Nonimaging Clinical Assessment of Impaired Swallowing in Community-Dwelling Older Adults in Taiwan

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ABSTRACT

Background: Impaired swallowing is common in elderly patients as well as those with neurological disorders and degenerative diseases. Convenient and accurate assessments should be available to community-dwelling older adults to diagnose and provide early management and care of swallowing difficulties, an important factor of influence on elderly life quality.

Purpose: This study used convenient nonimaging methods to assess swallowing functions in community-dwelling older adults and estimated the prevalence of swallowing difficulties.

Methods: The study adopted a survey method and recruited 216 community-dwelling older adults over 65 years old in northern Taiwan. Researchers used tools including a swallowing test, questionnaire, water test, peripheral arterial pulse oximeter, and laryngeal S-EMG to assess participant swallowing functions and the prevalence of impaired swallowing.

Results: We found a 9.5% prevalence of impaired swallowing based on swallow questionnaire and water test results. Age correlated negatively with swallowing speed. A one-way ANOVA showed a significant difference in swallowing speed among the four age groups (F = 6.478, p < .00). A post hoc Scheffe comparison showed significant differences in swallowing time between the 60- to 69- and 70- to 79-year-old groups and 60- to 69- and 80- to 89-year-old groups. Multiple regression of impaired swallowing on various independent variables showed a significant standardized coefficient of 0.163 for age (t = 2.328, p = .021). Logistic regression showed a significant Wals test value for age (p = .007). The Kappa value was 0.307 for agreement analysis between impaired swallowing and SaO₂ value reduction of more than 2%.

Conclusions/Implications for Practice: Swallowing function deteriorates with age. Results of this study provide an assessment of the prevalence of impaired swallowing in community-dwelling older adults in Taiwan. Results can help guide clinical nurses to enhance their objective assessment of impaired swallowing to improve patient quality of life.

Key Words: community-dwelling older adults, impaired swallowing, swallow assessment.

Introduction

Impaired swallowing is common in elderly patients and patients with neurological disorders (e.g., stroke, Parkinson’s disease, and multiple sclerosis) and degenerative diseases. This at-risk group is also more likely to rely on others to help or perform activities of daily living (Becker et al., 2011; Leopold & Kagel, 1997). The onset of swallowing dysfunction causes patients to no longer be able to enjoy the pleasure of eating. Dysfunction also necessitates lifestyle changes in terms of diet and food format that are a source of great frustration for patients and their families. Impaired swallowing increases risk of food and fluid aspiration into the trachea, which increases aspiration pneumonia and mortality risks (Morris, 2009). Therefore, convenient and accurate assessments are needed to confirm swallowing problems in community-dwelling older adults, an essential step in providing early care and promoting patient and family life quality.

Background

A study by Cabre et al. (2010) on 134 patients over 70 years old found 55% demonstrating clinical signs of oral–laryngeal impaired swallowing. A survey study by Holland et al. (2011) of healthy community-dwelling older adults found that 11.4% showed symptoms of swallowing difficulties. Turley and Cohen (2009) studied 248 retired older adults and found that 13.7% had impaired swallowing; 11–22% of stroke patients catch pneumonia during their acute or rehabilitative phases (Indredavik, Rohweder, Naalsund, & Lydersen, 2008); 21–42% of stroke patients in the acute stage show impaired swallowing, with 2–25% diagnosed with asymptomatic aspiration pneumonia (Ramsey, Smithard, & Kalra, 2005); and 50% of acute stroke patients experience dysphagia.

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during the immediate post-stroke period (Martino et al., 2003; Paciaroni et al., 2004). Wang, Chen, Lien, and Hwang (2001) diagnosed 12.8% of elderly people with impaired swallowing using a videofluoroscopic test (VFS) administered during regular health checkups. The abovementioned studies indicate the prevalence of impaired swallowing in the older adults as between 11.4–55% based on different survey methods and research populations. The high prevalence of impaired swallowing illustrates the significance of this health issue in older adults and disabled populations.

