Online Appendix

In addition to the main analyses presented in Table 2, sensitivity analyses were conducted to examine the associations of socioeconomic indicators with percent emphysema using alternative specifications of the socioeconomic variables (Table A.1), CT scan analysis or calibration methods (Table A.2), and for associations of socioeconomic indicators with percent emphysema and lung function using alternative covariate adjustment strategies (Table A.3) or within population subgroups (Table A.4 and Table A.5).

As alternatives to the grouped linear socioeconomic variables used in the main analysis, we considered indicator variables and a combined scale. An indicator variable analysis comparing each socioeconomic category to a common referent supported an approximate linear trend across categories (Table A.1). Likelihood ratio tests indicated that the more flexible indicator variable models do not provide significantly better fit to the data when compared with the grouped linear variable models (all p-values were greater than 0.2). When education, income, and wealth data were used to create a combined SES scale, the combined scale had a pattern of associations that was similar to that observed for education alone (Table A.1).

We evaluated the sensitivity of our associations to treatment of the raw CT scan data (Table A.2). Statistical adjustment for spirometry effort indicators, which may serve as a proxy for compliance with related breath-hold instructions during CT scanning, attenuated the observed associations slightly, but did not alter the pattern of statistical significance. For analyses using inside air calibration, which may remove some of the measurement error due to adiposity, all associations were statistically significant and in the same direction as the main findings.

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Our main adjustment strategy included a large number of covariates expected to serve as potential confounders or as precision variables in our analyses of SES indicators and respiratory outcomes. Precision variables are predictors of the dependent variable expected to explain some of the residual variance in a linear regression model, thus improving the statistical power to detect an association of interest. Each SES indicator was entered separately into a model with the same set of covariates. Alternative adjustment strategies we explored included a more minimal set of potential confounders, excluding any precision variables that could also be acting as mediators, as well as the simultaneous inclusion of all three SES indicators with the full set of covariates (Table A.3). In minimally adjusted models, we observed trends in the same direction as our main analysis estimates, and coefficients that were further from zero. This suggests that our main analysis estimates may be somewhat conservative due to the inclusion of potential mediators. In analyses with all three SES indicators included simultaneously, education remained a statistically significant predictor of all outcomes except FEV_1/FVC ratio.

The remaining sensitivity analyses were conducted for by restricting our sample to the following subgroups: participants without any missing data, non-obese participants, never smokers, heavy smokers, and four racial/ethnic subgroups (Table A.4 and Table A.5). The complete case analysis among participants without missing data yielded a pattern of associations similar to that from the main analysis, and somewhat wider confidence intervals due to the reduced sample size. The associations with percent emphysema persisted for non-obese participants and for never smokers, but not for heavy smokers. Finally, within the racial/ethnic subgroups we observed

patterns of association similar to those in the main analysis, with larger confidence intervals reflecting the reduced sample sizes (Table A.5).

Table A.1. Sensitivity analyses with alternative specifications of socioeconomic variables

