**Long-term exposure to traffic-related air pollution is associated with impaired odor identification: Results from the population-based KORA FIT study in Augsburg, Germany**

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Supplemental methods M1. Details on the measurement campaign (from Wolf et al., 2017)

The air pollutants were measured at 20 sites during 03/2014 - 04/2015, 12 of them located in the city of Augsburg and 8 in the two adjacent districts. The locations’ selection aimed to capture spatial variations in air pollution at KORA participants' residences and included urban traffic (n = 6), urban background (n = 5), regional traffic (n = 4), regional background (n = 4) sites, as well as one industrial site. To improve the model predictions in the lower concentration range, one regional background site was placed in the countryside. For each site, measurements were conducted 3 times for 14 days, in different seasons (warm, cold, and intermediate seasons). Due to a limited amount of measurement equipment, it was not feasible to measure at all 20 sites simultaneously. Four sites were measured simultaneously for two weeks, until moving to the next four sites. Thus, it took ten weeks to complete one measurement round for one season (5 x 2 weeks = 10 weeks). If a measurement at one of the sites failed, the measurement was repeated in an additional round for all components, to ensure that three valid measurements without missing data were available for each site. Overall, four measurements were repeated. Consequently, imputation was not needed. In addition, one urban background site served as a continuous reference site to adjust the discontinuous site measurements to the annual average, following the design of previous LUR studies (Hoek et al., 2008). The 14-day average measurements at the reference site continued between and after all measurement rounds for the entire period of the measurement campaign. At the 20 monitoring sites, PNC was measured using GRIMM UFP counters (model EDM 465 UFPC, GRIMM aerosol, Ainring, Germany) and a NanoScan SMPS Nanoparticle Sizer (model 3910, TSI, Shoreview, MN, USA) until 21/08/2014, when it was replaced by a fourth GRIMM UFP counter. At the reference site, a Twin Differential Mobility Particle Spectrometry (TDMPS, size range 3 to 800 nm) and an aerodynamic particle sizer (APS, Model 3321, TSI Inc., U.S., size range 0.8 to 10 μm) measured PNC across a size range of 3 to 10 μm (more details can be found in Pitz et al. (2008)). Instrument comparisons showed high agreement (R² = 0.97 - 0.98, Pearson r = 0.99), with device differences below 5%, except for one GRIMM counter requiring corrections. O3 and NOx were measured using Ogawa passive samplers (Ogawa & Co., USA Inc.), while PM10 and PM2.5 were collected with Harvard Impactors, and PMcoarse was derived from their difference. Reflectance of PM filters was converted to absorbance. Due to a high correlation between PM10abs and PM2.5abs (r = 0.98), the LUR model focused on PM2.5abs. To adjust for temporal variability, site measurements were corrected based on deviations from the reference site's average concentration for each period and its annual mean. PNC adjustments were performed daily due to its higher variability. All pollutants’ exposures were temporally adjusted and representative for the long-term average concentrations.

Wolf K, Cyrys J, Harciníková T, Gu J, Kusch T, Hampel R, Schneider A, Peters A. 2017. Land use regression modeling of ultrafine particles, ozone, nitrogen oxides and markers of particulate matter pollution in Augsburg, Germany. Science of the Total Environment 579 1531-1540. doi: doi: <https://doi.org/10.1016/j.scitotenv.2016.11.160>

Hoek G, Beelen R, De Hoogh K, Vienneau, D, Gulliver J, Fischer P, Briggs D. 2008. A review of land-use regression models to assess spatial variation of outdoor air pollution. Atmospheric environment 42 (33) 7561-7578. doi: <https://doi.org/10.1016/j.atmosenv.2008.05.057>

Pitz M, Birmili W, Schmid O, Peters A, Wichmann HE, Cyrys J. 2008. Quality control and quality assurance for particle size distribution measurements at an urban monitoring station in Augsburg, Germany. Journal of Environmental Monitoring 10 (9) 1017-1024. doi: <https://doi.org/10.1039/B807264G>

Supplemental methods M2. Details for greenness index and air temperature data

The greenness index derived from the median NDVI value within 1 km buffers around participants’ residences. NDVI was extracted and calculated for the year 2018 as the median from cloud-free (< 1% cloud coverage) Landsat 8 (30 m resolution) and Sentinel-2 (10 m resolution) satellite images taken between April and October. Using the formula NDVI = (NIR - RED)/(NIR + RED), the calculation is based on atmospherically corrected reflectance in the near-infrared (NIR) and visible red (RED) spectrums. Pixels with values below 0 were excluded before the assignment. A comprehensive explanation of the NDVI assessment can be found in Dandolo et al. (2022).

The daily mean air temperature was estimated using a multi-stage regression-based modeling scheme in 1 × 1 km across Germany and averaged for the year 2016. Input data from various sources, including weather station observations and remote sensing spatiotemporal predictors such as the land surface temperature, were included in a modeling approach consisting of two linear mixed models and a thin plate spline interpolation technique to achieve full countrywide coverage. The models performed very well all around Germany (R² ≥ 0.95, RMSE ≤ 1.54°C) while 10-fold cross validation against an independent and dense monitoring network in Augsburg confirmed its high performance in the study area of KORA FIT (R² = 0.99, RMSE = 1.07°C). More details for the air temperature estimations are available in Nikolaou et al. (2023).

Dandolo L, Hartig C, Telkmann K, Horstmann S, Schwettmann L, Selsam P, Schneider A, Bolte G, and on behalf of the INGER Study Group. 2022. Decision tree analyses to explore the relevance of multiple sex/gender dimensions for the exposure to green spaces: results from the KORA INGER study. International Journal of Environmental Research and Public Health 19 (12) 7476. doi: <https://doi.org/10.3390/ijerph19127476>

Nikolaou N, Dallavalle M, Stafoggia M, Bouwer LM, Peters A, Chen K, Wolf K, Schneider A. 2023. High-resolution spatiotemporal modeling of daily near-surface air temperature in Germany over the period 2000–2020. Environmental research 219 115062. doi: <https://doi.org/10.1016/j.envres.2022.115062>



Figure S1. Study area - Augsburg region.



Figure S2. Flowchart of the study population.

