**Supplemental Material**

**Low-level air pollution exposure and incidence of chronic obstructive pulmonary disease: the ELAPSE project**

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**Conflict of interest:** We declare that we have no conflicts of interest.

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**Online Supplement S1: Description of the three study cohorts.**

We included three out of 11 pooled ELAPSE large prospective cohorts into our analyses. One of the cohorts, the CEANS cohort, is composed of four individual Swedish cohorts. The other two study cohorts, the DCH cohort and the DNC cohort, are from Denmark.

**1) CEANS cohort study, Sweden: SDPP, SIXTY, SALT, and SNAC-K.**

**SDPP, Stockholm diabetes preventive program, Sweden**

The Stockholm diabetes prevention program was a population-based prospective study and aimed at investigating the etiology of type 2 diabetes and developing prevention strategies for type 2 diabetes (Eriksson et al. 2008). An initial survey included all men and women in the targeted age group in Stockholm County; for men in four municipalities (Värmdö, Upplands Bro, Tyresö and Sigtuna), and for women these four plus a fifth municipality (Upplands Väsby). All were screened by a questionnaire regarding presence of own diabetes and diabetes in relatives. Subjects with family history of diabetes (FHD) and randomly selected subjects without FHD, all without previously diagnosed diabetes, were invited to a health examination. This baseline study, 1992−1994 for men and 1996−1998 for women, comprised 7,949 subjects, aged 35−56 years, and about 50% had FHD. In the follow-up study eight to ten years later, 2,383 men (2002−2004) and 3,329 women (2004−2006) participated. At the health examinations, both at baseline and follow-up, an extensive questionnaire (information on lifestyle factors, such as physical activity, dietary habits, tobacco use, alcohol consumption, health status, socioeconomic status and psychosocial conditions) was completed. Diabetes heredity was confirmed and measurements of weight, height, hip and waist circumference as well as blood pressure were performed. In addition, an oral glucose tolerance test (OGTT) was made, and blood was sampled at fasting state and two hour after glucose intake. Outcomes based on the Swedish nationwide health registries (such as the myocardial infarction and stroke registries, the cause-of death register, and the national patient register) have been used.

**SIXTY, The Cohort of 60-year-olds, Sweden**

The Cohort of 60-year-olds is a study aiming to identify biological and socio-economic risk factors and predictors for cardiovascular diseases (Wändell et al. 2007). Recruitment took place between August 1997 and March 1999. A random sample of every third man and woman living in Stockholm County, who was born between 1 July 1937 and 30 June 1938, was invited to participate. In total, 4,232 subjects were included. Height, weight, BMI, Waist/Hip ratio and resting ECD, blood pressure and fasting blood samples were taken during a physical examination, while a comprehensive questionnaire was completed, including information on socioeconomic, medical and life-style factors. Outcomes based on the Swedish nationwide health registries (such as the myocardial infarction and stroke registries, the cause-of-death register and the national patient register) have been used.

**SALT, Stockholm Screening Across the Lifespan Twin study, Sweden**

Participants come from two sub-studies of the Swedish Twin Registry (STR) (Zagai et al. 2019). The Screening Across the Lifespan Twin study (SALT) (Lichtenstein et al. 2006) & TwinGene (Magnusson et al. 2013) was set-up to screen all twins born in Sweden before 1958 for the most common complex diseases with a focus on cardiovascular diseases. TwinGene is a sub-study establishing a biobank with DNA and serum from SALT participants. SALT is based on a telephone interview and recruitment took place between 1998 and 2002. Information concerning birth order and weight, zygosity, contact with twin partner and family constellation, diseases, use of medication, occupation, education, life style habits, gender- and age specific (hormone replacement therapy) and memory problems (age > 65 ) was collected. In TwinGene, twins born before 1958 were contacted 2004−2008. Health and medication data were collected from questionnaires. Blood sampling material was mailed to study subjects, who contacted a local health care center for blood sampling. Information about COPD come from linkages to Swedish nationwide health registries. This investigation on air pollution is restricted to participants living in Stockholm County.

**SNAC-K, The Swedish National study of Aging and Care in Kungsholmen (SNAC-K), Sweden**

SNAC-K is an ongoing longitudinal study aiming to investigate the ageing process and identify possible preventive strategies to improve health and care in elderly adults (Lagergren et al. 2004). The study population consists of randomly sampled individuals >=60 years old and in a central area of Stockholm (Kungsholmen) between March 2001 and June 2004. The sample was stratified for age and year of assessment giving sub-cohorts with 60, 66, 72, 78, 81, 84, 87, 90, 93, 96, and 99+ year olds. Information was collected through social interviews, assessment of physical functioning, clinical examination (incl. geriatric, neurological and physical assessments) as well as cognitive assessment. At baseline, information regarding events prior to the study period was gathered. The follow-up interval is six years for the younger age cohorts, and three years for the older age cohorts (81+). During the follow-up intervals, medical events of all subjects are registered through linkage with primary care registry and hospital discharge registry (available for all subjects in Sweden). In case of death, hospital and cause of death registries provide the clinical information, and informant interviews are carried out. The same protocol as for the baseline data collection is used during the follow-up, though only concerning the follow-up period. Website of study: https://www.snac-k.se. Any outcomes based on the Swedish nationwide health registries (such as the myocardial infarction and stroke registries, the cause-of-death register and the national patient register) have been used.

**2) DCH, Danish Diet, Cancer and Health study, Denmark**

The primary aim of the DCH study is to investigate diet and lifestyle in relation to incidence of cancer and other chronic diseases (Tjønneland et al. 2007). The study combines the collection of questionnaire data with storing of biological specimen in order to investigate genetic susceptibility and gene-environment interactions with regard to diet, dietary compounds, and the risk of cancer, and indigenous markers of nutritional, metabolic, and hormonal characteristics of study participants. Historical residential history of the study participants is available, which facilitate studies of air pollution and noise. The study enrolled participants in two areas, Copenhagen and Aarhus, Denmark. 160,725 individuals aged 50−64 years were invited to participate between December 1993 and May 1997. All participants were Danish-born, living in the Copenhagen or Aarhus areas and without medical history of cancer diagnosis registered in the Danish Cancer Registry at the time of invitation. Out of the 160,725 people invited, which were a random sample of all eligible individuals in the specified areas, 57,053 were enrolled. On enrolment, each participant completed self-administered questionnaires (in Danish) that included questions on dietary habits, health status, family history of cancer, social factors, reproductive factors, smoking, environmental smoking, and lifestyle habits. Anthropometric measurements including blood pressure and blood samples were also obtained. The DCH cohort is followed up regularly by use of complete nationwide registers hence the loss to follow-up is virtually nil. Data on cancer incidence from the Danish Cancer Registry and data on cause-specific mortality from the Danish Mortality Registry were used.

