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Chest; Prepublished online January 29, 2010;
DOI 10.1378/chest.09-1911

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Comparison of Pulmonary Function in Immigrant Versus US-Born Asian Indians

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Running title: Pulmonary function in immigrant and US-born Asian Indians.

Conflicts of Interest: None

Word count abstract: 193
Word count manuscript: 2397

ABSTRACT

Objective: Investigate whether there is a difference in pulmonary function between healthy adult US-born Asian Indians and immigrant Asian Indians attributable to country of birth, environmental and socioeconomic factors.

Design: Forced expiratory volume in one second (FEV_1), forced vital capacity (FVC), and forced mid-expiratory flow (FEF_{25-75}) were measured in India-born and US-born subjects residing in the Chicago metropolitan area. Hollingshead Index of Social Position was used to evaluate socioeconomic factors.

Results: There were 262 India-born (61.8% male), and 200 US-born (50% male) subjects who were healthy lifelong nonsmokers; their age range was 16-36 years. US-born Asian Indian men and women were taller and had higher pulmonary function values for height and age compared to immigrant Asian Indian men and women. The differences were most pronounced in women: about 7% for FVC, 9% for FEV_1, and 17% for FEF_{25-75}. Immigrant and US born subjects did not differ in socioeconomic position.

Conclusion: We conclude that US-born Asian Indian men and women have higher pulmonary function values for age and height compared to immigrant Asian Indian men and women. This probably reflects the effect of differing environmental conditions, which cause year of birth trends in lung volumes.

ABBREVIATIONS

ATS: American Thoracic Society

FEF_{25-75}: Forced Expiratory Flow between 25 and 75 percent of vital capacity

FEV_1: Forced Expiratory Volume in first second

FVC: Forced Vital Capacity

LLN: Lower Limit of Normal

PEF: Peak Expiratory Flow

HSI: Hollingshead Socioeconomic Index

INTRODUCTION

Our previous study showed that immigrant Asian Indians have lower pulmonary function values compared to Caucasians in the US (**1**). US census data of 2000 shows that the Asian Indian population currently living in the United States is increasing, and the US-born Asian Indian population is increasing as a consequence (**2**). There are no studies in the medical literature regarding lung function in US-born Asian Indians. Although race is a well known determinant of pulmonary function, environmental and socioeconomic factors are also known to affect lung function (**3**).

There are few studies that compare pulmonary function in the same ethnic population living in two different environments. Japanese-Americans were shown to produce larger flow-volume curves and to be taller compared to Japanese from Japan. (**4**). Asian Indians who were born in African Guyana had smaller lung volumes compared to Africans (**5**). Independent of smoking and respiratory disease, Nigerians had lower age and height adjusted FVC and FEV_1 than African Americans in both genders; however, relative lung function was better among Nigerians **(6).** On the other hand, no significant differences were reported in Caucasians living in Europe, Australia and North America **(7,8,9).**

We performed this study to find if there is a difference in pulmonary function between US-born and immigrant Asian Indians. We hypothesized that if the lung function in US-born Asian Indians was different from that of immigrant Asian Indians, this might be due to differences in environmental and socioeconomic conditions, or to differences in lung development in early childhood.

METHODS

Recruitment

This study included 462 subjects recruited over a period of ten years, 1995 to 2005. Healthy adult subjects of both sexes were recruited from a population of non-smoking Asian Indians residing in the Chicago metropolitan area. The subjects were divided into India-born immigrants and US-born Asian Indians. Immigrant Asian Indians were defined as subjects migrating to the US from the Asian India continent. Their ages ranged from 16 to 36. US-born Asian Indians were born to Asian Indian parents and grew up in the US. Spirometry was performed in the pulmonary function laboratory at North Chicago VA Medical Center or at festivals, picnics and ceremonies where subjects could be conveniently recruited. Some subjects were VA Medical Center medical residents and nursing staff. The research protocol was reviewed and approved by the Institutional Review Board of the Veterans Affairs Medical Center, which consists of the Research and Development Committee and The Human Studies Subcommittee.

