**Supplemental Material**

Long-Term Exposure to Outdoor Oxidant Gas Concentrations and Mortality: Effect Modification by PM2.5 Transition Metals and Oxidative Potential

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**eTable 1.** Distribution of 3-year average outdoor Ox across strata of PM2.5 components (Cu, S, Fe, Zn, Mn, Ni) and oxidative potential (glutathione (OPGSH), ascorbate (OPAA), and dithiothreitol (OPDTT))

|  |  |  |
| --- | --- | --- |
|  | **Ox** | |
| **Characteristic** | **Median (25th – 75th)** | **5th – 95th** |
| Overall | 28.75 (24.98 - 31.25) | 20.41 - 36.58 |
| OPGSH |  |  |
| > 50th | 29.39 (25.59 - 32.34) | 21.51 - 37.42 |
| < 50th | 28.24 (24.55 - 30.31) | 19.76 - 35.19 |
| OPDTT |  |  |
| > 50th | 29.26 (26.27 - 32.41) | 22.51 - 37.95 |
| < 50th | 28.26 (23.60 - 30.47) | 19.36 - 34.10 |
| OPAA |  |  |
| > 50th | 30.63 (28.10 - 33.58) | 23.41 - 38.10 |
| < 50th | 27.26 (23.30 - 29.59) | 19.46 - 32.53 |
| Cu |  |  |
| > 50th | 30.16 (28.20 - 32.42) | 23.53 - 37.38 |
| < 50th | 26.89 (23.17 - 29.58) | 19.39 - 35.27 |
| Fe |  |  |
| > 50th | 30.09 (28.07 - 32.35) | 23.43 - 37.32 |
| < 50th | 26.93 (23.15 - 29.63) | 19.40 - 35.34 |
| Zn |  |  |
| > 50th | 29.59 (26.90 - 31.97) | 22.48 - 37.07 |
| < 50th | 27.56 (23.35 - 30.16) | 19.37 - 35.70 |
| Mn |  |  |
| > 50th | 29.96 (27.91 - 32.25) | 23.44 - 37.24 |
| < 50th | 26.88 (23.03 - 29.70) | 19.28 - 35.45 |
| Ni |  |  |
| > 50th | 29.49 (26.18 - 31.99) | 20.34 - 37.12 |
| < 50th | 27.81 (24.19 - 30.26) | 20.42 - 35.63 |
| S |  |  |
| > 50th | 30.25 (28.07 - 33.04) | 23.24 - 37.81 |
| < 50th | 26.65 (23.04 - 29.33) | 19.24 - 32.69 |

**eTable 2.** Descriptive statistics for long-term average PM2.5 OP (pmol/min/µg) (glutathione (OPGSH), ascorbate (OPAA), and dithiothreitol (OPDTT)), sulfur, and transition metals (2016-2018) across 40 ground-level monitoring locations

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Characteristic** | **Mean (SD)** | **Percentile** | | | | |
| **Minimum** | **25th** | **50th** | **75th** | **Maximum** |
| *Oxidative Potential* | |  |  |  |  |  |
| OPGSH | 3.35(1.29) | 1.39 | 2.71 | 3.12 | 3.47 | 9.56 |
| OPAA | 2.95 (0.470) | 1.99 | 2.65 | 2.87 | 3.19 | 4.50 |
| OPDTT | 9.11 (1.67) | 5.70 | 8.24 | 9.21 | 10.3 | 13.6 |
| *Percent PM2.5 Mass Concentration (%)* | |  |  |  |  |  |
| Cu | 0.0798 (0.189) | 0.00437 | 0.0165 | 0.0226 | 0.0397 | 0.991 |
| Fe | 1.38 (0.822) | 0.580 | 0.873 | 1.28 | 1.65 | 5.30 |
| Zn | 0.220 (0.371) | 0.0470 | 0.0699 | 0.102 | 0.153 | 1.76 |
| Mn | 0.0440 (0.0334) | 0.0137 | 0.0236 | 0.0369 | 0.0456 | 0.187 |
| Ni | 0.00770 (0.0187) | 0.00123 | 0.00199 | 0.00263 | 0.00548 | 0.117 |
| S | 4.40 (3.11) | 1.80 | 3.21 | 3.81 | 4.40 | 22.4 |
| *Mass Concentration in PM2.5 (ng/m3)* | |  |  |  |  |  |
| Cu | 3.71 (9.23) | 0.168 | 0.758 | 1.16 | 2.19 | 55.2 |
| Fe | 80.4 (45.6) | 18.4 | 39.3 | 77.7 | 112 | 207 |
| Zn | 10.7 (14.3) | 1.92 | 4.20 | 5.13 | 9.35 | 78.4 |
| Mn | 2.66 (2.08) | 0.443 | 1.21 | 2.37 | 3.37 | 11.6 |
| Ni | 0.276 (0.379) | 0.0552 | 0.113 | 0.145 | 0.300 | 2.35 |
| S | 228 (76.0) | 74.4 | 180 | 223 | 250 | 470 |