**3) DNC, Danish Nurse Cohort study, Denmark**

The Danish Nurse Cohort was established in 1993 and includes a total of 28,731 female members of the Danish Nurse Organization who were 44 years of age or older at recruitment in 1993 or 1999 (Hundrup et al. 2012). Inspired by the American Nurses’ Health Study, the Danish Nurse Cohort aimed to provide the basis for research into the potential health effects related to use of hormone replacement therapy (HRT) in a European population. In 1993, the cohort was initiated by sending a questionnaire to 23,170 female members of the Danish Nurse Organization who were at least 44 years old at the time. The Danish Nurse Organization includes 95% of all nurses in Denmark. In total, 19,898 nurses accepted an invitation and answered a comprehensive questionnaire on lifestyle (smoking, alcohol consumption, leisure time physical activity, diet, BMI, etc.), occupational characteristics (shift work, work environment, etc.), health, reproductive factors, and other factors. The cohort was reinvestigated in 1999, adding 8,833 nurses (8,344 new nurses who turned 44 in the period 1993–1999 and 489 non-responders from the 1993 who were re-invited).

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**Table S1.** Overview of previous studies on air pollution and COPD incidence.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Authors, year** | **Cohort/Study** | **Sample Size (n)** | **COPD incidence definition** | **Adjusting for smoking** | **Pollutants (mean)** | **Effect Estimates** |
| Andersen et al, 2011 (Andersen et al. 2011) | The Danish Diet, Cancer and Health cohort, Denmark | 57,053 | Hospital contact (in-, outpatient, or emergency) primary discharge diagnoses ICD-10: J40–44 | Yes | NO2 (17.0 μg/m3) | HR (95% CI): 1.08 (1.02, 1.14) per 5.8 µg/m3 |
| Gan et al, 2013 (Gan et al. 2013) | A population-based cohort study, Vancouver, Canada | 467,994 | Hospitalization record the principal diagnosis, ICD-9: 490–492, 496; ICD-10: J40–J44 | No | PM2.5 (4.10 μg/m3)  NO2 (32.2 μg/m3)  BC (1.50 10-5m-1) | RR (95% CI):  1.02 (0.98, 1.06) per 1.58 µg/m3  1.00 (0.96, 1.05) per 8.40 µg/m3  1.06 (1.02, 1.09) per 0.97 10-5m-1 |
| Schikowski et al, 2014 (Schikowski et al. 2014) | The European Study of Cohorts for Air Pollution Effects (ESCAPE), four cohort studies, Europe | 6,550 for NO2;  3,692 for PM2.5 | 1) Lung function measurements: defined by NHANES reference equation (FEV1/FVC less than the lower limit of normal (LLN))  2) the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criterion (FEV1/FVC < 0.70) (analyze separately) | Yes | PM2.5 (range 9.52–17.76 μg/m3)  NO2 (range 22.39–28.95 μg/m3)  PM2.5(abs) (range 1.05–2.01 10-5m-1) | OR (95% CI):  LLN criterion:  1.06 (0.73, 1.53) per 5 µg/m3  1.05 (0.89, 1.23) per 10 µg/m3  1.06 (0.67, 1.67) per 1 10-5m-1  GOLD criteria:  0.73 (0.51, 1.03) per 5 µg/m3  0.99 (0.87, 1.14) per 10 µg/m3  0.71 (0.49, 1.02) per 1 10-5m-1 |
| Atkinson et al, 2015 (Atkinson et al. 2015) | A national English cohort, UK | 812,063 patients | 1) General practitioner (GP) records (Read codes diagnosis)  2) hospital admission records (ICD-10: J41–44) (analyze separately) | Yes | PM2.5 (12.9 μg/m3)  NO2 (22.5 μg/m3)  O3 (51.7 μg/m3) | HR (95% CI):  General practitioner  1.00 (0.94, 1.06) per 1.9 µg/m3  1.03 (0.96, 1.11) per 10.7 µg/m3  0.94 (0.89, 1.00) per 3.0 µg/m3  Hospital admission  1.05 (0.98, 1.13) per 1.9 µg/m3  1.06 (0.98, 1.15) per 10.7 µg/m3  0.96 (0.90, 1.02) per 3.0 µg/m3 |
| Carey et al, 2016 (Carey et al. 2016) | An adult cohort, London, UK | 211,016 | General practitioner (GP) records ((Read codes diagnosis)) or hospital admission records (ICD-10: J41–J44) | Yes | PM2.5 (road traffic sources only): (1.45 μg/m3)  NO2 (37.4 μg/m3) | HR (95% CI):  0.98 (0.81, 1.18) per 1 µg/m3  0.98 (0.82, 1.18) per 10 µg/m3 |
| Fisher et al, 2016 (Fisher et al. 2016) | The Nurses’ Health Study, USA | 121,701 female nurses | Self-reported physician-diagnosed COPD and subsequently reported COPD diagnostic tests | Yes | PM2.5 (14.2 μg/m3) | HR (95% CI):  0.93 (0.66, 1.31) per 10 μg/m3 |
| Weichenthal et al, 2017 (Weichenthal et al. 2017) | The Ontario Population Health and Environment Cohort (ONPHEC), Toronto, Canada | 1.1 million | Ontario COPD Database, hospital admissions and medication data): ICD-9: 491,492, 496 | No | PM2.5 (10.9 μg/m3)  NO2 (21.4 ppb)  UFPs (28,473 count/cm3) | HR (95% CI):  1.06 (1.04, 1.08) per 3.2 µg/m3  1.11 (1.07, 1.15) per 4.1 ppb  1.06 (1.04, 1.08) per 10,097 count/cm3 |
| Guo et al, 2018 (Guo et al. 2018) | The Taiwan MJ Health Management Institution cohort, Taiwan, China | 285,046 | Self-reported physician-diagnosed COPD or the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criterion (FEV1/FVC < 0.7) | Yes | PM2.5 (26.91 μg/m3) | HR (95% CI):  1.08 (1.04, 1.11) per 5 µg/m3 |
| Salimi et al, 2018 (Salimi et al. 2018) | The Sax Institute's 45 and Up Study, Sydney, Australia | 100,084 | Primary diagnosis of hospitalization ICD-10: J40-44 | Yes | PM2.5 (4.5 μg/m3)  NO2 (17.5 μg/m3) | HR (95% CI):  0.89 (0.79, 1.01) per 1 µg/m3  0.90 (0.82, 0.98) per 5 µg/m3 |
| Danesh Yazdi et al, 2019 (Danesh Yazdi et al. 2019) | The Medicare cohort, USA | 11,084,660 | Hospital admission with a primary or secondary discharge diagnosis ICD-9: 490–492, 494–496 | No | PM2.5 (NA)  O3 (NA) | HR (95% CI):  1.051 (1.05, 1.052) per 1 µg/m3  1.024 (1.023, 1.025) per 1 ppb |

