**Supplementary Table 4:** Associations between exposure to ambient air pollutants and Other Behavioural Problems

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Author, year** | **Pollutant (s)** | **Exposure window** | **┼Key association** | **Exposure measurement** | **Outcome measured** | **Effect estimates** | **Overall study quality** |
| Ahmed, 2022 (65) | PM2.5 | Gestation through Childhood | **+** | Annual PM2.5 and NO2 estimates since 1996 from a land-use regression model. Maternal residential proximity to roadways were used as a proxy measure of exposure to traffic-related air pollution | Emotional and Behavioral Problems | Children’s lifetime PM2.5 exposures (5.9–7.1 µg/m3) OR: 1.27 (95% CI: 1.03, 1.57)  First year of life PM2.5 exposures (5.9–7.1 µg/m3) OR: 1.30 (95% CI: 1.05, 1.60)  Greater NO2 exposure in all exposure windows was not significantly associated | \*\*\* |
| Gestation |  |
| Infancy | **+** | Emotional and Behavioral Problems |
| Childhood |  |
| NO2 | Gestation through Childhood | **-** |
| Bradley, 2023 (25) | PM2.5 | Birth through Childhood |  | Ground pollution estimation via Inverse Distance Weighted (IDW) interpolation for NO2 and from Modern-Era retrospective analysis for Research and Applications version 2 (MERRA-2) for PM2.5. Annual averages were then obtained from this data | Emotional and Conduct symptoms | NO2 exposure in middle childhood and concurrent PLEs (OR=1.10, 95% CI=1.02–1.20).  PM2.5 exposure in middle childhood and concurrent PLEs (OR=1.05, 95% CI=1.01–1.09). There was no association with PM2.5 and NO2 exposures and emotional and conduct symptoms | \*\* |
| Birth | **-** |
| Childhood | **-** |
| Childhood | **+** | Psychotic Like Experiences (PLE) |
| NO2 | Birth | **-** |
| Childhood | **-** | Emotional and Conduct symptoms |
| Childhood | **+** | Psychotic Like Experiences |
| Forns, 2016 (32) | NO2 | Childhood | **+** | Weekly averaged NO2 concentrations were measured using Gradko Environmental passive dosimeters. Annual outdoor school levels were obtained by averaging the results | General Behavioral Development via SDQ total difficulties score | Higher SDQ total difficulties scores for an IQR increase in outdoor NO2 (IQR = 22.26 ug/m3) (aMR = 1.07; 95% CI: 1.01, 1.14) | \* |
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| Harris, 2016 | PM2.5 | Gestation through Childhood | **-** | Land use regression models, to estimate mean exposure PM2.5 during the third trimester of gestation, the first three years of life, the first six years of life, and the year preceding behavioral ratings | General Behavioral Development via BRIEF and SDQ | No significant association was found in covariate-adjusted models with BRIEF and SDQ scores | \*\*\* |
| Iyanna, 2023 (93) | PM2.5 | Gestation through Infancy | **-** | Daily estimates of air pollutants were aggregated to derive average exposures for each pollutant during two time periods: 1) pregnancy and 2) exposure during the participant’s first year of life (date of birth to first birthday) | Severity of social deficits associated with Autism | SRS Total T-scores and NO2 exposure during prenatal (ʙ = 0.4, 95% CI: 0.7, 1.6) and first year of life (ʙ = 0.7, 95% CI: 0.3, 1.6) | \*\*\* |
| Gestation | **-** |
| Infancy | **-** |
| NO2 | Gestation | **-** |
| Infancy | **-** |