**eTable 3.** Hazard ratios (95% CI) for Ox (per IQR of 6.27) and nonaccidental, cardiovascular, and respiratory mortality across strata of ground-level measurements of PM2.5 oxidative potential (glutathione (OPGSH), ascorbate (OPAA), and dithiothreitol (OPDTT))

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PM2.5 Components** | **Nonaccidental** | | **Cardiovascular** | | **Respiratory** | |
| **Deaths** | **HR (95% CI)** | **Deaths** | **HR (95% CI)** | **Deaths** | **HR (95% CI)** |
| Overall | 118,000 | 1.092 (1.079 - 1.104) | 33,300 | 1.153 (1.129 - 1.177) | 10,600 | 1.084 (1.045 - 1.126) |
| OPGSH |  |  |  |  |  |  |
| < 50th | 61,600 | 1.025 (1.006 - 1.044) | 17,900 | 1.063 (1.028 - 1.099) | 5,500 | 1.076 (1.012 - 1.144) |
| > 50th | 56,500 | 1.149 (1.130 - 1.169) | 15,400 | 1.223 (1.184 - 1.263) | 5,100 | 1.101 (1.040 - 1.166) |
|  | Interaction p-value <0.001 | | Interaction p-value <0.001 | | Interaction p-value = 0.593 | |
| OPDTT |  |  |  |  |  |  |
| < 50th | 58,200 | 1.052 (1.032 - 1.072) | 16,400 | 1.115 (1.077 - 1.156) | 5,200 | 1.047 (0.982 - 1.116) |
| > 50th | 59,800 | 1.115 (1.098 - 1.132) | 16,900 | 1.158 (1.125 - 1.192) | 5,400 | 1.125 (1.068 - 1.184) |
|  | Interaction p-value <0.001 | | Interaction p-value =0.107 | | Interaction p-value = 0.084 | |
| OPAA |  |  |  |  |  |  |
| < 50th | 61,800 | 1.023 (1.005 -1.042) | 18,000 | 1.076 (1.041 - 1.112) | 5,500 | 1.045 (0.983 - 1.111) |
| > 50th | 56,300 | 1.162 (1.143 - 1.181) | 15,300 | 1.241 (1.202 - 1.282) | 5,100 | 1.180 (1.117 - 1.248) |
|  | Interaction p-value <0.001 | | Interaction p-value <0.001 | | Interaction p-value = 0.004 | |

All Cox proportional hazards models were stratified by age (5-year groups), sex, immigrant status, and census cycle, and included covariates for PM2.5 mass concentrations, individual-level income, educational attainment, marital status, Indigenous identity, employment status, occupational class, and visible minority status. In addition, we included neighbourhood-level variables for four dimension of the Canadian Marginalization Index (CAN-Marg) which describes inequalities in terms of material deprivation, residential instability, dependency, and ethnic concentration

**eTable 4**. Hazard ratios (95% CI) for Ox (per IQR of 6.27) and nonaccidental, cardiovascular, and respiratory mortality across strata of ground-level measurements of PM2.5 transition metals and sulfur

