values were collected from three peak isometric tongue pressure trials for each position (three anterior and three posterior) with a mandated 10-second rest between trials. The investigator set a timer to ensure a two-minute break between bulb placements. The investigator maintained contact with the tubing with their fingertips, ensuring they touched the ridge of the vermillion. The participants were instructed to press against the tongue bulb with as much effort as possible and with behavioral encouragement from the investigator. The specific verbal instructions were as follows:

“When I say ‘go,’ use your tongue to press the bulb against the roof of your mouth as hard as you can. Use your tongue only (no teeth or lips).”

The peak isometric tongue pressures from each of the three trials per bulb placement were taken directly from the IOPI liquid crystal display and were recorded on individual data sheets for each subject (Appendix B). The procedure described has been tested and demonstrated to have strong intra-reliability and inter-examiner reliability (Youmans & Stierwalt, 2006; Youmans et al., 2008). Investigators completed fidelity training with the principal investigator until achieving intra and inter-rater reliability at 90% or higher.
Dependent Measures

Three trials of the peak isometric tongue pressures in each tongue position (anterior and posterior) were documented. The highest of the three peak isometric tongue pressures were recorded as the maximum isometric tongue pressure (MIP), reflecting the participant’s maximum anterior lingual-palatal pressure and posterior lingual-palatal pressure. The MIP of the anterior and posterior trials were used to calculate a ratio.

Statistical Analysis

Descriptive statistics was used to describe the MIP and APTR distribution of the participants by age, sex, and ethnicity. Means were computed for anterior and posterior MIPs across healthy adults aged 60-79, males, and females. Subsequently, a one-tailed t-test was performed to determine if a difference existed between the anterior and posterior MIP. Additionally, two-tailed t-tests were performed for sex (males and females). A linear regression examined the relationship of the MIP for the anterior and posterior placements. MIP obtained from both anterior and posterior trials were used to compute an anterior-to-posterior tongue pressure ratio (APTR). Means were computed for APTR collectively and by sex. A two-tailed t-test was performed to determine if a difference existed between APTR and sex. A histogram illustrated the distributions of the APTR for all participants, males, and females. A scatter plot illustrated the APTR by sex.

Results

Two male participants were unable to demonstrate posterior elevation of the tongue despite training, therefore their posterior data values and anterior-to-posterior ratios were considered outliers and were excluded from data analysis (italicized in Table
1). Descriptions of MIP and APTR data were organized by sex, age, and ethnicity (Table 1). For all participants ($N = 50$), the mean anterior MIP was 46.48 kPa ($SD = 10.51$). The posterior MIP ($n = 48$) was 48.60 kPa ($SD = 10.49$). Males had a mean anterior MIP of 48 kPa ($SD = 12$) and posterior MIP of 49 kPa ($SD = 11$). Females had a mean anterior MIP of 45 kPa ($SD = 9$) and posterior MIP of 48 kPa ($SD = 10$). A paired 1-tailed t-test revealed no statistically significant difference between anterior and posterior MIPs ($p = 0.08$). Two-tailed t-tests revealed no statistical significance between sexes for anterior MIP ($p = 0.38$) or posterior MIP ($p = 0.70$). A linear regression analysis sorted by participant (Figure 1) revealed a positive correlation between the anterior and posterior MIPs ($R^2 = 0.97$). The mean anterior-posterior tongue ratio (APTR) is 0.98 kPa ($SD = .17$). Males had a mean APTR of 1.01 kPa ($SD = 0.18$) and females had a mean APTR of 0.96 kPa ($SD = 0.16$). A two-tailed t-test revealed no statistical difference in the APTR by sex ($p = 0.32$). A histogram demonstrated the APTR distributions for all participants, males, and females (Figure 2). A scatter plot (Figure 3) illustrated the APTR by sex.
Table 1

*MIP and APTR Data by Sex, Age, Ethnicity*

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<tr>
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<td>43</td>
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<td>0.81</td>
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<tr>
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<tr>
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<td>Caucasian</td>
<td>39</td>
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<tr>
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<td>59</td>
<td>64</td>
<td>0.92</td>
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<tr>
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<td>Caucasian</td>
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<td>27</td>
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</tr>
<tr>
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<td>Caucasian</td>
<td>57</td>
<td>50</td>
<td>1.14</td>
</tr>
<tr>
<td>79</td>
<td>Caucasian</td>
<td>24</td>
<td>27</td>
<td>0.89</td>
</tr>
</tbody>
</table>
Figure 1

*Anterior and Posterior MIP Linear Regression by Participant*
Figure 2

Histograms of APTR: all participants, females, males
Discussion

The purpose of this study addressed the gaps in the existing literature by identifying normative anterior and posterior tongue pressure data in healthy adults aged 60-79, investigating sex differences in tongue pressure, and establishing an anterior-to-posterior tongue pressure ratio that can be used during a clinical assessment.

The results for the mean MIPs align with the 40-75 kPa range reported by earlier studies (Crow & Ship, 1996; Youmans et al., 2008; Clark & Solomon, 2011; Peladeau-Pigeon & Steele; 2017; Galek et al., 2021). While existing literature identified greater anterior tongue pressure compared to posterior, the mean MIPs in this study were found to have no significant difference between the two locations (Clark & Solomon, 2011;
Adams et al., 2013). Since the muscle fiber type compositions in the anterior and posterior tongue differ, it was anticipated that the force generation of the locations would vary. However, the study revealed no significant difference in anterior and posterior MIP which may suggest that the tongue generates similar pressures in locations irrespective of muscular fiber composition in this population. The finding could potentially be attributed to age-related sarcopenia. Sarcopenia is characterized by a preferential loss of type II muscle fibers (Roos et al., 1997), leaving older individuals with a greater ratio of type I muscle fibers. Additionally, aging is associated with an increase in adipose and connective tissue (Bässler, 1987; Yamaguchi et al., 1982) along with a decline in muscle fiber diameter (Nakayama, 1991). The nature of the underlying adaptation of the tongue in aging warrants further investigation.

