the effects of respiratory muscle training on older females

Mark L. Watsford, Aron J. Murphy, Matthew J. Pine, Aaron J. Coutts
Human Performance Laboratory, University of Technology, Sydney

background

The population of Australia and indeed the world is ageing (ABS, 2001). One particular impact of the ageing of the population is an increased reliance on health care systems due to increased disease rates and morbidity. It is the aim of many intervention programs to improve participation in physical activity, however, many older individuals are limited in their exercise capacity (Evans & Campbell, 1993). This decreased capacity stems from a decrease in muscle mass, cardiovascular function and respiratory function (Astrand, Astrand, Hallback, & Killborn, 1973). Apart from a decrease in chest wall compliance and an alteration of lung volumes, one of many age-related alterations to respiratory function is decreased respiratory muscle strength (RMS) and endurance (RME) (Janssens, Pache & Nicod, 1999). A decline in RMS and RME may lead to dyspnea during activities of daily living, potentially affecting quality of life (Brown, 1992). This decline is of particular importance for the female population, with reportedly lower exercise participation rates and lower RMS levels when compared to males across the lifespan. With this knowledge, this study was undertaken to assess the impact of respiratory muscle training (RMT) on physiological function in older females.

methods

Twenty-six healthy females (mean age: 64.4 ± 2.7 yr, 161.8 ± 5.4 cm, 67.3 ± 8.6 kg) were recruited from the local area and assigned to an experimental (EXP, n=13) or control group (CON, n=13). Respiratory assessment included spirometry measures (Bosch, Spiro 501, Germany) of forced vital capacity, forced expiratory volume in 1 sec and maximum voluntary ventilation, measures of maximum inspiratory and expiratory pressures (MIP and MEP respectively) developed at the mouth through an occluded airway with 2 mm leak (Spirovis, Italy) and an incremental inspiratory muscle endurance (IME) test (PowerLung, USA). Performance assessment was undertaken in the form of a treadmill (Star-Trac 4500, USA) time-to-RPE 15 walking test (TRPE15) using a modified Borg 6-20 scale. During this walking test, $V0_2$, RPE for walking (WRPE), breathing RPE (BRPE) and heart rate (HR) were measured.

i n t e r v e n t i o n

Following pre-testing, the EXP group undertook a controlled RMT program for 8 weeks using a commercially available training device (PowerLung, USA) (Figure 1). Twelve training sessions were conducted each week consisting of inspiratory and expiratory efforts against resistances determined from MIP and MEP. Eight of the weekly sessions were focused on hypertrophy training intensities (3 sets of 10 repetitions), a further two sessions were endurance based (1 set of 40 repetitions), while the remaining two sessions were strength based (5 sets of 5 repetitions) (Figure 2). Training intensities were increased or decreased according to the session being undertaken. The CON group maintained current exercise participation rates. Testing was repeated following the intervention, with repeated measures ANOVA examining group and time differences. All statistical procedures undertaken involved an alpha level of 0.05.

Figure 1

	Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sun.
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	All Day
Practice Week	2 x 10		2 x 10		2 x 10		2 x 10		2 x 10		2 x 10		R
Week 1	2 x 10	2 x 10	2 x 10	1 x 30	2 x 10	3 x 5	2 x 10	1 x 30	2 x 10	3 x 5	2 x 10	2 x 10	E
Week 2	3 x 10	3 x 10	3 x 10	1 x 40	3 x 10	5 x 5	3 x 10	1 x 40	3 x 10	5 x 5	3 x 10	3 x 10	S
Week 3	3 x 10	3 x 10	3 x 10	1 x 40	3 x 10	5 x 5	3 x 10	1 x 40	3 x 10	5 x 5	3 x 10	3 x 10	T
Week 4	3 x 10	3 x 10	3 x 10	1 x 40	3 x 10	5 x 5	3 x 10	1 x 40	3 x 10	5 x 5	3 x 10	3 x 10	
Week 5	3 x 10		3 x 10		3 x 10		3 x 10		3 x 10		3 x 10		
Week 6	3 x 10	3 x 10	3 x 10	1 x 40	3 x 10	5 x 5	3 x 10	1 x 40	3 x 10	5 x 5	3 x 10	3 x 10	D
Week 7	3 x 10	3 x 10	3 x 10	1 x 40	3 x 10	5 x 5	3 x 10	1 x 40	3 x 10	5 x 5	3 x 10	3 x 10	A
Week 8	3 x 10	3 x 10	3 x 10	1 x 40	3 x 10	5 x 5	3 x 10	1 x 40	3 x 10	5 x 5	3 x 10	3 x 10	Y