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PM2.5 Components** | **Nonaccidental** | | **Cardiovascular** | | **Respiratory** | |
| **Deaths** | **HR (95% CI)** | **Deaths** | **HR (95% CI)** | **Deaths** | **HR (95% CI)** |
| Cu |  |  |  |  |  |  |
| < 50th | 63,000 | 1.057 (1.039 - 1.076) | 18,200 | 1.104 (1.069 - 1.141) | 5,600 | 1.068 (1.006 - 1.134) |
| > 50th | 55,000 | 1.139 (1.120 - 1.159) | 15,200 | 1.196 (1.158 - 1.235) | 5,000 | 1.132 (1.069 - 1.198) |
|  | Interaction p-value <0.001 | | Interaction p-value <0.001 | | Interaction p-value = 0.169 | |
| Fe |  |  |  |  |  |  |
| < 50th | 61,900 | 1.058 (1.040 - 1.077) | 17,800 | 1.107 (1.072 - 1.144) | 5,500 | 1.069 (1.006 - 1.136) |
| > 50th | 56,200 | 1.134 (1.115 - 1.153) | 15,500 | 1.188 (1.151 - 1.227) | 5,200 | 1.130 (1.068 - 1.195) |
|  | Interaction p-value <0.001 | | Interaction p-value = 0.003 | | Interaction p-value = 0.189 | |
| Zn |  |  |  |  |  |  |
| < 50th | 54,100 | 1.059 (1.039 - 1.080) | 15,500 | 1.097 (1.058 - 1.136) | 4,800 | 1.082 (1.012 - 1.155) |
| > 50th | 63,900 | 1.141 (1.124 - 1.158) | 17,800 | 1.205 (1.171 - 1.240) | 5,800 | 1.120 (1.065 - 1.178) |
|  | Interaction p-value <0.001 | | Interaction p-value <0.001 | | Interaction p-value = 0.405 | |
| Mn |  |  |  |  |  |  |
| < 50th | 59,600 | 1.054 (1.035 - 1.073) | 17,200 | 1.106 (1.070 - 1.144) | 5,200 | 1.052 (0.989 - 1.119) |
| > 50th | 58,400 | 1.141 (1.123 - 1.160) | 16,100 | 1.195 (1.158 - 1.233) | 5,400 | 1.143 (1.082 - 1.207) |
|  | Interaction p-value <0.001 | | Interaction p-value = 0.001 | | Interaction p-value =0.048 | |
| Ni |  |  |  |  |  |  |
| < 50th | 54,400 | 1.008 (0.989 - 1.027) | 15,800 | 1.049 (1.013 - 1.086) | 4,800 | 1.044 (0.978 - 1.113) |
| > 50th | 63,600 | 1.182 (1.163 - 1.201) | 17,500 | 1.249 (1.212 - 1.288) | 5,800 | 1.138 (1.079 - 1.201) |
|  | Interaction p-value <0.001 | | Interaction p-value = 0.001 | | Interaction p-value = 0.042 | |

**eTable 4 (continued)**. Hazard ratios (95% CI) for Ox (per IQR of 6.27) and nonaccidental, cardiovascular, and respiratory mortality across strata of ground-level measurements of PM2.5 transition metals and sulfur

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PM2.5 Components** | **Nonaccidental** | | **Cardiovascular** | | **Respiratory** | |
| **Deaths** | **HR (95% CI)** | **Deaths** | **HR (95% CI)** | **Deaths** | **HR (95% CI)** |
| S |  |  |  |  |  |  |
| < 50th | 56,000 | 1.008 (0.990 - 1.026) | 16,400 | 1.061 (1.027 - 1.096) | 4,900 | 1.004 (0.945 - 1.067) |
| > 50th | 62,000 | 1.174 (1.156 - 1.193) | 17,000 | 1.244 (1.208 - 1.282) | 5,700 | 1.189 (1.129 - 1.252) |
|  | Interaction p-value <0.001 | | Interaction p-value <0.001 | | Interaction p-value <0.001 | |

All Cox proportional hazards models were stratified by age (5-year groups), sex, immigrant status, and census cycle, and included covariates for PM2.5 mass concentrations, individual-level income, educational attainment, marital status, Indigenous identity, employment status, occupational class, and visible minority status. In addition, we included neighbourhood-level variables for four dimension of the Canadian Marginalization Index (CAN-Marg) which describes inequalities in terms of material deprivation, residential instability, dependency, and ethnic concentration

**eTable 5.** Hazard ratios (95% CI) for Ox (per IQR of 6.27) and nonaccidental mortality across strata of ground-level measurements of PM2.5 oxidative potential (glutathione (OPGSH), ascorbate (OPAA), and dithiothreitol (OPDTT)) stratified by sex

