

Online Supplement

Original Research

Borderline Forced Expiratory Volume in 1 Second to Forced Vital Capacity and Low Forced Expiratory Volume in 1 Second Predict Disease Progression in High-Risk Populations With COPD

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Supplement material I. Other analysis of using China equations to calculate the predicted value of FEV₁ and FVC

Supplement table 1. Basic characteristics of enrolled participants in borderline ratio and PRISm (low FEV₁) group.

	Normal ratio and normal FEV ₁	Borderline ratio	PRISm (low FEV ₁)	P value (borderline ratio vs normal spirometry)	P value (PRISm [low FEV ₁] vs normal spirometry)
N	1476	1172	512		
Age (years, mean [SD])	60.77 (8.47)	61.36 (8.37)	61.02 (8.31)	0.072	0.565
Gender (n [%])				0.678	0.006
Male	1037 (70.3)	833 (71.1)	393 (76.8)		
Female	439 (29.7)	339 (28.9)	119 (23.2)		
Income (ten thousand yuan/year, n [%])				<0.001	0.129
<2	558 (37.8)	458 (39.1)	189 (36.9)		
2-5	622 (42.1)	385 (32.8)	238 (46.5)		
≥5	296 (20.1)	329 (28.1)	85 (16.6)		
Education (n [%])				0.001	0.167
Primary school and below	802 (54.3)	564 (48.1)	255 (49.8)		
Middle and high school	641 (43.4)	560 (47.8)	247 (48.2)		
College and above	33 (2.2)	48 (4.1)	10 (2.0)		
Marriage (n [%])				0.685	0.089
Single	14 (0.9)	11 (0.9)	6 (1.2)		
Married	1405 (95.2)	1125 (96.0)	498 (97.3)		
Divorced	13 (0.9)	10 (0.9)	2 (0.4)		
Widowed	44 (3.0)	26 (2.2)	6 (1.2)		

Employment status (n [%])				<0.001	<0.001
On work	298 (20.2)	297 (25.3)	71 (13.9)		
Retire	95 (6.4)	179 (15.3)	54 (10.5)		
Homework	1053 (71.3)	646 (55.1)	367 (71.7)		
Unemployment	30 (2.0)	50 (4.3)	20 (3.9)		
Job (n [%])				0.330	0.745
Indoor	197 (65.7)	201 (66.8)	50 (69.4)		
Outdoor	71 (23.7)	78 (25.9)	14 (19.4)		
Other	32 (10.7)	22 (7.3)	8 (11.1)		
Fuel (n [%])				<0.001	0.224
Clean	565 (38.3)	577 (49.2)	218 (42.6)		
Unclean	907 (61.4)	592 (50.5)	293 (57.2)		
Unknown	4 (0.3)	3 (0.3)	1 (0.2)		
Smoking status (n [%])				0.242	0.160
Never	585 (39.6)	457 (39.0)	207 (40.4)		
Former	179 (12.1)	168 (14.3)	77 (15.0)		
Current	712 (48.2)	547 (46.7)	228 (44.5)		
Smoking exposure (pack years, mean [SD])	27.11 (18.15)	40.14 (43.13)	36.07 (34.38)	0.028	0.007
Secondhand smoke (n [%])	358 (24.3)	311 (26.5)	110 (21.5)	0.195	0.225
Cough before 14 years old (n [%])	95 (6.4)	77 (6.6)	32 (6.2)	0.953	0.965
Family history of COPD (n [%])	18 (1.2)	15 (1.3)	8 (1.6)	>0.999	0.717
Comorbidities (n [%])	200 (13.6)	192 (16.4)	113 (22.1)	0.047	<0.001
Symptoms (n [%])					
Cough	528 (35.8)	429 (36.6)	215 (42.0)	0.688	0.014

Breathlessness				0.008	0.120
None	493 (33.4)	424 (36.2)	146 (28.5)		
When walking	780 (52.8)	632 (53.9)	293 (57.2)		
When climbing	203 (13.8)	116 (9.9)	73 (14.3)		
Height (cm, mean [SD])	163.16 (7.76)	163.25 (7.58)	163.71 (7.45)	0.776	0.166
Weight (kg, mean [SD])	63.83 (10.75)	64.20 (10.79)	62.47 (9.99)	0.378	0.012
BMI (kg/m ² , mean [SD])	23.93 (3.37)	24.04 (3.38)	23.29 (3.26)	0.415	<0.001
Waist circumference (cm, mean [SD])	86.04 (9.10)	86.86 (9.59)	85.34 (8.87)	0.025	0.130
Hip circumference (cm, mean [SD])	94.38 (8.86)	94.99 (9.18)	93.25 (8.42)	0.084	0.012
Lung function					
FEV ₁ (L, mean [SD])	2.68 (0.56)	2.51 (0.66)	1.73 (0.43)	<0.001	<0.001
FEV ₁ % predicted (% mean [SD])	104.11 (16.35)	97.70 (21.25)	65.79 (12.68)	<0.001	<0.001
FVC (L, mean [SD])	3.04 (0.73)	3.33 (0.86)	2.03 (0.57)	<0.001	<0.001
FVC % predicted (% mean [SD])	90.73 (17.62)	99.37 (21.40)	59.63 (14.32)	<0.001	<0.001
FEV ₁ /FVC (mean [SD])	0.89 (0.07)	0.75 (0.03)	0.86 (0.11)	<0.001	<0.001

Abbreviations: BMI, body mass index; COPD, chronic obstructive pulmonary disease; FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, ratio of FEV₁/FVC; FEV₁ % predicted, proportion of predicted FEV₁ value; FVC % predicted, proportion of predicted FVC value.

Supplement table 2. Lung function change and disease progression during 2 years follows up.

