nologies Ltd., Birmingham, UK). POWERbreathe® is a pressure-threshold device that requires continuous application of inspiratory pressure throughout inspiration for the inspiratory regulating valve to remain open while it allows unrestricted expiration. Subjects were instructed to initiate each breath from RV and to continue the inspiratory effort up to the lung volume where the inspiratory muscle force output for the given load limited further excursion of the thorax. Because of the increased tidal volume, a decreased breathing frequency was adopted to avoid hyperventilation and the consequent hypocapnia. Previous studies from our lab (6) have suggested that the protocol used by the training group is successful in eliciting an adaptive response. The placebo group trained using the same device, but they performed 60 breaths once daily, at a resistance to inspiration equivalent to 15% PI_{max}, a load known to elicit a negligible training effect (5). The two seemingly different training protocols were designed to maintain the naivety of the subjects who were told that one group was training for strength and the other for endurance of the inspiratory muscles. All subjects kept a training diary recording their adherence to the program. Each of the two daily sessions of the training group lasted approximately 5 min, whereas the single training session of the placebo group lasted approximately 10–12 min, depending on the breathing frequency that each subject adopted.

Blood lactate. Arterialized capillary blood samples were taken from the ear lobe before the incremental load test and at the end of each stage. Analysis was done with an Analox GM7 (London, UK). The within-run precision was 1.6% at a whole blood lactate concentration of 5.0 $mmol \cdot L^{-1}$. At low levels of lactate concentration, measurement errors exceeding $\pm$ 0.2 $mmol \cdot L^{-1}$ were rare. Thus, a measured rise of more than 0.4 $mmol \cdot L^{-1}$ during the course of a progressive test was likely to represent a real increase in lactate concentration.

Statistical analysis. Results were analyzed using nonparametric repeated measures analysis of variance (Friedman's test) and Wilcoxon signed ranks test for intra- and inter-group comparisons, respectively. Probability values of less than 0.05 were considered significant. All results are expressed in means $\pm$ SD unless otherwise stated.

RESULTS

Respiratory Muscle Function: PI_{max}

After the initial 4 wk of the training period, PI_{max} increased by 40 $\pm$ 25 cm H_2O (40.7 $\pm$ 25.1%; $P < 0.01$) and by 5 $\pm$ 6 cm H_2O (4.6 $\pm$ 6.0%; $P = 0.083$) from baseline, in the IMT and placebo groups, respectively. After 11 wk of IMT, PI_{max} increased slightly more to a total increase of 44 $\pm$ 25 cm H_2O (45.3 $\pm$ 29.7%; $P < 0.01$) and 6 $\pm$ 11 cm H_2O (5.3 $\pm$ 9.8%; $P = 0.21$) from baseline, in the IMT and placebo groups, respectively (see Table 1.) The PI_{max} improvements of the training group, expressed in percentage, were significantly different both between groups and across time within the group. Analysis of the training diaries revealed that both groups compliance with the prescribed training was between 96–97%.

TABLE 1. PI_{max} in centimeters of H_2O (mean $\pm$ SE), and performance, in meters (m), during the 6-min all-out rowing effort for the training (IMT) and placebo groups, throughout the 11 wk of inspiratory muscle training.

	PI_{max} (cm H_2O)		Performance (m)	
	IMT	Placebo	IMT	Placebo
Baseline	104 ± 8	130 ± 12	1561 ± 9.3	1566 ± 20.7
4 wk	144 ± 10**	135 ± 11	1613 ± 12.2**	1582 ± 21.4*
11 wk	148 ± 10**	136 ± 12	1616 ± 13.4**	1592 ± 21.1**

*Significantly different from baseline ($P < 0.05$); **significantly different from baseline ($P < 0.01$).

Rowing Performance

6 min all-out. After the first 4 wk of the training period the performance in the 6-min all-out test improved, from baseline, by 3.4 $\pm$ 1.0% ($P < 0.05$) in the IMT group, and by 1.1 $\pm$ 0.4% ($P < 0.05$) in the placebo group. Upon completion of the training period, performance had increased from baseline a total of 3.5 $\pm$ 1.2% ($P < 0.05$) in the IMT group and 1.6 $\pm$ 1.0% ($P < 0.05$) in the placebo group from their baseline values (see Table 1.). These improvements were also significantly different between the two groups after 4 wk ($P < 0.05$) and after 11 wk ($P < 0.05$).

5000 m. The time for the completion of the 5000-m test, after the first 4 wk of IMT, decreased by 36 $\pm$ 9 s (3.1 $\pm$ 0.8%; $P < 0.05$), whereas the placebo group's time decreased by 11 $\pm$ 8 s (0.9 $\pm$ 0.6%; $P < 0.05$). The difference in the improvement between the two groups was also significant ($P < 0.05$). There were no data available for the 5000-m test upon completion of the 11-wk IMT period.

Lactate

After 4 wk of inspiratory muscle training blood lactate was lower relative to baseline values by 0.3 $\pm$ 0.3 $mmol \cdot L^{-1}$ ($P < 0.05$) in the third stage and 1.3 $\pm$ 1.3 $mmol \cdot L^{-1}$ ($P < 0.05$) in the fifth stage of the submaximal incremental test for the IMT group. Even though there was also a decreasing trend in the placebo group, it did not reach significance ($P = 0.11$, in the fifth stage). In the interval between the 4th and 11th week of inspiratory muscle training blood lactate decreased a further 0.37 $\pm$ 0.32 $mmol \cdot L^{-1}$ ($P < 0.05$) in the IMT group at the second stage of the incremental test with no significant changes in the placebo group. Overall, both IMT and placebo groups had a significant decrease in lactate of 1.3 $\pm$ 1.47 $mmol \cdot L^{-1}$ and 1.3 $\pm$ 1.2 $mmol \cdot L^{-1}$, respectively ($P < 0.05$) in the fifth stage of the incremental test. There was no significant difference between the groups. No changes occurred in the blood lactate response to the 6-min all-out effort throughout the study.

Respiratory Muscle Fatigue

Baseline fatigue, defined as the decrease of maximum mouth pressure generating capacity, after the baseline 6-min all-out rowing effort, was 11.2 $\pm$ 2.6% ($P < 0.05$) and 11.1