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PM2.5 Components** | **Nonaccidental Mortality** | | | |
| **Males** | | **Females** | |
| **Deaths** | **HR (95% CI)** | **Deaths** | **HR (95% CI)** |
| Overall | 55,000 | 1.064 (1.047 - 1.082) | 63,000 | 1.114 (1.097 - 1.131) |
| OPGSH |  |  |  |  |
| < 50th | 28,900 | 0.991 (0.965 - 1.018) | 32,700 | 1.054 (1.028 - 1.081) |
| > 50th | 26,100 | 1.141 (1.112 - 1.170) | 30,400 | 1.155 (1.129 - 1.183) |
| OPDTT |  |  |  |  |
| < 50th | 27,500 | 1.013 (0.985 - 1.041) | 30,700 | 1.089 (1.061 - 1.118) |
| > 50th | 27,500 | 1.088 (1.063 - 1.113) | 32,300 | 1.134 (1.111 - 1.158) |
| OPAA |  |  |  |  |
| < 50th | 29,000 | 0.991 (0.965 - 1.017) | 32,700 | 1.053 (1.027 - 1.079) |
| > 50th | 25,900 | 1.158 (1.130 - 1.187) | 30,300 | 1.163 (1.137 -1.190) |

All Cox proportional hazards models were stratified by age (5-year groups), sex, immigrant status, and census cycle, and included covariates for PM2.5 mass concentrations, individual-level income, educational attainment, marital status, Indigenous identity, employment status, occupational class, and visible minority status. In addition, we included neighbourhood-level variables for four dimension of the Canadian Marginalization Index (CAN-Marg) which describes inequalities in terms of material deprivation, residential instability, dependency, and ethnic concentration

**eTable 6.** Hazard ratios (95% CI) for Ox (per IQR of 6.27) and nonaccidental mortality across strata of ground-level measurements of PM2.5 transition metals and sulfur stratified by sex

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PM2.5 Components** | **Nonaccidental Mortality** | | | |
| **Males** | | **Females** | |
| **Deaths** | **HR (95% CI)** | **Deaths** | **HR (95% CI)** |
| Cu |  |  |  |  |
| < 50th | 29,500 | 1.026 (1.000 - 1.053) | 33,600 | 1.084 (1.058 - 1.111) |
| > 50th | 25,500 | 1.119 (1.091 - 1.148) | 29,500 | 1.155 (1.128 - 1.182) |
| Fe |  |  |  |  |
| < 50th | 28,900 | 1.026 (1.000 - 1.054) | 32,900 | 1.086 (1.060 - 1.113) |
| > 50th | 26,000 | 1.113 (1.085 - 1.141) | 30,100 | 1.150 (1.124 - 1.176) |
| Zn |  |  |  |  |
| < 50th | 25,200 | 1.024 (0.996 - 1.054) | 28,800 | 1.090 (1.061 - 1.119) |
| > 50th | 29,700 | 1.107 (1.083 - 1.132) | 34,200 | 1.168 (1.144 - 1.193) |
| Mn |  |  |  |  |
| < 50th | 27,800 | 1.023 (0.996 - 1.051) | 31,800 | 1.081 (1.054 - 1.108) |
| > 50th | 27,100 | 1.116 (1.089 - 1.143) | 31,300 | 1.161 (1.136 - 1.188) |
| Ni |  |  |  |  |
| < 50th | 25,500 | 0.985 (0.958 - 1.012) | 28,900 | 1.027 (1.000 - 1.054) |
| > 50th | 29,500 | 1.153 (1.126 - 1.181) | 34,100 | 1.205 (1.179 - 1.231) |
| S |  |  |  |  |
| < 50th | 26,400 | 0.987 (0.961 - 1.012) | 29,700 | 1.026 (1.002 - 1.052) |
| > 50th | 28,600 | 1.146 (1.120 - 1.173) | 33,400 | 1.197 (1.172 - 1.223) |

All Cox proportional hazards models were stratified by age (5-year groups), sex, immigrant status, and census cycle, and included covariates for PM2.5 mass concentrations, individual-level income, educational attainment, marital status, Indigenous identity, employment status, occupational class, and visible minority status. In addition, we included neighbourhood-level variables for four dimension of the Canadian Marginalization Index (CAN-Marg) which describes inequalities in terms of material deprivation, residential instability, dependency, and ethnic concentration

**eTable 7.** Hazard ratios (95% CI) for Ox (per IQR of 6.27) and cardiovascular mortality across strata of ground-level measurements of PM2.5 oxidative potential (glutathione (OPGSH), ascorbate (OPAA), and dithiothreitol (OPDTT)) stratified by sex