	Normal ratio with normal FEV ₁	Borderline ratio with normal FEV ₁	Normal ratio with low FEV ₁	Borderline ratio with low FEV ₁
FEV ₁ change in 2 years follow-up (L, mean [SD])	0.06 (0.70)	-0.13 (0.61)	1.09 (0.70)	0.66 (0.77)
FEV ₁ % predicted change in 2 years follow-up (% , mean [SD])	5.40 (28.96)	-2.72 (24.61)	43.85 (27.98)	28.71 (31.11)
FEV ₁ rapid decline in 2 years follow-up (n [%])	571 (38.7)	467 (47.6)	14 (4.4)	22 (11.5)
Airway obstruction in 2 years follow-up (n [%])	92 (6.2)	112 (11.4)	27 (8.4)	29 (15.2)

Abbreviations: BMI, body mass index; FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, ratio of FEV₁/FVC; FEV₁ % predicted, proportion of predicted FEV₁ value; FVC % predicted, proportion of predicted FVC value.

Supplement table 3. Lung function change and disease progression in borderline ratio and PRISm (low FEV₁) group during 2 years follow up.

	Normal ratio and normal FEV ₁	Borderline ratio	PRISm (low FEV ₁)	P value (borderline ratio vs normal spirometry)	P value (PRISm [low FEV ₁] vs normal spirometry)
FEV ₁ change in 2 years follow-up (L, mean [SD])	0.06 (0.70)	0.00 (0.70)	0.93 (0.76)	<0.001	<0.001
FEV ₁ % predicted change in 2 years follow-up (% , mean [SD])	5.40 (28.96)	2.40 (28.26)	38.21 (30.06)	0.007	<0.001

FEV ₁ rapid decline in 2 years follow-up (n [%])	571 (38.7)	489 (41.7)	36 (7.0)	0.122	<0.001
Airway obstruction in 2 years follow-up (n [%])	92 (6.2)	141 (12.0)	56 (10.9)	<0.001	0.001

Abbreviations: FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, ratio of FEV₁/FVC; FEV₁ % predicted, proportion of predicted FEV₁ value; FVC % predicted, proportion of predicted FVC value.

Supplement table 4. Risk factors of developing into airway obstruction in high-risk population of COPD with borderline ratio.

	Univariable	multivariable
Age	1.06 (1.03, 1.09)	1.07 (1.02, 1.12)
Gender		
Male	Ref	Ref
Female	0.47 (0.29, 0.74)	0.23 (0.07, 0.85)
Income (ten thousand yuan/year)		
<2	Ref	Ref
2-5	0.79 (0.52, 1.21)	2.48 (0.94, 6.57)
≥5	0.92 (0.60, 1.41)	2.63 (0.93, 7.40)
Education		
Primary school and below	Ref	Ref
Middle and high school	1.13 (0.79, 1.62)	1.07 (0.51, 2.27)
College and above	0.70 (0.24, 2.00)	1.32 (0.29, 6.06)
Marriage		
Single	Ref	Ref
Married	1.40 (0.18, 11.01)	/
Divorced	/	/
Widowed	0.83 (0.07, 10.27)	/
Employment status		
On work	Ref	Ref
Retire	1.10 (0.63, 1.94)	0.68 (0.32, 1.48)
Homework	0.92 (0.60, 1.42)	/
Unemployment	2.36 (1.13, 4.95)	/
Job		
Outdoor	Ref	Ref
Indoor	0.54 (0.26, 1.12)	0.49 (0.19, 1.25)

Other	1.06 (0.47, 2.41)	1.12 (0.42, 3.01)
Biofuel use	0.94 (0.66, 1.34)	1.15 (0.56, 2.35)
Smoking status		
Never	Ref	Ref
Former	1.60 (0.94, 2.74)	1.21 (0.40, 3.68)
Current	1.51 (1.01, 2.24)	0.73 (0.23, 2.34)
Smoking pack years	1.01 (1.00, 1.01)	1.00 (0.98, 1.02)
Secondhand smoke	1.20 (0.82, 1.77)	2.38 (1.18, 4.80)
Cough before 14 years old	1.38 (0.73, 2.63)	0.59 (0.19, 1.84)
Family history of COPD	1.85 (0.51, 6.62)	4.87 (0.74, 32.22)
Height	1.01 (0.98, 1.03)	1.38 (0.98-1.95)
Weight	0.99 (0.97, 1.00)	0.65 (0.42-1.01)
BMI	0.94 (0.88, 0.99)	3.00 (0.95-9.43)
Waist line	0.98 (0.97, 1.00)	0.94 (0.88-1.00)
Hip line	1.00 (0.98, 1.02)	1.05 (1.00-1.11)

Abbreviations: COPD, chronic obstructive pulmonary disease; BMI, body mass index; FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, ratio of FEV₁/FVC

Supplement table 5. Risk factors of developing into airway obstruction in high-risk population of COPD with PRISm (low FEV₁).

	Univariable	multivariable
Age	1.06 (1.02, 1.11)	1.10 (0.98, 1.23)
Gender		
Male	Ref	Ref
Female	0.89 (0.45, 1.75)	0.10 (0.01, 1.33)
Income (ten thousand yuan/year)		
<2	Ref	Ref
2-5	0.60 (0.32, 1.13)	0.96 (0.14, 6.32)
≥5	1.24 (0.60, 2.57)	0.82 (0.11, 6.29)
Education		
Primary school and below	Ref	Ref
Middle and high school	0.81 (0.46, 1.42)	0.97 (0.22, 4.21)
College and above	1.87 (0.38, 9.25)	2.04 (0.10, 40.30)
Marriage		
Single	Ref	Ref
Married	/	/
Divorced	/	/
Widowed	/	/
Employment status		
On work	Ref	Ref
Retire	1.09 (0.42, 2.85)	0.35 (0.05, 2.61)
Homework	0.43 (0.20, 0.92)	/
Unemployment	4.46 (1.50, 13.28)	/
Job		
Outdoor	Ref	Ref
Indoor	1.79 (0.64, 4.98)	1.04 (0.20, 5.59)

