

## **Supplementary tables**

**Table S1.** Number of subjects categorised by exclusion criteria.

<b>Exclusion Criteria</b>	<b>Female</b>	<b>Male</b>	<b>Total</b>
<b>No. of subjects before exclusion</b>	27,285	16,187	43,472
<b>*Current or ex-smokers</b>	375	6,420	6,795
<b>*Lung disease: asthma, emphysema, chronic obstructive pulmonary disease (COPD), lung fibrosis, lung cancer or tuberculosis (TB)</b>	996	298	1,294
<b>*Respiratory symptoms in the last 6 months: breathlessness during normal activity, persistent cough (at least 2 weeks), sputum during coughing, blood in the sputum, wheezing in the chest or early morning cough with chest tightness</b>	7,875	2,598	10,473
<b>*Cardiovascular diseases: Angina pectoris, Myocardial Infarction, Stroke</b>	1,407	385	1,792
<b>Unavailable spirometry data or spirometry grading= D, E, F</b>	11,155	4,510	15,665
<b>No. of subjects after exclusion</b>	5,477	1,976	7,453

\*Based on self-reported questionnaire

**Table S2.** List of South Asian spirometry equation studies published since 2005

	Location	Age (yrs)	Sample size	Remarks
<b>Bangladesh</b>				
Khuda et al. (2013) <sup>1</sup>	Bangladesh	18-40	995 healthy adults (628 males, 367 females)	Not included (No full-text)
<b>India</b>				
Saleem et al. (2012) <sup>2</sup>	Kashmir	18-65	3080 healthy adults (1974 males; 1106 females)	Included
Chhabra et al. (2014) <sup>3</sup>	Delhi	18-71	685 healthy adults (489 males; 196 females)	Included
Dasgupta et al. (2015) <sup>4</sup>	Kolkata	15-69	619 healthy adults (491 males, 128 females)	Included
Desai et al. (2016) <sup>5</sup>	Mumbai	18-75	310 healthy adults (185 males, 125 females)	Included
Biswas et al. (2018) <sup>6</sup>	Arunachal Pradesh	18-60	711 healthy adults (544 male, 167 females)	Included
Agarwal et al. (2020) <sup>7</sup>	Western India	>18 years	1258 healthy adults	Included
<b>Pakistan</b>				
Memon et al. (2007) <sup>8</sup>	Karachi	15-65	504 healthy adults (321 males; 183 females)	Included
<b>Sri Lanka</b>				
Sooriyakanthan et al. (2019) <sup>9</sup>	Northern Sri Lanka (Tamils)	14-85	775 males; 687 females	Included

<sup>1</sup>Khuda KM, Sultana R, Bari MR, Islam R, Erfan MA. Spirometric standard of healthy Bangladeshi adults aged 18-40 years. *Mymensingh Med J*. 2013 Jan;22(1):101-9.

<sup>2</sup>Saleem S, Shah S, Gailson L, et al. Normative Spirometric Values in Adult Kashmiri Population. *Indian J Chest Dis Allied Sci* 2012; 54:227-33.

<sup>3</sup>Chhabra SK, Kumar R, Gupta U, Rahman M, Dash DJ. Prediction equations for spirometry in adults from northern India. *Indian J Chest Dis Allied Sci*. 2014 Oct-Dec;56(4):221-9. Erratum in: *Indian J Chest Dis Allied Sci*. 2015 Jul-Sep;57(3):204.

<sup>4</sup>Dasgupta A, Ghoshal AG, Mukhopadhyay A, et al. Reference equation for spirometry interpretation for Eastern India. *Lung India* 2015.

<sup>5</sup>Desai U, Joshi JM, Chhabra SK, Rahman M-U. Prediction equations for spirometry in adults in western India. *Indian J Tuberc* 2016; 63: 176-82.

<sup>6</sup>Biswas Mrinmoy. Spirometry Prediction Equations for North-eastern Indian Population. *Indian J Physiol Pharmacol* 2018; : 431-8.

<sup>7</sup>Aggarwal A, Agarwal R, Dhooria S, et al. Joint Indian Chest Society-National College of Chest Physicians (India) guidelines for spirometry. *Lung India* 2019.

<sup>8</sup>Memon MA, Sandila MP, Ahmed ST. Spirometric reference values in healthy, non-smoking, urban Pakistani population. *J Pak Med Assoc* 2007; 57: 193-5.

<sup>9</sup>Sooriyakanthan M, Wimalasekera S, Kanagasabai S. Establishment of Reference Norms for Lung Function Parameters of Healthy Sri Lankan Tamils. *Pulm. Med* 2019

**Table S3.** List of South Asia reference equations used in this study

Publication	Sex	LFP	Predictive Equations	SEE
Saleem et al. (2012)	Female			
	15- 30 yrs	FEV <sub>1</sub>	-0.468-0.015Age+0.023Heigh	0.442
	31-50 yrs		0.063-0.004Age+0.017Height	0.416
	>50 yrs		-1.356-0.002Age+0.024Height	0.410
	15- 30 yrs	FVC	0.244-0.022Age+0.022Height	0.454
	31-50 yrs		0.508-0.004Age+0.016Height	0.446
	≥50 yrs		-0.772-0.002Age+0.022Height	0.442
	15- 30 yrs	FEV <sub>1</sub> /FVC(%)	67.8+0.137Age+0.105Height	3.139
	31-50 yrs		75.836-0.012Age+0.077Height	3.095
	≥50 yrs		54.976-0.021Age+0.205Height	3.166
	Male			
	15- 30 yrs	FEV <sub>1</sub>	-1.136-0.014Age+0.033Height	0.627
	31-50 yrs		0.242-0.005Age+0.023Height	0.634
	≥50 yrs		-1.483-0.030Age+0.037Height	0.563
	15- 30 yrs	FVC	-0.416-0.021Age+0.032Height	0.685
	31-50 yrs		0.411-0.005Age+0.025Height	0.671
	≥50 yrs		-1.747-0.031Age+0.04Height	0.589
	15- 30 yrs	FEV <sub>1</sub> /FVC(%)	72.742+0.106Age+0.089Height	2.891
	31-50 yrs		85.516-0.004Age+0.026Height	2.722
≥50 yrs	84.987-0.085Age+0.047Height		3.537	
Chhabra et al. (2014)	Female	FEV <sub>1</sub> (L)	-2.267 – 0.019(Age) + 0.033(Height)	0.286

