Lung function parameters of healthy Sri Lankan Tamil young adults

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(Index words: lung function parameters, VC, FVC, FEV1, PEFR)

Abstract

Objectives To establish reference norms of lung function parameters for healthy Sri Lankan Tamil young adults.

Design and setting Cross sectional study of Tamil students at the Faculty of Medicine, Jaffna.

Measurements Healthy non smoking students of Sri Lankan Tamil ethnic group were enrolled. Age, height, weight, BMI and spirometric measurements (Micro Quark) were recorded in 267 participants (137 females and 130 males).

Results Height was significantly correlated with (p<0.05) all the lung function parameters except FEV_1%, PEFR and MEF_{75} in males. Prediction equations were derived by regression analysis based on the height as an independent variable. Predicted lung function values for a particular age and height were lower than values predicted for Pakistanis, Kelatanese Malaysians and eastern Indians. The values were comparable to south Indians in Madras. Our FVC values of males and VC of females were closer to Sri Lankan Sinhalese. FEV_1 and FEF_{25-75} in males were slightly higher and FVC, FEV_1 and FEF_{25-75} in females were slightly lower in Tamils. When mean values were compared, these parameters were significantly higher in Tamil males (p<0.001) and significantly lower in Tamil females (p<0.001).

Conclusions These values will be useful in interpreting lung function parameters of the particular age group as there are no published norms for Sri Lankan Tamils. However, our study sample was confined to medical students of 20-28 years which may explain the differences with Sinhalese.

Ceylon Medical Journal 2014; **59**: 49-53

Introduction

Measurement of lung volume was first done by Borelli in 17th century, who measured the inspired volume in single breath [1]. In 18th century Thrackrah showed that the lung volumes were lower in women than in men. He also found low lung volumes in people who were exposed to dust frequently. In 1846, Hutchinson developed the first spirometer and recorded vital capacity [1]. However, volume spirometers are less portable and difficult to clean. Also the resistance of the instrument makes it difficult to perform the test. These features hindered the use of spirometer in routine practice. Advancement in technology resulted in portable flow sensing spirometers which can automatically display several parameters and store the results. This made spirometry a convenient tool which can be used in clinical practice.

Lung function tests play an important role in assessing lung dysfunction, diagnosing obstructive, restrictive and occupational lung diseases, establishing prognosis, evaluating response to treatment and investigating the fitness prior to anesthesia [2]. Although various techniques like body plethysmography, nitrogen washout, gas dilution, radiographic imaging methods and spirometry are available for the measurement of lung function spirometer and peak flow meter are the most frequently used instruments in clinical practice to measure dynamic lung volumes which helps and quantify respiratory disease [3].

Interpretation of lung function parameters depends on reference values derived from the normal healthy population. If not, it may lead to wrong interpretations and inappropriate treatment. Various factors influence pulmonary function. The most important factors are age, sex, race and height [4]. Lung function parameters in infants, children and adults differ between different ethnic groups [5]. Therefore it is important to use ethnic specific predicted values when interpreting the lung function parameters.

In Sri Lanka spirometric standard values are available for the Sinhalese ethnic group [6]. No published data are available for Sri Lankan Tamils. A study in 1988 concluded that anthropometric parameters of Sri Lankan Sinhalese and Tamils were not different. But the same study referred to another study conducted in the 1950s on anthropometric characters of Sri Lankan adults which reported

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that Tamils were taller than Sinhalese [7]. Due to these discrepancies there was a need to define lung function parameters in Sri Lankan Tamils. This study was done with the aim of establishing reference norms of lung function parameters for healthy Sri Lankan Tamil young adults.

Methods

The study was approved by the Ethical Review Committee of Faculty of Medicine, Jaffna. Volunteers among the students at the Faculty of Medicine, Jaffna were enrolled for this study. All those who were identified as Sri Lankan Tamils in the official documents were included. Details regarding smoking habits and diseases related to cardio vascular and respiratory systems were recorded. A physical examination was carried out by the authors who are medically qualified. Volunteers identified with cardio pulmonary diseases (asthma, tuberculosis, chronic heart failure), or symptoms of respiratory diseases (cough for more than one week, breathlessness, hemoptysis, wheezing, sputum) at the time of the study were excluded. Participants with chest deformities, physical disability, those who have undergone recent major thoraco abdominal surgery and smokers were also excluded from the study. Informed written consent was obtained from participants. The measurements were taken before lunch and at least two hours after breakfast. Participants rested for 15 minutes. In each participant all the anthropometric and spirometric measurements were completed at a single session.

