The Diesel Exhaust in Miners Study: A Nested Case-Control Study of Lung Cancer and Diesel Exhaust

Supplementary Methods

In addition to all respirable elemental carbon (REC) exposures, we also calculated odds ratios for REC exposure using a lag 15-year interval, under the assumption that exposures within the lag period prior to attained age had no influence on lung cancer mortality. Our choice of lag interval was not dependent on the magnitude of the odds ratio for REC exposure, but was empirically determined based on the improvement in model fit, as measured by the change in deviance relative to a model without REC exposure (Supplementary Figure 1, available online). For cumulative REC exposure (upper panel), the changes in deviance for the linear-exponential model were uniformly greater than for other model forms, indicating a substantially better fit to the data. The maximum change for the linear-exponential model occurred at 15 years. A likelihood-based 95% confidence interval for the lag interval was identified at the intersections of the curve with a line 3.84 units from the maximum, or from 10 to 18 years. The maximum changes in deviance for the other forms were generally similar, ranging from 10 to 17 years. For average REC intensity, results were less definitive (lower panel). The linear-exponential model was again the best fitting model, although the power model provided comparable fit for most choices of lag interval. The greatest change in deviance occurred at 13 and 17 years for the linear-exponential and power models, respectively. In addition, the maximum change in deviance was similar at very short lags of less than 5 years. For consistency in analyses, we presented results for exposures lagged 15 years for both cumulative REC and average REC intensity, as well as results for unlagged exposures.

Supplementary Table 1. Changes in deviance compared to a model without REC exposure and parameter estimates for models of odds ratios with continuous 15-year lagged average REC intensity and cumulative REC exposure.*

Model †	Change in Deviance	*P*‡	β	γ
15-year Lagged Average REC intensity, μg/m^3				
Full Range				
Log-linear	3.3	.069	0.0033	
Power§	5.3	.022	0.1663	
Linear§	4.1	.042	0.0068	
Linear-exponential§	5.2	.073	0.0194	-0.00522
Restricted Data, <128 μg/m^3				
Log-linear	2.7	.100	0.0078	
Power	2.8	.092	0.1566	
Linear§	3.2	.075	0.0139	
Linear-exponential	3.8	.152	0.0385	-0.01162
15-year Lagged Cumulative REC exposure, μg/m^3-y				
Full Range				
Log-linear	4.2	.041	0.0003	
Power¶	6.6	.010	0.1451	
Linear¶	8.3	.004	0.0015	
Linear-exponential¶	12.2	.002	0.0043	-0.00056
Restricted Data, <1280 μg/m^3-y				
Log-linear	15.8	<.001	0.0016	
Power	8.2	.004	0.1772	
Linear¶	15.6	<.001	0.0040	
Linear-exponential	16.0	<.001	0.0025	0.00053

*Adjusted for smoking status/mine location combination (surface work only/never smoker, surface work only/unknown/occasional smoker, surface work only/former smoker/< 1 pack/day, surface work only/former smoker/1 to < 2 pack/day, surface work only/former smoker/≥ 2 pack/day, surface work only /current smoker/< 1 pack/day, surface work only/current smoker/1 to < 2 pack/day, surface work only/current smoker/≥ 2 pack/day, ever UG work/never smoker, ever UG work/unknown/occasional smoker, ever UG work/former smoker/< 1 pack/day, ever UG work/former smoker/1 to < 2 pack/day, ever UG work/former smoker/≥ 2 pack/day, ever UG work/current smoker/< 1 pack/day, ever UG work/current smoker/1 to < 2 pack/day, ever UG work/current smoker/≥ 2 pack/day); history of respiratory disease 5 or more years before date of death/reference date; and history of a high-risk job for lung cancer for at least 10 years. REC = respirable elemental carbon.

†For exposure variable *d*, models include the log-linear model OR(*d*) = exp(β *d*); the power model, OR(*d*) = d^{β}; the linear model, OR(*d*) = 1 + β *d*; and the linear-exponential model, OR(*d*) = 1 + β *d* exp(γ *d*).

‡*P*-value for test of β = 0 (1 degree of freedom) or β = 0 and γ = 0 (2 degrees of freedom).

§Models displayed in text Figure 1, panels A and B.

¶Models displayed in text Figure 1, panels C and D.