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PM2.5 Components** | **Cardiovascular Mortality** | | | |
| **Males** | | **Females** | |
| **Deaths** | **HR (95% CI)** | **Deaths** | **HR (95% CI)** |
| Overall | 14,600 | 1.117 (1.082 - 1.152) | 18,700 | 1.179 (1.147 - 1.212) |
| OPGSH |  |  |  |  |
| < 50th | 7,900 | 1.029 (0.978 - 1.082) | 10,000 | 1.087 (1.040 - 1.137) |
| > 50th | 6,700 | 1.190 (1.133 - 1.252) | 8,700 | 1.246 (1.193 - 1.301) |
| OPDTT |  |  |  |  |
| < 50th | 7,300 | 1.118 (1.061 - 1.179) | 9,100 | 1.113 (1.061 - 1.167) |
| > 50th | 7,300 | 1.082 (1.035 - 1.131) | 9,600 | 1.214 (1.169 - 1.262) |
| OPAA |  |  |  |  |
| < 50th | 7,900 | 1.047 (0.996 - 1.100) | 10,100 | 1.097 (1.050 - 1.146) |
| > 50th | 6,700 | 1.219 (1.161 - 1.280) | 8,600 | 1.257 (1.205 - 1.311) |

All Cox proportional hazards models were stratified by age (5-year groups), sex, immigrant status, and census cycle, and included covariates for PM2.5 mass concentrations, individual-level income, educational attainment, marital status, Indigenous identity, employment status, occupational class, and visible minority status. In addition, we included neighbourhood-level variables for four dimension of the Canadian Marginalization Index (CAN-Marg) which describes inequalities in terms of material deprivation, residential instability, dependency, and ethnic concentration

**eTable 8.** Hazard ratios (95% CI) for Ox (per IQR of 6.27) and cardiovascular mortality across strata of ground-level measurements of PM2.5 transition metals and sulfur stratified by sex

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PM2.5 Components** | **Cardiovascular Mortality** | | | |
| **Males** | | **Females** | |
| **Deaths** | **HR (95% CI)** | **Deaths** | **HR (95% CI)** |
| Cu |  |  |  |  |
| < 50th | 7,900 | 1.085 (1.033 - 1.140) | 10,200 | 1.118 (1.071 - 1.167) |
| > 50th | 6,600 | 1.142 (1.088 - 1.200) | 8,500 | 1.237 (1.185 - 1.291) |
| Fe |  |  |  |  |
| < 50th | 7,800 | 1.089 (1.037 - 1.145) | 10,000 | 1.120 (1.073 - 1.170) |
| > 50th | 6,800 | 1.134 (1.080 - 1.190) | 8,700 | 1.229 (1.178 - 1.282) |
| Zn |  |  |  |  |
| < 50th | 6,800 | 1.060 (1.004 - 1.119) | 8,700 | 1.125 (1.073 - 1.180) |
| > 50th | 7,800 | 1.153 (1.104 - 1.205) | 10,000 | 1.243 (1.197 - 1.291) |
| Mn |  |  |  |  |
| < 50th | 7,500 | 1.102 (1.048 - 1.160) | 9,700 | 1.108 (1.060 - 1.159) |
| > 50th | 7,000 | 1.129 (1.077 - 1.183) | 9,000 | 1.246 (1.196 - 1.298) |
| Ni |  |  |  |  |
| < 50th | 6,900 | 1.020 (0.967 - 1.075) | 8,900 | 1.068 (1.020 - 1.119) |
| > 50th | 7,700 | 1.209 (1.154 - 1.266) | 9,800 | 1.278 (1.228 - 1.331) |
| S |  |  |  |  |
| < 50th | 7,200 | 1.039 (0.990 - 1.091) | 9,100 | 1.077 (1.032 - 1.125) |
| > 50th | 7,400 | 1.200 (1.148 - 1.257) | 9,600 | 1.277 (1.227 - 1.328) |

All Cox proportional hazards models were stratified by age (5-year groups), sex, immigrant status, and census cycle, and included covariates for PM2.5 mass concentrations, individual-level income, educational attainment, marital status, Indigenous identity, employment status, occupational class, and visible minority status. In addition, we included neighbourhood-level variables for four dimension of the Canadian Marginalization Index (CAN-Marg) which describes inequalities in terms of material deprivation, residential instability, dependency, and ethnic concentration

