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THE EFFECTS OF AGING ON OROPHARYNGEAL SWALLOW DURATION IN NONDYSPHAGIC WOMEN

By

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ABSTRACT

THE EFFECTS OF AGING ON OROPHARYNGEAL SWALLOW DURATION IN NONDYSPHAGIC WOMEN

By

Ruth Renee Hannibal

In order for speech-language pathologists to understand how to diagnose and effectively treat dysphagia, it is imperative that they have a thorough understanding of the normal swallow. This cross-sectional research study was designed to examine whether aging influenced nondysphagic women's swallowing status and whether nondysphagic women's perceptions aging and swallowing changed as people aged. In addition, this study examined whether the use of cervical auscultation was reliable in detecting changes in normal swallowing sounds as women age.

Fifty-five adult women distributed in three different age groups were participants: Group 1(20-29), Group 2(40-49), and Group 3 (60-95). The participants completed a Medical Health Questionnaire which indicated normal oropharyngeal swallowing history and which ruled out any conditions that would likely contribute to dysphagia.

Chi-square analysis of the Swallowing Status Questionnaire (questions SSQ1-SSQ7) revealed that across groups there was a significant difference between the responses given as "rarely" compared to any of the other responses. The vast majority of participants regardless of age, reported to have

no difficulty with chewing and swallowing skills. In addition, the response between the three age groups on any of the seven questions indicated no significant differences. Thus, the participants perceived their eating and drinking skills to be normal. Regarding their perceptions of aging on swallowing, the youngest group indicated that aging would likely affect one's ability to chew and swallow, while the remaining two groups reported that aging did not affect ones' chewing and swallowing abilities.

To determine reliability using cervical auscultation, participants completed three trials of liquids (5cc) and three cracker trials during both the training period and the experimental study. Results of the training period revealed inter-rater reliability was 100%. Reliability during the study revealed the investigator judged all 60 swallowing sounds to be normal. The rater judged the first 24 sounds as 'unable to detect'. While the investigator and rater did not agree on any of the first four participants' swallow sounds, the raters had perfect agreement with the remaining six participants. Thus, cervical auscultation was viewed as a reliable screening adjunct to the clinical swallowing examination.

Thanks family and friends for your prayers and support throughout this process

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CHAPTER I

INTRODUCTION

Deglutition is defined as "the act of swallowing" (Dirckx, 2001, p. 253). It may be initiated voluntarily or involuntarily (Murray & Carrau, 2001). Miller (1986) specifically described deglutition as "the semiautomatic motor action of the muscles of the respiratory and gastrointestinal tracts to propel food from the oral cavity to the stomach" (p. 91). The study of the normal swallow is important because of issues related to the quality of life, morbidity, and mortality (Horner & Massey, 1988). It is also important to the natural enjoyment of foods and liquids. When dysphagia (a swallowing disorder) occurs, the quality of life may change in a number of ways such as aspiration (which may lead to aspiration pneumonia) and dehydration and malnutrition (which may lead to weight loss).

The normal swallow is a complex physiologic process that results from interacting cranial and parasympathetic nerves and skeletal and smooth muscles (Bass, 1997; Cherney & O'Neill, 1986; Crary & Groher, 2003). Swallowing requires over 40 pairs of muscles that must be coordinated and work smoothly together in order to ensure a safe and efficient swallow (Bass, 1997; Perlman & Christenen, 1997). During the normal swallow, food is propelled from the oral cavity to the stomach safely and efficiently. The motor action of swallowing removes secretions and particles from the upper respiratory tract and protects the tract from aspiration (Bass, 1997; Dray, Hillel, & Miller, 1998; Miller, 1986).

The normal swallow, however, can become compromised or interrupted because of symptoms such as reduced tongue base control, reduced pharyngeal

contraction, cricopharyngeal dysfunction, or esophageal diverticulum. Although there are many symptoms and disorders of deglutition, the prevalence of dysfunction for the entire United States (U. S.) population is unknown (Cherney, 1994; Crary & Groher, 2003; Kuhlemeir, 1994). Researchers are continually confronted with the challenge of determining appropriate definitions and parameters for normal deglutition. There are several reasons for this problem, as explained by Massey and Shaker (1997). First, there are no universally accepted criteria for defining what is normal. "There are plenty of aspects of deglutition in which there is no gold standard for, or even overwhelming consensus about, what is normal" (p.7). A second critical issue is the sample size of the reference group for determining normalcy. A third issue is the "generalizability of the normal range for a measured parameter to different study conditions" (p. 7)

The field of communication disorders has advocated for normative data on swallowing and the inclusion of professional education and training at the undergraduate and graduate levels. To ensure proficient diagnosis and treatment of dysphagia, the study of deglutition should be included in the curriculum at both the undergraduate and graduate levels (Logemann, 1997). She noted that because 30% to 90% of a speech-language pathologist's (SLP's) time in health care settings is spent working with dysphagic patients, he/she should have a thorough understanding of the upper aerodigestive tract, respiration, and dysphagia in order to diagnose and treat dysphagia. Serious problems such as pneumonia and aspiration can further complicate the patient's health status.

As the population of the United States continues to increase and to age, and because of demographic changes, there is a need to conduct studies on the effects of aging in healthy elderly adults across the adult lifespan. Rademaker, Logemann, Pauloski & Colangelo (1998) indicated the need to establish norms of the normal swallow across the adult lifespan in order to provide the knowledge base needed for diagnosing and treating dysphagia. The U.S. population is getting increasingly older. The number of older Americans will rapidly increase between 2010 and 2030 when the "baby boomers" reach age 65. Data since the 1930's shows that women's life expectancy has been longer than men. In 1991, there were 19 million women and 12.8 million men over 65 years of age, corresponding to a gender ratio of 148 women to every 100 men (Lueckenotte, 2000). Since women outlive men, they will require more services by numerous health care professionals, including speech-language pathologists. Thus, the inclusion of women in research studies is important.

Statement of the Problem

Normal swallowing is a complex process. It can, however, become compromised secondary to a number of age-related changes such as arthritis or cervical osteophytes, laryngeal pathology such as carcinoma, or esophageal pathology such as Zenker's diverticulum or esophagitis. Additionally, structural changes due to surgery or prolonged intubation can cause swallowing disorders.

Studies have suggested that there are changes in the oral motor function of the elderly and that older individuals take more time to chew and prepare a bolus for a consistency that is easier to swallow (Sonies, Baum & Shawer, 1984).

Further, swallowing begins to slow around age 45 and is significantly slower by age 70 (Robbins, Hamilton, Loft & Kempster, 1992). Because normative data and changes in the oral and pharyngeal stages of swallow across the life span in women are lacking, new studies are needed to accurately diagnosis and treat dysphagia effectively in this population.

The speech-language pathologist should "have a large, integrated knowledge base as well as many attributes, skills, and competencies to work effectively and safely with a range of dysphagic patients" (Logemann, 1997). Videofluoroscopic Swallow Study (VFSS) and Fiberoptic Endoscopic Examination of Swallowing (FEES) are two instruments that provide imaging of the oropharyngeal areas in swallowing and used to diagnosed dysphagia. Videofluoroscopy is the most frequently used instrumental procedure for evaluating deglutition and oropharyngeal dysphagia (Logemann, 1998; O'Donoghue & Bagnall, 1999). It is considered the "gold standard" for assessing oropharyngeal function during swallowing because it permits the imaging of rapid dynamic movements of swallowing (Arvedeson & Lefton-Grieft, 1999; McCullough, Wertz, Rosebek, & Dinneen, 1999; Perlman, 1997; Daniels, MCAdams, Brailey & Foundas, 1997; Ekberg & Feinberg, 1991; Dodds, Steward & Logemann, 1990).

The clinician should become more knowledgeable about the purpose and function of each instrument in order to choose which instrument would give the best objective information needed in the diagnosis and treatment of swallowing dysfunction (Logemann, 1998). Each instrument has its own strengths and

weaknesses (Mills, 2000). Advances in technology have given clinicians and researchers a better understanding of complex and physiologic biomechanics of the swallow mechanism (Perlman, 1997; Sonies & Baum, 1988; Sonies, 1997). Logemann (1998) reported that videofluoroscopy enables visualization of (1) the oral cavity during chewing and the oral stage of swallowing; (2) the triggering of the pharyngeal swallow in relation to position of the bolus; and (3) the motor aspects of the pharyngeal swallow, including movements of the larynx, hyoid, tongue base, pharyngeal walls, and cricopharyngeal region (pp. 60-61). With videofluoroscopy, the clinician can observe the movement of a bolus in sagittal and antero-posterior positions. Further, VFSS allows the clinician to analyze information frame-by-frame and follow the path of the bolus from the oral cavity via the esophagus to the stomach. Kendall, McKenzie, & Leonard (1997) indicated that "Objective data can also facilitate interpretations of greater subtlety; increasing our understanding of swallow dynamics and leading to more tailored and appropriate interventions" (p. 101).

Although videofluoroscopy is the "gold" standard for evaluating the swallow mechanism, it is also a costly procedure. Aviv et al. (2000) conducted a study designed to determine cost effectiveness of two instruments used to diagnose dysphagia: the modified barium swallow (MBS) procedure and flexible endoscopic evaluation of swallowing with sensory testing (FEEST) in 30 hospital head and neck cancer patients. The patients ranged in ages from 50 to 80 years. Half of the patients were diagnosed by MBS and half by FEEST. Results revealed the MBS generated 40% more reimbursement ($451.00) than did the

inpatient first consult using FEEST ($321.23). Further, other cost factors must be considered such as the number of personnel required (e.g., persons who transport patients, radiologists, radiology technicians) and their salaries. Additionally, equipment cost and repair, overhead, and disposal supplies such as barium and x-ray film contribute to the overall costs of these procedures.

With the rise in health care costs, many medical facilities have sought different avenues to provide quality services in cost effective ways. Cervical auscultation is a noninvasive clinical process that is gaining recognition and credibility among speech-language pathologists as a means of detecting clinical signs of dysphagia (Cichero & Murdoch, 2002; Cichero & Murdoch, 1998; Nilsson, Ekberg, Olsson, Kjellin & Hindfelt, 1996; Hamlet, Penny & Formolo, 1994; Takahashi, Groher & Michi, 1994a; and Takahashi, Groher & Michi, 1994b). A variety of instruments have been used (e.g. accelerometer, a sonograph with Doppler, a laryngeal microphone, and a stethoscope) placed at specific sites (trachea or larynx) to detect acoustic data about the swallow (Zenner, 2000). The most widely used instrument in cervical auscultation is the stethoscope. It is inexpensive and can be performed at bedside by a health care provider trained in listening to swallowing sounds.

The U.S. demographics show that women outlive men; therefore, they will rely more on the medical profession as they age. With changes in body mass, increased risk of osteoporosis and changes in health care policy, there is a need to study the variability of normal swallowing of women across the life span.

Historically, women have not been included in biomedical and longitudinal research. The Baltimore Study Longitudinal Study began in 1958 and was a pioneer study that provided information concerning the elderly. One limitation to that study was that the data were based on findings from a male population and generalizations were made to women and minorities. It was not until the 1980s that women were included in the study (Ebersole & Hess, 1998). When the U.S. demographics are taken into consideration, the 2000 census reported that there were 14.4 million men and 20.6 million women who were age 65 and over putting the male-female ratio at 0.7:1 (Hetzel & Smith, 2000). Overall, the male-female ratio decreases as age increases. In the 65-to-74 age group, the male-female ratio was 0.82:1 while in the 75-to 84 age group it was 0.65:1. For the old-old group, 85 years and older, the male-female ratio was 0.41:1. To address the lack of studies with women and minorities, NIH (1994) issued guidelines for including women and minorities in clinical research. Specifically, it states that "It is important, however, that women and minorities be included in clinical research if scientists are to make valid inferences about health and disease in these groups (National Institutes of Health, NIH Publication No. 97-4160, 1994, p.14). Because normative data of the changes in the oral and pharyngeal stages of swallow across the life span in women are lacking, new studies are needed to accurately diagnose and effectively treat dysphagia.

With the increased number of elderly who have dysphagia and related illnesses, cost containment is a factor in patient care. Therefore SLPs must be innovative and knowledgeable about using noninvasive methods in addition to

VFSS and FEES to evaluate dysphagia. Changes in Medicare reimbursement have prompted many facilities to be vigilant about providing quality services to their patients in a cost effective way. In many settings such as long-term care facilities, the use of videofluoroscopy is limited due to such factors as patient's medical status and/ or location of a facility. There is a growing need in the area of dysphagia management to use noninvasive methods such as cervical auscultation as an adjunct to the clinical swallowing examination as a means of qualifying, quantifying, and detective clinical signs of dysphagia (Cichero & Murdoch, 2002; Cichero & Murdoch, 1998; Nilsson, Ekberg, Olsson, Kjellin & Hindfelt, 1996; Hamlet, Penny & Formolo, 1994; Takahashi, Groher & Michi, 1994a; and Takahashi, Groher & Michi, 1994b).

Purpose of the Study

A prerequisite to evaluating the nature and extent of dysphagia in persons with swallowing disorders is to understand the nature of swallowing in persons without swallowing disorders. This study addressed the following questions: (1) Does aging change nondysphagic women's swallowing status across the adult age span? (2) Does aging change nondysphagic women's perceptions of swallowing as they age? and; (3) Is cervical auscultation a reliable screening adjunct to the clinical swallowing examination?

CHAPTER II

REVIEW OF THE LITERATURE

This chapter provides an extensive review of literature and research concerning deglutition. It is divided into sections that are relative to (1) normal swallow, (2) effects of aging on normal swallow, (3) neurogenic swallowing, (4) the Clinical Swallowing Examination, and (5) cervical auscultation. Schecthter (1998) reported that "the act of swallowing is the most intricate neuromuscular action carried out in the body" (p. 525). It includes "an integrated interdependent group of complex feeding behaviors emerging from interacting cranial nerves of the brainstem and governed by neural regulatory mechanisms of the medulla as well as in sensorimotor and limbic cortical systems" (Bass, 1997, p.7).

To provide accurate diagnosis and appropriate treatment of pathologic swallowing, the SLP must understand the neuromuscular controls of normal swallow (Perlman & Christensen, 1997) and have a thorough understanding of the normal function of the upper aerodigestive tract (Logemann, 1983; 1997; 1998). In the healthy adult, the chewing and swallowing sequence is performed by highly intricate coordination of the muscles and cranial nerves involved in swallowing. An individual can talk, chew, and drink liquids all at the same time while a portion of the food is held in the mouth (Bass, 1997).

When dysphagia occurs, the individual's quality of life may change. Individuals may experience coughing, choking, and aspiration during meals. When an individual has frequent episodes of aspiration and an inability to expel foreign material, the quality of life may be diminished (Murry & Carrau, 2001).

Individuals may be able to cough and protect the airway of the aspirant. Although the cough is one of the most important mechanisms for airway protection and maintenance (Murray, 1999), it should be noted that it may not always be a reliable indicator of dysphagia in those individuals with decreased sensitivity to pharyngeal problems or those with compromised health issues.

When pulmonary infections occur because of chronic and acute aspiration and/or resultant pneumonia, a decrease in health status occurs. Patients with neurologic impairments often have difficulty swallowing liquids and ingesting food safely and efficiently. When individuals do not ingest enough liquids or when they have difficulty swallowing liquids, a negative fluid balance results (dehydration). When a person does not safely ingest enough food for nutritional needs because of neurologic disease or other swallowing disorders, dehydration and malnutrition may occur which lead to weight loss and can be severe enough to cause weakness leading to decrease in activities that are performed routinely and on a daily basis (activities of daily living, Dirckx, 2001). Thus, continuous weight loss may be an indication of a swallowing disorder (Murry & Carrau, 2001).

Normal Swallow

The normal swallow is a complex, physiologic action. It requires integration and execution of neural and muscular events and intact anatomy. The normal swallow is a continuous motor action of food being propelled from the oral cavity to the stomach. Accurate diagnosis and appropriate treatment of dysphagia first requires that the SLP has an understanding of the neuromuscular controls of the normal swallow (Perlman & Christensen, 1997).

The upper aerodigestive tract is "a series of tubes and valves that must open or close at appropriate times during the swallow" (Logemann, 1997, p. 232). The upper aerodigestive tract consists of the nasal cavity, oral cavity, pharynx, larynx, and cervical esophagus. It serves three functions: respiration, swallowing, and speaking (Logemann, 1997). The nares, at the base of the external nose, allow access to the nasal cavity. The nasal cavity is primarily responsible for the passage of air. The velopharyngeal valve (the entry to the nose from the pharynx) is normally closed during swallowing.

The oral cavity consists of the lips anteriorly, teeth, hard and soft palates, uvula, faucial arches, tongue, the palatine tonsils, and mandible. The lips are responsible for keeping food and liquids in the mouth during chewing and swallowing. The teeth assist in bolus formation. The tongue, divided into oral and pharyngeal portions, has a role in swallowing and speaking. The pharyngeal tongue, extending from the soft palate to the hyoid bone and valleculae, applies pressure to the food bolus and propels it posteriorly to the esophagus (Logemann, 1998).

The larynx, trachea, bronchi, and lungs are situated superiorly to the airway. The larynx serves three basic functions: protection, respiratory, and phonatory (Sasaki & Isaacson, 1988). Its primary biologic function is that of protecting the airway during swallowing. Three valves in the larynx are responsible for closing during the swallow: the true vocal folds, the arytenoid cartilages (with the false vocal folds and the base of the epiglottis), and the

epiglottis (Logemann, 1997). When the larynx is closed, it protects foreign matter from entering the airway.

The pharynx lies at the confluence of the upper digestive and respiratory tracts which allows for airflow during respiration and for bolus flow during deglutition. The pharynx closes briefly during swallowing. It is located behind the nose, mouth, and larynx (Bass, 1997) and consists of the superior, medial, and inferior pharyngeal constrictors. The pharyngeal constrictors form the pyriform sinuses which, along with the vallecula, are known as the pharyngeal recesses. These recesses form the normal pathway for food to pass through the pharynx during swallowing. During deglutition, the pharynx moves the bolus from the oral cavity into the esophagus without allowing nasal regurgitation or aspiration into the lungs. Normal flow of bolus is aboral and abnormal if retrograde (Siebens, 1990).

