

Exposure Assessment

There are many alternative indicators that have been developed to assess exposure to local traffic-related pollutants, including distance to a major roadway, traffic-weighted distance to roadway, dispersion modeling, and land-use regression modeling (Jerrett et al. 2005). Using the CALINE4 line-source dispersion model, we examined the effect of local traffic-generated air pollution exposures that accounted for roadway geometry, traffic volume, and meteorology. We estimated the contribution of local traffic to concentrations of nitrogen oxides (NO_x) and particulate matter with aerodynamic diameter less than 2.5 μm (PM_{2.5}). The estimated pollutant exposures should be regarded as indicators of primary emissions from local vehicular traffic on top of background ambient levels. Modeled NO_x, for example, represented only the incremental contribution of local traffic to a more homogeneous community background concentration of NO_x that included both primary and secondary pollution resulting from long range transport and regional atmospheric photochemistry. The modeled NO_x and PM_{2.5} concentrations were highly correlated (R≥0.90), further underscoring that our modeled NO_x represented primary local NO_x from vehicular traffic in addition to other highly correlated and unmeasured pollutants contained in traffic exhaust. Because it is impossible to clearly distinguish different pollutants contained in traffic exhaust with our model, we refer to our exposure metric as local-traffic emissions, rather than as a specific pollutant.

In our previous studies, we found that hourly CALINE4 modeled NO_x and nitrogen dioxide (NO₂) exposures were poorly to moderately correlated with hourly measurements (Unpublished data). The correlations improved when we aggregated hourly data to daily, and further to monthly averages. This is mainly due to the lack of real-time measures for traffic activities in combination with mixing height and atmospheric stability data. Real-time data for total vehicle counts are available for freeways but not surface streets and not for diesel trucks. Therefore, we had to rely on annual average daily traffic counts (scaled by diurnal and weekday/weekend profiles by roadway and vehicle types). Mixing heights were assigned based on the averages of measurements taken in 1997 in the Southern California Ozone Study according to season and hour. Stability classes were assigned using a standard method based on wind speed and cloud cover (U.S. Environmental Protection Agency 2005). Therefore, the traffic and meteorological data use to derive the traffic related pollution measures may not reflect real-time situations at fine time scales, but rather reflect longer-term averages in accordance with our observation that correlations generally increased with longer averaging periods (monthly>daily>hourly).

REFERENCES

- Jerrett M, Arain A, Kanaroglou P, Beckerman B, Potoglou D, Sahuvaroglu T, et al., 2005. A review and evaluation of intraurban air pollution exposure models. *J Expo Anal Environ Epidemiol* 15(2):185-204.
- U.S. Environmental Protection Agency. 2005. Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions; Final Rule. 40 CFR Part 51: Washington, DC: U.S. Environmental Protection Agency.

Supplemental Material, Table 1. Average exposure levels^a for non-preeclampsia and preeclampsia and for term and preterm deliveries by pregnancy period.

| | Frequency | Entire | | 1 st | | 2 nd | | 3 rd | |
|----------------------------|-----------|-----------|-----|-----------------|-------------------|------------------------|-------------------|------------------------|-------------------|
| | | estimated | | trimester | | trimester ^b | | trimester ^b | |
| | | pregnancy | | NO _x | PM _{2.5} | NO _x | PM _{2.5} | NO _x | PM _{2.5} |
| Non-preeclampsia | 78,744 | 7.2 | 1.8 | 7.4 | 1.8 | 7.3 | 1.8 | 7.1 | 1.8 |
| Preeclampsia | 2,442 | 7.9 | 2.0 | 8.0 | 2.0 | 7.9 | 2.0 | 7.9 | 2.0 |
| Term | 74,474 | 7.2 | 1.8 | 7.4 | 1.8 | 7.2 | 1.8 | 7.1 | 1.8 |
| Preterm (<37 weeks) | 6,712 | 7.8 | 1.9 | 7.9 | 1.9 | 7.8 | 1.9 | | |
| Moderate preterm (<35 wks) | 2,749 | 8.3 | 2.0 | 8.5 | 2.0 | 8.3 | 2.0 | | |
| Very preterm (<30 wks) | 775 | 9.0 | 2.2 | 9.1 | 2.2 | 8.9 | 2.2 | | |

^aThe units are ppb for NO_x and µg m⁻³ for PM_{2.5}.

