HYDRATION IN OLDER ADULTS:
IS THERE A DIFFERENCE IN SELF-REPORTED HEALTHY OLDER ADULTS
AND THOSE WITH DYSPHAGIA
AS MEASURED USING BIOELECTRICAL IMPEDANCE ANALYSIS?

A Thesis by

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Bachelor of Arts, Wichita State University, 2011

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and the faculty of the Graduate School of
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the requirements for the degree of
Master of Arts

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IS THERE A DIFFERENCE IN SELF-REPORTED HEALTHY OLDER ADULTS
AND THOSE WITH DYSPHAGIA
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and recommend that it be accepted in partial fulfillment of the requirement for the degree of
Master of Arts with a major in Communication Sciences and Disorders.

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ABSTRACT

Bioelectrical Impedance Analysis (BIA) was used to investigate body composition and hydration of older residents (65+ years) in a Continuing Care Retirement Community (CCRC). BIA is a safe, non-invasive, efficient, valid, and reliable tool that can document hydration in older adults. Participants were women who viewed themselves as healthy (n = 16) and those with dysphagia (n = 8). Participants with dysphagia were expected to be less well hydrated than those who did not have swallowing difficulties. All were tested at the same time of day after a 3-hour fast. Independent-samples t-test analyses showed no significant differences between Total Body Water (TBW), Fat Free Mass (FFM), Fat Mass (FM), and percent Body Fat (% BF) for the two groups. When compared to previously published data for age-matched women, the TBW values of the two participant groups were notably less. FFM values for both groups of participants also were less than expected. FM and % BF values were notably greater than expected. The presence of dysphagia did not appear to have an adverse effect on hydration level. This may reflect the limited number of participants with dysphagia. Alternatively, results may suggest that residential facilities are unique environments in which all residents can be considered at-risk for dehydration. If true, results support the efforts of CCRC administrators to promote person-centered care to optimize residents’ health and quality of life, including adequate hydration, and suggest that BIA could be a valuable tool to facilitate the early identification of residents at-risk for dehydration.

KEYWORDS: Bioelectrical impedance analysis; dehydration; quality of life; residential facilities
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This was a feasibility study to explore the practicality of using Bioelectrical Impedance Analysis (BIA) to determine level of hydration (or dehydration) in residents of a Continuing Care Retirement Community (CCRC). The optimal detection of dehydration is through analysis of blood plasma, serum and electrolyte levels and detailed observation of an older adult over several days. The premise of this study is not to imply that BIA could replace blood analysis and observation over time. Rather, it is to suggest that BIA may serve as a valuable complement to methods currently used with residents in CCRCs as it is non-invasive, efficient, able to be administered by many healthcare providers, including speech-language pathologists, dietitians, and Certified Nursing Assistants, and provides immediate results.

**Dehydration**

Appropriate daily hydration is essential for brain and body functions. These functions include the ability to maintain a high level of cognition and energy, and to regulate body temperature, absorb nutrients, and eliminate toxins (Felesky-Hunt, 2001; Kleiner, 1999). As the aging process affects sensory and physiological functions, including the sensations of hunger and thirst, all older adults, those 65+ years of age, are at-risk for not consuming foods and liquids as frequently and sufficiently as their body requires (Boss & Seegmiller, 1981; Ferry, 2005; Shin, Panton, Dutton, & Ilich, 2011; Stachenfeld, DiPietro, Nadel, & Mack, 1997; Toto, 1994). The risk of inadequate hydration is compounded when older adults experience the diseases that are associated with increasing age, e.g., stroke, Parkinson’s Disease, dementia, and the swallowing
difficulties (dysphagia) that frequently result (Bratlund, O’Donoghue, & Rocchiccioli, 2010; Easterling & Robbins, 2008).

Older adults need to ingest 1500 to 2000 mL of fluid each day to ensure an adequate level of hydration (Wotton, Crannitch, & Munt, 2008). This fluid intake comes from food and drink. A balanced daily diet of 2500 to 3000 kilocalories (kcal) generally will provide about 1000 mL of water from food. This is complemented by the fluid intake from drinking (Casa, Clarkson, & Roberts, 2005). A daily water loss of only 2% increases the vulnerability of older adults for dehydration (Suhayda & Walton, 2002). Healthy older adults can make a conscious decision to drink more liquids on a regular basis. However, older adults who are challenged by cognitive decline, mobility difficulties, incontinence, and swallowing problems related to pathology such as diabetes, stroke, Parkinson’s disease, or dementia are at increased risk for dehydration and the infections, particularly of the urinary tract, that frequently result (Collins & Claros, 2011; Easterling & Robbins, 2008; Ferry, 2005; Mentes, 2006; Suhayda & Walton, 2002).

Dehydration is defined as an imbalance in the body’s level of water or sodium that occurs when an older adult does not take in the amount of fluid needed to replenish what the body is losing. This imbalance causes a deficit in the fluids and electrolytes that are essential for brain and body functions (Faes, Spigt, & Rikkert, 2007). Dehydration can be acute or chronic with serious consequences such as medication toxicity (Chernoff, 1994), loss of muscle function (Askew, 1996), decreased cognition (Bratlund et al., 2010; Sansevero, 1997), infection, delirium, weakness, fatigue, and increased risk of death (Bennett, Thomas, & Riegel, 2004; Ferry, 2005). Clear risk factors for dehydration have been identified for older adults, particularly those in residential care. These risk factors include being female, African-American, obese, recently transferred from one location to another, and with noted changes in physiological status,
including swallowing difficulties and decreased oral intake (Wotton et al., 2008). Many older adults in residential care facilities have experienced at least one episode of dehydration during a six month period (Mentes, 2006). Further, dehydration is one of the 10 most frequent diagnoses reported when older adults are hospitalized, and the reason 65% of older adults from residential facilities are admitted (Bratlund et al., 2010; Hodgkinson, Evans, & Wood, 2003; Sheehy, Perry, & Cromwell, 1999). Such hospitalizations cost at least $5.5 million a year (Kim, 2007). If the dehydration is not treated effectively, these older adults are at-risk for continued poor health, re-admission to hospital, increased healthcare costs, and possible death.

Dehydration in an older adult is diagnosed through an evaluation of the physical and cellular changes that occur as a result of the fluid imbalance (Stookey, Pieper, & Cohen, 2005; Vivanti, Harvey, Ash, & Battistutta, 2008). Cellular changes occur in the levels of sodium and potassium in blood plasma, blood urea nitrogen (BUN), urine specific gravity (SG), and creatinine, an indicator of renal function (Venes, 2001; Wakefield, Mentes, Holman, & Culp, 2009; Wotton et al., 2008). These changes can be determined through a complete blood count (CBC) and urine analysis. Blood and pulse pressure measurements also can provide insight into hydration. The physical characteristics that are charted over several days include a pronounced thirst, increased respiration rate, increased heart rate (tachycardia), drying of the mouth, lips, and tongue, decreased skin turgor (elasticity), sunken eyes, loss of weight, decreased muscle strength, increased capillary refill time in veins of the hands and feet, adverse changes in neurological, including cognitive, functions, and decreased urine output with a darkening color (Bennett et al., 2004; Mentes, 2006; Vivanti et al., 2008). As some medications and foods can cause urine discoloration, monitoring urine status may not be a reliable dehydration marker. Further, an older adult can be dehydrated for some time before any of the other expected
characteristics appear (Mentes, 2006).

Data show that dehydration is preventable and reversible if identified early (Shanholtzer & Patterson, 2003; Suhayda & Walton, 2002; Wotton et al., 2008). Blood analysis, while optimal, is invasive, expensive and time-consuming, and usually conducted after the physical characteristics of dehydration are apparent. Obtaining the results of laboratory work can take time, placing a dehydrated older adult at additional risk. Interpreting laboratory work in order to recognize and determine dehydration also takes practice and experience. By this time, dehydration may no longer be preventable (Mentes, 2006; Suhayda & Walton, 2002).