		FVC (L)	$20.07 - 0.010(\text{Age}) - 0.261(\text{Height}) + 0.000971(\text{Height}^2)$	0.315
		FEV <sub>1</sub> /FVC (%)	$97.182 - 0.440(\text{Age})$	4.97
	Male	FEV <sub>1</sub> (L)	$-3.682 - 0.024(\text{Age}) + 0.046(\text{Height})$	0.402
		FVC (L)	$-5.048 - 0.014(\text{Age}) + 0.054(\text{Height}) + 0.006(\text{Weight})$	0.479
		FEV <sub>1</sub> /FVC(%)	$102.56 - 0.679(\text{Age}) + 0.00477(\text{Age}^2) - 0.080(\text{Weight})$	5.79
Dasgupta et al. (2015)	Female	FEV <sub>1</sub> (L)	$0.0381 - 0.0197(\text{Age}) + 0.0196(\text{Height})$	0.370
		FVC (L)	$0.0972 - 0.0186(\text{Age}) + 0.0216(\text{Height})$	0.465
		FEV <sub>1</sub> /FVC	$0.9205 - 0.00214(\text{Age}) + 0.00001(\text{Height})$	0.076
	Male	FEV <sub>1</sub> (L)	$-1.7649 - 0.0218(\text{Age}) + 0.0337(\text{Height})$	0.434
		FVC (L)	$-2.5370 - 0.0211(\text{Age}) + 0.0418(\text{Height})$	0.518
		FEV <sub>1</sub> /FVC	$1.08994 - 0.00133(\text{Age}) - 0.0012(\text{Height})$	0.092
Desai et al. (2016)	Female	FEV <sub>1</sub> (L)	$\text{Exp}[-1.552 + 0.0043(\text{Age}) - 0.000144(\text{Age}^2) + 0.015(\text{Height})]$	0.115
		FVC (L)	$\text{Exp}[-1.616 + 0.014(\text{Age}) - 0.000219(\text{Age}^2) + 0.015(\text{Height})]$	0.097
		FEV <sub>1</sub> /FVC(%)	$104.35 - 0.085(\text{Age}) + 0.0065(\text{Age}^2)$	6.34
	Male	FEV <sub>1</sub> (L)	$-3.275 - 0.020(\text{Age}) + 0.043(\text{Height})$	0.346
		FVC (L)	$\text{Exp}[-1.048 - 0.0045(\text{Age}) + 0.015(\text{Height})]$	0.111
		FEV <sub>1</sub> /FVC(%)	$89.09 - 0.179(\text{Age})$	4.73
Biswas et al. (2019)	Female	FEV <sub>1</sub> (L)	$0.770 - 0.021(\text{Age}) + 0.011(\text{Height})$	0.356
		FVC (L)	$0.687 - 0.021(\text{Age}) + 0.014(\text{Height})$	0.359
		FEV <sub>1</sub> /FVC	N/A	
	Male	FEV <sub>1</sub> (L)	$0.269 - 0.025(\text{Age}) + 0.020(\text{Height})$	0.460
		FVC (L)	$0.003 - 0.024(\text{Age}) + 0.024(\text{Height})$	0.448
		FEV <sub>1</sub> /FVC	N/A	

Agarwal et al. (2020)	Female	FEV <sub>1</sub> (L)	$-0.8376314 - 0.0095561(\text{Age}) + 0.0210584(\text{Height})$	0.30546
		FVC (L)	$-1.217951 - 0.0061151(\text{Age}) + 0.0253754(\text{Height})$	0.36038
		FEV <sub>1</sub> /FVC(%)	$91.41677 - 0.2019615(\text{Age}) - 0.003514(\text{Height})$	5.7629
	Male	FEV <sub>1</sub> (L)	$-0.6050618 - 0.0172575(\text{Age}) + 0.0249218(\text{Height})$	0.40664
		FVC (L)	$-1.00747 - 0.0129677(\text{Age}) + 0.0299966(\text{Height})$	0.48185
		FEV <sub>1</sub> /FVC(%)	$88.87519 - 0.2001275(\text{Age}) + 0.0084023(\text{Height})$	5.056
Memon et al. (2007)	Female	FEV <sub>1</sub> (L)	$-1.866 - 0.019(\text{Age}) + 0.032(\text{Height})$	0.480
		FVC (L)	$-3.072 - 0.020(\text{Age}) + 0.042(\text{Height})$	0.611
		FEV <sub>1</sub> /FVC	N/A	
	Male	FEV <sub>1</sub> (L)	$-1.440 - 0.020(\text{Age}) + 0.030(\text{Height})$	0.427
		FVC (L)	$-0.848 - 0.020(\text{Age}) + 0.032(\text{Height})$	0.508
		FEV <sub>1</sub> /FVC	N/A	
Sooriyakanthan et al. (2019)	Female	FEV <sub>1</sub> (L)	$- 1.186 - 0.018(\text{Age}) + 0.026(\text{Height})$	0.306
		FVC (L)	$- 1.985 - 0.018(\text{Age}) + 0.033(\text{Height})$	0.364
		FEV <sub>1</sub> /FVC	N/A	
	Male	FEV <sub>1</sub> (L)	$- 2.192 - 0.021(\text{Age}) + 0.036(\text{Height})$	0.398
		FVC (L)	$- 3.311 - 0.022(\text{Age}) + 0.046(\text{Height})$	0.469
		FEV <sub>1</sub> /FVC	N/A	

**Table S4. Summary of post hoc statistical test (tukey) for comparing differences in mean for FEV<sub>1</sub>, FVC and FEV<sub>1</sub>/FVC between countries (Bangladesh, India, Pakistan and Sri Lanka) \***