Stages of Normal Swallow

Although normal swallow is divided into four stages (oral preparatory, oral, pharyngeal, esophageal), it is best understood as one integrated behavior with four distinct components. It is a continuous motor action of food or liquids being propelled from the oral cavity to the stomach. The normal swallow will be discussed in the aforementioned four stages.

Oral Preparatory Stage

The oral preparatory stage, the initial stage of the swallowing process, begins when the liquid and/or food bolus is brought to the mouth for mastication and deglutition. If the material is for the purpose of mastication, it must be mixed

with saliva in preparation for bolus formation and flow. Mansson and Sanburg (1975) indicated that there must be an adequate amount of saliva in the oral cavity for preparation of "dry swallow" and bolus formation. Once the food is placed in the mouth, a lip seal is formed by action of the orbiculais oris, buccinator muscles and by placement of the tongue tip against the alveolar ridge by the genioglossus. The orbicularis oris, buccal tone, genioglossus action and oral cavity pressure prevent drooling and keep the bolus from falling into the anterior and lateral sulci as the pressure in the oral cavity increases.

Logemann (1993) indicated that the action of the tongue (which is complimented by the masseters, temporalis, and internal and external ptyergoid muscles) collects the food onto the teeth for mastication, retrieves the bolus from the teeth, mixes it with saliva to form a cohesive bolus, and then returns it to the teeth. The intrinsic muscles of the tongue facilitate mastication of the bolus. The food is chewed in a lateral rotary fashion. Lingual shaping brings the food and liquid together on the dorsal tongue before sealing it against the hard palate.

The contraction of the palatoglossus muscles lowers the soft palate to the tongue and forms a seal to prevent the material from prematurely spilling into the pharynx. During this time the larynx and pharynx are at rest. Nasal breathing continues until the voluntary swallow is initiated (Logemann, 1983). Toward the end of the oral preparatory stage, the tongue brings the food together in a bolus. The oral preparatory stage is under voluntary and cognitive control (Cherney, 1994; Hardy & Robinson, 1993; Lazarus, 1989; Logemann, 1993). Additionally,

this stage, along with the oral stage, is sensitive to abnormalities of cognition and/or behavior changes.

Oral Stage

The oral stage of normal swallow begins when the bolus is transported posteriorly in the oral cavity, and triggers the pharyngeal swallow. Structures involved in manipulation of the food bolus are the teeth, tongue, lips, jaw, soft palate, muscles of mastication and buccal muscles. The primary muscles involved in chewing are the masseters, temporalis, and pterygoid muscles (Bass, 1997). The major responsibility of the massester is to close the jaw while the temporalis moves the jaw up, forward, or backward. The pterygoid muscles and the temporalis muscles elevate the velum (Perlman & Christensen, 1997). The lateral pterygoid muscles depress the mandible during mastication. Both sets of pterygoid muscles work together in food mastication (Bass, 1997; Perlman & Christensen, 1997; Corbin-Lewis, Liss, Sciortino, 2005).

Lingual mixing continues by action of the intrinsic muscles for the purpose of bolus formation. The tongue elevates to the hard palate to move the bolus posteriorly in an anterior-posterior rolling action. Anterior-to-posterior elevation of the tongue squeezes the bolus toward the pharynx by contraction of the genioglossus, geniohyoid, hyoglossus, anterior and posterior digastricus, stylohyoid, and styloglossus muscles. Elevation of the velum by the levator veli palatini, superior pharyngeal constrictor, and palatopharyngeus muscles, seals the nasopharynx (Siebens, 1990). When the bolus reaches the anterior faucial arch region, the oral stage ends and the pharyngeal stage begins. The oral

stage usually takes 1.0-1.5 seconds to complete (Logemann, 1998) and is under voluntary control.

Pharyngeal Stage

Once the pharyngeal stage of swallow begins at the anterior faucial arch region, the anterior portion of the tongue is retracted and depressed, mastication ceases, and respiration is inhibited momentarily (Bass, 1997). This stage, which takes approximately one second, is under involuntary control. Any abnormality in laryngeal structures operating correctly can cause morbidity. As the bolus enters the pharynx, the leading edge fills the vallecular space; the epiglottis begins to tilt, and thyrohyoid movement at C1-C3 cause elevation of the hyoid bone and larynx. "As the hyo-laryngeal complex elevates, the floor of the pharynx elevates with it resulting in a shortening of the pharynx" (Murray, 1999, p. 124). Once the swallow has been initiated, the tongue prevents food from reentering the oral cavity, while the soft palate contracts and elevates resulting in the closure of the velopharynx. The airway is sealed by action of the intrinsic laryngeal muscles. The relaxation of the cricopharyngeus muscle, together with the passive opening of the upper esophageal sphincter, allows the bolus to pass into the esophagus. The sphincter then closes, and the pharyngeal structures return to their original position (Cherney, 1992, 1994; Hardy & Robinson, 1993; Palmer, Drennan & Baba, 2000; Spieker, 2000).

Esophageal Stage

During the esophageal stage the bolus is propelled downward by a peristaltic wave which is under involuntary neural control (Logemann, 1988). The

lower esophageal sphincter relaxes and allows the bolus to move through the distal esophagus (Cherney, 1992; Cherney & O'Neill, 1986; Palmer et al., 2000; Schnechter, 1998; Spieker, 2000). Studies show that the range of duration for bolus travel through the lower esophagus is between eight to 20 seconds in adults (Logemann, 1993).

Effects of Aging on Normal Swallow

"Aging is a highly individualized process that affects each person in unique ways" (McConnell, 1997, p.7). Normal age-related changes in the oropharyngeal area can affect chewing and swallowing (Logemann, 1993). Aging alone does not cause swallowing problems severe enough to interfere with functional swallowing (Cherney & O'Neill, 1986); however, some age-related changes might slow the swallowing process (Robbins, Hamilton, Lof, & Kempster, 1992). Madison stated that "human aging is influenced by a composite of biologic, psychologic, social, functional, and spiritual factors" (p.20). Since every individual is different, the course of aging varies from individual to individual.

The biologic theory of aging suggests that there are physiologic changes in the body's structure and function that occur over the lifespan. The age-related changes occur independently of any external or pathologic influence (Madison, 2000, p. 21). These biologic theories of aging raise questions about factors that trigger the aging process.

Additionally, the sociologic theories tend to look at the social adaptations individuals make as they grow older. The circumstances usually determine how each individual will respond to societal pressures.

Lueckenotte (2000) stated that while a biologic theory is concerned with physiological processes, the psychologic theory of aging refers to how the individual copes with the environmental and biologic changes that occur throughout life. Such changes might affect learning capacity, memory, feelings, and intellectual function. The psychologic theory is influenced by both biologic and sociologic aging factors.

While there are systemic changes that occur throughout the lifespan, there are also localized changes that occur in the oropharynx and esophagus that may lead to pathologic conditions. Robbins et al. (1992) contend that swallowing may have age-related, physiologic, or iatrogenic causes.

With reference to age-related changes and nutritional status, Granieri (1990) divided the effects of aging into primary, secondary, and tertiary types. Primary effects occur as a result of the normal aging process, and secondary effects result from disease process. Tertiary effects are related to psychological, environmental, and social factors and changes, which can impact oral intake and place the older person at increased risk for illness and changes in swallowing physiology. Hudson & Mills (2000) and Sheth & Diner (1988) reported that the ability to chew is unaffected by age but is affected by poor dentition, tooth loss or dental prosthetics, and atrophy of the alveolar ridge.

Oral Cavity Changes

While many studies in the field of dysphagia focus on the pharyngeal phase of swallow because of aspiration risks, few have examined the oral phase and its effects on swallowing. The oral system is composed of flexible and rigid

tissues (Hudson & Mills, 2000). The teeth, mandible, maxilla, temporomandibular joint (TMJ), and hard palate comprise the rigid elements. The soft palate, muscles of mastication and tongue comprise the flexible elements. The increased prevalence of dysphagia in the elderly could be attributed to loss of motor activity in the oral cavity, pharynx, and larynx. In addition, there also may be a progressive decrease of sensory capacity in the laryngopharynx with increasing age (Aviv et al., 1994).

Changes in tongue position and movement are sometimes altered in older individuals. Atrophic tongue muscles can lead to decreased oral intake and may affect ingestion and enjoyment of food (Logemann, 1990). With changes in the tongue, persons may experience difficulty in bolus formation before propelling the food posteriorly to initiate swallow. Labial posture and weakness can also occur with aging and cause spillage of material from the oral cavity.

To form a bolus, material must be mixed with saliva (Logemann, 1998). Johnson and Scott (1993) noted the seven functions of saliva: (1) protect the teeth and gums and assist with oral hygiene, (2) lubricate food to assist with chewing and form food into a bolus for ease of swallow, (3) lubricate the tongue and lips during speech, (4) facilitate taste, (5) destroy micro-organisms and clear toxic substances, (6) initiate carbohydrate digestion and, (7) regulate acidity in the esophagus (p.1). Additionally, decreased salivary flow may lead to xerostomia (dry mouth) and result in difficulty with mastication and swallowing (Donner & Jones, 1991). Although xerostomia associated with normal aging has

been reported, age-related salivary dysfunction has not yet been supported by research (Linton, 1997).

Xerostomia occurs in approximately 20% of the population at or above 65 years of age (Linton, 1997). Xerostomia can lead to many different problems in the oral cavity including impeded bolus lubrication, mastication, bolus flow, and decreased oral mucosal and dental health (Leonard, Kendall, Mckenzie & Goodrich, 1997). Because of poor bolus flow, residue can remain on the surface of the tongue and palate and in pharyngeal crevices, placing the individual at risk for post swallow aspiration. Further, with concomitant xerostomia oral residue increases bolus viscosity which increases aspiration risk.

There are numerous causes of xerostomia which include (1) obstructive nasal diseases that promote mouth breathing; (2) drugs (i.e. antidepressants, anticholingerics, decongestants, diuretics, antihypertensives, antineoplastics, antipsychotics); (3) vitamin B complex deficiency; (4) diabetes; (5) dehydration; (6) anxiety; and (7) fear (Ebersole & Hess, 2000; Linton, 1997; Leonard, Kendall, McKenzie & Goodrich, 1997). Several of the above are the result of multiple medications (whether prescribed or over the counter) secondary to acute and chronic illnesses. Ebersole and Hess (2000) further contend that other causes of xerostomia include radiation therapy (of the head and neck for tumors), blockage of salivary ducts, parotid gland fibrosis, primary or secondary Sjogren's syndrome, defective sensory receptors, and/or impaired cognition (p. 223).

In addition to xerostomia, other causes of oral cavity changes in the elderly include temporomandibular joint pain, periodontal disease, tooth loss,

burning and painful tongue, oral lesions and root caries (Linton, 1997). Individuals affected by dry mouth may experience altered taste sensation, which can lead to poor oral intake and weight loss, increased oral pain, dysphagia, and an inability to clear bacteria that cause caries. Additionally, oral ulcers may develop if the individual wears dentures and has decreased lubrication.

Oro-dental health is important for all individuals across the lifespan and is of particular importance for the elderly (Ebersole & Hess, 2000). Dental health of the elderly is often neglected because it is assumed that older individuals are edentulous. Tooth loss, however, is not a natural part of the aging process (Ebersole & Hess, 2000). In addition to oral health, it is important to look at dental factors that can contribute to poor oral health. Poor oro-dental status can lead to tooth loss, decreased eating pleasure, poor communication skills, and compromised oral hygiene, which can put the elderly at risk for malnutrition. Further, loss of teeth limits food choices (Ebersole & Hess, 2000).

Ebersole and Hess (2000) reported changes in the buccal cavity that occur during the aging process. These changes include (1) teeth becoming brittle, drier, and of darker color; (2) loss of enamel covering which may cause teeth to become loose (because of bone loss resorption or a breakdown of the supporting tissue); (3) gum recession; (4) reduced gingival vascularity; (5) periodontal tissue loss; (6) alveolar bone atrophy; (7) periodontal disease; and (8) uneven teeth secondary to years of crushing and grinding wear. In addition to tooth loss, an individual may find it difficult to chew certain foods because of poor dentition, ill fitting dental prosthetics, or atrophic changes in the alveolar ridge

(Hudson & Mills, 2000; Logemann, 1990). Edentulous individuals may choose food consistencies that are easier for them to chew and which may be deficient in nutritive value.

Linton (1997) reported that oral cavity disorders seen in the elderly are frequently caused by systemic, local, and physiological changes. These changes include hypertension, nutritional deficiencies, dehydration, decreased circulation, atrophy, decreased glandular secretions, and shortness of breath. Many elderly individuals suffer from chronic conditions such as hypertension and osteoporosis both of which lead to nutritional problems.

Since food and liquid are essential for sustaining life and play an important cultural role, any decrement in gestation becomes problematic. Mealtime remains a social and interpersonal activity time for many older individuals (Robbins et al., 1992). Decreased enjoyment of food can also become problematic if there are other sensory deficits. Wilson (1995) reported a 40 per cent decrement in smell and taste in the elderly. Ebersole and Hess (2000) and Hensel (2000) reported age-related losses in fine taste and smell, usually occurring around the sixth decade. A decrease in smell may compromise the ability to detect food that is spoiled. In addition, smoking accelerates this process. Brozenec (2000) indicated that taste bud atrophy might lead to an inability to discriminate between flavors (sour and salty) and cause decreased eating pleasure and poor nutrition. Malnutrition and starvation may eventually lead to death.

Decreased ability to perform daily living activities associated with eating or feeding can lead to malnutrition. The individual may not be able to shop for or

prepare food and may have decreased strength for eating. "A feeding disorder is impairment in the process of food transport outside of the alimentary system" (Crary & Groher, 2003, p.1). Decreased strength and coordination, especially of the dominant hand, could contribute to a feeding disorder.

Fucile et al. (1998) studied the effects of aging on functional eating skills in 79 healthy older individuals ranging in ages 60-97 years and explored the relationship between denture wearing and food avoidance. Their results revealed that functional eating skills did not deteriorate with age; the difficulties that occurred were related to denture use. Rademaker et al. (1998) examined swallowing variation with age and with liquid bolus volume in women ages 20-89 and found that differences in swallowing function occurred with age. These differences were related to altered bolus transit time, velopharyngeal closure, criocopharyngeal opening, laryngeal elevation, and hyoid movement. Sonies et al. (1988) used ultrasound to assess timing of the oropharngeal phase of the swallow in normal subjects and discovered that, as people age; there was an increase in swallow duration.

A study by Tracy et al. (1989) evaluated the effect of bolus volume upon temporal measures of oropharyngeal swallow in normal volunteers in three age groups (young, middle-aged, and older) of normal subjects. Duration of pharyngeal swallow response, peristaltic amplitude, and peristaltic velocity decreased, whereas duration of pharyngeal swallow delay increased across their three age groups.

Pharyngeal Cavity Changes

As with normal oral cavity changes, there are also laryngeal and tracheal changes that occur due to normal aging. Calcification can cause the cartilage of the larynx and trachea to stiffen. Additionally, cilia lining the trachea are less pliable and thus, less effective (Ebersole & Hess, 2000).

Decreased muscular tonicity can cause delayed pharyngeal clearing especially in the pyriform sinuses. The pharynx is then susceptible to types of diverticula formation (Groher, 1997), such as Zenker's and Killian-Jamieson diverticula, and dysmotility of the pharyngeal muscles. Cervical osteophytes, tumors, and rheumatoid arthritis can also contribute to pharyngeal changes. Zenker's diverticulum is "a pouch that develops in the hypopharynx . . . and typically forms at the junction of the oblique and circular fibers of the hypopharynx (Killian's dehiscence)" (Crary & Groher, 2003 p. 97). Killian-Jamieson diverticulum is "located laterally and inferior to the insertion of the cricopharyngeal muscle on the cricoid cartilage" (Eckberg, 1997, p.211). Logemann (1990) indicated that in some adults over 60, maximum laryngeal elevation lasts longer and that the larynx appears to descend more slowly.

Esophageal Cavity Changes

Although "esophageal function is essentially preserved with aging" (Linton, 1997, p.319), there has been evidence to show that problems that increase with age (e.g. hiatial hernia, gastroesophageal reflux, and diminished strength and tonicity in the esophagus) can cause problems with peristaltic contractions. Muscle weakness can also cause slowing of the action of the food in the

esophagus. The reduced action of the food into the esophagus causes some of the material to stay above the aortic arch (Sheth & Diner, 1988).

Another age-related problem is a motility disorder called achalasia. "Achalasia is an esophageal motility disorder that is characterized by a decrease in peristalsis of the body of the esophagus, increase resting pressure of the cardiac sphincter, and failure of the cardiac sphincter to fully relax during swallowing" (Brozenec, 2000, p. 552). The exact etiology of achalasia is unclear. The incidence is said to be 1 to 2 persons in 2000 (Bronzenec, 2000). Brozenec further stated that symptoms of achalasia include (1) progressive dysphagia; (2) vomiting of food (3) nausea; and (4) weight loss (p. 522). Individuals with achalasia report pain during eating. Progression of dysphagia from solids to liquids and nocturnal aspiration can occur, both of which can lead to bacterial infections. The onset of achalasia is insidious and often its diagnosis is delayed. Severe weight loss may signify malignancy or cancer. The study also indicated that about five percent of clients have esophageal squamous cell carcinoma.

Neurogenic Swallowing Disorders

Dysphagia has become one of the fastest growing areas in the field of speech-language pathology (Sonies, 1997). During the past ten years, speech-language pathologists have seen the number of referrals for dysphagia services increase in hospitals, long-term care facilities, private practice, and clinics (Kahrilas, Dodds, Dent, Logeman & Shaker, 1998; Sonies, 1997). As a result of neurologic diseases, neurogenic dysphagia is common (Gordon, Hewer and Wade, 1987). Horner & Massey (1988) reported that the prevalence of dysphagia

following stroke ranges from 25% to 32%. One-third of the patients in an acute care setting study were dysphagic (Groher & Bukatman's, 1986). Additionally, Trupe, Siebens, and Siebens (1984) reported that 50-60% of patients in an acute care setting may be dysphagic, while Cherney (1994) reported that at least 42 per cent of the patients in inpatient rehabilitation facilities were dysphagic.