Other	1.34 (0.26, 7.03)	1.60 (0.18, 14.12)
Biofuel use	0.40 (0.23, 0.72)	0.38 (0.07, 2.02)
Smoking status		
Never	Ref	Ref
Former	1.31 (0.57, 3.03)	0.86 (0.09, 8.44)
Current	1.39 (0.75, 2.56)	0.16 (0.01, 2.21)
Smoking pack years	1.01 (1.00, 1.02)	1.02 (0.99, 1.06)
Secondhand smoke	2.47 (1.37, 4.46)	5.51 (0.99, 30.48)
Cough before 14 years old	0.83 (0.25, 2.83)	0.28 (0.02, 3.89)
Family history of COPD	5.11 (1.19, 21.97)	1.61 (0.04, 61.00)
Height	0.98 (0.94, 1.02)	1.55 (0.92-2.62)
Weight	0.97 (0.94, 1.00)	0.50 (0.25-1.01)
BMI	0.95 (0.87, 1.04)	4.73 (0.76-29.66)
Waist line	1.01 (0.98, 1.04)	0.99 (0.89-1.11)
Hip line	1.03 (1.00, 1.06)	1.01 (0.88-1.15)

Abbreviations: COPD, chronic obstructive pulmonary disease; PRISm, preserved ratio impaired spirometry; BMI, body mass index; FEV₁, forced expiratory volume in one second; FEV₁ % predicted, proportion of predicted FEV₁ value

Supplement table 6. Risk factors of FEV₁ rapid decline in high-risk population of COPD with borderline ratio.

	Univariable	multivariable
Age	0.99 (0.97, 1.00)	0.97 (0.95, 1.00)
Gender		
Male	Ref	Ref
Female	0.80 (0.62, 1.04)	0.95 (0.46, 1.96)
Income (ten thousand yuan/year)		
<2	Ref	Ref
2-5	0.86 (0.65, 1.14)	1.06 (0.59, 1.90)
≥5	1.20 (0.90, 1.59)	1.55 (0.84, 2.87)
Education		
Primary school and below	Ref	Ref
Middle and high school	1.18 (0.93, 1.50)	0.65 (0.40, 1.06)
College and above	1.13 (0.62, 2.06)	0.85 (0.34, 2.14)
Marriage		
Single	Ref	Ref
Married	0.81 (0.25, 2.68)	0.19 (0.02, 2.29)
Divorced	0.51 (0.09, 3.11)	0.17 (0.01, 5.30)
Widowed	1.64 (0.40, 6.76)	0.46 (0.02, 8.61)
Employment status		
On work	Ref	Ref
Retire	0.64 (0.44, 0.94)	0.83 (0.50, 1.38)
Homework	0.64 (0.49, 0.85)	0.61 (0.05, 7.34)
Unemployment	0.64 (0.35, 1.19)	/
Job		
Outdoor	Ref	Ref
Indoor	0.51 (0.33, 0.79)	0.45 (0.26, 0.78)

Other	1.05 (0.59, 1.86)	1.15 (0.60, 2.20)
Biofuel use	0.96 (0.76, 1.22)	1.23 (0.79, 1.92)
Smoking status		
Never	Ref	Ref
Former	1.15 (0.80, 1.66)	0.81 (0.38, 1.73)
Current	1.26 (0.98, 1.62)	0.45 (0.21, 0.96)
Smoking pack years	1.00 (1.00, 1.00)	1.01 (1.00, 1.03)
Secondhand smoke	1.04 (0.80, 1.36)	1.14 (0.72, 1.79)
Cough before 14 years old	1.10 (0.69, 1.75)	0.86 (0.43, 1.73)
Family history of COPD	0.73 (0.25, 2.14)	1.23 (0.25, 6.02)
Height	1.01 (1.00, 1.03)	1.09 (0.90-1.32)
Weight	1.01 (1.00, 1.02)	0.89 (0.70-1.13)
BMI	1.01 (0.98, 1.05)	1.30 (0.69-2.42)
Waist line	1.00 (0.99, 1.01)	1.00 (0.96-1.04)
Hip line	1.01 (1.00, 1.02)	1.03 (0.99-1.07)

Abbreviations: COPD, chronic obstructive pulmonary disease; BMI, body mass index; FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, ratio of FEV₁/FVC.

Supplement table 7. Risk factors of FEV₁ rapid decline in high-risk population of COPD with PRISm (low FEV₁).