	FEV <sub>1</sub> (L)		FVC (L)		FEV <sub>1</sub> /FVC	
	Mean diff.	p-value	Mean diff.	p-value	Mean diff.	p-value
<b>Female</b>						
North India – Bangladesh	-0.11	<0.0001	-0.11	<0.0001	-0.01	<0.0001
South India – Bangladesh	-0.44	<0.0001	-0.61	<0.0001	0.06	<0.0001
Pakistan – Bangladesh	-0.12	<0.0001	-0.11	0.013	-0.01	0.058
Sri Lanka – Bangladesh	- 0.11	<0.0001	-0.18	<0.0001	0.02	<0.0001
South India – North India	-0.33	<0.0001	-0.50	<0.0001	0.06	<0.0001
Pakistan – North India	-0.01	0.999	0.00	1.000	-0.00	1.000
Sri Lanka – North India	-0.00	1.000	-0.07	0.001	0.03	<0.0001
Pakistan – South India	0.32	<0.0001	0.50	<0.0001	-0.06	<0.0001
Sri Lanka – South India	0.32	<0.0001	0.43	<0.0001	-0.03	<0.0001
Sri Lanka – Pakistan	0.01	0.999	-0.07	0.258	0.03	<0.0001
<b>Male</b>						
North India – Bangladesh	-0.13	0.001	-0.13	0.003	-0.01	0.325
South India – Bangladesh	-0.53	<0.0001	-0.70	<0.0001	0.02	0.044
Pakistan – Bangladesh	-0.04	0.982	0.03	0.998	-0.01	0.308
Sri Lanka – Bangladesh	-0.09	0.074	-0.16	0.001	0.01	0.010
South India – North India	-0.41	<0.0001	-0.57	<0.0001	0.02	0.001
Pakistan – North India	0.09	0.729	0.16	0.295	-0.01	0.823
Sri Lanka – North India	0.03	0.895	-0.03	0.959	0.02	<0.0001
Pakistan – South India	0.50	<0.0001	0.73	<0.0001	-0.03	0.006
Sri Lanka – South India	0.44	<0.0001	0.54	<0.0001	-0.00	0.991
Sri Lanka – Pakistan	-0.05	0.943	-0.19	0.169	0.03	0.004

\*represents the differences in mean between 2 countries [eg. North India – Bangladesh= Mean of FEV<sub>1</sub> (North India) – Mean of FEV<sub>1</sub> (Bangladesh)]

**Table S5.** Baseline characteristics of external study participants (HELIOS) by sex values are expressed in mean (SD), unless indicated otherwise (n=339).

	<b>Female</b>	<b>Male</b>
<b>n</b>	<b>214</b>	<b>125</b>
<b>Age (yrs)</b>	50.8 (11.1)	51.3 (10.5)
<b>Age group (yrs)</b>	%	%
30-39	18.7	12.8
40-39	24.3	32.0
50-59	36.0	34.3
≥60	21.0	20.8
<b>Height (cm)</b>	157.1 (5.9)	170.4 (5.9)
<b>Weight (kg)</b>	67.7 (14.1)	77.9 (11.9)
<b>FEV<sub>1</sub> (L)</b>	1.94 (0.44)	2.75 (0.55)
<b>FVC (L)</b>	2.36 (0.53)	3.38 (0.61)
<b>FEV<sub>1</sub>/FVC (%)</b>	82.1 (5.4)	81.5 (5.9)

**TableS6.** Mean z-scores and % of subjects with z-scores below -1.645 in male (n=1976) and female (n=5477) using GLI2012 and NHANESIII reference values.

<b>GLI 2012</b>									
<b>Ethnic</b>	<b>FEV<sub>1</sub> (L)</b>			<b>FVC (L)</b>			<b>FEV<sub>1</sub>/FVC</b>		
<b>Others/Mixed</b>	<i>Predicted (SD)</i>	<i>z-score(SD)</i>	<i>z &lt; -1.645 (%)</i>	<i>Predicted (SD)</i>	<i>z-score(SD)</i>	<i>z &lt; -1.645 (%)</i>	<i>Predicted (SD)</i>	<i>z-score(SD)</i>	<i>z &lt; -1.645 (%)</i>
<i>Male</i>	3.16 (0.46)***	-1.43 (1.05)	39.9	3.85 (0.51)***	-1.46 (1.16)	41.7	0.82 (0.02)***	-0.20 (1.01)	8.1
<i>Female</i>	2.32 (0.34)***	-1.65 (1.04)	48.8	2.77 (0.36)***	-1.69 (1.18)	49.0	0.84 (0.03)***	-0.15 (1.04)	5.3
<b>African-American</b>									
<i>Male</i>	2.89 (0.42)***	-0.80 (1.06)	19.7	3.53 (0.46)***	-0.75 (1.10)	19.2	0.82 (0.02)***	-0.16 (0.96)	6.8
<i>Female</i>	2.14 (0.31)***	-1.08 (1.03)	27.4	2.58 (0.33)***	-1.06 (1.10)	26.5	0.83 (0.03)***	-0.07 (0.99)	4.2
<b>Caucasian</b>									
<i>Male</i>	3.39 (0.49)***	-1.86 (0.98)	58.2	4.18 (0.55)***	-1.89 (1.02)	58.6	0.81 (0.02)***	-0.05 (0.94)	5.3
<i>Female</i>	2.49 (0.36)***	-2.07 (0.98)	66.8	3.01 (0.39)***	-2.11 (1.05)	66.5	0.83 (0.03)*	0.00 (0.97)	3.2
<b>South-East Asian</b>									
<i>Male</i>	3.11 (0.45)***	-1.30 (1.05)	34.8	3.71 (0.49)***	-1.12 (1.10)	29.5	0.84 (0.03)***	-0.46 (1.02)	11.4
<i>Female</i>	2.20 (0.32)***	-1.27 (1.03)	33.9	2.59 (0.33)***	-1.12 (1.14)	28.9	0.85 (0.02)***	-0.42 (1.06)	9.4
<b>NHANESIII</b>									
<b>Ethnic</b>	<b>FEV<sub>1</sub> (L)</b>			<b>FVC (L)</b>			<b>FEV<sub>1</sub>/FVC</b>		
<b>Caucasian</b>	<i>Predicted (SD)</i>	<i>Mean (SD)</i>	<i>z &lt; -1.645 (%)</i>	<i>Predicted (SD)</i>	<i>Mean (SD)</i>	<i>z &lt; -1.645 (%)</i>	<i>Predicted (SD)</i>	<i>Mean (SD)</i>	<i>z &lt; -1.645 (%)</i>
<i>Male</i>	3.38 (0.53)***	-2.05 (1.15)	63.3	4.26 (0.57)***	-2.28 (1.128)	72.2	0.79 (0.03)***	0.31 (1.08)	4.5
<i>Female</i>	2.50 (0.38)***	-2.23 (1.07)	70.8	3.06 (0.38)***	-2.36 (1.084)	75.4	0.81 (0.03)***	0.17 (1.07)	3.8
<b>African-American</b>									
<i>Male</i>	2.85 (0.45)***	-0.70 (1.06)	17.6	3.51 (0.47)***	-0.71 (1.12)	18.5	0.81 (0.02)*	-0.07 (0.99)	6.3
<i>Female</i>	2.06 (0.37)***	-0.76 (1.04)	18.3	2.49 (0.38)***	-0.78 (1.05)	18.5	0.83 (0.03)	-0.03 (0.98)	4.1

Paired sample t-test (observed-predicted) p-value: \*\*\*<0.0001; \*\*<0.001; \*<0.01



**Table S7.** Mean of predicted values, z-scores and % of subjects with z-scores below -1.645, in males (n=1976) and females (n=5477) using published South Asian reference values.