| Joo, 2021 (63) | PM2.5 | Childhood | **+** | Exposure to fine particulate matter measured by averaging the worst levels of particles with an aerodynamic diameter ≤2.5 μm, PM2.5 during 2018 | Indirect association to Internalizing Behavioral Problems | PM2.5 was not associated with children's internalizing problem behavior but it was significantly associated with maternal depression s (b = 0.017, p < .001) which in turn was associated with children's internalizing problem behavior (b = 0.269, p < .001). The indirect effect of maternal depression on children's internalizing problem behavior (path 4: b =0.004, p < .01) was also statistically significant | \*\*\* |
| Loftus, 2020 (66) | NO2 | Gestation through Childhood | **+** | To estimate ambient NO2 at every residential location, validated universal kriging models (land-use regression with spatial smoothing) were applied based on air quality monitoring data from AQS and IMPROVE networks and modeling of over 300 geographic covariates | Externalizing Behavior | Prenatal NO2 exposure by 2 ppb higher had 6% higher externalizing behavior scores (95% CI: 1, 11).  Postnatal NO2 by 2 ppb higher had 8% higher externalizing scores (95% CI: 0, 16%).  NO2 was also associated with a higher odds externalizing problems (OR prenatal = 1.57 [95%CI: 1.02, 2.40]; OR postnatal = 1.96 [95%CI: 1.03, 3.71] | \*\*\* |
| Gestation | **+** |
| Childhood | **+** |
| Luminati, 2022 (62) | NO2 | Childhood | **-** | Annual mean outdoor NO2 concentrations at the home address of the children predicted by a land use regression (LUR) model based on NO2 measurements over 2 one-week periods at 80 locations in 2019 | Behavioral Problems | No association between yearly NO2 exposure and children's cognitive development (beta -0.05, 95% CI [-0.20; 0.10]) or behavioral problems (beta 0.02, 95% CI [-0.80; 0.12]) | \*\*\* |
| Ni, 2022 (71) | PM2.5 | Gestation through Infancy | **-** | Biweekly nitrogen dioxide (NO2), PM2.5 predictions from region-specific models were estimated, and averaged the exposure concentrations over each trimester, the whole pregnancy, and the two postnatal windows from childbirth to 2 y old and from 2 to 4 y old obtained | Behavioral Problems | Higher exposures to NO2 in the first trimester [b: 0.70; 0.13, 1.27) per 2 ppb NO2], the second trimester [b: 0.92, 0.31, 1.53) per 2 ppb NO2], and averaged over the whole pregnancy [b: 1.24: 0.39, 2.08 per 2 ppb NO2] were associated with more behavioral problems in children, however not significant.  Adverse association between PM2:5 in the first trimester and behavioral functioning [b: 1.32 (0.12, 2.52)], but insignificant.  Similar positive but non-significant associations postnatally | \*\*\* |
| 1st trimester | **-** |
| 2nd trimester | **-** |
| 3rd trimester | **-** |
| Pregnancy | **-** |
| Infancy | **-** |
| NO2 | 1st trimester | **-** |
| 2nd trimester | **-** |
| 3rd trimester | **-** |
| Pregnancy | **-** |
| Infancy | **-** |
| Qi, 2023 (35) | PM2.5 | Childhood Short Term | **-** | Hourly data of six air pollutants, i.e., PM2.5 and NO2 captured by 22 ambient monitoring stations were downloaded from the Wuhan Ecological Environment Bureau website. Daily averages of air pollutants (PM2.5 and NO2) were calculated, and the annual averages of each pollutant were summarized | Internalizing Behavior | **Short term**:  Odds of increase in NO2 (per 1 gμ/m3) with externalizing behaviors, ORs of 1.067 (95% CI 1.024, 1.111) at lag060 and 1.060 (95% CI 1.010, 1.113) at lag0120. The results showed that the association between NO2 and externalizing behavior was stronger in boys (p < 0.05) than in girls.  **Long term:** Odds of increase in NO2 (per 1 gμ/m3) with externalizing behaviors of 1.12 (95% CI 1.00-1.256)  Moreover, PM2.5 (OR=1.236 [95% CI 1.114, 1.371]) were positively associated with a higher risk of internalizing behaviors | \* |
| Childhood Long Term | **+** |