PM2.5: particulate matters with aerodynamic diameters of less than 2.5 μm; NO2: nitrogen dioxide; BC: black carbon; O3: ozone; HR: hazard ratio; RR: relative risk; OR: odds ratio; CI: confidence interval; COPD: chronic obstructive pulmonary disease; FEV1: forced expiratory volume in 1 s; FVC: forced vital capacity.

NO2 1 ppb = 1.88 µg/m3; O3 1 ppb = 2.00 µg/m3.

\*: We illustrated the reference numbers in the manuscript.

**Table S2.** Characteristics of participants by cohorts and first-ever COPD hospitalization status at baseline.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Characteristic at baseline\*** | **All cohorts (N=98,508)** | | | **DCH (N=53,057)** | | | **DNC (N=25,080)** | | | | | |
| **1993 (N=16,973)** | | | **1999 (N=8,107)** | | |
| **Total** | **No COPD** | **COPD** | **Total** | **No COPD** | **COPD** | **Total** | **No COPD** | **COPD** | **Total** | **No COPD** | **COPD** |
| Baseline period | 1992−2004 | | | 1993−1997 | | | 1993 | | | 1999 | | |
| End of follow-up | 2011, 2015 | | | 2015 | | | 2015 | | | 2015 | | |
| Person-years at risk | 1,637,916 | 1,584,771 | 53,145 | 930,156 | 890,530 | 39,626 | 328,325 | 317,691 | 10,633 | 127,691 | 126,644 | 1,047 |
| Follow-up time, years (mean ± SD) | 16.6±4.7 | 16.9±4.9 | 10.8±5.8 | 17.5±4.7 | 18.0±4.2 | 10.8±5.7 | 19.3±5.6 | 19.7±5.3 | 12.2±6.1 | 15.8±2.4 | 15.8±2.3 | 9.5±4.4 |
| Number of observations | 98,508 | 93,580 | 4,928 | 53,057 | 49,381 | 3,676 | 16,973 | 16,101 | 872 | 8,107 | 7,997 | 110 |
| Age, years (mean ± SD) | 55.8±7.5 | 55.6±7.5 | 58.3±5.9 | 56.6±4.4 | 56.5±4.3 | 57.9±4.4 | 56.2±8.4 | 56.0±8.4 | 59.3±7.3 | 47.9±4.2 | 47.9±4.1 | 49.4±6.0 |
| **Age categories, n (%)** |  |  |  |  |  |  |  |  |  |  |  |  |
| < 65 years old | 91,529 (93) | 86,983 (93) | 4,546 (92) | 52,435 (99) | 48,822 (99) | 3,613 (98) | 14,360 (85) | 13,685 (85) | 675 (77) | 7,982 (98) | 7,877 (98) | 105 (95) |
| ≥ 65 years old | 6,979 (7) | 6,597 (7) | 382 (8) | 622 (1) | 559 (1) | 63 (2) | 2,613 (15) | 2,416 (15) | 197 (23) | 125 (2) | 120 (2) | 5 (5) |
| Female, n (%) | 64,689 (66) | 61,563 (66) | 3,126 (63) | 27,835 (52) | 25,852 (52) | 1,983 (54) | 16,973 (100) | 16,101 (100) | 872 (100) | 8,107 (100) | 7,997 (100) | 110 (100) |
| BMI, kg/m2 (mean ± SD) | 25.3±4.0 | 25.3±4.0 | 25.3±4.4 | 26.0±4.1 | 26.1±4.0 | 25.8±4.4 | 23.6±3.4 | 23.7±3.4 | 23.2±3.7 | 23.9±3.6 | 23.9±3.6 | 24.0±5.0 |
| **BMI, WHO categories, n (%)** |  |  |  |  |  |  |  |  |  |  |  |  |
| <18.5 | 1,281 (1) | 1,144 (1) | 137 (3) | 406 (1) | 335 (1) | 71 (2) | 488 (3) | 438 (3) | 50 (6) | 140 (2) | 135 (2) | 5 (5) |
| 18.5−24.9 | 50,004 (51) | 47,549 (51) | 2,455 (50) | 22,939 (43) | 21,288 (43) | 1,651 (45) | 11,714 (69) | 11,109 (69) | 605 (69) | 5,532 (68) | 5,465 (68) | 67 (61) |
| 25.0−29.9 | 35,672 (36) | 33,983 (36) | 1,689 (34) | 22,051 (42) | 20,657 (42) | 1,394 (38) | 3,892 (23) | 3,720 (23) | 172 (20) | 1,895 (23) | 1,866 (23) | 29 (26) |