FEV <sub>1</sub> (L)	Female			Male		
	Predicted (sd)	z-score (sd)	z <-1.645 (%)	Predicted (SD)	z-score (sd)	z <-1.645 (%)
<i>Observed</i>	<i>1.81 (0.43)</i>	-	-	<i>2.55 (0.59)</i>	-	-
CHH	1.89 (0.34)***	-0.28 (1.15)	11.3	2.78 (0.48)***	-0.57 (1.15)	16.3
DAS	2.13 (0.30)***	-0.87 (0.87)	17.5	2.78 (0.39)***	-0.53 (1.04)	13.5
DES	1.85 (0.29)***	-0.37 (2.82)	30.1	2.87 (0.42)***	-0.94 (1.31)	26.3
BIS	1.50 (0.29)***	0.86 (0.93)	0.7	2.42 (0.37)***	0.28 (1.00)	4.2
AGA	1.93 (0.19)***	-0.39 (1.10)	12.5	2.70 (0.30)***	-0.39 (1.13)	12.2
MEM	2.14 (0.33)***	-0.68 (0.68)	8.3	2.58 (0.36)*	-0.07 (1.06)	7.2
SOO	1.95 (0.30)***	-0.47 (1.05)	12.7	2.76 (0.40)***	-0.55 (1.13)	15.5
SAL	2.40 (0.23)***	-1.41 (0.01)	36.1	3.49 (0.58)***	-1.52 (0.02)	43.5
<b>FVC (L)</b>						
<i>Observed</i>	<i>2.20 (0.51)</i>	-	-	<i>3.16 (0.70)</i>	-	-
CHH	2.40 (0.26)***	-0.65 (1.30)	20.4	3.57 (0.48)***	-0.87 (1.18)	23.3
DAS	2.54 (0.29)***	-0.74 (0.84)	13.3	3.36 (0.43)***	-0.40 (1.03)	10.4
DES	2.27 (0.30)***	-0.72 (4.15)	38.5	3.37 (0.42)***	-1.93 (4.88)	51.5
BIS	1.87 (0.29)**	0.91 (1.11)	1.7	2.86 (0.38)***	0.67 (1.23)	3.4
AGA	2.35 (0.18)***	-0.43 (1.19)	14.5	3.33 (0.29)***	-0.35 (1.16)	12.8
MEM	2.40 (0.39)***	-0.33 (0.64)	2.7	3.50 (0.37)***	-0.67 (1.06)	17.3
SOO	2.21 (0.33)*	-0.04 (1.07)	6.8	3.24 (0.46)***	-0.17 (1.14)	9.2
SAL	2.70 (0.24)	-1.12 (0.01)	26.1	3.86 (0.71)***	-1.05 (0.02)	28.8
<b>FEV<sub>1</sub>/FVC</b>						
<i>Observed</i>	<i>0.82 (0.06)</i>	-	-	<i>0.81 (0.06)</i>	-	-
CHH	0.78 (0.06)***	0.96 (1.60)	3.7	0.77 (0.03)***	0.59 (1.17)	4.0
DAS	0.83 (0.03)**	-0.04 (0.84)	2.8	0.83 (0.02)**	-0.30 (0.68)	4.0
DES	1.15 (0.07)***	-5.07 (1.44)	99.7	0.81 (0.02)***	-0.10 (1.33)	11.0
AGA	0.82 (0.03)***	0.09 (1.10)	4.7	0.81 (0.03)***	-0.13 (1.26)	10.0
SAL	0.86 (0.01)***	-1.25 (0.03)	38.2	0.89 (0.01)***	-2.85 (0.05)	71.9

1. Paired sample t-test (observed-predicted) p-value: \*\*\*<0.0001; \*\*<0.001; \*<0.01

2. CHH= Chhabra, DAS= Dasgupta, DES= Desai, BIS= Biswas, AGA= Aggarwal, MEM= Memon, SOO= Sooriyanathan, SAL= Saleem

**Table S8.** Table of characteristics for participants in development dataset (n=5589) and internal validation dataset (n=1864).

	<b>Female</b>		<b>Male</b>	
	Development	Internal validation	Development	Internal validation
<b>No. of subjects</b>	4121	1356	1468	508
<b>Age (yrs)</b>	44.5 (12.8)	44.5 (12.9)	45.3 (13.0)	44.1 (13.6)
<b>Age group (yrs)</b>	%	%	%	%
18-30	13.9	13.9	13.6	15.8
31-39	25.7	24.9	21.0	26.8
41-49	25.6	27.1	30.0	24.6
50-59	20.3	19.0	20.7	18.3
≥60	14.6	15.2	14.7	14.6
<b>Height (cm)</b>	151.5 (5.9)	151.5 (6.1)	163.9 (7.0)	163.8 (7.1)
<b>Weight (kg)</b>	59.4 (12.9)	59.7 (13.4)	67.0 (14.2)	66.6 (14.4)
<b>Countries</b>	%	%	%	%
Bangladesh	76.2	73.3	23.8	26.7
North India	68.1	70.3	31.9	29.7
South India	68.7	69.8	31.3	30.2
Pakistan	75.6	70.4	24.4	29.6
Sri Lanka	77.7	76.2	22.3	23.8

**Table S9.** Regression output for FEV<sub>1</sub>, FVC and FEV<sub>1</sub>/FVC stratified by sex (n=5589, female: n=4121; male: n=1468)