	Difference per unit	Difference from referent socioeconomic category				
		0: Lowest	1: Low-Medium	2: Medium	3: High-Medium	4: Highest
Percent Emphysema						
Education	**1.1 (0.8 to 1.5)**	Ref	1.2 (-0.1 to 2.5)	**2.2 (1.0 to 3.5)**	**4.1 (2.7 to 5.5)**	**4.1 (2.6 to 5.7)**
Income	**0.4 (0.1 to 0.8)**	Ref	0.5 (-0.8 to 1.7)	0.4 (-0.8 to 1.7)	**1.8 (0.5 to 3.0)**	1.5 (-0.1 to 3.0)
Wealth	**0.6 (0.3 to 1.0)**	Ref	-0.2 (-1.5 to 1.1)	0.7 (-0.7 to 2.1)	1.0 (-0.4 to 2.5)	**2.4 (0.9 to 3.9)**
Combined scale*	**1.2 (0.8 to 1.7)**					
FEV$_1$ (ml)						
Education	**17 (5 to 29)**	Ref	-9 (-56 to 38)	19 (-25 to 64)	48 (-5 to 101)	**52 (0 to 105)**
Income	7 (-5 to 19)	Ref	10 (-37 to 57)	-9 (-59 to 40)	33 (-18 to 84)	21 (-31 to 73)
Wealth	**16 (3 to 29)**	Ref	50 (-6 to 105)	**71 (14 to 127)**	57 (-1 to 114)	**87 (28 to 146)**
Combined scale*	**23 (6 to 40)**					
FVC (ml)						
Education	**25 (10 to 40)**	Ref	-7 (-65 to 52)	30 (-24 to 84)	**69 (5 to 133)**	**84 (19 to 148)**
Income	2 (-13 to 16)	Ref	6 (-50 to 62)	-10 (-69 to 48)	16 (-43 to 75)	2 (-59 to 64)
Wealth	**18 (2 to 34)**	Ref	**70 (3 to 137)**	**86 (19 to 154)**	**79 (11 to 148)**	**100 (28 to 173)**
Combined scale*	**26 (6 to 46)**					
FEV$_1$/FVC Ratio (%)						
Education	-0.1 (-0.3 to 0.2)	Ref	0.0 (-0.9 to 1.0)	0.0 (-0.9 to 0.8)	-0.2 (-1.1 to 0.8)	-0.2 (-1.2 to 0.8)
Income	0.2 (-0.0 to 0.4)	Ref	0.3 (-0.5 to 1.2)	0.2 (-0.7 to 1.1)	0.8 (-0.1 to 1.7)	0.8 (-0.1 to 1.8)
Wealth	0.2 (-0.1 to 0.4)	Ref	0.3 (-0.8 to 1.4)	0.7 (-0.4 to 1.8)	0.3 (-0.8 to 1.4)	0.8 (-0.3 to 2.0)
Combined scale*	0.02 (-0.1 to 0.5)					

Notes: FEV$_1$ indicates forced expiratory volume, 1 second; FVC, forced vital capacity; values shown are regression coefficients and 95% confidence intervals for variables with a range of 0 through 4 for education (less than a high school education; high school degree; some college; completed college; graduate degree), income (lowest quintile, < $9000 per person annually; highest quintile, > $40 000 per person annually) or wealth (no wealth indicators reported; only one indicator reported; two indicators reported; three indicators reported; car ownership, home ownership, financial investments, and real estate investments all reported); and the difference between extreme categories can be calculated by multiplying difference coefficient by 4; bold face font indicates statistical significance

* The combined scale was created by taking a simple average of the three socioeconomic variables, and thus with a range from 0 to 4

† Main analysis included adjustment for age; sex; race; ethnicity; whether the participant was born in the US; height; body mass index (BMI); history of hay fever; history of asthma before age 45; family history of emphysema among siblings; occupational exposure to dust; residential exposure to air pollution; environmental tobacco exposure in the childhood home, adult home, or workplace; smoking status; pack-years, and CT equipment type if applicable

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Table A.2. Sensitivity analyses altering CT scan analysis and calibration methods

	Difference per socioeconomic category[*]			
	Main analysis (in Table 2)	Adjusted for spirometry effort[†]	Inside air calibration[‡]	Attenuation threshold of 950 HU[§]
Percent Emphysema				
Education	**1.1 (0.8 to 1.5)**	**1.1 (0.7 to 1.4)**	**1.1 (0.8 to 1.5)**	**0.23 (0.14 to 0.32)**
Income	**0.4 (0.1 to 0.8)**	0.3 (0.0 to 0.7)	**0.5 (0.1 to 0.8)**	0.07 (-0.01 to 0.15)
Wealth	**0.6 (0.3 to 1.0)**	**0.5 (0.1 to 0.8)**	**0.5 (0.2 to 0.9)**	**0.11 (0.03 to 0.19)**