**eTable 9.** Hazard ratios (95% CI) for Ox (per IQR of 6.27) and respiratory mortality across strata of ground-level measurements of PM2.5 oxidative potential (glutathione (OPGSH), ascorbate (OPAA), and dithiothreitol (OPDTT)) stratified by sex

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PM2.5 Components** | **Respiratory Mortality** | | | |
| **Males** | | **Females** | |
| **Deaths** | **HR (95% CI)** | **Deaths** | **HR (95% CI)** |
| Overall | 4,900 | 1.049 (0.993 - 1.109) | 5,700 | 1.113 (1.058 - 1.170) |
| OPGSH |  |  |  |  |
| < 50th | 2,500 | 1.037 (0.947 - 1.135) | 3,000 | 1.106 (1.017 - 1.203) |
| > 50th | 2,300 | 1.092 (1.003 - 1.190) | 2,800 | 1.112 (1.029 - 1.202) |
| OPDTT |  |  |  |  |
| < 50th | 2,400 | 0.992 (0.902 - 1.090) | 2,800 | 1.096 (1.005 - 1.195) |
| > 50th | 2,500 | 1.073 (0.994 - 1.159) | 2,900 | 1.163 (1.085 - 1.247) |
| OPAA |  |  |  |  |
| < 50th | 2,500 | 1.017 (0.930 - 1.113) | 3,000 | 1.069 (0.983 - 1.162) |
| > 50th | 2,300 | 1.155 (1.063 - 1.255) | 2,800 | 1.204 (1.117 - 1.298) |

All Cox proportional hazards models were stratified by age (5-year groups), sex, immigrant status, and census cycle, and included covariates for PM2.5 mass concentrations, individual-level income, educational attainment, marital status, Indigenous identity, employment status, occupational class, and visible minority status. In addition, we included neighbourhood-level variables for four dimension of the Canadian Marginalization Index (CAN-Marg) which describes inequalities in terms of material deprivation, residential instability, dependency, and ethnic concentration

**eTable 10.** Hazard ratios (95% CI) for Ox (per IQR of 6.27) and respiratory mortality across strata of ground-level measurements of PM2.5 transition metals and sulfur stratified by sex

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PM2.5 Components** | **Respiratory** | | | |
| **Males** | | **Females** | |
| **Deaths** | **HR (95% CI)** | **Deaths** | **HR (95% CI)** |
| Cu |  |  |  |  |
| < 50th | 2,600 | 1.047 (0.959 - 1.143) | 3,000 | 1.085 (1.000 - 1.177) |
| > 50th | 2,300 | 1.103 (1.013 - 1.201) | 2,700 | 1.161 (1.075 - 1.253) |
| Fe |  |  |  |  |
| < 50th | 2,500 | 1.038 (0.949 - 1.134) | 2,900 | 1.097 (1.010 - 1.191) |
| > 50th | 2,300 | 1.113 (1.023 - 1.211) | 2,800 | 1.148 (1.065 - 1.238) |
| Zn |  |  |  |  |
| < 50th | 2,200 | 1.055 (0.957 - 1.162) | 2,600 | 1.103 (1.008 - 1.207) |
| > 50th | 2,600 | 1.085 (1.006 - 1.171) | 3,200 | 1.151 (1.075 - 1.232) |
| Mn |  |  |  |  |
| < 50th | 2,400 | 1.023 (0.934 - 1.120) | 2,800 | 1.077 (0.990 - 1.171) |
| > 50th | 2,400 | 1.106 (1.020 - 1.201) | 2,900 | 1.178 (1.094 - 1.268) |
| Ni |  |  |  |  |
| < 50th | 2,300 | 1.028 (0.936 - 1.130) | 2,600 | 1.055 (0.965 - 1.153) |
| > 50th | 2,600 | 1.099 (1.014 - 1.192) | 3,200 | 1.174 (1.093 - 1.262) |
| S |  |  |  |  |
| < 50th | 2,300 | 1.004 (0.919 - 1.097) | 2,600 | 1.003 (0.923 - 1.090) |
| > 50th | 2,600 | 1.144 (1.059 - 1.236) | 3,100 | 1.230 (1.147 - 1.318) |