**Bioelectrical Impedance Analysis**

Bioelectrical impedance analysis (BIA) has been recommended as a portable, safe, non-invasive, valid, reliable, and efficient tool to measure body composition and hydration in older adults (Bussolotto et al., 1999; Ritz, 2001; Roubenoff et al., 1997; Tengvall et al., 2009). It is also easily administered compared to other body composition measures. Thus, it appears a valuable tool to use with older adults in residential care to facilitate the early identification of dehydration, prevent diseases related to dehydration, and optimize older adults’ quality of life.

BIA is calculated from an individual’s height, weight, gender, and race using mathematical prediction equations (Chumlea et al., 2002; Tengvall et al., 2009). Through surface electrodes, BIA measures an older adult’s total body water (TBW). This TBW is comprised of extracellular water (ECW; approximately 45% of body water) and intracellular water (ICW; approximately 55% of body water). The ECW and ICW values are used to predict Fat Free Mass (FFM). Body Fat (BF) then can be calculated as the difference between body weight and FFM (Armstrong, Kenefick, & Castellani, 1997; Azcue, Wesson, Neuman, & Pencharz, 1993; Baumgartner, Chumlea, & Roche, 1989; Brodie, Moscrip, & Hutcheon, 1998; Dehghan &
BIA is preferred over Body Mass Index (BMI) in determining the body composition of older adults, and normative data have been established (Chumlea et al., 2002; Roubenoff et al., 1997; Tengvall et al., 2009). With increasing age, lean body mass decreases and fat mass increases for most people. Thus, even if weight remains stable, an older adult’s body composition changes. As a result, BMI (calculated from height and weight measures, i.e., kg/m²) can inaccurately reflect the amount of body fat (Roubenoff et al., 1997). Normative data for BMI have been categorized as follows: underweight (<18.5), normal range (18.5-24.9), overweight (25.0-29.9), and obese (≥30.0). Kyle and colleagues (2004) documented that BIA measures are valid for persons with a BMI up to 34.

Roubenoff and colleagues (1997) evaluated body composition data from a two national, longitudinal studies of nutrition and aging and developed specific BIA equations for Caucasian, ambulatory, self-reported healthy men and women over the age of 70, using dual-energy x-ray absorptiometry (DXA) as the reference method. These investigators ensured that the same BIA electrode placement was used for all participants in each population evaluated for the study and reasoned that, as the participants were relatively healthy, the possibility of extreme overhydration or dehydration was avoided. Tengvall and colleagues (2009) also validated BIA against DXA for BF and FFM estimations in 839 well-nourished participants over 70 years of age.

During BIA, each adult lays supine and is connected to the impedance monitor through
paired surface electrodes placed on the anterodorsal aspects of the right foot and the right wrist, as body composition can be predicted accurately by the measurement of resistance in the arm and leg (Baumgartner et al., 1989). The adult rests hands to the side, not touching the trunk, with feet apart so that the medial thighs do not touch, for 15-20 minutes to stabilize the body’s electrical energy. Following this rest period, a small (50kHz), not felt, alternating electrical current is introduced into the body for approximately one minute, until the values being recorded stabilize. An alternating current is used as it penetrates the body at low levels of voltage and amperage (Chumlea & Guo, 1994). The current magnitude is small but large enough to produce voltages that are above the interfering electrical “noise” of the body. As the current frequency of 50kHz is considered unlikely to stimulate electrically excitable tissues, the procedure is viewed as safe (Chumlea & Guo, 1994; Sergi et al., 1994).

Impedance measures the electrical conductivity of the body. The underlying principle of BIA is that body water is a conductor for the electrical current and Body Fat (Fat Mass) impedes the current more than Fat Free Mass (FFM). Impedance to the current flow can be measured by the decrease in voltage between the two pairs of electrodes at the hand and foot, i.e., the body’s resistance (from the inner paired electrodes) and reactance (from the outer paired electrodes). Resistance reflects extracellular space, i.e., the transit of the electrical current primarily through extracellular fluids; reactance measures cellular activity, i.e., the transit of the current through body tissues (Chumlea & Guo, 1994; Powers et al., 2009; Ritz, 2001). The resistive volume is measured as ionic resistance, and the cellular volume is measured as capacitive reactance. Both are expressed in ohms and are obtained from equations in the BIA proprietary software (www.rjlsystems.com). Dehydration is known to increase resistance (Dehghan & Merchant, 2008). If dehydration is confirmed, treatment can begin immediately. The only older adults for
whom BIA might not be advisable are those with an implanted device, such as a pacemaker (Shanholtzer & Patterson, 2003).

Given the vulnerability of older adults in residential care to dehydration and the profound effects dehydration can have on brain and body functions, BIA may be of value to facilitate the early detection of hydration risk in such older adults.

**Purpose of the Study**

This study used BIA to investigate the body composition and hydration status of older adult residents in a CCRC. The following research question was posed:

*Is there a difference between the body composition and hydration status of a group of self-reported healthy older adults and an age-matched group of older adults with documented swallowing problems, as measured using BIA?*

The hypothesis was that the self-reported healthy older adults would demonstrate body composition and hydration values within the range expected for people their age. Further, that the older adults with swallowing problems would show a poorer level of hydration. The significance of the expected outcomes would be that BIA is a readily usable tool to monitor older adults at-risk for dehydration, and therefore, it is important to include in protocols to evaluate hydration. The inclusion of BIA in such protocols could facilitate the early identification of older adults with any hydration issues and thus facilitate early intervention. Further, the use of BIA could assist in educating older adults about strategies to optimize their health and quality of life, and decrease health care costs by reducing their need to be hospitalized for the treatment of dehydration (Patterson & Spinks, 2011).
Participants

There were 24 older adults (65+ years) in this study. All were Caucasian women and residents of the Kansas Masonic Home (KMH) in Wichita, Kansas. These adults were categorized into two groups: (a) 16 self-reported healthy adults, with no acute health concerns and no swallowing problems, as judged from their responses to a questionnaire, and (b) 8 age-matched adults with documented swallowing problems subsequent to non-progressive disease. A self-report of health status is an accepted measure for older adults with no acute health concerns (Moorman & Inoue, 2013). All volunteers who met the criteria for the two groups were tested. Thus, participant categorization was not randomized. Four additional volunteers were excluded. Two of these residents were taking prescribed diuretics and two were on fluid restrictions.

All participants signed an Informed Consent form, either personally or through a Designated Power of Attorney. All completed the Mini-Mental State Examination (MMSE; Folstein, Folstein, & Fanjiang, 2001) and passed a hearing screening test documenting their ability to hear, aided or unaided. All received $20 for their participation. Their prescribed medications were documented but were not considered criteria for exclusion.

The participants with swallowing difficulties were identified by nursing staff and/or the speech-language pathologist at KMH due to the healthcare providers’ concerns about the participants’ risk for dehydration. The time-post-onset and the etiology of the dysphagia were documented but allowed to vary.

Testing

Each participant underwent the following assessments:
**Oral-Motor Examination.** This was a non-invasive examination of oral hygiene, lubrication, dentition, and coordinated movement of facial, tongue, and throat muscles. The investigator used a small flashlight, dental mirror, and tongue depressor during a series of tasks.

**Functional Oral Intake Scale** (*FOIS*; Crary, Carnaby-Mann, & Groher, 2005). This 7-point ordinal scale was used to rate participants’ swallowing ability and the type of food and liquid they consumed regularly. At Level 7, swallowing is considered safe and efficient with a total oral diet and no restrictions. At Level 1, an adult is considered unable to swallow anything safely by mouth and all nutrition and hydration are received through a tube into the esophagus or the stomach. The *FOIS* scale was completed by a certified speech-language pathologist.

**Body Mass Index (BMI).** BMI is an accepted measure of the nutritional status of an individual. It can be used as an estimate of general health (Akner & Flöistrup, 2003; Salva et al., 2009) and to determine the effect of a swallowing impairment on nutritional status (Martin-Harris et al., 2008). BMI was calculated by dividing weight in kilograms by height in squared meters (i.e., kg/m²). BMI measures were compared to normative data with each participant ranked according to one of four categories: underweight, normal range, overweight, and obese.