FEMALE									
VARIABLES	FEV <sub>1</sub> (L)			FVC (L)			FEV <sub>1</sub> /FVC		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
Age	-0.0173*** (0.000399)	-0.0172*** (0.000399)	-0.0167*** (0.000403)	-0.0200*** (0.000485)	-0.0199*** (0.000482)	-0.0185*** (0.000486)	-0.000209*** (7.36e-05)	-0.000229*** (7.25e-05)	-0.000605*** (7.27e-05)
Height	0.0238*** (0.000868)	0.0251*** (0.000964)	0.0242*** (0.000939)	0.0305*** (0.00105)	0.0343*** (0.00117)	0.0336*** (0.00113)	-0.000628*** (0.000160)	-0.00149*** (0.000175)	-0.00158*** (0.000169)
Weight		-0.00139*** (0.000432)	0.0005 (0.000442)		-0.00390*** (0.000523)	-0.00148*** (0.000533)		0.000877*** (7.86e-05)	0.000765*** (7.97e-05)
Study Region									
2.North India			-0.169*** (0.0127)			-0.172*** (0.0153)			-0.0123*** (0.00229)
3.South India			-0.296*** (0.0212)			-0.432*** (0.0256)			0.0473*** (0.00383)
4.Pakistan			-0.204*** (0.0266)			-0.199*** (0.0321)			-0.0152*** (0.00480)
5.Sri Lanka			-0.0679*** (0.0132)			-0.139*** (0.0159)			0.0246*** (0.00238)
Constant	-1.027*** (0.136)	-1.152*** (0.141)	-1.060*** (0.138)	-1.533*** (0.165)	-1.883*** (0.170)	-1.859*** (0.166)	0.929*** (0.0250)	1.008*** (0.0256)	1.039*** (0.0248)
Observations	4,121	4,121	4,121	4,121	4,121	4,121	4,121	4,121	4,121
R-squared	0.429	0.430	0.471	0.422	0.430	0.473	0.005	0.034	0.118
N	4121	4121	4121	4121	4121	4121	4121	4121	4121
RSD	0.323	0.322	0.311	0.392	0.390	0.375	0.0595	0.0586	0.0560
Adjusted R-squared	0.428	0.430	0.470	0.422	0.430	0.472	0.00444	0.0334	0.117
MALE									
VARIABLES	FEV <sub>1</sub> (L)			FVC (L)			FEV <sub>1</sub> /FVC		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
Age	-0.0215*** (0.000909)	-0.0215*** (0.000907)	-0.0210*** (0.000912)	-0.0224*** (0.00107)	-0.0224*** (0.00107)	-0.0211*** (0.00107)	-0.00122*** (0.000126)	-0.00122*** (0.000125)	-0.00145*** (0.000128)
Height	0.0350***	0.0379***	0.0365***	0.0458***	0.0516***	0.0500***	-0.000703***	-0.00132***	-0.00134***

	(0.00169)	(0.00193)	(0.00188)	(0.00199)	(0.00227)	(0.00220)	(0.000234)	(0.000266)	(0.000263)
<b>Weight</b>		-0.00295***	-0.00109		-0.00575***	-0.00347***		0.000614***	0.000599***
Study Region		(0.000943)	(0.000946)		(0.00111)	(0.00111)		(0.000130)	(0.000133)
<b>2.North India</b>			-0.199***			-0.212***			-0.00988**
			(0.0283)			(0.0332)			(0.00397)
<b>3.South India</b>			-0.404***			-0.558***			0.0214***
			(0.0450)			(0.0527)			(0.00631)
<b>4.Pakistan</b>			-0.162**			-0.129*			-0.0172*
			(0.0644)			(0.0753)			(0.00902)
<b>5.Sri Lanka</b>			-0.0604*			-0.144***			0.0198***
			(0.0331)			(0.0387)			(0.00464)
<b>Constant</b>	-2.225***	-2.507***	-2.303***	-3.349***	-3.902***	-3.704***	0.976***	1.035***	1.049***
	(0.284)	(0.297)	(0.291)	(0.336)	(0.349)	(0.340)	(0.0394)	(0.0410)	(0.0407)
<b>Observations</b>	1,468	1,468	1,468	1,468	1,468	1,468	1,468	1,468	1,468
<b>R-squared</b>	0.429	0.432	0.471	0.422	0.433	0.476	0.063	0.077	0.114
<b>N</b>	1468	1468	1468	1468	1468	1468	1468	1468	1468
<b>RSD</b>	0.449	0.448	0.432	0.531	0.526	0.506	0.0622	0.0618	0.0606
<b>Adjusted R-squared</b>	0.428	0.431	0.469	0.421	0.431	0.474	0.0616	0.0751	0.110

M1: adjusted for age, height

M2: adjusted for age, height, weight

M3: adjusted for age, height, weight and study region (factorial variable)

\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$

**Table S10.** Internal validation: mean z-score and % predicted for M1, M2 and M3, stratified by study regions and sex (n=1864).

	FEMALE					
	FEV <sub>1</sub>		FVC		FEV <sub>1</sub> /FVC	
	Mean z-score	% predicted	Mean z-score	% predicted	Mean z-score	% predicted
<b>Bangladesh</b>						
M1	0.25	104.7	0.27	105.2	-0.10	99.3
M2	0.23	104.3	0.23	104.4	-0.04	99.7
M3	-0.02	99.8	-0.04	99.5	0.04	100.2
<b>North India</b>						
M1	-0.14	97.6	-0.04	99.3	-0.29	97.9
M2	-0.14	97.7	-0.03	99.7	-0.32	97.7
M3	0.11	102.0	0.12	102.0	-0.03	99.8
<b>South India</b>						
M1	-0.62	88.3	-0.85	83.6	0.88	106.4
M2	-0.59	88.9	-0.79	84.9	0.80	105.7
M3	0.01	100.7	-0.04	99.5	0.14	100.9
<b>Pakistan</b>						
M1	-0.25	95.5	-0.10	97.9	-0.42	96.9
M2	-0.21	96.2	0.00	99.4	-0.57	96.0
M3	0.09	101.3	0.14	101.8	-0.19	98.7
<b>Sri Lanka</b>						
M1	0.14	102.6	0.06	101.3	0.15	101.1
M2	0.14	102.7	0.07	101.7	0.13	100.9
M3	0.05	100.9	0.10	101.9	-0.16	98.9
	MALE					
	FEV <sub>1</sub>		FVC		FEV <sub>1</sub> /FVC	
	Mean z-score	% pred	Mean z-score	% pred	Mean z-score	% pred
<b>Bangladesh</b>						
M1	0.32	106.1	0.38	107.0	-0.12	99.1
M2	0.29	105.6	0.33	106.2	-0.08	99.4
M3	0.04	100.9	0.06	101.4	-0.06	99.6
<b>North India</b>						
M1	-0.21	97.9	-0.15	97.4	-0.19	98.5
M2	-0.20	97.7	-0.13	97.7	-0.21	98.4
M3	-0.03	99.8	-0.02	99.5	-0.03	99.7
<b>South India</b>						
M1	-0.43	106.4	-0.57	92.6	0.31	90.8
M2	-0.42	105.7	-0.56	92.9	0.30	91.3
M3	0.20	100.9	0.19	105.7	0.02	105.5
<b>Pakistan</b>						
M1	-0.32	94.5	-0.15	97.5	-0.24	98.2
M2	-0.29	95.3	-0.09	98.8	-0.31	97.7
M3	-0.23	96.3	-0.17	97.5	0.00	100.0
<b>Sri Lanka</b>						
M1	0.22	104.6	0.07	101.9	0.37	102.9
M2	0.23	105.0	0.10	102.5	0.35	102.7
M3	0.09	102.1	0.06	101.6	0.08	100.6