All Cox proportional hazards models were stratified by age (5-year groups), sex, immigrant status, and census cycle, and included covariates for PM2.5 mass concentrations, individual-level income, educational attainment, marital status, Indigenous identity, employment status, occupational class, and visible minority status. In addition, we included neighbourhood-level variables for four dimension of the Canadian Marginalization Index (CAN-Marg) which describes inequalities in terms of material deprivation, residential instability, dependency, and ethnic concentration

**eTable 11.** Hazard ratios (95% CI) for Ox (per IQR of 6.27) and nonaccidental, cardiovascular, and respiratory mortality across strata of both sulfur and ground-level measurements of PM2.5 transition metals

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Transition Metal** | **Transition Metal and S ≤ 50th** | | **Transition Metal and S > 50th** | | **Interaction P-value** |
| **Deaths** | **HR (95% CI)** | **Deaths** | **HR (95% CI)** |
| *Nonaccidental Mortality* | |  | | |  |
| Cu | 50,200 | 1.046 (1.026 - 1.066) | 49,100 | 1.185 (1.164 - 1.207) | <0.001 |
| Fe | 48,600 | 1.050 (1.030 - 1.071) | 48,700 | 1.188 (1.166 - 1.210) | <0.001 |
| Zn | 40,300 | 1.031 (1.008 - 1.054) | 48,200 | 1.178 (1.157 - 1.200) | <0.001 |
| Mn | 46,300 | 1.044 (1.023 - 1.065) | 48,700 | 1.188 (1.166 - 1.209) | <0.001 |
| Ni | 47,400 | 0.989 (0.969 - 1.009) | 55,000 | 1.178 (1.158 - 1.198) | <0.001 |
| Cardiovascular Mortality | | | |  |  |
| Cu | 14,500 | 1.101 (1.063 - 1.141) | 13,300 | 1.252 (1.209 - 1.296) | <0.001 |
| Fe | 14,100 | 1.109 (1.070 - 1.150) | 13,200 | 1.254 (1.211 - 1.299) | <0.001 |
| Zn | 11,500 | 1.072 (1.029 - 1.117) | 13,000 | 1.248 (1.204 - 1.293) | <0.001 |
| Mn | 13,400 | 1.107 (1.067 - 1.149) | 13,100 | 1.254 (1.211 - 1.298) | <0.001 |
| Ni | 13,800 | 1.039 (1.001 - 1.078) | 15,000 | 1.238 (1.198 - 1.278) | <0.001 |
| *Respiratory Mortality* | | | | |  |
| Cu | 4,300 | 1.033 (0.966 - 1.104) | 4,500 | 1.164 (1.095 - 1.237) | 0.009 |
| Fe | 4,200 | 1.041 (0.973 - 1.114) | 4,400 | 1.174 (1.104 - 1.248) | 0.010 |
| Zn | 3,500 | 1.014 (0.940 - 1.095) | 4,400 | 1.160 (1.091 - 1.233) | 0.007 |
| Mn | 4,000 | 1.015 (0.947 - 1.087) | 4,400 | 1.173 (1.103 - 1.247) | 0.002 |
| Ni | 4,200 | 1.003 (0.936 - 1.075) | 5,000 | 1.157 (1.093 - 1.224) | 0.002 |

All Cox proportional hazards models were stratified by age (5-year groups), sex, immigrant status, and census cycle, and included covariates for PM2.5 mass concentrations, individual-level income, educational attainment, marital status, Indigenous identity, employment status, occupational class, and visible minority status. In addition, we included neighbourhood-level variables for four dimension of the Canadian Marginalization Index (CAN-Marg) which describes inequalities in terms of material deprivation, residential instability, dependency, and ethnic concentration

**eFigure 1**. A)Map of ground-level monitoring location across Canada (2016-2018) for PM2.5 oxidative potential (glutathione (OPGSH), ascorbate (OPAA), and dithiothreitol (OPDTT)) and mass proportions of Cu, S, Fe, Zn, Mn, and Ni in PM2.5; B) Map showing locations where mass proportions of Ni and S are both above or below the median.

**A)**

**Chart, scatter chart

Description automatically generated**

**B)**

**Diagram

Description automatically generated with medium confidence**

**eFigure 2.** Spearman correlations (percent) between long-term estimates of PM2.5 OP (glutathione (GSH), ascorbate (AA), and dithiothreitol (DTT)) and mass proportions of PM2.5 components (2016-2018)

![Chart

Description automatically generated]()