**Weight**

Participants’ body weight was measured in kilograms (kg) using a Seca® calibrated electronic scale (H & C Weighing Systems, Columbia, MD). Participants were bare-foot and wore typical everyday clothing. They removed all accessories prior to being weighed. If any participant was unable to stand on the scale, the most recent weight, as documented by nursing staff, was used. The weight measurement also was included in the calculations for each participant’s BIA.
Height

Participants’ height was measured in centimeters (cm) using a portable stadiometer (Pearson Surgical Supplies, Sylmar, CA). Participants stood bare-foot on the stadiometer platform. If participants were unable to stand, their height was calculated from measurements of head to shoulder; shoulder to waist; waist to hip; hip to knee; and knee to ankle, following published guidelines (Chumlea, Roche, & Steinbaugh, 1985). The height measurement also was included in the calculations for BIA.

Mann Assessment of Swallowing Ability (MASA; Carnaby-Mann & Lenius, 2008; Mann, 2002). This 24-item test documented the type and severity of swallowing difficulties and risk for aspiration. It was administered to any participant with a swallowing problem.

Bioelectrical Impedance Analysis (BIA). The portable RJL Systems Quantum II Bioelectrical Impedance Analyzer (BIA) was used (http://www.rjlsystems.com/pdf-files/bc-manual.pdf). Testing occurred late-morning. All participants were asked to consume no food or liquid for at least three hours prior to the test and to empty their bladder before testing began (Roubenoff, Dallal, & Wilson, 1995; Roubenoff et al., 1997). Participants were asked to lie supine, with arms 30 degrees from the body and both legs not touching, on a comfortable, non-metal surface. All jewelry, shoes, and socks were removed from the right side of the body where the surface electrodes were placed. Electrode sites were cleaned with alcohol. Two pairs of surface electrodes were placed on the back of the right hand and the top of the right foot. A small pillow was used to support each participant’s head during testing. Resistance and Reactance measures were documented and Total Body Water (TBW in kg), Fat Free Mass (FFM in kg), Fat Mass (FM in kg), and Body Fat (BF
in %) were calculated as follows, using the formulae documented by Lukaski and Bolonchuk (1988):

\[
TBW = 0.372(\text{Height in centimeters} \div \text{Resistance}) + 3.05(\text{Sex}) + 0.142(\text{Weight in Kg}) - 0.069(\text{Age in years})
\]

- For women, Sex = 0
- The hydration constant of FFM is 0.73

\[
FFM = TBW \div 0.73
\]

\[
FM = \text{Weight} - FFM
\]

\[
BF\% = FM \div \text{Weight} \times 100
\]

Procedures

Institutional Review Board (IRB) approval from Wichita State University and the Kansas Masonic Home (KMH) was obtained prior to data collection (Appendix A). Individual meetings with potential participants (and their family members or designated legal guardians) were arranged for each to review and sign the informed consent form (Appendices B & C). Following this, each potential participant completed the MMSE. An ASHA-certified speech-language pathologist completed the FOIS to identify the presence and severity of any swallowing difficulty. All data were obtained in a comfortable, private room selected by each participant. The completion of all test procedures took no longer than 2 hours. The intent was to complete all procedures on the same day. However, when same-day testing proved difficult for some participants, testing was separated over two consecutive days but completed at the same time on each day.

Data Analysis

The dependent variables in this study were the components of body composition and
level of hydration, as measured using BMI and Bioelectrical Impedance Analysis (BIA). The independent variable was group: self-reported healthy older adults and those with dysphagia. Scores from the various measures were coded and entered into Statistical Package for the Social Sciences (SPSS) software, Version 18.0 for Windows, for analysis. Independent-samples t-tests were run to test for any differences between the two participant groups with regard to age and cognitive status, as measured by the score on the MMSE. Additional t-tests were run to document any differences between groups related to body composition and level of hydration. Predictive, or regression, analyses to identify the effects of dysphagia and cognitive decline on hydration level were not possible at this point in the study due to the limited number of participants under each of these variables.
CHAPTER III
RESULTS

The mean age of the 16 self-reported healthy older women was 84.43 (± 7.67) years. The mean age of the 8 women with documented dysphagia was 89.24 (± 4.64) years. The age difference between these two groups was not significant ($t = -1.62, df = 22, p = 0.12$). With regard to cognitive function, a score of 21+/30 on the $MMSE$ indicates a respondent is cognitively able to understand the purpose of the testing (Brandão, Nascimento, & Vianna, 2010; Folstein et al., 2001; Milman et al., 2008). $MMSE$ scores for the self-reported healthy women ranged from 19-29 (mean 25.94 ± 3.32). The range of $MMSE$ scores for the women with dysphagia was 12-29 (mean 23.63 ± 6.95). The difference in $MMSE$ scores for these two groups was not significant ($t = 1.12, df = 22, p = 0.28$).

All self-reported healthy older women scored a 6 or above on the 7-point $FOIS$ scale, confirming independent swallowing ability. All women with dysphagia scored a 3, 4, or 5 on the $FOIS$ scale, reflecting their swallowing difficulties. The women with dysphagia were eating orally but needed special preparations to facilitate safe swallowing, such as detexturized food and/or thickened liquids. No participant with dysphagia was on tube feeding as her primary form of nourishment. The etiologies of the dysphagia were stroke ($n = 7$) and diabetes ($n = 1$).

In addition to over-the-counter calcium, vitamins, and drops for dry eyes, all self-reported healthy women were taking medication prescribed for blood pressure. Other medications were for heart problems ($n = 12$), depression ($n = 6$), cholesterol ($n = 5$), osteoporosis ($n = 5$), gastroesophageal reflux disorder ($n = 4$), “restless leg syndrome” ($n = 4$), diabetes ($n = 3$), hypothyroidism ($n = 6$), seizures ($n = 2$), blood clots ($n = 2$), dementia ($n = 2$), duodenal ulcer ($n
= 1), constipation (*n* = 1), chronic obstructive pulmonary disorder (COPD; *n* = 1) and insomnia (*n* = 1). Two participants had prescriptions for pain, to be taken as needed. Medications for the eight women with dysphagia also included over-the-counter calcium, vitamins, and eye drops. Prescribed medications were for high blood pressure (*n* = 4), heart problems (*n* = 4), gastroesophageal reflux disease (*n* = 4), pain (*n* = 4), hypothyroidism (*n* = 4), depression (*n* = 3), and to prevent urinary tract infections (*n* = 3).

Means and standard deviations (SD) for all participants’ body composition and hydration measures, compared to previously published values, are presented in Table 1. Participants in the two groups did not differ significantly in height (*t* = -0.10, *df* = 22, *p* = 0.92). With regard to weight, the self-reported healthy women appeared heavier, but the difference in means for the two groups was not significant (*t* = 1.49, *df* = 22, *p* = 0.15). Body Mass Index (BMI) measures for the self-reported healthy participants ranged from 22.40 to 36.88 (mean 27.83 ± 4.15). BMI measures for participants with dysphagia ranged from 17.61 to 34.84 (mean 24.42 ± 5.44). The difference between the two groups was not significant (*t* = 1.71, *df* = 22, *p* = 0.10) and the measures for both groups were within 1.0 SD of previously published expected BMI values for women their age. There were two participants with a BMI over 34, one in the healthy group; one in the dysphagia group. As BIA measures are considered valid for a BMI ≤ 34 (Kyle et al., 2004), these two participants were excluded and the analyses were re-run. Results are presented in Table 2. There were significant differences in weight (*t* = 2.20, *df* = 20, *p* = 0.04) and BMI (*t* = 2.64, *df* = 20, *p* = 0.02) reflecting the greater weight of the self-reported healthy participants.