An initial swallowing assessment includes assessments of patient eating history, oral hygiene, tongue movements and sensations, protective reflexes and respiration and vocalization, and ability to swallow foods of various textures. These assessments are primarily physical examinations of neuromuscular functions and actual swallowing tests. Swallowing tests can employ imaging and nonimaging methods to increase test accuracy (Logemann, 1983; Ramsey, Smithard, & Kalra, 2003). The dynamic VFS swallowing test is the current gold standard of objective swallowing tests and the most commonly used clinical swallowing test tool (Ramsey et al., 2003; Wooi, Scott, & Perry, 2001). As the middle- to large-sized swallowing test equipment commonly used in the clinic is not practical for implementation in the community, small portable devices such as ultrasound, surface electromyography (S-EMG), peripheral artery pulse oximeter, and stethoscope for cervical auscultation are preferred (Bodén, Hallgren, & Witt Hedström, 2006; Ludlow et al., 2007). The S-EMG electrically stimulates neck muscles to gather data on the oral–pharyngeal phase of the swallowing process. Peak S-EMG values have been shown to be substantially different in patients with swallowing impairment. Measuring tongue base and laryngeal muscular activities during swallowing tests provides information about swallowing time during the oral phase, initiation and termination of swallow reflex, and swallowing frequency for further analysis. This test is objective, direct, convenient for observing, and portable, making it appropriate for mobility-challenged patients. This test objectively and accurately improves understanding of patient oral–laryngeal muscular activities and swallowing difficulties and provides accurate data on neck muscular activity (Ding, Logemann, Laeson, & Rademaker, 2003; Ertekin et al., 2002; Perlman, Luschei, & Du Mond, 1989).

Pulse oximeters use sensors to detect oxygen saturation in peripheral arteries. This device is used during swallowing tests to monitor respiratory obstructions and subsequent oxygen supply deficits that affect arterial oxygen saturation during swallowing. If swallowing difficulties are the cause of respiratory obstructions impairing gas exchange, such difficulties will likely result in hypoventilation and ventilation–perfusion mismatch with reduced inspiration volume. Food invasion into the trachea may cause aspiration pneumonia. The pulse oximeter thus provides direct evidence on foreign object aspiration risk during the swallowing process. Sensitivity of pulse oximeter monitoring during swallowing tests ranges from 73% to 87%, with a specificity range of 39–87% (Ramsey et al., 2003). Pulse oximeters are most effective when used in combination with other assessment methods. It provides a noninvasive, objective, direct, convenient, and portable observation tool that is appropriate for use with mobility-challenged patients.

Commonly used clinical swallowing tests include the water test, physical examinations, neurological examination, and the swallow questionnaire. The water test measures patients’ actual swallowing speed, swallowing frequency, average water volume per swallow, ability to swallow water completely, and abnormal swallowing difficulties during the swallowing process. It is an objective, direct, and convenient method to test swallowing efficacy. Patient swallowing history is also an important reference indicator during the swallowing test. Aside from actively observing a patient’s food intake, a structured, self-evaluation questionnaire is a simple, convenient, and safe clinical test for identifying subjective swallowing problems.

**Aims**

The objective of this study was to assess swallowing functions in community-dwelling older adults using nonimaging methods and then estimate impaired swallowing prevalence. Primary assessment tools were the swallowing test, a structured questionnaire, the water test, peripheral arterial pulse oximeter, and laryngeal S-EMG. A simple community assessment model gathered data pertaining to swallowing functions and prevalence of impaired swallowing.

**Methods**

**Design**

This study adopted a survey design and used a convenience sampling method to screen research participants. Data from participants were analyzed. The primary investigator and several part-time research assistants participated in the entire data collection and analysis processes.

**Sample/Participants**

This study recruited participants from Shilin District, the second most populous administrative district in Taipei City, Taiwan. Participants were assessed during a community health screening activity provided by the Shilin District Health Service Center. Swallowing function evaluations of community older adults was conducted at “Evergreen Care Stations” located in each subdistrict. Inclusion criteria were (a) community-dwelling older adults older than 65 years old, (b) clear mental cognizance, (c) able to communicate in Mandarin or Taiwanese, (d) consumes food orally only, and (e) no other neurological diseases (stroke subjects within 3 months of acute stage were excluded for safety reasons). Subjects with head or neck tumors, cancer patients, and patients with chronic pulmonary diseases were excluded from participation.
Data Collection
Participants filled out personal information forms and swallow questionnaires. A research assistant then conducted individual face-to-face interviews with each participant. The principal investigator used equipment and neurological examination methods to evaluate participant swallowing function. Participants then filled out the questionnaire and received physical examination to assess swallowing functions. A 90-ml water test evaluated swallowing time, speed, and frequency. Researchers also recorded any patient coughing observed. A peripheral arterial pulse oximeter monitored blood oxygen saturation (\(\text{SaO}_2\)), with laryngeal S-EMG monitoring implemented simultaneously.