Age was calculated in years as on the last birthday. Body weight was measured to the nearest 0.5 kg using a standard laboratory scale (Seca, Germany) without footwear or heavy clothing. Height was measured to the nearest 0.5 cm using a standard stadiometer (Seca) while the participant was fully erect, eyes looking straight ahead and the feet together without shoes [8]. Body Mass Index (BMI) was calculated based on these measurements.

Micro quark electronic spirometer (Cosmed Srl-Italy) was used for spirometric measurements. According to the manufacturer, the spirometer can detect volumes up to 12 l and the flow range is 0.03-20 l/s. Accuracy of the system is ± 3% or 50 ml. The system was calibrated daily with a 3 l calibration syringe supplied by the manufacturer.

Paticipants were sitting erect with both feet on floor and facing away from the monitor. A nose clip was used. Each participant performed both slow vital capacity and forced vital capacity manoeuvres. In slow vital capacity manoeuvre, they were asked to hold the mouthpiece tightly without any leaking of air and breathe normally and then deep inspiration, slow deep expiration and then again deep inspiration. While each participant was performing the manoeuvre, pattern of the graph was observed on the monitor by the authors to look for any obstruction or leak and to confirm the accuracy of the manoeuvre. Correctly performed manoeuvre without any leaking of air and obstruction in the mouth piece was accepted. Likewise three manoeuvres were accepted only when the difference between two largest vital capacities (VC) was less than 150 ml [8]. Manoeuvre with largest VC was selected and VC, inspiratory reserve volume (IRV) and expiratory reserve volume (ERV) were recorded.

In forced vital capacity manoeuvre, participants were asked to breathe normally through mouth piece without leakage of air for 3 cycles and then inhale fully, hold for just an instant and exhale completely and forcefully. The procedure was accepted when there was no volume change at the end for 1s or exhalation time of 6 s. Minimum of three and a maximum of eight manoeuvres were performed until the difference between best two forced vital capacity (FVC) values was less than 200 ml. The manoeuvre which gave the largest FVC and forced expiratory volume in the first second (FEV_1) was selected for analysis [8]. FVC, FEV1, FEV 1% (FEV_1 as percentage of FVC), mid expiratory flow rate (FEF_{25-75}), expiratory flow rates at 75 (MEF_{75}), 50 (MEF_{50}) and 25 (MEF_{25}), percentage of expiration and peak expiratory flow rate (PEFR) were recorded.

Results

Two hundred and sixty seven (130 males, 137 females) were included in the study. The age range was 20-28 years. Mean age 22.3 years (SD ± 1.774) in males and 22.2 years (SD ± 1.464) in females. The height range was 142-172.5 cm in females and 152.5-192 cm in males. The mean and standard deviation of anthropometric and spirometric values were obtained separately for males and females (Table1). The differences between mean values of both sexes were significant ($p < 0.05$).

There was significant correlation ($p<0.05$) between height and all lung function parameters except $FEV_1\%$, PEFR and MEF_{75} in males. Vital capacity had significant correlation with all measured anthropometric values in females (Table 2). As the height correlated with most of the parameters it was used to form prediction equations (Table 3).

We predicted the lung function values of a female 22 years old with a height of 156 cm using prediction equations of our study and compared our values with those of other ethnic groups as reported in several studies (Table 4). Similar comparison was made for a male of 23 years with a height of 170 cm (Table 5).

Table 1. Anthropometric and lung function parameters of healthy Sri Lankan Tamil young adults

Variables	*Males Mean (SD)*	*Females Mean (SD)*
Height (cm)	170.78±55.73	157.58±5.98
Weight (kg)	63.94±11.48	51.85±8.90
BMI (kg/m^2)	21.91±3.76	20.80±3.37
FVC (L)	3.66±0.50	2.35±0.43
FEV1 (L)	3.34±0.43	2.19±0.39
FEV1 %	91.64±6.00	92.36±9.58
FEF_{25-75} (l/s)	4.39±1.02	2.95±0.75
MEF_{75} (l/s)	6.79±1.57	4.12±1.09
MEF_{50} (l/s)	4.89±1.10	3.26±0.84
MEF_{25} (l/s)	2.59±0.84	1.85±0.55
PEFR (l/s)	440.93±107.13	258.95±69.7
VC (L)	3.52±0.56	2.27±0.40
ERV(L)	1.03±0.42	0.63±0.27
IRV (L)	1.93±0.50	1.19±0.34