Notes: Values shown are regression coefficients and 95% confidence intervals for an additional increment of a grouped linear variable with a range of 0 through 4 for education (less than a high school education; high school degree; some college; completed college; graduate degree), income (lowest quintile, < $9000 per person annually; highest quintile, > $40 000 per person annually) or wealth (no wealth indicators reported; only one indicator reported; two indicators reported; three indicators reported; car ownership, home ownership, financial investments, and real estate investments all reported); and the difference between extreme categories can be calculated by multiplying difference coefficient by 4; bold face font indicates statistical significance

[*] All models included adjustment for age; sex; race; ethnicity; whether the participant was born in the US; height; body mass index (BMI); history of hay fever; history of asthma before age 45; family history of emphysema among siblings; occupational exposure to dust; residential exposure to air pollution; environmental tobacco exposure in the childhood home, adult home, or workplace; smoking status; pack-years, and CT equipment type; N = 3,963

[†] Models included main adjustment variables plus spirometry effort indicators: adequate expiratory time (at least 6 seconds) and high technician-rated effort

[‡] The main analysis was calibrated using outside air attenuation, and for this sensitivity analysis calibration using air inside the mainstem bronchi; this approach may remove some of the attenuation artifact due to thoracic wall fat.

[§] Percent emphysema was defined for the main analysis as the percentage of total voxels in the lung that fell below –910 HU for the main analysis, an attenuation threshold selected based upon pathology comparisons and the generally mild degree of emphysema in this sample, but for this sensitivity analysis a threshold of 950 HU was used; the 950 HU threshold is expected to define a more severe phenotype

Table A.3. Sensitivity analyses altering adjustment strategy

	Difference per socioeconomic category		
	Minimal adjustment[*]	Main analysis (in Table 2)[†]	Main + socioeconomic indicators[‡]
Percent Emphysema			
Education	**1.2 (0.9 to 1.6)**	**1.1 (0.8 to 1.5)**	**1.1 (0.7 to 1.5)**
Income	**0.6 (0.3 to 0.9)**	**0.4 (0.1 to 0.8)**	-0.1 (-0.4 to 0.3)
Wealth	**0.9 (0.5 to 1.2)**	**0.6 (0.3 to 1.0)**	0.2 (-0.1 to 0.6)
FEV$_1$ (ml)			
Education	**31 (19 to 43)**	**17 (5 to 29)**	**15 (2 to 28)**
Income	**17 (6 to 29)**	7 (-5 to 19)	-8 (-37 to 21)
Wealth	**32 (18 to 45)**	**16 (3 to 29)**	-4 (-54 to 45)
FVC (ml)			
Education	**35 (20 to 50)**	**25 (10 to 40)**	**26 (10 to 43)**
Income	13 (-1 to 27)	2 (-13 to 16)	-16 (-37 to 5)
Wealth	**28 (12 to 44)**	**18 (2 to 34)**	-2 (-54 to 50)
FEV$_1$/FVC Ratio (%)			
Education	0.1 (-0.1 to 0.4)	-0.1 (-0.3 to 0.2)	-0.2 (-0.4 to 0.0)
Income	**0.3 (0.0 to 0.5)**	0.2 (-0.0 to 0.4)	0.2 (-0.4 to 0.7)
Wealth	**0.4 (0.2 to 0.7)**	0.2 (-0.1 to 0.4)	-0.0 (-0.5 to 0.4)

Notes: FEV$_1$ indicates forced expiratory volume, 1 second; FVC, forced vital capacity; values shown are regression coefficients and 95% confidence intervals for an additional increment of a grouped linear variable with a range of 0 through 4 for education (less than a high school education; high school degree; some college; completed college; graduate degree), income (lowest quintile, < $9000 per person annually; highest quintile, > $40 000 per person annually) or wealth (no wealth indicators reported; only one indicator reported; two indicators reported; three indicators reported; car ownership, home ownership, financial investments, and real estate investments all reported); and the difference between extreme categories can be calculated by multiplying difference coefficient by 4; bold face font indicates statistical significance

[*] Minimally adjusted models included adjustment for age; sex; race; ethnicity; whether the participant was born in the US; height; history of hay fever; history of asthma before age 45; family history of emphysema among siblings; and environmental tobacco exposure in the childhood home; and CT equipment type if applicable; other covariates, including smoking history, body mass index, and adult exposures were excluded from this model because of their potential role as mediators