| ≥30.0 | 11,551 (12) | 10,904 (12) | 647 (13) | 7,661 (14) | 7,101 (14) | 560 (15) | 879 (5) | 834 (5) | 45 (5) | 540 (7) | 531 (7) | 9 (8) |
| **Smoking status, n (%)** |  |  |  |  |  |  |  |  |  |  |  |  |
| Current smoker | 32,295 (33) | 28,683 (31) | 3,612 (73) | 19,112 (36) | 16,319 (33) | 2,793 (76) | 6,351 (37) | 5,737 (36) | 181 (21) | 2,320 (29) | 2,246 (28) | 74 (67) |
| Previous smoker | 29,642 (30) | 28,724 (31) | 918 (19) | 14,805 (28) | 14,188 (29) | 617 (17) | 4,845 (28) | 4,664 (29) | 614 (70) | 2,636 (33) | 2,612 (33) | 24 (22) |
| Never smoker | 36,571 (37) | 36,173 (39) | 398 (8) | 19,140 (36) | 18,874 (38) | 266 (7) | 5,777 (34) | 5,700 (35) | 77 (9) | 3,151 (39) | 3,139 (39) | 12 (11) |
| Smoking duration, years (mean ± SD) | 17.0±16.5 | 16.2±16.2 | 33.2±13.3 | 19.0±17.1 | 17.9±16.9 | 34.3±12.6 | 16.4±15.8 | 15.7±15.5 | 30.3±13.9 | 12.5±12.7 | 12.3±12.6 | 24.3±12.5 |
| Smoking intensity, n/day (mean ± SD) | 9.2±10.4 | 8.8±10.2 | 16.2±10.5 | 10.4±11.2 | 9.9±11.1 | 16.8±10.6 | 8.4±9.3 | 8.0±9.2 | 14.5±9.3 | 7.5±8.4 | 7.4±8.3 | 15.9±11.2 |
| **Marital status, n (%)** |  |  |  |  |  |  |  |  |  |  |  |  |
| Single | 8,482 (9) | 8,086 (9) | 396 (8) | 3,213 (6) | 3,003 (6) | 210 (6) | 1,787 (11) | 1,673 (10) | 114 (13) | 757 (9) | 743 (9) | 14 (13) |
| Married or living with partner | 70,287 (71) | 67,264 (72) | 3,023 (61) | 38,022 (72) | 35,702 (72) | 2,320 (63) | 11,495 (68) | 1,0991 (68) | 504 (58) | 6,146 (76) | 6,078 (76) | 68 (62) |
| Divorced/Separated | 13,764 (14) | 12,700 (14) | 1,064 (22) | 8,903 (17) | 8,030 (16) | 873 (24) | 2,103 (12) | 1,976 (12) | 127 (15) | 1,041 (13) | 1,016 (13) | 25 (23) |
| Widowed | 5,975 (6) | 5,530 (6) | 445 (9) | 2,919 (6) | 2,646 (5) | 273 (7) | 1,588 (9) | 1,461 (9) | 127 (15) | 163 (2) | 160 (2) | 3 (3) |
| **Employment status, n (%)** |  |  |  |  |  |  |  |  |  |  |  |  |
| Employed | 75,323 (76) | 72,202 (77) | 3,121 (63) | 41,628 (78) | 39,180 (79) | 2,448 (67) | 11,907 (70) | 11,434 (71) | 473 (54) | 7,687 (95) | 7,594 (95) | 93 (85) |
| Others | 23,185 (24) | 21,378 (23) | 1,807 (37) | 11,429 (22) | 10,201 (21) | 1,228 (33) | 5,066 (30) | 4,667 (29) | 399 (46) | 420 (5) | 403 (5) | 17 (15) |
| **Educational levels, n (%)\*** |  |  |  |  |  |  |  |  |  |  |  |  |
| Low level | 14,085 (14) | 13,088 (14) | 997 (20) | 7,806 (15) | 6,934 (14) | 872 (24) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Medium level | 40,988 (42) | 38,707 (41) | 2,281 (46) | 33,486 (63) | 31,292 (63) | 2,194 (60) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| High level | 43,435 (44) | 41,785 (45) | 1,650 (33) | 11,765 (22) | 11,155 (23) | 610 (17) | 16,973 (100) | 16,101 (100) | 872 (100) | 8,107 (100) | 7,997 (100) | 110 (100) |
| Asthma, n (%)# | 667 (1) | 487 (1) | 180 (4) | 461 (1) | 317 (1) | 144 (4) | 96 (1) | 66 (0.4) | 30 (3) | 80 (1) | 75 (1) | 5 (5) |
| Mean year income, €φ | 20990.9 | 21046.1 | 19942.2 | 20203.9 | 20236.9 | 19760.0 | 19227.6 | 19218.8 | 19389.5 | 18980.6 | 18979.8 | 19038.1 |

