The Effects of Expiratory Muscle Strength Training on Non-Speech and Speech Tasks

Jenna Cheeseman, Dallin Ellingson, Aidan Sterling

Faculty of Rehabilitation Medicine, Department of Communication Sciences and Disorders

University of Alberta, Edmonton, AB, Canada

Abstract: The purpose of this study was to determine the effects of an intensive expiratory muscle strength training (EMST) program on the respiratory system. Specifically, lung volume events, chest wall muscle activation patterns and expiratory pressures were measured before and after treatment. The participant involved in this study was a healthy female, 26 years old. The participant completed a set of non-speech and speech tasks before and after EMST. Chest wall kinematics were used to measure lung volume events, surface EMGs were used to measure rib cage and abdominal muscle activity and an expiratory threshold loading device was used to measure changes in expiratory pressure. Results from training indicated positive respiratory and muscle activation changes not only for the treatment target (i.e., expiratory pressure) but for non-treatment targets (i.e., vital capacity, maximum duration phonation, speech, and maximum expiratory pressure generation). These preliminary results have implications for use of an accessible training program geared to maintaining respiratory function for both non-speech and speech activities in healthy older adults.

Background

- **Expiratory Muscle Strength Training** (EMST) consists of applying an expiratory threshold loading at the mouth. It has been shown to increase expiratory pressures,[1] which are important for functions such as airway clearing and speech.
- Previous research has demonstrated beneficial effects of EMST on speech and non-speech functions in individuals with Parkinson disease and Multiple Sclerosis[2,3].
- Little is known about how the use of EMST impacts respiratory function in typically aging adults[4,5].

Research Question

Following a 2-weeks bout of intensive EMST, will a healthy younger adult exhibit changes in lung function and chest wall muscular activity during non-speech and speech activities?

Method

- A healthy female participated (26 years old).
- Pre- and post training tasks including: *(a)* forced vital capacity (VC) maneuvers; *(b)* maximum duration phonations; *(c)* expiratory pressures against maximum, 80% maximum, 20% maximum threshold loading; *(d)* a standardized reading passage; and *(e)* resting tidal breathing –control condition
- During each of these tasks, chest wall kinematics were measured using variable inductance plethysmography. Muscle activity was measured using surface electromyography (sEMG) over the intercostal and oblique muscles [6].
- Training was 2 weeks and included 25 blows (5 sec each, starting at 80% maximum threshold), twice daily, increasing resistance as tolerated across day. The EMST device used was the EMST150TM (Figure 1).

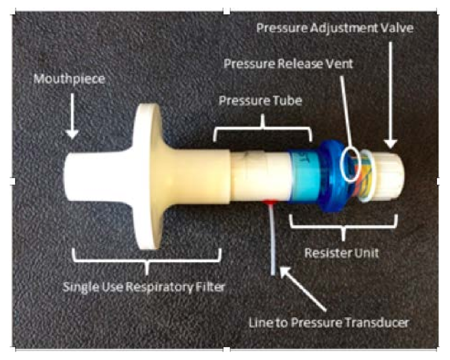

Figure 1: EMST Device

- Variables derived for each task included: Lung volume initiation, termination and excursion (% VC), percent rib cage contribution to lung volume excursion, and intercostal-oblique intermuscular coherence.
- Paired sample *t*-tests were used to analyze the data.