Ethical Considerations
This study was approved by the Institutional Review Board of the National Taipei University of Nursing and Health Sciences (#95A069). The researcher confirmed participant consent after explaining the research protocol. Swallowing test results were explained to each participant after each test.

Measurement
This study used four tools to assess swallowing efficacy. These included the swallow questionnaire, water test, pulse oximeter, and SEMG. The swallow questionnaire and water test were the main evaluation tools. The others were supplementary. Each tool is further elaborated below.

Swallow questionnaire
We adopted the protocol described by Nathadwarawala, McGroary, and Wiles in 1994 to assess swallowing problems. Assessment was based on three criteria. First, participants were asked whether they had a problem with swallowing. Second, a 16-item questionnaire was used to identify symptoms potentially caused by impaired swallowing or aspiration. Third, a standardized examination of the 5th, 7th, and 9th through 12th cranial nerves was performed. Questionnaire and neurological examination results were integrated to produce a symptoms and signs of impaired swallowing score. Finally, a timed swallowing test was performed.

1. Swallowing Questionnaire
   Participants were screened using a questionnaire developed by Nathadwarawala, McGroary, and Wile (1994). The questionnaire consists of 16 questions pertaining to a patients’ personal condition or behavior and explores general ingestion status and swallowing awareness. Lin, Chen, Chen, and Portwood (2001) translated the questionnaire into Chinese and conducted psychometric assessments. The content validity index for the swallowing questionnaire was .988. The coefficient of equivalence between the Chinese version and the original English version was .81. The Kuder–Richardson formula 20 for internal consistency was .74.

2. Neurological Examination
   Nathadwarawala et al. designed a scoring system for swallowing based on a clinical examination of the 5th, 7th, and 9th through 12th cranial nerves. The examination collects biophysical data during a 10- to 15-minute period. The researcher and a neurologist conducted an interrater reliability examination on 20 neurology outpatient clinic subjects and obtained a reliability rate of 90–100%.

   This study used the swallow questionnaire to evaluate and score swallowing difficulty. Swallowing difficulty was confirmed if participants showed the following two symptoms and clinical features: (a) subjective complaint of swallowing difficulty and (b) a swallow questionnaire and neurological examination score higher than 2 points. A researcher conducted the physical examination component of the swallow test. Possible scores ranged from 0 to 17.25 points, with higher scores indicating higher degree of swallowing difficulty.

   This study assessed participant swallow function using questionnaire that combined the Chinese version of Nathadwarawala et al.’s (1994) swallow questionnaire and Lin et al.’s (2001) swallow questionnaire and a swallow test formulated by Lin et al. Participants presenting more than two of the symptoms or clinical signs were identified as having swallow dysfunctions. Higher scores correlated with a higher degree of swallow dysfunction. The seven questions in the swallow examination portion were asked verbally by researchers, with a range of total possible scores ranging from 0 to 17.25. Higher scores correlated with a higher degree of swallow dysfunction.

90-ml water swallowing test
Researchers adopted the swallowing test developed by Nathadwarawala et al. (1994). Participants were asked to drink 90 ml of cold tap water in a standard paper cup as quickly as possible. The cup was readied at the lips, and the participant was kept from drinking until an observer sitting immediately adjacent gave a “go” signal. Number of swallows was determined by touching the participants’ throat and neck with the fingers to feel the movement of the hyoid bone and thyroid cartilage. Time interval from the signal given to the last swallow was measured using a stopwatch. The return of the moving larynx to resting position after the last swallow was used as the end point. The test was terminated for those participants who coughed or had difficulty swallowing all 90 ml of the fluid during the course. In this instance, the researcher measured the remaining water to calculate volume swallowed per second. Interrater reliability was established between the study’s primary investigator and a speech language pathologist based on test results for 20 normal adults. The intraclass coefficient was .94–.99. Intra-rater reliability of the primary investigator of the study was .94–.97.

S-EMG
This study adopted a method from Perlman et al. (1989) that monitors neck muscle activities to understand the peak values, average activities, and durations of S-EMG during the swallowing process to accurately measure the starting time of the swallow reflex and total swallow time during the oral–laryngeal phase. The details of muscle selection and S-EMG
settings were adopted from a method published by Ding et al. (2003). Electrodes used to record the S-EMG during food intake were placed over the orbicularis oris inferior, submental muscle region, and infrahyoid muscle region. EMG equipment, model BIOPAC MP34, used in this study monitored laryngeal muscle activities during swallow and measured swallow reflex starting time and oral–pharyngeal swallow time.