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Figure S3. Histogram and barplot depicting the odor identification score in continuous and dichotomous class, respectively.

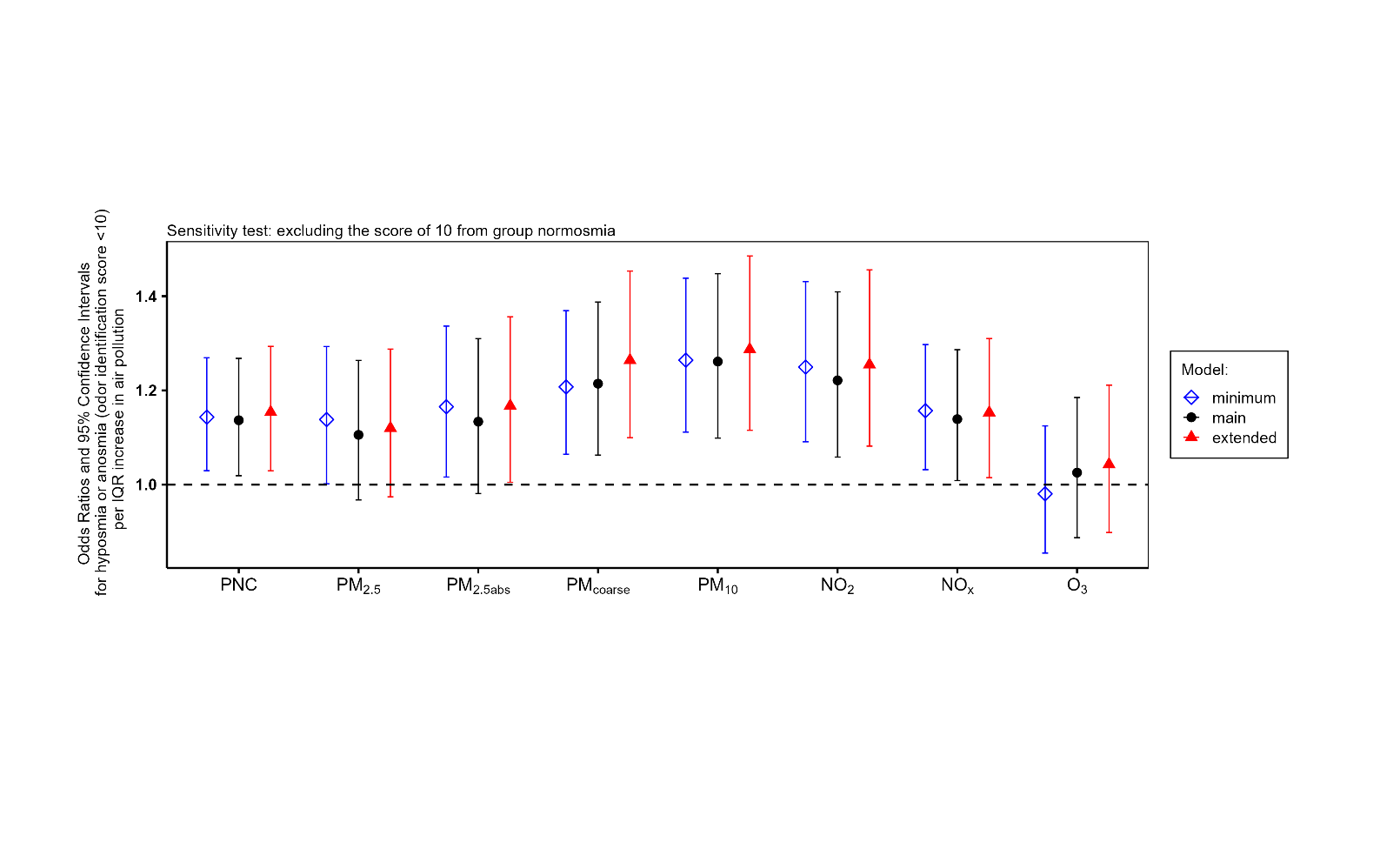


Figure S4. Associations between various air pollutants and odor identification excluding score = 10 from the normosmic group; Odds Ratios are presented for hyposmia or anosmia (odor identification score < 10) vs. normosmia (odor identification score > 10) per interquartile range (IQR) increase in each air pollutant (PNC, PM2.5, PM2.5abs, PMcoarse, PM10, NO2, NOx and O3); Error bars present 95 % Confidence Intervals; Minimum model: each pollutant, sex and age; Main model: minimum model, training, income, socio-economic status, physical activity, smoking status, body mass index and alcohol consumption; Extended model: main model, diabetes, asthma, chronic obstructive pulmonary disease, hay fever, allergies and hypertension; PNC = particle number concentration; PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone.