**Continue Table S2.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Characteristic at baseline\*** | **CEANS (N=20,371)** | | | | | | | | | | | |
| **SDPP (N=7,520)** | | | **SIXTY (N=3,928)** | | | **SALT (N=6,124)** | | | **SNAC-K (N=2,799)** | | |
| **Total** | **No COPD** | **COPD** | **Total** | **No COPD** | **COPD** | **Total** | **No COPD** | **COPD** | **Total** | **No COPD** | **COPD** |
| Baseline period | 1992−1998 | | | 1997−1999 | | | 1998−2002 | | | 2001−2004 | | |
| End of follow-up | 2011 | | | 2011 | | | 2011 | | | 2011 | | |
| Person-years at risk | 118,408 | 117,957 | 451 | 50,007 | 49,527 | 480 | 62,841 | 62,231 | 610 | 20,487 | 20,190 | 296 |
| Follow-up time, years (mean ± SD) | 15.7±2.6 | 15.8±2.5 | 10.5±3.9 | 12.7±2.6 | 12.8±2.5 | 7.5±3.8 | 10.3±2.5 | 10.3±2.4 | 6.1±3.6 | 7.3±2.9 | 7.4±2.8 | 2.7±4.7 |
| Number of observations | 7,520 | 7,477 | 43 | 3,928 | 3,864 | 64 | 6,124 | 6,024 | 100 | 2,799 | 2,736 | 63 |
| Age, years (mean ± SD) | 47.1±4.9 | 47.0±4.9 | 50.3±3.5 | 60.0±0 | 60.0±0 | 60.0±0 | 57.8±10.6 | 57.6±10.5 | 67.0±10.4 | 72.8±10.4 | 72.8±10.4 | 74.1±8.6 |
| **Age categories, n (%)** |  |  |  |  |  |  |  |  |  |  |  |  |
| < 65 years old | 7,520 (100) | 7,477 (100) | 43 (100) | 3,928 (100) | 3,864 (100) | 64 (100) | 4,623 (75) | 4,585 (76) | 38 (38) | 681 (24) | 673 (25) | 8 (13) |
| ≥ 65 years old | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1,501 (25) | 1,439 (24) | 62 (62) | 2,118 (76) | 2,063 (75) | 55 (87) |
| Female, n (%) | 4,590 (61) | 4,563 (61) | 27 (63) | 2,047 (52) | 2,011 (52) | 36 (56) | 3,390 (55) | 3,331 (55) | 59 (59) | 1,747 (62) | 1,708 (62) | 39 (62) |
| BMI, kg/m2 (mean ± SD) | 25.7±4.0 | 25.7±4.0 | 25.1±4.6 | 26.8±4.2 | 26.8±4.2 | 25.9±4.8 | 24.6±3.4 | 24.6±3.4 | 23.9±4.2 | 25.6±4.3 | 25.6±4.3 | 25.7±3.1 |
| **BMI, WHO categories, n (%)** |  |  |  |  |  |  |  |  |  |  |  |  |
| <18.5 | 51 (1) | 47 (1) | 4 (9) | 26 (1) | 23 (1) | 3 (5) | 93 (2) | 90 (1) | 3 (3) | 77 (3) | 76 (3) | 1 (2) |
| 18.5−24.9 | 3,596 (48) | 3,581 (48) | 15 (35) | 1,392 (35) | 1,364 (35) | 28 (44) | 3,595 (59) | 3,532 (59) | 63 (63) | 1,236 (44) | 1,210 (44) | 26 (41) |
| 25.0−29.9 | 2,927 (39) | 2,908 (39) | 19 (44) | 1,750 (45) | 1,730 (45) | 20 (31) | 2,036 (33) | 2,012 (33) | 24 (24) | 1,121 (40) | 1,090 (40) | 31 (49) |
| ≥30.0 | 946 (13) | 941 (13) | 5 (12) | 760 (19) | 747 (19) | 13 (20) | 400 (7) | 390 (6) | 10 (10) | 365 (13) | 360 (13) | 5 (8) |
| **Smoking status, n (%)** |  |  |  |  |  |  |  |  |  |  |  |  |
| Current smoker | 1,982 (26) | 1,950 (26) | 32 (74) | 832 (21) | 791 (20) | 41 (64) | 1,297 (21) | 1,246 (21) | 51 (51) | 401 (14) | 394 (14) | 7 (11) |
| Previous smoker | 2,737 (36) | 2,727 (36) | 10 (23) | 1,513 (39) | 1,494 (39) | 19 (30) | 2,038 (33) | 1,997 (33) | 41 (41) | 1,068 (38) | 1,042 (38) | 26 (41) |
| Never smoker | 2,801 (37) | 2,800 (37) | 1 (2) | 1,583 (40) | 1,579 (41) | 4 (6) | 2,789 (46) | 2,781 (46) | 8 (8) | 1,330 (48) | 1,300 (48) | 30 (48) |
| Smoking duration, years (mean ± SD) | 12.7±13.0 | 12.6±12.9 | 30.9±12.4 | 15.5±16.3 | 15.2±16.2 | 33.2±13.4 | 14.7±17.0 | 14.3±116.7 | 38.1±16.9 | 15.6±19.2 | 15.6±19.2 | 16.8±19.8 |
| Smoking intensity, n/day (mean ± SD) | 8.5±8.8 | 8.5±8.8 | 17.4±7.8 | 8.0±9.2 | 7.9±9.2 | 14.8±8.8 | 7.5±9.9 | 7.4±9.8 | 16.5±12.3 | 4.0 ±6.1 | 4.0±6.1 | 4.2±6.2 |
| **Marital status, n (%)** |  |  |  |  |  |  |  |  |  |  |  |  |
| Single | 1,234 (16) | 1,217 (16) | 17 (40) | 181 (5) | 177 (5) | 4 (6) | 855 (14) | 837 (14) | 18 (18) | 455 (16) | 436 (16) | 19 (30) |
| Married or living with partner | 6,286 (84) | 6,260 (84) | 26 (60) | 2,905 (74) | 2,866 (74) | 39 (61) | 4,148 (68) | 4,104 (68) | 44 (44) | 1,285 (46) | 1,263 (46) | 22 (35) |
| Divorced/Separated | 0 (0) | 0 (0) | 0 (0) | 641 (16) | 623 (16) | 18 (28) | 688 (11) | 671 (11) | 17 (17) | 388 (14) | 384 (14) | 4 (6) |
| Widowed | 0 (0) | 0 (0) | 0 (0) | 201 (5) | 198 (5) | 3 (5) | 433 (7) | 412 (7) | 21 (21) | 671 (24) | 653 (24) | 18 (29) |
| **Employment status, n (%)** |  |  |  |  |  |  |  |  |  |  |  |  |
| Employed | 6,826 (91) | 6,785 (91) | 41 (95) | 2,669 (68) | 2,635 (68) | 34 (53) | 3,955 (65) | 3,934 (65) | 21 (21) | 651 (23) | 640 (23) | 11 (17) |
| Others | 694 (9) | 692 (9) | 2 (5) | 1,259 (32) | 1,229 (32) | 30 (47) | 2,169 (35) | 2,090 (35) | 79 (79) | 2,148 (77) | 2,096 (77) | 52 (83) |
| **Educational levels, n (%)\*** |  |  |  |  |  |  |  |  |  |  |  |  |
| Low level | 2,370 (32) | 2,348 (31) | 22 (51) | 1,570 (40) | 1,539 (40) | 31 (48) | 1,631 (27) | 1,577 (26) | 54 (54) | 708 (25) | 690 (25) | 18 (29) |
| Medium level | 2,889 (38) | 2,875 (38) | 14 (33) | 1,264 (32) | 1,240 (32) | 24 (38) | 2,229 (36) | 2,201 (37) | 28 (28) | 1,120 (40) | 1,099 (40) | 21 (33) |
| High level | 2,261 (30) | 2,254 (30) | 7 (16) | 1,094 (28) | 1,085 (28) | 9 (14) | 2,264 (37) | 2,246 (37) | 18 (18) | 971 (35) | 947 (35) | 24 (38) |
| Asthma, n (%)# | 0 (0) | 0 (0) | 0 (0) | 1 (0.03) | 1 (0.03) | 0 (0) | 13 (0.2) | 13 (0.2) | 0 (0) | 16 (1) | 15 (1) | 1 (2) |
| Mean year income, €φ | 24,340.7 | 24,353.9 | 22031.0 | 24,758.8 | 24,776.3 | 23,704.9 | 25,321.1 | 25,348.6 | 23,664.5 | 28,662.4 | 28,662.8 | 28,645.0 |