**Oximeter for measuring oxygen saturation of peripheral arterial blood**

This study used the 90-ml water test from Lim et al. (2001) combined with a pulse oximeter to monitor blood oxygen saturation before, during, and after the swallowing test. A ≥2% drop of baseline peripheral blood oxygenation saturation (\(\text{SaO}_2\)) during the monitoring process predicted respiratory tract aspiration. In this study, a portable pulse oximeter was used for peripheral arterial blood oxygen analysis. The sensitivity of the pulse oximeter in predicting aspiration during swallowing was 76.9%. Its specificity was 83.3% \((\chi^2 = 18.154, p < .001)\). This study used the portable pulse oximeter model BCI 3303 Head-held Pulse Oximeter for peripheral arterial blood oxygenation analysis. Baseline \(\text{SaO}_2\) was measured before the 90-ml water test and continuously monitored during the 90-ml water test, until 2 minutes after the last swallow (larynx descending back to its preswallow resting position).

**Criteria Used to Screen Impaired Swallowing**

This study modified an impaired swallowing classification and scoring system developed by Nathadwarawala et al. (1994). Participant inclusion criteria included (a) self-reported swallowing difficulty, (b) a score of 2 or more on a swallowing questionnaire combined with a neurological examination for symptoms and signs of impairment, and (c) coughing or choking during a timed swallowing test or a test results below the 10th percentile, based on averages reported from a gender-based study of an older population (Lin, Wu, Chen, Wang, & Chen, 2002). Participants who did not meet any of the above criteria were defined as normal. Those who met one, two, or three criteria were defined as probably normal, probably swallowing impaired, and swallowing impaired, respectively.

**Data Analysis**

Collected data were coded and registered, then analyzed using descriptive and inferential statistical analysis methods including frequency, percentage, average, one-way ANOVA, Kappa agreement, and logistic regression using the SPSS statistical software package for Windows (version 19.0).

**Results**

We recruited a total of 216 community-dwelling older adults (156 women and 60 men) as participants. Average age was 74.2 years \((SD = 6.33\) years). The largest proportion (40.3%) was educated to the elementary school level, 57.4% were married, and most were retired and unemployed (95.8%). In terms of health condition, 72.2% had a history of illness, with hypertension as the most common chronic disease reported (46.3%, 100 participants; Table 1), and 19.2% (41 participants) self-reported as having impaired swallowing. 93.5% (202 participants) scored an average of 0.83 points \((SD = 1.28\) points) on the swallowing examination, and 10.5% scored over 2 points on the swallow questionnaire. 1.9% (4 participants) exhibited a choking or coughing reaction in the water test, 10.2% (21 participants) had a swallowing speed slower than 4.22 ml/sec \(^{-1}\) (<10th percentile), 9.5% (19 participants) had more than two impaired swallowing manifestations (Table 2), and 9.2% showed an \(\text{SaO}_2\) reduction from baseline of more than 2% (Table 3).

Agreement analysis between confirmed impaired swallowing and decreased \(\text{SaO}_2\) values revealed that three participants...
showed more than two instances of impaired swallowing
and a >2% decrease in SaO₂ (Table 4). The kappa value for
agreement analysis was 0.307, demonstrating statistical sig-
nificance (p < .001). Swallowing speed from the water test
differed significantly among the four age groups. The swal-
lowing speed averaged 10.179 ml/sec (SD = 3.90) for partic-
ipants in the 65- to 69-year-old group, 9.32 ml/sec (SD =
4.00) for those in the 70- to 79-year-old group, 7.07 ml/sec
(SD = 3.48) for those in the 80- to 89-year-old group, and
4.88 ml/sec (SD = 0.45) for those in the 90- to 99-year-old
group. Swallowing speed correlated negatively with age.
One-way ANOVA further confirmed a statistical difference
in swallowing speed among the four groups (F = 6.478,
p < .001). Post hoc analysis using Scheffe analysis showed sig-
nificant differences in swallowing time between the 60- to
69- and 70- to 79-year-old groups as well as the 60- to 69-
and 80- to 89-year-old groups.