1. One sided t-test of mean z-score=0; \*\*\*p<0.0001, \*\*p<0.001, \*P<0.01

2. M1: adjusted for age, height; M2: adjusted for age, height, weight; M3: adjusted for age, height, weight, study region

**Table S11.** Internal validation: percentage of healthy subjects categorised below lower limit of normal (LLN) for FEV<sub>1</sub>, FVC, FEV<sub>1</sub>/FVC, stratified by reference equations and sex (n=1864).

% < LLN	Female			Male		
	FEV <sub>1</sub> (L)	FVC (L)	FEV <sub>1</sub> /FVC	FEV <sub>1</sub> (L)	FVC (L)	FEV <sub>1</sub> /FVC
<b>M1</b>	5.4	4.2	5.2	5.5	4.9	5.3
<b>M2</b>	5.2	4.3	5.4	5.7	5.3	5.3
<b>M3</b>	4.1	3.2	5.4	5.5	5.1	5.1
<b>CHH</b>	11.5	18.7	3.6	15.4	21.7	4.1
<b>DAS</b>	17.7	12.3	2.8	12.4	10.6	4.1
<b>DES</b>	30.3	37.1	99.8	25.2	50.6	11.0
<b>BIS</b>	0.4	1.0	-^	4.5	3.9	-^
<b>AGA</b>	11.6	13.0	4.9	11.2	12.0	10.4
<b>MEM</b>	8.3	2.0	-^	6.9	15.4	-^
<b>SOO</b>	12.5	5.5	-^	14.2	9.4	-^
<b>SAL1</b>	36.7	26.2	37.8	44.9	28.3	28.2
<b>NHA(AA)</b>	18.9	18.2	4.2	15.9	16.7	6.9
<b>GLI(AA)</b>	27.9	25.9	4.1	17.3	18.5	6.9

M1, M2, M3 are predictive equations from current study; CHH= Chhabra; DAS= Dasgupta; DES= Desai; BIS= Biswas; AGA= Aggarwal; MEM= Memon; SOO= Sooriyakanthan; SAL= Saleem; NHA(AA)= NHANES (African-American); GLI(AA)= GLI2012 (African-American)

Note:

-^spirometry reference equations are not available for measuring FEV<sub>1</sub>/FVC

**Table S12.** Internal validation: Disease classification in healthy subjects, stratified by reference equations and sex (n=1864).

	Female				Male				
	Normal	Obstructive	Restrictive	Mixed	Normal	Obstructive	Restrictive	Mixed	
<b>M1</b>	91.2%	4.6%	3.5%	0.6%	<b>M1</b>	90.4%	4.7%	4.3	0.6
<b>M2</b>	91.0%	4.7%	3.6%	0.7%	<b>M2</b>	90.6%	4.1%	4.1%	1.2%
<b>M3</b>	91.9%	4.9%	2.7%	0.4%	<b>M3</b>	90.8%	4.1%	4.1%	1.0%
<b>CHH</b>	76.5%	2.5%	19.8%	1.1%	<b>CHH</b>	75.6%	2.8%	20.3%	1.4%
<b>DAS</b>	85.9%	1.8%	11.3%	1.0%	<b>DAS</b>	86.6%	2.8%	9.3%	1.4%
<b>DES</b>	0.0%	62.9%	0.2%	36.9%	<b>DES</b>	44.5%	4.9%	44.5%	6.1%
<b>SAL</b>	47.0%	26.8%	15.3%	10.9%	<b>SAL</b>	19.9%	51.8%	8.7%	19.7%
<b>SAL1</b>	50.5%	28.7%	11.7%	9.0%	<b>SAL1</b>	0%	80.0%	0.0%	20.0%
<b>AGA</b>	83.5%	3.5%	11.6%	1.4%	<b>AGA</b>	79.9%	8.1%	9.6%	2.4%
<b>NHA(AA)</b>	79.4%	2.4%	16.4%	1.8%	<b>NHA(AA)</b>	78.2%	5.1%	15.0%	1.8%
<b>GLI(AA)</b>	71.8%	2.3%	24.0%	1.8%	<b>GLI(AA)</b>	76.8%	4.7%	16.3%	2.2%

M1, M2, M3 are predictive equations from current study; CHH= Chhabra; DAS= Dasgupta; DES= Desai; BIS= Biswas; AGA= Aggarwal; MEM= Memon; SOO= Sooriyakanthan; SAL= Saleem; NHA(AA)= NHANES (African-American); GLI(AA)= GLI2012 (African-American)

**Table S13.** External validation (HELIOS): Percentage of healthy subjects categorised as below LLN (n=339, female: n=214; male: n=125).

	% of subjects below Lower Limit of Normal (LLN)					
	FEV <sub>1</sub> (L)		FVC (L)		FEV <sub>1</sub> /FVC	
	Female	Male	Female	Male	Female	Male
<b>M1</b>	1.9	4.8	1.9	4.8	1.9	2.4
<b>M2</b>	1.9	4.8	0.9	4.8	2.3	2.4
<b>M3 (BGD)</b>	4.7	6.4	5.1	10.4	2.3	2.4
<b>M3 (NI)</b>	0.9	4.0	1.9	4.0	1.9	2.4
<b>M3 (SI)</b>	0.5	3.2	0.5	1.6	13.1	4.0
<b>M3 (P)</b>	0.5	4.8	1.4	6.4	1.9	2.4
<b>M3 (SL)</b>	3.3	6.4	1.9	6.4	4.7	4.0
<b>NHA (C)</b>	60.7	50.4	80.8	76.0	1.4	2.4
<b>NHA (AA)</b>	9.8	12.8	14.0	14.4	1.9	2.4
<b>GLI (C)</b>	57.0	47.2	61.2	56.8	1.4	2.4
<b>GLI (AA)</b>	14.9	13.6	20.6	12.8	1.9	2.4
<b>GLI (SEA)</b>	20.1	18.4	22.9	22.4	2.3	4.8
<b>GLI (OTH)</b>	36.4	21.6	39.7	36.0	1.9	2.4