Interview and Clinical Examination

Positive smoking status was defined by any answer indicating prior or current history of smoking cigarettes, pipe, cigars, or marijuana use. Smokers were excluded (**3**). All subjects were screened by means of a self-administered health questionnaire (**10**) to exclude cardiopulmonary or other diseases that might affect pulmonary function. Specifically, subjects with a history of asthma, chronic bronchitis, chronic cough, exposure to any toxic chemicals, or surgery involving the chest wall were not eligible. Subjects who were unable to perform spirometry according to ATS guidelines were excluded. Spirometry was postponed if the subjects had any flu like illness or cold. Age was recorded to the nearest year; height was entered to the nearest inch and converted to cm, and body weight was recorded in each case. Hollingshead Socioeconomic Index **(11)** was introduced later in the study and was obtained in only 203 subjects (US-born 96 and Immigrant 107 subjects).

Participant Preparation, Equipment and Quality Assurance

All subjects signed an informed consent document. After the purpose of the tests and the methods to be used were explained to the subjects, spirometric testing was performed by trained personnel using a Winspiro Spirotech spirometer. The same spirometer was used both in and out of the laboratory. The ATS guidelines for spirometry were strictly followed (**3, 12)**.

Spirometry was performed in a sitting position. Acceptability criteria also included spirograms free from artifacts, having good starts with extrapolated volume less than 5% of FVC or 0.15 liter, whichever was greater, and satisfactory exhalation of 6 seconds or a plateau in the volume-time curve. Three acceptable spirograms were obtained; the two largest FEV_1 and FVC values had to agree within 0.2 liters of each other. The largest values were used in the analyses. $FEF_{25\text{-}75}$ was derived from the FVC maneuver with the highest sum of FVC plus FEV_1.

Statistical Analysis

Results from 13 participants whose spirometry test sessions did not meet the ATS standards for acceptability and reproducibility were excluded from all analyses.

We need to model lung function indices as a function of age, height and sex. In addition the model needs to allow for smooth changes across the age range. We therefore used generalized additive modelling of location, scale and shape (GAMLSS) [**13**]. This technique offers a choice of error distributions, uses the Box-Cox power transform to obtain near-normal data distributions, and allows to model the median and the coefficient of variation using cubic smoothing splines. In addition it allows to model additive and multiplicative relationships. All models were fitted using the package GAMLSS (**14**) in R (version 2.9.2) (**15**).

We used the normal and the Box-Cox-Cole-Green distributions, and the Box-Cox power exponential distribution to test for non-normal kurtosis. Given the wide range of models that may be tested we adopted the stepwise approach advocated by Cole (**16**), *i.e.* in all analyses first establish whether age and height are both required in modelling the median, and whether any height-age relationship is additive or multiplicative; subsequently we fitted cubic splines. The process was then repeated for the coefficient of variation, subsequently for skewness. Finally we tested for differences between centres in the predicted median and in the variability. The model with the smallest Schwarz Bayesian Criterion (SBC) within a family of models was selected. The final choice of the most appropriate and parsimonious model was based on inspection of worm plots (**17**), QQ-plots and the distribution of residuals.

Multiple linear regression analysis was applied to observed lung function values as a function of standing height, age and country of birth (CoB). The FEV_1, FVC, FEV_1/FVC and FEF_{25-75} were dependent variables while height and age were independent variables. To facilitate inspection of the magnitude of differences in predicted values, these were determined for each dependent variable for a subject age 25 years and of average height: 175 cm for men, and 165 cm for women. Explained variances (R^2), and residual standard deviations (RSD), were also reported. P-values less than or equal to 0.05 were considered to be significant. Statistical analysis was done using R version 2.9.2 statistical software (**15**).