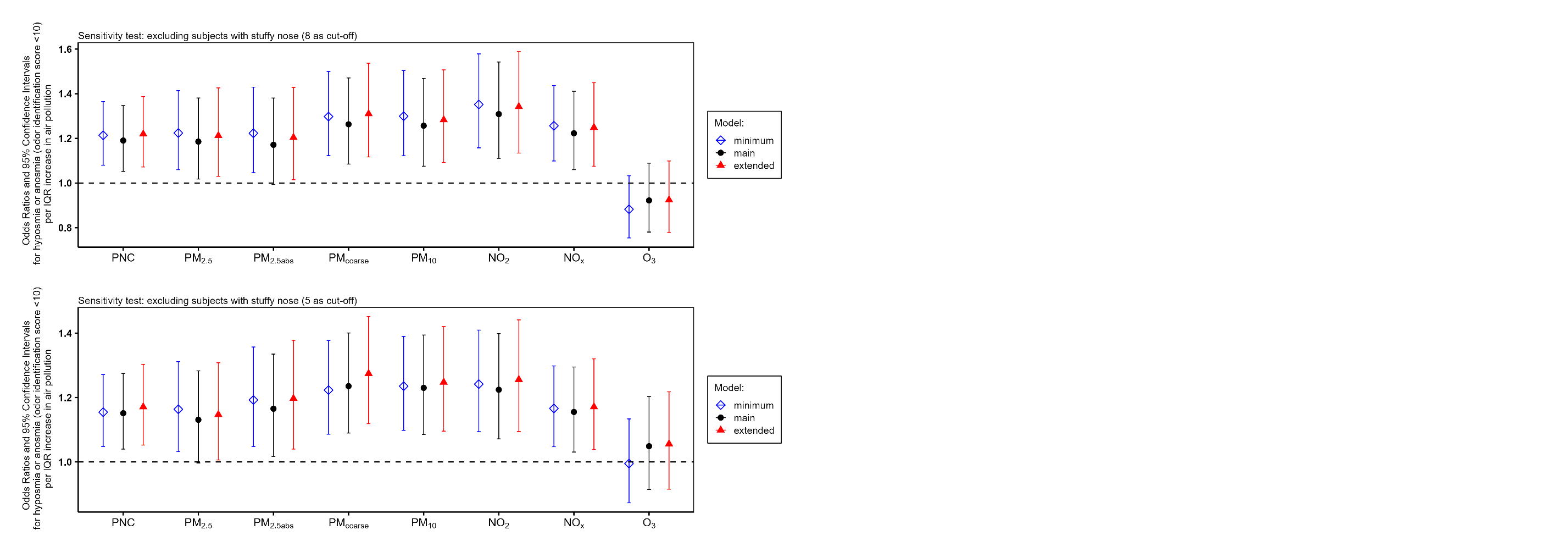
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Figure S5. Associations between various air pollutants and odor identification excluding subjects with stuffy nose (scale 1 to 10), using either answer 8 or 5 as a cut-off; Odds Ratios are presented for hyposmia or anosmia (odor identification score < 10) vs. normosmia (odor identification score ≥ 10) per interquartile range (IQR) increase in each air pollutant (PNC, PM2.5, PM2.5abs, PMcoarse, PM10, NO2, NOx and O3); Error bars present 95 % Confidence Intervals; Minimum model: each pollutant, sex and age; Main model: minimum model, training, income, socio-economic status, physical activity, smoking status, body mass index and alcohol consumption; Extended model: main model, diabetes, asthma, chronic obstructive pulmonary disease, hay fever, allergies and hypertension; PNC = particle number concentration; PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone.

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Figure S6. Associations between various air pollutants and odor identification including Bayesian information criterion (BIC) selection for the covariates, evaluating all possible combinations; Odds Ratios are presented for hyposmia or anosmia (odor identification score < 10) vs. normosmia (odor identification score ≥ 10) per interquartile range (IQR) increase in each air pollutant (PNC, PM2.5, PM2.5abs, PMcoarse, PM10, NO2, NOx and O3); Error bars present 95 % Confidence Intervals; Minimum model: each pollutant, sex and age; Main model: minimum model, training, income, socio-economic status, physical activity, smoking status, body mass index and alcohol consumption; Extended model: main model, diabetes, asthma, chronic obstructive pulmonary disease, hay fever, allergies and hypertension; BIC-based selected model: each pollutant, sex, age and socio-economic status; PNC = particle number concentration; PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone.

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| Table S1. Sniffin’ Sticks 12-Item Test: multiple choices per pen. | |
| Pen 1 | 1 = orange; 2 = strawberry  3 = blackberry; 4 = pineapple |
| Pen 2 | 1 = smoke; 2 = leather  3 = glue; 4 = grass |
| Pen 3 | 1 = honey; 2 = chocolate  3 = vanilla; 4 = cinnamon |
| Pen 4 | 1 = chives; 2 = spruce  3 = peppermint; 4 = onion |
| Pen 5 | 1 = coconut; 2 = walnut  3 = banana; 4 = cherry |
| Pen 6 | 1 = peach; 2 = apple  3 = lemon;4 = grapefruit |
| Pen 7 | 1 = licorice; 2 = wine gum  3 = chewing gum; 4 = cookies |
| Pen 8 | 1 = cigarette; 2 = coffee  3 = wine; 4 = candle smoke |
| Pen 9 | 1 = cloves; 2 = pepper  3 = cinnamon; 4 = mustard |
| Pen 10 | 1 = pear; 2 = plum  3 = peach; 4 = pineapple |
| Pen 11 | 1 = chamomile; 2 = raspberry  3 = rose; 4 = cherry |
| Pen 12 | 1 = bread; 2 = fish  3 = cheese; 4 = ham |

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| Table S2. Definitions of smoking status and alcohol consumption in KORA FIT study. | |
| Smoking status | Smoking status was categorized as follows:  - Current smokers reported currently smoking cigarettes.  - Ex-smokers were those who did not currently smoke but had previously smoked  regularly or occasionally and had quit smoking.  - Never smokers had never smoked cigarettes.  Smoking cigars and pipes were excluded from the classification. |
| Alcohol consumption | Alcohol consumption was calculated as the average daily intake (g/day) over the past week.  Formula:  Alcohol intake was assessed through two separate questions: one for the weekend (last Saturday and Sunday) and one for the weekdays (previous week’s Monday-Friday), where participants reported their consumption of beer, wine, and spirits, in liters.  Then the intake was derived using conversion factors:  40 grams of alcohol per liter of beer, 22 grams per liter of light beer, 3 grams per liter of  alcohol-free beer, 100 grams per liter of wine, and 6.2 grams per glass of spirits. |

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| Table S3. Descriptive statistics for the annual average air pollution concentrations at the residential locations of the KORA FIT participants (N = 2,943). | | | | |
| Air pollutant | Mean ± SD | | | P-value |
|  | Hyposmia or anosmia  (N = 800) | Normosmia  (N = 2,143) | Total  (N = 2,943) |  |
| PNC (103/cm3) | 7.11 ± 1.68 | 6.90 ± 1.69 | 6.95 ± 1.69 | 0.003 |
| **PM2.5 (μg/m3)** | 11.68 ± 1.00 | 11.57 ± 1.03 | 11.60 ± 1.03 | 0.012 |
| **PM2.5abs (10-5/m)** | 1.17 ± 0.17 | 1.15 ± 0.17 | 1.17 ± 0.17 | 0.005 |
| **PMcoarse (μg/m3)** | 4.91 ± 1.06 | 4.78 ± 1.04 | 4.82 ± 1.05 | 0.001 |
| **PM10 (μg/m3)** | 16.39 ± 1.46 | 16.20 ± 1.36 | 16.25 ± 1.39 | < 0.001 |
| NO2 (**μg/m3**) | 14.08 ± 4.19 | 13.44 ± 4.24 | 13.61 ± 4.23 | < 0.001 |
| NOx (**μg/m3**) | 21.93 ± 6.79 | 21.02 ± 7.06 | 21.27 ± 6.70 | 0.001 |
| O3 (**μg/m3**) | 39.12 ± 2.28 | 39.13 ± 2.32 | 39.13 ± 2.31 | 0.918 |

Hyposmia or anosmia: odor identification score < 10; normosmia: odor identification score ≥ 10; SD = standard deviation; IQR = interquartile range; PNC = particle number concentration; PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone; Differences between normosmic versus hyposmic or anosmic were quantified by two-sample t-test or Wilcoxon test, if not normally distributed.

