Dynamic ventilatory functions in assessment of pulmonary system in gutkha users

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Background

There are diverse opinions about the degree of adaptability of the respiratory system in delivering the physiological needs in case of tobacco users. Role of the normal respiratory system in delivering oxygen to meet the demands of various degrees of exercise has been a topic of considerable debate. One view holds that the respiratory system is not normally the most limiting factor in the delivery of oxygen; others hold the absence of structural adaptability to physical training as the cause of limitation of the pulmonary system. The role of ventilatory functions in evaluating the respiratory functions in gutkha users has not been studied adequately in previous studies. Hence, there was a need for this study.

Materials and methods

Pulmonary function tests were performed before and after maximal exercise testing to assess dynamic lung functions in two groups: gutkha chewers and nongutkha chewers.

Results

On studying the differences in dynamic lung functions in two groups of nongutkha chewers and gutkha chewers, there was no difference in forced vital capacity and forced expiratory volume in 1 s, before or after exercise testing. The other flow rates maximum mid-expiratory flow, peak expiratory flow rate, and mid-expiratory flow 25–75% were on the higher side in nonchewer individuals, which were consistently maintained after exercise testing. A higher adaptability of the respiratory system to the training stimulus in the form of a higher elastic recoil pressure of the lungs and a lower resistance of medium to small airways is suggested as the mechanism of adaptability in this study.

Keywords:

airflow limitation, dynamic lung functions, exercise testing, gutkha chewers, ventilatory functions

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Introduction

There are diverse opinions about the degree of adaptability of the respiratory system in delivering the physiological needs in case of tobacco users. Opinions about the degree of adaptability of the respiratory system in delivering the physiological needs in case of severe exercise in normal individuals vary. There are reports that the respiratory system is not normally the most limiting factor in the delivery of oxygen to the muscles during maximal muscle aerobic metabolism, whereas others do not subscribe to this [1]. The role of ventilatory functions in evaluating the respiratory functions in gutkha users has not been studied adequately in previous studies. Hence, there was a need for this study.

Mechanical constraints on exercise hyperpnoea have been studied as a factor limiting performance in endurance athletes [2]. Others have considered the absence of structural adaptability to physical training as one of the ‘weaknesses’ inherent in the healthy pulmonary system response to exercise [3].

Effect of tobacco in cigarettes is well-known but smokeless tobacco is generally perceived to be less harmful. This view is true as far as the effect on the respiratory system is concerned.

Ventilatory functions are an important part of functional diagnostics [4], aiding selection and optimization of training and early diagnosis of respiratory diseases. Assessment of exercise response of dynamic lung functions in the healthy pulmonary system in trained and untrained individuals has a role in clearing gaps in the above areas. Gutkha chewers present with an opportunity for testing endurance and adaptability of the respiratory system in this group as compared with comparable nonusers.

Materials and methods

The present study was conducted in the Department of Physiology, PES Institute of Medical Sciences, Kuppam as a part of cardiopulmonary efficiency studies on two groups of gutkha chewers (n = 30) and nonchewer controls (n = 30) comparable in age and sex. Institutional ethics committee approval was obtained.

Informed consent was obtained and clinical examination to rule out any underlying disease was performed. Healthy young adult men between 19 and 25 years who regularly chew gutkha for at least past 3 years were considered in the study group, whereas nonchewer individuals anthropometrically comparable were taken as the control group. Smoking, clinical evidence of anemia, obesity, and involvement of the cardiorespiratory system were considered as exclusion criteria.

Detailed procedure of exercise treadmill test and computerized spirometry was explained to the participants.

Dynamic lung functions were measured in both groups before exercise by following the standard procedure of spirometry using computerized spirometer Spl-95 (France International Medical Company, Lyon, France). This instrument is French made with a reliability of ±0.05 litre and option for manual standardization. All participants were made to undergo maximal exercise testing to maximal oxygen consumption (VO_2 max) levels on a motorized treadmill. Treadmill is manufactured by Afton company (Shagun Health Products Pvt. Ltd, Chennai, Tamil Nadu, India) with three preset elevations suitably standardized with highly sensitive sensors for heart rate monitor.

Submaximal and maximal exercise testing protocol was used.