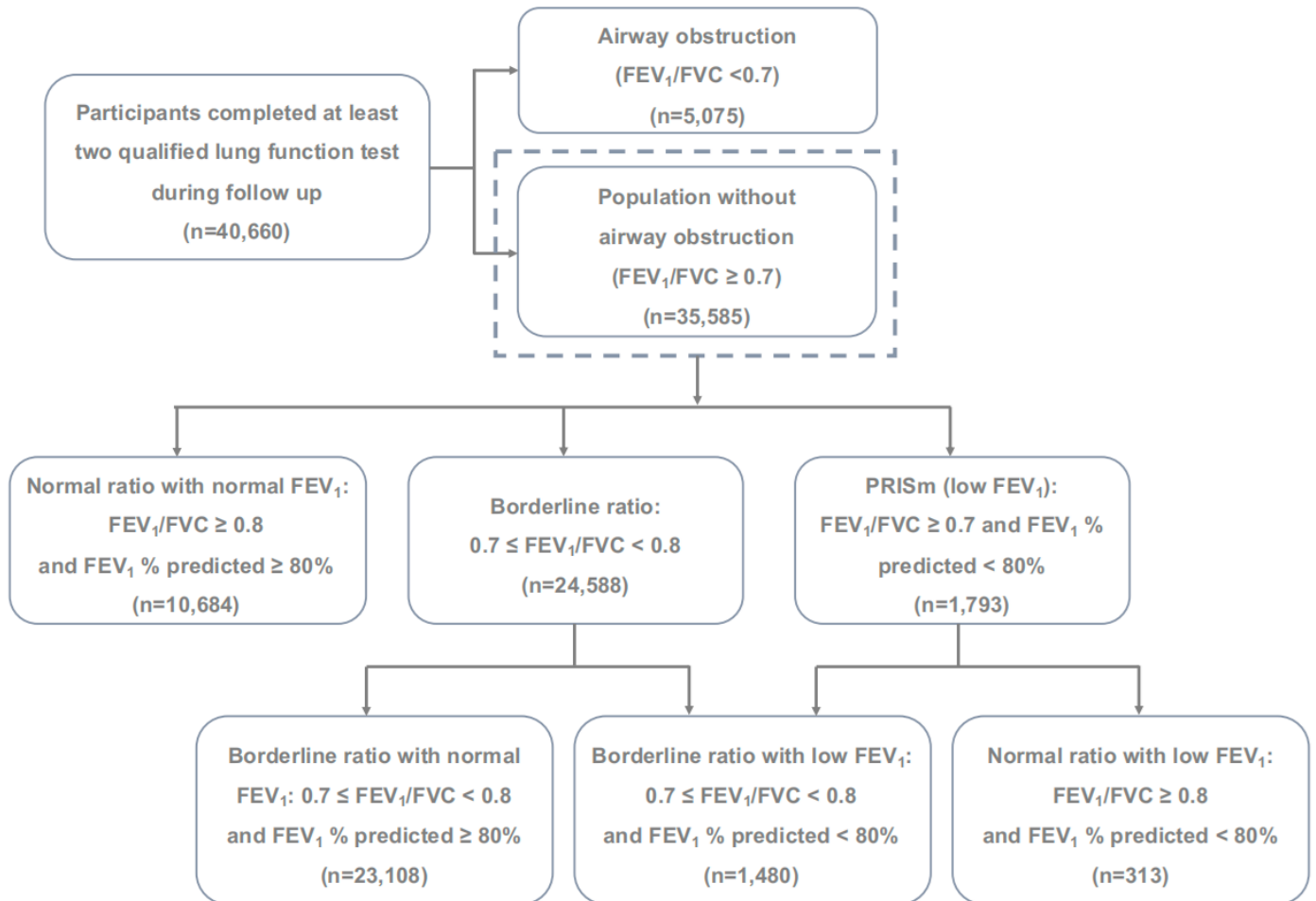
	Univariable	multivariable
Age	0.98 (0.94, 1.02)	0.94 (0.86, 1.03)
Gender		
Male	Ref	Ref
Female	0.29 (0.09, 0.97)	1.17 (0.07, 20.87)
Income (ten thousand yuan/year)		
<2	Ref	Ref
2-5	0.86 (0.37, 1.99)	1.47 (0.21, 10.23)
≥5	2.66 (1.12, 6.30)	1.62 (0.21, 12.34)
Education		
Primary school and below	Ref	Ref
Middle and high school	1.26 (0.62, 2.55)	0.84 (0.20, 3.54)
College and above	4.00 (0.78, 20.52)	5.72 (0.34, 96.82)
Marriage		
Single	Ref	Ref
Married	/	/
Divorced	/	/
Widowed	/	/
Employment status		
On work	Ref	Ref
Retire	1.01 (0.41, 2.53)	2.59 (0.54, 12.38)
Homework	0.14 (0.06, 0.32)	/
Unemployment	0.23 (0.03, 1.92)	/
Job		
Outdoor	Ref	Ref
Indoor	0.33 (0.09, 1.20)	0.10 (0.01, 0.77)

Other	1.91 (0.51, 7.14)	2.53 (0.39, 16.27)
Biofuel use	0.68 (0.34, 1.36)	0.74 (0.19, 2.84)
Smoking status		
Never	Ref	Ref
Former	1.57 (0.45, 5.50)	6.34 (0.31, 128.27)
Current	3.36 (1.42, 7.98)	5.71 (0.37, 87.52)
Smoking pack years	1.01 (1.00, 1.03)	1.03 (0.99, 1.06)
Secondhand smoke	1.51 (0.70, 3.24)	1.37 (0.30, 6.20)
Cough before 14 years old	1.45 (0.42, 5.01)	0.10 (0.01, 1.27)
Family history of COPD	/	/
Height	1.04 (0.99, 1.09)	1.20 (0.69-2.08)
Weight	1.02 (0.99, 1.16)	0.77 (0.39-1.55)
BMI	1.02 (0.92, 1.13)	1.48 (0.22-9.78)
Waist line	1.03 (0.99, 1.07)	1.12 (0.97-1.30)
Hip line	1.02 (0.98, 1.06)	0.98 (0.85-1.12)

Abbreviations: COPD, chronic obstructive pulmonary disease; PRISm, preserved ratio impaired spirometry; BMI, body mass index; FEV₁, forced expiratory volume in one second; FEV₁ % predicted, proportion of predicted FEV₁ value

Supplement material II. Analysis among general participants based on the data from UK Biobank

Supplement figure 1. Flow chart based on the data from UKB.



Abbreviations: FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, ratio of FEV₁/FVC; FEV₁ % predicted, proportion of predicted FEV₁ value.

Supplement table 8. Basic characteristics of enrolled general participants based on the data from UKB.

	Normal ratio with normal FEV ₁	Borderline ratio with normal FEV ₁	Normal ratio with low FEV ₁	Borderline ratio with low FEV ₁
N	10684	23108	313	1480
Age (years, mean [SD])	53.25 (7.55)	56.02 (7.35)	53.19 (7.59)	55.57 (7.47)
Gender (n [%])				
Male	4331 (40.5)	10329 (44.7)	113 (36.1)	570 (38.5)
Female	6353 (59.5)	12779 (55.3)	200 (63.9)	910 (61.5)
Ethnic (n [%])				
Asia	375 (3.5)	645 (2.8)	14 (4.5)	43 (2.9)
White	9985 (93.5)	21916 (94.8)	284 (90.7)	1390 (93.9)
Mix	324 (3.0)	547 (2.4)	15 (4.8)	47 (3.2)
Smoking status (n [%])				
Never	6980 (65.3)	13795 (59.7)	206 (65.8)	826 (55.8)
Former	3213 (30.1)	7961 (34.5)	82 (26.2)	524 (35.4)
Current	491 (4.6)	1352 (5.9)	25 (8.0)	130 (8.8)
Smoking exposure (pack years, mean [SD])	16.10 (13.04)	17.97 (14.47)	23.73 (29.24)	24.94 (17.41)
Symptoms (n [%])				
Dyspnea	194 (5.3)	318 (4.5)	15 (21.1)	46 (11.8)
Wheeze	1188 (11.3)	3071 (13.4)	62 (20.1)	358 (24.6)
Chest pain	1295 (12.2)	2768 (12.1)	62 (20.0)	264 (18.1)
Height (cm, mean [SD])	76.98 (15.59)	75.52 (14.35)	83.56 (20.44)	80.41 (17.03)
Weight (kg, mean [SD])	167.83 (8.95)	169.27 (9.00)	167.58 (9.49)	168.67 (8.90)
BMI (kg/m ² , mean [SD])	27.23 (4.70)	26.26 (4.07)	29.70 (6.71)	28.14 (5.39)
Lung function				
FEV ₁ (L, mean [SD])	3.15 (0.72)	3.03 (0.69)	2.14 (0.51)	2.13 (0.47)