RESULTS

Two hundred sixty-two India-born (162 male and 100 female), and 200 US-born (100 male and 100 female) subjects met the inclusion criteria. Subject characteristics are displayed in **Table I**. Age ranged between 16 and 36 years in all groups. Age distribution for each group is shown in **Table II**. Heights ranged 152 to 188 cm (mean 175.8±6.2) for men and 150 to 174 cm (mean 161.8±6.1) for women in the US-born group. In the immigrant group, heights ranged 157 to 193 cm (173.8±6.3 cm) for men and 127 to 183 cm (159.7±6.7 cm) for women. Height as a spline function of age revealed a slight difference between groups ($P = 0.0544$) in males, but not in females ($P = 0.091$). Weight did not differ significantly between the groups. The Hollingshead social index (HSI) yielded a high score with no differences between groups by using Chi square test ($P > 0.05$).

In view of the age differences between groups, pulmonary function might be on the rise in the youngest subjects, and on the decline in the older adults. However, analysis with cubic splines (gamlss) did not reveal such a pattern; in fact, a conventional linear regression equation (using SPSS) best described the relationships, log transformation leading to the best results. Conventional multiple linear regression analysis of pooled data with adjustment of the intercept for country of birth showed a highly significant difference between spirometric indices in males and females, and consistent interaction with country of birth in females. Regression equations were then obtained for FEV1, FVC, FEV1/FVC and FEF25-75 (Table III) for sexes separately, using country of birth as a categorical variable. In women, country of birth contributed significantly to all predicted values; in men born in the USA there was a consistent tendency for values to be higher, which was statistically significant for the FVC (**Table III**). These equations were used to generate predicted values for FEV_1, FVC, FEV_1/FVC and FEF_{25-75} for age 25 at an average height 175 cm (165 cm for women) (**table IV**). In US-born women the FVC was on average 7%, the FEV_1 9.%, and FEF_{25-75} 17% higher (**table IV**) than in immigrant women. **Figures 1 and 2** illustrate predicted values for FEV_1 and FVC for US-born and immigrant Asian Indian men and women, predicted values based on published equations from the Indian subcontinent, and for white Americans.

DISCUSSION

We found that for the same age and height US-born Asian Indian men and women have higher pulmonary function values compared to immigrant Asian Indian men and women. The differences are significant for FEV_1, FVC, FEV_1/FVC and FEF_{25-75} in women. White American males age 16-36 who participated in the NHANES III study (**25**) were significantly taller than US-born and India-born Indians by 2.0 and 4.4 cm, respectively; the same applied to females (2.1 and 4.7 cm difference).

Pulmonary function values in immigrant Asian Indians are grossly comparable with published data from the Indian subcontinent (**Figures 1 and 2**). We anticipated some growth in the youngest subjects and limited decline in the eldest ones, but appropriate statistical techniques did not reveal any dependence of pulmonary function on age. This is due to the relatively small age range in this study, which is associated with a transitional plateau in function from the end of the adolescent growth to a fall with advancing age. This explains the difference with our previous prediction equation (**1**). Vijayan (**24**), who also investigated Asian Indians with a limited age range (15-40 year), similarly found a plateau. In the same age range Stanojevic *et al*. (**22**) also found a near plateau in American whites (**Figures 1 and 2**) in the NHANES III data.

The lower pulmonary function, adjusted for differences in age and height, in immigrant than in US-born Asian Indians is unlikely to be genetically determined, but might be related to environmental, socioeconomic and nutritional factors. We used Hollingshead Social Index questionnaire for social-economic factors between groups. Both groups showed high educational and income levels. US-born Asian Indians as well as immigrant Asian Indians were mainly college or university students. As a result no significant socioeconomic educational differences were observed between these two groups. However, India and the US are dissimilar in terms of health care, socioeconomic level and life standards (**26**). Many studies, including that of Asian Indian children (**27,28**), demonstrated that lower socioeconomic status was associated with lower pulmonary function in both children and adults (**29,30,31,32**). Lower educational attainment was a predictor of rapid FEV_1 decline (**33**). The Copenhagen Heart Study demonstrated that education and income were independently and positively associated with FEV_1 and FVC (**32**).