Furthermore, multiple regression analysis of impaired
swallowing based on the independent variables of age, gen-
der, and peak S-EMG values showed a standardized coef-
cient for age of 0.159 (statistically significant at t = 2.230,
p = .027). Logistic regression of greater than two impaired
swallowing items with the independent variables of age,
gender, and peak S-EMG values showed the significance of
the overall model (χ² = 9.499, p < .05), which indicated a
good goodness of fit for the model. However, our derived
Hosmer–Lemeshow test value of 11.275 was not statisti-
cally significant (p = 9.05). Among the independent vari-
able, the Wals value for age was statistically significant
(p = .01), whereas the other two independent variables (i.e.,
gender and peak S-EMG) were not statistically significant.
Therefore, results show that age effectively predicts and
explains impaired swallowing (Table 5). In addition, a sim-
ple regression between cases with more than two impaired

### TABLE 2.
**Swallow Questionnaire, 90-ml Water Test, and Dysphagia Confirmation Results**

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>%</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-reported difficulty with swallowing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>41</td>
<td>19.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>172</td>
<td>80.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swallow impairment score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;2 (probably abnormal)</td>
<td>21</td>
<td>10.5</td>
<td>0.83</td>
<td>1.28</td>
<td>0.00–7.75</td>
</tr>
<tr>
<td>90-ml water test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swallow time (second)</td>
<td>205</td>
<td></td>
<td>13.00</td>
<td>9.12</td>
<td>4.48–79.32</td>
</tr>
<tr>
<td>Swallow speed (ml/sec)</td>
<td>205</td>
<td></td>
<td>9.10</td>
<td>4.01</td>
<td>0.83–20.68</td>
</tr>
<tr>
<td>Swallow frequency (times)</td>
<td>205</td>
<td></td>
<td>6.63</td>
<td>3.44</td>
<td>2.00–21.00</td>
</tr>
<tr>
<td>Mean swallow amount (ml)</td>
<td>205</td>
<td></td>
<td>17.00</td>
<td>7.77</td>
<td>3.14–45.00</td>
</tr>
<tr>
<td>Water residual amount (ml)</td>
<td>6</td>
<td></td>
<td>0.18</td>
<td>1.73</td>
<td>0.00–24.00</td>
</tr>
<tr>
<td>Swallowing rate &lt;4.22 ml.s⁻¹</td>
<td>21</td>
<td>10.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choking present in water test</td>
<td>4</td>
<td>1.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swallowing rate &lt;4.22 ml.s⁻¹ or choking</td>
<td>23</td>
<td>11.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defined as abnormal/probably abnormal swallowing (≥2 criteria)</td>
<td>19</td>
<td>9.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.** Defined as abnormal/probably abnormal swallowing if two or more of the following were present: (1) self-report of swallow difficulty, (2) swallow impairment score of >2, and (3) swallowing rate of <4.22 ml.s⁻¹ or choking. (Reference cited from Nathadwarawala, McGroary, & Wiles, 1994, and Lin, Wu, Chen, Wang, & Chen, 2002).

### TABLE 3.
**Oximetry Test and S-EMG Results**

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oximetry (%)</td>
<td>206</td>
<td>0.66</td>
<td>0.71</td>
<td>0–4</td>
</tr>
<tr>
<td>Mean decreased level O₂ saturation ≥ 2%</td>
<td>19</td>
<td>9.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-EMG</td>
<td>203</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak S-EMG value (mV)</td>
<td></td>
<td>0.35</td>
<td>0.38</td>
<td></td>
</tr>
<tr>
<td>Average S-EMG activity (mV)</td>
<td></td>
<td>−0.00034</td>
<td>0.00300</td>
<td></td>
</tr>
<tr>
<td>EMG duration (sec)</td>
<td></td>
<td>13.26</td>
<td>9.88</td>
<td>3.84–79.32</td>
</tr>
</tbody>
</table>

**Note.** S-EMG = surface electromyography.
swallowing items and decreased SaO\(_2\) values was not statistically significant (Table 6).