Result

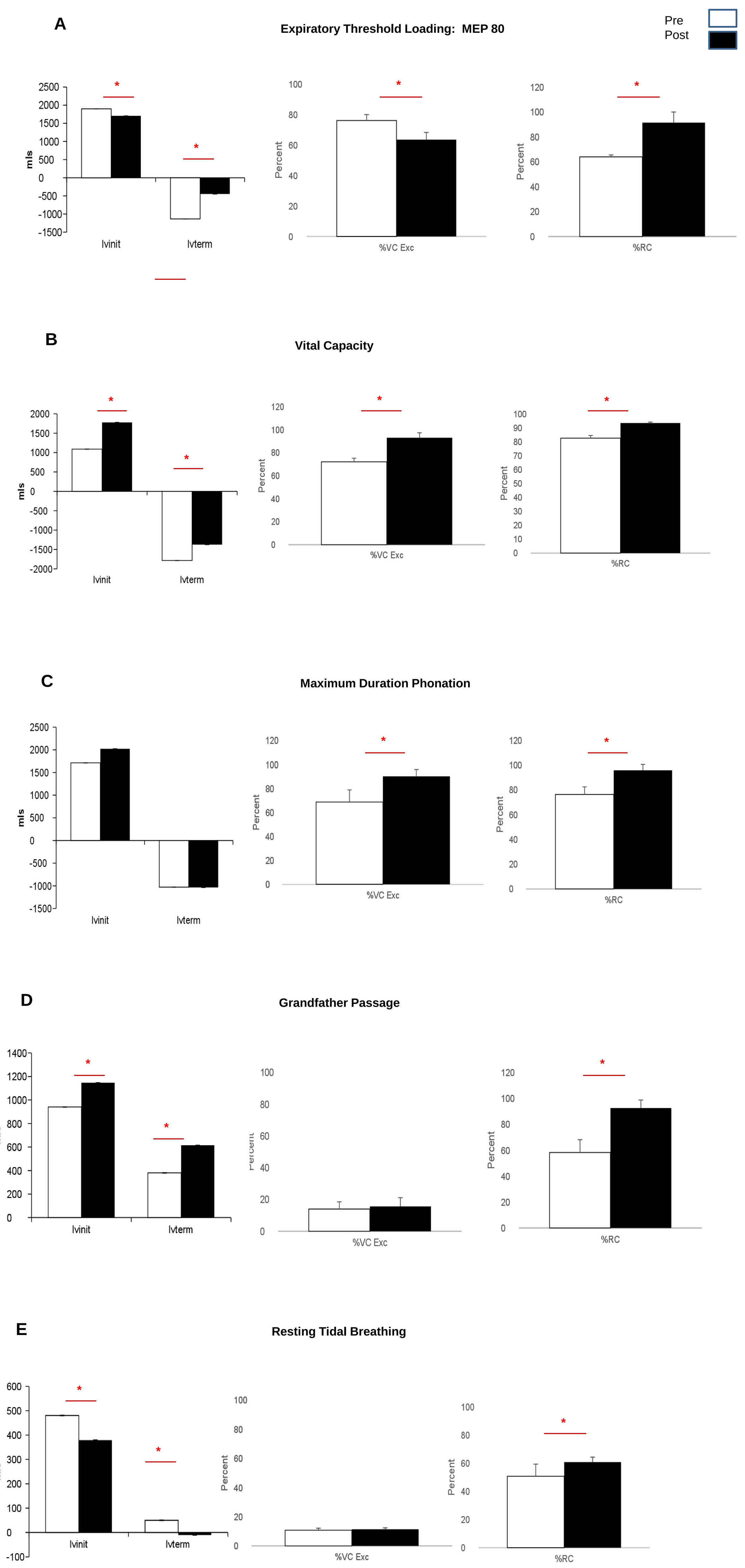

Figure 2. Speech breathing kinematics pre-post training for Expiratory Threshold Loading at MEP 80 (**A**); Vital Capacity (**B**); Maximum Duration Phonation (**C**); Grandfather Passage (**D**); and Resting Tidal Breathing (**E**). LVI= Lung Volume Initiation; LVT = Lung Volume Termination; %VC Excursion = Lung Volume Excursion in % Vital Capacity; %RC = % Rib Cage Contribution to Lung Volume Excursion. * = statistical significance with *Bonferroni* correction $p < .01$.