One of the myriad of problems associated with neurogenic dysphagia is aspiration. Aspiration is the entry of material into the airway below the level of the true vocal folds (Smith, Logemann, Colangelo, Radamaker & Pauloski, 1999). Aspiration can occur before, during, or after the swallow for a number of reasons, including but not limited to, hypoglossal nerve incompetence, unilateral paralysis, incomplete closure of the larynx, poor tongue control of the bolus, poor coordination of the epiglottis, or reduced anterior laryngeal movement (Batchelor et al., 1996; Logemann, 1993). Aspiration can also cause life-threatening pulmonary diseases. Although the pulmonary system can tolerate and clear small amounts of aspirated material, a large build-up of aspirated material can obstruct the bronchi and lead to complications, even death. Infiltrates can be detected if a chest x-ray shows involvement of the lower right lobe (Blitzer, 1990). Aspiration can be detrimental to those individuals whose medical condition is already compromised, especially those who have had strokes, respiratory and/ or pulmonary problems.

Daniel et al. (1998) revealed that of 55 stroke patients studied, 21 (38%) aspirated. Seven of the 21 (33%) aspirated overtly, and 14 (67%) silently. Ding and Logemann (2000) revealed that between 48% and 55% of stroke patients in

their study aspirated. Garon, Engle, and Ormiston (1996) measured aspiration and silent aspiration in 1000 patients who had multiple neurological pathologies and found that 573 (57%) patients aspirated; additionally, 276 (52%) of the 573 were silent aspirators.

Linden and Siebens (1983) showed that 11 of 15 subjects with central nervous system damage had laryngeal penetration, and nine of 15 exhibited pooling of liquids in the pyriform sinuses. Horner and Massey (1988) reported that one-half of the patients with strokes showed aspiration, with silent aspiration occurring in 8 of 21 patients (38%). According to Horner, Massey and Brazer (1990), 49% of patients studied (who had bilateral strokes) aspirated secondary to incomplete laryngeal elevation and closure and weak pharyngeal peristalsis after the swallow during videofluoroscopy.

Horner, Buoyer, Albert, and Helms (1991) investigated the correlation of neurologic findings with radiographic lesions; their results revealed that 15 of 23 patients exhibited aspiration. Of the 15 patients who aspirated, the majority had bilateral strokes with multiple lesion loci. Their results also revealed significant statistical associations between aspiration and pharyngeal residue, cranial nerve IX abnormality, vocal fold weakness, and severe dysarthria.

Pneumonia is associated with aspiration (aspiration pneumonia) in patients who have had strokes or other neurologic and neuromuscular diseases such as Alzheimer's disease and Parkinson's disease. According to Arms, Dines, and Tinstman (1974), Mendelson in 1946 was the "first to describe aspiration pneumonia as a clinical entity in obstetrical anesthesia" (p. 138). They further

stated that the most common symptoms of aspiration identified in their 88 patients were cough and dyspnea.

Aspiration pneumonia develops after the aspiration of colonized oropharyngeal contents (Marik & Kaplan, 2003, p. 329). Marik et al. further indicated that the incidence of pneumonia increases with age. The highest rate is seen in those individuals 75 years and older. Additionally, those who reside in nursing homes also had a high incidence of pneumonia. Gordon, Hewer and Wade (1987) indicated that aspiration is thought to be a significant cause of pneumonia in individuals who have had strokes. In a study by Hanning, Wuttage-Hanning, Hormann and Herrmann (1989), six per cent of patients who had a stroke died within the first year from aspiration pneumonia.

Aspiration pneumonia causes serious complications after stroke and often results in a longer hospital stay and can cause death (Ding & Logemann, 2000). Although not all pneumonias are caused by food or aspirated contents, pneumonia is seen in about 34 per cent of all stroke-related deaths and is the third highest cause of death the first month post stroke (Horner & Massey, 1988).

Reynolds, Gilbert, Good, Knappertz, et al. (1998) studied variables associated with the development of pneumonia in patients with ischemic strokes. Their purpose was to use the clinical swallowing examination and videofluoroscopy to identify those individuals who were at risk for aspiration and subsequent pneumonia and to determine hospital outcome. Their results revealed that of the 102 patients studied, a 21% rate of pneumonia was noted.

Toharo et al. (2003) used the water swallowing test, food test and the x-ray test (static radiographs of the pharynx) to predict aspiration without the use of videofluoroscopy. Their results showed 90% sensitivity for all three non-videofluoroscopic tests for predicting aspiration. They also concluded that clinicians could use these three tests when VFSS is not available or feasible. Additionally, the water test can be used as a screening procedure to determine which dysphagic patients will need VFSS.

Kendall and Leonard (2001) determined the incidence of abnormalities in timing and extent of pharyngeal constriction in an elderly population with dysphagia. Seventy-three percent demonstrated incomplete pharyngeal constriction relative to controls. Poor pharyngeal constriction accounted for 75% of aspiration cases. In addition, they found that although hyoid elevation was slow and of reduced duration in older dysphagic patients, it was appropriate for patients' ages. These findings may indicate that the elderly use compensatory movements to minimize the short duration of hyoid elevation on the upper esophageal sphincter.

In a similar study by Leonard, Kendall, McKenzie, Gonclaves, & Walker (2000) on 60 adult normal volunteers, dynamic videofluoroscopic swallow studies were performed to establish normative data for displacement of upper aerodigestive tract structures during deglutition. They studied hyoid bone displacement, larynx-to-hyoid bone approximation, pharyngeal constriction, and the extent of pharyngoesophageal sphincter (PES) opening during various volumes of liquid swallows and found that there was a direct relationship

between bolus size and hyoid bone displacement, PES opening, and pharyngeal constriction.

Deglutition is a complex process that can become compromised by subtle changes in the ability to chew and swallow. Some changes occur over a period of time due to normal aging but a disease condition warrants concern and attention. To assess these changes, a clinical swallow examination is usually performed before radiographic studies in order to document changes in structure and function of the oral and pharyngeal cavities. Some clinicians incorporate cervical auscultation as an adjunct to the CSE to detect clinical changes in swallowing. Cervical auscultation is an inexpensive, noninvasive procedure that is used to listen to swallowing sounds. When patients cannot be transported to hospital facility for a videofluoroscopic swallow study or FEES, cervical auscultation is employed to document changes in swallowing and to provide immediate information regarding the person's swallow.

The Clinical Swallowing Examination

"The Clinical Swallowing Examination (CSE) allows a circumscribed exploration of a patient's muscle function, sensation, and airway protective functions" (Murray, 1999). It is used in hospitals, long-term care, and other clinical facilities to provide clinicians with information relevant to patients' swallowing problems. Additionally, CSE provides the clinician with information of the patients' readiness to undergo further evaluation relevant to therapeutic processes (Goodrich & Walker, 1997; Murray, 1999; Zenner, 2000).

The Clinical Swallowing Examination is used to obtain the patient's medical history, to acquire details about swallowing difficulty, and to assess oral-motor function. Other names given to this procedure in the literature include physical examination (Sonies & Baum, 1988), bedside dysphagia examination (Murry & Carrau, 2001); clinical/bedside examination (ASHA, 2000; McCullough, et al., 1999), and clinical examination (Perlman et al., 1991; Daniels et al.; 1997; Miller, 1997). In this research the process will be referred to as Clinical Swallowing Examination (Murray, 1999).

The Clinical Swallowing Examination allows the clinician to gather pertinent information regarding the patient's complaint or swallow-related problem, relevant health history, and clinical observations of swallowing including oral-motor anatomy and function and observation of swallow (Goodrich & Walker, 1997; Miller, 1997; Murray, 1999; Zenner, 2000; Schulze-Delrieu & Miller, 1997). It is the most common method for evaluating swallow function before performance of a videofluoroscopic swallow study (VFSS) or when VFSS is not available (Tohara, Saitoh, Mays, Kuhlemeier, & Palmer, 2003).

Zenner (2000) indicates three components of the CSE should include history taking, meal observation, and physical examination. The case history and the physical examination are relevant to this study. The case history is the starting point of the clinical swallow examination of the patient suspected of dysphagia (Zenner, 2000). The clinician gathers information relevant to the patient's dyspahgia from a number of sources which include written medical records, observations by health care professionals and family, and those of the

clinician. It is important that the clinician review both past and recent medical records. Additionally, it is important that the SLP include (1) age, gender, heredity, and ethnic background; (2) neurologic, psychiatric, systemic/metabolic, respiratory, or esophageal disease; (3) surgery; (4) radiologic study results; and (5) advance directives (Groher, 2000) as part of the diagnostic process. After data collection and at the completion of the CSE, the clinician should be able to develop a tailored management program for the patient or determine if further instrumental assessment is warranted.

For hospital patients, the nursing staff can be invaluable in providing information regarding the patient's swallowing problems as they provide information regarding food preferences or whether the patient fatigues during meals. For those individuals who reside in the community, the family's description concerning the patient's swallowing disorder or attempts at minimizing the disorder is of particular importance to the speech-language pathologist. It is also important for the speech-language pathologist to note the impact the swallowing disorder has on family members' or caregiver's lives. For example, mealtime is when families get together to discuss the events of the day. Additionally, meals are social times that bring family and friends together. It is important for caregivers to understand the types of food that are difficulty for the patient to chew and swallow and to make appropriate compensations.

The physical examination portion of the Clinical Swallowing Examination assesses the patient's oral-motor structure and function and provides the clinician with the opportunity to verify and test the information gathered during the

case history and meal observation portions (Zenner, 2000). Miller (1997) indicated that the purposes of the physical examination for the clinical assessment of swallowing are to (1) establish a possible cause of dysphagia; (2) assess the patient's ability to protect the airway; (3) determine the practicality of oral feeding and/or recommend alternative methods for nutritional management; (4) determine the need for additional specific diagnostic tests, studies or referrals; and (5) establish baseline clinical data that can be used to chart changes in feeding function of patients with progressively deteriorating diseases (pp. 153-154). During the physical examination the clinician examines motor speech performance, oral reflexes, mobility and strength of the oral musculature, conducts inspection of the oral cavity and tests swallows. During trial swallows the clinician examines mastication, oral transit of the bolus, pharyngeal and laryngeal elevation, phase transition, and airway protection (Zenner, 2000; Goodrich & Walker, 1997; Miller, 1997).

Miller (1997) indicated that the CSE should allow the clinician to (1) screen for the presence or absence of swallowing impairments; (2) contribute information regarding the possible etiology of the dysphagia relative to its anatomic and physiologic basis; (3) ascertain the relative aspiration risk for certain patients; (4) determine the need for an alternative means of nutritional management; and (5) recommend additional tests and procedures necessary to diagnose and/or treat dysphagia (p.169). The American Speech-Language Hearing Association (ASHA) (2000) has also indicated that the clinical examination might include "use of tools and techniques (such as cervical

auscultation and pulse oximetry) to detect and monitor clinical signs of dysphagia" (p. 2).

The Clinical Swallowing Examination may be modified in certain circumstances to fit the situation and individual needs of patients. The CSE does not allow visualization of structures or function of oral, pharyngeal, and laryngeal areas during the swallow and cannot provide etiologic information about aspiration. Clinicians, however, rely on results of the Clinical Swallowing Examination since it (1) is used as the first step in assessment of swallowing; (2) incorporates more aspects of swallowing than movement of the larynx, pharynx, and mouth; (3) provides information regarding ingestion of food and liquids for sustaining nutrition and hydration; (4) is readily available and does not require expensive equipment; and (5) is not invasive and has no known health risks (Goodrich & Walker, 1997; Zenner, 2000).

ASHA (2000) indicated that the purposes of the clinical swallowing examination are to enable the speech-language pathologist to (1) integrate information from the interview/case history, review of medical/clinical records, standardized protocols, observations from physical examination and collaboration with physicians and other caregivers; (2) observe and assess the integrity and function of the following structures of the upper airway and digestive tract: face, jaw, lips, oral mucosa, tongue, teeth, hard palate, soft palate during nonspeech, speech, and swallowing tasks; (3) identify the presence and observe the characteristics of dysphagia based on clinical signs and symptoms; this may include identifying factors that may affect swallowing function such as bolus size,

consistency, and fatigue during a meal, posture, positioning, and environmental conditions; (4) identify clinical signs and symptoms of esophageal dysphagia or gastroesophageal reflux in order to make an appropriate referral to another specialty; (5) determine the need for an instrumental evaluation following the clinical examination; (6) identify and follow up with patients who may require reevaluation, instruction, intervention, or other procedures prior to the instrumental evaluation; (7) determine whether the patient is an appropriate candidate for treatment and/or management, based on clinical examination findings such as medical stability, cognitive status, nutritional status, psycho-social-environmental and behavioral factors; (8) recommend, as appropriate, the route of nutritional management (i.e., oral vs. nonoral); (9) recommend clinical interventions (e.g. positioning, food and liquid consistency modifications, feeding routine alterations) and other clinical strategies designed to enhance the efficiency and safety of swallowing; and (10) provide counseling, education, and training to the patient, health care providers, and care givers.

Cervical Auscultation

Speculations on Physiologic Cause of Swallowing Sounds

There has been speculation concerning the physiologic cause of swallowing sounds. Cichero and Murdoch (1998) pointed out that the acoustic signature of the swallow can be discussed in terms of (1) duration of the signal, (2) frequency characteristics of the signal, and (3) amplitude of the waveform (p.40). Researchers have agreed that the average duration of the swallow signal for a liquid bolus is 500 msec. and for one third teaspoon of paste it is 250 msec.

Cardiac and Vocal Tract Analogy Hypothesis

Cichero and Murdoch (1998) proposed that the sounds of the heart and vocal tract are propagated via vibration of muscles and valves. Additionally they indicated that there may be a similarity or comparison between the generation of heart and vocal tract sounds to swallowing sounds which they coined 'cardiac analogy hypothesis'. They further mentioned that there are four cardiac sounds perceivable in humans, each with different components. The first has four components, but only two are audible via stethoscope. The second heart sound is said to be caused by vibration initiated by closure of the aortic and semilunar valves and sudden cessation of back flow of blood. There is inconsistency surrounding the third cause of the heart sound. The fourth cause of heart sounds seems to occur with atrial contraction as the valve separates a second time due to increased flow across the valve (p. 42). They feel that the swallowing sounds of a healthy nondysphagic individual are distinctive from the sounds of an individual with dysphagia. If cervical auscultation could prove beneficial in detecting where structure and function breakdown in physiologic swallowing occurs, it would be a useful diagnostic tool in clinical swallowing examination. Cichero and Murdoch (1998) point out that cervical auscultation may have its roots in techniques of cardiovascular and respiratory sounds analysis. In summary, Cichero and Murdoch (1998) indicate that cardiac sounds appear to be caused by vibration which is initiated by (1) opening or closure of valves in the heart, (2) general disturbance of the muscles of the heart caused by vibration, or (3) fluid flow into a confined space initiating the vibration (p. 42).

Similarly, when comparing the vocal tract to the cardiac phenomenon, there are sites and structures within the tract that are potential vibratory sources. In the swallowing mechanism, there are a series of valves (oropharyngeal, laryngeal, and esophageal) and pumps (pharyngeal, esophageal, and respiratory) that act as potential vibratory sources. The vocal tract is a vibrating column and many speech sounds that are generated and modified are periodic. Thus, the question is: Is there a similar pattern for swallowing sounds? Cichero and Murdoch further state that the swallowing sounds are aperiodic in nature. The frequency components are not related to each other and do not show a visually repeatable pattern.

When comparing the generation of heart and swallowing sounds, heart sounds are aperiodic although repetitive, a situation which gives more credence to the argument that heart sounds and swallowing sounds may be generated in a similar fashion. When examining the cardiac and vocal tract analogy hypothesis, several things should be considered: (1) the difference in the male and female vocal tract, (2) gender differences in the swallowing sounds, and (3) the site of placement of the acoustic detector. Female and male vocal tract sizes and configurations are different. Additionally, the female swallow duration is shorter than that of the male (Takahashi et al., 1994). Considering the cardiac analogy hypothesis, there is greater attention given to the best placement of the acoustic detector unit on the cervical region. Takahashi et al. (1994) indicated that the best placement for listening to swallowing sounds is over the lateral border of the trachea, immediately inferior to the cricoid cartilage.

Shaw et al. (2004) conducted a study that used bronchial auscultation (BA) paired with the clinical examination to detect dysphagia and aspiration. Their results indicated that although there was high agreement for risk of aspiration, specificity was low. Bronchial auscultation was highly specific in confirming the absence of aspiration with a relativity low sensitivity to the presence of aspiration. Bronchial auscultation is therefore thought to potentially be a useful adjunct to the clinical swallowing examination.

Leslie (2005) presented an overview of studies that have used cervical auscultation. She reported that although cervical auscultation continues to be used as a possible adjunct to the CSE, there still needs to be future research to answer questions such as what causes changes in swallowing.
Youmans & Stierwalt (2005) studied several measures of duration, intensity, and frequency of the acoustic swallowing signal. Additionally, they looked at correlations between the variables and bolus consistencies using cervical auscultation. Their results compared favorably with previous reports. There were no gender specific differences among the variables studied. Leslie et al. (2004) indicated that "cervical auscultation is experiencing a renaissance as an adjunct to the clinical swallowing assessment" (p.231). Cervical auscultation is being used by a number of clinicians in long-term care (LTC) facilities where the clinical examination may be the only assessment procedure used to detect aspiration and to make decisions concerning the resident's diet level (Zenner, Losinski & Mills, 1995). Zenner et al. further revealed that, although the clinical swallowing examination does not accurately assess the mechanics of the pharyngeal

swallow, CSE is an appropriate tool to use in determining a diet level in LTC when cervical auscultation is used.

Dawson's (1964) investigation of the use of auscultation with the stethoscope did not use the stethoscope to detect swallowing sounds but to find out which stethoscope was better suited for use with his patients. Abella and Formolo (1992) compared the acoustic properties of six popular stethoscopes. Of the six stethoscopes tested the Littman Cardiology II provided the best overall performance. Hamlet, Penny and Formolo (1994) investigated stethoscope acoustics for cervical auscultation of swallowing. The Littman Cardiology II and the Hewlett-Packard Rappaport Sprague were found to have superior acoustical performance as compared to those tested for use in the cervical auscultation of swallowing sounds.

Takahasi, Groher and Michi's (1994) investigated three different swallowing sounds using cervical auscultation: (1) acoustic detector unit for analyzing swallowing sounds (2) type of adhesive suited for attachment to the detector, and (3) best site for swallowing sound detection. Fourteen normal adult volunteers (nine males, mean age 32.4) and five females (mean age 29.4) served as participants. Results revealed that the optimal site for detecting swallowing sounds was the lateral border of the trachea immediately inferior to the cricoid cartilage. The detector of choice was an accelerometer with double-sided paper tape wire selected because of its wide range of frequency response and small attenuation level.