FEV ₁ % predicted (% mean [SD])	107.27 (13.15)	103.30 (12.79)	73.19 (7.37)	73.33 (6.62)
FVC (L, mean [SD])	3.81 (0.87)	4.01 (0.92)	2.59 (0.63)	2.86 (0.64)
FVC % predicted (% mean [SD])	104.20 (12.92)	108.56 (13.36)	71.06 (7.74)	78.50 (7.68)
FEV ₁ /FVC (mean [SD])	0.83 (0.02)	0.76 (0.03)	0.83 (0.03)	0.75 (0.03)

Abbreviations: BMI, body mass index; COPD, chronic obstructive pulmonary disease; FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, ratio of FEV₁/FVC; FEV₁ % predicted, proportion of predicted FEV₁ value; FVC % predicted, proportion of predicted FVC value.

Supplement table 9. Basic characteristics of enrolled participants in borderline ratio and PRISm (low FEV₁) group based on the data from UKB.

	Normal ratio and normal FEV ₁	Borderline ratio	PRISm (low FEV ₁)	P value (borderline ratio vs normal spirometry)	P value (PRISm [low FEV ₁] vs normal spirometry)
N	10684	24588	1793		
Age (years, mean [SD])	53.25 (7.55)	56.00 (7.36)	55.15 (7.54)	<0.001	<0.001
Gender (n [%])				<0.001	0.054
Male	4331 (40.5)	10899 (44.3)	683 (38.1)		
Female	6353 (59.5)	13689 (55.7)	1110 (61.9)		
Ethnic (n [%])				<0.001	0.500
Asia	375 (3.5)	688 (2.8)	57 (3.2)		
White	9985 (93.5)	23306 (94.8)	1674 (93.4)		
Mix	324 (3.0)	594 (2.4)	62 (3.5)		
Smoking status (n [%])				<0.001	<0.001
Never	6980 (65.3)	14621 (59.5)	1032 (57.6)		
Former	3213 (30.1)	8485 (34.5)	606 (33.8)		
Current	491 (4.6)	1482 (6.0)	155 (8.6)		
Smoking exposure (pack years, mean [SD])	16.10 (13.04)	18.46 (14.80)	24.80 (19.10)	<0.001	<0.001
Symptoms (n [%])					
Dyspnea	194 (5.3)	364 (4.8)	61 (13.3)	0.314	<0.001
Wheeze	1188 (11.3)	3429 (14.1)	420 (23.9)	<0.001	<0.001
Chest pain	1295 (12.2)	3032 (12.4)	326 (18.4)	0.596	<0.001
Height (cm, mean [SD])	76.98 (15.59)	75.81 (14.57)	80.96 (17.71)	<0.001	<0.001
Weight (kg, mean [SD])	167.83 (8.95)	169.23 (9.00)	168.48 (9.01)	<0.001	0.005
BMI (kg/m ² , mean [SD])	27.23 (4.70)	26.37 (4.19)	28.41 (5.67)	<0.001	<0.001

Lung function					
FEV ₁ (L, mean [SD])	3.15 (0.72)	2.98 (0.71)	2.13 (0.48)	<0.001	<0.001
FEV ₁ % predicted (% mean [SD])	107.27 (13.15)	101.49 (14.39)	73.31 (6.76)	<0.001	<0.001
FVC (L, mean [SD])	3.81 (0.87)	3.94 (0.94)	2.81 (0.65)	<0.001	<0.001
FVC % predicted (%, mean [SD])	104.20 (12.92)	106.75 (14.92)	77.20 (8.19)	<0.001	<0.001
FEV ₁ /FVC (mean [SD])	0.83 (0.02)	0.76 (0.03)	0.76 (0.04)	<0.001	<0.001

Abbreviations: BMI, body mass index; COPD, chronic obstructive pulmonary disease; FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, ratio of FEV₁/FVC; FEV₁ % predicted, proportion of predicted FEV₁ value; FVC % predicted, proportion of predicted FVC value.

Supplement table 10. Lung function change and disease progression during follow-up based on the data from UKB.

	Normal ratio with normal FEV ₁	Borderline ratio with normal FEV ₁	Normal ratio with low FEV ₁	Borderline ratio with low FEV ₁
Follow up years (years, mean [SD])	8.21 (2.51)	8.15 (2.59)	8.00 (2.58)	7.89 (2.61)
FEV ₁ annual change (L, mean [SD])	-0.04 (0.05)	-0.04 (0.05)	0.02 (0.06)	0.01 (0.06)
FEV ₁ % predicted annual change (%; mean [SD])	-0.21 (1.91)	-0.25 (1.98)	1.46 (2.28)	1.20 (2.26)
FEV ₁ rapid decline during follow-up (n [%])	2943 (27.5)	6870 (29.7)	22 (7.0)	138 (9.3)
Airway obstruction during follow-up (n [%])	441 (4.1)	2548 (11.0)	17 (5.4)	238 (16.1)

Abbreviations: FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, ratio of FEV₁/FVC; FEV₁ % predicted, proportion of predicted FEV₁ value; FVC % predicted, proportion of predicted FVC value.

Supplement table 11. Lung function change and disease progression in borderline ratio and PRISm (low FEV₁) group during follow up based on the data from UKB.