Factors such as social class, income, education, family size, urban or rural location, housing, overcrowding and nutrition have all been implicated in the differences in height between successive cohorts (**34,35**). In both sexes, US-born subjects were taller than the immigrant group. In similar studies Japanese Americans were taller compared to those living in Japan (**4**), and also had larger lung volumes (**4, 36**) for the same age and height. This is in agreement with the finding that Asian Indian adolescents born in the UK had longer legs than immigrant children (**28**). In the developing world poor growth in infancy, *i.e*. in the first 1–2 years of life, leads to reduced height-for-age (**34**). As conditions improve individuals grow taller, more so because of an increase in leg length than in trunk size. Thus the sitting height/height ratio changes (**37**), coming closer to that for American whites. Indeed, ethnic differences in lung volumes are often found to be considerably smaller when related to sitting than to standing height (**28,38**); differences in body proportions may also underlie the differences in lung volumes between groups. This is in keeping with the impact of differences in socioeconomic status on lung function in Asian Indian children over and above an effect on anthropometric indices, attributable to different living conditions and dietary habits (**27**). Thus it is most likely that differences in living conditions and dietary habits in early childhood are responsible for the fact that American born Asian Indians develop larger lungs for age and height than those born in India. This represents the cohort-related differences in height and lung volumes previously reported within countries (**34,37,39-43**). Levels of indoor or outdoor particulate air pollution during early life or later vary greatly within Indian cities and urban areas, and greatly exceed levels in Chicago (**26**).

Significant outdoor air pollution in Indian cities as well as indoor air pollution caused by using biomass fuel for heating and cooking may affect lung function (**44**). Another factor could be childhood respiratory diseases. Better access to the health system and better vaccination coverage in the US may decrease the prevalence of respiratory disease and preserve lung function. Swimming and living at altitude, especially high altitude (>3000 m), may increase lung volumes (**45**), but these are unlikely to have contributed to our findings.

Although US-born Asian Indians had higher pulmonary function compared to the immigrant group, these were significantly lower compared to Caucasians in the US (**Fig. 1 and 2**). This reflects true ethnic differences in physiology between Asian Indians and Caucasians that remain after taking into account anthropometric variables (**28,38,46**).

Our study has some limitations. The first one is the limited age range. We could not recruit US-born Asian Indians above age 36 because most of the Asian Indians are immigrant in this country, and US-born Asian Indians as a first generation still make a very young population. This precluded investigating whether the time-related trend in growth of body dimensions and lung volumes equally affected older birth cohorts. Since most, if not all, of the differences between cohorts are believed to develop in the first two years of life (**34,35**), including children and adolescents in the study would have allowed to shed light on the temporal development of differences between cohorts born in the US and in India. Another limitation is that we did not include factors other than socioeconomic index and age of immigration as explanatory variables for differences in pulmonary function. Such data that might have helped to explain the finding that pulmonary function in Indian females differed much more from their American counterparts than in males. Finally, because the study subjects were not a random sample of the Asian Indian population, we cannot exclude that some selection bias may have occurred. However, the Asian Indian community living in the USA generally comes together during these kinds of events, so that any selection bias will be quite limited. In both groups we had a significant contribution from medical workers of Asian Indian origin. Also, most Asian Indians coming to the US originate from well educated middle working class. Accordingly we couldn't find any lower index individual, the small range precluding firm conclusions about the relationship between socioeconomic index and pulmonary function.

In conclusion, US-born Asian Indians show higher pulmonary function compared to immigrant Asian Indians. These differences most likely reflect differing environmental and socioeconomic conditions in the country of birth leading to birth cohort related trends in lung development and growth; such differences should be taken into account when interpreting pulmonary function in these groups.

Author contributions

AF contributed to conception and design of original idea, data analysis and draft of the manuscript.

ASC contributed to data collection, conception and design of original idea, data analysis and draft of the manuscript.

MEC contributed to data collection, conception and design of original idea, data analysis and draft of the manuscript.