Despite the noted differences in weight and BMI between the two groups, there were no significant differences with regard to Resistance measures (*t* = -0.65, *df* = 20, *p* = 0.52). Although the SD for both groups was large, the mean measure for each group was within 1.0 SD
Table 1. Mean measures (± standard deviations) of participants’ body composition and hydration compared to previously published expected values.\(^1\)

<table>
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<tr>
<th>Measures</th>
<th>Women with Dysphagia ((n = 8)) 89.24 yrs ± 4.64</th>
<th>Self-Reported Healthy Women ((n = 16)) 84.43 yrs ± 7.67</th>
<th>Expected Values for 80-89 yr old women(^2,3)</th>
</tr>
</thead>
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<tr>
<td>Body Mass Index (BMI)(^4) (kg/m(^2))</td>
<td>24.42 ± 5.44</td>
<td>27.83 ± 4.15</td>
<td>24.4 ± 3.4/22.1 ± 3.2</td>
</tr>
<tr>
<td>Mean height (cm)</td>
<td>155.87 ± 9.34</td>
<td>155.54 ± 6.18</td>
<td>156.2 ± 6.3(^2)</td>
</tr>
<tr>
<td>Mean weight (kg)</td>
<td>59.83 ± 14.01</td>
<td>67.58 ± 10.96</td>
<td>59.5 ± 9.0</td>
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<tr>
<td><strong>Bioelectrical Impedance Analysis (BIA)</strong></td>
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<tr>
<td>· Resistance (ohms)</td>
<td>634.34 ± 146.10</td>
<td>615.92 ± 109.32</td>
<td>679 ± 73.00(^3)</td>
</tr>
<tr>
<td>· Reactance (ohms)</td>
<td>44.09 ± 8.72</td>
<td>50.66 ± 10.94</td>
<td>40.7 ± 6.8</td>
</tr>
<tr>
<td>· Total Body Water (kg)</td>
<td>18.56 ± 5.77</td>
<td>20.78 ± 5.69</td>
<td>30.2 ± 3.9(^2)</td>
</tr>
<tr>
<td>· Fat Mass (kg)</td>
<td>33.84 ± 11.02</td>
<td>39.02 ± 9.65</td>
<td>23.50 ± 7.5</td>
</tr>
<tr>
<td>· Fat Free Mass (kg)</td>
<td>25.43 ± 7.91</td>
<td>28.46 ± 7.79</td>
<td>35.9 ± 3.3</td>
</tr>
<tr>
<td>· Body Fat (%)</td>
<td>56.70 ± 12.94</td>
<td>57.65 ± 11.45</td>
<td>38.8 ± 7.4</td>
</tr>
</tbody>
</table>

\(^1\)There were no statistically significant differences found between self-reported healthy women and those with dysphagia on all measures.
\(^2\) Chumlea et al. (2002)
\(^3\) Tengvall et al. (2009)
\(^4\) Underweight (<18.5); Normal (18.5-24.9); Overweight (25.0-29.9); Obese (≥30.0)

There were no significant differences between the two groups on Reactance measures \((t = 1.20, df = 20, p = 0.25)\) and the mean measure for each group also was within 1.0 SD of previously published measures, or in the case of the self-reported healthy group, close to this.
Table 2. Mean measures (± standard deviations) for participants with a BMI ≤ 34 compared to previously published expected values.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Women with Dysphagia ( (n = 7) ) 89.70 yrs ± 4.81</th>
<th>Self-Reported Healthy Women ( (n = 15) ) 84.46 yrs ± 7.94</th>
<th>Expected Values for 80-89 yr old women(^1) (1^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Mass Index (BMI)(^3) ((\text{kg/m}^2))</td>
<td>22.93 ± 3.71</td>
<td>27.23 ± 3.49(^*)</td>
<td>24.4 ± 3.4/22.1 ± 3.2</td>
</tr>
<tr>
<td>Mean height (cm)</td>
<td>155.64 ± 10.49</td>
<td>155.75 ± 6.33</td>
<td>156.2 ± 6.3(^2)</td>
</tr>
<tr>
<td>Mean weight (kg)</td>
<td>56.14 ± 10.07</td>
<td>66.41 ± 10.25(^*)</td>
<td>59.5 ± 9.0</td>
</tr>
<tr>
<td>Bioelectrical Impedance Analysis (BIA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>· Resistance (ohms)</td>
<td>659.37 ± 138.04</td>
<td>624.11 ± 107.95</td>
<td>679 ± 73.00(^3)</td>
</tr>
<tr>
<td>· Reactance (ohms)</td>
<td>46.31 ± 6.51</td>
<td>51.58 ± 10.67</td>
<td>40.7 ± 6.8</td>
</tr>
<tr>
<td>· Total Body Water (L)</td>
<td>17.45 ± 5.24</td>
<td>20.57 ± 5.83</td>
<td>30.2 ± 3.9(^2)</td>
</tr>
<tr>
<td>· Fat Mass (kg)</td>
<td>31.58 ± 9.71</td>
<td>38.12 ± 9.27</td>
<td>23.50 ± 7.5</td>
</tr>
<tr>
<td>· Fat Free Mass (kg)</td>
<td>23.90 ± 7.17</td>
<td>28.18 ± 7.98</td>
<td>35.9 ± 3.3</td>
</tr>
<tr>
<td>· Body Fat (%)</td>
<td>56.52 ± 13.96</td>
<td>57.38 ± 11.80</td>
<td>38.8 ± 7.4</td>
</tr>
</tbody>
</table>

\(^*\) p ≤ 0.05  
\(^1\) Chumlea et al. (2002)  
\(^2\) Tengvall et al. (2009)  
\(^3\) Underweight (<18.5); Normal (18.5-24.9); Overweight (25.0-29.9); Obese (≥30.0)

No significant differences were observed between the two groups for Total Body Water \((t = 1.21, df = 20, p = 0.24)\), Fat Mass \((t = 1.52, df = 20, p = 0.14)\), Fat Free Mass \((t = 1.21, df = 20, p = 0.24)\), or percent Body Fat \((t = 0.15, df = 20, p = 0.88)\). However, when compared to previously published values, the measures for both self-reported healthy adults and those with dysphagia were more than 2.0 SDs below the expected mean for TBW and FFM, and more than
2.0 SDs above the expected mean for FM and % BF. These comparisons are illustrated in Figure 1.

Figure 1. Comparison of previously published expected values for age-matched mean Total Body Water (kg), Fat Mass (kg), Fat Free Mass (kg), and % Body Fat with those of self-reported healthy participants (n = 15) and those with dysphagia (n = 7)

Two self-reported healthy participants and two participants with dysphagia did not achieve the passing score of 21 on the MMSE. One of these participants had been excluded from the analysis due to her high BMI measure. The remaining three participants were excluded from the previous 22 and the data were again analyzed to address the question of whether cognitive function affected body composition and hydration. With the exception of BMI, there were no significant differences between the self-reported healthy participants (n = 13) and the participants with dysphagia (n = 6) with regard to body composition and hydration measures. Results are presented in Table 3.
Table 3. Mean measures (± standard deviations) for participants with a BMI ≤ 34 and MMSE ≥ 21 compared to previously published expected values.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Women with Dysphagia ((n = 6)) 89.00 yrs ± 4.84</th>
<th>Self-Reported Healthy Women ((n = 13)) 84.00 yrs ± 8.45</th>
<th>Expected Values for 80-89 yr old women(^1,2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MMSE</strong>(^3)</td>
<td>27.33 ± 1.21</td>
<td>26.77 ± 2.05</td>
<td>n/a</td>
</tr>
<tr>
<td>Body Mass Index (BMI)(^4) (kg/m(^2))</td>
<td>23.82 ± 3.15</td>
<td>27.14 ± 3.06</td>
<td>24.4 ± 3.4/22.1 ± 3.2</td>
</tr>
<tr>
<td><strong>Bioelectrical Impedance Analysis (BIA)</strong></td>
<td>634.03 ± 132.19</td>
<td>630.60 ± 96.31</td>
<td>679 ± 73.00(^3)</td>
</tr>
<tr>
<td>· Resistance (ohms)</td>
<td>47.03 ± 6.83</td>
<td>51.97 ± 10.00</td>
<td>40.7 ± 6.8</td>
</tr>
<tr>
<td>· Reactance (ohms)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>· Total Body Water (L)</td>
<td>18.22 ± 5.28</td>
<td>20.63 ± 5.83</td>
<td>30.2 ± 3.9(^2)</td>
</tr>
<tr>
<td>· Fat Mass (kg)</td>
<td>31.79 ± 10.61</td>
<td>37.89 ± 9.83</td>
<td>23.50 ± 7.5</td>
</tr>
<tr>
<td>· Fat Free Mass (kg)</td>
<td>24.96 ± 7.23</td>
<td>28.26 ± 7.98</td>
<td>35.9 ± 3.3</td>
</tr>
<tr>
<td>· Body Fat (%)</td>
<td>55.38 ± 14.93</td>
<td>57.02 ± 12.57</td>
<td>38.8 ± 7.4</td>
</tr>
</tbody>
</table>