^bDue to truncated third trimesters for preterm births, we present results only for 1st and 2nd trimester exposures.

Supplemental Material, Table 2. Adjusted odds ratios per inter-quartile range increase in estimated NO_x and PM_{2.5} exposures traffic by trimester of gestation for preeclampsia, preterm, moderate preterm, and very preterm birth.

| Outcome | Pollutant | IOR (95% CI) ^a | | |
|------------------|-------------------|---------------------------|---------------------------|--|
| | | 1 st trimester | 2 nd trimester | 3 rd trimester ^b |
| Preeclampsia | NO _x | 1.09 (1.05, 1.15) | 1.10 (1.06, 1.15) | 1.11 (1.06, 1.16) |
| | PM _{2.5} | 1.10 (1.06, 1.15) | 1.12 (1.07, 1.16) | 1.10 (1.06, 1.15) |
| PTD (<37 weeks) | NO _x | 1.05 (1.02, 1.08) | 1.06 (1.03, 1.09) | |
| | PM _{2.5} | 1.03 (1.01, 1.06) | 1.04 (1.01, 1.07) | |
| MPTD (<35 weeks) | NO _x | 1.12 (1.07, 1.17) | 1.13 (1.08, 1.17) | |
| | PM _{2.5} | 1.08 (1.03, 1.12) | 1.08 (1.04, 1.12) | |
| VPTD (<30 weeks) | NO _x | 1.21 (1.13, 1.30) | 1.24 (1.15, 1.32) | |
| | PM _{2.5} | 1.17 (1.09, 1.26) | 1.18 (1.10, 1.27) | |

^aInter-quartile range was 5.65 ppb for NO_x and 1.35 µg m⁻³ for PM_{2.5}. Adjusted for maternal age, maternal race/ethnicity, parity, prenatal care insurance type, poverty, and season of conception in all models. Additionally adjusted for pyelonephritis in PTD, MPTD, and VPTD models, and for diabetes in preeclampsia models.

^bDue to truncated third trimesters for preterm births, we present results only for 1st and 2nd trimester exposures.

Supplemental Material, Table 3. Crude and adjusted odds ratios per inter-quartile range increase in estimated entire pregnancy NO_x exposure for preeclampsia by study region, race/ethnicity, poverty, insurance type, infant gender, maternal age, parity, diabetes, and severity of preeclampsia.

| | | Cases (n) | Crude IOR (95% CI) | Adjusted IOR (95% CI) ^a |
|--------------------------|--------------------------|--------------|-----------------------|---------------------------------------|
| Study region | Los Angeles | 1,303 | 1.10 (1.04, 1.17) | 1.08 (1.02, 1.15) |
| | Orange County | 1,139 | 1.13 (1.06, 1.20) | 1.07 (0.99, 1.15) |
| Race | Hispanic | 868 | 1.08 (1.00, 1.16) | 1.07 (1.00, 1.15) |
| | White | 900 | 1.20 (1.12, 1.28) | 1.15 (1.07, 1.24) |
| | African American | 280 | 0.98 (0.85, 1.13) | 0.97 (0.84, 1.12) |
| | Asian | 205 | 1.16 (1.00, 1.34) | 1.18 (1.01, 1.37) |
| | Other | 189 | 1.18 (1.03, 1.35) | 1.15 (0.99, 1.32) |
| Poverty | Poverty<14% ^b | 1,408 | 1.15 (1.09, 1.21) | 1.09 (1.03, 1.16) |
| | Poverty≥14% | 1,034 | 1.09 (1.02, 1.16) | 1.07 (1.00, 1.15) |
| Insurance | Public | 778 | 1.07 (0.98, 1.15) | 1.04 (0.96, 1.13) |
| | Private | 1,547 | 1.16 (1.11, 1.22) | 1.12 (1.06, 1.18) |
| | Unknown | 117 | 1.13 (0.95, 1.35) | 1.15 (0.96, 1.38) |
| Infant gender | Female | 1,162 | 1.13 (1.07, 1.20) | 1.08 (1.02, 1.15) |
| | Male | 1,280 | 1.15 (1.09, 1.21) | 1.12 (1.05, 1.18) |
| Maternal age | <20 | 205 | 1.24 (1.08, 1.42) | 1.24 (1.08, 1.43) |
| | 20-29 | 979 | 1.04 (0.97, 1.11) | 1.01 (0.95, 1.09) |
| | 30-39 | 1,093 | 1.20 (1.13, 1.27) | 1.14 (1.06, 1.21) |
| | >40 | 165 | 1.33 (1.16, 1.53) | 1.31 (1.13, 1.52) |
| Parity | No previous children | 2,192 | 1.12 (1.07, 1.16) | 1.10 (1.05, 1.15) |
| | ≥1 previous children | 250 | 1.15 (1.00, 1.31) | 1.13 (0.98, 1.31) |
| Diabetes | No | 2,158 | 1.15 (1.10, 1.20) | 1.12 (1.07, 1.17) |
| | Yes | 284 | 1.01 (0.89, 1.15) | 0.98 (0.85, 1.12) |
| Severity of preeclampsia | | | 1.12 (1.07, 1.17) | 1.09 (1.03, 1.14) |
| | | 444 | 1.27 (1.17, 1.38) | 1.20 (1.09, 1.31) |
| | | 170 | 1.05 (0.90, 1.24) | 1.05 (0.88, 1.24) |