\*: Low educational level means primary school or less; Medium educational level means up to secondary school or equivalent; High educational level means university degree and more.

#: This character “Asthma” means the prevalence of Asthma among participants at baseline.

φ: Mean year income is a continuous variable in euros, which is at municipality-level in 2001 for DCH and DNC and at neighborhood level in 1994 for CEANS.

BMI: body mass index; SD: standard deviation; WHO: world health organization; COPD: chronic obstructive pulmonary disease.

**Table S3.** Description of air pollutants by cohort and first-ever COPD hospitalization status for the year 2010.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pollutants** | **Cohorts** | **Number of observations** | **Total** | | |  | **No COPD** | | |  | **COPD** | | |
| **Mean ± SD** | **Range** | **IQR** |  | **Mean ± SD** | **Range** | **IQR** |  | **Mean ± SD** | **Range** | **IQR** |
| **PM2.5, µg/m3** |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | All | 98,508 | 12.12±2.48 | 3.24−19.49 | 2.48 |  | 12.07±2.50 | 3.24−19.49 | 2.60 |  | 13.04±1.86 | 4.00−19.49 | 1.91 |
|  | SDPP | 7,520 | 7.63±0.92 | 3.79−10.96 | 0.75 |  | 7.63±0.92 | 3.79−10.96 | 0.75 |  | 7.48±0.92 | 4.00−9.70 | 0.76 |
| **CEANS** | SIXTY | 3,928 | 8.31±0.92 | 3.24−11.01 | 0.88 |  | 8.30±0.92 | 3.24−11.01 | 0.88 |  | 8.39±0.66 | 6.96−9.67 | 1.00 |
|  | SALT | 6,124 | 8.38±0.84 | 3.47−11.37 | 0.88 |  | 8.38±0.84 | 3.47−11.37 | 0.88 |  | 8.56±0.84 | 4.85−9.91 | 0.65 |
|  | SNAC-K | 2,799 | 8.56±0.84 | 5.16−11.37 | 0.59 |  | 8.56±0.84 | 5.16−11.37 | 0.61 |  | 8.43±0.86 | 5.53−9.74 | 0.65 |
| **DCH** | DCH | 53,057 | 13.20±1.43 | 7.29−19.49 | 1.58 |  | 13.18±1.43 | 7.29−19.49 | 1.56 |  | 13.42±1.47 | 8.15−19.49 | 1.97 |
| **DNC** | 1993 | 16,973 | 12.74±1.54 | 6.48−19.14 | 1.87 |  | 12.74±1.54 | 6.48−19.14 | 1.86 |  | 12.78±1.53 | 7.95−17.15 | 1.91 |
|  | 1999 | 8,107 | 13.80±1.51 | 6.89−19.49 | 2.34 |  | 13.80±1.51 | 6.89−19.49 | 2.34 |  | 13.70±1.60 | 10.34−16.88 | 2.61 |
| **NO2, µg/m3** |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | All | 98,508 | 25.11±7.97 | 2.68−72.23 | 11.88 |  | 24.98±7.97 | 2.68−72.23 | 11.86 |  | 27.53±7.51 | 3.59−61.47 | 11.30 |
|  | SDPP | 7,520 | 15.47±4.29 | 2.96−37.09 | 5.39 |  | 15.47±4.29 | 2.96−37.09 | 5.40 |  | 14.91±3.64 | 4.24−26.41 | 3.89 |
| **CEANS** | SIXTY | 3,928 | 20.67±6.14 | 2.68−47.88 | 7.01 |  | 20.66±6.16 | 2.68−47.88 | 7.01 |  | 21.22±5.18 | 10.90−33.92 | 6.87 |
|  | SALT | 6,124 | 21.29±6.18 | 2.98−50.32 | 7.34 |  | 21.26±6.18 | 2.98−50.32 | 7.29 |  | 22.72±5.93 | 3.59−35.74 | 5.92 |
|  | SNAC-K | 2,799 | 27.39±5.10 | 11.62−42.61 | 7.38 |  | 27.41±5.11 | 11.62−42.61 | 7.38 |  | 26.61±4.66 | 16.44−35.56 | 6.60 |
| **DCH** | DCH | 53,057 | 25.11±7.97 | 2.68−72.23 | 11.88 |  | 24.98±7.97 | 2.68−72.23 | 11.86 |  | 27.53±7.51 | 3.59−61.47 | 11.30 |
| **DNC** | 1993 | 16,973 | 21.90±8.01 | 4.54−72.23 | 10.53 |  | 21.85±7.99 | 4.54−72.23 | 10.47 |  | 22.87±8.20 | 7.05−47.52 | 12.01 |
|  | 1999 | 8,107 | 25.84±8.47 | 6.42−54.26 | 13.78 |  | 25.85±8.47 | 6.42−54.26 | 13.79 |  | 25.22±8.28 | 8.96−47.02 | 13.55 |
| **BC, 10-5m-1** |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | All | 98,508 | 1.17±0.41 | 0.11−3.66 | 0.64 |  | 1.17±0.41 | 0.11−3.66 | 0.64 |  | 1.32±0.38 | 0.22−3.13 | 0.54 |
|  | SDPP | 7,520 | 0.56±0.19 | 0.14−1.39 | 0.30 |  | 0.56±0.19 | 0.14−1.39 | 0.30 |  | 0.55±0.17 | 0.26−0.89 | 0.31 |
| **CEANS** | SIXTY | 3,928 | 0.80±0.25 | 0.11−2.10 | 0.32 |  | 0.80±0.25 | 0.11−2.10 | 0.32 |  | 0.82±0.21 | 0.35−1.29 | 0.30 |
|  | SALT | 6,124 | 0.83±0.25 | 0.16−2.43 | 0.31 |  | 0.83±0.25 | 0.16−2.43 | 0.32 |  | 0.88±0.24 | 0.22−1.51 | 0.29 |
|  | SNAC-K | 2,799 | 1.08±0.15 | 0.43−1.74 | 0.15 |  | 1.08±0.15 | 0.43−1.74 | 0.15 |  | 1.06±0.13 | 0.85−1.44 | 0.15 |
| **DCH** | DCH | 53,057 | 1.34±0.35 | 0.35−3.66 | 0.48 |  | 1.34±0.35 | 0.35−3.66 | 0.49 |  | 1.40±0.34 | 0.54−3.13 | 0.46 |
| **DNC** | 1993 | 16,973 | 1.09±0.37 | 0.13−3.66 | 0.52 |  | 1.09±0.37 | 0.13−3.66 | 0.52 |  | 1.13±0.38 | 0.28−2.30 | 0.56 |
|  | 1999 | 8,107 | 1.30±0.38 | 0.36−2.74 | 0.55 |  | 1.30±0.38 | 0.36−2.74 | 0.55 |  | 1.23±0.39 | 0.53−2.36 | 0.62 |
| **O3, µg/m3** |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | All | 98,508 | 78.13±4.62 | 50.96−91.87 | 6.00 |  | 78.17±4.59 | 50.96−91.87 | 5.95 |  | 77.41±5.07 | 55.20−89.75 | 7.21 |
|  | SDPP | 7,520 | 77.55±1.92 | 68.37−85.01 | 2.59 |  | 77.55±1.93 | 68.37−85.01 | 2.59 |  | 77.85±1.69 | 72.83−80.42 | 2.23 |
| **CEANS** | SIXTY | 3,928 | 76.70±2.52 | 63.15−83.79 | 2.88 |  | 76.70±2.52 | 63.15−83.79 | 2.90 |  | 76.53±2.26 | 71.95−82.36 | 2.81 |
|  | SALT | 6,124 | 76.57±2.72 | 57.17−84.87 | 2.87 |  | 76.57±2.72 | 57.17−84.87 | 2.86 |  | 76.25±2.78 | 69.32−83.46 | 3.07 |
|  | SNAC-K | 2,799 | 75.10±2.67 | 58.63−82.50 | 2.91 |  | 75.10±2.68 | 58.63−82.50 | 2.91 |  | 75.34±2.15 | 69.07−78.26 | 2.95 |
| **DCH** | DCH | 53,057 | 77.55±5.10 | 50.96−87.79 | 7.15 |  | 77.60±5.09 | 50.96−87.79 | 7.11 |  | 76.80±5.18 | 55.20−85.99 | 7.85 |
| **DNC** | 1993 | 16,973 | 80.41±4.00 | 50.96−91.87 | 3.96 |  | 80.44±3.99 | 50.96−91.87 | 3.94 |  | 79.89±4.26 | 61.87−89.75 | 4.19 |
|  | 1999 | 8,107 | 80.61±3.84 | 57.02−91.83 | 3.88 |  | 80.61±3.84 | 57.02−91.83 | 3.86 |  | 80.73±4.48 | 62.61−86.99 | 4.66 |