Figure 2 The respiratory muscle training program followed by the EXP group. All breaths include inspriatory and expiratory resistance.

results

Following the training, there were many significant improvements in the EXP group. RMS increased (MIP +30%; MEP +38%) (Figures 3 and 4 respectively) along with IME (+35%) (Figure 5) following eight weeks of training, indicating the effectiveness of the RMT program (p<0.05). Furthermore, TRPE15 (+12%) increased significantly following the training period (p<0.05). Several submaximal physiological charges occurred in the EXP group following the RMT program. At walking speeds of 5.0 km·h^{-1} and 5.5 km·h^{-1}, VO_2 (-7%; -6%), BRPE (-6%; -8%) and HR (-5%; -4%) decreased significantly (Table 1). There were no changes to spirometry for EXP, or to any variable for the CON group.

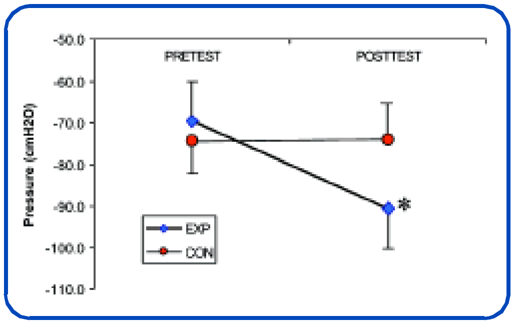

Figure 3 Maximum inspiratory pressure results.
* Significantly different from pre-test.

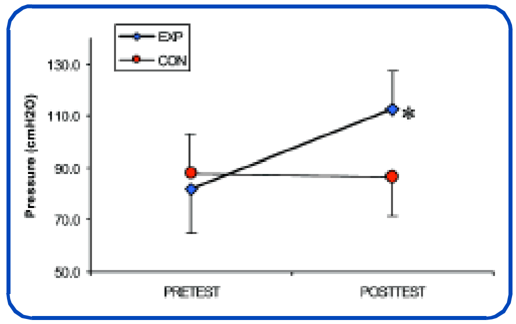

Figure 4 Maximum expiratory pressure results.
* Significantly different from pre-test.

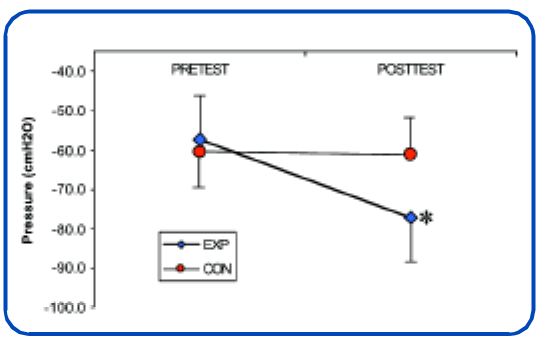

Figure 5 Inspiratory muscle endurance test results. Value is reported as greatest pressure sustained for a completed 2 min stage during the endurance test.
* Significantly different from pre-test.