	Normal ratio and normal FEV ₁	Borderline ratio	PRISm (low FEV ₁)	P value (borderline ratio vs normal spirometry)	P value (PRISm [low FEV ₁] vs normal spirometry)
Follow up years (years, mean [SD])	8.21 (2.51)	8.13 (2.59)	7.91 (2.60)	0.018	<0.001
FEV ₁ annual change (L, mean [SD])	-0.04 (0.05)	-0.03 (0.06)	0.01 (0.06)	0.006	<0.001

FEV ₁ % predicted annual change (%, mean [SD])	-0.21 (1.91)	-0.16 (2.02)	1.24 (2.27)	0.043	<0.001
FEV ₁ rapid decline during follow-up (n [%])	2943 (27.5)	7008 (28.5)	160 (8.9)	0.069	<0.001
Airway obstruction during follow-up (n [%])	441 (4.1)	2786 (11.3)	255 (14.2)	<0.001	<0.001

Abbreviations: FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, ratio of FEV₁/FVC; FEV₁ % predicted, proportion of predicted FEV₁ value; FVC % predicted, proportion of predicted FVC value.

Supplement material III. Sensitivity analysis of using the race-neutral Global Lung Function Initiative equations (GLI Global) to calculate the predicted value of FEV₁ and FVC

Supplement table 12. Basic characteristics of enrolled participants based on GLI Global.

	Normal ratio with normal FEV ₁	Borderline ratio with normal FEV ₁	Normal ratio with low FEV ₁	Borderline ratio with low FEV ₁
N	1426	945	371	227
Age (years, mean [SD])	60.80 (8.41)	61.12 (8.50)	60.20 (8.83)	62.37 (7.74)
Gender (n [%])				
Male	997 (69.9)	668 (70.7)	292 (78.7)	165 (72.7)
Female	429 (30.1)	277 (29.3)	79 (21.3)	62 (27.3)
Income (ten thousand yuan/year, n [%])				
<2	539 (37.8)	363 (38.4)	129 (34.8)	95 (41.9)
2-5	600 (42.1)	306 (32.4)	187 (50.4)	79 (34.8)
≥5	287 (20.1)	276 (29.2)	55 (14.8)	53 (23.3)
Education (n [%])				
Primary school and below	780 (54.7)	454 (48.0)	189 (50.9)	110 (48.5)
Middle and high school	615 (43.1)	451 (47.7)	175 (47.2)	109 (48.0)
College and above	31 (2.2)	40 (4.2)	7 (1.9)	8 (3.5)
Marriage (n [%])				
Single	14 (1.0)	9 (1.0)	4 (1.1)	2 (0.9)
Married	1358 (95.2)	904 (95.7)	359 (96.8)	221 (97.4)
Divorced	13 (0.9)	8 (0.8)	1 (0.3)	2 (0.9)
Widowed	41 (2.9)	24 (2.5)	7 (1.9)	2 (0.9)
Employment status (n [%])				
On work	289 (20.3)	253 (26.8)	46 (12.4)	44 (19.4)

Retire	94 (6.6)	140 (14.8)	22 (5.9)	39 (17.2)
Homework	1015 (71.2)	512 (54.2)	290 (78.2)	134 (59.0)
Unemployment	28 (2.0)	40 (4.2)	13 (3.5)	10 (4.4)
Job (n [%])				
Indoor	228 (59.4)	241 (61.2)	36 (52.2)	54 (63.5)
Outdoor	100 (26.0)	103 (26.1)	24 (34.8)	25 (29.4)
Other	56 (14.6)	50 (12.7)	9 (13.0)	6 (7.1)
Fuel (n [%])				
Clean	540 (37.9)	468 (49.5)	152 (41.0)	109 (48.0)
Unclean	882 (61.9)	474 (50.2)	218 (58.8)	118 (52.0)
Unknown	4 (0.3)	3 (0.3)	1 (0.3)	0 (0.0)
Smoking status (n [%])				
Never	571 (40.0)	362 (38.3)	141 (38.0)	95 (41.9)
Former	169 (11.9)	135 (14.3)	58 (15.6)	33 (14.5)
Current	686 (48.1)	448 (47.4)	172 (46.4)	99 (43.6)
Smoking exposure (pack years, mean [SD])	21.67 (24.10)	24.93 (41.14)	21.30 (22.55)	22.67 (28.11)
Secondhand smoke (n [%])	349 (24.5)	252 (26.7)	71 (19.1)	59 (26.0)
Cough before 14 years old (n [%])	95 (6.7)	67 (7.1)	23 (6.2)	10 (4.4)
Family history of COPD (n [%])	18 (1.3)	11 (1.2)	5 (1.3)	4 (1.8)
Comorbidities (n [%])	196 (13.7)	148 (15.7)	80 (21.6)	44 (19.4)
Symptoms (n [%])				
Cough	506 (35.5)	328 (34.7)	149 (40.2)	101 (44.5)
Breathlessness				
None	484 (33.9)	357 (37.8)	100 (27.0)	67 (29.5)
When walking	744 (52.2)	503 (53.2)	221 (59.6)	129 (56.8)

When climbing	198 (13.9)	85 (9.0)	50 (13.5)	31 (13.7)
Height (cm, mean [SD])	162.92 (7.68)	163.22 (7.59)	165.19 (7.53)	163.39 (7.54)
Weight (kg, mean [SD])	63.58 (10.61)	64.47 (10.79)	63.69 (10.33)	63.08 (10.77)
BMI (kg/m ² , mean [SD])	23.91 (3.32)	24.15 (3.37)	23.33 (3.40)	23.58 (3.40)
Waist circumference (cm, mean [SD])	85.96 (9.07)	86.94 (9.76)	85.10 (9.02)	86.50 (8.87)
Hip circumference (cm, mean [SD])	94.36 (8.84)	95.23 (9.32)	92.98 (8.45)	93.96 (8.51)
Lung function				
FEV ₁ (L, mean [SD])	2.69 (0.56)	2.69 (0.56)	1.83 (0.49)	1.77 (0.46)
FEV ₁ % predicted (% mean [SD])	102.80 (15.76)	102.48 (16.44)	65.95 (12.53)	67.43 (12.64)
FVC (L, mean [SD])	3.05 (0.73)	3.56 (0.74)	1.99 (0.58)	2.37 (0.62)
FVC % predicted (% mean [SD])	92.51 (17.48)	107.44 (17.32)	56.80 (12.45)	71.61 (13.59)
FEV ₁ /FVC (mean [SD])	0.89 (0.07)	0.76 (0.03)	0.93 (0.07)	0.74 (0.03)

Abbreviations: BMI, body mass index; COPD, chronic obstructive pulmonary disease; FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, ratio of FEV₁/FVC; FEV₁ % predicted, proportion of predicted FEV₁ value; FVC % predicted, proportion of predicted FVC value.