PM2.5: particulate matters with aerodynamic diameters of less than 2.5 μm; NO2: nitrogen dioxide; BC: black carbon; O3: ozone.

The annual average concentrations of PM2.5, NO2, BC, and O3 were estimated for the year 2010 at 100 m resolution. O3 was estimated during the warm season from April 1 through September 30.

**Figure S1.** The temporal variations of annual mean air pollution concentrations back-extrapolated using the ratio (left) and the absolute difference (right) method during follow-up periods (1992-2011 for CEANS and 1993-2015 for DCH) in 71,389 participants of CEANS (N=19,304) and DCH (N=52,085) cohorts**.**

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**Table S4.** Pearson correlations between air pollutants by cohorts for the year 2010 at 100 m resolution.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Cohorts** | **Number of observations** | **Pollutants** | **PM2.5** | **NO2** | **BC** | **O3** |
| **All** | 98,508 |  |  |  |  |  |
|  |  | PM2.5 | 1.00 |  |  |  |
|  |  | NO2 | 0.63 | 1.00 |  |  |
|  |  | BC | 0.74 | 0.91 | 1.00 |  |
|  |  | O3 | -0.13 | -0.48 | -0.37 | 1.00 |
| **CEANS- SDPP** | 7,520 |  |  |  |  |  |
|  |  | PM2.5 | 1.00 |  |  |  |
|  |  | NO2 | 0.60 | 1.00 |  |  |
|  |  | BC | 0.49 | 0.67 | 1.00 |  |
|  |  | O3 | -0.18 | -0.70 | -0.33 | 1.00 |
| **CEANS-** **SIXTY** | 3,928 |  |  |  |  |  |
|  |  | PM2.5 | 1.00 |  |  |  |
|  |  | NO2 | 0.69 | 1.00 |  |  |
|  |  | BC | 0.59 | 0.84 | 1.00 |  |
|  |  | O3 | -0.45 | -0.71 | -0.71 | 1.00 |
| **CEANS-** **SALT** | 6,124 |  |  |  |  |  |
|  |  | PM2.5 | 1.00 |  |  |  |
|  |  | NO2 | 0.67 | 1.00 |  |  |
|  |  | BC | 0.55 | 0.84 | 1.00 |  |
|  |  | O3 | -0.47 | -0.74 | -0.76 | 1.00 |
| **CEANS-** **SNAC-K** | 2,799 |  |  |  |  |  |
|  |  | PM2.5 | 1.00 |  |  |  |
|  |  | NO2 | 0.75 | 1.00 |  |  |
|  |  | BC | 0.29 | 0.43 | 1.00 |  |
|  |  | O3 | -0.49 | -0.66 | -0.75 | 1.00 |
| **DCH** | 53,057 |  |  |  |  |  |
|  |  | PM2.5 | 1.00 |  |  |  |
|  |  | NO2 | 0.72 | 1.00 |  |  |
|  |  | BC | 0.70 | 0.93 | 1.00 |  |
|  |  | O3 | -0.25 | -0.34 | -0.34 | 1.00 |
| **DNC-1993** | 16,973 |  |  |  |  |  |
|  |  | PM2.5 | 1.00 |  |  |  |
|  |  | NO2 | 0.64 | 1.00 |  |  |
|  |  | BC | 0.69 | 0.92 | 1.00 |  |
|  |  | O3 | -0.32 | -0.42 | -0.42 | 1.00 |
| **DNC-1999** | 8,107 |  |  |  |  |  |
|  |  | PM2.5 | 1.00 |  |  |  |
|  |  | NO2 | 0.61 | 1.00 |  |  |
|  |  | BC | 0.64 | 0.93 | 1.00 |  |
|  |  | O3 | -0.16 | -0.21 | -0.20 | 1.00 |

