VENTILATORY FUNCTION IN MALAY MUSLIMS DURING NORMAL ACTIVITY AND THE RAMADAN FAST

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ABSTRACT

Pulmonary function parameters were examined in a Malay Muslim population during normal activity and Ramadan fasting conditions. The validity of employing various lung function prediction formulae for the subjects was also assessed. Present findings indicate that the water deprivation regime and resultant dehydration during Ramadan did not cause significant changes in ventilatory functions. Although pulmonary prediction formulae based on Caucasian and African populations were inapplicable to the subjects examined, the equations derived from the neighbouring populations in Singapore could be employed.

Keywords: spirometry, fasting Asiatic Muslims

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INTRODUCTION

Pulmonary measurements have been extensively explored in several ethnic populations. The inhabitants of Malaysia and Singapore are composed of three major racial groups, Malay, Indian and Chinese, with distinctive physical and cultural characteristics. Normal ventilatory functions of the Chinese (1) and Malay race (2) residing in Singapore have been examined in some detail with derivation of prediction formulae, whereas residents of Malaysia have not been similarly investigated.

It is the cultural and religious practice of the Malay Muslims in both countries to undergo total abstention from food and drink during daylight hours and increased preoccupation with religious meditation during the entire month of Ramadan. Previous investigations by the present authors have reported that the altered activity and feeding patterns during the fasting month exerted biological effects on selected physiological variables (3-5). Consequently, an awareness of normal adaptations to the Ramadan regime in health is important in the clinical evaluation of Malay Muslim patients during the fasting month.

The principal aims of the present study are to ascertain whether the Ramadan regime affected normal lung functions and to assess the applicability of various prediction formulae to the derivation of the pulmonary parameters examined in a representative sample of Malay Muslims resident in Malaysia.

MATERIALS AND METHODS

Thirteen healthy young male adults of sedentary habits were investigated. None of the subjects were heavy smokers. They belonged to the Malay ethnic group and performed the Ramadan fast annually. The subjects gave their informed consent to the study.

Lung functions were measured during the second and third week of the fasting month and then repeated a month after termination of the fast at the same time of day to eliminate circadian effects (between 1400 and 1600 hours).

Height and nude weight were recorded on arrival at the laboratory. All spirometric measurements were made with the subject in the standing position. The forced vital capacity (FVC), expiratory reserve volume (ERV) and forced expiratory volume in one second (FEV_1) were measured directly with a 13.5 litre Collins Respirometer. The highest value for three efforts were accepted. The functional residual capacity (FRC) was measured in duplicate using the closed circuit helium dilution method of Di Salvo and Goto (6) and an average value was calculated for each subject. The residual volume (RV) and total lung capacity (TLC) were calculated by subtracting ERV from FRC and by adding FVC to RV respectively.

Measurement of anatomic dead space (V_D) was based on Bohr's equation (7) and calculated according to the following modification:

$$V_D = \frac{F_{ET,CO2} - F_{E,CO2}}{F_{ET,CO2}} \quad V_T - \text{valve dead space}$$

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The fractional concentration of CO_2 in end-tidal expired air ($F_{ET,CO}$) was assumed to be representative of FCO in alveolar gas ($F_{A,CO}$). V_T represented tidal volume and the dead space of the valve used was 50 ml (manufacturer's specification). The subject sat upright and breathed through a low resistance valve while expired gas was sampled at the mouthpiece and analyzed for CO_2 with an infrared gas analyzer with a peak detector assembly which detected and held peak values of CO_2 with each end-tidal volume (Sensormedics LB-2 CO_2 analyzer). A timed gas collection of 3-4 min was used for data collection. The expired gas volume was analyzed for CO_2 concentration ($F_{E,CO}$) and divided by breathing frequency to obtain the mean tidal volume (V_T). Average $F_{ET,CO}$ was calculated using all the breaths during which expired air was collected. The validity of the above method for estimation of anatomic dead space is supported by the work of Young (8), Shepard et al (9) and Magaria et al (10).

All lung volumes including anatomic dead space were measured at an ambient temperature of 23°C and corrected to BTPS.

Peak expiratory flow (PEF) was measured with a Wright peak flow meter and expressed in ATPS (ambient temperature 23°C, ambient pressure 758 torr) with the subject in a standing position. The maximum value for 4 or 5 efforts was accepted.

RESULTS

The physical characteristics and pulmonary measurements of the subjects are presented in Table I. The significance of differences in the parameters examined during normal and Ramadan fast conditions was tested with the Student's t test. Two parameters - $\%V_D/V_T$ and PEF reached statistical significance at $p < 0.05$ and $p < 0.01$ respectively.

Table I

Mean and standard error of pulmonary function values measured under normal and Ramadan fast conditions.

