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PULMONARY FUNCTION STUDIES IN ROWERS

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Abstract : The present study attempts to investigate the pulmonary functions of snake boat rowers before and after rowing. This is made on 12 healthy traditional snake boat rowers ranging from age 16–23 years of Kavanattinkara boat race, Kottayam, Kerala, India. The pulmonary function tests were carried out with vitallograph compact–II spirometer. The results show a decrease in pulmonary functions "lung volumes" and "flow rates" after rowing in comparison to basal condition.

Key words : lung volumes flow rates rowers

INTRODUCTION

Rowing is popular throughout the world both as a recreational and competitive sport. Snake boat race is one of the traditional, most colourful backwater sports in Kerala. These snake boats are known as "*Chundan Vallom*". The sleek steamlined design of *Chundan Vallom* aids the swiftness of the craft. The 60–65 m long vessel is manoeuvered by a hundred oarsmen flashing their oars and churring the waters in fascinating rhythm and dip which also showers spray into the air. The direction of the boat is controlled by the rower standing on the back of the boat by dipping the long oar in the waterfront. Ideal rower must have the flexibility, power and high degree of muscular endurance, with precise skill and technique which require to harness these fitness components to move the boat (2).

Competitive rowing has been considered to utilise a greater muscle mass than any other sport (3). The strokes are carried out by different sets of muscles, harmonizing together and running into each other, so that the whole appears to be smooth and easy action (4). The main muscle groups concerned in rowing are the muscle of the upper back and arm (2). Rowing involves maximal activation of all major energy pathways (5). Anaerobic processes are brought into play during rowing (6). and it is attained by the muscular activity of paddling the oar through the waterfront (2, 5). Blood lactate concentration increases during anaerobic process and it results in "lactic O_2 deficit" (6). This will directly or indirectly stimulate the respiratory centre and affect the breathing process. It is assumed that the three attributes of maximal O_2 uptake, greater rowing strength and greater anaerobic capacity, together make a superior rower (7). From the earlier observations done by Smith and co-workers (1), it is clear that ventilatory limitation is produced during rowing due to rowing posture, reduction in values of VO_{2max} and VE_{max}. Rowing in a

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snake boat in the backwaters of Kerala is characteristically different from kayaking and canoeing followed in other places as more than one hundred persons actively participate in rowing race. Effort put forth by the competitors in this type of race is comparatively much more than that made in kayaking and canoeing. Respiration is a limiting factor during rowing. As such, no work has been reported so far with regard to respiratory functions of rowers in snake boat race. So it is proposed to take up a detailed investigation on the respiratory functions of rowers in snake boat race.

METHODS

The present study was conducted on 15 rowers of Kavanattinkara boat race at Kumarakam backwaters in Kerala. Out of 15 rowers, three subjects were avoided from the study due to over age and for statistical convenience. The boat used was the half size snake boat of category *Kovallam (Odivallom)* of dimensions: length 23 m, 125½ cm breadth (at the centre position) and height 38 cm (middle). The distance of the race was 1 km and the time taken to complete the race was 3 min, 4 sec. The anthropometric measurements of subjects i.e., age, height, weight, were noted (Table I). Data regarding respiratory symptoms, smoking and alcoholic habits or rowers were collected by a questionnaire. The lung function tests were made with spirometer - vitallograph compact II (Buckingham MK 18 ISW) after demonstration and explanation of tests to the subjects. The latter gives the print out of VC - vital capacity, IVC - inspiratory vital capacity, FVC - forced vital capacity, FEV_1 - forced expiratory volume in 1 sec, PEF - Peak expiratory flow rate, FEF - forced expiratory flow rate at 50%, 75% and 25%, FIF - Forced inspiratory flow rates at 50%, 75% and 25%, MVV - maximum voluntary ventilation by indirect method and FMFT - forced mid flow time. The values are automatically expressed in BTPS units. Tests

TABLE I : Mean, age, height and weight of rowers.

Parameter	Mean Group (n = 12)	SD
Age (yrs)	19.92	±2.07
Height (cm)	167.25	±5.34
Weight (kg)	51.17	±2.44

TABLE II: Lung volumes in rowers.

