Respiratory Muscle Strength in Elderly Thais

ความแข็งแรงของกล้ามเนื้อหายใจในผู้สูงอายุไทย

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ABSTRACT

The ageing process is generally characterized by a loss of muscle mass and strength, a so-called sarcopenia. This study aimed to compare respiratory muscle strength (RMS) and its components between men (n=9) and women matched by age (n=9) in Thai elderly with age ranged between 55-80 years old. Correlations between the RMS and age in 41 women were also performed. PImaxFRC, PImaxRV, PEmax, Pnsn and RMS in women were 47.3%, 45.1%, 44.4%, 36.4% and 45% lower ($p<0.01$), respectively, than in men counterparts. Moreover, there were negative correlations between RMS and age in the elderly women; PImaxFRC ($r=-0.4237$), PImaxRV ($r=-0.4213$), PEmax ($r=-0.4838$), Pnsn ($r=-0.4265$) and RMS ($r=-0.4693$) ($p<0.01$). These findings suggest a higher RMS in the elderly men compared to women and RMS declines with age in the elderly Thai women.

บทคัดย่อ

กระบวนการแก่ชราหรือในผู้สูงอายุจะมีการสูญเสียความแข็งแรงของกล้ามเนื้อ งานวิจัยนี้มีวัตถุประสงค์เพื่อเปรียบเทียบความแข็งแรงของกล้ามเนื้อหายใจ (respiratory muscle strength, RMS) ในผู้สูงอายุชายและหญิงจำนวน 50 คน ที่มีอายุระหว่าง 55-80 ปี และศึกษาความสัมพันธ์ระหว่าง RMS กับอายุในผู้สูงอายุหญิง โดยพบว่าเมื่อเปรียบเทียบกับผู้สูงอายุชาย ค่า PImaxFRC, PImaxRV, PEmax, Pnsn และ RMS ในผู้สูงอายุหญิง (ชายและหญิงกลุ่มละ 9 คน) มีค่าน้อยกว่า 47.3%, 45.1%, 44.4%, 36.4% และ 45% ($p<0.01$) ตามลำดับ นอกจากนี้ยังพบความสัมพันธ์เชิงลบระหว่าง PImaxFRC ($r= -0.4237$), PImaxRV ($r= -0.4213$), PEmax ($r= -0.4838$), Pnsn ($r= -0.4265$) และ RMS ($r= -0.4693$) ($p<0.01$) กับอายุในผู้สูงอายุหญิง ข้อมูลที่พบครั้งนี้ยืนยันว่าผู้สูงอายุชายมีความแข็งแรงของกล้ามเนื้อหายใจมากกว่าผู้สูงอายุหญิง และความแข็งแรงของกล้ามเนื้อหายใจในเพศหญิงจะลดลงตามอายุที่เพิ่มมากขึ้น

Key Words: Respiratory muscle strength, Elderly

คำสำคัญ: ความแข็งแรงของกล้ามเนื้อหายใจ ผู้สูงอายุ

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Introduction

The "elderly" in Asia is defined as an age of 65 years old or older, while "early elderly" are those from 65 to 74 years old and "late elderly" are those over 75 years old (Hajime, 2006). In contrast, in Britain, the elderly are those after 50 years old (Roebuck, 1979) whereas WHO refers to those who are over 50 or 55 years old (WHO, 2001).

Life expectancy is increasing all over the world. The number of people aged 60 years or over in Thailand, with no exception, had also increased (Siriboon et al., 2008). The ageing process leads to a loss of muscular strength, a reduction in cardiovascular capacity, a reduction in joint mobility and a decline in cognitive capacity (Roubenoff et al., 2001) and eventually a poor quality of life (Sato et al., 2002). Furthermore, a reduction in respiratory muscle strength (RMS) with age has been demonstrated previously (Janssens et al., 1999). It has been reported that maximal inspiratory pressure (PImax) was lesser with increasing age in women while maximal expiratory pressure (PEmax) was lower with increasing age in both men and women (Berry et al., 1996). Specifically, this age-related reduction in RMS was obviously observed in 60 to 89 years old women (Simoes at al., 2009). In comparison with healthy Japanese men, the mean Sniff nasal inspiratory pressure (SNIP) value was lower in women and apparently, they were related to age in men and BMI in women (Kamide et al., 2009).