^aInter-quartile range was 5.65 ppb for NO_x and 1.35 μg m⁻³ for PM_{2.5}. Mutually adjusted for the same variables in Table 3 except those used for stratification.

^bThis means <14% of population in the census block groups lived below the poverty level.

Supplemental Material, Table 4. Crude and adjusted odds ratios per inter-quartile range increase in estimated entire pregnancy NO_x exposure for PTD stratified by study region, race/ethnicity, poverty, insurance type, infant gender, maternal age, parity, delivery type, and preeclampsia status.

| | | Cases (n) | Crude IOR (95% CI) | Adjusted IOR (95% CI) ^a |
|---------------------|--------------------------|--------------|-----------------------|---------------------------------------|
| Study region | Los Angeles | 3,928 | 1.05 (1.02, 1.09) | 1.04 (1.00, 1.08) |
| | Orange County | 2,784 | 1.04 (1.00, 1.09) | 1.02 (0.97, 1.07) |
| Race | Hispanic | 2,365 | 1.04 (1.00, 1.09) | 1.05 (1.00, 1.09) |
| | White | 2,175 | 1.12 (1.07, 1.17) | 1.07 (1.01, 1.12) |
| | African American | 891 | 1.02 (0.95, 1.10) | 1.05 (0.97, 1.13) |
| | Asian | 648 | 1.05 (0.96, 1.15) | 1.03 (0.94, 1.13) |
| | Other | 633 | 1.10 (1.01, 1.19) | 1.08 (0.99, 1.18) |
| Poverty | Poverty<14% ^b | 3,641 | 1.09 (1.05, 1.13) | 1.04 (1.01, 1.08) |
| | Poverty≥14% | 3,071 | 1.06 (1.02, 1.11) | 1.07 (1.02, 1.11) |
| Insurance | Public | 2,481 | 1.09 (1.04, 1.14) | 1.10 (1.05, 1.15) |
| | Private | 3,990 | 1.09 (1.06, 1.13) | 1.04 (1.00, 1.08) |
| | Unknown | 241 | 1.04 (0.91, 1.19) | 1.03 (0.89, 1.18) |
| Infant gender | Female | 3,110 | 1.11 (1.07, 1.15) | 1.06 (1.02, 1.10) |
| | Male | 3,602 | 1.13 (1.09, 1.17) | 1.09 (1.05, 1.13) |
| Maternal age | <20 | 492 | 1.04 (0.94, 1.16) | 1.05 (0.95, 1.17) |
| | 20-29 | 2,734 | 1.11 (1.07, 1.15) | 1.08 (1.03, 1.12) |
| | 30-39 | 3,055 | 1.14 (1.10, 1.19) | 1.04 (0.99, 1.08) |
| | >40 | 431 | 1.16 (1.04, 1.28) | 1.09 (0.98, 1.22) |
| Parity | No previous children | 5,743 | 1.09 (1.06, 1.12) | 1.05 (1.02, 1.08) |
| | ≥1 previous children | 969 | 1.24 (1.16, 1.33) | 1.14 (1.06, 1.23) |
| Delivery type | Non-spontaneous | 857 | 1.12 (1.04, 1.19) | 0.99 (0.91, 1.07) |
| | Spontaneous | 5,855 | 1.11 (1.08, 1.15) | 1.08 (1.05, 1.12) |
| Delivery method | C-section | 2,637 | 1.17 (1.12, 1.21) | 1.11 (1.07, 1.16) |
| | Vaginal | 4,075 | 1.10 (1.07, 1.14) | 1.05 (1.01, 1.09) |
| Preeclampsia status | No | 5,931 | 1.11 (1.08, 1.14) | 1.06 (1.03, 1.09) |
| | Yes | 781 | 1.09 (1.00, 1.19) | 1.04 (0.95, 1.14) |