Supplementary Table 2. Odds ratios and 95% confidence intervals for average and cumulative REC, lagged 15 years, for expanded exposure categories.*

Exposure Metric	Case patients	Control subjects	OR (95% CI)	P_{trend}
Average REC intensity				
15-year Lagged, μg/m^3				
0 to < 2	81	313	1.0 (referent)	.088
2 to <4	15	48	2.23 (0.94 to 5.30)	
4 to <8	9	25	1.40 (0.47 to 4.20)	
8 to <16	7	20	1.84 (0.54 to 6.28)	
16 to <32	12	39	1.63 (0.60 to 4.45)	
32 to <64	29	90	2.02 (0.92 to 4.43)	
64 to <128	18	58	2.06 (0.87 to 4.88)	
128 to <256	22	54	2.81 (1.21 to 6.53)	
≥256	5	19	2.64 (0.67 to 10.40)	
Cumulative REC				
15-year Lagged, μg/m^3-y				
0 to <20	83	290	1.0 (referent)	.027
20 to <40	11	69	0.49 (0.20 to 1.20)	
40 to <80	7	33	1.16 (0.40 to 3.39)	
80 to <160	14	43	1.40 (0.58 to 3.38)	
160 to <320	18	47	2.13 (0.91 to 5.02)	
320 to <640	23	80	1.71 (0.77 to 3.79)	
640 to <1,280	30	58	4.30 (1.88 to 9.84)	
1,280 to <2,560	9	34	2.13 (0.76 to 6.00)	
≥2,560	3	12	3.14 (0.61 to 16.09)	

*P-values based on two-sided Wald test for linear trend. Adjusted for smoking status/mine location combination (surface work only/never smoker, surface work only/unknown/occasional smoker, surface work only/former smoker/< 1 pack/day, surface work only/former smoker/1 to < 2 pack/day, surface work only/former smoker/≥ 2 pack/day, surface work only /current smoker/< 1 pack/day, surface work only/current smoker/1 to < 2 pack/day, surface work only/current smoker/≥ 2 pack/day, ever UG work/never smoker, ever UG work/unknown/occasional smoker, ever UG work/former smoker/< 1 pack/day, ever UG work/former smoker/1 to < 2 pack/day, ever UG work/former smoker/≥ 2 pack/day, ever UG work/current smoker/< 1 pack/day, ever UG work/current smoker/1 to < 2 pack/day, ever UG work/current smoker/≥ 2 pack/day); history of respiratory disease 5 or more years prior to date of death/reference date; and history of a high-risk job for lung cancer for at least 10 years. OR = odds ratio; CI = confidence interval; REC = respirable elemental carbon.

Supplementary Table 3. Changes in deviance compared to a model without REC exposure and parameter estimates for models of odds ratios (OR) with continuous unlagged average REC intensity and cumulative REC exposure.*

Model †	Change in Deviance	*P*‡	β	γ
Unlagged Average REC intensity, μg/m^3				
Log-linear	3.7	.054	0.0030	
Power	7.2	.007	0.2622	
Linear	5.3	.021	0.0087	
Linear-exponential	8.4	.015	0.0422	-0.00553
Restricted, <128 μg/m^3				
Log-linear	1.6	.199	0.0058	
Power	1.5	.226	0.1591	
Linear	2.2	.138	0.0122	
Linear-exponential	3.5	.173	0.0527	-0.01211
Unlagged Cumulative REC exposure, μg/m^3-y				
Log-linear	2.3	.132	0.0001	
Power	3.2	.073	0.1272	
Linear	2.8	.094	0.0002	
Linear-exponential	4.7	.094	0.0016	-0.00042
Restricted, <1280 μg/m^3-y				
Log-linear	6.4	.011	0.0010	
Power	3.1	.078	0.1661	
Linear	6.9	.009	0.0022	
Linear-exponential	6.9	.032	0.0025	-0.00011

*Adjusted for smoking status/mine location combination (surface work only/never smoker, surface work only/unknown/occasional smoker, surface work only/former smoker/< 1 pack/day, surface work only/former smoker/1 to < 2 pack/day, surface work only/former smoker/≥ 2 pack/day, surface work only /current smoker/< 1 pack/day, surface work only/current smoker/1 to < 2 pack/day, surface work only/current smoker/≥ 2 pack/day, ever UG work/never smoker, ever UG work/unknown/occasional smoker, ever UG work/former smoker/< 1 pack/day, ever UG work/former smoker/1 to < 2 pack/day, ever UG work/former smoker/≥ 2 pack/day, ever UG work/current smoker/< 1 pack/day, ever UG work/current smoker/1 to < 2 pack/day, ever UG work/current smoker/≥ 2 pack/day); history of respiratory disease 5 or more years prior to date of death/reference date; and history of a high-risk job for lung cancer for at least 10 years. REC = respirable elemental carbon.

†For exposure variable d, models include the log-linear model $OR(d) = \exp(\beta d)$; the power model, $OR(d) = d^{\beta}$; the linear model, $OR(d) = 1 + \beta d$; and the linear-exponential model, $OR(d) = 1 + \beta d \exp(\gamma d)$.

‡*P*-value for test of $\beta = 0$ (1 degree of freedom) or $\beta = 0$ and $\gamma = 0$ (2 degrees of freedom).