Respiratory diseases are highly prevalent as a consequence of impaired respiratory musculature (Sharma et al., 2006; Watsford et al., 2007). Respiratory muscle dysfunction can lead to reduced daily activities and, in extreme cases, respiratory failure. RMS is weaker in women compared to men, but declines with aging in both sexes. Diaphragm strength is roughly 25% lower in healthy elderly persons as compared to young adults (Jeffrey et al., 2000). This decline in RMS with age is primarily due to muscle fiber atrophy, i.e. approximately 20% by age 70 (Jaeock et al., 2009). Several studies have reported a negative correlation between age and RMS, i.e., 8-10% per decade from 40 years onwards (McConnell et al., 1999; Enright et al., 1994; Neder et al., 1999; Chen et al., 1989). Recently, the lower pulmonary function in sedentary Thai women was associated with lower RMS (Dumrongchua et al., 2012). Apparently, no studies have been conducted in regard to relationships between age and RMS in elderly Thai women.

Objectives of the study

This study designed to appraise firstly, associations between RMS and age among elderly women from 55 to 77 years of age and secondly, to compare RMS between men with aged matched women.

Materials and Methods

Study design and population

The study was analytical and descriptive approved by the Human Research Ethics Committee, Khon Kaen University, and informed assent was obtained from each participant. Fifty normal elderly subjects of both genders (9 men and 41 women) aged between 55-80 years were recruited. The number of subjects was calculated according to a previous study (Amano et al., 2001). All subjects were completed a confidential health-screening questionnaire. They were healthy with BMI of 18.5–24.9 kg/m^2 with no history of regular alcohol drinking or smoking. Those having history of cardiovascular (i.e. coronary heart disease, arrhythmia and chronic heart failure), neuromuscular, arthritic, pulmonary, patients with severe microvascular diseases, diabetes mellitus, hypertension or other debilitating diseases were not included in this study.

Experimental Protocols

Participants were asked to have 2 visits to our Laboratory Unit. On the first visit, physical examinations and measurements of anthropometry were obtained. Measurements of respiratory muscle strength were recorded in the second visit.

Body mass index (BMI)

Height and weight were measured for each participant, according to the WHO guidelines. Participants wore light clothing without shoes. Weight was determined using a digital scale, to the nearest tenth. Height was measured standing with feet together and arms relaxed at the sides. The BMI was calculated as weight (kg) divided by height (m^2).

Respiratory muscle strength

A MICRORPM® (Medical, UK) was used to measure inspiratory and expiratory muscle strength. All participants underwent maximal inspiratory pressure at residual volume (PImaxRV) and at function residual capacity (PImaxFRC), sniff nasal pressure (Pnsn) and maximal expiratory pressure (PEmax) evaluation. All of procedures are referenced base on American/European Respiratory Society "ATS/ERS Statement on Respiratory Muscle Testing" (ATS/ERS, 2002). Each testing lasted at least 1.5 s and was measured at least 5 times or more than that, until the closed highest 2 values were achieved. The highest value was recorded. RMS was calculated as [PImaxRV+PEmax]/2.

PImaxFRC and Pnsn reflects the strength of the diaphragm, while PImaxRV reflects the strength of the diaphragm and other inspiratory muscles, PEmax reflects the strength of the abdominal muscles and other expiratory muscles (Paul et al., 2012).

Statistical Analyses

Data were expressed as means±SD. The Stata 10 Statistical software was used to perform the statistical analysis. Unpaired t-test was used to compare differences in characteristics and all parameters between men and women. Two-sample Wilcoxon rank-sum (Mann-Whitney) test was used when data deviate from normality. A value of $p<0.05$ was taken to be the threshold of statistical significance.

Results

Relationships between RMS, its components and age

Clinical characteristics of the elderly women ranged between 55 to 77 years old are summarized in Table 1. As can be seen, BMI and cardiovascular indices were within normal ranges which are indicative of being healthy.