Table 3. Simple regression equation for lung function parameters of healthy Sri Lankan Tamil young adults

Parameter	*Sex*	*Regression equation*	*SEE*
Forced expiratory volume (FEV 1)	Male	0.032H-2.085	0.388
	Female	0.022H-1.298	0.366
Forced vital capacity (FVC)	Male	0.034H-2.117	0.467
	Female	0.024H-1.356	0.412
Mid expiratory flow rate (FEF_{25-75})	Male	0.034H-1.374	1.008
	Female	0.034H-2.424	0.730
Expiratory flow rate (MEF_{75})	Female	0.044H-2.833	1.060
Expiratory flow rate (MEF_{50})	Male	0.034H-0.976	1.091
	Female	0.039H-2.828	0.812
Expiratory flow rate (MEF_{25})	Male	0.026H-1.808	0.830
	Female	0.020H-1.27	0.539
Vital capacity (VC)	Male	0.037H-2.829	0.388
	Female	0.021H-1.091	0.362

H=height

Table 2. Correlation co-efficient between anthropometric and lung function parameters of healthy Sri Lankan Tamil young adults

	Age (year)		*Height (cm)*		*Weight (kg)*		*BMI (kg/m^2)*	
	Male	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*
FEV 1	0.027	0.106	0.427**	0.345**	0.127	0.175*	-0.045	0.029
FVC	0.175*	0.15	0.385**	0.324**	0.185*	0.253**	0.032	0.126
FEV1 %	-0.293*	0.32	-0.022	0.164	-0.133	-0.051	-0.045	-0.127
FEF_{25-75}	-0.24**	0.027	-0.189*	0.270**	-0.013	0.404	-0.088	-0.08
MEF_{75}	-0.014	0.099	0.111	0.243**	-0.031	0.007	-0.088	-0.102
MEF_{50}	-0.192	0.058	0.178*	0.275**	0.000	0.046	-0.071	-0.076
MEF_{25}	-0.335	-0.021	0.176*	0.216**	-0.005	0.059	-0.070	0.038
PEFR	0.101	0.091	0.136	0.269**	0.086	0.023	0.0131	-0.098
VC	0.089	0.321**	0.382*	0.320**	0.276*	0.382**	0.126	0.27**

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

Table 4. Comparison of lung function parameters of young females of different ethnic groups (standardized to a height of 156 cm and age of 22 years)

Ethnic group	FVC	FEV1	FEF_{25-75}	MEF_{50}	MEF_{25}	VC
Sri Lankans						
Tamils (present study)	2.388	2.134	2.88	3.265	1.85	2.185
Sinhalese (6)	2.637	2.475	3.463	4.64	2.222	
Sinhalese (9)	2.484	2.298				2.167
Indians						
Madras (10)	2.577	2.156				
Calcutta (11)	2.76	2.428	3.31			2.723
Malaysian						
Kelatanese(12)	2.63	2.3724				
Pakistani (14)	2.6787	2.2315				

Table 5. Comparison of lung function parameters of young males of different ethnic groups (standardized to a height of 170 cm and age of 23 years)

	FVC	FEV1	FEF_{25-75}	MEF_{50}	MEF_{25}	VC
Sri Lankans (6)						
Tamils (present study)	3.633	3.355	4.406	4.804	2.612	3.461
Sinhalese (6)	3.629	3.171	4.018	4.909	2.902	
Indians						
Madras (10)	3.683	3.4897				
Calcutta (15)	4.171	3.609	4.884			4.224
Malaysian						
Kelatanese (12)	3.897	3.517				
Pakistani (14)	4.2184	3.3902				

Discussion

Lung function parameters were predicted for particular age and height as indicated in Table 4 and 5, and compared with those reported in other studies [6, 9, 11]. Asians have lower values than Caucasians [6, 9, 11]. FVC and FEV1 in our study were lower than those of Pakistanis, Kelatanese Malaysians, and eastern Indians. This may be due to differences in body dimensions which are influenced by genetic, nutritional and environmental factors. The values in our study were comparable to those in Madras, south India [10].