\(^1\) Chumlea et al. (2002)  
\(^2\) Tengvall et al. (2009)  
\(^3\) A passing score = 21+ points out of 30  
\(^4\) Underweight (<18.5); Normal (18.5-24.9); Overweight (25.0-29.9); Obese (≥30.0)
CHAPTER IV
DISCUSSION

Older adults move into residential care for a variety of reasons. An underlying theme may be that they understand they are not as healthy or independent as they wish to be. The self-reported healthy residents in this study desired to maintain an independent lifestyle without the responsibility of taking care of a house and to be close to family. All were ambulatory and some were still driving. Prescribed medications showed that some were being treated for disease-related conditions. Potential side effects of the prescribed medications included adverse effects on eating, drinking, and swallowing, e.g., dry mouth, nausea, coughing/choking, decreased appetite, changes in taste, and difficulties with saliva management. However, as judged from their responses to a questionnaire, no participant reported any such difficulties. Some of the residents with documented dysphagia had moved from Independent Living at KMH into Assisted Living or Memory Care after experiencing a stroke. Others had relocated to KMH after a period of hospitalization or from another long-term care facility. All were taking prescription medications to assist in their recovery.

The two groups of residents with Body Mass Index measures of 34 or less were close in age (mid to late 80s). They also appeared close in cognitive function, as judged from their mean passing scores on the MMSE. However, the responses of two of the residents in the self-reported healthy group and two of the residents in the dysphagia group rated below the passing score of 21. These four women were taking medication prescribed for dementia. The cognitive decline resulting from dementia frequently is associated with dysphagia, and dysphagia is a known factor that adversely affects hydration levels (Easterling & Robbins, 2008). A re-analysis of the data
excluding these four participants showed no significant differences in hydration levels between the two groups. The non-dementia medication profiles for both groups also were similar in the type of medications prescribed, dosages, and number of medications per participant. Neither group appeared over-medicated (Holmes et al., 2008).

The expectation that the hydration level, as measured using BIA, of residents who perceived themselves as healthy would be notably better than those who had dysphagia was not confirmed. The BIA Resistance and Reactance measures for both groups of residents were not significantly different and essentially within the expected ranges for similarly-aged women documented by Chumlea et al. (2002) and Tengvall et al. (2009). Therefore, based on these Resistance and Reactance measures, neither the self-reported healthy residents nor the residents with dysphagia appeared to be dehydrated.

However, BIA Resistance and Reactance values alone do not predict hydration levels. Rather, these values are pieces of the mathematical equations that document Total Body Water, Fat Mass, Fat Free Mass, and % Body Fat to determine body composition and hydration. Although not significantly different, the Total Body Water values for the self-reported healthy women were higher (more positive) than those for women with dysphagia. This finding matched the expectation that dysphagia may indeed have an adverse effect on hydration level.

The lack of significant differences between the two groups in the current study may have been due to the limited number of participants with dysphagia. Alternatively, the finding that the hydration level of residents with dysphagia was not significantly different from that of the self-reported healthy residents may imply that the swallowing difficulties experienced by the residents in the study were not severe enough to impact their food and liquid intake. All residents with dysphagia needed food and/or liquid modifications, and such food and liquid modifications
have been shown to adversely affect oral intake (Colodny, 2005, Ferry, 2005). Another possibility is that some of the self-reported healthy residents also were experiencing swallowing difficulties that they did not recognize or chose not to acknowledge. The subsequent administration of the Swallowing Quality of Life survey (McHorney et al., 2002) to the self-reported healthy older adults did reveal that some were making dietary modifications, e.g., eliminating steak from their diet due to difficulty chewing. The lack of differences between participants with dysphagia and those who viewed themselves as healthy also could reflect the high quality of health care and attention all residents were receiving at KMH. Continued collection of data from older adults with dysphagia will clarify this issue.

Although there were no significant differences between the two groups of residents with regard to Total Body Water, Fat Mass, Fat Free Mass, and % Body Fat, there was a demonstrable difference between the documented values for these two groups and previously published values. The Fat Mass and % Body Fat values for residents in both groups were substantially greater than expected values. The Fat Free Mass values for residents in both groups were substantially less than expected values. Of further concern was the finding that Total Body Water values for both groups were substantially lower than expected and residents with documented dysphagia had the lowest Total Body Water values.

All participants resided at the same facility and were served food and drink from the same kitchen. The weight of the participants in both groups suggested they were well-nourished. However, their higher-than-expected Fat Mass may have been an indicator of poorer physical performance which can adversely affect agility, mobility, and balance in daily activities and increase the risk for falls (Shin et al., 2011). Age-related accumulation of Fat Mass in older adults is well-documented, with related loss of fat free and skeletal muscle mass, and decreases
in level of activity (Dehghan & Merchant, 2008; Kyle et al., 2001; Morley et al., 2010; Speakman & Westerterp, 2010). Resistance training and consistent increased movement in daily activities has been shown to decrease Fat Mass in older adults (Adamo & Farrar, 2006; Puggaard, Larsen, Ebbesen, & Jeune, 1999) and such increased movement may be a valuable recommendation for the participants in the current study. The increased activity would be beneficial in attenuating the sarcopenia of aging and the loss of bone mass as well.

Further, the participants in both groups did not appear to be drinking as much as they need. With non-disease-related aging, the sensations of hunger and thirst lessen (Boss & Seegmiller, 1981; Ferry, 2005; Stachenfeld et al., 1997; Toto, 1994). The decreased desire to eat and drink may be compounded in disease-related aging. Conversations with all participants revealed that many limited their liquid intake in the evening to avoid frequent trips to the bathroom and disrupted sleep at night.

Given the sensory and physiological changes that occur with healthy aging, how these changes can increase in disease conditions, and the notably lower Total Body Water levels for residents in both groups, all participants in this study could be considered at-risk for inadequate hydration. Such results may imply that there is something unique about residential care compared to living in the community at-large and support the importance of staff education and effective staff-resident interactions to establish and maintain strategies to optimize hydration in older adults. The normative data for body composition and hydration were generally developed from community-dwelling older adults (Roubenoff et al., 1997; Shin et al., 2011; Tengvall et al., 2009). Community-dwelling older adults might be healthier and more active than older adults living in residential care. As long-term care facilities move to a person-centered household model of care, normative data from community-dwelling older adults provide an important goal.
One could argue that the findings of this study were spurious and that repeat testing after a period of several days would be advisable to document the reliability of the measures. Although the test-retest approach is not necessary (Shanholtzer & Patterson, 2003), data from repeat testing may assist in clarifying the possible effect of the medications all residents were taking. However, the normative BIA data obtained by Chumlea et al. (2002) and Tengvall et al. (2009) included older adults who were taking prescribed medications similar to those being taken by the KMH residents. A concern also could be raised that a three-hour fast prior to testing was insufficient. Typically, BIA is conducted following an all-night fast or a minimum of a four-hour fast (Roubenoff et al., 1997). This was not possible for the residents this study. Many residents needed to take medications with food and/or liquid first thing in the morning, particularly those with diabetes and high blood pressure.