^aInter-quartile range was 5.65 ppb for NO_x and 1.35 μg m⁻³ for PM_{2.5}. Mutually adjusted for the same variables in Table 3 except those used for stratification.

^bThis means <14% of population in the census block groups lived below the poverty level.

Supplemental Material, Table 5. Crude and adjusted odds ratios per inter-quartile range increase in estimated entire pregnancy NO_x exposure for MPTD stratified by study region, race/ethnicity, poverty, insurance type, infant gender, maternal age, parity, delivery type, and preeclampsia status.

| | | Cases (n) | Crude IOR (95% CI) | Adjusted IOR (95% CI) ^a |
|---------------------|--------------------------|--------------|-----------------------|---------------------------------------|
| Study region | Los Angeles | 1,797 | 1.12 (1.06, 1.17) | 1.09 (1.03, 1.15) |
| | Orange County | 952 | 1.13 (1.06, 1.21) | 1.06 (0.98, 1.15) |
| Race | Hispanic | 1,062 | 1.11 (1.05, 1.18) | 1.12 (1.05, 1.19) |
| | White | 741 | 1.21 (1.12, 1.30) | 1.12 (1.04, 1.22) |
| | African American | 435 | 1.05 (0.95, 1.17) | 1.07 (0.96, 1.18) |
| | Asian | 245 | 1.24 (1.10, 1.41) | 1.22 (1.07, 1.39) |
| | Other | 266 | 1.12 (0.99, 1.27) | 1.10 (1.07, 1.25) |
| Poverty | Poverty<14% ^b | 1,358 | 1.19 (1.13, 1.25) | 1.11 (1.05, 1.17) |
| | Poverty≥14% | 1,391 | 1.13 (1.07, 1.2) | 1.12 (1.06, 1.19) |
| Insurance | Public | 1,128 | 1.16 (1.09, 1.24) | 1.15 (1.08, 1.23) |
| | Private | 1,532 | 1.20 (1.14, 1.26) | 1.09 (1.03, 1.15) |
| | Unknown | 89 | 1.17 (0.97, 1.42) | 1.20 (1.08, 1.46) |
| Infant gender | Female | 1,271 | 1.20 (1.14, 1.27) | 1.12 (1.06, 1.19) |
| | Male | 1,478 | 1.24 (1.18, 1.30) | 1.15 (1.09, 1.21) |
| Maternal age | <20 | 221 | 1.08 (0.94, 1.25) | 1.09 (0.94, 1.26) |
| | 20-29 | 1,145 | 1.20 (1.14, 1.27) | 1.15 (1.08, 1.22) |
| | 30-39 | 1,209 | 1.24 (1.17, 1.31) | 1.10 (1.03, 1.17) |
| | >40 | 174 | 1.32 (1.16, 1.51) | 1.22 (1.06, 1.42) |
| Parity | No previous children | 2,420 | 1.19 (1.14, 1.23) | 1.12 (1.07, 1.17) |
| | ≥1 previous children | 329 | 1.36 (1.23, 1.51) | 1.24 (1.10, 1.39) |
| Delivery type | Non-spontaneous | 344 | 1.26 (1.15, 1.38) | 1.09 (0.98, 1.22) |
| | Spontaneous | 2,405 | 1.21 (1.16, 1.26) | 1.14 (1.10, 1.19) |
| Delivery method | C-section | 1,316 | 1.24 (1.18, 1.31) | 1.16 (1.09, 1.22) |
| | Vaginal | 1,433 | 1.22 (1.16, 1.28) | 1.12 (1.06, 1.19) |
| Preeclampsia status | No | 2,327 | 1.20 (1.16, 1.25) | 1.11 (1.07, 1.16) |
| | Yes | 422 | 1.23 (1.12, 1.36) | 1.17 (1.05, 1.29) |

^aInter-quartile range was 5.65 ppb for NO_x and 1.35 µg m⁻³ for PM_{2.5}. Mutually adjusted for the same variables in Table 3 except those used for stratification.