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| Table S4. Main analysis: Odds Ratios and 95% Confidence Intervals of anosmia or hyposmia (odor identification score < 10) vs. normosmia (odor identification score ≥ 10) per interquartile range increase in each air pollutant. | | | | |
| Air pollutant | IQR | OR (95% CI) | | |
|  |  | Minimum model  (N = 2,943) | Main model  (N = 2,706) | Extended model  (N = 2,553) |
| PNC (103/cm3) | 1.9 | **1.13 (1.03, 1.24)** | **1.12 (1.02, 1.24)** | **1.15 (1.03, 1.27)** |
| **PM2.5 (μg/m3)** | 1.4 | **1.14 (1.01, 1.28)** | 1.10 (0.98, 1.25) | 1.12 (0.99, 1.28) |
| **PM2.5abs (10-5/m)** | 0.3 | **1.17 (1.03, 1.33)** | **1.14 (1.00, 1.30)** | **1.17 (1.02, 1.34)** |
| **PMcoarse (μg/m3)** | 1.4 | **1.19 (1.06, 1.33)** | **1.20 (1.06, 1.35)** | **1.24 (1.10, 1.41)** |
| **PM10 (μg/m3)** | 2.0 | **1.21 (1.08, 1.36)** | **1.20 (1.06, 1.36)** | **1.23 (1.08, 1.40)** |
| NO2 (**μg/m3**) | 6.3 | **1.22 (1.08, 1.38)** | **1.20 (1.06, 1.37)** | **1.24 (1.08, 1.41)** |
| NOx (**μg/m3**) | 8.7 | **1.15 (1.04, 1.28)** | **1.13 (1.01, 1.27)** | **1.15 (1.03, 1.30)** |
| O3 (**μg/m3**) | 3.5 | 1.00 (0.88, 1.14) | 1.04 (0.91, 1.19) | 1.05 (0.91, 1.21) |

IQR = interquartile range; OR = Odds Ratio, 95%; CI = 95% Confidence Interval; PNC = particle number concentration; PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone; Minimum model: each pollutant, sex and age; Main model: minimum model, training, income, socio-economic status, physical activity, smoking status, body mass index and alcohol consumption; Extended model: main model, diabetes, asthma, chronic obstructive pulmonary disease, hay fever, allergies and hypertension.

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| Table S5. Two-pollutant models: Odds Ratios and 95% Confidence Intervals of anosmia or hyposmia (odor identification score < 10) vs. normosmia (odor identification score ≥ 10) per interquartile range increase in each air pollutant (N = 2,706). | | | |
| Air pollutant | IQR | Adjusted for | OR (95% CI) |
| PNC (103/cm3) | 1.9 | - | **1.12 (1.02, 1.24)** |
| O3 | **1.13 (1.02, 1.25)** |
| **PM2.5 (μg/m3)** | 1.4 | - | 1.10 (0.98, 1.25) |
| **PM2.5abs** | 0.99 (0.85, 1.15) |
| **PMcoarse** | 1.03 (0.87, 1.22) |
| **PM10** | 1.00 (0.86, 1.16) |
| O­3 | 1.12 (0.99, 1.27) |
| **PM2.5abs (10-5/m)** | 0.3 | - | **1.14 (1.00, 1.30)** |
| **PM2.5** | 1.11 (0.92, 1.33) |
| O3 | **1.14 (1.00; 1.30)** |
| **PMcoarse (μg/m3)** | 1.4 | - | **1.20 (1.06, 1.35)** |
| **PM2.5** | **1.20 (1.03, 1.39)** |
| O3 | **1.20 (1.06, 1.35)** |
| **PM10 (μg/m3)** | 2.0 | - | **1.20 (1.06, 1.36)** |
| **PM2.5** | **1.21 (1.04, 1.41)** |
| NO2 | 1.13 (0.95, 1.35) |
| O3 | **1.20 (1.06, 1.36)** |
| NO2 (**μg/m3**) | 6.3 | - | **1.20 (1.06, 1.37)** |
| **PM10** | 1.10 (0.91, 1.32) |
| O3 | **1.22 (1.07, 1.40)** |
| NOx (**μg/m3**) | 8.7 | - | **1.13 (1.01, 1.27)** |
|  |  | O3 | **1.14 (1.02, 1.28)** |
| O3 (**μg/m3**) | 3.5 | - | 1.04 (0.91, 1.19) |
| PNC | 1.06 (0.93, 1.21) |
| **PM2.5** | 1.07 (0.94, 1.23) |
| **PM2.5abs** | 1.06 (0.92, 1.21) |
| **PMcoarse** | 1.01 (0.89, 1.16) |
| **PM10** | 1.04 (0.91, 1.19) |
| NO2 | 1.09 (0.95, 1.25) |
| NOx | 1.07 (0.94, 1.23) |

IQR = interquartile range; OR = Odds Ratio, 95%; CI = 95% Confidence Interval; PNC = particle number concentration; PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone; Main model was used: minimum model (each pollutant, sex and age), training, income, socio-economic status, physical activity, smoking status, body mass index and alcohol consumption.