MP contributed to data collection, conception and design of original idea, data analysis and draft of the manuscript.

SG contributed to data collection, conception and design of original idea, data analysis and draft of the manuscript.

STS contributed to conception and design of original idea, data analysis and draft of the manuscript.

PHQ contributed to data analysis and draft of the manuscript.

Table I. Characteristics of Immigrant and US-Born Asian Indians.

Groups		Female		Male	
		Immigrant	US-born	Immigrant	US-born
Number		100	100	162	100
Mean Age	yr	25.06±5.2	22.0±3.61	27.8±4.4	22.06±2.95
Mean Height	cm	159.7±6.65	161.8±6.11	173.7±6.4	175.7±6.17
Mean Weight	kg	55.44±7.6	54.1±8.6	71.8±8.7	72.5±10.9
Mean FEV_1	L	2.52±0.34	2.81±0.33	3.47±0.49	3.75±0.51
Mean FVC	L	2.88±0.39	3.11±0.39	4.07±0.6	4.33±0.61
FEV_1/FVC		0.879±0.056	0.904±0.049	0.855±0.062	0.870±0.059
Mean FEF	L/s	2.98±0.68	3.66±0.88	3.93±1.01	4.39±1.12
HSI					
Upper		-	-	-	-
Upper-middle		18	38	43	23
Middle		15	17	31	18
Lower-middle		-	-	-	-
Lower		-	-	-	-

Footnote: Mean ± standard deviation. HSI = Hollingshead Socioeconomic Index; the numbers of subjects for each score are depicted. Height as a spline function of age revealed a slight difference between groups (P = 0.0544) in males, but not in females (P = 0.091). Weight did not differ significantly between the groups. The Hollingshead social index (HSI) yielded a high score with no differences between groups by using Chi square test (P > 0.05).

Table II. Age Distribution for Immigrant and US-Born Asian Indians.

Groups	Female		Male	
	Immigrant	US-born	Immigrant	US-born
16-20	16	36	12	35
21-25	30	49	39	51
26-30	32	13	63	12
31-36	19	2	48	2
Total	100	100	162	100

Table III - Prediction Equations for US-born and Immigrant Asian Indian Men and Women

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Men

$\ln(FEV_1)$ -0.3807 + 0.0103•H – 0.0065•A + 0.0218•CoB*, RSD = 0.1225, R^2 = 0.313

$\ln(FVC)$ -0.6060 + 0.0117•H – 0.0011•A* + 0.0326•CoB*, RSD = 0.1288, R^2 = 0.277

$\ln(FEV_1/FVC)$ 0.2253 – 0.0014•H – 0.0054•A – 0.0108•CoB*, RSD = 0.0688, R^2 = 0.107

$\ln(FEF_{25\text{-}75})$ 0.8721 + 0.0053•H - 0.0169•A + 0.0053•CoB*, RSD = 0.262, R^2 = 0.119

Women

$\ln(FEV_1)$ -0.3471 +0.0083•H – 0.0014•A* + 0.0862•CoB, RSD = 0.1174, R^2 = 0.303

$\ln(FVC)$ -0.4028 + 0.0088•H + 0.0017•A* +0.0661•CoB, RSD = 0.1193, R^2 = 0.251

$\ln(FEV_1/FVC)$ 0.0287 – 0.0005•H* – 0.0032•A + 0.0202•CoB, RSD = 0.0617, R^2 = 0.110

$\ln(FEF_{25\text{-}75})$ 0.5375 + 0.0046•H – 0.0078•A + 0.1549•CoB, RSD = 0.2284, R^2 = 0.188

Footnote: Volumes and flows are in L and L/s, respectively. H = height (cm), A = age (yr), CoB = country of birth, where India-born = 0, and USA-born = 1; ln = natural logarithm, RSD = residual standard deviation, R^2 = explained variance; * $p > 0.05$.

Table IV. Predicted Pulmonary Function values for a 25 year old Asian-Indian man and woman of about average height (175 cm in men, 165 cm in women).