Table 1 Clinical characteristics of elderly women. Data are expressed as mean ± SD; BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate

	Women (n=41)
Age (yrs)	64.0 ± 6.0 (55-77)
Weight (kg)	55.1 ± 5.3
Height (cm)	155.1 ± 5.0
BMI (kg/m^2)	22.8 ± 2.0
SBP (mm Hg)	120.0 ± 11.7
DBP (mm Hg)	71.2 ± 10.5
HR (/min)	73 ± 8

Fig.1 depicts the relationships between RMS and age in 41 elderly women. It was found that PImaxFRC, PImaxRV, PEmax, Pnsn and RMS were significantly and negatively correlated with age (y= -1.20x+148.6, r= -0.42;

y= -1.17x+154.8, r= -0.42; y= -1.46x+175.8, r= -0.48; y= -1.16x+147.7, r= -0.43 and y= -1.32x+165.3, r= -0.47 ($p< 0.01$).

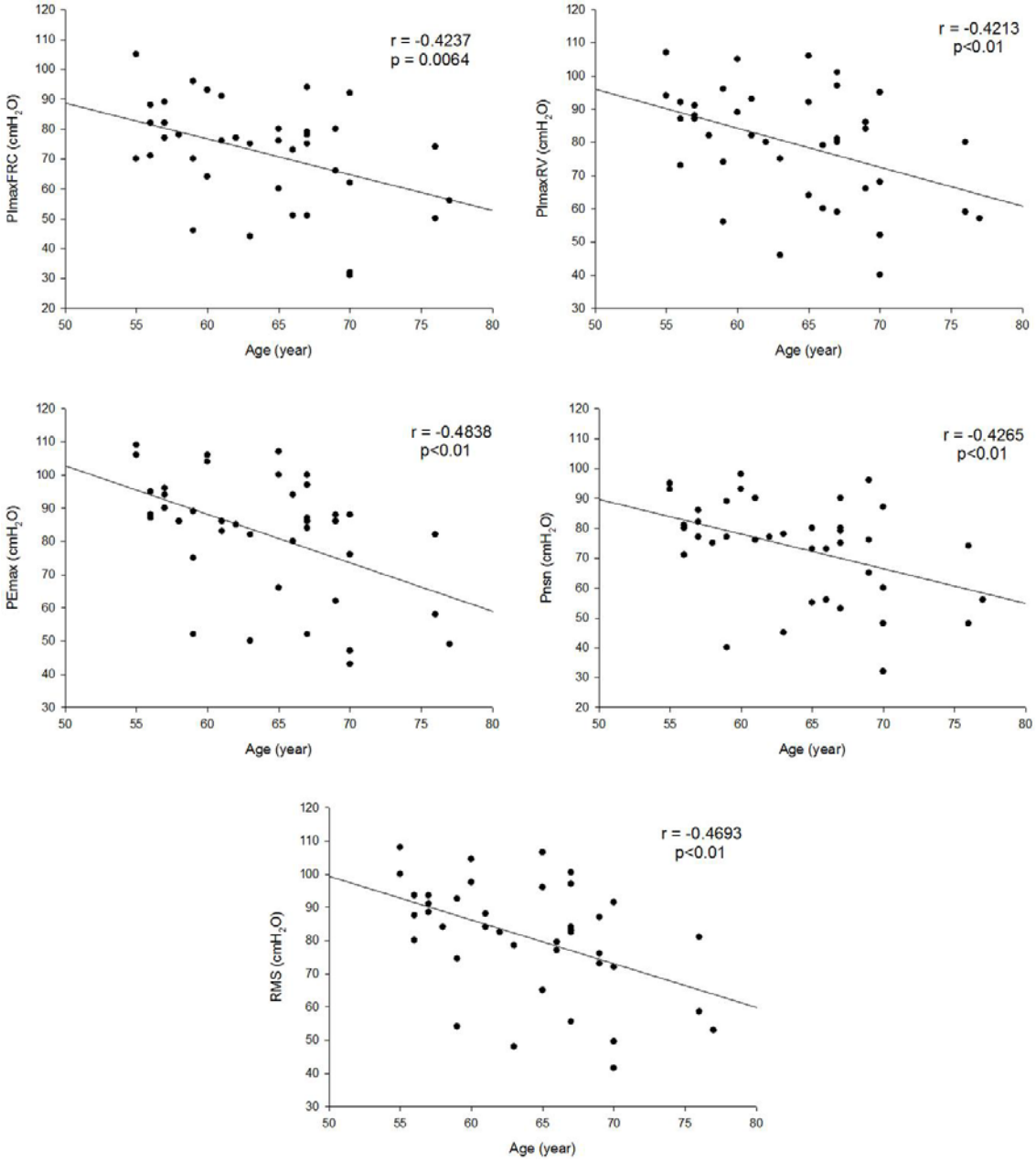

Figure 1 Relationships between age and maximal inspiratory pressure from function residual capacity (PImaxFRC), maximal inspiratory pressure at residual volume (PImaxRV), maximal expiratory pressure (PEmax), sniff nasal pressure (Pnsn) and respiratory muscle strength (RMS)

Comparisons of RMS between men and women

Clinical characteristics of 18 participants are summarized in Table 2. The average age of men was identical to that of women as they were matched by age while the body weight was significantly higher by 16% ($p<0.01$). The height was slightly greater in men compared to women although it did not reach a significant level. Nevertheless, height, BMI, SBP, DBP and HR were not significantly different between the two groups.

Table 2 Clinical characteristics of the study population. BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate. Values are means ± SD tested by Mann-Whitney test[a] and independent t-test[b]. [**] $p< 0.01$