*M3(BGD) = Bangladesh, M3(NI)= North India, M3(SI) = South India, M3(P)= Pakistan, M3(SL)=Sri Lanka; NHA(C)= NHANES (Caucasian); NHA(AA)= NHANES (African-American); GLI(C)= GLI2012 (Caucasian); GLI(AA)= GLI2012 (African-American); GLI(SEA)= GLI2012 (South East Asian); GLI(OTH)= GLI (Others)*

**Supplementary figure**

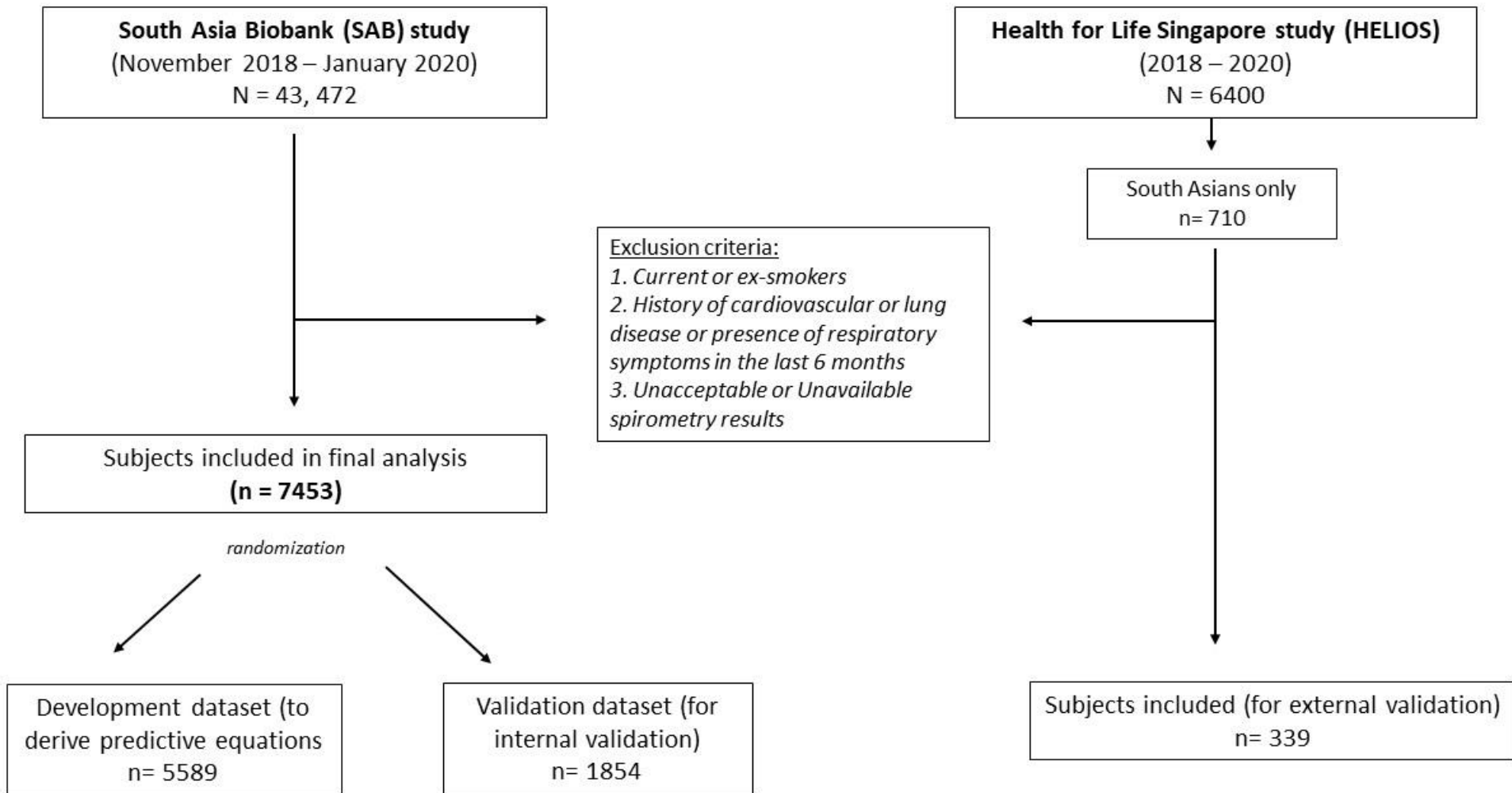


Figure S1. Flowchart of study design



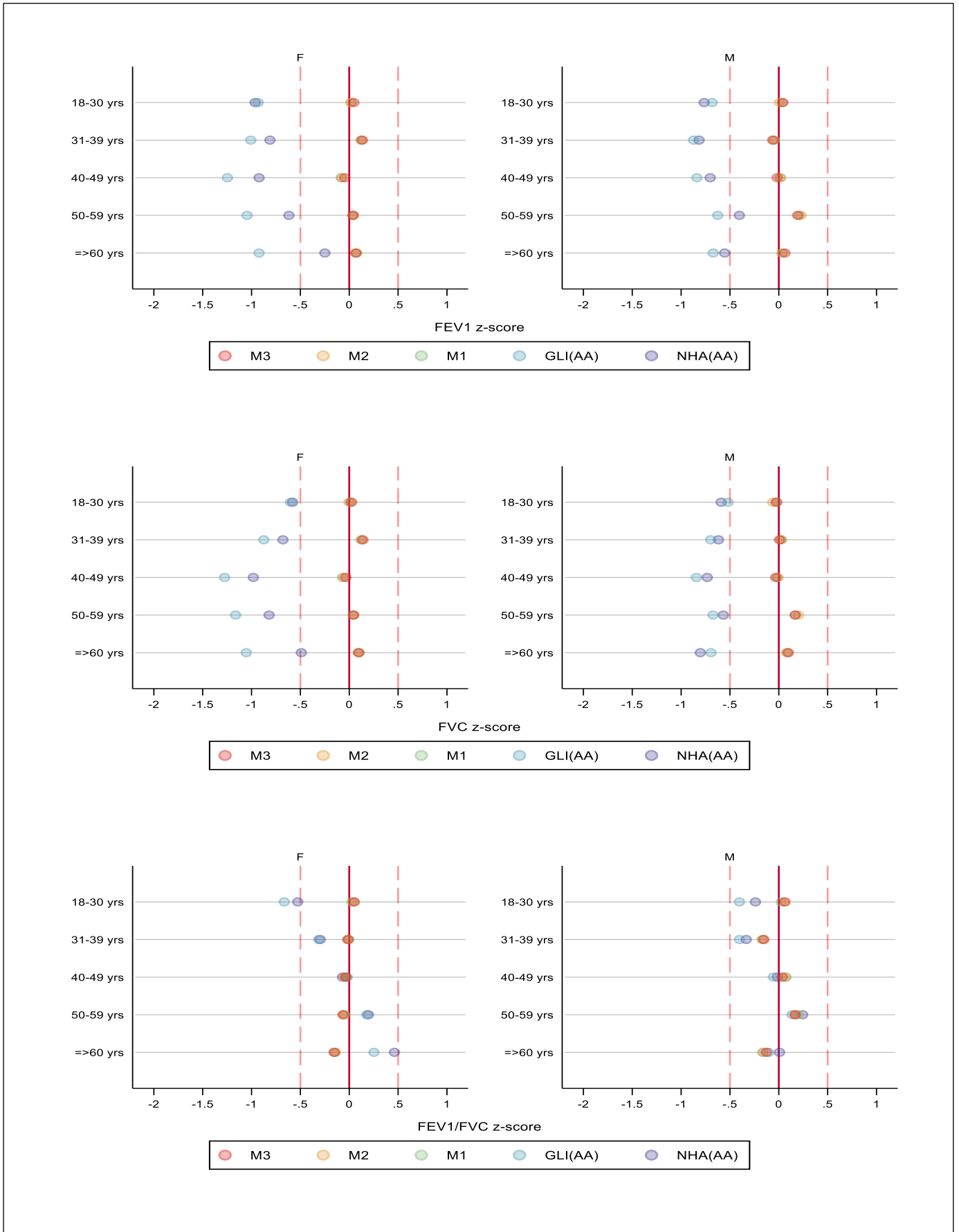


Figure S2. Mean z-score of FEV<sub>1</sub>, FVC and FEV<sub>1</sub>/FVC using GLI2012, NHANES