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| Table S6. Effect modification analysis - sex: Odds Ratios and 95% Confidence Intervals of anosmia or hyposmia (odor identification score < 10) vs. normosmia (odor identification score ≥ 10) per interquartile range increase in each air pollutant (N = 2,706). | | | | |
| Air pollutant | IQR | OR (95% CI) | | Pinteraction |
|  |  | Female  (N = 1,436) | Male  (N = 1,270) |  |
| PNC (103/cm3) | 1.9 | **1.24 (1.07, 1.44)** | 1.02 (0.89, 1.16) | *0.052* |
| **PM2.5 (μg/m3)** | 1.4 | 1.18 (0.99, 1.41) | 1.02 (0.86, 1.21) | 0.183 |
| **PM2.5abs (10-5/m)** | 0.3 | **1.28 (1.05, 1.56)** | 1.01 (0.84, 1.21) | *0.072* |
| **PMcoarse (μg/m3)** | 1.4 | **1.31 (1.10, 1.57)** | 1.08 (0.91, 1.27) | 0.129 |
| **PM10 (μg/m3)** | 2.0 | **1.34 (1.12, 1.61)** | 1.07 (0.91, 1.26) | *0.094* |
| NO2 (**μg/m3**) | 6.3 | **1.31 (1.08, 1.59)** | 1.09 (0.91, 1.30) | 0.186 |
| NOx (**μg/m3**) | 8.7 | **1.26 (1.07, 1.49)** | 1.01 (0.87, 1.18) | ***0.040*** |
| O3 (**μg/m3**) | 3.5 | 1.01 (0.83, 1.21) | 1.09 (0.91, 1.32) | 0.521 |

IQR = interquartile range; OR = Odds Ratio, 95%; CI = 95% Confidence Interval; PNC = particle number concentration, PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone; Main model was used: minimum model (each pollutant, and age), training, income, socio-economic status, physical activity, smoking status, body mass index and alcohol consumption; Pinteraction is the p-value derived from the interaction term between the respective exposure and sex.

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| Table S7. Effect modification analysis - age: Odds Ratios and 95% Confidence Intervals of anosmia or hyposmia (odor identification score < 10) vs. normosmia (odor identification score ≥ 10) per interquartile range increase in each air pollutant (N = 2,706). | | | | |
| Air pollutant | IQR | OR (95% CI) | | Pinteraction |
|  |  | < 65 years  (N = 1,563) | ≥ 65 years  (N = 1,143) |  |
| PNC (103/cm3) | 1.9 | **1.20 (1.03, 1.38)** | 1.08 (0.95, 1.24) | 0.680 |
| **PM2.5 (μg/m3)** | 1.4 | 1.12 (0.94, 1.33) | 1.11 (0.94, 1.31) | 0.465 |
| **PM2.5abs (10-5/m)** | 0.3 | 1.19 (0.99, 1.42) | 1.10 (0.91, 1.33) | 0.918 |
| **PMcoarse (μg/m3)** | 1.4 | **1.26 (1.07, 1.50)** | 1.15 (0.96, 1.37) | 0.574 |
| **PM10 (μg/m3)** | 2.0 | **1.30 (1.09, 1.55)** | 1.12 (0.95, 1.33) | 0.425 |
| NO2 (**μg/m3**) | 6.3 | **1.22 (1.03, 1.45)** | 1.20 (0.99, 1.45) | 0.692 |
| NOx (**μg/m3**) | 8.7 | 1.16 (0.99, 1.36) | 1.14 (0.97, 1.33) | 0.662 |
| O3 (**μg/m3**) | 3.5 | 1.02 (0.85, 1.22) | 1.06 (0.88, 1.29) | 0.980 |

IQR = interquartile range; OR = Odds Ratio, 95%; CI = 95% Confidence Interval; PNC = particle number concentration; PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone; Main model was used: minimum model (each pollutant, and sex), training, income, socio-economic status, physical activity, smoking status, body mass index and alcohol consumption; Pinteraction is the p-value derived from the interaction term between the respective exposure and age.

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| Table S8. Effect modification analysis - physical activity: Odds Ratios and 95% Confidence Intervals of anosmia or hyposmia (odor identification score < 10) vs. normosmia (odor identification score ≥ 10) per interquartile range increase in each air pollutant (N = 2,706). | | | | |
| Air pollutant | IQR | OR (95% CI) | | Pinteraction |
|  |  | Inactive  (N = 743) | Active  (N = 1,963) |  |
| PNC (103/cm3) | 1.9 | 0.99 (0.83, 1.19) | **1.18 (1.04, 1.33)** | 0.255 |
| **PM2.5 (μg/m3)** | 1.4 | 1.03 (0.82, 1.29) | 1.13 (0.98, 1.31) | 0.650 |
| **PM2.5abs (10-5/m)** | 0.3 | 1.01 (0.79, 1.30) | **1.19 (1.01, 1.39)** | 0.452 |
| **PMcoarse (μg/m3)** | 1.4 | 1.09 (0.86, 1.38) | **1.24 (1.07, 1.43)** | 0.501 |
| **PM10 (μg/m3)** | 2.0 | 1.10 (0.87, 1.39) | **1.24 (1.07, 1.43)** | 0.579 |
| NO2 (**μg/m3**) | 6.3 | 1.16 (0.90, 1.49) | **1.21 (1.04, 1.40)** | 0.980 |
| NOx (**μg/m3**) | 8.7 | 1.00 (0.81, 1.23) | **1.19 (1.04, 1.36)** | 0.282 |
| O3 (**μg/m3**) | 3.5 | 1.05 (0.83, 1.34) | 1.04 (0.89, 1.22) | 0.999 |

IQR = interquartile range; OR = Odds Ratio, 95%; CI = 95% Confidence Interval; PNC = particle number concentration; PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone; Main model was used: minimum model (each pollutant, sex and age), training, income, socio-economic status, smoking status, body mass index and alcohol consumption; Pinteraction is the p-value derived from the interaction term between the respective exposure and physical activity.