This study addressed the concern about the risk for dehydration in older adults in residential care, particularly those with dysphagia, and the practicality of using BIA as an early, cost effective, and non-invasive indicator of level of hydration. All participants in the study were interested in the procedure and experienced no ill-effects from it. Both participants and staff asked questions about BIA and thus it had value as an educational tool to promote the importance of adequate, daily hydration. The procedure was straightforward, efficient, and suitable for older adults. These attributes, coupled with the important finding of lower-than-expected levels of hydration for the participants in both groups, support the use of Bioelectrical Impedance Analysis as a cost-effective precursor to the blood and urine analyses and observations currently used with residents in CCRCs to determine dehydration.
Conclusions

1. BIA was useful in documenting high Fat Mass and low Total Body Water in a group of older women in residential care. These measures provide valuable baseline data for intervention strategies to increase physical activity and hydration and optimize quality of life for residents.

2. The inclusion of BIA in the regular evaluation of wellness and hydration status of all older adults in residential care may decrease hospitalizations for dehydration and reduce costs to the residents and administrators.


APPENDICES
APPENDIX A. Institutional Review Board Application

Wichita State University Institutional Review Board (IRB) for the Protection of Human Subjects

Application for Approval of Research Involving Human Subjects

Name of Principal Investigator(s): Lyn Goldberg, PhD, CCC-SLP (CSD)
(For a student project, Principal Investigator must be a WSU faculty member; student is listed as Co-Investigator.)

Departmental/Program Affiliation of PI: Communication Science and Disorders Campus Box: 75 Phone: 6115 E-mail: lyn.goldberg@wichita.edu

Name(s) of Co-Investigator(s): Amanda Foley
Co-Investigator(s) is/are: _Faculty Member X Graduate Student _____ Undergraduate Student
Other, please specify

______________________________________________________________

Type of Project: ___ Class Project ___ Capstone Project X Thesis or Dissertation Funded Research X Unfunded Research ___ Secondary Data Collection/Analysis ___ Program Evaluation

Research Design: Experimental

Title of Project/Proposal: Investigating hydration levels in older adults with swallowing difficulties.

Expected Completion Date: May 2013 Funding Agency (if applicable):

Please attach additional sheets, if necessary, with numbers of responses corresponding to those listed below.

1. Describe the research in non-technical language.

The purpose of this study is to document the level of hydration in older adults (age 65+) who are residents in a continuing care facility and who have swallowing problems (dysphagia). Many of these older adults are thought to be dehydrated due to multiple risk factors (Wotton, Crannitch, & Munt, 2008). These risk factors include age, gender, trauma (emotional and physical), physical dependency, poor health and related polypharmacy (e.g., multiple medications needed for the treatment of diabetes mellitus
and decreased renal function), cognitive impairment (including dementia), and illness (Mentes, 2006; Palmisano-Mills, 2007). Dysphagia is a frequent consequence of these risk factors (Leonard & Kendall, 2008).

Dehydration has been documented as the reason 65% of older adults from residential facilities are admitted to hospital (Bratlund et al., 2010). If the dehydration is not treated effectively, these older adults are at-risk for continued poor health, re-admission to hospital, increased healthcare costs, and possible death.

Dehydration occurs when fluid taken into the body does not match the amount of fluid lost. The resulting imbalance causes a deficit in the fluids and electrolytes that are essential for brain and body functions (Faes et al., 2007). Dehydration in an older adult is diagnosed through an evaluation of the physical and cellular changes that occur as a result of this fluid imbalance (Vivanti, Harvey, Ash & Battistutta, 2008; Stookey, Pieper, & Cohen, 2005). Physical changes include a pronounced thirst, increased respiration rate, increased heart rate (tachycardia), drying of the mouth and lips, decreased skin turgor (elasticity), sunken eyes, loss of weight, decreased muscle strength, decreased urinary output with increased color, increased capillary refill time in veins of the hands and feet, and adverse changes in neurological, including cognitive, function. Cellular changes occur in the levels of sodium and potassium in blood plasma, blood urea nitrogen (BUN), urine specific gravity (SG), and creatinine, an indicator of renal function (Venes, 2001; Wakefield et al., 2009; Wotton et al., 2008). These changes can be determined through a complete blood count (CBC) and urine analysis. Blood and pulse pressure measurements also can provide insight into hydration.

Obtaining the results of laboratory work can take time, placing a dehydrated older adult at additional risk. Interpreting laboratory work in order to recognize and determine dehydration also takes practice and experience. Given the vulnerability of older adults in residential care, the profound effects of dehydration on brain and body functions, and the time needed for an accurate and comprehensive evaluation of physical and cellular changes, the proposed study seeks to determine if Bioelectrical Impedance Analysis (BIA), a valid, reliable, and non-invasive procedure, can be performed as a more immediate method to determine older adults’ risk of dehydration.

Bioelectrical Impedance Analysis (BIA)
The BIA system calculates extracellular body water (ECW) and total body water (TBW). From these two measures, intracellular body water (ICW) can be extrapolated. All three measures are factored into an equation that includes age, gender, height, weight, and race to calculate the body’s resistance (R) and reactance (Xc) to determine hydration and fat mass (Olde Rikkert et al., 1997). The resistance or impedance to a weak electrical current is inversely proportional to the amount of total body water and lean body mass.

To determine resistance and reactance, two pairs of surface electrodes are placed on the back of the right hand and foot while the adult being tested rests comfortably in a supine position. A constant, low level (50kHz), alternating electrical current is released into the body via the surface electrodes. This current is generally not felt, or may be perceived
initially as a slight tingle. The amount of extra- and intra-cellular fluids in the body serve as conductors for the passage of the current. The test is considered safe and has documented validity and reliability (Roubenoff et al., 1997; Shanholtzer & Patterson, 2003). It takes approximately five minutes for data collection following a rest period of at least 15 minutes (picture below).

In the proposed study, 20 older adults considered at-risk for dehydration will undergo the BIA protocol. These older adults will be matched for age and gender with 20 self-reported healthy older adults living independently in the same facility who do not report any swallowing difficulties. These self-reported healthy older adults also will undergo the BIA protocol.

2. Describe the study/research design.

The proposed study is an experimental design. The group of 20 self-reported healthy older adults will serve as a control for the experimental group of 20 older adults who are considered at-risk for dehydration. All participants who meet the criteria for the two groups will be tested. Thus, participant categorization will not be randomized.

3. Describe the benefits of the research to the human subjects, if any, and of the benefits to human or scientific knowledge.

The participants in the experimental group will be assessed for hydration level. Those who are determined to be dehydrated will receive immediate, evidence-based intervention from the certified and licensed nursing staff and speech-language pathologist (SLP) who are employed full-time at the facility. Individuals also will continue to be monitored by nursing staff for any medical complications. Results of the study are expected to facilitate the development and implementation of a dehydration protocol that can be followed by SLPs and nursing staff at skilled nursing facilities. This protocol will facilitate the accurate and timely identification of older adults who are at-risk for dehydration and spare many individuals from increased ill-health and related medical expenses. An additional expected benefit is that Certified Nursing Assistants (or Personal Care Providers) at the facility can be trained to administer the BIA protocol to assist Registered Nurses and SLPs in identifying individuals at risk for dehydration.

Participants in the control group, by definition, will not have problems with swallowing. However, in selecting the 20 self-reported healthy older adults for this control group, some volunteers who are at increased risk for dehydration may be identified. These individuals will be referred for preventive healthcare and this timely intervention will prevent them from getting sick and incurring further healthcare costs.

4. Describe the subjects, how the subjects are to be selected, how many are to be used, and indicate
explicitly whether any are minors (under age 18 per Kansas law) or otherwise members of "vulnerable" populations, including, but not limited to, pregnant women, prisoners, psychiatric patients, etc.

There will be two groups of participants in this study: (a) the experimental group - those thought to be dehydrated or considered at-risk for dehydration (n=20) and (b) the control group (n=20). All participants will be 65 years of age or older and matched as closely as possible for age and gender. The intent is that all will be cognitively able to provide informed written consent for the study. Cognitive status will be measured through administration of the 30-item Mini-Mental State Examination (MMSE; Folstein, Folstein, & Fanjiang, 2001; Attachment 1). If any participant in the experimental group is unable to provide informed consent, his/her caregiver or legal guardian will be asked to provide this.