and current predictive equations (M1, M2 and M3), stratified by age group and sex in internal validation (n=1864). NHA(AA)= NHANES (African-American); GLI(AA)= GLI2012 (African-American).

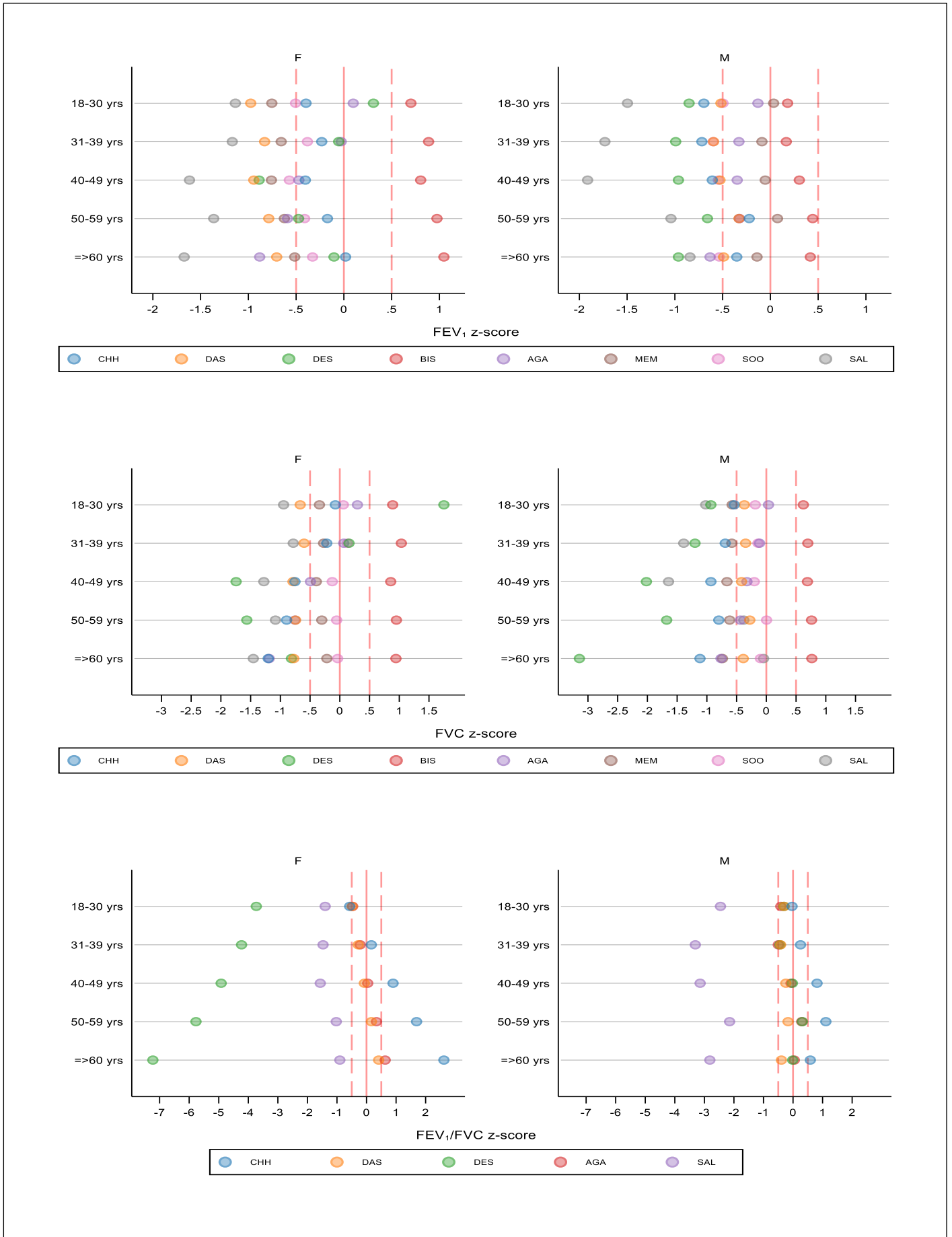


Figure S3. Mean z-score of FEV<sub>1</sub>, FVC and FEV<sub>1</sub>/FVC using South Asian published equations, stratified by age group and sex in internal validation (N=1864). (CHH= Chhabra; DAS= Dasgupta; DES= Desai; BIS= Biswas; AGA= Aggarwal; MEM= Memon; SOO= Sooriyakanthan; SAL= Saleem)