Parameter	At rest Group (n = 12) (Mean ± SD)	After rowing Group (n = 12) (Mean ± SD)	P value
VC (l)	3.07 ± 0.31	2.87 ± 0.51	N.S
IVC (l)	1.97 ± 0.49	1.90 ± 0.62	<0.01
FVC (l)	2.86 ± 0.55	2.67 ± 0.61	N.S
FEV_1 (l)	1.92 ± 0.69	1.81 ± 0.50	<0.05
$FEV_{0.5}$ (l)	1.33 ± 0.61	1.10 ± 0.62	N.S
$FEV_{0.5}$/FVC%	43.83 ± 14.55	40.08 ± 14.27	N.S
FEV_1/VC%	68.17 ± 20.12	62.42 ± 17.27	N.S
FEV_1/FVC%	67.50 ± 4.28	68.92 ± 13.53	N.S
FEV_1/IVC%	109.34 ± 36.50	98.50 ± 36.85	N.S
$MVV_{IND (l/min)}$	78.24 ± 4.77	68.00 ± 4.34	N.S

were carried out before and immediately after rowing. The time taken by each subject to perform the test was 1–2 min. Mean, standard deviation and P–value were taken to indicate statistical significance.

RESULTS

The lung volumes (Table II and Fig. 1) show a decrease after rowing when compared with resting condition. The IVC (< 0.01) and FEV_1

TABLE III: Expiratory flow rates in rowers.

Parameter	*At rest Group (n = 12) (Mean ± SD)*	*After rowing Group (n = 12) (Mean ± SD)*	*P value*
*PEF (l/min)	170.34 ± 6.73	135.75 ± 6.70	N.S
$FEF_{25\%}$ (l/s)	2.32 ± 1.00	2.18 ± 1.00	N.S
$FEF_{50}\%$ (l/s)	2.16 ± 0.89	1.86 ± 0.90	<0.01
$FEF_{75\%}$ (l/s)	1.65 ± 0.76	1.32 ± 0.74	<0.02
$FEF_{0.2\text{-}1.2}$ (l/s)	2.34 ± 0.98	2.10 ± 0.74	<0.01
$FEF_{25\text{-}75\%}$ (l/s)	2.09 ± 0.85	1.79 ± 1.05	<0.01
$FEF_{75\text{-}85\%}$ (l/s)	1.32 ± 0.69	1.16 ± 0.69	N.S
FMFT (s)	0.83 ± 0.34	0.92 ± 0.25	N.S

*Not represented in the figure.

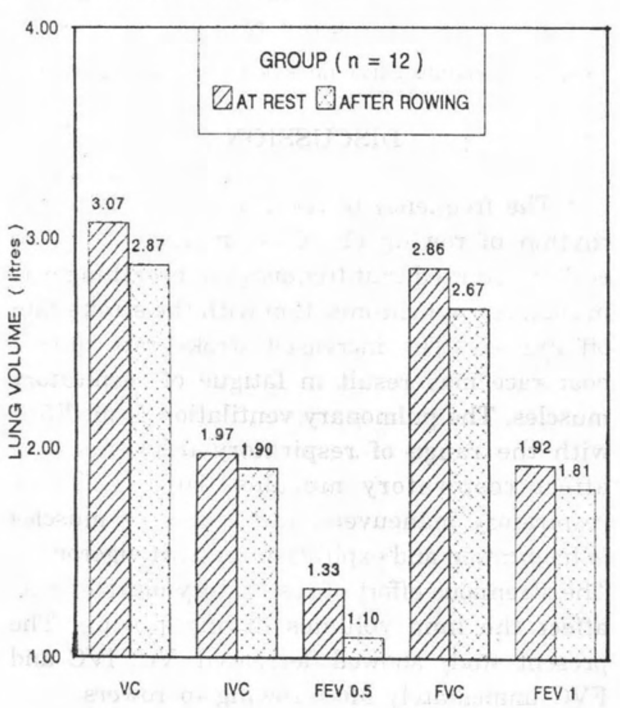

Fig. 1a: Lung volumes, before and after rowing.

