**Supplementary Table 1: Basic characteristics of COPD patients with or without OSA.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Characteristics** | **Total** | **COPD without OSA** | **COPD with OSA**  | **Statistics** | ***P*-value*\**** |
| Number of participants, *n* (%) | 109 (100.0) | 45 (41.3) | 64 (58.7) |  |  |
| Gender, *n* (%) |  |  |  | 2.513\* | 0.158 |
| Male | 94 (86.2) | 36 (38.3) | 58 (61.7) |  |  |
| Female | 15 (13.8) | 9 (60.0) | 6 (40.0) |  |  |
| Age (years), Median (IQR) | 66.0 (12.5) | 68.0 (11.0) | 65.0 (13.3) | 0.240† | 0.549 |
| BMI (kg/m2), Median (IQR) | 23.9 (4.5) | 23.5 (5.1) | 24.0 (4.5) | 0.398† | 0.562 |
| Smoking status, *n* (%) |  |  |  | 5.105\* | 0.078 |
| Never smoker | 14 (12.8) | 4 (28.6) | 10 (71.4) |  |  |
| Former smoker | 68 (62.4) | 25 (36.8) | 43 (63.2) |  |  |
| Current smoker | 27 (24.8) | 16 (59.3) | 11 (40.7) |  |  |
| Smoke packs per year (packs/year), Median (IQR) | 31.7 (34.2) | 25.0 (50.0) | 21.5 (38.5) | 0.670† | 0.475 |
| Cooking oil fumes, *n* (%) |  |  |  | 0.417\* | 0.539 |
| No | 74 (67.9) | 29 (39.2) | 45 (60.8) |  |  |
| Yes | 35 (32.1) | 16 (45.7) | 19 (52.7) |  |  |
| Occupation exposure, *n* (%) |  |  |  | 1.999\* | 0.172 |
| No | 64 (58.7) | 30 (46.9) | 34 (53.1) |  |  |
| Yes | 45 (41.3) | 15 (33.3) | 30 (66.7) |  |  |
| Drug therapy, *n* (%) |  |  |  | 12.918\* | 0.012 |
| LAMA | 15 (13.8) | 7 (46.7) | 8 (53.3) |  |  |
| LABA + ICS | 33 (30.3) | 11 (33.3) | 22 (66.7) |  |  |
| LAMA + LABA + ICS | 41 (37.6) | 12 (29.3) | 29 (70.7) |  |  |
| Theophylline | 13 (11.9) | 10 (76.9) | 3 (23.1) |  |  |
| Other drugs | 7 (6.4) | 5 (71.4) | 2 (28.6) |  |  |
| Lung function, Median (IQR) |  |  |  |  |  |
| FVC (L) | 2.9 (1.0) | 3.3 (1.2) | 2.8 (1.0) | 0.722† | 0.102 |
| FEV1 (L) | 1.9 (1.1) | 2.1 (1.2) | 1.9 (1.1) | 0.367† | 0.998 |
| FEV1/FVC (%) | 77.9 (25.2) | 82.0 (19.5) | 76.1 (29.2) | 0.051† | 0.828 |
| GOLD stage, *n* (%) |  |  |  | 1.334\* | 0.721 |
| GOLD 1 | 24 (22.0) | 9 (37.5) | 15 (62.5) |  |  |
| GOLD 2 | 54 (49.5) | 25 (46.3) | 29 (53.7) |  |  |
| GOLD 3 | 24 (22.0) | 8 (33.3) | 16 (66.7) |  |  |
| GOLD 4 | 7 (6.4) | 3 (42.9) | 4 (57.1) |  |  |

 \**χ*2 value; †*Z* value. BMI: Body mass index; COPD: Chronic obstructive pulmonary disease; FEV1: Forced expiratory volume in 1 s; FVC: Forced vital capacity; GOLD: Global Initiative for Chronic Obstructive Lung Disease; ICS: Inhaled corticosteroids; LABA: Long-acting beta 2 agonists; LAMA: Long-acting antimuscarinic antagonists; IQR: Interquartile range; OSA: Obstructive sleep apnea.