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| Table S9. Effect modification analysis - smoking: Odds Ratios and 95% Confidence Intervals of anosmia or hyposmia (odor identification score < 10) vs. normosmia (odor identification score ≥ 10) per interquartile range increase in each air pollutant (N = 2,706). | | | | |
| Air pollutant | IQR | OR (95% CI) | | Pinteraction |
|  |  | No smoker  (N = 2,323) | Smoker  (N = 383) |  |
| PNC (103/cm3) | 1.9 | 1.10 (0.99, 1.23) | 1.18 (0.94, 1.48) | 0.712 |
| **PM2.5 (μg/m3)** | 1.4 | 1.08 (0.95, 1.24) | 1.15 (0.84, 1.57) | 0.974 |
| **PM2.5abs (10-5/m)** | 0.3 | 1.10 (0.95, 1.27) | 1.31 (0.92, 1.87) | 0.879 |
| **PMcoarse (μg/m3)** | 1.4 | **1.17 (1.02, 1.33)** | 1.25 (0.91, 1.71) | 0.857 |
| **PM10 (μg/m3)** | 2.0 | **1.17 (1.03, 1.34)** | 1.26 (0.92, 1.71) | 0.863 |
| NO2 (**μg/m3**) | 6.3 | **1.16 (1.01, 1.34)** | 1.35 (0.93, 1.94) | 0.643 |
| NOx (**μg/m3**) | 8.7 | 1.11 (0.98, 1.26) | 1.16 (0.91, 1.48) | 0.782 |
| O3 (**μg/m3**) | 3.5 | 1.07 (0.93, 1.24) | 0.86 (0.62, 1.21) | **0.037** |

IQR = interquartile range; OR = Odds Ratio, 95%; CI = 95% Confidence Interval; PNC = particle number concentration; PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone; Main model was used: minimum model (each pollutant, sex and age), training, income, socio-economic status, physical activity, body mass index and alcohol consumption; Pinteraction is the p-value derived from the interaction term between the respective exposure and smoking.

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| Table S10. Effect modification analysis - body mass index: Odds Ratios and 95% Confidence Intervals of anosmia or hyposmia (odor identification score < 10) vs. normosmia (odor identification score ≥ 10) per interquartile range increase in each air pollutant (N = 2,706). | | | | |
| Air pollutant | IQR | OR (95% CI) | | Pinteraction |
|  |  | Not obese  (N = 1,890) | Obese  (N = 816) |  |
| PNC (103/cm3) | 1.9 | **1.16 (1.03, 1.31)** | 1.06 (0.88, 1.28) | 0.113 |
| **PM2.5 (μg/m3)** | 1.4 | 1.11 (0.96, 1.29) | 1.07 (0.86, 1.35) | 0.330 |
| **PM2.5abs (10-5/m)** | 0.3 | 1.12 (0.96, 1.31) | 1.17 (0.93, 1.48) | 0.328 |
| **PMcoarse (μg/m3)** | 1.4 | **1.19 (1.03, 1.38)** | 1.22 (0.98, 1.51) | 0.419 |
| **PM10 (μg/m3)** | 2.0 | **1.21 (1.04, 1.40)** | 1.19 (0.96, 1.49) | 0.236 |
| NO2 (**μg/m3**) | 6.3 | **1.17 (1.00, 1.36)** | **1.29 (1.01, 1.64)** | 0.652 |
| NOx (**μg/m3**) | 8.7 | **1.16 (1.01, 1.33)** | 1.09 (0.90, 1.32) | 0.349 |
| O3 (**μg/m3**) | 3.5 | 1.03 (0.88, 1.20) | 1.06 (0.83, 1.35) | 0.742 |

IQR = interquartile range; OR = Odds Ratio, 95%; CI = 95% Confidence Interval; PNC = particle number concentration; PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone; Main model was used: minimum model (each pollutant, sex and age), training, income, socio-economic status, physical activity, smoking status and alcohol consumption; Pinteraction is the p-value derived from the interaction term between the respective exposure and body mass index.

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| Table S11. Effect modification analysis - subjective odor identification ability: Odds Ratios and 95% Confidence Intervals of anosmia or hyposmia (odor identification score < 10) vs. normosmia (odor identification score ≥ 10) per interquartile range increase in each air pollutant (N = 2,705). | | | | |
| Air pollutant | IQR | OR (95% CI) | | Pinteraction |
|  |  | Not very good  (N = 1,166) | Very good  (N = 1,539) |  |
| PNC (103/cm3) | 1.9 | 1.09 (0.95, 1.25) | 1.15 (0.99, 1.33) | 0.647 |
| **PM2.5 (μg/m3)** | 1.4 | 1.00 (0.84, 1.19) | **1.21 (1.01, 1.45)** | 0.126 |
| **PM2.5abs (10-5/m)** | 0.3 | 0.99 (0.82, 1.20) | **1.29 (1.06, 1.56)** | *0.054* |
| **PMcoarse (μg/m3)** | 1.4 | 1.13 (0.95, 1.34) | **1.29 (1.08, 1.54)** | 0.291 |
| **PM10 (μg/m3)** | 2.0 | 1.17 (0.99, 1.39) | **1.23 (1.03, 1.47)** | 0.709 |
| NO2 (**μg/m3**) | 6.3 | 1.06 (0.89, 1.27) | **1.36 (1.12, 1.64)** | *0.075* |
| NOx (**μg/m3**) | 8.7 | 1.06 (0.91, 1.23) | **1.21 (1.02, 1.43)** | 0.279 |
| O3 (**μg/m3**) | 3.5 | 1.16 (0.96, 1.40) | 0.96 (0.80, 1.16) | 0.127 |

IQR = interquartile range; OR = Odds Ratio, 95%; CI = 95% Confidence Interval; PNC = particle number concentration; PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone; Main model was used: minimum model (each pollutant, sex and age), training, income, socio-economic status, physical activity, smoking status, body mass index and alcohol consumption; Pinteraction is the p-value derived from the interaction term between the respective exposure and subjective odor identification ability.