	Men	Women
Men:Women	9	9
Age (years)	63.6 ± 8.3	63.6 ± 8.3[b]
Weight (kg)	66.7 ± 6.6	57.7 ± 5.7[**b]
Height (cm)	164.4 ± 7.3	158.8 ± 5.4[b]
BMI (kg/m^2)	24.6 ± 1.3	22.6 ± 2.3[a]
SBP (mm Hg)	119.3 ± 9.7	126.4 ± 9.3[b]
DBP (mm Hg)	71.1 ± 9.5	73.4 ± 11.7[b]
HR (/min)	70 ± 8	72 ± 7[b]

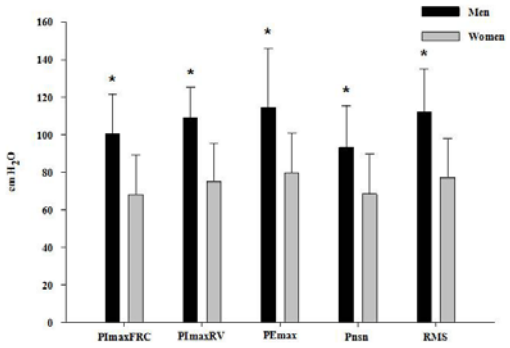

Figure 2 Comparisons in maximal inspiratory pressure from function residual capacity (PImaxFRC), maximal inspiratory pressure at residual volume (PImaxRV), maximal expiratory pressure (PEmax), sniff nasal pressure (Pnsn) and respiratory muscle strength (RMS) between men and women. Values are mean ± SD, [*] $p<0.01$

Table 3 Comparisons of the RMS between elderly men and women. PImaxFRC, maximal inspiratory pressure from function residual capacity; PImaxRV, maximal inspiratory pressure at residual volume; PEmax, maximal expiratory pressure; Pnsn, sniff nasal pressure; RMS, respiratory muscle strength or (PImaxRV+ PEmax)/2. Values are mean ± SD tested by Mann-Whitney test. [**] $p<0.01$

	Men (n=9)	Women (n=9)
PImaxFRC (cmH_2O)	100.3 ± 21.0[**]	68.1 ± 21.0
PImaxRV (cmH_2O)	109.0 ± 16.0[**]	75.1 ± 20.1
PEmax (cmH_2O)	114.5 ± 31.5[**]	79.3 ± 21.4
Pnsn (cmH_2O)	93.3 ± 22.0[**]	68.4 ± 21.1
RMS (cmH_2O)	112.0 ± 23.0[**]	77.2 ± 20.6

Table 3 and Fig. 2 show respiratory muscle strength in elderly men and women. By comparison with women, men had greater PImaxFRC, PImaxRV, PEmax and Pnsn by 47.3%, 45.1%, 44.4% and 36.4% respectively ($p<0.01$). Accordingly, the RMS in men was 45% higher compared to women ($p<0.01$).