The participants in the experimental group will reside in the skilled nursing section of the Kansas Masonic Home (KMH) in Wichita, Kansas. These participants will be identified by nursing staff and/or the speech-language pathologist at KMH due to their concerns about risk for dehydration. The time-post-onset and the etiology of any dysphagia for the participants in the experimental group will be documented but allowed to vary. Following their referral for the study, participants will be contacted by the investigator to discuss the study and to review and sign an informed consent form prior to any data collection.

Participants in the control group will be older adults who are living independently in the residential facility and who report no acute health concerns and no swallowing difficulties.

All participants are considered members of a "vulnerable" population as they are older adults. All will be offered $20 to participate.

5. Describe each procedure step-by-step, including the frequency, duration, and location of each procedure.

After providing their written informed consent, participants will undergo the following procedures on one occasion only:
- Mini-Mental State Examination (MMSE; Folstein et al., 2001; Attachment 1). This test documents cognitive function via a score out of 30 possible points.
- Oral Motor Examination (Attachment 2). This is a non-invasive examination of oral hygiene, lubrication, dentition, and coordinated movement of facial, tongue, and throat muscles. The investigator will use a small flashlight, dental mirror, and tongue depressor.
- Swallowing-Specific Quality of Life Survey (SWAL-QOL; McHorney et al., 2002; Attachment 3). This 44-item survey measures the relationship of swallowing difficulty to the factors of burden of care; duration of eating; desire to eat; food selection; ability to communicate; fear of eating; mental health; social integration; fatigue; and adequate sleep. A 5-point rating scale is used throughout.
Functional Oral Intake Scale (FOIS; Crary, Carnaby-Mann, & Groher, 2005; Attachment 4). This 7-point ordinal scale is used to rate participants’ swallowing ability and the type of food and liquid they consume regularly. At Level 7, swallowing is considered safe and efficient with a total oral diet and no restrictions. At Level 1, an adult is unable to swallow anything safely by mouth and all nutrition and hydration are received through a tube into the esophagus or the stomach.

Reflux Symptom Index (RSI; Belafsky, Postma & Koufman, 2002; Attachment 5). This 9-item index uses a 6-point rating scale, ranging from 0 = No Problem to 5 = Severe Problem. A maximum total score of 45 is possible, reflecting the presence of severe reflux.

Body Mass Index (BMI). Body weight will be measured in kilograms (kg) using a Seca® calibrated electronic scale (H & C Weighing Systems, Columbia, MD). Height will be measured in centimeters (cm) using a portable stadiometer (Pearson Surgical Supplies, Sylmar, CA). Body mass index (BMI) will be calculated by dividing weight by height squared, i.e., kg/m² (Akner & Flöistrup, 2003). BMI measures will be compared to normative data and ranked according to one of four categories: underweight, normal range, overweight, and obese.

Bioelectrical Impedance Analysis (BIA). This 20-minute test (15 minutes rest + 5 minutes data collection) identifies resistance and reactance values that reflect an individual’s level of hydration. Testing needs to occur following at least 15 minutes of rest with no consumption of food or liquid for the past two hours. Ideally, testing will be completed first thing in the morning following a long period of sleep and hours of fasting (Roubenoff et al., 1997).

Mann Assessment of Swallowing Ability (MASA; Mann, 2002). This 24-item test documents the type and severity of swallowing difficulties and risk for aspiration. It will be administered to the participants in the experimental group only.

These one-time procedures are summarized in the table on the following page. The completion of all test procedures is expected to take 2-3 hours. The intent is to complete all procedures on the same day. The order of presentation will be counter balanced within preliminary and experimental testing categories. However, if same-day testing proves difficult for some participants, testing will be separated over two consecutive days.

Data Analysis. The independent variable in this study is level of hydration (as measured using Bioelectrical Impedance Analysis). There are multiple dependent variables. Scores from the various measures will be coded and entered into Statistical Package for the Social Sciences (SPSS) software, Version 18.0 for Windows, for analysis. An Analysis of Variance (ANOVA) will be run to examine the effects of the independent variable on the multiple dependent variables.
Table 1. Purpose and duration of procedures.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Purpose</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informed Consent</td>
<td>To ensure participants understand what they are being asked to do, including risks and benefits</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Mini-Mental State Exam</td>
<td>To document cognitive status</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Swallowing Quality of Life Scale</td>
<td>To confirm no swallowing difficulties, or document swallowing difficulties</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Functional Oral Intake Scale</td>
<td>To document type of food/liquid consumed</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Reflux Symptom Index</td>
<td>To document reflux symptoms</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>To document height, weight and body composition</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Oral-Motor Examination</td>
<td>To assess oral hygiene, structure and function</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Mann Assessment of Swallowing Ability</td>
<td>To document severity of swallowing difficulty</td>
<td>20 minutes</td>
</tr>
<tr>
<td>Bioelectrical Impedance Analysis</td>
<td>To document level of hydration</td>
<td>20 minutes</td>
</tr>
</tbody>
</table>

6. Describe any risks or discomforts (physical, psychological, or social) and how they will be minimized.

Any risks or discomforts are expected to be minimal for the self-reported healthy participants in the control group. These participants will have reported they have no swallowing difficulties and no difficulties with level of hydration; therefore, completing preliminary and experimental testing procedures, including Bioelectrical Impedance Analysis, should cause little difficulty. A careful case history will be taken prior to any data collection to verify that no participant in the control group has any implanted device, e.g., a cardiac pacemaker. BIA is not performed when such implanted devices are present. Qualified healthcare personnel at KMH will be available to assist, if needed.

The participants in the experimental group are in this group because they are considered at-risk for dehydration; therefore, their case history may document multiple disease processes for which they may take multiple prescribed medications. All medications will be documented as some are known to have an adverse effect on hydration. Care will be
taken to ensure that these older adults do not have any implanted devices. Qualified nursing staff will be readily available in the event of any adverse reaction. With regard to the Bioelectrical Impedance Analysis, participants also will be reminded that isolation transformers are in place within the equipment to prevent exposure to any intense currents. There is a minimal risk of injuring skin when removing the bioelectrical impedance electrodes if a participant’s skin is particularly dry or thin due to aging. Investigators will take special care in removing the electrodes. Each participant will be tested with a new set of electrodes that will be thrown away after testing.

Participants in either group may become tired or fatigued during testing. If this occurs, testing will be halted temporarily and participants will be encouraged to take a break. The investigator will monitor participants for signs of fatigue throughout testing.

7. Describe how the subject’s personal privacy is to be protected and confidentiality of information guaranteed (e.g. disposition of questionnaires, interview notes, recorded audio or videotapes, etc.).

All testing procedures will be conducted in a private room at the Kansas Masonic Home (KMH). All documentation, including, but not limited to, informed consent, assessment forms, notes and data will be secured in a locked file cabinet in the office of the Primary Investigator. No audio or videotapes will be recorded. When data are entered for analysis, each participant will be identified by a number, rather than a name or initials. When analyzed data are presented or published, the analysis will represent group differences. No individual will be able to be identified.

8. Describe the informed consent process and attach a copy of all consent and/or assent documents. These documents must be retained for three years beyond completion of the study. Any waiver of written informed consent must be justified.

The Informed Consent forms follow this document. Two forms have been developed, one for each group of participants: Form A for participants in the control group; Form B for participants in the experimental group. Participants will be encouraged to read the relevant form carefully prior to signing. If requested, the investigator will read the form aloud. Any questions participants, or their caregivers, have will be answered to their satisfaction before they are asked to document their consent to participate in the study.

9. Attach all supporting material, including, but not limited to, questionnaire or survey forms and letters of approval from cooperating institutions.

The following attachments are provided: (but not submitted with this thesis)

- Attachment 1 - Mini-Mental State Examination (MMSE)
- Attachment 2 - Oral Motor Examination
- Attachment 3 - Swallowing-Specific Quality of Life Survey (SWAL-QOL)
- Attachment 4 - Functional Oral Intake Scale (FOIS)
- Attachment 5 - Reflux Symptom Index (RSI)
- Attachment 6 - The approval of administrators at KMH.
The Principal Investigator agrees to abide by the federal regulations for the protection of human subjects and to retain consent forms for a minimum of three (3) years beyond the completion of the study. If the data collection or testing of subjects is to be performed by student assistants, the Principal Investigator will assume full responsibility for supervising the students to ensure that human subjects are adequately protected.