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| Table S12. Effect modification analysis - urbanization: Odds Ratios and 95% Confidence Intervals of anosmia or hyposmia (odor identification score < 10) vs. normosmia (odor identification score ≥ 10) per interquartile range increase in each air pollutant (N = 2,706). | | | | |
| Air pollutant | IQR | OR (95% CI) | | Pinteraction |
|  |  | Rural  (N = 1,700) | Urban  (N = 1,006) |  |
| PNC (103/cm3) | 1.9 | **1.16 (1.01, 1.33)** | 1.01 (0.87, 1.17) | 0.322 |
| **PM2.5 (μg/m3)** | 1.4 | 1.02 (0.87, 1.20) | 1.10 (0.93, 1.31) | 0.346 |
| **PM2.5abs (10-5/m)** | 0.3 | 1.10 (0.93, 1.29) | 1.01 (0.84, 1.22) | 0.653 |
| **PMcoarse (μg/m3)** | 1.4 | **1.21 (1.06, 1.39)** | 0.99 (0.82, 1.21) | 0.134 |
| **PM10 (μg/m3)** | 2.0 | **1.30 (1.12, 1.51)** | 1.01 (0.83, 1.24) | **0.029** |
| NO2 (**μg/m3**) | 6.3 | **1.15 (1.00, 1.33)** | 1.07 (0.87, 1.31) | 0.511 |
| NOx (**μg/m3**) | 8.7 | 1.13 (0.97, 1.33) | 1.04 (0.90, 1.20) | 0.741 |
| O3 (**μg/m3**) | 3.5 | 1.09 (0.91, 1.29) | 1.03 (0.83, 1.27) | 0.580 |

IQR = interquartile range; OR = Odds Ratio, 95%; CI = 95% Confidence Interval; PNC = particle number concentration; PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone; Main model was used: minimum model (each pollutant, sex and age), training, income, socio-economic status, physical activity, smoking status, body mass index and alcohol consumption; Pinteraction is the p-value derived from the interaction term between the respective exposure and urbanization.

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| Table S13. Effect modification analysis - normalized difference vegetation index: Odds Ratios and 95% Confidence Intervals of anosmia or hyposmia (odor identification score < 10) vs. normosmia (odor identification score ≥ 10) per interquartile range increase in each air pollutant (N = 2,706). | | | | |
| Air pollutant | IQR | OR (95% CI) | | Pinteraction |
|  |  | Low NDVI  (N = 1,755) | High NDVI  (N = 951) |  |
| PNC (103/cm3) | 1.9 | 1.08 (0.97, 1.20) | 1.22 (0.97, 1.52) | 0.475 |
| **PM2.5 (μg/m3)** | 1.4 | 1.05 (0.92, 1.21) | 1.10 (0.91, 1.34) | 0.948 |
| **PM2.5abs (10-5/m)** | 0.3 | 1.12 (0.97, 1.29) | 1.03 (0.85, 1.25) | 0.324 |
| **PMcoarse (μg/m3)** | 1.4 | **1.24 (1.07, 1.43)** | 1.08 (0.85, 1.36) | 0.793 |
| **PM10 (μg/m3)** | 2.0 | **1.16 (1.01, 1.34)** | **1.26 (1.04, 1.53)** | *0.081* |
| NO2 (**μg/m3**) | 6.3 | **1.21 (1.02, 1.43)** | **1.26 (1.03, 1.55)** | *0.058* |
| NOx (**μg/m3**) | 8.7 | 1.07 (0.96, 1.20) | 1.24 (0.98, 1.56) | 0.736 |
| O3 (**μg/m3**) | 3.5 | 1.09 (0.93, 1.28) | 0.96 (0.75, 1.22) | 0.457 |

IQR = interquartile range; OR = Odds Ratio, 95%; CI = 95% Confidence Interval; PNC = particle number concentration; PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone; Main model was used: minimum model (each pollutant, sex and age), training, income, socio-economic status, physical activity, smoking status, body mass index and alcohol consumption; Pinteraction is the p-value derived from the interaction term between the respective exposure and normalized difference vegetation index (NDVI).

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| Table S14. Effect modification analysis - air temperature: Odds Ratios and 95% Confidence Intervals of anosmia or hyposmia (odor identification score < 10) vs. normosmia (odor identification score ≥ 10) per interquartile range increase in each air pollutant (N = 2,552). | | | | | | |
| Air pollutant | IQR | OR (95% CI) | | | Pinteraction  ≤ Q1 vs. Q1 - Q3 | Pinteraction  Q1 - Q3 vs. ≥ Q3 |
|  |  | ≤ Q1  (N = 635) | Q1 - Q3  (N = 1,254) | ≥ Q3  (N = 663) |  |  |
| PNC (103/cm3) | 1.9 | 1.10 (0.88, 1.38) | 1.15 (0.98, 1.35) | 0.96 (0.80, 1.15) | 0.760 | 0.392 |
| **PM2.5 (μg/m3)** | 1.4 | 1.12 (0.86, 1.45) | 1.02 (0.84, 1.23) | 1.02 (0.84, 1.25) | 0.413 | 0.614 |
| **PM2.5abs (10-5/m)** | 0.3 | 1.03 (0.78, 1.36) | 1.13 (0.94, 1.36) | 0.95 (0.78, 1.15) | 0.848 | 0.776 |
| **PMcoarse (μg/m3)** | 1.4 | 0.86 (0.68, 1.10) | **1.29 (1.10, 1.51)** | 0.98 (0.80, 1.21) | **0.046** | 0.174 |
| **PM10 (μg/m3)** | 2.0 | 1.09 (0.83, 1.42) | **1.30 (1.09, 1.56)** | 0.98 (0.77, 1.24) | 0.597 | *0.097* |
| NO2 (**μg/m3**) | 6.3 | 1.27 (0.96, 1.68) | 1.14 (0.96, 1.36) | 1.00 (0.81, 1.22) | 0.249 | 0.939 |
| NOx (**μg/m3**) | 8.7 | 1.19 (0.91, 1.56) | 1.11 (0.93, 1.33) | 0.97 (0.79, 1.18) | 0.440 | 0.785 |
| O3 (**μg/m3**) | 3.5 | 0.86 (0.70, 1.06) | **1.25 (1.03, 1.52)** | 0.99 (0.76, 1.29) | **0.015** | 0.108 |

IQR = interquartile range; OR = Odds Ratio, 95%; CI = 95% Confidence Interval; PNC = particle number concentration; PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone; Main model was used: minimum model (each pollutant, sex and age), training, income, socio-economic status, physical activity, smoking status, body mass index and alcohol consumption; Pinteraction is the p-value derived from the interaction term between the respective exposure and air temperature; Q1 represents air temperature values below or equal to the first quantile of the air temperature distribution, Q1-Q3 represents air temperature values between the first and third quantiles of the air temperature distribution, Q3 represents air temperature values above or equal to the third quantile of the air temperature distribution.