Discussion

The important findings of the present study was that men had a relative higher RMS, e.g. PImaxFRC, PImaxRV, PEmax and Pnsn compared to women and they decreases with increasing age in women. The greater RMS could be due to higher body weight and height in men as suggested by previous studies (Jeffrey et al., 2000; Harms, 2006; Kamide et al., 2009; Simoes et al., 2011). Men were strongly and independently associated with higher values of maximal inspiratory pressure (Harms, 2006). Moreover, the stronger RMS is unlikely to be due to sex difference in the elastic properties of the lungs (Rohrbach et al., 2003) or chest wall or pulmonary compliance (Johnson et al., 1993). Therefore, it is likely that the higher lung volumes in men are due to stronger respiratory muscle strength.

The negative correlations of age with PImaxFRC, PImaxRV, PEmax, Pnsn and RMS in our study support previous studies suggesting a decline in RMS with increasing age in both men and women (Fiz et al., 1998; Chen et al., 1989; Enright et al., 1994; Karvonen et al., 1994). Moreover, a previous study has observed the changes the structure and function of respiratory skeletal muscles in elderly individuals (Tolep et al., 1993). In 1995, Tolep and coworkers found that diaphragm strength was reduced in elderly individuals in an age-related manner which may result in diaphragm fatigue in the presence of conditions that impair inspiratory muscle function or increase ventilatory load (Tolep et al., 1995). Inaddition, a study done in 100 healthy individuals between 40 and 89 years old found that there was a significant and progressive lessening of RMS with advancing age (Simoes et al., 2007). They postulated that the aging process itself induced changes to the pulmonary tissue and rib cage, calcification of rib articulation cartilage, loss of muscle mass (a process known as sarcopenia) in the diaphragm and accessory musculature, and lower muscle response to neural stimulation.

Conclusions

Our study suggests the higher RMS in elderly Thai men compared to women and a decline in RMS with age in elderly Thai women. However, a further study on larger population is required to confirm this finding.

Although this study was carefully prepared, we are still aware of its limitations and shortcomings. First of all, the study was conducted in small numbers of participants to compare the RMS between men and women (n=9 each). We, therefore, matched the 2 groups by age. Second, the population of the women used for studying correlations between age and the RMS was small. It would be better if it was done in a larger group.

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References

Amano M, Kanda T, Ue H, Moritani T. 2001. Exercise training and autonomic nervous system activity in obese individuals. Med Sci Sport Exerc. 33: 1287-91.

American Thoracic Society/European Respiratory Society, 2002. ATS/ERS Statement on Respiratory uscle Testing. Am J Respira Crit Med. 166: 518-624.

Berry, Jean K., Vitalo, Candice A., Larson, Janet L., Patel, Minu, Kim, Mi Ja. 1996. Respiratory Muscle Strength In Older Adults. Nursing Research. 45(3): 154-159.

Chen H-I, Kuo C-S. 1989. Relationship between respiratory muscle function and age, sex, and other factors. J Appl Physiol. 66: 943-948.

Dumrongchua K, Tunkamnerdthai. 2012. Respiratory muscle strength and pulmonary function in sedentary Thais. Proc Grad Res Conf. 13: 829-837.

Enright PL, Kronmal RA, Manolio TA. 1994. Respiratory muscle strength in the elderly. Correlates and reference values. Cardiovascular Health Study Research Group. Am J Respir Crit Care Med. 149(2 Part 1): 430-8.

Fiz JA, Romero P, Gomez R, Hernandez MC, Ruiz J, Izquierdo J, Coll R, Morera J. 1998. Indices of respiratory muscle endurance in healthy subjects. Respiration. 65: 21-27.

Hajime Orimo, Hideki Ito, Takao Suzuki, Atsushi Araki, Takayuki Hosoi, Motoji Sawabe. 2006. Reviewing the definition of “elderly”. Geriatr Gerontol Int. 6: 149-158.

Harms CA. 2006. Does gender affect pulmonary function and exercise capacity?. Respir Physiol Neurobiol. 151: 124-31.

Jaeock K, Paul D, Christine S. 2009. Effect of expiratory muscle strength training on elderly cough function. Archives of Gerontology and Geriatrics. 48: 361-366.