Table 1. Pre-post Mean Comparisons for Kinematic Variables

TASK	VARIABLE	*t* Value (degrees of freedom)	*p* Value
MEP 80	Lung Volume Initiation Lung Volume Termination Lung Volume Excursion (in %VC) Percent Rib Cage Contribution	3.40 (8) 10.54 (8) 4.61 (8) 7.09 (8)	$p < .009$ $p < .0001$ $p < .002$ $p < .0001$
Vital Capacity	Lung Volume Initiation Lung Volume Termination Lung Volume Excursion (in %VC) Percent Rib Cage Contribution	6.13 (4) 14.02 (4) 6.84 (4) 9.32 (4)	$p < .004$ $p < .0001$ $p < .002$ $p < .0001$
Maximum Duration Phonation	Lung Volume Initiation Lung Volume Termination Lung Volume Excursion (in %VC) Percent Rib Cage Contribution	2.35 (5) 0.03 (5) 1.41 (5) 4.76 (5)	$p < .006$ $p < .98$ $p < .23$ $p < .005$
Grandfather Passage	Lung Volume Initiation Lung Volume Termination Lung Volume Excursion (in %VC) Percent Rib Cage Contribution	5.54 (18) 2.76 (18) 0.74 (18) 9.25 (18)	$p < .0001$ $p < .01$ $p < .47$ $p < .0001$
Resting Tidal Breathing	Lung Volume Initiation Lung Volume Termination Lung Volume Excursion (in %VC) Percent Rib Cage Contribution	3.52 (16) 3.44 (16) 1.27 (16) 3.24 (16)	$p < .003$ $p < .003$ $p < .22$ $p < .005$

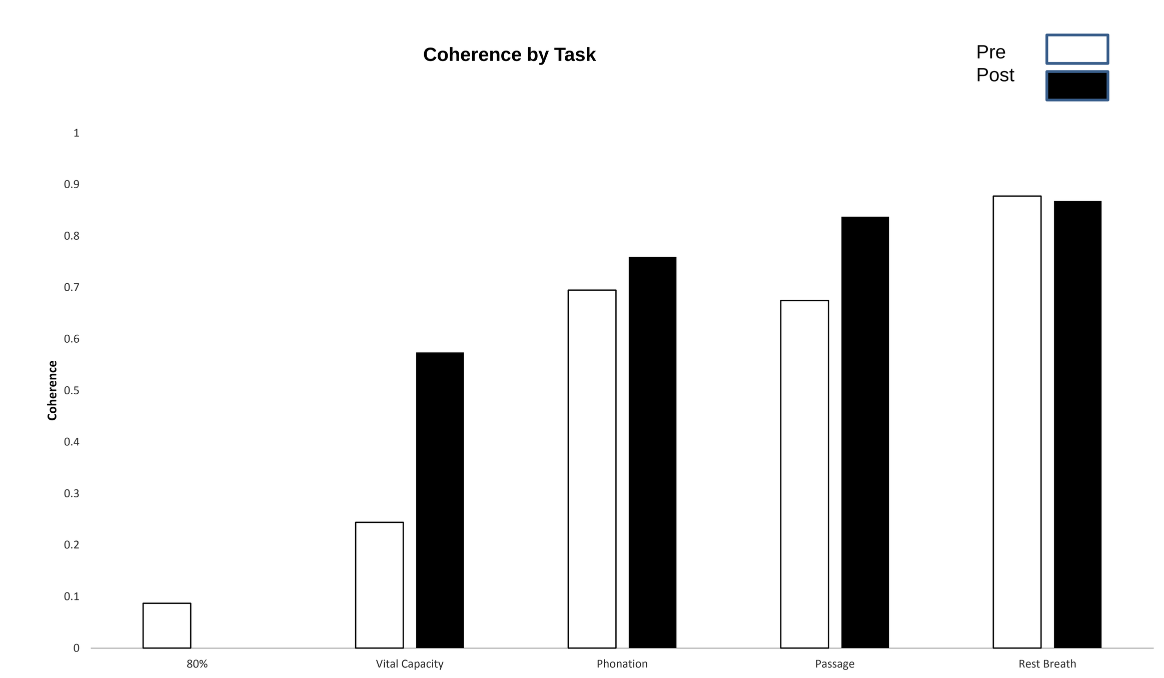

Figure 3. Pre-post coherence changes for each task. 80% = MEP 80; Vital Capacity; Phonation = Maximum Duration Phonation; Passage = Grandfather Passage; and Rest Breath = Resting Tidal Breathing.