[†] Main analysis included adjustment for age; sex; race; ethnicity; whether the participant was born in the US; height; body mass index (BMI); history of hay fever; history of asthma before age 45; family history of emphysema among siblings; occupational exposure to dust; residential exposure to air pollution; environmental tobacco exposure in the childhood home, adult home, or workplace; smoking status; pack-years, and CT equipment type if applicable

[‡] Models included main adjustment variable plus simultaneous inclusion of the 5-category grouped linear variables for education, income and wealth

Table A.4. Sensitivity analyses by subgroup

	Difference per socioeconomic category[*]				
	Main analysis (in Table 2) (N = 3,706)	Complete case analysis[†] (N = 2,349)	Body mass index < 30 (N = 2,605)	Never smokers[‡] (N = 1,755)	Heavy smokers[§] (N = 1,045)
Percent Emphysema					
Education	**1.1 (0.8 to 1.5)**	**1.3 (0.9 to 1.7)**	**1.5 (1.0 to 1.9)**	**1.2 (0.7 to 1.6)**	0.6 (-0.5 to 1.6)
Income	**0.4 (0.1 to 0.8)**	0.4 (0.0 to 0.8)	**0.6 (0.1 to 1.0)**	**0.5 (0.0 to 0.9)**	0.1 (-0.7 to 0.9)
Wealth	**0.6 (0.3 to 1.0)**	0.4 (-0.1 to 0.9)	**1.0 (0.5 to 1.4)**	**0.6 (0.1 to 1.0)**	0.1 (-0.8 to 1.0)
FEV$_1$ (ml)					
Education	**17 (5 to 29)**	**15 (0 to 29)**	6 (-9 to 20)	3 (-11 to 18)	**37 (10 to 64)**
Income	7 (-5 to 19)	8 (-5 to 22)	-3 (-17 to 12)	1 (-14 to 15)	15 (-11 to 41)
Wealth	**16 (3 to 29)**	16 (0 to 33)	3 (-12 to 18)	-0 (-16 to 16)	**39 (9 to 68)**
FVC (ml)					
Education	**25 (10 to 40)**	**27 (9 to 45)**	**21 (3 to 40)**	10 (-9 to 29)	**44 (13 to 76)**
Income	2 (-13 to 16)	3 (-14 to 21)	-4 (-22 to 13)	-9 (-26 to 9)	15 (-15 to 45)
Wealth	**18 (2 to 34)**	**26 (6 to 47)**	7 (-12 to 27)	8 (-12 to 28)	31 (-4 to 65)
FEV$_1$/FVC Ratio (%)					
Education	-0.1 (-0.3 to 0.2)	-0.2 (-0.5 to 0.1)	-0.4 (-0.6 to -0.1)	-0.1 (-0.4 to 0.2)	0.1 (-0.4 to 0.7)
Income	0.2 (-0.0 to 0.4)	0.2 (0.0 to 0.5)	0.0 (-0.2 to 0.3)	0.3 (0.0 to 0.5)	0.1 (-0.3 to 0.6)
Wealth	0.2 (-0.1 to 0.4)	-0.1 (-0.4 to 0.3)	-0.0 (-0.3 to 0.3)	-0.1 (-0.4 to 0.2)	0.6 (0.0 to 1.1)

Notes: FEV$_1$ indicates forced expiratory volume, 1 second; FVC, forced vital capacity; values shown are regression coefficients and 95% confidence intervals for an additional increment of a grouped linear variable with a range of 0 through 4 for education (less than a high school education; high school degree; some college; completed college; graduate degree), income (lowest quintile, < $9000 per person annually; highest quintile, > $40 000 per person annually) or wealth (no wealth indicators reported; only one indicator reported; two indicators reported; three indicators reported; car ownership, home ownership, financial investments, and real estate investments all reported); and the difference between extreme categories can be calculated by multiplying difference coefficient by 4; bold face font indicates statistical significance