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| Table S15. Sensitivity analysis excluding score = 10 from the normosmic group: Odds Ratios and 95% Confidence Intervals of anosmia or hyposmia (odor identification score < 10) vs. normosmia (odor identification score > 10) per interquartile range increase in each air pollutant. | | | | |
| Air pollutant | IQR | OR (95% CI) | | |
|  |  | Minimum model  (N = 2,148) | Main model  (N = 1,979) | Extended model  (N = 1,861) |
| PNC (103/cm3) | 1.9 | **1.14 (1.03, 1.27)** | **1.14 (1.02, 1.27)** | **1.15 (1.03, 1.29)** |
| **PM2.5 (μg/m3)** | 1.4 | **1.14 (1.00, 1.29)** | 1.11 (0.97, 1.26) | 1.12 (0.97, 1.29) |
| **PM2.5abs (10-5/m)** | 0.3 | **1.17 (1.02, 1.34)** | 1.13 (0.98, 1.31) | **1.17 (1.00, 1.36)** |
| **PMcoarse (μg/m3)** | 1.4 | **1.21 (1.06, 1.37)** | **1.21 (1.06, 1.39)** | **1.26 (1.10, 1.45)** |
| **PM10 (μg/m3)** | 2.0 | **1.26 (1.11, 1.44)** | **1.26 (1.10, 1.45)** | **1.29 (1.12, 1.49)** |
| NO2 (**μg/m3**) | 6.3 | **1.25 (1.09, 1.43)** | **1.22 (1.06, 1.41)** | **1.25 (1.08, 1.46)** |
| NOx (**μg/m3**) | 8.7 | **1.16 (1.03, 1.30)** | **1.14 (1.01, 1.29)** | **1.15 (1.01, 1.31)** |
| O3 (**μg/m3**) | 3.5 | 0.98 (0.85, 1.12) | 1.03 (0.89, 1.18) | 1.04 (0.90, 1.21) |

IQR = interquartile range; OR = Odds Ratio, 95%; CI = 95% Confidence Interval; PNC = particle number concentration; PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone; Minimum model: each pollutant, sex and age; Main model: minimum model, training, income, socio-economic status, physical activity, smoking status, body mass index and alcohol consumption; Extended model: main model, diabetes, asthma, chronic obstructive pulmonary disease, hay fever, allergies and hypertension.

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| Table S16. Sensitivity analysis excluding subjects with stuffy nose (using 8 and 5 as cut-offs): Odds Ratios and 95% Confidence Intervals of anosmia or hyposmia (odor identification score < 10) vs. normosmia (odor identification score ≥ 10) per interquartile range increase in each air pollutant. | | | | | |
| Air pollutant | IQR | Cut-off | OR (95% CI) | | |
|  |  |  | Minimum model  (N = 1,971; N = 2,801) | Main model  (N = 1,803; N = 2,575) | Extended model  (N = 1,707; N = 2,429) |
| PNC (103/cm3) | 1.9 | 8 | **1.21 (1.08, 1.36)** | **1.19 (1.05, 1.35)** | **1.22 (1.07, 1.39)** |
| 5 | **1.15 (1.05, 1.27)** | **1.15 (1.04, 1.27)** | **1.17 (1.05, 1.30)** |
| **PM2.5 (μg/m3)** | 1.4 | 8 | **1.22 (1.06, 1.41)** | **1.19 (1.02, 1.38)** | **1.21 (1.03, 1.43)** |
| 5 | **1.16 (1.03, 1.31)** | **1.13 (1.00, 1.28)** | **1.15 (1.01, 1.31)** |
| **PM2.5abs (10-5/m)** | 0.3 | 8 | **1.22 (1.05, 1.43)** | 1.17 (0.99, 1.38) | **1.20 (1.02, 1.43)** |
| 5 | **1.19 (1.05, 1.36)** | **1.17 (1.02, 1.33)** | **1.20 (1.04, 1.38)** |
| **PMcoarse (μg/m3)** | 1.4 | 8 | **1.30 (1.12, 1.50)** | **1.26 (1.08, 1.47)** | **1.31 (1.12, 1.54)** |
| 5 | **1.22 (1.09, 1.38)** | **1.24 (1.09, 1.40)** | **1.27 (1.12, 1.45)** |
| **PM10 (μg/m3)** | 2.0 | 8 | **1.30 (1.12; 1.50)** | **1.26 (1.08, 1.47)** | **1.28 (1.09, 1.51)** |
| 5 | **1.24 (1.10, 1.39)** | **1.23 (1.09, 1.39)** | **1.25 (1.10, 1.42)** |
| NO2 (**μg/m3**) | 6.3 | 8 | **1.35 (1.16; 1.58)** | **1.31 (1.11, 1.54)** | **1.34 (1.13, 1.59)** |
| 5 | **1.24 (1.09, 1.41)** | **1.22 (1.07, 1.40)** | **1.26 (1.09, 1.44)** |
| NOx (**μg/m3**) | 8.7 | 8 | **1.26 (1.10, 1.44)** | **1.22 (1.06, 1.41)** | **1.25 (1.08, 1.45)** |
| 5 | **1.17 (1.05, 1.30)** | **1.16 (1.03, 1.29)** | **1.17 (1.04, 1.32)** |
| O3 (**μg/m3**) | 3.5 | 8 | 0.88 (0.75, 1.03) | 0.92 (0.78, 1.09) | 0.92 (0.78, 1.10) |
| 5 | 0.99 (0.87, 1.13) | 1.05 (0.91, 1.20) | 1.06 (0.92, 1.22) |

IQR = interquartile range; OR = Odds Ratio, 95%; CI = 95% Confidence Interval; PNC = particle number concentration; PM2.5 = particulate matter (PM) with an aerodynamic diameter less than 2.5 μm; PM2.5abs = PM2.5 absorbance; PMcoarse = PM between 2.5 and 10 μm; PM10 = PM with an aerodynamic diameter less than 10 μm; NO2 = nitrogen dioxide; NOx = nitrogen oxides; O3 = ozone; Minimum model: each pollutant, sex and age; Main model: minimum model, training, income, socio-economic status, physical activity, smoking status, body mass index and alcohol consumption; Extended model: main model, diabetes, asthma, chronic obstructive pulmonary disease, hay fever, allergies and hypertension.