When compared with values of Sri Lankan Sinhalese, FVC values for males in our sample were closer to Sinhalese. FEV_1 and FEF_{25-75} were slightly higher in our sample compared to Sri Lankan Sinhalese. In females FVC and FEV_1 were lower. Forced expiratory flows also were lower in our females compared to that of Sinhalese. But the vital capacity was not different. When our mean values were compared with those of Sinhalese, FVC, FEV_1, FEF_{25-75} were higher in Tamil males and lower in Tamil females ($p<0.001$).

The values in Sinhalese were at body temperature and pressure was measured with saturated water vapour, whereas we did not measure the room temperature and barometric pressure at the time of the study. If approximate corrections are considered, our values are likely to be slightly higher than the above mentioned values. We used a nose clip while doing the spirometry. This may have had some influence on the values. In addition variations due to different instruments used in both studies are also possible.

Our study has several limitations. The difference we have observed may be due to small sample size and it was confined to medical students. Our prediction equation had a low standard error of estimate. The study was done in a healthy, non smoking population. The participants of our study were mainly from the Northern and Eastern provinces of Sri Lanka. As published reference values for lung function parameters in Sri Lankan Tamils are not available these findings will be useful in interpreting lung function parameters in the future. This is a preliminary study and large scale studies with wider representation is needed for better results.

Acknowledgements

The authors acknowledge Mr. S.B. Rameshkumar for technical assistance.

References

1. Cotes JE, Chin DJ, Miller MR. Lung function: Physiology, Measurement and Application in Medicine, 6th ed. Blackwell publishing, 2006.
2. Boskabady MH, Keshmiri M, Banihashemi B, Anvary K. Lung Function Values in Healthy Non-Smoking Urban Adults in Iran. *Respiration* 2002; **69**: 320-6.
3. John DP, Pierce R. Pocket Guide to Spirometry. 2nd ed. 2007.
4. Kart L, Gulmez I, Cetinkaya F, *et al.* Pulmonary function parameters in healthy people in urban Central Anatolia. *Turkish Respiratory Journal* 2002; **02**: 48-53.
5. Lin FL, Kelso JM. Pulmonary function studies in healthy Filipino adults residing in the United Status. *Journal of Allergy and Clinical Immunology* 1999; **104**: 338-40.
6. Udupihille M. Spirometric and flow standards for healthy adults non-smoking Sri Lankans belonging to Sinhalese ethnic group. *Annals of Human Biology* 1995; **22**: 321-36.
7. Balasuriya P. Anthropometric study of medical students. *Ceylon Journal of Medical Science* 1988; **31**: 19-24.
8. AARC Clinical Practice Guideline. Spirometry, 1996 Update. Reprinted from *Respiratory care* 1996; **41**: 629-36. Available at web.carteret.edu/keoughp/ LFreshwater/CPAP/PFT/PFT/ Spirometry.pdf Accessed on Sept 2012.
9. Udupihille M. Lung function in young Sri Lankan females. *Journal of National Science Council of Sri Lanka* 1988; **16**: 229-32.
10. Vijayan VK, Kuppurao KV, Venkatesan P, *et al.* Pulmonary function in healthy young adult Indians in Madras. *Thorax* 1990; **45**: 611-5.
11. Chatterje S, Saha D. Pulmonary function studies in healthy non-smoking women of Calcutta. *Annals of Human Biology* 1993; **20**: 31-8.
12. Bandyopadhyay A. Pulmonary function studies in young healthy Malaysians of Kelantan, Malaysia. *Indian Journal of Medical Research* 2011; **134**: 653-7.
13. Gnanou J, Caszo B, Haniza W, *et al.* Prediction equation for lung function in healthy, life time never smoking Malaysian population. *Southeast Asian Journal of Tropical Medicine and Public Health* 2011; **4**: 965-76.
14. David E, Williams R, Miller D, Taylor WF. Pulmonary function studies in healthy Pakistani adults. *Thorax* 1978; **33**: 243-9.
15. Chatterjee S, Saha D, Chatterjee BP. Pulmonary function studies in healthy non-smoking men of Calcutta. *Annals of Human Biology* 1988; **15**: 365-74.