[*] Models included adjustment for age; sex; race; ethnicity; whether the participant was born in the US; height; body mass index (BMI); history of hay fever; history of asthma before age 45; family history of emphysema among siblings; occupational exposure to dust; residential exposure to air pollution; environmental tobacco exposure in the childhood home, adult home, or workplace; smoking status; pack-years, and CT equipment type if applicable

[†] The main analysis used multiple imputation to fill in missing data, but this complete case analysis excluded participants missing any variable from each model

[‡] Never smokers reported that they had smoked fewer than 100 cigarettes in their lifetime; confirmed this information a second time during a clinic visit at least 18 months later; and had urinary cotinine levels were less than 100 ng/mL at the time of the CT scan)

[§] Heavy smokers reported 10 or more pack-years of cigarette smoking history at baseline

Table A.5. Sensitivity analyses by race/ethnicity

	Difference per SES category[*]			
	Black (N = 936)	Chinese (N = 615)	Hispanic (N = 838)	White (N = 1,317)
Percent Emphysema				
Education	**0.8 (0.1 to 1.5)**	**1.4 (0.7 to 2.2)**	**1.2 (0.4 to 2.0)**	**1.2 (0.4 to 1.9)**
Income	0.2 (-0.5 to 0.9)	0.7 (0.0 to 1.4)	0.6 (-0.1 to 1.3)	0.1 (-0.6 to 0.8)
Wealth	0.4 (-0.3 to 1.1)	**1.1 (0.3 to 1.8)**	0.7 (0.0 to 1.5)	0.8 (0.0 to 1.7)
FEV_1 (ml)				
Education	12 (-10 to 34)	21 (-2 to 44)	-1 (-29 to 26)	12 (-11 to 35)
Income	21 (-1 to 42)	14 (-9 to 37)	-15 (-43 to 12)	6 (-16 to 29)
Wealth	**27 (3 to 50)**	-6 (-34 to 22)	**36 (9 to 62)**	17 (-12 to 46)
FVC (ml)				
Education	23 (-4 to 51)	**35 (7 to 63)**	8 (-29 to 45)	12 (-16 to 40)
Income	17 (-9 to 44)	14 (-15 to 42)	-21 (-54 to 11)	-4 (-31 to 23)
Wealth	26 (-3 to 55)	-12 (-43 to 19)	**57 (23 to 91)**	22 (-13 to 57)
FEV_1/FVC Ratio (%)				
Education	-0.3 (-0.7 to 0.2)	-0.3 (-0.7 to 0.1)	-0.1 (-0.6 to 0.4)	0.1 (-0.3 to 0.5)
Income	0.3 (-0.2 to 0.8)	0.0 (-0.4 to 0.5)	0.1 (-0.4 to 0.6)	0.3 (-0.1 to 0.7)
Wealth	0.3 (-0.1 to 0.8)	-0.1 (-0.7 to 0.5)	-0.1 (-0.6 to 0.4)	0.1 (-0.4 to 0.6)

Notes: FEV_1 indicates forced expiratory volume, 1 second; FVC, forced vital capacity; values shown are regression coefficients and 95% confidence intervals for an additional increment of a grouped linear variable with a range of 0 through 4 for education (less than a high school education; high school degree; some college; completed college; graduate degree), income (lowest quintile, < $9000 per person annually; highest quintile, > $40 000 per person annually) or wealth (no wealth indicators reported; only one indicator reported; two indicators reported; three indicators reported; car ownership, home ownership, financial investments, and real estate investments all reported); and the difference between extreme categories can be calculated by multiplying difference coefficient by 4; bold face font indicates statistical significance

[*] Models within each racial/ethnic subgroup included adjustment for age; sex; whether the participant was born in the US; height; body mass index (BMI); history of hay fever; history of asthma before age 45; family history of emphysema among siblings; occupational exposure to dust; residential exposure to air pollution; environmental tobacco exposure in the childhood home, adult home, or workplace; smoking status; pack-years, and CT equipment type if applicable