		MEN		WOMEN	
		US-BORN	IMMIGRANT	US-BORN	IMMIGRANT
FVC	(L)	4.25	4.11	3.18	2.98
FEV_1	(L)	3.60	3.52	2.93	2.68
FEV_1/FVC		0.85	0.86	0.89	0.87
FEF_{25-75}	(L/s)	3.98	3.96	3.51	3.01

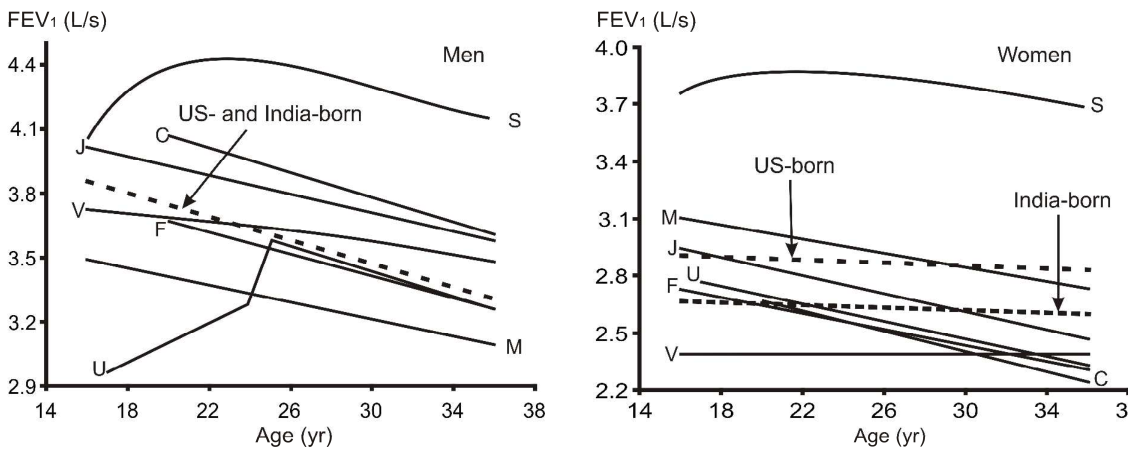

Figure 1 – Predicted values for FEV_1 in men (175 cm) and women (165 cm) for white Americans (S) and persons of Indian extraction. Interrupted lines represent results from the present study.

Footnote: C = Chatterjee (**18,19**); F = Fulambarker (**1**), J = Jindal (**20**); M = Memon (**21**); S = Stanojevic (**22**); U = Udupihille (**23**); V =Vijayan (**24**).

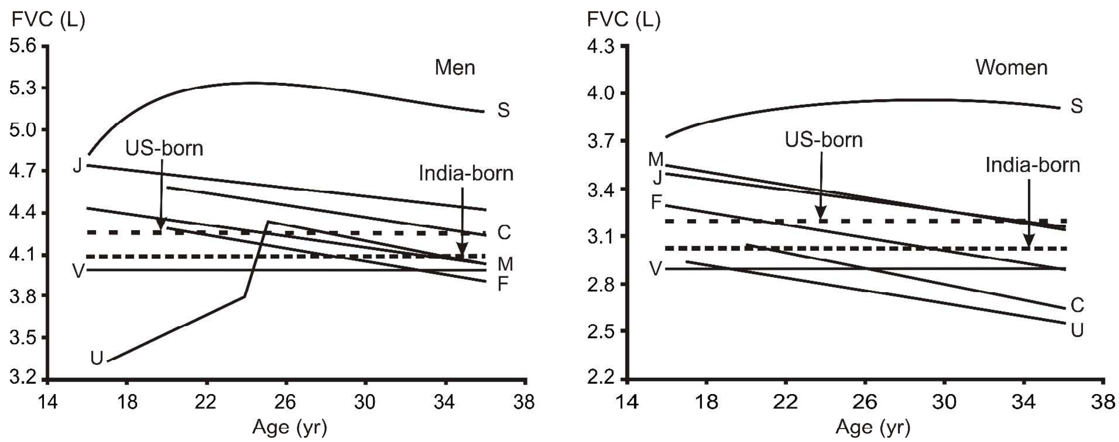

Figure 2 – Predicted values for FVC in men (175 cm) and women (165 cm) for white Americans (S) and persons of Indian extraction. Interrupted lines represent results from the present study.