		Pretest	Posttest
HR 4.5 km·h^{-1}	EXP	105 ± 11	101 ± 11
	CON	103 ± 8	103 ± 8
HR 5.0 km·h^{-1}	EXP	110 ± 13	105 ± 13 *
	CON	109 ± 10	108 ± 9
HR 5.5 km·h^{-1}	EXP	116 ± 13	112 ± 14 *
	CON	117 ± 8	117 ± 8
VO_2 4.5 km·h^{-1}	EXP	1027 ± 181	978 ± 177
	CON	966 ± 271	929 ± 265
VO_2 5.0 km·h^{-1}	EXP	1096 ± 183	1017 ± 191 *
	CON	1008 ± 231	976 ± 220
VO_2 5.5 km·h^{-1}	EXP	1156 ± 185	1090 ± 182 *
	CON	1044 ± 161	1063 ± 159

Table 1 Treadmill walking results for heart rate (HR; b·min^{-1}) and oxygen consumption (VO2; mL·min^{-1}).
* Significantly different from pretest value (p<0.05).

discussion

RMS was improved to a level superior to that witnessed in 50-59 yr females from the same demographic (Watsford et al., 2002), to a level of 30-39 yr females (Neder et al., 1999). An increase in RMS may improve exertional respiratory efficiency, thus impacting on submaximal walking performance. In turn, there may be decreased respiratory muscle blood flow during exercise, accounting for the improvement in oxygen consumption. Improved walking efficiency will have large implications for exercise participation and adherence in this age group, as many tasks undertaken by this age group are within this intensity range. These individuals may have the capacity to perform a greater quantity of exercise following RMT intervention and therefore have the capacity to maintain or improve health to a greater degree. Mobility impairments cause many older individuals to be restricted from performing exercise of moderate to high intensity. When attempting to improve fitness level, elevated intensity is a crucial component, thus, individuals with mobility impairments may benefit from the performance of RMT, as the training is performed in a seated position. The increased RMS will positively affect exercise intensity, thus improving adherence and assisting to augment fitness level.

conclusion

Eight weeks of controlled RMT may improve the strength and endurance capacity of the respiratory muscles in older females. Such improvements may impact on functional performance in the form of improved walking efficiency. These results suggest that the strength adaptations from RMT assists exercise tasks where the respiratory system may be a limiting factor for the older population.

ACKNOWLEDGEMENT

The authors thank PowerLung for their support of this research project. This company were responsible for the supply of the respiratory muscle training devices.

Reprinted with permission by

Mark L. Watsford and the University of Technology, Sydney

PowerLung®

SCIENCE OF BETTER BREATHING

10690 Shadow Wood Drive, Suite 100
Houston, Texas 77043 USA
www.powerlung.com
sales@powerlung.com

For additional information or to request additional copies, call (800) 903-3087 • (713) 465-1180.

REFERENCES

1. Astrand, I., Astrand, P. O., Hallback, I., & Kilbom, A. (1973). Reduction in maximal oxygen uptake with age. Journal of Applied Physiology, **35**(5), 649-654.

2. Australian Bureau of Statistics, 2001. Population by age and sex, cat. no. 3201.0. ABS, Canberra.

3. Brown, D. R. (1992). Physical activity, ageing, and psychological well-being: an overview of the research. Canadian Journal of Sport Science, **17**, 185-193.

4. Evans, W. J., & Campbell, W. W. (1993). Sarcopenia and age-related changes in body composition and functional capacity. Journal of Nutrition, **123** (2 Suppl), 465-468.

5. Janssens, J. P., Pache, J. C., & Nicod, L. P. (1999). Physiological changes in respiratory function associated with ageing. European Respiratory Journal, 13, 197-205.

6. Neder, J. A., Andreoni, S., Lerario, M. C. & Nery, L. E. (1999). Reference values for lung function tests II. Maximal respiratory pressures and voluntary ventilation. Brazilian Journal of Medical and Biological Research. **32**, 719-727.

7. Watsford, M. L., Murphy, A. J. & Pine M. J. (2002). Physical activity and the age-related decline of respiratory system function. Journal of Science and Medicine in Sport. 5(4):22.