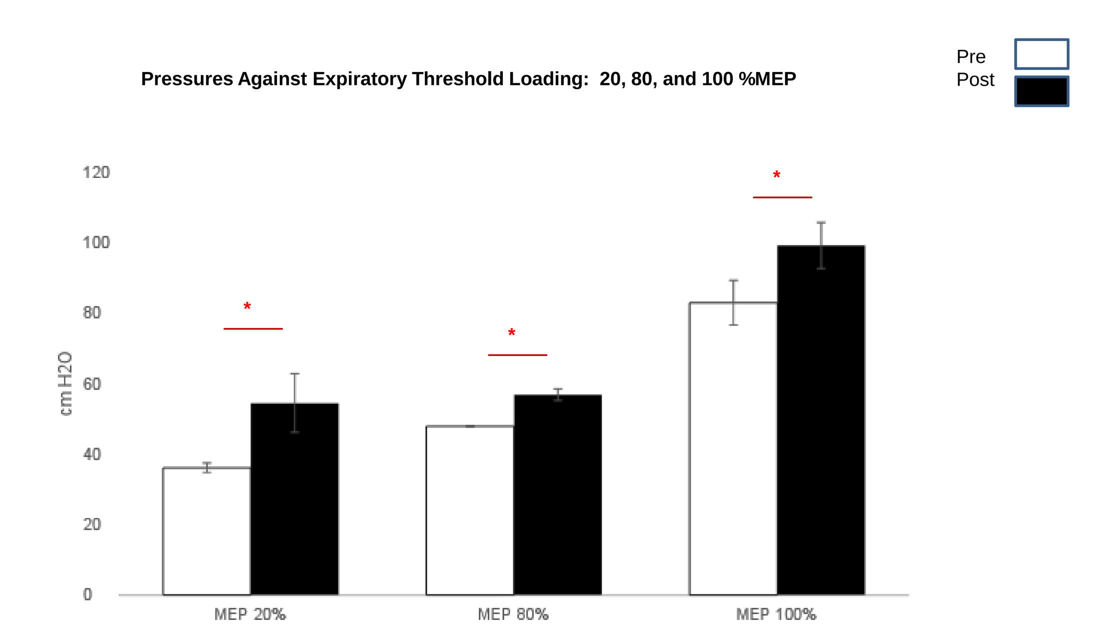

Figure 4. Pre-post training pressure changes for expiratory threshold loading at MEP 20, MEP 80, and MEP 100. Statistical results: MEP 20, $t = 4.87$ (8), $p < .001$; MEP 80, $t = 12.20$ (8), $p < .0001$; and MEP 100, $t = 4.01$ (8), $p < .004$. * = statistical significance with *Bonferroni* correction $p < .016$.

Conclusion

- The purpose of this study was to investigate changes in lung volume events and chest wall muscle activation for non-speech and speech tasks following intensive EMST.
- **Following Treatment:**
  - Increases in lung volume excursion and percent rib cage contribution were apparent in both the targeted treatment task (80% MEP) and most of the non-treatment tasks.
  - Changes in breathing indicate improvement not only in biomechanical efficiency but increase in overall lung function needed for maximum performance and speaking tasks[4,5].
- **Following Treatment:**
  - Intermuscular coherence values increased for vital capacity, maximum duration phonation, and the reading passage.
  - Changes in coherence may indicate an increase in neuromuscular drive to the chest wall[6].

Where is the study going?

Future Research:

- Future research will expand this study to include and compare data from both younger adults (age 18-35 years) and older adults (age 60-80 years).

Clinical Implications:

- For this participant, EMST may have improved respiratory functions both biomechanically and in terms of neuromuscular modulation.
- Future research on a larger population may suggest that EMST could be used as a practical and accessible exercise for people of all ages.
- It may also support a home training program for maintenance of healthy respiratory function in older individuals who experience limited access to fitness facilities.

Limitations:

- Since this study followed one participant, generalization of the data to a wider population is limited.

References

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