| NO2 | Childhood Short Term | **+** | Externalizing Behavior |
| Childhood Long Term | **+** |
| Ren, 2019 (36) | PM2.5 | Gestation | **+** | Exposure in the first, second, and third trimesters was calculated as the average of the daily mean concentrations of each pollutant during the 1-13 weeks, 14-27 weeks and the 28 weeks to delivery separately. Individual exposure throughout pregnancy was computed as the mean of the average daily concentrations during the full gestational months | Total Behavioral difficulties | In single-pollutant models, during full gestation, positive associations were observed between exposure to NO2 (aOR = 1.204, 95% CI 1.042, 1.392), PM2.5 (aOR = 1.095, 95% CI 1.021, 1.176) and total difficulties, and exposure to PM2.5 (aOR = 1.053, 95% CI 1.000, 1.109) and prosocial behavior, respectively for 1 g/m3 increase in each air pollutant. In second trimester exposure to PM2.5 (aOR = 1.078, 95%CI 1.023, 1.137) was positively associated with total behavioral difficulties after adjusting for PM10 | \* |
| 1st Trimester |  |
| 2nd Trimester | **+** |
| 3rd Trimester | **-** |
| Pregnancy | **+** |
| NO2 | 1st Trimester |  |
| 2nd Trimester | **-** |
| 3rd Trimester | **-** |
| Pregnancy | **+** |
| Shin, 2022 (38) | PM2.5 | Gestation through Childhood |  | Hourly air pollutant concentrations from 260 municipal and local district air quality fixed-site monitoring stations to compute 24-h mean for each measurement site | Internalizing Behavior and Total Problems | Increase in 1st trimester exposure to ambient air pollution was significantly associated with internalizing problems score 0.19 (0.05–0.32) per 1 μg/m3 increase in PM2.5 and 0.20 (0.02–0.37) per 1 ppb increase in NO2. Additionally, PM2.5 (0.16; 0.03-0.30) during the first trimester were significantly associated with total problems score. Not significant for postnatal exposure | \* |
| 1st Trimester | **+** |
| 2nd Trimester |  |
| 3rd Trimester |  |
| Infancy | **-** |
| Childhood | **-** |
| NO2 | 1st Trimester | **+** | Internalizing Behaviour |
| 2nd Trimester |  |
| 3rd Trimester |  |
| Infancy | **-** |
| Childhood | **-** |
| Tokuda, 2023 (64) | PM2.5 | Gestation through Childhood |  | Exposure to outdoor PM2.5 during pregnancy and the first five years of life with a machine learning-based spatio temporal model. residential addresses geocoded. Average concentrations of outdoor PM2.5 for each trimester, the entire pregnancy, and 0–1, 1–3, and 3–5 years after childbirth. | Externalizing Behavior | Exposure during the first trimester, 0-1 and 3-5 years of age was associated with children's externalizing problems (OR 2.77: 95% CI: 1.05-7.29], OR 1.66 [95% CI: 1.05-2.62], and OR 1.80 [1.19-2.74] per IQR increase, respectively) | \*\*\* |
| 1st Trimester | **+** |
| 2nd Trimester | **-** |
| 3rd Trimester | **-** |
| Infancy | **+** |
| Childhood | **+** |
| Yu, 2022 (31) | NO2 | Gestation |  | Daily data of ambient NO2 levels Shanghai Environmental Monitoring Center (SEMC) via air quality monitoring stations. Weekly mean levels of exposure to ambient NO2 during gestational weeks 1–36 for each pregnant woman based on their dwelling districts in Shanghai by averaging the daily mean concentrations for each gestational week | Social Behaviour domain of neurodevelopmental outcomes | Each 10-μg/m3 increase in weekly average NO2 concentrations had adverse associations with social-behavior in weeks 31–36 (developmental-quotient changes: − 0.91% to − 0.20%, P-values < 0.05) | \*\* |
| 3rd Trimester | **+** |

**┼**: [**+**] Statistically significant, [**-**] Statistically Non – significant