Footnote: C = Chatterjee (**18,19**); F = Fulambarker (**1**), J = Jindal (**20**); M = Memon (**21**); S = Stanojevic (**22**); U = Udupihille (**23**); V =Vijayan (**24**).

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Table I. Characteristics of Immigrant and US-Born Asian Indians.

Groups		Female		Male	
		Immigrant	US-born	Immigrant	US-born
Number		100	100	162	100
Mean Age	yr	25.06±5.2	22.0±3.61	27.8±4.4	22.06±2.95
Mean Height	cm	159.7±6.65	161.8±6.11	173.7±6.4	175.7±6.17
Mean Weight	kg	55.44±7.6	54.1±8.6	71.8±8.7	72.5±10.9
Mean FEV_1	L	2.52±0.34	2.81±0.33	3.47±0.49	3.75±0.51
Mean FVC	L	2.88±0.39	3.11±0.39	4.07±0.6	4.33±0.61
FEV_1/FVC		0.879±0.056	0.904±0.049	0.855±0.062	0.870±0.059
Mean FEF	L/s	2.98±0.68	3.66±0.88	3.93±1.01	4.39±1.12
HSI					
Upper		-	-	-	-
Upper-middle		18	38	43	23
Middle		15	17	31	18
Lower-middle		-	-	-	-
Lower		-	-	-	-

Footnote: Mean ± standard deviation. HSI = Hollingshead Socioeconomic Index; the numbers of subjects for each score are depicted. Height as a spline function of age revealed a slight difference between groups (P = 0.0544) in males, but not in females (P = 0.091). Weight did not differ significantly between the groups. The Hollingshead social index (HSI) yielded a high score with no differences between groups by using Chi square test (P > 0.05).

Table II. Age Distribution for Immigrant and US-Born Asian Indians.

Groups	Female		Male	
	Immigrant	US-born	Immigrant	US-born
16-20	16	36	12	35
21-25	30	49	39	51
26-30	32	13	63	12
31-36	19	2	48	2
Total	100	100	162	100

Table III - Prediction Equations for US-born and Immigrant Asian Indian Men and Women

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Men

$\ln(FEV_1)$ -0.3807 + 0.0103•H – 0.0065•A + 0.0218•CoB*, RSD = 0.1225, R^2 = 0.313

$\ln(FVC)$ -0.6060 + 0.0117•H – 0.0011•A* + 0.0326•CoB*, RSD = 0.1288, R^2 = 0.277

$\ln(FEV_1/FVC)$ 0.2253 – 0.0014•H – 0.0054•A – 0.0108•CoB*, RSD = 0.0688, R^2 = 0.107

$\ln(FEF_{25-75})$ 0.8721 + 0.0053•H - 0.0169•A + 0.0053•CoB*, RSD = 0.262, R^2 = 0.119

Women

$\ln(FEV_1)$ -0.3471 +0.0083•H – 0.0014•A* + 0.0862•CoB, RSD = 0.1174, R^2 = 0.303

$\ln(FVC)$ -0.4028 + 0.0088•H + 0.0017•A* +0.0661•CoB, RSD = 0.1193, R^2 = 0.251

$\ln(FEV_1/FVC)$ 0.0287 – 0.0005•H* – 0.0032•A + 0.0202•CoB, RSD = 0.0617, R^2 = 0.110

$\ln(FEF_{25-75})$ 0.5375 + 0.0046•H – 0.0078•A + 0.1549•CoB, RSD = 0.2284, R^2 = 0.188

Footnote: Volumes and flows are in L and L/s, respectively. H = height (cm), A = age (yr), CoB = country of birth, where India-born = 0, and USA-born = 1; ln = natural logarithm, RSD = residual standard deviation, R^2 = explained variance; * $p > 0.05$.