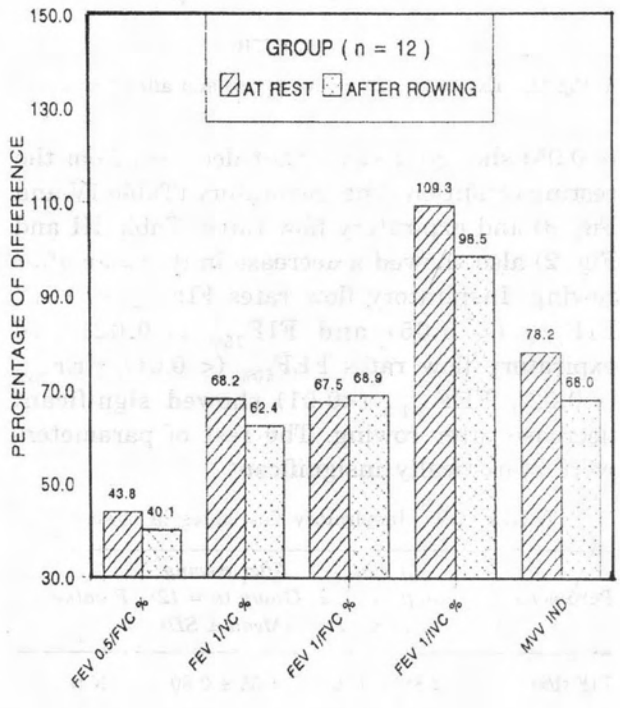

Fig. 1b: Lung volumes, before and after rowing.

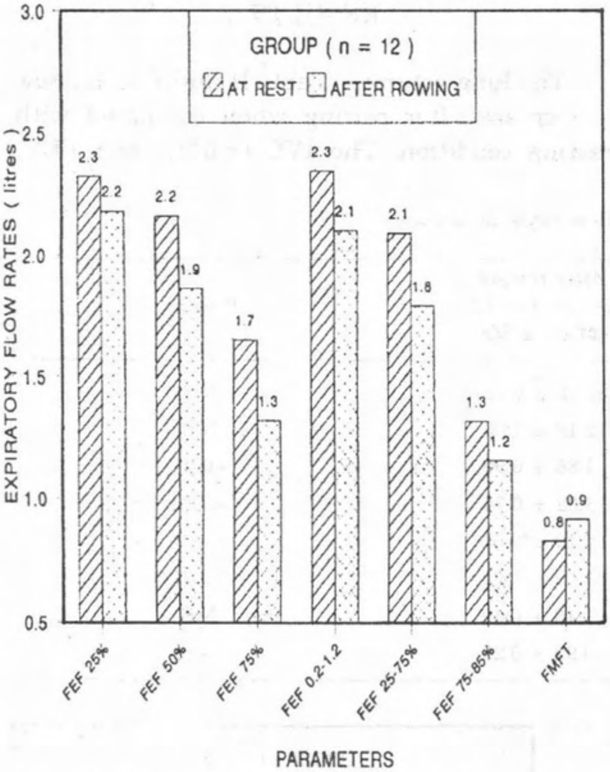

Fig. 2: Expiratory flow rate before and after rowing.

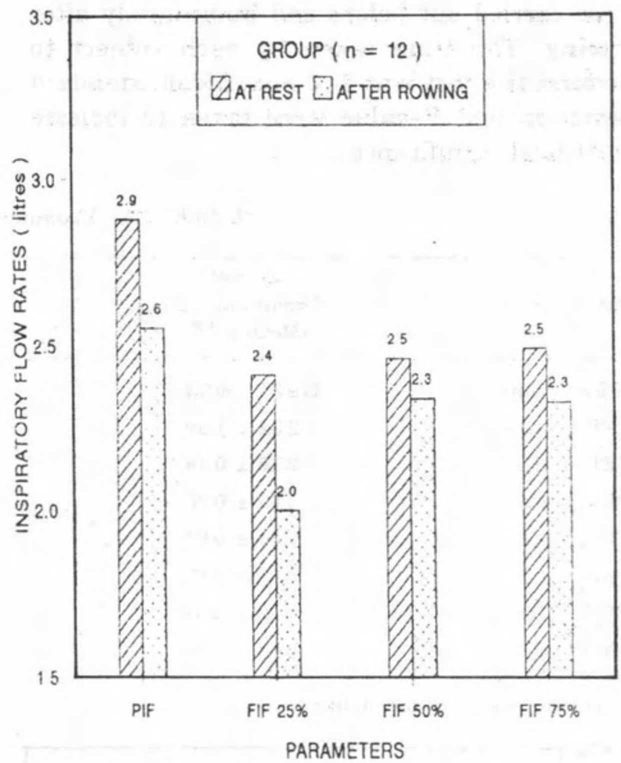

Fig. 3: Inspiratory flow rates before and after rowing.

(< 0.05) showed a significant decrease from the resting condition. The inspiratory (Table IV and Fig. 3) and expiratory flow rates (Table III and Fig. 2) also showed a decrease in its value after rowing. Inspiratory flow rates $FIF_{25\%}$ (< 0.01), $FIF_{50\%}$ (< 0.05) and $FIF_{75\%}$ (< 0.02) and expiratory flow rates $FEF_{50\%}$ (< 0.01), $FEF_{75\%}$ (< 0.02), $FEF_{.2\text{-}1.2}$ (<0.01) showed significant decrease after rowing. The rest of parameters were statistically insignificant.