**Supplementary Table 2: Distributions of daily average concentrations of air pollutants and meteorological data.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Air pollutants** | **Mean ± SD** | **Min** | **P25** | **P50** | **P75** | **Max** | **IQR** |
| PM2.5 (μg/m3) | 64.6 ± 67.5 | 5.0 | 23.5 | 39.0 | 83.5 | 364.0 | 60.0  |
| PM10 (μg/m3) | 93.3 ± 80.6 | 0 | 43.5 | 72.0 | 118.5 | 550.0 | 75.0  |
| SO2 (μg/m3) | 9.2 ± 8.9 | 2.0 | 3.0 | 6.0 | 11.0 | 42.0 | 8.0  |
| CO (mg/m3) | 1.1 ± 1.1 | 0.2 | 0.5 | 0.8 | 1.1 | 7.5 | 0.6  |
| NO2 (μg/m3) | 48.5 ± 26.5 | 10.0 | 31.0 | 41.0 | 53.0 | 153.0 | 22.0  |
| O3 (μg/m3) | 92.3 ± 65.7 | 0 | 43.5 | 74.0 | 141.5 | 262.0 | 98.0  |
| Temperature (°C) | 11.8 ± 11.4 | -4.0 | 1.0 | 11.0 | 23.5 | 31.0 | 22.5  |
| RH (%) | 48.0 ± 18.5 | 14.0 | 35.0 | 44.0 | 64.5 | 88.0 | 29.5  |

CO: Carbon monoxide; IQR: Interquartile range; Max: Maximum; Min: Minimum; NO2: Nitrogen dioxide; O3: Ozone; PM10: Particulate matter with aerodynamic diameter <10 μm; PM2.5: Particulate matter with aerodynamic diameter <2.5 µm; RH: Relative humidity; SD: Standard deviation; SO2: Sulfur dioxide.

**Supplementary Table 3: Spearman’s correlation coefficients among air pollutants and meteorological parameters.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Air pollutants** | PM2.5 | PM10 | SO2 | CO | NO2 | O3 | Temperature | RH |
| PM2.5 | 1.000  | 0.837‡  | 0.625‡  | 0.876‡  | 0.682‡  | -0.105  | -0.055  | 0.568‡  |
| PM10 | 　 | 1.000  | 0.625‡  | 0.712‡  | 0.699‡  | 0.012  | -0.014  | 0.306‡  |
| SO2 | 　 | 　 | 1.000  | 0.688‡  | 0.689‡  | -0.389‡  | -0.508‡  | -0.036  |
| CO | 　 | 　 | 　 | 1.000  | 0.717‡  | -0.282†  | -0.208\*  | 0.544‡  |
| NO2 | 　 | 　 | 　 | 　 | 1.000  | -0.401‡  | -0.352‡  | 0.265† |
| O3 | 　 | 　 | 　 | 　 | 　 | 1.000  | 0.854‡  | -0.014  |
| Temperature | 　 | 　 | 　 | 　 | 　 | 　 | 1.000  | 0.256†  |
| RH | 　 | 　 | 　 | 　 | 　 | 　 | 　 | 1.000  |

CO: Carbon monoxide; NO2: Nitrogen dioxide; O3: Ozone; PM10: Particulate matter with aerodynamic diameter <10 μm; PM2.5: Particulate matter with aerodynamic diameter <2.5 µm; RH: Relative humidity; SO2: Sulfur dioxide. \**P*<0.05; †*P*<0.01; ‡*P*<0.001.

**Supplementary Table 4: Associations between ambient air pollutants and sleep parameters in two-pollutant models.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sleep parameters | Air pollutants | Two-pollutant model with PM2.5 | Two-pollutant model with PM10 | Two-pollutant model with NO2 | Two-pollutant model with SO2 | Two-pollutant model with O3 | Two-pollutant model with CO |
| ODI | PM2.5-lag05 |  | 0.87% (-0.02%,1.77%) | 0.74% (-0.22%,1.71%) | 0.68% (-0.22%,1.59%) | 0.65% (-0.22%,1.52%) | 0.26% (-0.76%,1.28%) |
|  | PM10-lag07 | 0.62% (-0.57%,1.81%) |  | 0.12% (-0.17%,0.40%) | 0.1% (-0.18%,0.39%) | -0.52% (-1.02%,0.02%) | 0.06% (-0.23%,0.35%) |
|  | SO2-lag07 | 6.12% (-8.43%,22.99%) | 9.02% (-5.56%,25.85%) | 8.4% (-6.14%,25.20%) |  | 8.02% (-6.59%,24.92%) | 3.89% (-10.62%,20.74%) |
|  | O3-lag07 | -0.26% (-1.07%, 0.54%) | -0.29% (-1.11%,0.52%) | -0.59% (-1.46%,0.23%) | 0.28% (-0.53%,1.10%) |  | -0.28% (-1.09%,0.53%)\* |
|  |  |  |  |  |  |  |  |
| Base SpO2 | PM2.5-lag01 |  | -0.01% (-0.04%,0.04%) | 0.002% (-0.16%,0.02%) | 0.01% (-0.004%,0.02%) | 0.01% (-0.04%,0.019%) | -0.012% (-0.04%,0.014%) |
|  | PM10-lag06 | 0.18% (-0.15%,0.50%) |  | 0.23% (-0.05%,0.52%) | 0.22% (-0.06%,0.51%) | 0.21% (-0.07%,0.50%) | 0.19% (-0.10%,0.47%) |
|  |  |  |  |  |  |  |  |
| Min SpO2 | PM10-lag06 | -0.88% (-2.49%,0.72%) |  | 0.14% (-0.15%,0.43%) | 0.13% (-0.16%,0.42%) | 0.13% (-0.16%,0.27%) | 0.09% (-0.20%,0.38%) |
|  |  |  |  |  |  |  |  |
| T90 | PM2.5-lag04 |  | -1.13% (-3.03%,0.77%) | -1.15% (-2.43%, -0.12%) | -0.93% (-1.85%, -0.02%) | -0.92% (-1.62%, -0.21%) | -0.13% (-1.88%, 1.62%) |
|  | PM10-lag04 | 0.20% (-1.35%,1.76%) |  | -0.63% (-1.62%, 0.34%) | -0.58% (-1.26%,0.09%) | -0.66% (-1.24%, -0.09%) | 0.26% (-0.76%,1.28%) |