Cichero and Murdoch (2002) revisited the methodology used by Takahashi et al. to study acoustic detector and placement site for listening to swallowing sounds. It was found that the electret microphone -- as opposed to the accelerometer - - was better for recording swallowing sounds. Cichero and Murdoch agreed on the placement site (the lateral border of the trachea immediately inferior to the cricoid cartilage) for listening to swallowing sounds. Additionally, they concluded "that cervical auscultation is within the reach of the average dysphagia clinic" (p. 40).

CHAPTER III

METHOD

Participants

The purpose of this study was to examine aging on swallowing in nondysphagic women across the age span, aging on nondysphagic women's perceptions of swallowing as people age, and whether cervical auscultation was a reliable screening adjunct to the clinical swallowing examination. Criteria for inclusion were women who (1) fit the age criteria; 20-29, 40-49, 60-80+; (2) were negative for neurologic or degenerative diseases on medical history; (3) were negative for diagnosis of dysphagia; (4) had no history of cancer of the brain, oral cavity or the larynx; and (5) reported no illnesses to all questions on the Medical Health Questionnaire without reported illnesses. Only those individuals who met all of the criteria were included in the study.

This study was approved by the University Committee on Research Involving Human Subjects (UCRIHS # 00-473) at Michigan State University and the Institutional Review Board (IRB # -00657-2001) at Valdosta State University. Participants were provided with verbal and written descriptions of the research by the Principal Investigator and gave informed consent by signing the Research Consent Form (Appendix C). The consent form provided participants with a (1) summary of the proposed research, (2) description of procedures, (3) statement of possible discomforts/risks involved in study participation, (4) benefits of participation and, (5) statement concerning confidentiality of data and personal information.

Several referral sources were contacted via telephone requesting their members' participation in the study. A letter to prospective referral sources (Appendix A) was given to explain the purpose of the study and criteria for participation. Those who responded included The Norway Senior Citizens Club; members of the Bushy Pond Baptist Church in Norway, South Carolina; Victory Temple Evangelistic Center Virtuous Women of Excellence Ministry; and faculty, staff, and students from the College of Education in Valdosta, Georgia. Individuals in the general community of Norway, South Carolina, were also contacted. In addition, participants at the Child Development Center in Valdosta and some members of their families were also included in this study.

Data Collection

Medical History Questionnaire

The investigator was invited to the Norway Senior Citizens regular monthly meeting. At that time the written-oral script (Appendix B) was given and read to the group, allowing time for questions. After a question and answer period, all participants were given a Research Consent Form to complete (Appendix C). After signing the Research Consent Form, the Medical History Questionnaire (MHQ) (Appendix D) was provided. Questions were answered regarding some of the items on the MHQ. Data were collected and completed in one visit.

Women of the Virtuous Women of Excellence Ministry, Child Development Center, and the Department of Special Education and Communication Disorders made individual appointments with the Principal Investigator so that data could be collected. The procedure for data collection was the same for all groups. Data

collection was completed in one session and took approximately 45 minutes per appointment to complete.

After providing consent to participate in the study, each participant completed a Medical History Questionnaire (MHQ) (Appendix D). The Questionnaire was divided into medical (15 items) and surgical (5 items) categories. Participants answered 'yes' or 'no' to the 20 questions. Those who answered 'yes' to having had a diagnosed neurologic or degenerative disease or cancer of the brain, oral cavity or larynx were excluded from the study because the reported conditions could possibly interfere with the normal swallow process. Seven women (all over 60 years old) were excluded because of medical conditions such as history of dementia, oral cancer, stroke, and fear of the stethoscope. Only those individuals who indicated no history of neurologic disorder degenerative disorder or cancer of the brain, oral cavity or larynx on the Medical History Questionnaire were participants in the study.

Swallowing Status Questionnaire

Participants who responded negatively on all of the MHQ items were given the Swallowing Status Questionnaire (SSQ) (Appendix E). The Swallowing Status Questionnaire consisted of nine questions, seven on the effects of aging on swallowing status and two on their perceptions of the effects of aging on swallowing.

Participants answered "always", "frequently", "sometimes", or "rarely" to seven swallowing questions. 'Always' was operationally defined as "coughing after swallowing liquids or solids at every meal." The term 'frequently' was

defined as "coughing after swallowing liquids or solids one time per day." 'Sometimes' was defined as "coughing after swallowing liquids or solids one to two times per month." The term 'rarely' was defined as "coughing after swallowing liquids or solids one time or less per year." Additionally, participants were asked to answer "yes", "no", or "don't know" to two perception questions.

Clinical Swallowing Examination and Cervical Auscultation

Participants who did not indicate any pathology on the Medical History Questionnaire and completed the Swallowing Status Questionnaire were administered the Clinical Swallowing Examination (CSE) (Appendix F) with cervical auscultation by the investigator. The CSE consisted of 28 oral-motor tasks to assess sensory and motor capabilities and the structure and function of the swallowing mechanism. Items for the CSE and cervical auscultation were adapted from Duffy (2005); Murray (1999); Hardy (1995); Love and Webb (2001); Cichero & Murdoch (2002); Zenner (2000); Cichero & Murdoch (1998); Nilsson, Ekberg, Olsson, Kjellin, & Hindfelt, (1996); Zenner, Losinski, & Mills (1995); Hamlet, Penny & Formolo (1994); Takahashi, Groher & Michi (1994a); and Takahashi, Groher & Michi (1994b).

The same protocol for the Clinical Swallowing Examination with cervical auscultation was used for all participants. Participants were seated in a straight back chair facing the Principal Investigator. Examination of the oral cavity and laryngeal area is the standard procedure when performing a clinical swallowing examination (Murray, 1999). Examination of the oral cavity is a procedure used by SLPs to determine whether or not a client has deviations in the structure and

function of the oral mechanism (St. Louis & Ruscello, 1981). It is also used to screen a client for potential oral or pharyngeal swallowing problems and determine if further instrumental assessments or sub-specialty evaluations are warranted (Logemann, 1998). When performing clinical swallowing examinations to determine structure and function of the oral cavity, speech-language pathologists have begun to use those recommended by the World Health Organization (2001) International Classification of Function (Clark, 2005).

Structure of the Oral Cavity

Facial symmetry. To assess facial symmetry, the participant was instructed to sit straight in a chair, relax, and to look forward and breathe quietly through the mouth; observation of asymmetry due to drooping of the entire face on one side or corner of mouth, or flattening of the nasolabial fold was noted.

Lip closure. Lip closure was examined when the participant's upper and lower lip contacted in a symmetric resting posture; any deviations were noted.

Lingual size. Lingual size was assessed when the participants opened their mouth with the tongue resting on the inside of the oral cavity; structural abnormalities were noted.

Tongue. The tongue was observed at rest on the floor of the oral cavity for at least one minute; any fasciculations or tremors were noted.

Hard palate. Hard palate appearance was assessed for height and concavity; deviations were noted.

Soft palate. Soft palate at rest was examined as the participants opened their mouth wide for observation; any deviations in height, concavity and symmetry were noted.

Condition of teeth. Assessment of the teeth was made regarding natural or missing teeth, and whether participant had a complete set or upper or lower dentures. Additionally, notation was made if participant had any other dental appliances such as partials, bridges or fillings, or whether the patient was edentulous.

Function of the Oral Structures

Labial protrusion. To assess labial protrusion, the participant was instructed to "pucker your lips as though you were kissing or saying "oo" like this."

Labial retraction. *Labial retraction was assessed by having the participant* retract the lips as if smiling or saying "ee."

Labial range of motion. The participant alternately pursed and retracted the lips in an exaggerated smile or grimace.

Labial strength. To assess labial strength, the participant was instructed to "place your lips around the tongue blade and press down on it while I try to pull it out of your mouth. Don't let me pull it out."

Labial seal. Labial seal was visually examined when the participant swallowed trials of liquids and solids. Upper and lower lips had to make contact and remained closed during bolus formation of solids and liquids; any spillage was noted.

Lingual protrusion. Lingual protrusion was assessed when the participant was instructed to "stick out the tongue."

Lingual retraction. To assess lingual retraction, the participant was instructed to "pull your tongue as far back into your mouth as possible."

Lingual strength. Lingual strength was assessed on both sides of the inner oral cavity by having the participant press against the tongue blade, as well as by protruding the tongue against a tongue blade.

Lingual elevation. To assess lingual elevation, the participant raised the tongue tip or blade to the upper lip, alveolar ridge or hard palate.

Lingual depression. Lingual depression was assessed by having the participant lower the tongue tip behind the bottom teeth.

Lingual range of motion. Lingual range of motion was assessed by having the participant move the tongue from the left corner to the right corners of the oral cavity. Additionally, the tongue was moved in a circular motion along the length of the maxillary, mandibular and buccal sulci.

Velar elevation. To assess velar elevation, the participant was instructed to "say /a/ for as long as you can." Additionally, participant was asked to "say /a/, /a/, /a/" in order to examine sequential ability to raise and lower the velum.

Jaw at rest and during movement. To assess the mandible, the participant was instructed to "open and close your mouth as rapidly as you can." Mandibular range of motion was examined when the participant was instructed to "move your jaw to the right then to your left."

Gag Reflex. To elicit gag reflex, the participant's tonsillar pillars or tongue base were stroked with a tongue depressor.

Volitional cough. To assess volitional cough, the participant was instructed to "cough and clear your throat."

Trial Swallows and Cervical Auscultation

Cervical auscultation is a noninvasive procedure used to detect swallowing problems in clients with dysphagia. It is a clinical process that is gaining recognition and credibility among speech-language pathologists as a means of detecting clinical signs of dysphagia (Cichero & Murdoch, 2002; Cichero & Murdoch, 1998; Nilsson, Ekberg, Olsson, Kjellin & Hindfelt, 1996; Hamlet, Penny & Formolo, 1994; Takahashi, Groher & Michi, 1994a; and Takahashi, Groher & Michi, 1994b).

Cervical auscultation using a stethoscope, microphone, and audiotape recorder was used on three trial swallows of liquids and three swallows of a cracker. The Principal Investigator placed the flat side of the stethoscope over the lateral border of the trachea immediately inferior to the cricoid cartilage (Takahashi, Groher & Michi, 1994a; 1994b).

To assess swallowing sounds, participants were given three trials (5 cc each trial of liquids (total 15 cc) and three trials of a cracker (one ounce per trial) for mastication. The instructions and protocol remained constant for all participants. Participants were given 5 cc of water measured in a medicine cup for accuracy and consistency. Each participant was instructed to swallow all of the water at one time when given instructions by the principal investigator.

A Littman Cardiology III stethoscope and an electret condenser microphone were used to listen to swallow sounds. The microphone was inserted into the left bifurcation of the stethoscope and audio recorded on an Optimus portable tape recorder (Mills, personal communication, 2002). Bolus formation was informally evaluated by observing rotary chewing of a solid bolus (from the cracker) and formation of a liquid bolus (from the water) for deglutition. Laryngeal elevation was manually observed for the elevation of the mandible, hyoid bone, and larynx. Oral cavity residue was observed post swallows of solids and liquids. Vocal quality change, salivary flow/control, and reflexive cough were noted following all swallow trials.

Scoring of Clinical Swallowing Examination

Assessment of the condition of the teeth was scored as '+' if present and '–'if not present. Information gathered was relative to whether the patient had natural teeth, dentures, partials, bridges, or was edentulous.

Structures were assessed as normal or abnormal. Structures received a '1' if they appeared normal and a '2' if they appeared abnormal.

A task executed correctly and immediately following verbal instructions and visual demonstration was scored '1'. Tasks executed correctly with delay (3-5 sec) following verbal instructions and visual demonstrations were scored '2'. Function executed incorrectly and immediately following executed tasks when verbal instructions and visual demonstrations were scored "3". Tasks performed incorrectly and after a time delay following verbal instructions and visual demonstrations were scored "4" (Appendix F).

Swallowing sounds were examined using a Littman Cardiology III stethoscope and a microphone and scored as (1)"1" for clear audible sound without coughing (normal); (2) "2" wet gurgly sound without coughing; (3) "3" wet gurgly sound with immediate coughing; (4) "4" wet gurgly sound with delayed coughing; and (5) unable to detect. Each swallow was recorded on audiotape.

Inter-rater Reliability during Training Period

Reliability training was conducted in an audiological booth to assure constant silence during rater training. The principal investigator trained an experienced (of 30 years) certified speech-language pathologist to judge the swallow sounds. Although the rater had used cervical auscultation in the past, she was not a regular user of the procedure. After training was completed, both raters judged the swallows of 10 subjects to be normal. The ten participants ranged in age from 23-27 years with a mean age of 23. All were college undergraduate students - one African American and nine Caucasian. They were not a part of the 55 participants used in the study. A Littman Cardiology III Stethoscope was used by each rater to listen to swallow sounds. Each rater judged a total of 60 swallows (three liquids and three solids). Each rater judged three liquid trials and three solids without knowing how the other rated the swallows until data collection was completed.

Equipment and Materials

Swallowing sounds were recorded using (1) 3M Littmann Cardiology III stethoscope; (2) Radio Shack electret condenser 1 cm^2 microphone; (3) an Optimus CRT-111 Portable cassette tape recorder; and (4) Sony HF

audiocassette tape. Other test material included (a) a penlight; (b) latex exam gloves; (c) sterile tongue depressors; and (d) 30cc medicine cups. The solid test material was one 1.0 ounce Nabisco cracker. The liquid test boluses were presented in 5.0 ml volumes of water.

The Radio Shack electret condenser microphone was an omnidirectional microphone with frequency response of 70-16,000 Hz. Impedance was 1000 Ohms±20% and sensitivity at -65dB±3dB. An Optimus CRT-III portable cassette tape recorder was used to audiotape swallowing sounds. It is a 2-track monaural tape recorder with a frequency response of 125- 6.3 KHz ±.6dB.

Group means, percentages, and standard deviations were calculated using SPSS statistical software. Chi-square procedures were used to test for statistical significance for each of the nine questions on the Swallowing Status Questionnaire and between the 3 different age groups used in this study.

CHAPTER IV

RESULTS

This cross sectional study sought to document aging on oropharyngeal swallow in nondysphagic women across the age span, whether aging changed nondysphagic women's perceptions of swallowing as people age, and whether cervical auscultation was a reliable screening adjunct to the clinical swallowing examination. Women were recruited from the communities of Norway, South Carolina, and Valdosta, Georgia. The social status of the participants included undergraduate students, teachers, and retirees.

Participants consisted of 55 competent nondyspahgic adult women ranging in age from 20 to 95. Group 1 included 20 women ranging in age from 20-29 (M=25, SD=1.638); Group 2 consisted of 20 women ranging in age from 40-49 (M=47, SD=2.927), and Group 3 consisted on 15 women ranging in age from 60-95 (M= 73, SD =10.036).

Fifteen participants in Group I were African American and five were Caucasian. Group 2 consisted of 16 African American and four Caucasian. Group 3 included 14 women who were African American and one Caucasian. Overall 82% of participants were African American and 18% Caucasian (Table 1).

	GROUP 1 (20-29)	GROUP 2 (40-49)	GROUP 3 (60-95)
African American	15	16	14
Caucasian	5	4	1
Total	20	20	15
Mean Age	25	47	73

Table 1. Ethnicity, total number of participants and mean age across groups

Medical History Questionnaire

The Medical Health Questionnaire (MHQ) was administered to all participants to rule out medical conditions associated with dysphagia. Participants answered 'yes' or 'no' to 20 questions regarding their medical and surgical histories. Results of the MHQ revealed medical and surgical histories were negative for history of central nervous system disease, gastrointestinal pathology, or head or neck carcinoma. A total of 62 women were recruited for the study. Seven of the women were excluded because of history of stroke, oral cancer, dementia, or fear of the stethoscope. After completing the MHQ, 55 women qualified to participate in the study (Table1).

Swallowing Status Questionnaire

Each participant was given the Swallowing Status Questionnaire (SSQ) after qualifying to participate in this study. Each person answered seven questions regarding their swallowing status and two questions regarding their perception of the effects of aging on swallowing. The following descriptors were used to rate the first seven questions. 'Always' referred to coughing after swallowing liquids or solids at every meal; 'Frequently' referred to coughing after

swallowing liquids or solids one time per day; 'Sometimes' referred to coughing after swallowing liquids or solids one to two times per month; and 'Rarely' referred to coughing one time or less after swallowing liquids or solids per year. The remaining two questions were answered by using 'yes', 'no', and, don't know.'

Question 1 of SSQ (Figure1) asked, "In general, do you cough after drinking liquids?" Groups 1 and 2 responded with 80 percent that they 'rarely' coughed after drinking liquids while 20% indicated that they 'sometimes' coughed after drinking liquids. Group 3 responded with 73% 'rarely' coughed after drinking liquids, and 27% said they 'sometimes' coughed after drinking liquids.

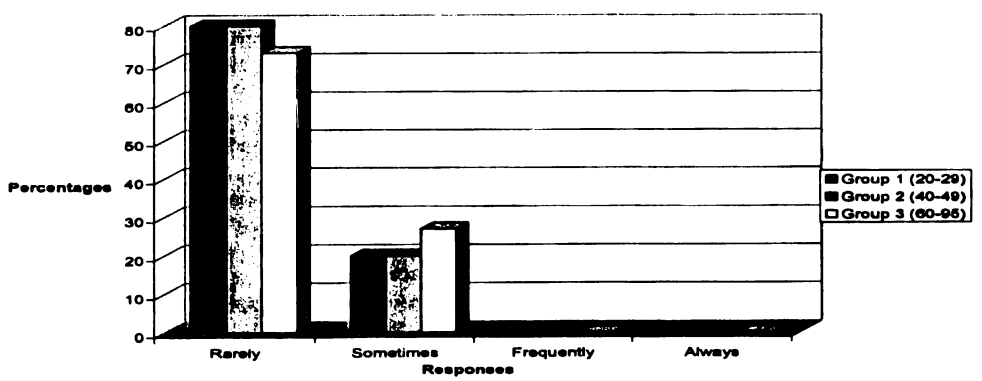

Figure1. Group mean percentages of responses across three age groups for SSQ1 (In general, do you cough after drinking liquids?)

In reference to SSQ2 (Figure 2) "In general, do you cough after swallowing foods?" Groups 1 & 2 responded 90% 'rarely' and 10% responded

'sometimes'. Group 3 participants indicated 93% 'rarely' coughed after swallowing foods while 7 percent indicated that they 'sometimes' coughed after swallowing food.