**Discussion**

Results of the swallow questionnaire, swallow assessment, and swallowing test identified a 9.5% prevalence of impaired swallowing among study participants. This rate was similar to the 11.4% identified in another study that asked participants to self-evaluate their swallowing difficulties in mailed questionnaires (Holland et al., 2011) and less than the 13.7% reported in Turley and Cohen’s 7-point Likert scale study of dysphagia severity in retired older adults (Turley & Cohen, 2009). Holland et al.’s (2011) self-reported impaired swallowing rate of 11.4% is less than the 19.2% self-reported rate in our study. However, the actual rate of impaired swallowing in our study was 10.5–11.15%, as evaluated by the questionnaire, physical examinations, and swallowing test. The actual rate in our study was similar to that in Holland’s study. Our self-reported impaired swallowing question used a yes–no question format rather than Holland’s (2011) structured guidance format. Our study was more likely to overestimate the impaired swallowing rate, because participants were asked to describe swallowing functions subjectively rather than in terms of objective, medically defined clinical symptoms. Also, this study’s use of a convenience sample from one district in Taipei City may bias findings. Future research may expand the scope of recruitment to improve generalizability of findings.

Logistic regression analysis showed age to be an important predictive variable. When age and the other two independent variables (i.e., gender and peak S-EMG values) were used in the regression model, the variance explained by age was significantly higher than the other two variables. Therefore, age was a predictor of impaired swallowing. Such infers that participant age correlates negatively with swallowing function, a result similar to that of Ding et al. (2003). We also found muscle activation of the submental muscles to take longer in older than younger participants. Submental and infraphyoid muscle activation and onset times differed in participants of different ages.

We found an impaired swallowing rate of 9.5% among community-dwelling older adults without neuromuscular diseases. It would be reasonable to expect a higher rate if we included participants with diseases known to be associated with impaired swallowing. As findings support that swallowing function decreases with age, the swallowing test should be

**TABLE 4.**

*Results of the Association Test Between Impaired Swallowing and Change in SaO\(_2\) (N = 206)*

<table>
<thead>
<tr>
<th>Item</th>
<th>SaO(_2) Change &gt; 2%:</th>
<th>Kappa</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-reported impaired</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>swallowing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>18</td>
<td>146</td>
<td></td>
</tr>
<tr>
<td>Score for impaired</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>swallowing &gt; 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>5</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>14</td>
<td>153</td>
<td></td>
</tr>
<tr>
<td>Swallowing speed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 4.22 ml.s(^{-1})</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>4</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>15</td>
<td>169</td>
<td></td>
</tr>
<tr>
<td>Coughing during swallow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>18</td>
<td>191</td>
<td></td>
</tr>
<tr>
<td>Impaired swallowing items</td>
<td></td>
<td></td>
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<tr>
<td>≥ 2</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Yes</td>
<td>3</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>16</td>
<td>173</td>
<td></td>
</tr>
</tbody>
</table>

*p < .001.

**TABLE 5.**

*Logistic Regression of Impaired Swallowing Variables and Model Fit*

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE</th>
<th>Wald</th>
<th>df</th>
<th>p</th>
<th>Odds Ratio</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>-0.955</td>
<td>0.670</td>
<td>2.028</td>
<td>1</td>
<td>.154</td>
<td>0.385</td>
<td>[0.103, 1.432]</td>
</tr>
<tr>
<td>Age</td>
<td>0.102</td>
<td>0.038</td>
<td>7.226</td>
<td>1</td>
<td>.007</td>
<td>1.107</td>
<td>[1.028, 1.192]</td>
</tr>
<tr>
<td>Peak S-EMG</td>
<td>-0.836</td>
<td>0.821</td>
<td>1.035</td>
<td>1</td>
<td>.308</td>
<td>0.434</td>
<td>[0.087, 2.168]</td>
</tr>
<tr>
<td>Constant</td>
<td>-9.448</td>
<td>2.880</td>
<td>10.761</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall model fit</td>
<td>(\chi^2)</td>
<td>9.499*</td>
<td></td>
<td></td>
<td></td>
<td>11.275</td>
<td></td>
</tr>
</tbody>
</table>