**Table S5.** Back-extrapolated air pollution exposure at baseline and COPD incidence.

|  |  |  |  |
| --- | --- | --- | --- |
| **Pollutants** | **Main model 3** | **Baseline exposure analyses** | |
| **(N=98,508)** | **Ratio method** | **Difference method** |
| **PM2.5** | 1.17 (1.06, 1.29) | 1.03 (0.98, 1.08) | 1.00 (0.94, 1.06) |
| **NO2** | 1.11 (1.06, 1.16) | 1.07 (1.04, 1.11) | 1.11 (1.06, 1.15) |
| **BC** | 1.11 (1.06, 1.15) | 1.08 (1.04, 1.12) | 1.11 (1.06, 1.15) |
| **O3** | 0.99 (0.93, 1.05) | 1.03 (0.97, 1.09) | 1.03 (0.97, 1.09) |

Results are presented as hazard ratio and 95% confidence interval [HR (95%CI)] for the following increments: 5 µg/m3 for PM2.5, 10 µg/m3 for NO2, 0.5 10-5 m-1 for BC and 10 µg/m3 for O3.

**Figure S2.** Results for Sensitivity Analysis by time-varying exposure analyses among two cohorts with available information (CEANS and DCH, N=71,389) based on Model 3.

****

Results are presented as hazard ratio and 95% confidence interval [HR (95%CI)] for the following increments: 5 µg/m3 for PM2.5, 10 µg/m3 for NO2, 0.5 10-5 m-1 for BC, and 10 µg/m3 for O3.

Three different exposure types were applied: Exposure\_2010: exposure in 2010; TV\_ratio: time-varying exposure analysis with a ratio method; TV\_ratio: time-varying exposure analysis with an absolute difference method.

Four different exposure types were applied: Model 3 all: using model 3 with all cohort participants; Model 3 TV ID only: using model 3 with time-varying exposure analysis available two cohort participants; TV\_strata\_1year: time-varying exposure analysis with 1-year strata for the calendar time; TV\_strata\_5year: time-varying exposure analysis with 5-year strata for the calendar time;

**Table S6.** Results for Sensitivity Analysis by time-varying exposure analyses among two cohorts with available information (only CEANS and DCH, N=71,389) based on Model 3.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Pollutants** | **Main model 3** | **Time-varying analyses** | | | |
| Reduced dataset (N=71,389) | Strata by per year of follow-up time | | Strata by 5-years of follow-up time | |
| Ratio method | Difference method | Ratio method | Difference method |
| **PM2.5** | 1.19 (1.07, 1.34) | 1.13 (1.04, 1.24) | 1.20 (1.08, 1.34) | 1.10 (1.03, 1.18) | 1.12 (1.04, 1.20) |
| **NO2** | 1.11 (1.05, 1.16) | 1.09 (1.05, 1.14) | 1.11 (1.06, 1.16) | 1.09 (1.05, 1.14) | 1.11 (1.06, 1.16) |
| **BC** | 1.11 (1.05, 1.16) | 1.13 (1.08, 1.19) | 1.13 (1.08, 1.18) | 1.13 (1.07, 1.18) | 1.13 (1.08, 1.18) |
| **O3** | 1.01 (0.94, 1.08) | 0.99 (0.96, 1.02) | 0.99 (0.96, 1.02) | 0.99 (0.96, 1.02) | 0.99 (0.96, 1.02) |

Results are presented as hazard ratio and 95% confidence interval [HR (95%CI)] for the following increments: 5 µg/m3 for PM2.5, 10 µg/m3 for NO2, 0.5 10-5 m-1 for BC, and 10 µg/m3 for O3.

**Table S7.** Results for Sensitivity Analysis by restricting participants to different cohorts based on Model 3.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Cohorts** | **Number of observations** | **HR (95%CI)** | | | |
| **PM2.5** | **NO2** | **BC** | **O3** |
| **All cohorts** | 98,508 | 1.17 (1.06, 1.29) | 1.11 (1.06, 1.16) | 1.11 (1.06, 1.15) | 0.99 (0.93, 1.05) |
| **Exclude CEANS** | 78,137 | 1.17 (1.06, 1.29) | 1.11 (1.07, 1.16) | 1.11 (1.06, 1.16) | 0.99 (0.93, 1.05) |
| **Exclude DCH** | 45,451 | 1.08 (0.89, 1.32) | 1.12 (1.04, 1.21) | 1.11 (1.02, 1.21) | 0.94 (0.82, 1.09) |
| **Exclude DNC** | 73,428 | 1.20 (1.07, 1.34) | 1.11 (1.05, 1.16) | 1.11 (1.06, 1.16) | 1.01 (0.94, 1.08) |
| **Only CEANS** | 20,371 | 1.13 (0.57, 2.25) | 1.01 (0.81, 1.25) | 1.05 (0.80, 1.37) | 1.08 (0.67, 1.74) |
| **Only DCH** | 53,057 | 1.20 (1.06, 1.34) | 1.11 (1.06, 1.17) | 1.11 (1.06, 1.17) | 1.01 (0.94, 1.09) |
| **Only DNC** | 25,080 | 1.11 (0.90, 1.37) | 1.13 (1.04, 1.23) | 1.12 (1.03, 1.22) | 0.91 (0.78, 1.05) |

Results are presented as hazard ratio and 95% confidence interval [HR (95%CI)] for the following increments: 5 µg/m3 for PM2.5, 10 µg/m3 for NO2, 0.5 10-5 m-1 for BC and 10 µg/m3 for O3.

**Figure S3.** Effect modification on the association of long-term air pollution exposure with first-ever COPD hospitalization by baseline characters.



Results are presented as hazard ratio and 95% confidence interval [HR (95%CI)] for the following increments: 5 µg/m3 for PM2.5, 10 µg/m3 for NO2, 0.5 10-5 m-1 for BC and 10 µg/m3 for O3.

Effect modification analyses were conducted based on Model 3 and evaluated by introducing interaction terms. P values for whether there were statistical differences between strata were tested by the Wald test. Red long dash lines indicate the HRs equal to 1 and green long dash lines indicate the estimated HRs for all participants based on Model 3.

#: Low educational level means primary school or less; Medium educational level means up to secondary school or equivalent; High educational level means university degree and more.

\*: A statistically significant P value (at 5% level) for effect modification analyses.