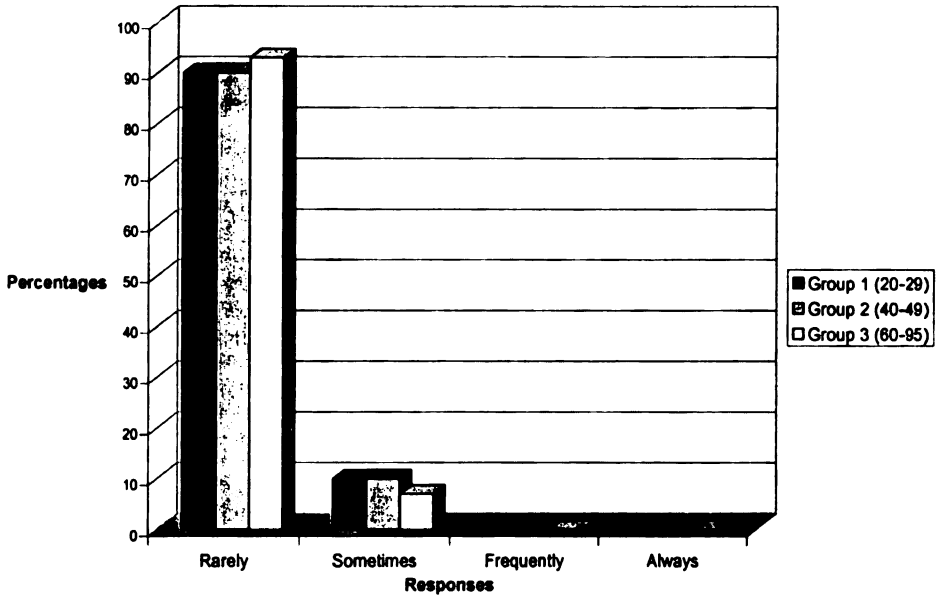

Figure 2. Group mean percentages of responses across three age groups for SSQ2 (In general, do you cough after swallowing foods?)

Question 3 asked, "In general, do you cough after swallowing saliva?" Data regarding this question are listed in Figure 3. All participants in Group 1 responded 100% that they 'rarely' coughed after swallowing saliva. Eighty-five percent of Group 2 indicated that they 'rarely' coughed after swallowing saliva while 15% indicated that they 'sometimes' coughed after swallowing saliva. Seventy-three percent of Group 3 responded that they 'rarely' cough after

swallowing saliva while 27% said they 'sometimes' coughed after swallowing saliva.

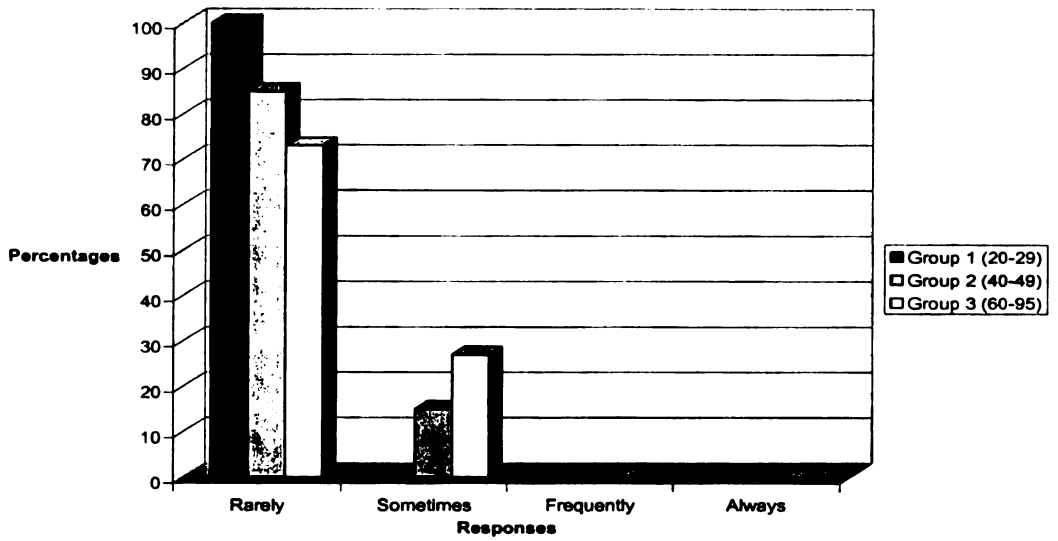

Figure 3. Group mean percentages of responses across three age groups for SSQ3 (In general, do you cough after swallowing saliva?)

In SSQ4 participants were asked, "In general do you take small drinks of liquids to avoid coughing?" Eighty-five percent responded 'rarely' and 15 percent of the participants in Group 1 indicated that they sometimes take small drinks of liquids to avoid coughing. In Group 2, 70 percent of the participants responded 'rarely' while 30 percent indicated that they 'sometimes' take small drinks to avoid coughing. Seventy-three percent in Group 3 indicated that they 'rarely' took small drinks of liquids to avoid coughing while 27 percent of the participants indicated that they 'sometimes' take small drinks to avoid coughing. Data regarding responses to SSQ4 are presented in Figure 4.

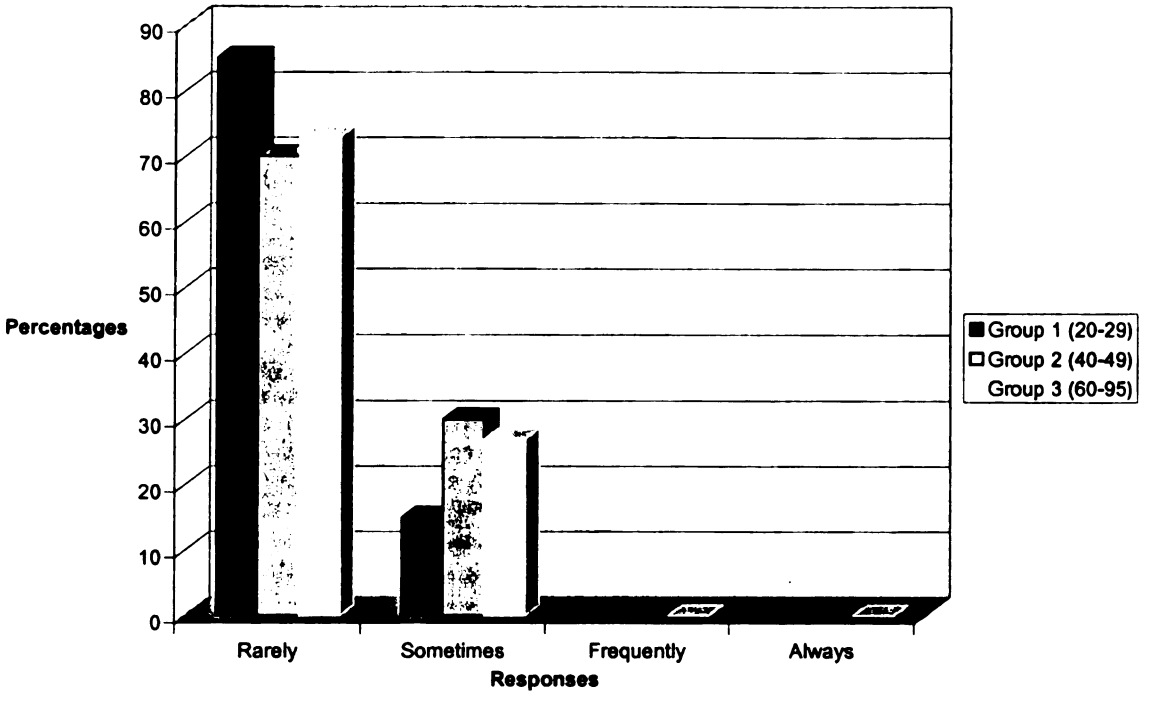

Figure 4. Group mean percentages of responses across three age groups for SSQ4 (In general, do you take small drinks of liquids to avoid coughing?)

SSQ5 asked, "In general do you eat small bites of food to avoid coughing?" Results revealed ninety percent of the participants in Group 1 indicated that they 'rarely' eat small bites of food to avoid coughing while five percent said 'sometimes', and five percent indicated that they 'always' take small bites of food to avoid coughing. Group 2 reported similar responses. Ninety-five percent indicated 'rarely' and five percent indicated that they 'sometimes' eat small bites of food to avoid coughing. Eighty percent of the participants in Group 3 reported they 'rarely' eat small bites of food while 13 percent indicated sometimes to this question (Figure 5) and seven percent responded 'always.'

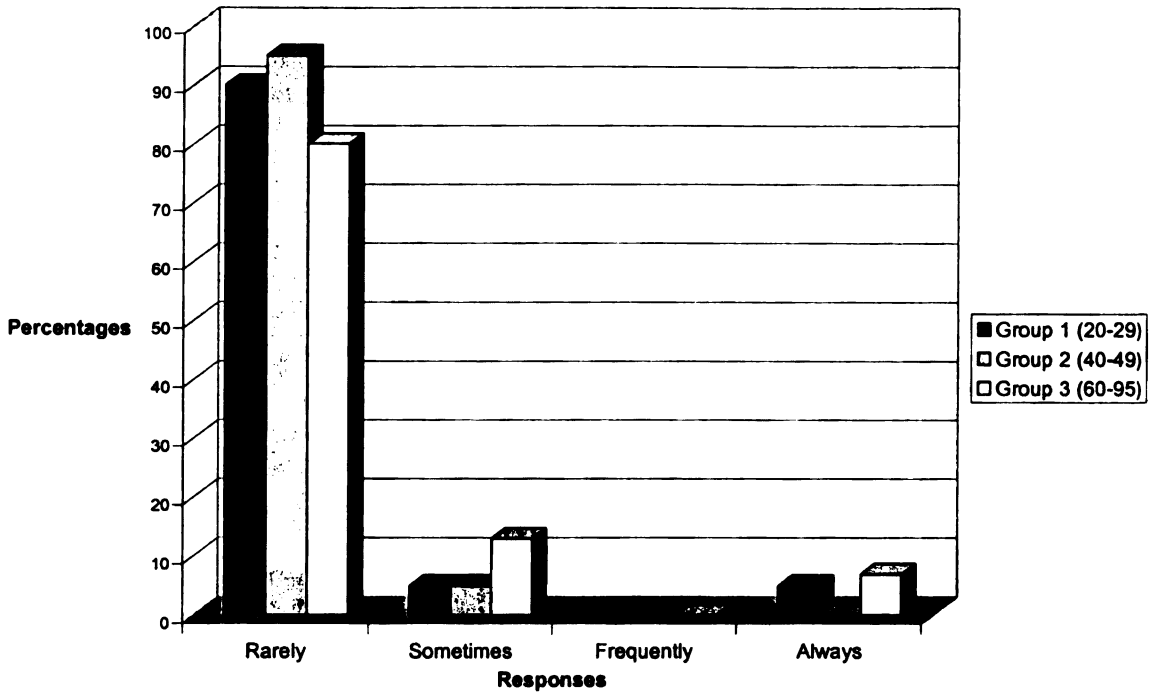

Figure 5. Group mean percentages of responses across three age groups for SSQ5 (In general, do you eat small bites of food to avoid coughing?)

Regarding SSQ6 (Figure 6), "In general do you experience pain while swallowing?" Eighty-five of the participants in Group 1 indicated 'rarely' while 15% indicated 'sometimes'. Ninety-five percent responded 'rarely' and 5% responded 'sometimes' in Group 2. Respondents in Group 3 responded with 93% indicated 'rarely' while 7% responded 'sometimes.'

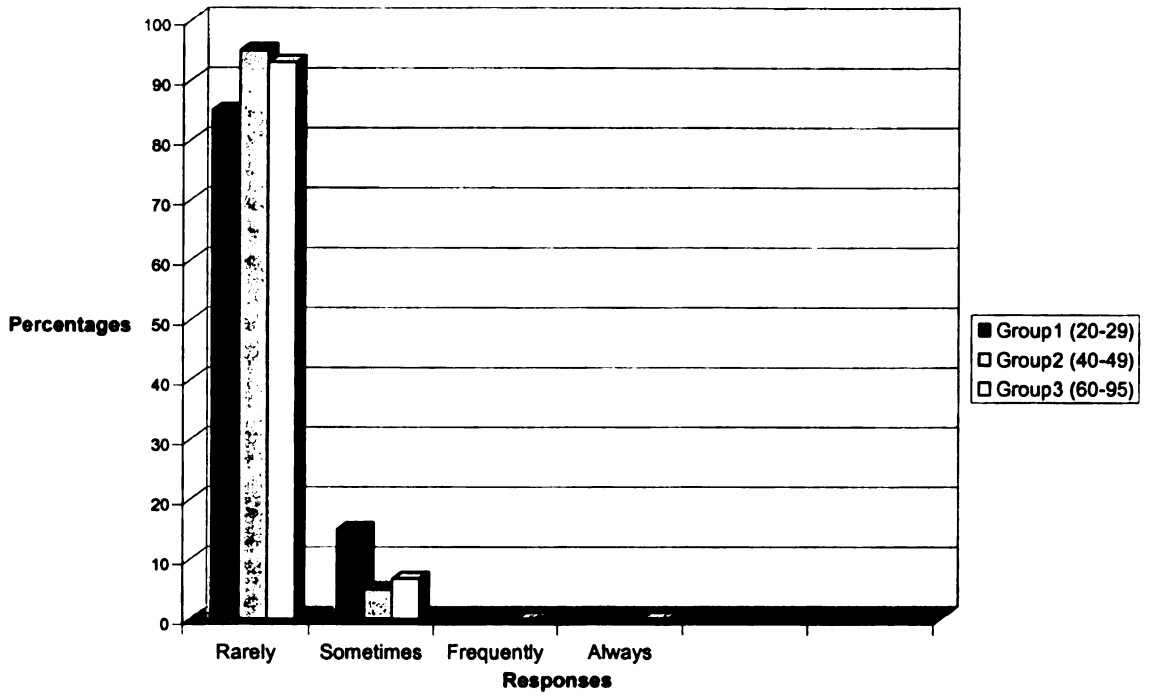

Figure 6. Group mean percentages of responses across three age groups for SSQ6 (In general, do you experience pain while swallowing?)

SSQ7 asked (Figure 7) "In general, do you experience heartburn or indigestion following meals?" Ninety-five percent in Group 1 responded 'rarely,' five percent said 'always'. Answers varied in Group 2. Fifty-five percent responded 'rarely', 30 percent sometimes, and five percent said 'frequently', and 10 percent indicated 'always' to this question. Seventy-three percent of the respondents in Group 3 indicated that 'rarely' while 27 percent responded 'sometimes' experiencing heartburn or indigestion following meals.

A chi-square analysis was performed on each of these seven questions (SSQ1 – SSQ7). Results revealed that across groups there was a significant difference at the $p < .01$ level between the response given as "rarely" compared

to any of the other responses. Thus, in all of the seven questions regarding their current eating and drinking experiences, the vast majority of the subjects, regardless of age, reported to have no difficulty with these activities. In addition, the responses between the three age groups, on each of the seven questions, indicated no significant differences at the p = .01 level. That is, the age of the women did not show any differences regarding how they viewed their current eating and drinking activities. The women in each age group perceived their eating and drinking activities to be normal.

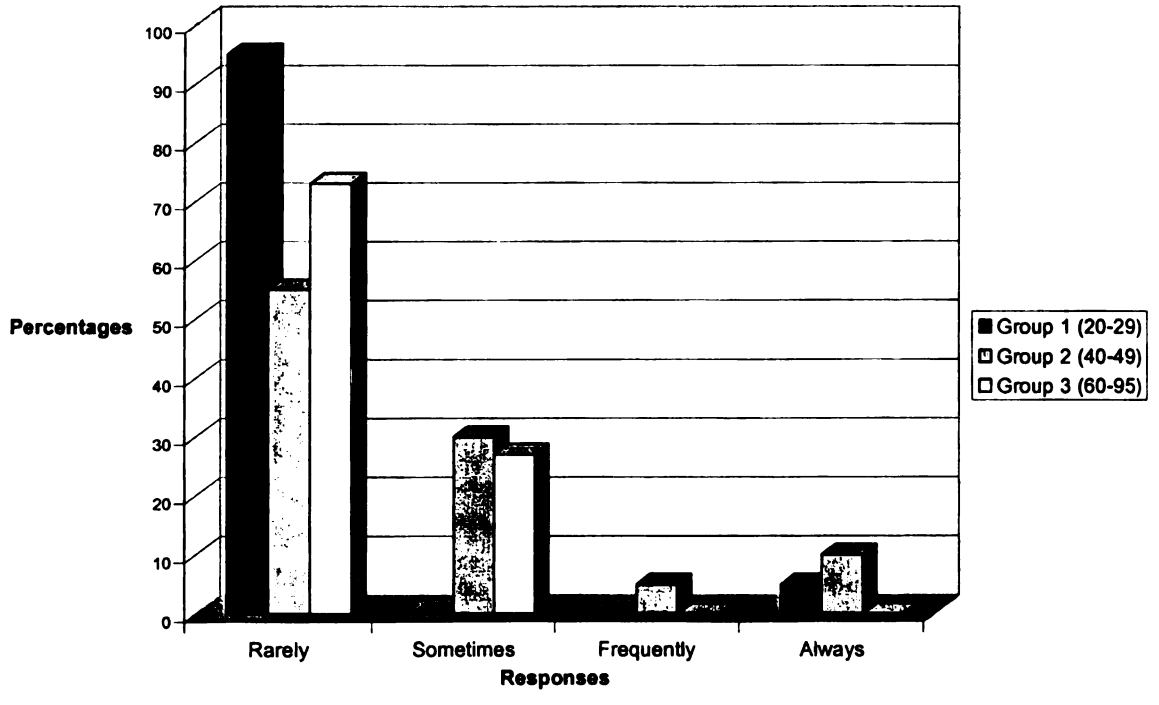

Figure 7. Group mean percentages of responses across three age groups for SSQ7 (In general, do you experience heartburn or indigestion following meals?)