*\(\chi^2\) = 9.499*  Hosmer–Lemeshow test value = 11.275
included in regular community-dwelling elderly care programs to facilitate early identification and intervention. This study found a rate of abnormal peripheral blood oxygen concentration of 9.2% among participants, a rate similar to that for impaired swallowing. The kappa value was 0.307 (p < .001) in agreement analyses for participants with greater than two confirmed impaired swallowing items and a larger than 2% decreased SaO₂ value, indicating a high correlation between impaired swallowing and decreased SaO₂ value. Causal pathway analysis of variables showed the predictive power of age on impaired swallowing. Despite the high level of agreement between impaired swallowing and decreased SaO₂ value, these two variables did not significantly contribute to the regression model. This may be due to the insufficient sensitivity and stability of pulse oximetry in measuring blood oxygen concentration in peripheral arteries. Saber, McCarthy, and Schilz (2000) reported false negative findings when using pulse oximetry to measure blood oxygen concentration in the peripheral arteries. Ramsey et al. (2003) reported a correlation coefficient of 0.82–0.99 between blood oxygen concentrations measured by pulse oximeter and those measured with an oxygen analyzer. However, they warned of false negative findings when using peripheral arterial pulse oximeter alone and suggested using the oximeter in combination with other swallowing tests to increase sensitivity. Smith, Lee, O’Neil, and Connolly (2000) also recommended combining the oximeter with other assessment methods to evaluate impaired swallowing. Although pulse oximeter is a convenient and easy screening tool for evaluating community-dwelling participants, its accuracy needs to be strengthened.

The coughing response during the water test differed significantly from the impaired swallowing score. This indicates that the coughing response during water test is an immediate abnormal neuromuscular discoordination response. Coughing is considered as an important index of swallowing abnormality. In addition, the slower swallowing speed observed in more senile participants may be related to the degeneration of neurological swallowing functions. This result is similar to the findings of Ding et al. (2003). In addition, elderly participants tend to reduce swallowing speed to decrease coughing risk when asked to drink fast. Other factors contributing to slower swallowing speed may be the popularity among community-dwelling older adults in Taiwan of drinking tea. Slower swallowing speed may be attributable to our use of water in the test. Also, many participants wore removable dentures, with some of them experiencing denture-gum discomfort because of gum atrophy. Such discomfort may interfere with drinking ease and swallowing speed. Another contributing factor may be that fluid water is not easy for food bolus formation in the oral cavity, which creates additional oral–laryngeal coordination challenges for the older adults while swallowing.

Conclusions

Increased age correlates with increased degeneration of swallowing functions. The VFS is limited in its ability to diagnose degree of swallowing impairment in older adults. Therefore, we suggest clinical healthcare workers to adopt simpler testing methods to assess elderly and disabled populations. Whereas the S-EMG would be difficult for frontline healthcare worker to adopt and use, the swallow questionnaire, examinations, oximetry, and 90-ml water test are all convenient and efficient tests for healthcare workers to use. Such tools are worth promoting and applying in the clinical environment. Finally, we consider the development of measurement instruments used to assess swallowing functions and swallow training outcomes to be the evaluation index of swallow function and effectiveness.

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以非影像方式評估台灣社區老人之吞嚥障礙

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背 景 吞嚥障礙常出現於腦神經功能損傷、退化性疾病以及老年病患者，社區老人的吞嚥問題應用簡易精確的評估方式確認其吞嚥障礙，及早提供吞嚥照護計畫，以提升居家長者的生活品質。

目 的 透過簡易吞嚥評估方式，以非影像方式評估社區高齡個案吞嚥功能及估計吞嚥障礙盛行率。

方 法 採調查研究法，主要評估工具為吞嚥檢查及問卷量表，吞嚥測試以及末梢動脈血氧飽和分析器與喉部表面肌電圖等，以瞭解高齡族群吞嚥功能及其吞嚥障礙盛行率。研究對象為台灣北部某行政區年齡大於65歲以上之社區民眾，進行吞嚥評估，共收案216位。

結 果 以吞嚥問卷檢查及吞嚥測試（water test）進行吞嚥功能檢測發現，吞嚥障礙比率為9.5%。以年齡區分發現，四組比較年齡大其吞嚥速度越緩慢。One-way ANOVA分析四組別之吞嚥速度達統計顯著差異（F = 6.478, p < .00），以Scheffe事後比較發現，吞嚥時間在年齡60－69歲與70－79歲、80－89歲組間有統計之顯著差異。吞嚥障礙與研究變項之複迴歸分析發現，年齡標準化相關係數為0.163，達統計之顯著差異（r = 2.328; p = .021）。羅吉式迴歸統計分析自變項中年齡的Wals檢定值達統計之顯著差異（p = .007）；而吞嚥障礙與SaO2下降＞2%同意度分析Kappa = 0.307。

結 論／實務應用 年齡越大學吞嚥功能越容易退步，本研究結果能提供台灣社區老人發生吞嚥障礙比率，可作為臨床護理指引並提供評估吞嚥障礙客觀性之參考。

關鍵詞：社區老人、吞嚥障礙、吞嚥評估。

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