Participants were instructed about the detailed procedure to be followed on the day before and were told to avoid any drugs, tea, coffee, etc.

On the day of testing, participants were given enough time to adapt to laboratory conditions and a warm-up of 6 min.

After exercise, the assessment of dynamic lung functions was repeated. All these set of recordings were performed on both the nonathlete as well as the athlete groups. Data were recorded immediately following exercise during warm-down phase.

Statistical analysis was performed using the paired Student's t-test for comparing parameters within the group before and after exercise testing and the unpaired t-test for comparing the two groups of individuals.

A P-value of less than 0.01 was considered significant (Table 1).

Results

It is clear from Table 1 that gutkha chewers and non chewers were anthropometrically similar.

On comparing dynamic lung functions in gutkha chewers before and after exercise testing there was no statistically significant difference as shown in Tabe 2. A similar pattern was seen in non chewers as shown in Table 3.

On comparing dynamic lung functions before exercise testing between the two study groups in Table 4, it is clear that maximum mid expiratory flow rate, peak expiratory flow rate and mid expiratory flow were significantly higher in non chewers.

Discussion

Considerable information can be obtained by studying the exercise response of dynamic lung functions in gutkha chewers and nonchewer individuals.

Intragroup comparison is helpful in noting the exercise response and intergroup comparison in evaluating adaptations of the respiratory system to gutkha chewing.

On comparing the anthropometric data of the two study groups, it is clear that the age-matched and sex-matched individuals have no statistically significant

Table 1 Comparison of anthropometric data and VO_2 max of nonchewers and gutkha chewers with statistical analysis

Parameters	Gutkha chewers	Nonchewers	P-value	Remarks
Age (years)	21.48 ± 2.61	21.45 ± 2.88	<0.10	NS
Height (cm)	166.70 ± 7.50	165.91 ± 7.24	<0.10	NS
Weight (kg)	60.05 ± 5.64	59.48 ± 6.26	<0.10	NS
BMI (kg/m^2)	22.01 ± 2.47	22.60 ± 1.75	<0.10	NS
VO_2 max (l/min)	2.99 ± 0.17	2.98 ± 0.27	<0.10	NS

d.f. = 58; NS, not significant; VO_2 max, maximal oxygen consumption; $P < 0.01$ is considered significant; $P < 0.001$ is considered highly significant.

Table 2 Comparison of dynamic lung functions of gutkha chewers before exercise testing and after exercise testing with statistical analysis

Parameters	BE	AE	P-value	Remarks
FVC (l)	3.58 ± 0.52	3.34 ± 0.56	<0.10	NS
FEV_1 (l)	3.56 ± 0.50	3.29 ± 0.05	<0.05	NS
FEV_1/FVC	0.94	0.95		
MMEF (l/s)	4.99 ± 1.31	4.99 ± 1.46	<0.10	NS
PEFR (l/s)	7.22 ± 1.78	6.72 ± 1.96	<0.10	NS
MEF 75 (l/s)	6.42 ± 1.94	5.86 ± 1.74	<0.10	NS
MEF 50 (l/s)	5.47 ± 1.44	5.45 ± 1.63	<0.10	NS
MEF 25 (l/s)	3.47 ± 1.16	3.71 ± 1.47	<0.10	NS

Gutkha chewers (n = 30); *d.f.* = 29; AE, after exercise; BE, before exercise; FEV_1, forced expiratory volume in 1 s; FVC, forced vital capacity; MEF, mid-expiratory flow; MMEF, maximum mid-expiratory flow; NS, not significant; PEFR, peak expiratory flow rate; $P < 0.01$ is considered significant.

