

**Reliability of the Iowa Oral Performance Instrument:
Measuring tongue and handgrip strength and endurance
in young and elderly adults**

By

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BSpPath (Hons)

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Declaration

The thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to the final version of my thesis being made available worldwide when deposited in the University's Digital Repository, subject to the provisions of the Copyright Act 1968.

Signed .

U Valerie Jean Adams

Date *3 March 2014*



ACKNOWLEDGEMENT OF AUTHORSHIP

I hereby certify that the work embodied in this thesis contains a published paper/s/scholarly work of which I am a joint author. I have included as part of the thesis a written statement, endorsed by my supervisor, attesting to my contribution to the joint publication/s/scholarly work.

Chapters 1 and 2 were written with editorial support of my supervisors.

For Chapter 3, I conducted the systematic review and meta-analysis and wrote the first draft.

For Chapters 4, 5, 6, and 7, I designed all aspects of the projects in collaboration with my supervisors. I conducted all measurements, analysed all data and wrote the first draft of all four chapters. This was followed by editorial support from my supervisors.

Chapter 8 was written with editorial support of my supervisors.

Signed ...

Valerie Adams

Signed .

Primary Supervisor: Professor Robin Callister

Dated: 26/7/13

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Abstract

Appropriate tongue strength is essential for the oral and pharyngeal phases of swallowing and contributes to the formation, placement, and manipulation of a bolus within the oral cavity and propulsion into the pharynx. Examination of tongue strength is a frequent component of the clinical assessment of swallowing by speech-language pathologists. Such assessment is based usually on subjective judgement of the force being applied by the tongue against resistance provided by the speech-language pathologist's fingers resting against the cheek or a tongue depressor. This method raises concerns regarding the reliability of tongue strength measurements due to an inability to eliminate assessor bias and the variability introduced by multiple assessors in most clinical environments.

This thesis presents the results of research that examined investigations of objective measurement of tongue strength and endurance as well as handgrip strength and endurance. Two studies were conducted using the same methods. Healthy young (21 males: 30 females) and elderly (6 males: 24 females) participants underwent anterior and posterior tongue and handgrip strength and endurance assessments using the Iowa Oral Performance Instrument (IOPI) on four occasions separated by approximately two weeks. Strength assessments consisted of three attempts to exert maximal isometric force. Sustained isometric endurance assessments consisted of one attempt to sustain 50% of maximal isometric force. Three statistical analyses providing different indices of reliability were used. Random and systematic change outcomes through sampling error and learning effects were assessed using change in the mean between sessions. Within-subject variation was determined using typical error expressed as a coefficient of variation, which represents the technical and biological sources of error in measurement within participants. Rank order repeatability of the

results among trials was investigated using intraclass correlation coefficients (ICC, r). Additional exploratory strategies were conducted with maximum tongue (anterior and posterior positions) and handgrip strength values analysed using three approaches: 1) the highest of the three trials in the session; 2) the average of the three trials in the session; and 3) the average of the two highest trials in the session.

The key findings are that tongue and hand isometric strength measurements obtained using the IOPI demonstrate excellent reliability for analysis of groups when a familiarisation session is provided prior to clinical evaluation. Further, performing multiple trials within an assessment session with consistency criteria is an additional strategy to improve the reliability of these strength measurements. These strategies also improve the sensitivity of the IOPI measurements for evaluating strength improvements and the effectiveness of interventions in individuals. Multiple attempts resulting in some consistency in the maximum values obtained should be attained to establish that a true representation of current maximal strength is obtained. Further investigation is required to determine the reliability of tongue and hand endurance measures using the IOPI.

The effects of age and sex on measures of tongue and handgrip strength using the IOPI were examined. Participants recruited were categorised into three groups: young, mid-aged and elderly. The results from this study found that tongue and hand strength were influenced by age with no differences between young and mid-aged groups, however large reductions in strength were apparent in the elderly group. In addition and as expected, males were stronger than females in all age groups including the elderly cohort.

As a result of the poor reliability of sustained isometric tongue endurance measures, an additional study assessing repeated isometric tongue endurance was conducted. Healthy young participants underwent anterior and posterior tongue strength

and endurance assessment on four occasions alternating bulb positions separated by a period of one day. For this assessment of endurance, the IOPI was set to 90% of the participant's maximal strength and participants were asked to perform repeated contractions at the target force for as long as possible by pressing their tongue against the roof of their mouth repetitively. The key findings of this study are that although isometric tongue strength measurements obtained using the IOPI demonstrated acceptable reliability, repeated isometric tongue endurance measurements obtained during the same sessions were not reliable. This is also consistent with our findings that sustained isometric tongue endurance tests do not meet the standards of reliability necessary to be recommended for use.

In summary, all studies in this thesis found that tongue and handgrip strength measurements across all ages are reliable when measured using the IOPI. However, tongue and handgrip endurance values were found to be highly variable and cannot be recommended. Future research may be directed at identifying protocols that result in reliable measures of tongue and handgrip endurance.



Preface

Results reported in the dissertation have been published in scientific journals as well as presented at scientific meetings. These publications and presentations to date are listed below.

Publications

Peer Reviewed Papers Published in Scientific Journals (IF = Impact Factor)

- * **Adams, V.**, Mathisen, B., Baines, S., Lazarus, C., & Callister, R. (2014). Reliability of measurements of tongue and hand strength and endurance using the Iowa Oral Performance Instrument in healthy adults. *Dysphagia*, 29(1), 83-95. **IF=1.938**
- * **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. **IF=1.938**
- * **Adams, V.**, Callister, R., & Mathisen, B. (2011). Using tongue-strengthening exercise programs in dysphagia intervention. *Asia-Pacific Journal of Speech, Language & Hearing*, 14(3), 139-146.

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- * **Adams, V.**, Mathisen, B., Baines, S., Lazarus, C., & Callister, R. (January, 2014). Reliability of measurements of tongue and hand strength and endurance using the Iowa Oral Performance Instrument in young, mid-aged and old-older adults. *Disability & Rehabilitation*. **IF=1.541**

- * **Adams, V.**, Mathisen, B., Baines, S., Lazarus, C., & Callister, R. (January, 2104). Effects of age and sex using the Iowa Oral Performance Instrument to measure tongue and handgrip strength in healthy and elderly adults.
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Abstracts of Scientific Papers Presented at Conferences

- * **Adams, V.**, Mathisen, B., Baines, S., Lazarus, C., & Callister, R. (2013). Reliability of measurements of tongue strength and endurance using the Iowa Oral Performance Instrument with healthy adults. The Dysphagia Research Society 21st Annual Scientific Meeting (**International:** Seattle, USA)
- * **Adams, V.**, Mathisen, B., Baines, S., Lazarus, C., & Callister, R. (2013). Reliability of measurements of tongue and hand strength and endurance using the Iowa Oral Performance Instrument in the frail elderly in a residential aged-care facility. The Dysphagia Research Society 21st Annual Scientific Meeting (**International:** Seattle, USA)
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Determining the optimal duration and intensity of tongue strengthening exercise
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- * **Adams, V.,** Mathisen, B., Baines, S., Lazarus, C., & Callister, R. (2012).
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- * **Adams, V.,** Mathisen, B., Baines, S., Lazarus, C., & Callister, R. (2011).
Evaluation of the effects of tongue strengthening exercises in people with
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