Participants answered 'yes', 'no', or 'don't know' to two questions regarding their perceptions of the effects aging has on swallowing. SSQ8 asked "Does getting older affect one's ability to swallow?" Sixty percent in Group1 responded 'yes' and 20 percent responded 'no' and 'don't know', respectively. Participants in Group 2 responded with 20 percent to 'yes', 35 percent to 'no' and 45 percent 'don't know'. Twenty percent of the participants in Group 3 responded 'yes', 53 percent said 'no', and 27 percent said 'don't know'.

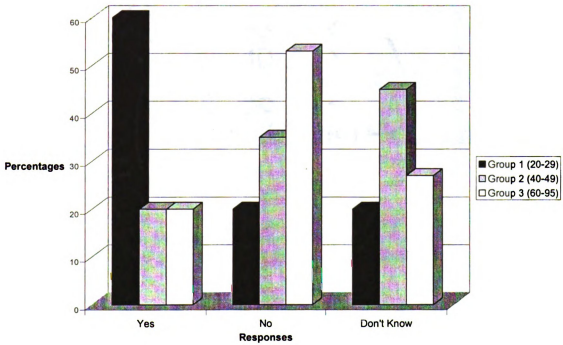

Figure 8. Group mean percentages of responses across three age groups for SSQ8 (Does getting older effect one's ability to swallow?)

In reference to SSQ9 (Figure 9), "Does getting older effect one's ability to chew?" 55 percent in Group 1 indicated 'yes,' 25 percent said 'no' and 20 percent

said 'don't know'. Group 2 responded with 20 percent 'yes', and 40 percent 'no' and 'don't know', respectively. Twenty-seven percent in Group 3 indicated 'yes', 46 percent said 'no', and 27 percent said 'don't know' to this question.

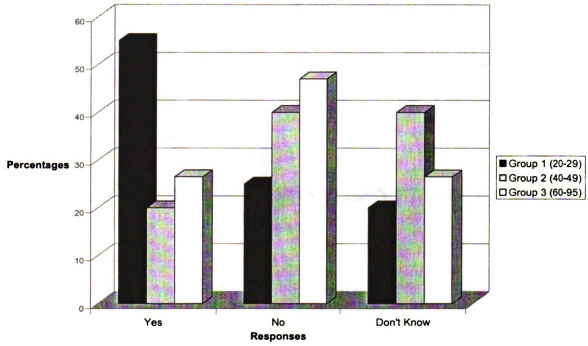

Figure 9.Group mean percentages of responses across three age groups for SSQ9 (Does getting older effect one's ability to chew?)

Group mean percentages were calculated for questions SSQ1–SSQ7 for each group (Figure 10). Results revealed 89% respondents in Group 1 reported 'rarely', 9% responded 'sometimes', and .71% responded 'always'. Group 2 results revealed 81% 'rarely', 16% 'sometimes', .71% 'frequently', and 1% 'always.' Group 3 responded with 80% 'rarely', 19% 'sometimes', and 1% 'always' to SSQ1-SSQ7.

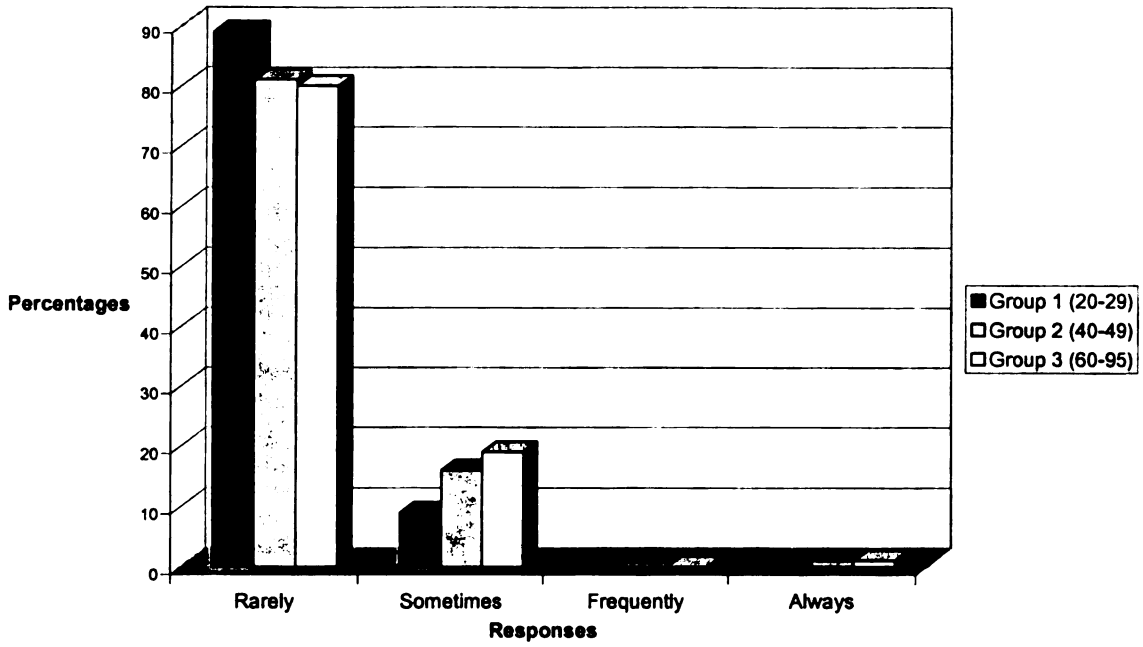

Figure 10. Group mean percentages of responses across three age groups for SSQ1-SSQ7.

Group mean percentages and standard deviation were calculated for questions SSQ8 and SSQ9 (Figure 11). Group 1 results revealed 58% responded 'yes', 23% responded 'no', and 20% responded 'don't know'. Results of Group 2 revealed 20% responded 'yes', 38% responded 'no', and 43% responded 'don't know. Group 3 responses revealed 24% answered 'yes', 50% responded 'no', and 27% responded 'don't know' that aging did effect one's ability to chew and swallow. Overall, over half of Group 1 indicated that getting older effects one's ability to chew and swallow. Less than half of Group 2 indicated that they did not know if aging affected one's ability to chew and

swallow, while half of Group 3 indicated that getting older did not effect one's ability to chew and swallow.

Chi-square statistical analysis was performed on SSQ8-SSQ9 respectively. Only one analysis revealed any statistically significance at the $p<.05$ level. The youngest group, ages 20-29, responded that more swallowing difficulties would occur as one gets older. The two older groups did not have that same opinion. Participants in groups 2 and 3 spread their responses across 'yes', 'no', and 'don't know' regarding the influence of aging on swallowing.

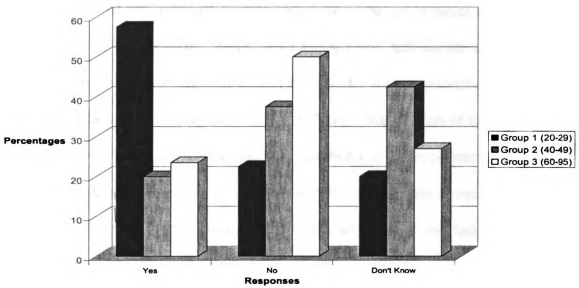

Figure 11. Group mean percentages of responses across three age groups for SSQ8-SSQ9.

Clinical Swallowing Examination and Cervical Auscultation

As a component of the Clinical Swallowing Examination (CSE) (Appendix F), an oropharyngeal examination was performed to assess structure and function of the swallowing mechanism on 55 nondysphagic participants involved in the principal investigation. Ten of the 55 participants were used in the reliability training session with the Principal Investigator and a Rater. Modifications from Murray (1999) and McKaig and Thibodeau (1998) were used to analyze the results.

Structure of the orofacial area included examination of facial symmetry at rest, lip closure, lingual size, tongue at rest, hard and soft palate examination, and condition of the teeth. No significant asymmetry was observed on the facial area, or the lips at rest. Labial seal was functional. Observation of the tongue at rest revealed normal appearance. No fasciculations or tremors were observed. Hard palate width and height were judged normal. Soft palate at rest with uvula midline was normal. All participants received a score of '1' indicating structure was normal and functioning properly for swallowing purposes.

Examination of the teeth and gingiva indicated that the participants in Groups 1 and 2 maintained their natural teeth, while 12 of 15 of the participants in Group 3 had missing teeth and some wore dentures; but the missing teeth reportedly did not interfere with mastication of solid bolus. Gingiva of the mandible, maxilla, and sublingual areas were normal. The mucous lining of the buccal cavity was also examined. No abnormalities were noted in any of the 55 participants.

Function of the oral structures, which included labial protrusion, retraction, range of motion, strength, and seal were scored using a 1-5 scale. Additionally, lingual protrusion, retraction, strength, elevation, depression, range of motion, velar elevation, and jaw (at rest and during movement) were examined and scored using a 1-5 scale. Gag reflex and volitional cough were also examined. No deficits were found in function of the orofacial structures. Velar elevation and gag reflex were timely and functional.

Cervical auscultation was performed on 55 participants by the Principal Investigator. All participants were given verbal instructions and three trials of liquids (5 cc each) and of solids (cracker). Each participant sat in a chair with a straight back. Swallow sounds were judged using a five point scoring system.

Twenty participants were included in Group 1(20-29). Participants scored a "1" indicating clear audible sound without coughing and all demonstrated timely posterior transfer of bolus. Laryngeal elevation/excursion also was functional. Nineteen of the twenty participants in Group 2 had a clear audible sound without coughing. One participant in Group 2 coughed on the first trial of liquids, scoring a '3' wet gurgly sound with immediate coughing. All 15 participants in Group 3 received a '1' clear audible sound without coughing on all swallows.

Reliability

Ten of the 55 participants in this study were used for inter-rater reliability of cervical auscultation. Four members of Group 1, three from Group 2, and three from Group 3 were included in the inter-rater reliability session. Data were collected during one appointment.

The Principal Investigator and a second rater did not confer with each other concerning judging of the trial swallows until all data collection was completed. A Littmann Cardiology III Stethoscope was used by each rater. Data collection at Valdosta State University was collected in an audiological suite to reduce environmental noises. Participants received three trials of liquids (5 cc each) and three of solids. Each rater placed the stethoscope at the lateral border of the trachea immediately inferior to the cricoid.

Results of inter-rater reliability revealed that the principal investigator judged all 60 swallows as normal, '1' indicating clear audible sound without coughing. The second rater judged the first 24 sounds of the first four participants as '5' indicating 'unable to detect.' All sounds that were rated "1" were considered "normal". However, the remaining six participants were judged by the second rater as normal, '1' clear audible sound without coughing. Thus while the two raters did not agree on any of swallow sounds using cervical auscultation for the first four participants, the raters had perfect agreement with the remaining six participants.

CHAPTER V

DISCUSSION

Understanding the nature of swallowing in individuals without swallowing disorders is a precursor to successfully evaluating persons with dysphagia. This cross-sectional study was designed to examine the following questions: does aging change nondysphagic women's swallowing status across the adult age span? Does aging change nondysphagic women's perceptions of swallowing as people age? And, is cervical auscultation a reliable screening adjunct to the clinical swallowing examination. Fifty-five women between the ages of 20 and 95 were participants in this study. The vast majority of the participants in all three groups regardless of age, reported to have no difficulty with chewing or swallowing activities. Additionally, the age of the participants did not show any differences regarding how they viewed their current eating and drinking activities. The women in each age group perceived their eating and drinking activities to be normal. However, the youngest group felt that swallowing would become more difficult as one ages. In contrast, the other two groups did not feel that age would have a negative impact on their chewing and swallowing activities.

Cervical auscultation is gaining recognition as a screening adjunct to the clinical swallowing examination. It was employed in this study to determine its reliability as a screening procedure. The investigator and rater were in 100% agreement in judging normal swallowing sounds during the training period as well as during the study. Therefore, cervical auscultation was determined to be a reliable screening

adjunct to detect the normal swallow of women across the adult age span.

Significance and Clinical Implications

Advancing age increases the elderly to chronic and acute illnesses predisposing them to conditions that may cause dysphagia. Age-related studies of alterations in swallowing have identified several age associated impairments in swallowing (Hudson, Daubert, Mills, 2000) such as impaired pharyngeal peristalsis and upper esophageal opening (Shaker, et al., 1993). Logemann (1993) indicated that normal age-related changes in the oropharyngeal area can affect chewing and swallowing while Rademaker et al. (1988) found that differences in swallowing function such as altered bolus transit time, velopharyngeal closure and cricopharyngeal opening occurred with age. Further, Sonies et al.(1988) found that as people age, there was an increase in swallow duration.

On the other hand, Cherney & O'Neill (1986) indicated that aging alone does not cause swallowing severe enough to interfere with functional swallowing. Hudson and Mills (2000) and Sheth and Diner (1988) contend that the ability to chew and swallow is unaffected by age but is affected by tooth loss. Similarly, Fucile et al. (1988) indicated that functional eating skills did not deteriorate with age but rather was related to denture wear. The current research concurred with these studies, finding that healthy elderly community dwellers maintained their functional chewing and swallowing abilities. Thus, people can expect to be able to masticate and swallow without restrictions as they age, given no other confounding medical conditions.

Logemann (1998) indicated that cervical auscultation has excellent potential. Many researchers have advocated the use of cervical auscultation as an adjunct to the clinical swallowing examination (Youmans & Stierwalt, 2005, Leslie, 2004, 2002, Mills, 2002, Zenner, et al., 1995). The benefits of using cervical auscultation as an adjunct to the CSE are numerous. Given the increased incidence of dysphagia in the elderly and a need for early detection of swallowing changes, an expeditious and accurate way of screening for swallowing changes is paramount (Youmans & Stierwalt, 2005). Early detection of such changes can warrant more advanced and specific testing. The Clinical Swallowing Examination with cervical auscultation can provide immediate outcomes without modifying the examination. Further, "cervical auscultation maintains its advantages such as its naturalness, relative inexpensiveness, noninvasiness, and availability" (Youmans & Stierwalt, 2005, p.195). The patient can be seen at bedside, the food does not have to tinted with blue or green dye for enhancement nor does it need to be coated with barium for contrast. The patient only has to retrieve the food from an eating utensil.

Cervical auscultation can become a very effective procedure used to diagnose dysphagia. It is cost prohibitive to use equipment such as videofluoroscopy (VFSS) and fiberoptic endoscopic evaluation of swallowing (FEES) in every setting to diagnose dysphagia (e.g. long-term care facilities). Cervical auscultation is a noninvasive procedure that is used to listen to swallowing sounds via stethoscope. The cost is inexpensive compared to VFSS and FEES, both which requires expensive equipment as well as several skilled

medical personnel. Additionally, risks to patients by using radiation and allergic reactions to barium sulfate are eliminated when cervical auscultation is used. Although there is no procedural code or cost attached to cervical auscultation, in most hospitals the bedside dysphagia examination is the initial step in screening for dysphagia before extensive procedure are warranted. In addition, cervical auscultation requires only minimal physical involvement by the patient and one skilled professional.

Another significant aspect of this study was its focus on women across the adult age span. Although not part of the experimental design the majority (82%) of the participants were African American. NIH (1994) reported that women and minorities should be included in clinical research if inferences about their health and disease are to be made. This research addressed the above mentioned issue. The participants were healthy community dwellers, with varied backgrounds, from Norway, South Carolina and Valdosta, Georgia between the ages of 20 and 95. No other data has reported specifically concerning the swallow mechanism across adult African American women as they age.

Limitations and Future Research

More research is needed to verify the reliability of cervical auscultation with individuals who have dysphagia as an adjunct to the clinical swallowing examination. This study showed that cervical auscultation was reliable for normal patterns of swallowing. Unexpectedly, no participants demonstrated any chewing or swallowing difficulties during the actual food and drink trials. Stroud et al. (2002) indicated in their study on cervical auscultation, that they found the level

of agreement over chance between multiple raters was 0.28, 'fair' agreement (Kappa statistic 0.21- 0.40). Leslie et al. (2004) indicate that as more detailed studies continue to be conducted in cervical auscultation (CA) and training in using CA, reliability may improve. This should include those patients who have suffered strokes as well as those with neurodegenerative diseases.

Another area for further study is training for judging normal and disordered swallowing sounds. Leslie et al. (2004) used 31 SLPs to participate in their study. Stroud et al. (2002) recruited five SLPs experienced in cervical auscultation to judge swallowing sounds via cervical auscultation. While there are no specific guidelines for training someone to use cervical auscultation, in a their study Stroud et al. defined experience as "having received at least five hours of training on cervical auscultation and having used auscultation to assess patients for at least one session per week as part of their current job" (p.641). In the current study, the second rater was trained for over a week, with 100% reliability with the principle investigator. More importantly, however, there was a gap of several months between the training of CA with this rater and her actually rating of the experimental sounds. Being unsure with what she was listening for, her first four participants were all scored as 'unable to detect'. In subsequent participants, rater 2 and the principal investigator were in identical agreement. In the future, if not performing cervical auscultation for a period of time, professionals should go through refresher training before conducting this procedure with a patient.

In support of how normal swallow sounds, Selly et al. (2004) indicated that two clear "clicks" maybe heard during each normal swallow. McKaig and Thibodeau (1998) described the swallow sounds as (1) " a click associated with articulation of the epiglottis, (2) a wet pop associated with the opening of the cricopharyngeus, and (3) a puff or huff associated with the release of subglottal air trapped when the vocal folds closed to protect the airway. Abnormal sounds were characterized as including "a wet sucking noise" (p. 26).

While there is no universal time frame for a person to be trained on listening to swallowing sounds, this problem can be addressed from a pedagogical standpoint. In a study by Sitoh, Lee, Phua, Lieu & Chan (2000) a geriatrician conducted a simple bedside assessment of elderly patients 24 hours upon admission to a hospital. Being unaware of each others results, a geriatrician identified 42 patients with a swallowing dysfunction, while the speech-language pathologist's diagnosed 40 patients to have dysphagia.

In addition, recording of the sounds can be made and utilized as training tapes. Morinière, Beutter & Boiron (2006) used cervical auscultation to assess the acoustic sounds of swallowing. They recorded 240 recordings for the 30 subjects in their study. Leslie et al. (2004) recorded swallowing sounds on compact discs and mailed to 31 SLPs so that they could rate the swallow sounds as normal or abnormal. Such recordings can be used in medical and nursing schools, medical technology programs, and communication disorders programs to teach their students how to listen to and judge swallow sounds. It would be easier for medical and medical technology students to perform such training

since students in those programs are already trained on how to listen to lung sounds. Once trained, health professionals such as SLPs, physicians, physician assistants, nurses, and geriatricians, can incorporate cervical auscultation into their routine physical examination.