Janssens JP, Pache JC, Nicod LP. 1999. Physiological changes in respiratory function associated with ageing. Eur Respir J. 13(1): 197-205.

Jeffery Mador, Thomas J, Kufel, Lilibeth A. Pineda. 2000. Quadriceps and diaphragmatic function after exhaustive cycle exercise in the healthy elderly. Am J Respir Crit Care Med. 162: 1760-1766.

Johnson BD, Babcock MA, Suman OE, Dempsey JA. 1993. Exercise-induced diaphragmatic fatigue in healthy humans. J Physiol. 460: 385-405.

Kamide N, Ogino M, Yamashina N, Fukuda M. 2009. Sniff nasal inspiratory pressure in healthy Japanese subjects: mean values and lower limits of normal. Respiration. 77(1): 58-62.

Karvonen J, Saarelainen S, Nieminen MM. 1994. Measurement of respiratory muscle forces based on maximal inspiratory and expiratory pressures. Respiration. 61: 28-31.

McConnell AK, Copestake AJ. 1999. Maximum static respiratory pressures in healthy elderly men and women:issues of reproducibility and interpretation. Respiration. 66(3): 251-8.

Neder JA, Andreoni S, Lerario MC. 1999. Reference values for lung function tests. II. Maximal respiratory pressures and voluntary ventilation. Braz J Med Biol Res. 32(6): 719-27.

Paul L Enright, John Moxham. 2012. Tests of respiratory muscle strength. Retrieved January 15, 2012, from http://www.uptodate.com /contents /tests-of-respiratory-muscle-strength.

Roebuck J. When does old age begin?: the evolution of the English definition. Journal of Social History. 12(3): 416-28.

Rohrbach M, Perret C, Kayser B, Boutellier U, Spengler CM. Task failure from inspiratory resistive loaded breathing: a role for inspiratory muscle fatigue?. Eur J Appl Physiol 2003; 90: 405-10.

Roubenoff R. 2001. Origins and clinical relevance of sarcopenia. Can J Appl Physiol. 26(1): 78-89.

Sato S, Demura S, Kobayashi H. 2002. The relationship and its change with aging between ADL and daily life satisfaction characteristics in independent Japanese elderly living at home. J Physiol Anthrop Appl Hum Sci. 21(4): 195-204.

Sharma G, Goodwin J. 2006. Effect of aging on respiratory system physiology and immunology. Clin Interv Aging. 1(3): 253-60.

Simoes RP, Auad MA, Dionísio J, Mazzonetto M. 2007. Influência da idade e do sexo na força muscular respiratória [Influence of age and sex on respiratory muscle strength]. Fisioter Pesqu. 14(1): 36-41.

Simoes RP, Castello V, Auad MA, Mazzonetto M. 2009. Prevalence of reduced respiratory muscle strength in institutionalized elderly people. Sao Paulo Med J. 127(2): 78-83.

Simoes RP, Deus AP, Auad MA, Dionisio J, Mazzonetto M, Borghi-Silva A. 2011. Maximal respiratory pressure in healthy 20 to 89 year-old sedentary individuals of central Sao Paulo State. Rev Bras Fisioter. 14: 60-7.

Siriboon, Milintangkun. 2008. Elderly. Retrieved November 16, 2012, from http://www.cps.chula.ac.th/research_division/article_ageing/ageing_001.html.

Tolep K, Kelsen SG. 1993. Effect of aging on respiratoryskeletal muscles. Clin Chest Med. 14(3): 363-378.

Tolep K, N Higgins, S Muza, G Criner, and S G Kelsen. 1995. Comparison of diaphragm strength between healthy adult elderly and young men. Am. J. Respir. Crit. Care Med. 152: 677-82.

Watsford ML, Murphy AJ, Pine MJ. 2007. The effects of ageing on respiratory muscle function and performance in older adults. J Sci Med Sport. 10(1): 36-44.

World Health Organization. 2001. Definition of an older or elderly person. Proposed Working Definition of an Older Person in Africa for the MDS Project. Retrieved November 16, 2012, from http://www.who.int/healthinfo/survey/ageingdefnolder/en/index.html.