Signature of Principal Investigator  Date

Signature of Co-Investigator  (for student project)  Date

Selected References


APPENDIX B. Informed Consent Form (A)

Investigating hydration levels in older adults with swallowing difficulties.

I, _________________________, agree to participate in the study, Investigating hydration levels in older adults with swallowing difficulties. I have been informed that the information I provide will assist the investigators in determining an efficient and effective way to identify dehydration in older adults in residential care before they may need to undergo invasive blood analysis procedures. I confirm that I am living independently at the Kansas Masonic Home and have no known health issues that compromise my swallowing ability, nor have I ever had a stroke. I understand that I will receive $20 for my participation.

I understand that I will be asked to complete the following questionnaires:

- The Mini-Mental State Exam (MMSE)
- The Swallowing Quality of Life Scale (SWAL-QOL)
- The Functional Oral Intake Scale (FOIS)
- The Reflux Symptom Index (RSI).

I understand I will work with Dr. Lyn Goldberg, the Primary Investigator, to complete these questionnaires and this should take about an hour. I have been told that the MMSE is a short test of thinking and memory and that the three questionnaires (the SWAL-QOL, FOIS, and RSI) will document my perceptions of my general health, swallowing ability, what I eat and drink, and whether I have any difficulties with reflux (indigestion). I understand that I will complete these questionnaires in a private room of my choosing at KMH.

After finishing the questionnaires, I understand I will work with Dr. Goldberg or her graduate student, Amanda Foley, to complete measures of my height and weight to calculate my Body Mass Index (BMI) and two additional procedures:

- Oral-Motor Examination
- Bioelectrical Impedance Analysis (BIA).

For the oral-motor examination, I will be asked to move my face, tongue, palate, and throat in specific ways. I will perform most of the movements with my mouth open and Amanda will use a small flashlight to see what I am doing and to see how well-lubricated the lining of my mouth and tongue is. This should take about 15 minutes. For the BIA testing, I understand that I will lay on my back on a comfortable but supportive surface. Two pairs of surface electrodes will be placed on the back of my right hand and foot. I will rest in this position for 15 minutes. Then, a weak electrical current will be released into my body through these surface electrodes. I have been assured that this procedure is safe and that I probably will not feel this weak current, or, if I do, I will feel it as a slight tingle. This part of the test will take 5 minutes. The two measurements it provides will indicate how well hydrated my body is.
I understand that all the test procedures should take between 2-3 hours to complete. I have been told that if I am unable to complete all the procedures on the same day, they will be administered over two consecutive days. I understand further that I can take a break from data collection whenever I am tired. In addition, if I experience any discomfort with any testing, I can stop the test immediately. Then I can decide if I want to continue with the study or stop.

I do understand that my participation in this study is voluntary. I know that I can withdraw from the study at any time. If I do decide to withdraw from the study, I know any data I have provided will be shredded or deleted and that there will be no negative effects on any other activities in which I am involved at Wichita State University.

I have been assured that any data I provide will remain confidential and be kept in a locked cabinet in Dr. Goldberg’s office. When the investigators present or publish data from this study, I understand that my data will not be shown in any way that would enable others to identify me. I understand further that once the study is published, the data I have provided will be shredded or deleted.

I understand that I can contact Dr. Goldberg at (316) 978-6115 or by e-mail at Lyn.goldberg@wichita.edu if I have questions or concerns about the study. If my concern involves Dr. Goldberg, I understand I can contact staff in the Office of Research Administration (ORA) at (316) 978-3285 for assistance.

I agree that this study has been explained to me and I understand what I am being asked to do. I have been given the opportunity to ask questions and my questions have been answered to my satisfaction.

_______________________________                                _________________________
Signature                                                                                     Date

____________________________
Printed name

_______________________________
Signature of investigator                                                               Date

____________________________
Printed name

1845 N. Fairmount, Wichita, KS  67260-0075
Telephone: (316) 978-3240   •   Fax: (316) 978-3291   •   E-mail: csd@wichita.edu   Website:
www.wichita.edu/csdu
APPENDIX C: Informed Consent Form (B)

Investigating hydration levels in older adults with swallowing difficulties.

I, ________________________, agree to participate in the study, Investigating hydration levels in older adults with swallowing difficulties. I have been informed that the information I provide will assist the investigators in determining an efficient and effective way to identify dehydration in older adults in residential care before they may need to undergo invasive blood analysis procedures. I confirm that I am living at the Kansas Masonic Home (KMH). I understand that I will receive $20 for my participation.

I understand that I will be asked to complete the following questionnaires:
- The Mini-Mental State Exam
- The Swallowing Quality of Life Scale (SWAL-QOL)
- The Functional Oral Intake Scale (FOIS)
- The Reflux Symptom Index (RSI).

I understand I will work with Dr. Lyn Goldberg, the Primary Investigator, to complete these questionnaires and this should take about an hour. I have been told that the MMSE is a short test of thinking and memory and that the three questionnaires (the SWAL-QOL, FOIS, and RSI) will document my perceptions of my general health, swallowing ability, what I eat and drink, and whether I have any difficulties with reflux (indigestion). I understand that I will complete these questionnaires in a private room of my choosing.

After finishing the questionnaires, I understand I will work with Dr. Goldberg, or her graduate student, Amanda Foley, to complete measures of my height and weight to calculate my Body Mass Index (BMI) and three additional procedures:
- Oral-Motor Examination
- Bioelectrical Impedance Analysis (BIA)
- Mann Assessment of Swallowing Ability.

For the oral-motor examination, I will be asked to move my face, tongue, palate, and throat in specific ways. I will perform most of the movements with my mouth open and Amanda will use a small flashlight to see what I am doing and to see how well-lubricated the lining of my mouth and tongue is. This should take about 15 minutes. For the BIA testing, I understand that I will lay on my back on a comfortable but supportive surface. Two pairs of surface electrodes will be placed on the back of my right hand and foot. I will rest in this position for 15 minutes. Then, a weak electrical current will be released into my body through these surface electrodes. I have been assured that this procedure is safe and that I probably will not feel this weak current, or, if I do, I will feel it as a slight tingle. This part of the test will take 5 minutes. The two measurements it provides will indicate how well hydrated my body is. I understand that the Mann Assessment of Swallowing Ability has 24 questions that help to document any difficulty I have with
swallowing.

I understand that all the test procedures should take between 2-3 hours to complete. I have been told that if I am unable to complete all the procedures on the same day, I can complete them over two consecutive days. I understand further that I can take a break from data collection whenever I am tired. In addition, if I experience any discomfort with any testing, I can stop the test immediately. Then I can decide if I want to continue with the study or stop.

I do understand that my participation in this study is voluntary. I know that I can change my mind and withdraw from the study at any time. If I decide to withdraw from the study, I know that any data I have provided will be shredded or deleted and there will be no negative effects on any other activities in which I am involved at KMH or Wichita State University.

I have been assured that any data I provide will remain confidential and be kept in a locked cabinet in Dr. Goldberg’s office. When the investigators present or publish data from this study, I understand that any details from my medical records that are used in a manuscript or presentation will be presented in a way that protects my privacy and does not enable anyone to identify me. I know that if I would like a copy of the manuscript, I can ask for one. I understand further that once the study is published, the data I have provided will be shredded or deleted.

I understand that I can contact Dr. Goldberg at (316) 978-6115 or by e-mail at Lyn.goldberg@wichita.edu if I have questions or concerns about the study. If my concern involves Dr. Goldberg, I understand I can contact staff in the Office of Research Administration (ORA) at (316) 978-3285 for assistance.

I agree that this study has been explained to me and I understand what I am being asked to do. I have been given the opportunity to ask questions and my questions have been answered to my satisfaction.

________________________________________  _________________________
Signature                                           Date

________________________________________
Printed name

________________________________________  _________________________
Signature of investigator  Date