CIs: Confidence intervals; CO: Carbon monoxide; NO2: Nitrogen dioxide; O3: Ozone; ODI: Oxygen desaturation index; PM10: Particulate matter with aerodynamic diameter <10 μm; PM2.5: Particulate matter with aerodynamic diameter <2.5 µm; SO2: Sulfur dioxide; SpO2: Oxygen saturation; T90: Percentage of total sleep time with oxygen saturation < 90%.



**Supplementary Figure 1:** The differences in health indicators AHI and ODI (A), SpO2 (B) and T90, T85 and T80 (C) of COPD with or without OSA group. AHI: Apnea-hypopnea Index; COPD: Chronic Obstructive Pulmonary Disease; ODI: Oxygen Desaturation Index; OSA: Obstructive sleep apnea; SpO2: Oxygen saturation; T80: Percentage sleep time with < 80% saturation; T85: Percentage sleep time with < 85% saturation; T90: Percentage of total sleep time with oxygen saturation < 90%. \**P* <0.05.

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**Supplementary Figure 2:** Associations between exposure to air pollutants and ODI among all participants using MLR model (an IQR increase in PM2.5 [A], PM10 [B], O3 [C] and SO2 [D]). The MLR model adjusted for confounders including gender, age, body mass index (BMI), smoking status, occupational exposure, cooking oil fumes exposure, GOLD stage, temperature, and RH. GOLD: Global initiative for chronic obstructive lung disease; IQR: Interquartile range; MLR: Multiple linear regression; O3: Ozone; ODI: Oxygen desaturation index; PM10: Particulate matter with aerodynamic diameter <10 μm; PM2.5: Particulate matter with aerodynamic diameter <2.5 µm; RH: Relative humidity; SO2: Sulfur dioxide.



**Supplementary Figure 3:** Associations between exposure to PM2.5 and base-SpO2 (A), PM10 and base-SpO2 (B), and PM10 and min-SpO2 (C) among all participants using MLR model (an IQR increase in PM2.5, PM10). The MLR model adjusted for confounders including gender, age, body mass index (BMI), smoking status, occupational exposure, cooking oil fumes exposure, GOLD stage, temperature, and RH. GOLD: Global initiative for chronic obstructive lung disease; IQR: Interquartile range; MLR: Multiple linear regression; PM10: Particulate matter with aerodynamic diameter <10 μm; PM2.5: Particulate matter with aerodynamic diameter <2.5 µm; RH: Relative humidity; SpO2: Oxygen saturation.



**Supplementary Figure 4:** Associations between exposure to air pollutants PM2.5 (A), PM10 (B) and T90 among all participants using MLR model (an IQR increase in PM2.5, PM10). The MLR model adjusted for confounders including gender, age, body mass index (BMI), smoking status, occupational exposure, cooking oil fumes exposure, GOLD stage, temperature, and RH. GOLD: Global initiative for chronic obstructive lung disease; IQR: Interquartile range; MLR: Multiple linear regression; PM10: Particulate matter with aerodynamic diameter <10 μm; PM2.5: Particulate matter with aerodynamic diameter <2.5 µm; RH: Relative humidity; T90: Percentage of total sleep time with oxygen saturation < 90%.