Another area for further study is the consensus regarding the instrumentation for collecting the data. Researchers have used a variety of instruments including a Toshiba notebook computer with a hard drive via a Littmann Cardiology III stethoscope (Leslie, et al, 2004). Youman & Stierwalt (2005) used an accelerometer and an ICP sensor signal conditioner set to a computerized speech Lab for recording and analysis. Takahashi et al. (1994) used a TEAC 501 accelerometer, an electret condenser microphone and KAY 5500 DSP Sonogram and Perox B215 tape recorder to record swallow sounds. Stroud et al. (2002) used a radiotranslucent stethoscope head containing an electret microphone into a Panasonic 5-VHS video recorder, VFSS and audio recorders. Given the variety of instruments used, there needs to be consensus among researchers regarding the best type of instruments to use to listen to and record swallow sounds.

Another limitation of this study was sample size per group, especially participants in the old-old group. This study consisted of three groups of 20, 20, and 15 across age group respectively. Additionally, the study composed of primarily of African-American participants. A study of this type would need to be expanded upon, not only number, but gender, and other minority groups as well.

Conclusions

Although there are normal age-related changes that occur in the oropharyngeal area, these changes are not severe enough to interfere with functional chewing and swallowing abilities. This study revealed that women across the age span did not report any difficulties in their mastication and deglutition skills. It was also shown that the youngest group felt that aging would likely cause one to experience chewing and swallowing difficulties while the two remaining groups did not feel aging would likely cause one to experience difficulties with chewing and swallowing. Further, this study showed that as women maintained their health that mastication and deglutition skills also remained intact.

This study further revealed that cervical auscultation was a reliable screening adjunct to the Clinical Swallowing Examination. Future research of cervical auscultation should prove beneficial as a screening adjunct to the clinical swallowing examination when videofluoroscopy and fiberoptic endoscopic evaluation of swallowing are not available.

APPENDICES

APPENDIX A

Letter to Prospective Referral Sources

Dear Sir or Madame:

My name is Ruth Renee Hannibal. I am a doctoral candidate in the Department of Audiology and Speech Sciences and Disorders at Michigan State University in East Lansing, Michigan and a faculty member in the Department of Special Education and Communication Disorders at Valdosta State University in Valdosta, Georgia. My area of study for my dissertation is the effect of aging on the oropharyngeal swallow in nondysphagic women (i.e., women who do not have a swallowing disorder). I am seeking participants who meet the following criteria: (1) women between the ages of 20-29; 40-49; 60+ (2) have no medical history of neurologic and or degenerative diseases; (3) have no history of diagnosed swallowing disorder and; (4) no diagnosed cancer of the mouth or throat.

The purpose of this study is to evaluate the effectiveness of the swallow and perceptions women have concerning swallowing as it relates to aging. Potential subjects should understand the participation in this study is voluntary and that there is no monetary benefit associated with participating in this study. The study will take approximately 45 minutes.

I am requesting that you share this information with the women in your organization/auxiliary and women's ministry. If there are women who are interested, please ask them to contact me at (229) 219-1310 or at (229) 244-9717, or email me at rrhannib@valdosta.edu. Thank you for your cooperation.

Thank you,

Ruth Renee Hannibal
Department of Audiology and Speech Sciences
Michigan State University
East Lansing, Michigan

Appendix B

WRITTEN-ORAL SCRIPT

Written-Oral Script

Hello, my name is Ruth Renee Hannibal. I am an Assistant Professor in the Department of Special Education and Communication Disorders at Valdosta State University and a doctoral candidate at Michigan State University. Your name was give to me by your president/ professor. You indicated that you were interested in participating in a study to assess women's swallowing. Please allow me to explain the purpose of my study so that you can decide if you still want to participate.

There has been minimal to no research on the effects of normal aging has on the swallowing process, particularly in women. The profession of speech-language pathology is continuing to work with individuals across the life-span who has swallowing disorders and is looking for ways to be cost efficient in providing services. The use of a stethoscope to listen to swallowing sounds is still new, but is gaining recognition among some speech-language pathologists, especially when the individuals that they serve can not be taken to the hospital for x-rays of their throat. This study is designed to assess the swallowing in women ages 20-29; 40-49; 60+.

The study involves four steps: (1) reading and signing a consent form for participation in the study; (2) answering questions concerning your medical, surgical and swallowing history; (3) and an examination of mouth (tongue, teeth, lips, throat); and (4) swallowing 15 cc of water and chewing and swallowing one cracker.

There are no known risks involved in this study.

The entire study will take approximately 45 minutes and should be competed within that time.

Now that the purpose and procedures have been explained, do you wish to participate?

If the answer is 'yes' data will be collected during the meeting and/or appointments will be made to collect the data.

If the answer is 'no,' Thank you very much for your time.

Appendix C

Department of Communicative Sciences and Disorders
Research Consent Form for
"The effects of aging on oropharyngeal swallow in nondysphagia women"

Department of Communicative Sciences and Disorders
Research Consent Form for
"The effects of aging on oropharyngeal swallow in nondysphagia women"

Summary: There has been minimal research on the effects of the normal aging process in swallowing in women who do not have swallowing problems. Because of Medicare changes speech-language pathologists are looking for noninvasive means of diagnosing swallowing problems. This study is designed to examine the effectiveness of the use of the clinical swallowing evaluation using a stethoscope to detect subtle swallowing problems in women ages 20-29; 40-49; 60+

Procedures: This study will take approximately 45 minutes to complete.

Step 1: Reading and signing this consent form giving me permission to include you in this research.

Step 2: Answering questions to a swallowing questionnaire. The swallowing questionnaire is given to determine whether any reported conditions will interfere with the normal swallowing.

Step 3: A Clinical Swallowing Examination to assess the structure and function of the lips, tongue, hard palate, soft palate and the swallow. This involves simple movements of these structures and using a stethoscope on the windpipe and/or voice box to listen while you swallow.

Discomforts/Risks: There are no risks involved in this study. The Clinical Swallowing Examination is a noninvasive procedure used daily in hospitals.

Benefits: There are no direct benefits or compensation from this study. The data gathered would assist health care providers with valuable information needed to expand the knowledge on how listening to swallowing sounds using a stethoscope can be used as a noninvasive means for detecting clinical signs of swallowing disorders.

Confidentiality: Your name will not be revealed to anyone other than me and another speech-language pathologist who will assist in the data collection. The data will be located in my office in a locked cabinet.

Your privacy will be protected to the maximum extent allowable by law.
The results of this study may be presented at professional conferences and may appear in appropriate journals and other publications.
Your privacy will be protected to the maximum extent allowable by law.

If you have questions about this study, please contact the investigator Ruth Renee Hannibal at (229) 219-1310, e-mail: rrhannib@valdosta.edu or regular mail: Valdosta State University, Special Education and Communication Disorders, 1500 N. Patterson St, Valdosta, GA 31698-0102. If you have questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact – anonymously, if you wish – Peter Vasilenko, Ph.D, at (517) 432-4503, e-mail: rcrihs@msu.edu or regular mail: 202 Olds Hall, East Lansing, MI 48824.

Your signature below indicates your voluntary agreement to participate in this study.

Name _____ Date _____

Appendix D

Medical History Questionnaire

Medical History Questionnaire

Name _____ BD _____ Grp ____/____
Please answer and circle all the questions as accurately as possible.

Have you ever been diagnosed by a doctor and/or have treatment for any of the conditions below?

1. Lou Gehrig Disease (ALS)	Yes	No
2. Alzheimer's Disease	Yes	No
3. Cervical Osteophytes	Yes	No
4. Dermatomyositis	Yes	No
5. Dysphagia (swallowing problem)	Yes	No
6. Esophagitis	Yes	No
7. Gastroesophageal Reflux	Yes	No
8. Head Injury	Yes	No
9. Hiatus Hernia	Yes	No
10. Parkinson's Disease	Yes	No
11. Polio	Yes	No
12. Spinal Cord Injury	Yes	No
13. Stroke	Yes	No
14. Transient Ischemic Attack (TIA. mini strokes)	Yes	No
15. Other	Yes	No

Surgical

Have you ever had surgery and/or radiation of the following because of cancer?

16. Tongue	Yes	No
17. Neck	Yes	No
18. Throat	Yes	No
19. Esophagus	Yes	No
20. Brain	Yes	No

Appendix E

Swallowing Status Questionnaire

Swallowing Status Questionnaire

Name _____

Please circle the answers to the questions below. Use the descriptions as a guide.

Always= coughing after swallowing liquids or solids at every meal.
Frequently= coughing after swallowing liquids or solids one time per meal.
Sometimes= coughing after swallowing liquids or solids one to two times per month per meal.
Rarely= coughing one time or less after swallowing liquids or solids per year.

1. In general, do you cough after drinking liquids?
   Always Frequently Sometimes Rarely
2. In general, do you cough after swallowing foods?
   Always Frequently Sometimes Rarely
3. In general, do you cough after swallowing saliva?
   Always Frequently Sometimes Rarely
4. In general, do you take small drinks of liquids to avoid coughing?
   Always Frequently Sometimes Rarely
5. In general, do you eat small bites of food to avoid coughing?
   Always Frequently Sometimes Rarely
6. In general, do you experience pain while swallowing?
   Always Frequently Sometimes Rarely
7. In general, do you experience heartburn or indigestion following meals?
   Always Frequently Sometimes Rarely

Perceptions

Please circle your answer

8. Does getting older affect one's ability to swallow?
   Yes No Don't know

9. Does getting older affect one's ability to chew?
   Yes No Don't know

Appendix F

Clinical Swallowing Examination

Clinical Swallowing Examination

Name _____ Date _____
BD _____ Age _____
Group _____/_____

Structure Score: 1= structure is normal 2= structure is abnormal

Face at rest _____ Lips at rest _____
Lingual size _____ Hard palate _____
Soft palate _____

Examination of teeth **+= present** **- = absent**

Natural teeth _____ Missing teeth _____
Dentures: complete _____ upper _____ lower _____
Partials: Upper _____ lower _____ Bridges _____
Edentulous _____

Function: Score: 1 = function is executed correctly and immediately
2 = function is executed correctly with delay (3-5s)
3 = function is executed incorrectly and immediately
4 = function is executed incorrectly and delayed

Labial protrusion (VII): ___	Full protrusion of lips
Labial retraction (VII) : ___	Full retraction of lips
Labial strength (VII): ___	Firm grasp of tongue blade
Labial seal (VII): ___	No audible leakage of 5mL of water. No drooling
Labial ROM (VII) ___	Alternate purse and retract lips for 10 cycles
Lingual protrusion (XII):___	Fully extended tongue with no deviations
Lingual retraction (XII): ___	Fully retracted tongue into the oral cavity with no deviations
Lingual strength (XII): ___	Tactile resistance against tongue blade
Lingual ROM (XII): ___	Contact of tongue against left and right sides of lips and ability to sweep tongue along length of the maxillary and mandibular and buccal sulci
Lingual elevation (XII): ___	Elevation of tongue tip or blade to upper lip, alveolar ridge, and hard palate
Lingual depression (XII): ___	Lowering of tongue tip behind bottom teeth
Velar elevation (X): ___	Movement upward and backward upon phonation of /a/
Mandible (V): ___	Ability to open and close mouth without difficulty

Mandible ROM (V):	___	Movement of jaw right to left without difficulty
Volitional cough (X):	___	Strong and forceful cough

Trial Swallows	**Observational signs**	**+ = present ---- = not present**
Saliva Swallows:	___	Ability to swallow saliva without difficulty
Bolus formation:	___	Ability to perform rotary chewing of solids to form bolus
Laryngeal elevation:	___	Visual observation of elevation of larynx during Trial swallows
Oral residue:	___	No oral residue on teeth, hard palate, tongue, Lateral or anterior residue
Vocal quality:	___	Clear sustained phonation following trial swallows
Salivary flow/control:	___	No signs of drooling at rest or during or after trial swallows
Reflexive cough:	___	Absence of cough following trial swallows

Cervical Auscultation: Score:1 = clear audible sound without coughing
2 = wet gurgly sound without coughing
3 = wet gurgly sound with immediate coughing
4 = wet gurgly sound with delay coughing
5 = unable to detect

Liquids	**Solids**
1. _____	1. _____
2. _____	2. _____
3. _____	3. _____

REFERENCES

REFERENCES

Abella, M. Formolo, J. Penny, D.G. (1992). Comparison of the acoustic properties of six popular stethoscopes. Journal of Acoustics Society of America, 91(4) 2224-2228.

American Speech-Language Hearing Association (2000). Clinical indications for instrumental assessment of dysphagia (guidelines). ASHA Desk Reference. Rockville, MD. Author.

Arms, R.A., Dines, D.E., & Tinstman, T. (1974). Aspiration pneumonia. Chest, 65(2).

Arvedson, J.C., & Lefton-Grief, M.A. (1998).Pediatric videofluoroscopic swallow studies. A professional manual with caregiver guidelines Austin, Texas: Communication Skill Builders.

Aviv, J.E., et al. (1994). Age-related changes in pharyngeal and supraglottic sensations. Annals of otology rhinology and laryngology, 103(10), 749-756.

Bass, N.H. (1997). The neurology of swallowing. In Micheal E. Groher (Ed.). 3rd ed. (pp.7-35). Newton, MA.: Butterworth-Heinemann.

Batchelor, B., Neilsen, S., Sexton, K. (1996). Issues in maintaining hydration in nursing home patients who aspirate thin liquids. Journal of Medical Speech-Language Pathology. 4(3), 217-221.

Blitzer, A. (1990). Approaches to the patient with aspiraton and swallowing disabilities. Dysphagia, 5, 129-137.

Brozenec, S. (2000). Gastrointestinal functions. In Annette G. Lueckenotte (Ed.). Gerontological Nursing. (.43-552). St. Louis: Mosby.

Cherney, L.R. & O"Neill, P. (1986). Swallowing disorders and the aged. Topics in Geriatric Rehabilitation, 1(4) 45-59.

Cherney, L.R. (1994). Clinical management of dysphagia in adults & children. (2nd ed.). Gaithersburg,MD: Aspen Publishers, Inc.

Cichero, J.A.Y. & Murdoch, B.E. (2002). Detection of swallowing sounds: Methodology revisited. Dysphagia, 17, 40-49.

Cichero,J. A. & Murdoch, B. E. (1998). The physiologic cause of swallowing sounds: answers from heart sounds and vocal tract acoustics. Dysphagia, 13(1), 39-52.

Clark, H.M. (2005). Clinical decision making and oral motor treatments. The Asha Leader. 10 (8). American Speech-Language Hearing Association: MD.

Crary, M.A. & Groher, M.E. (2003). Introduction to adult swallowing disorders. Missouri: Butterworth Heinemann.

Daniels, S.K., McAdam, C.P., Brailey, K., and Foundas, A.L.,(1997). Clinical assessment of swallowing and prediction of dysphagia severity. American Journal of Speech-Language Pathology, 6(4) 17-24.

Daniels, S.K., Brailey, K., Priestly, D.H., Herrington, I.R., Weisberg, L.A., Foundas, A.L. (1998). Aspiration in patients with acute stroke. Archives of Physical Medicine and Rehabilitation. 79 14-19.

Daniels, S.K., Corey, D.M., Hadskey, L.D., Legendre, C., Priestly, D.H.M, Rosenbek, J.C., et al. (2004). Mechanism of sequential swallowing during straw drinking in healthy young and older adults. Journal of Speech,Language, and Hearing Research. 47, 33-34.

Dawson, J.B. (1964). Auscultation and the stethoscope. Practitioner, 193, 315-322.

Ding, R. & Logemann, J. (2000). Pneumonia in stroke patients: A retrospective study. Dysphagia, 15, 51-57.

Dirckx, H.H. (2001). Stedman's concise medical dictionary for the health professions. Illustrated. 4th ed. p. 253. Baltimore: MD: Williams & Wilkins.

Dodds, W.J., Stewart, E.T., Logemann, J.A.. (1990). Physiology and radiology of the normal oral and pharyngeal phases of swallowing. American Journal of Roentenology, 154, 953-963.

Donner, M.W. & Jones, B. (1991). Aging and neurological disease. In M.W. Donner & B. Jones (Eds.), Normal and abnormal swallowing imaging in diagnosis and therapy (pp.189-202). New York: Spinger-Verlag.

Dray, T.G., Hillel, A.D., Miller, R. (1998). Dysphagia caused by neurologic deficits. Otolaryngologic Clinics of North America, 31(3), 507-524.

Duffy, J. (2005). Motor speech disorders: Substrates, differential diagnosis and Management (2nd ed.). United States: Elsevier Mosby.

Ebersole, P. & Hess, P. (2000). Toward healthy aging human needs and nursing response. (5th ed.) St. Louis: Mosby.

Edwards, J., Hawkins, D. (2000). Radiologic concepts in the management of adult dysphagia. In Russell H. Mills (Ed.), Evaluation of dysphagia in adults: Expanding the diagnostic options, (pp. 65-102). Austin, TX: Pro·Ed.

Ekberg, O., Feinberg, M.J. (1991). Altered swallowing function in elderly patients without dysphagia: Radiologic findings in 56 cases. American Journal of Roentgenology, 156(6), 1181-1184.

Eckberg, O. (1997). Radiologic evaluation of swallowing. In Michael E. Groher (ed.). Dysphagia:Diagnosis and management (3rd ed.). (pp. 191-222). Butterworth-Heinemann.

Ergun, G.A. & Miskovitz, P.F. (1992). Aging and esophagus: common pathologic conditions and their effect upon swallowing in the geriatric population. Dysphagia, 7, 58-63.

Fucile, S., Wright, P.M., Chan, I., Yee, S., Langlais, M.E., & Gisel, E. (1998). Functional oral-motor skills: do they change with age? Dysphagia, 13(4), 195-210.

Garon, B.R., Engle, M., Orimiston, C. (1996). Silent aspiration: Results of 1,000 videofluoroscopic swallow evaluations. Journal of NeuroRehabilitation, 10(2), 121-126.

Gleeson, D. (1996). The effects of aging on selected parameters of oropharyngeal swallowing. Unpublished doctoral dissertation. Michigan State University.

Goodrich, S.J., & Walker, A. I. (1997). Clinical swallow evaluation. In Rebecca Leonard & Katherine Kendall (Eds.), Dysphagia assessment and treatment planning: A Team approach. (pp. 59-72). San Diego: Singular Publishing Group, Inc.