Supplement table 13. Basic characteristics of enrolled participants in borderline ratio and PRISm (low FEV₁) group based on GLI Global.

	Normal ratio and normal FEV ₁	Borderline ratio	PRISm (low FEV ₁)	P value (borderline ratio vs normal spirometry)	P value (PRISm [low FEV ₁] vs normal spirometry)
N	1426	1172	598		
Age (years, mean [SD])	60.80 (8.41)	61.36 (8.37)	61.03 (8.49)	0.088	0.579
Gender (n [%])				0.548	0.004
Male	997 (69.9)	833 (71.1)	457 (76.4)		
Female	429 (30.1)	339 (28.9)	141 (23.6)		
Income (ten thousand yuan/year, n [%])				<0.001	0.471
<2	539 (37.8)	458 (39.1)	224 (37.5)		
2-5	600 (42.1)	385 (32.8)	266 (44.5)		
≥5	287 (20.1)	329 (28.1)	108 (18.1)		
Education (n [%])				<0.001	0.153
Primary school and below	780 (54.7)	564 (48.1)	299 (50.0)		
Middle and high school	615 (43.1)	560 (47.8)	284 (47.5)		
College and above	31 (2.2)	48 (4.1)	15 (2.5)		
Marriage (n [%])				0.765	0.237
Single	14 (1.0)	11 (0.9)	6 (1.0)		
Married	1358 (95.2)	1125 (96.0)	580 (97.0)		
Divorced	13 (0.9)	10 (0.9)	3 (0.5)		
Widowed	41 (2.9)	26 (2.2)	9 (1.5)		
Employment status (n [%])				<0.001	<0.001
On work	289 (20.3)	297 (25.3)	90 (15.1)		

Retire	94 (6.6)	179 (15.3)	61 (10.2)		
Homework	1015 (71.2)	646 (55.1)	424 (70.9)		
Unemployment	28 (2.0)	50 (4.3)	23 (3.8)		
Job (n [%])				0.453	0.193
Indoor	228 (59.4)	295 (61.6)	90 (58.4)		
Outdoor	100 (26.0)	128 (26.7)	49 (31.8)		
Other	56 (14.6)	56 (11.7)	15 (9.7)		
Fuel (n [%])				<0.001	0.049
Clean	540 (37.9)	577 (49.2)	261 (43.6)		
Unclean	882 (61.9)	592 (50.5)	336 (56.2)		
Unknown	4 (0.3)	3 (0.3)	1 (0.2)		
Smoking status (n [%])				0.172	0.108
Never	571 (40.0)	457 (39.0)	236 (39.5)		
Former	169 (11.9)	168 (14.3)	91 (15.2)		
Current	686 (48.1)	547 (46.7)	271 (45.3)		
Smoking exposure (pack years, mean [SD])	21.67 (24.10)	24.49 (38.96)	21.82 (24.80)	0.024	0.899
Secondhand smoke (n [%])	349 (24.5)	311 (26.5)	130 (21.7)	0.248	0.206
Cough before 14 years old (n [%])	95 (6.7)	77 (6.6)	33 (5.5)	0.988	0.387
Family history of COPD (n [%])	18 (1.3)	15 (1.3)	9 (1.5)	>0.999	0.824
Comorbidities (n [%])	196 (13.7)	192 (16.4)	124 (20.7)	0.069	<0.001
Symptoms (n [%])					
Cough	506 (35.5)	429 (36.6)	250 (41.8)	0.582	0.008
Breathlessness				0.008	0.019
None	484 (33.9)	424 (36.2)	167 (27.9)		
When walking	744 (52.2)	632 (53.9)	350 (58.5)		

When climbing	198 (13.9)	116 (9.9)	81 (13.5)		
Height (cm, mean [SD])	162.92 (7.68)	163.25 (7.58)	164.50 (7.58)	0.272	<0.001
Weight (kg, mean [SD])	63.58 (10.61)	64.20 (10.79)	63.46 (10.49)	0.143	0.808
BMI (kg/m ² , mean [SD])	23.91 (3.32)	24.04 (3.38)	23.42 (3.40)	0.327	0.003
Waist circumference (cm, mean [SD])	85.96 (9.07)	86.86 (9.59)	85.63 (8.98)	0.015	0.454
Hip circumference (cm, mean [SD])	94.36 (8.84)	94.99 (9.18)	93.36 (8.48)	0.076	0.019
Lung function					
FEV ₁ (L, mean [SD])	2.69 (0.56)	2.51 (0.66)	1.80 (0.48)	<0.001	<0.001
FEV ₁ % predicted (% mean [SD])	102.80 (15.76)	95.70 (20.99)	66.51 (12.58)	<0.001	<0.001
FVC (L, mean [SD])	3.05 (0.73)	3.33 (0.86)	2.13 (0.62)	<0.001	<0.001
FVC % predicted (% mean [SD])	92.51 (17.48)	100.50 (21.87)	62.42 (14.76)	<0.001	<0.001
FEV ₁ /FVC (mean [SD])	0.89 (0.07)	0.75 (0.03)	0.86 (0.11)	<0.001	<0.001

Abbreviations: BMI, body mass index; COPD, chronic obstructive pulmonary disease; FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, ratio of FEV₁/FVC; FEV₁ % predicted, proportion of predicted FEV₁ value; FVC % predicted, proportion of predicted FVC value.