Table 3 Comparison of dynamic lung functions of nonchewers before exercise testing and after exercise testing with statistical analysis

Parameters	BE	AE	*P*-value	Remarks
FVC (l)	3.11 ± 0.39	3.12 ± 0.30	<0.05	NS
FEV_1 (l)	3.17 ± 0.30	3.09 ± 0.30	<0.05	NS
FEV_1/FVC	0.99	0.99		
MMEF (l/s)	6.09 ± 1.21	6.44 ± 1.07	<0.1	NS
PEFR (l/s)	8.73 ± 1.09	8.59 ± 0.84	<0.1	NS
MEF 75 (l/s)	8.27 ± 1.28	8.14 ± 1.13	<0.1	NS
MEF 50 (l/s)	6.38 ± 1.20	6.83 ± 0.92	<0.1	NS
MEF 25 (l/s)	4.34 ± 1.11	5.01 ± 1.05	<0.05	NS

Nonchewers ($n = 30$); *d.f.* = 29; AE, after exercise; BE, before exercise; FEV_1, forced expiratory volume in 1 s; FVC, forced vital capacity; MEF, mid-expiratory flow; MMEF, maximum mid-expiratory flow; NS, not significant; PEFR, peak expiratory flow rate; $P < 0.01$ is considered significant.

Table 4 Comparison of dynamic lung functions of gutkha chewers and nonchewers before exercise testing with statistical analysis

Parameters	Gutkha chewers	Nonchewers	*P*-value	Remarks
FVC (l)	3.56 ± 0.52	3.32 ± 0.39	<0.05	NS
FEV_1 (l)	3.52 ± 0.51	3.27 ± 0.35	<0.05	NS
FEV_1/FVC	0.95	0.99		
MMEF (l/s)	4.93 ± 1.31	6.02 ± 1.21	<0.001	HS
PEFR (l/s)	7.21 ± 1.78	8.75 ± 1.09	<0.001	HS
MEF 75 (l/s)	6.41 ± 1.94	8.28 ± 1.28	<0.001	HS
MEF 50 (l/s)	5.42 ± 1.44	6.39 ± 1.20	<0.01	S
MEF 25 (l/s)	3.45 ± 1.17	4.35 ± 1.12	<0.01	S

d.f. = 58; FEV_1, forced expiratory volume in 1 s; FVC, forced vital capacity; MEF, mid-expiratory flow; MMEF, maximum mid-expiratory flow; NS, not significant; PEFR, peak expiratory flow rate; S, significant $P < 0.01$; HS, highly significant $P < 0.001$.

difference in height, weight, and BMI taking a *P*-value of less than 0.01 as significant.

VO_2 max values were statistically similar in both groups. This observation is expected in view of the short duration of gutkha use and the relative reserve capacities of the cardiovascular and respiratory systems. VO_2 max is an objective index of the functional capacity of the body's ability to generate power.

Forced vital capacity (FVC) is the volume expired with the greatest force and speed from total lung capacity and forced expiratory volume (FEV_1) that expired in the first second during the same maneuver. The FEV_1 was initially used as an indirect method of estimating its predecessor as the principal pulmonary function test, the maximal breathing capacity [5].

On comparing the response of exercise within the two study groups and in-between them, there was no statistically significant difference in FVC and FEV_1 under any condition.

A normal FEV_1/FVC ratio is observed always.

Another way of looking at forced expiration is to measure both expiratory flow and the volume expired. The maximum flow obtained from a flow–volume curve is the peak expiratory flow rate (PEFR). The peak flow occurs at high lung volumes and is effort dependent. Flow at lower lung volumes is effort independent. Flow at lower lung volumes depends on the elastic recoil pressure of the lungs and the resistance of the airways upstream or distal to the point at which dynamic compression occurs. Measurements of flow at low lung volumes and mid-expiratory flow (MEF 25–75%) are often used as indices of peripheral or small airways resistance [5].

On examining (Tables 2 and 3), it is clear that exercise per-se does not cause a statistically significant change in dynamic lung function parameters maximum mid-expiratory flow (MMEF), PEFR, MEF 25–75% in either of the groups. This finding supports the hypothesis that the respiratory system is not normally the most limiting factor in the delivery of oxygen.

On comparing dynamic lung functions in terms of the above flow rates of gutkha chewers and controls before exercise (Table 4), it is seen that controls have higher MMEF, PEFR, and MEF 25–75%. This suggests a higher adaptability of the respiratory system to the exercise stimulus.

These changes are consistently maintained after maximal exercise testing, suggesting a higher elastic recoil pressure of the lungs and a lower resistance of medium to small airways in response to exercise as a result of adaptive mechanisms in the pulmonary system.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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