The average MIPs provide insight into the oral phase of swallowing. According to limited histological studies (Sanders et al., 2013), the tip to the blade of the tongue is predominantly composed of type II muscle fibers. The average anterior MIP can provide insight into the functionality of manipulation and propulsion of boluses from the oral cavity into the pharynx. According to Sanders (2013), the body and base of the tongue are mostly comprised of type I muscle fibers and the average posterior MIP can provide insight into the functionality of upper airway closure during mastication.

Sex differences were inconsistently identified across the literature. The current study found that sex did not have an impact on the tongue pressure, consistent with recent research (Clark & Solomon, 2011; Peladeau-Pigeon & Steele, 2017) and differing from earlier literature (Crow & Ship, 1996; Youmans & Stierwalt, 2006; Stierwalt & Youmans, 2007).
The study also contributes to the literature by introducing an anterior-to-posterior tongue pressure ratio. The APTR can be beneficial to clinical assessment as it can contribute to normalization and baseline comparison of objective data. The study found no differences in sex in the APTR, further supporting the utility of the ratio as a standardized measure. The APTR can account for individual differences in tongue pressure generation and provide a reference for normalized data. The data could allow for the identification of an individual’s baseline tongue pressure and for comparison over time or in response to treatment. The ratio could also serve to provide a diagnostic surrogate into the composition of the type I and type II muscle fiber types.

The findings of the current study have important clinical implications for understanding normal tongue function, particularly concerning tongue pressure generation. Through the establishment of normative tongue pressure data, a benchmark is available for the assessment of tongue function in adults ages 60-79. The data can be used with patients to identify tongue weakness and tailor treatment plans respectively. Furthermore, by adhering to the established research method by Youmans et al. (2008), this study maintains methodological rigor and reliability.

It is important to acknowledge the potential limitations of the current study. First, it is challenging to quantify if a participant is using their maximal effort, which may have led to variability in the results. Second, the assessment method does not allow for direct visualization of the oral cavity. Though efforts were made to ensure consistent bulb placement, there is room for error with the bulb maintaining the correct position during the lingual task. Moreover, the limited time for training participants on the lingual tasks may have influenced measurement reliability. Additionally, this study’s participants were
predominantly Caucasian, limiting the generalization to other ethnic groups. This study also relied on self-reporting of good health status, which may overlook health nuances or lead to the inclusion of individuals with undiagnosed health conditions.

Future studies could explore additional aspects influencing tongue pressure and expand the understanding of the tongue. A study following the same participants over time to observe changes in tongue pressure could potentially provide valuable insights into natural degeneration. Furthermore, narrower age increments such as five-year intervals could offer a more detailed understanding of how tongue function changes with age. Future studies could also consider a participant's activity and socialization level, as these factors may influence tongue pressure. It would also be beneficial to compare this study to other healthy age ranges to provide a broader understanding of natural age-related changes in tongue pressure. Future research could also investigate tongue pressures of diverse ethnic groups so that the results could be generalizable to the respective populations. Lastly, studies including investigation of languages other than English could provide valuable insights into how tongue pressure varies across different linguistic backgrounds.

Conclusion

Tongue function in adults aged 60-79 can be better understood by providing objective tongue pressure measurements. The anterior and posterior regions of the tongue generate similar levels of pressure and are not influenced by sex in this population.

Establishing normative data for anterior and posterior tongue pressures and an anterior-to-posterior tongue pressure ratio provides valuable information for assessing and
managing oral function in aging adults. Future studies are needed to investigate age-related changes and confounding factors that may influence tongue pressure.
References


Appendix A

Oral Mechanism Form

Participant Code: ____________________________

Instructions: Circle pass (+) or fail (-) for each item. If any items earn a fail rating, the examinee has failed.

Structures at rest
Symmetry + -

Jaw control
ROM + -

Labial function
Lip spread /i/ symmetry + -
Lip round /u/ + -
Lip closure at rest + -

Lingual function
Protrusion to teeth + -
Retraction /k/ + -
Lick lips + -
Lateralize to corners + -
Lateralize to buccal cavity + -
Elevation to alveolar ridge + -
Lowering of tip + -

Palatal function
(movement/symmetry)
Prolonged /a/ + -

Final score (circle one): pass fail
Appendix B

Data Collection Form

Participant Code: ____________

Data Collection

Age:

Sex:

Ethnicity:

Language(s):

Oral Mechanism Examination

Pass or Fail: pass fail

Do you have a history of swallowing, respiratory, or speech impairments; neurologic trauma, disease, or insult; and head or neck injury (exceptions include dental work); or cancer?

Yes or no: yes no

Using Iowa Oral Performance Instrument (IOPI), complete the tables below:

*Anterior Tongue Pressure*

<table>
<thead>
<tr>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Posterior Tongue Pressure*

<table>
<thead>
<tr>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Anterior MIP: __________________ Posterior MIP: __________________

APTR: __________________