Table IV. Predicted Pulmonary Function values for a 25 year old Asian-Indian man and woman of about average height (175 cm in men, 165 cm in women).

	MEN		WOMEN	
	US-BORN	IMMIGRANT	US-BORN	IMMIGRANT
FVC (L)	4.25	4.11	3.18	2.98
FEV_1 (L)	3.60	3.52	2.93	2.68
FEV_1/FVC	0.85	0.86	0.89	0.87
FEF_{25-75} (L/s)	3.98	3.96	3.51	3.01

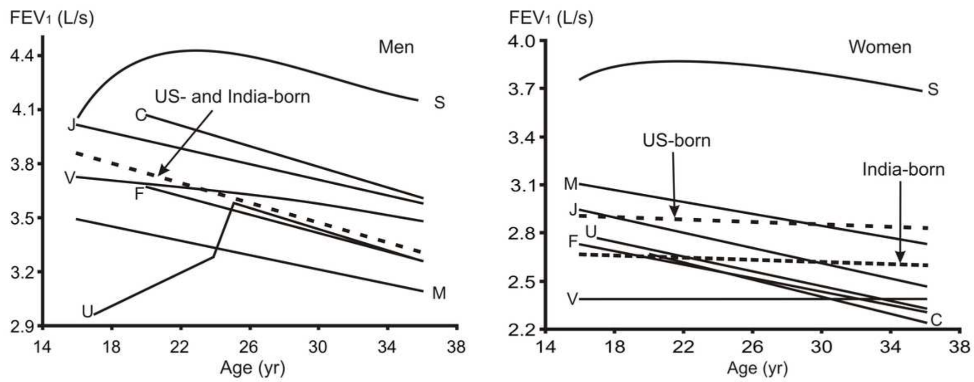

Figure 1 – Predicted values for FEV1 in men (175 cm) and women (165 cm) for white Americans (S) and persons of Indian extraction. Interrupted lines represent results from the present study.

Footnote: C = Chatterjee (18,19); F = Fulambarker (1), J = Jindal (20); M = Memon (21); S = Stanojevic (22); U = Udupihille (23); V =Vijayan (24).

50x20mm (600 x 600 DPI)

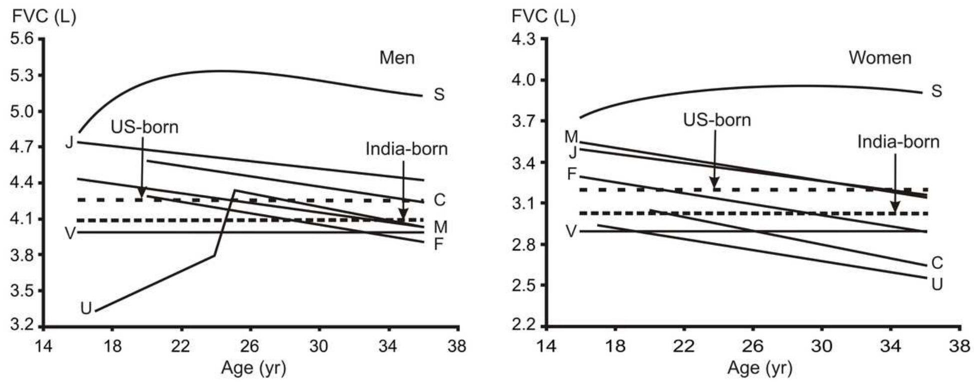

Figure 2 – Predicted values for FVC in men (175 cm) and women (165 cm) for white Americans (S) and persons of Indian extraction. Interrupted lines represent results from the present study.

Footnote: C = Chatterjee (18,19); F = Fulambarker (1), J = Jindal (20); M = Memon (21); S = Stanojevic (22); U = Udupihille (23); V =Vijayan (24).

51x20mm (600 x 600 DPI)