TABLE IV: Inspiratory flow rates in rowers.

Parameter	*At rest* *Group (n = 12)* *(Mean ± SD)*	*After rowing* *Group (n = 12)* *(Mean ± SD)*	*P value*
PIF (l/s)	2.88 ± 0.76	2.55 ± 0.80	N.S
$FIF_{25\%}$ (l/s)	2.41 ± 1.18	2.00 ± 0.90	<0.01
$FIF_{50\%}$ (l/s)	2.46 ± 0.85	2.34 ± 0.92	<0.05
$FIF_{75\%}$ (l/s)	2.49 ± 0.67	2.33 ± 0.60	<0.05

DISCUSSION

The frequency of respiration equals to the rhythm of rowing (1). Cunningham *et al* (8) earlier observed that frequency of breathing was in complete synchronisation with the stroke rate off the oar. The increased stroke rate during boat race may result in fatigue of respiratory muscles. The pulmonary ventilation is modified with the range of respiratory frequency and affect respiratory muscles. During forced respiratory maneuvers, the accessory muscles of inspiration and expiration contract vigorously. The strenuous effort of respiratory muscles may affect the lung volumes during rowing. The present study showed decreased VC, IVC and FVC immediately after rowing in rowers.

At high lung volumes, the flow rates continue to increase as the pressure increases, during exercise (9). But in the present study a decrease in the lung volumes was observed in rowers as compared to resting condition and therefore the intrapleural pressure is lowered along with the flow rates, i.e., PIF, FIF, PEF and FEF. This was in agreement with the earlier observation of Smith *et al* (1) that maximal limit of pulmonary ventilation is lower with arm exercise. Further, this physiologic response is probably due to the relative small muscle mass of the upper body which actively take part in arm-exercise during rowing. The physiologic strain is greater in arm-exercise, since it is directly related to thorax which in turn results in respiratory changes viz. volume and pressure. At first, there will be decrease in intrathoracic pressure at the beginning of rowing due to raising of arm, later the arm is pressed downward along the sides of the chest wall increasing the intrathoracic pressure and therby expiration. This means inspiration followed expiration takes place during rowing which is being repeated till the competition is over. During rowing there will be change in thoracic pressure and volume. This is mainly due to the movement of arms during rowing. Rowing is an activity involving greater arm-exercise and this may be the reason for decrease in lung volumes and flow rates in rowers after the rowing in the present study.

The part of work done during inspiration by inspiratory muscle is "stored" in the elastic structures of the system and is then utilized to supply part of the power for the expiration by expiratory muscle. When these two muscles get fatigue, it results in the reduced inspiratory and expiratory air flow rates in turbulent in the trachea and the bronchi which results in high flow resistance. Owing to large total cross area of finest air tubes, the air flow in this region is low. The greatest part of resistance to air flow within the lungs lies in airways greater than 2 mm internal diameter and particularly in the medium sized bronchi (7). The high airway resistance in the upper and lower airways may result in lower expiratory and inspiratory flow rates. The reduced volume of PEF, $FEF_{25-75\%}$ in present study may be due to respiratory muscle fatigue and higher resistance in the airways as reported earlier by Astrand.

Well-trained and very fit athlete can apparently utilize some 95 per cent of their MVV during exercise, but less fit subjects can obtain about 60–70% of their MVV (10). Even though the subjects were physically fit, the MVV results show a decrease. This may be due to the indirect method of study adopted. The relationship between smoking and alcoholic effect on respiratory functions has not been studied due to inadequate data available in the present study. The sitting posture or hunched back position of the rower can affect the limit of ventilation during rowing (1). This limit in ventilation may prolong for few min after rowing and as the study is carried out immediately after the rowing process the values of VC, IVC, FVC and FEV_1 show a reduced values from the basal conditions. Stress factors has a very important role in the physiological variations in a competition like rowing. So further study is to be carried out in stress related physiological changes during rowing.

To sum up, this study highlights changes in pulmonary function in rowers. It is observed that the "lung volumes" and "flow rates" showed a rate of decrease from the resting condition. This may be due to

1. Fatigue of respiratory muscle and higher resistance in the airways;

2. The change in pressure and volume of thorax especially seen in rowers;

3. The hunched back position or sitting posture.

The present study has proposed the reasons of decrease in respiratory endurance in rowers and further thrust is given for research in the area which is essential for the science of rowing and sports physiology.

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