Supplement table 14. Lung function change and disease progression during 2 years follow up based on GLI Global.

	Normal ratio with normal FEV ₁	Borderline ratio with normal FEV ₁	Normal ratio with low FEV ₁	Borderline ratio with low FEV ₁
FEV ₁ change in 2 years follow-up (L, mean [SD])	0.05 (0.69)	-0.15 (0.60)	1.02 (0.72)	0.61 (0.75)
FEV ₁ % predicted change in 2 years follow-up (% mean [SD])	5.28 (29.92)	-3.30 (24.22)	40.70 (28.32)	25.57 (29.51)
FEV ₁ rapid decline in 2 years follow-up (n [%])	559 (39.2)	445 (47.1)	18 (4.9)	32 (14.1)
Airway obstruction in 2 years follow-up (n [%])	88 (6.2)	103 (10.9)	31 (8.4)	38 (16.7)

Abbreviations: FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, ratio of FEV₁/FVC; FEV₁ % predicted, proportion of predicted FEV₁ value; FVC % predicted, proportion of predicted FVC value.

Supplement table 15. Lung function change and disease progression in borderline ratio and PRISm (low FEV₁) group during 2 years follow up based on GLI Global.

	Normal ratio and normal FEV ₁	Borderline ratio	PRISm (low FEV ₁)	P value (borderline ratio vs normal spirometry)	P value (PRISm [low FEV ₁] vs normal spirometry)
FEV ₁ change in 2 years follow-up (L, mean [SD])	0.05 (0.69)	0.00 (0.70)	0.86 (0.76)	0.063	<0.001

FEV ₁ % predicted change in 2 years follow-up (%, mean [SD])	5.28 (29.92)	2.29 (27.77)	34.96 (29.67)	0.009	<0.001
FEV ₁ rapid decline in 2 years follow-up (n [%])	559 (39.2)	477 (40.7)	50 (8.4)	0.462	<0.001
Airway obstruction in 2 years follow-up (n [%])	88 (6.2)	141 (12.0)	69 (11.5)	<0.001	<0.001

Abbreviations: FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, ratio of FEV₁/FVC; FEV₁ % predicted, proportion of predicted FEV₁ value; FVC % predicted, proportion of predicted FVC value.

Supplement table 16. Risk of developing into airway obstruction during follow-up in high-risk population of COPD without airway obstruction at baseline based on GLI Global.

	Univariable	Model 1	Model 2
Normal ratio with normal FEV ₁	Ref	Ref	Ref
Borderline ratio with normal FEV ₁	1.86 (1.38, 2.50)	1.83 (1.35, 2.47)	1.73 (1.27, 2.35)
Normal ratio with low FEV ₁	1.39 (0.91, 2.12)	1.38 (0.89, 2.12)	1.31 (0.85, 2.03)
Borderline ratio with low FEV ₁	3.06 (2.03, 4.61)	2.84 (1.87, 4.30)	2.66 (1.74, 4.08)
Normal ratio with normal FEV ₁	Ref	Ref	Ref
Borderline ratio	2.08 (1.57, 2.75)	2.02 (1.52, 2.68)	1.98 (1.48, 2.65)
PRISm (Low FEV ₁)	1.98 (1.42, 2.76)	1.95 (1.39, 2.72)	1.81 (1.28, 2.55)

Abbreviations: COPD, chronic obstructive pulmonary disease; FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, ratio of FEV₁/FVC; FEV₁ % predicted, proportion of predicted FEV₁ value.

Logistic regression model was used, and results were showed using odds ratio (OR) and 95% confidence interval (CI).

Model 1: age and sex

Model 2: age, sex, education, income, marriage, employment, BMI, smoking and pack years.

Supplement table 17. Risk of FEV₁ rapid decline during follow-up in high-risk population of COPD patients without airway obstruction at baseline based on GLI Global.

	FEV ₁ change in 2 years follow-up (continuous variable)			FEV ₁ rapid decline (categorical variable)		
	Univariable	Model 1	Model 2	Univariable	Model 1	Model 2
Normal ratio with normal FEV ₁	Ref	Ref	Ref	Ref	Ref	Ref
Borderline ratio with normal FEV ₁	-0.20 (-0.25 to -0.14)	-0.20 (-0.25 to -0.14)	-0.15 (-0.21 to -0.10)	1.38 (1.17, 1.63)	1.39 (1.17, 1.64)	1.23 (1.04, 1.46)
Normal ratio with low FEV ₁	0.98 (0.90 to 1.05)	0.98 (0.90 to 1.06)	0.96 (0.88 to 1.03)	0.08 (0.05, 0.13)	0.08 (0.05, 0.12)	0.08 (0.05, 0.13)
Borderline ratio with low FEV ₁	0.56 (0.47 to 0.65)	0.55 (0.46 to 0.65)	0.58 (0.49 to 0.68)	0.25 (0.17, 0.38)	0.26 (0.17, 0.38)*	0.23 (0.15, 0.34)
Normal ratio with normal FEV ₁	Ref	Ref	Ref	Ref	Ref	Ref
Borderline ratio	-0.05 (-0.10, 0.00)	-0.05 (-0.11, 0.00)	-0.01 (-0.07, 0.04)	1.06 (0.91, 1.25)	1.07 (0.92, 1.26)	0.96 (0.82, 1.14)
PRISm (Low FEV ₁)	0.82 (0.75, 0.89)	0.81 (0.75, 0.88)	0.81 (0.75, 0.88)	0.14 (0.10, 0.19)	0.14 (0.10, 0.19)	0.12 (0.09, 0.17)

Abbreviations: COPD, chronic obstructive pulmonary disease; FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, ratio of FEV₁/FVC; FEV₁ % predicted, proportion of predicted FEV₁ value.

Linear model was used for analysis in FEV₁ change in 2 years follow-up (continuous variable), and results were showed using β and 95% confidence interval (CI). Logistic regression analysis was used for analysis in FEV₁ decline (categorical variable), and results were showed using odds ratio (OR) and 95% CI.

Model 1: age and sex

Model 2: age, sex, education, income, marriage, employment, BMI, smoking and pack years.