Gordon, C., Hewler, R.L., & Wade, D.T. (1987). Dysphagia in acute stroke. British Medical Journal, 295, 411-414.

Granieri, E. (1990). Nutrition and the older adult. Dysphagia, 4, 196-201.

Groher, M. E. (2000). The case history. In Russel H. Mills (Ed.). Evaluation of dysphagia in adults: Expanding the diagnostic options. (1-25). Austin, TX: Pro•Ed.

Groher, M.E. (1997). Mechanical disorders of swallowing. In Michael E. Groher (Ed.). Dysphagia: Diagnosis and management. 3rd ed. 73-106.

Groher, M. & Bukatman, R. (1986). The prevalence of swallowing disorders in two teaching hospitals. Dysphagia, 1, 3-6.

Hamlet, S., Penny, D.G., & Formolo, J. (1994). Stethoscope acoustics and cervical auscultation of swallowing. Dysphagia.9, 63-68.

Hanning, C., Wuttage-Hannig, A., Hormann, A, & Herrmann, I.F. (1989). Cinematographic study of the pathologic mechanism of aspiration pneumonia. ROFO150: 260-267.

Hardy, E. (1995). Bedside evaluation of dysphagia. Bisbee, AZ.: Imaginart.

Hardy, E. & Robinson, N. M. (1993). Swallowing disorders treatment manual, Bisbee, AZ: Imaginart.

Hedge, M.N. (2006). A coursebook on aphasia and other neurogenic language disorders. (3rd ed.). (pp. 515-516). United States: Thomas•Delmar Learning.

Hensel, S. L. (2000). Sensory function. In Annette Lueckenotte (Ed.). Gerontological nursing. (pp.695-720). St. Louis: Mosby.

Hetzel, L. & Smith, A. (2001). The 65 years and over population: 2000 Census 2000 Brief. U.S. Department of Commerce. Retrieved 8/28/06 @ www. census.gov.

Horner, J., Massey, E.W., & Brazer, S. R. (1990). Aspiration in bilateral stroke patients. Neurology, 40, 1686-1688.

Horner, J. & Massey, W. (1988). Silent aspiration following stroke. Neurology, 38, 317-319.

Horner, J., Buoyer, F.G., Alberts, M.J., & Helms, M.J. (1991). Dysphagia following brain-stem stroke: clinical correlates and outcomes. Archives of Neurology, 48, 1170-1173.

Hudson, H., Daubert, C. R., Mills, R.H. (2000). The interdependency of protein-Energy malnutrition, aging, and dysphagia. Dysphagia, 15, 31-38

Hudson, J. C. & Mills, R. H. (2000). Dental aspects of swallowing. In Russell H. Mills (Ed.). Evaluation of dysphagia in adults: Expanding the diagnostic options, (pp. 207-237). Austin, TX: Pro·Ed.

Johnson, H. & Scott, A. (1993). A practical approach to saliva control. Tucson, AZ: Communication Skill Builders.

Kahrilas, P.J., Dodds, W.J., Dent, J., Logemann, J.A.,& Shaker, R. (1988). Upper esophageal sphincter function during deglutition. Gastroenterology, 95, 52-62.

Kawashima, K., Motohashi, Y., & Fujishima, I. (2004). Prevalence of dysphagia among community-dwelling elderly individuals as estimated using a questionnaire for dysphagia screening. Dysphagia, 19, 266-271.

Kendall, K., McKenzie, S., Leonard, R. J., Gonclaves, M. I. & Walker, A. (2000). Timing of events in normal swallowing. A videofluoroscopic study. Dysphagia, 15, 74-83.

Kendall, K.A. & Leonard, P.J. (2001). Bolus transit and airway protection coordination in older dysphagic patients. The Laryngoscope, 111(pt. 1), 2017-2022.

Kendall, K., McKenzie, S., & Leonard, R. (1997). Dynamic swallow study: Objective measures and normative date. In Rebecca Leonard and Katherine Kendall (Eds.). Dysphagia assessment and treatment planning: A team approach. (pp. 101-125). San Diego: Singular Publishing Group, Inc.

Kuhlemeler, K.V. (1994). Epidemiology and dysphagia. Dysphagia, 9, 209-217.

Lazarus, C.L. (1989). Swallowing disorders after traumatic brain injury. Journal of Head Trauma and Rehabilitation, 4(4), 34-41.

Leonard,R.J., Kendall, K.A., McKenzie,S., Gonclaves, M.I., & Walker, A. (2000). Structural displacements in normal swallowing: A videofluoroscopy study. Dysphagia, 15, 146-152.

Leonard, R., Kendall, K., McKenzie, S., & Goodrich, S. (1997). The treatment plan. In Rebecca Leonard and Katherine Kendall (Eds.). Dysphagia assessment and treatment planning: A team approach. San Diego: Singular Publishing Group, Inc. 181-210.

Leslie, P. (2005). Cervical auscultation: Myths and magic, evidence and clinical implications. Paper presented at 2005 ASHA Convention San Diego, CA.

Leslie, P., Drinnan, M. J., Finn, P., Ford, G.A., & Wilson, J.A., (2004). Reliability and validity of cervical auscultation: A controlled comparison using videofluoroscopy. Dysphagia 19(4), 231-240.

Linden, P. & Siebens, A. A. (1983). Dysphagia: Prediciting laryngeal penetration. Archives of Physical Medicine and Rehabilitiation, 64, 281-284.

Linton, A.D. (1997). Age-related changes in the gastrointestinal system. In Mary Ann Matteson, Eleanor S. McConnell, and Adrianne Dill Linton (Eds.). Gerontological nursing: Concepts and practice. 2nd ed. (pp. 317-336). Philadelphia: W.B. Saunders Co.

Logemann, J.A. (1983). Evaluation and treatment of swallowing disorders. San Diego: College-Hill Press.

Logemann, J.A., (1990). Effects of aging on the swallowing mechanism. In G. Sisson and H. Pelzer (Eds.). The Otolaryngologic Clinics of North America: Head and Neck Diseases in the Elderly. 23(6) 1045-1056. Philadelphia: W.B. Saunders.

Logemann, J.A. (1993). Noninvasive approaches to deglutitive aspiration. Dysphagia, 8, 331-333.

Logemann, J.A. (1997). Professional education and training. In Barbara C. Sonies (Ed.), Dysphagia: A continuum of care. (pp. 123-134). Maryland: Aspen Publishers, Inc.

Logemann, J.A. (1997). Structural and functional aspects of normal and disordered swallowing. In Carole T. Ferrand & Ronald L. Bloom (Eds.), Introduction to organic and neurogenic disorders of communication current score of practice. (pp.229-246). MA: Allyn & Bacon.

Logemann, J.A. (1998). Evaluation and treatment of swallowing disorders (2nd ed.). Austin,TX: Pro•Ed.

Logemann, J.A., Pauloski, B.A., Rademaker, A.W., Colangelo, L.A., Kahrilas, P.J., & Smith, C. H. (2000). Temporal and biomechanical characteristics of oropharyngeal swallow in younger and older men. Journal of Speech, Language, and Hearing Research, 43, 1264-1274.

Logemann, J.A., Pauloski, B.R., Rademaker, A.W. & Kahrilas, P.J. (2002).Oropharyngeal swallow in Younger and older women: videofluoroscopic Analysis. Journal of speech and hearing Research, 45, 434-445.

Love, R.J. & Webb, W.G. (2001). Neurology for the speech-language pathologist. 4th ed. Boston: Butterworth Heinemann.

Lueckenotte, A.G. (2000). Overview of gerontological nursing. (pp. 1-19). Gerontological Nursing, St. Louis: Mosby.

Madison, H.E. (2000). Theories of aging. In Annette Lueckenotte (Ed.), Gerontological Nursing, (pp. 20-33).

Mansson, I. & Sanberg, N. (1975). Oro-pharyngeal sensitivity and elicitation of swallowing in man. Acta Ololaryngology, 79, 140-145.

Marik, P.E. & Kaplan, D. (2003). Aspiration pneumonia and dysphagia in the elderly. Chest, 124 (1), 328-336.

Massey, B.T, & Shaker, R. (1997). Introduction to the field of deglutition and deglutition disorders. In Andrienne L. Pearlman and Konrad Schulze-Delrieu (Eds.). Deglutition and its disorders: Anatomy, physiology, and management (pp.1-15). Singular Publishing Group, Inc. San Diego.

Matteson, M.A., Beason, L.B., & McConnel, E.S. (1997). Psychosocial problems associated with aging. In Mary Ann Matteson, Eleanor S. McConnel & Adrianne Dill Linton (Eds.). Gerontological nursing: Concepts and practice. (2nd ed.). (pp. 653-659). Philadelphia: W. B. Saunders.

McConnell, E.S. (1997). Conceptual bases for gerontological nursing practice: Models, trends, and issues. In Mary Ann Matheson, Eleanor S. McConnell & Andrianne Dill Linton (Eds.), Gerontological nursing: Concepts and practice, 2nd edition (pp. 4-62). Philadelphia: W.B. Saunders Co.

McCullough, G.H., Wertz, R.T., Rosenbek, J.C. & Dinneen, C. (1999). Clinician's preferences and practices in conducting clinical/bedside and videofluoroscopic swallowing examinations in an adult, neurogenic population. American Journal of Speech Language pathology. 8, 149-163.

McKaig, T. & Thibodeau, J. (1998). Bedside assessment of swallowing safety: The clinician's software and user's manual. Butterworth Heinemann: Boston.

Miller, A. (1986). Neurophysiological basis of swallowing. Dysphagia, 1, 91-100.

Miller, R. (1997). Clinical examination of dysphagia. In Michael Groher (Ed.), Dysphagia: Diagnosis and management, 2nd ed. (pp.169-189). Boston: Butterworth-Heinenman.

Mills, R. (2000). Increasing the precision of the videofluoroscopy swallowing examination. In Russell M. Mills (ed.). Evaluation of dysphagiai in adults: expanding the diagnostic options. (pp. 103-144). Austin, TX: Pro•Ed.

Morinière, S., Beutter, P., & Boiron, M. (2006). Sound component duration of health human pharyngoesophageal swallowing: A gender comparison study. Dysphagia, 175-182.

Murray, J. (1999). Manual of dysphagia assessment in adults. San Diego: Singular Publishing Group, Inc.

Murray, L.L. & Clark, H.M. (2006). Neurogenic disorders of language: Theory driven clinical practice. (pp. 23). United States: Delmar•Learning.

Murry, T. & Carrau, R.L. (2001). Clinical manual for swallowing disorders. San Diego: Singular-Thomas Learning.

National Institutes of Health. (1994). Outreach notebook for the NIH guidelines on inclusion of women and minorities as subjects in clinical research. NIH Publication No. 97-4160.

Nilsson, H., Ekberg, O., Olsson, R., & Hindfelt, B. (1994). Quantitative aspects of swallowing in an elderly nondysphagic population. Dysphagia, 11, 180-184.

O'Donoghue, S. & Bagnall, A. (1999). Videofluoroscopic evaluation in the assessment of swallowing disorders in paediatric and adult populations. Folia Phoniatrica et Logopaedica, 51(4-5), 158-171.

Palmer, J.B., Drennan, J.C., & Baba, M. (2000). Evaluation and treatment of swallowing impairments. American Family Physician, 61(8), 2453-2462.

Perlman, A. (1997). Application of instrumental procedures to the evaluation and treatment of dysphagia. In Barbara C. Sonies (Ed.), Dysphagia: A continuum of care (pp. 137-159). Gaithesburg, MD: Aspen Publishers, Inc.

Perlman, A. L. & Christensen, J. (1997). Topography and functional anatomy of the swallowing structures. In Adrienne L. Perlman & Konrad Schulze-Delrieu (Eds.). Deglutition and its disorders: Anatomy, physiology, clinic diagnosis and management. San Diego: Singular Publishing Group, Inc.

Perlman, A., Langmore, S., Milianti, F., Miller, R., Mills, R.H., & Zenner, P. (1991). Comprehensive clinical examination of oropharyngeal swallowing function: Veteran's Administration Procedure. Seminars in Speech and Language. 12(3). Pp. 246-253.

Pinnington, L. L., Muhiddin, K.A., Lobeck, M. & Pearce, V.R. (2000). Interrater and intrraterreliability of the Exeter dysphagia assessment technique applied to healthy adults. Dysphagia 15, 6-9.

Rademaker, B., Pauloski, R., Colangelo, L.A., & Logemann, J.A. (1998). Age and volume effects on liquid swallowing function in normal women. Journal of Speech, Language and Hearing Research April 41(2), 275-284.

Reynolds, P.S., Gilbert, L., Good, D.C., Knappertz, V.A., Crenshaw, C., Wayne, S .L., Pillbury, D., & Tegeler, C.H. (1998). Pneumonia in dysphagic stroke patients: Effects on outcomes and identification of high risk patients. Journal of neurological rehabilitation, 12, 15-21.

Robbins, J., Hamilton, J., Lof, G., Kempster, G. (1992). Oropharyngeal swallowing in normal adults of different ages. Gastroenterology, 103(3), 823-829.

Schechter, G.L. (1998). Systemic causes of dysphagia in adults. In Randall L. Plant and Gary L. Schechter (Eds.). The Ololaryngologic Clinics of North America: Dysphagia in children and adults and Geriatrics. 31(3) 525-535. Philadelphia: W.B. Saunders.

Schulze-Delrieu, K.S. & Miller, R. M. (1997). Clinical assessment of dysphagia. In Adrienne L. Perlman & Konrad Schulze-Delrieu (Eds.). Deglutition and its disorders: Anatomy, physiology, clinical diagnosis and management (pp. 125-152). San Diego: Singular Publishing Group, Inc.

Selly, W.G., Ellis, P.E., Flack, F.C., Bayliss, C.R., Chir, B., Pearce, V.R. (1994). The synchronization of respiration and swallowing sounds with videofluoroscopy during swallowing. Dysphagia, 9 (3), 162-167.

Shaw, J.L., et al. (2004). Bronchial auscultation: An effective adjunct to speech and language therapy bedside assessment when detecting dysphagia and aspiration? Dysphagia, 19(4), 211-218.

Sheth, N. & Diner, W.C. (1988). Swallowing in the elderly. Dysphagia, 2, 209-215.

Siebens, A. A. (1990). Rehabilitation for swallowing impairment. In Frederic J. Kottke and Justus F. Lehmann (Eds.). Krusen's handbook of physical medicine and rehabilitation (4th ed.), Philadelphia: W.B. Saunders.

Sitoh, Y.Y, Lee, A., Phya, S.Y., Lieu, P.K., & Chan, S.P. (2000). Bedside assessment of swallowing: A useful screening tool for dysphagia in an acute geriatric ward. Singapore Medical Journal, 41(8), 376-381.

Smith, C.H., Logemann, J.A., Colangelo, L .A., Rademaker, A. W. & Pauloski, B.R. (1999). Incidence and patient characteristics associated with silent aspiration in the acute care setting. Dysphagia, 14(1) 1-7.

Sonies, B.C. (1997). Preface (Ed.), Dysphagia: A continuum of care. MD: Aspen Publishers, Inc.

Sonies, B.C. & Baum, B.J. (1988). Evaluation of swallowing pathophysiology. Otolaryngologic Clinics of North America, 21(4), 637-648.

Sonies, B.C., Baum, B.J. & Shawker, T.H. (1984). Tongue motion in situ observation. Journal of Gerontology, 39 pp 279-283.

Sonies, B.C., Parent, L.J., Morrish, K.&, Baum, B.J. (1988). Durational aspects of the oral-pharyngeal phase of swallow in normal adults. Dysphagia, 3, 110.

Spieker, M.R. (2000). Evaluating dysphagia. American Family Physician. 61(12) 3639-3648.

Splaingard, M. L., Hutchins, B., Sultan, L.D. & Chaudhuri, G. (1988). Aspiration in rehabilitation patients: Videofluoroscopy vs. beside clinical assessment. Archives of Physical Rehabilitation, 69, 637-640.

Stroud, A.E., Lawrie, B.W. & Wiles, C.M. (2002).Inter- and intra-rater reliability of cervical auscultation to detect aspiration in patients with dysphagia. Clinical Rehabilitation. 16, 640-646.

St. Louis, K. O. & Ruscello, D.M. (1981). The oral speech mechanism screening examination. Baltimore: University Park Press.

Takahashi, K., Groher, M.E., Michi, K., (1994). Methodology for detecting swallowing sounds. Dysphagia, 9, 54-62.

Takahaski, K. Groher, M.E., & Michi, K. (1994). Symmetry and reproducibility of swallowing sounds. Dysphagia, 9(3) 168-173.

Thompson, P.G. (1990). Aging in the 1990's and beyond. In F. Patrick Moloneu and Kevin M. Means (Eds.). Physical Medicine and Rehabilitation: State of the Arts Review. Rehabilitation and the aging population 4(1). pp. 157-166.

Tohara, H., Saithoh, E., Mays, K.A., Kuhlemeire, K., & Palmer, J.B. (2003). Three tests for predicting aspiration without videofluoroscopy. Dysphagia, 18, 126-134.

Tracy, J.F., Logemann, J.A., Jahrilas, P.J., Pothen, J., Kobara, M., & Krugler, C. (1989). Preliminary observations on the effects of age on oropharyngeal deglutition. Dysphagia, 4 90-94.

Trupe, E. H., Siebens, H., & Siebens, A. (1984). Prevalence of feeding and swallowing disorders in a nursing home. Archieves of Physical medicine and Rehabilitation, 65, 651-652.

Wilson, W.R. (1995). Nose and throat disorders. In W.B. Abrams, M.H. Beers & R. Berkow. (Eds.). Merck Manual of geriatrics. (2nd ed). NJ: Merck Research Laboratories.

Yorkston, K., Miller, R., Strand, E. (2004). Management of speech and swallowing in degenerative diseases. (2nd ed). Tucson, AZ: Communication Skill Builders.

Youmans, S.R. & Stierwalt, J.A. (2005). An acoustic profile of normal swallowing. Dysphagia, 20: 195-209.

Zenner, P.M., Losinski, D.S., Mills, R. (1995). Using cervical auscultation in the clinical dysphagia examination in long-term care. Dysphagia, 10, 27-31.

Zenner, P. (2000). The clinical examination for dysphagia. In Russel H. Mills (ed.). Evaluation of dysphagia in adults: Expanding the diagnostic options. (27-64). Austin, TX: Pro•Ed.