	NORMAL	RAMADAN FAST
Age (yrs)	24.3 ± 1.6	24.3 ± 1.6
Height (cm)	170 ± 2.0	170 ± 2.0
Weight (kg)	57.0 ± 2.0	55.6 ± 1.9
Body Surface Area (m^2)	1.62 ± 0.03	1.62 ± 0.03
Lung volumes (litres, BTPS) n = 13		
FVC	3.90 ± 0.12	3.82 ± 0.11
FEV_1	3.37 ± 0.11	3.29 ± 0.09
$\%FEV_1/FVC$	86 ± 1	86 ± 1
FRC	3.08 ± 0.18	3.31 ± 0.16
RV	1.70 ± 0.16	1.80 ± 0.12
TLC	5.60 ± 0.24	5.62 ± 0.19
%RV/TLC	30 ± 2 <	32 ± 1 <
PEF ($l.min^{-1}$, ATPS)	571 ± 14	520 ± 14**
V_D & V_T (ml, BTPS) n = 11		
V_D	184 ± 5.6	172 ± 5.0
V_T	487 ± 22	536 ± 23
$\%V_D/V_T$	38 ± 2	33 ± 2*

* $p < 0.05$
** $p < 0.01$

Table II

Comparison of pulmonary function values according to prediction formulae of various investigators standardized for a 24-year-old male 167 cm tall, weighing 57 kg with body surface area 1.62 m². (Volumes expressed in litres at BTPS with body position in parenthesis).

INVESTIGATOR	MATERIAL	FVC	FEV_1	$\%FEV_1/FVC$	FRC	RV	TLC	%RV/TLC
Present authors	Malaysian Malay (standing)	3.90	3.37	86	3.08	1.70	5.6	30
Da Costa (1)	Singapore Chinese (sitting)	3.91	3.22	82	3.07	1.52	5.18	26
Zee & Chew (2)	Singapore Malay (standing)	3.79	3.44	91	-	-	-	-
Woolcock et al (19)	New Guinea highlander (standing)	4.13	3.59	87	2.84		5.16	-
Johannsen & Erasmus (20)	African Bantu (sitting)	3.42	2.82	82	2.12	0.98	4.58	21
Needham et al (15)	British Caucasian (sitting)	4.74	-	-	3.44	1.86	6.2	28
Kory et al (21)	American Caucasian (standing)	4.60	3.90	85	-	-	-	-
Goldman & Becklake (22)	South African Caucasian (sitting)	4.60	-	-	3.51	1.47	-	-

Comparison of mean values for lung volumes for the present series with representative samples in the literature is shown in Table II.

DISCUSSION

The majority population of Malaysia is composed of the Malay race who performs the annual Ramadan fast. The behavioural aspects of the fast and their impact on various physiological parameters have been examined and reported (3-5). Findings pertinent to the present investigation from the above reports are that the Ramadan regime seemed to exert an effect on the autonomic nervous system and induce mild dehydration in the afternoon hours after the fast had entered its second week. More severe dehydration had been reported in Muslims residing in arid climates (11). Studies on the effects of moderate dehydration in healthy men have produced conflicting reports of a decrease (12) and an increase (13) in lung volumes which were ascribed to changes in the size of the anatomic dead space which was not examined. The other most important factor which would cause significant changes in airway volume would be bronchomotor tone under autonomic regulation.

The results of the present study showed that anatomic dead space (V_D) and $\%V_D/V_T$ decreased during fasting. The reason for the latter measurement reaching statistical significance was a combination of decreased V_D and

increased V_T during Ramadan. It is not possible to distinguish between the two variables. The values obtained for V_D are compatible with the normal range reported by others (7,14). The main determinants of peak expiratory flow are expiratory muscle effort, alveoli elastic recoil and airway size. A reduction in expiratory effort and anatomic dead space are possible contributors to the lowered PEF values observed during Ramadan. Differences in spirometric lung volumes were too minimal to be suggestive of altered alveoli elasticity, strength of the respiratory muscles or dead space effects resulting from the fasting regime.

Publications with sufficient data to allow comparisons with representative ethnic groups are used to derive the pulmonary function values shown in Table II. In an attempt to eliminate differences due to height, age, weight and surface area, the regression equations were standardized for the above characteristics. Equations for vital capacity (VC) and forced vital capacity (FVC) were used interchangeably since differences in the two volumes have been shown to be insignificant in normal subjects (15). Although specific subdivisions of lung volume compartments in various postures have been measured in Malaysians of the Malay race (16-18), a complete set of lung volume subdivisions in the same body position has not been previously examined and reported. Consequently, formulae used for prediction of normality by local clinicians are still based on data on Caucasian populations with an arbitrary correction factor of less 10%.

The limited size of the present sample does not permit formulation of prediction equations. However, comparisons presented in Table II indicate that while discrepancies between observed and predicted values are relatively major when compared with Caucasian and African populations, there is marked similarity with the Singapore values (1,2). Major factors which have been shown to influence normal lung volumes include anthropometry and power of respiratory muscles. The present results show that the populations of Singapore and Malaysia are highly similar in the above characteristics. Our findings are also in agreement with the well established positive correlationship of lung volumes to height.

The conclusions to be drawn from the present study are that the regression equations of Da Costa (1) which evolved from the Chinese population resident in Singapore allow prediction of expected values in the Malay population of Malaysia. Furthermore, the observance of the Ramadan fast does not exert a significant effect on pulmonary volume functions in healthy individuals.

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