^bThis means <14% of population in the census block groups lived below the poverty level.

Supplemental Material, Table 6. Crude and adjusted odds ratios per inter-quartile range increase in estimated entire pregnancy NO_x exposure for VPTD stratified by study region, race/ethnicity, poverty, insurance type, infant gender, maternal age, parity, delivery type, and preeclampsia status.

| | | Cases (n) | Crude IOR (95% CI) | Adjusted IOR (95% CI) ^a |
|---------------------|--------------------------|--------------|-----------------------|---------------------------------------|
| Study region | Los Angeles | 546 | 1.21 (1.11, 1.31) | 1.19 (1.10, 1.29) |
| | Orange County | 229 | 1.24 (1.09,1.40) | 1.17 (1.01, 1.35) |
| Race | Hispanic | 293 | 1.17 (1.05, 1.30) | 1.18 (1.05, 1.31) |
| | White | 203 | 1.37 (1.21, 1.54) | 1.26 (1.10, 1.44) |
| | African American | 145 | 1.15 (0.98, 1.35) | 1.17 (1.00, 1.38) |
| | Asian | 60 | 1.45 (1.18, 1.78) | 1.41 (1.14, 1.75) |
| | Other | 74 | 1.30 (1.08, 1.56) | 1.27 (1.05, 1.54) |
| Poverty | Poverty<14% ^b | 358 | 1.31 (1.19, 1.43) | 1.22 (1.11, 1.35) |
| | Poverty≥14% | 417 | 1.22 (1.11, 1.34) | 1.22 (1.11, 1.33) |
| Insurance | Public | 350 | 1.29 (1.17, 1.42) | 1.29 (1.17, 1.42) |
| | Private | 409 | 1.30 (1.20, 1.41) | 1.17 (1.07, 1.29) |
| | Unknown | 16 | 1.00 (0.60, 1.66) | 0.99 (0.59, 1.65) |
| Infant gender | Female | 371 | 1.33 (1.22, 1.45) | 1.26 (1.15, 1.39) |
| | Male | 404 | 1.32 (1.22, 1.43) | 1.24 (1.13, 1.35) |
| Maternal age | <20 | 66 | 1.33 (1.08, 1.65) | 1.38 (1.11, 1.70) |
| | 20-29 | 322 | 1.26 (1.15, 1.39) | 1.21 (1.10, 1.34) |
| | 30-39 | 335 | 1.37 (1.25, 1.50) | 1.22 (1.10, 1.36) |
| | >40 | 52 | 1.41 (1.15, 1.72) | 1.32 (1.06, 1.66) |
| Parity | No previous children | 692 | 1.29 (1.21, 1.37) | 1.23 (1.14, 1.31) |
| | ≥1 previous children | 83 | 1.50 (1.26, 1.80) | 1.41 (1.15, 1.72) |
| Delivery type | Non-spontaneous | 102 | 1.18 (0.99, 1.41) | 1.08 (0.88, 1.33) |
| | Spontaneous | 673 | 1.34 (1.26, 1.43) | 1.28 (1.19, 1.37) |
| Delivery method | C-section | 413 | 1.33 (1.23, 1.44) | 1.24 (1.14, 1.36) |
| | Vaginal | 362 | 1.33 (1.22, 1.45) | 1.27 (1.15, 1.39) |
| Preeclampsia status | No | 663 | 1.33 (1.25, 1.42) | 1.25 (1.17, 1.34) |
| | Yes | 112 | 1.17 (0.99, 1.39) | 1.14 (0.95, 1.37) |

^aInter-quartile range was 5.65 ppb for NO_x and 1.35 µg m⁻³ for PM_{2.5}. Mutually adjusted for the same variables in Table 3 except those used for stratification.

^bThis means <14% of population in the census block groups lived below the poverty level.

Supplemental Material, Table 7. Adjusted odds ratios per inter-quartile range increase in traffic related air pollution for preterm birth based on multi-logit models^a for the three preterm birth outcomes.

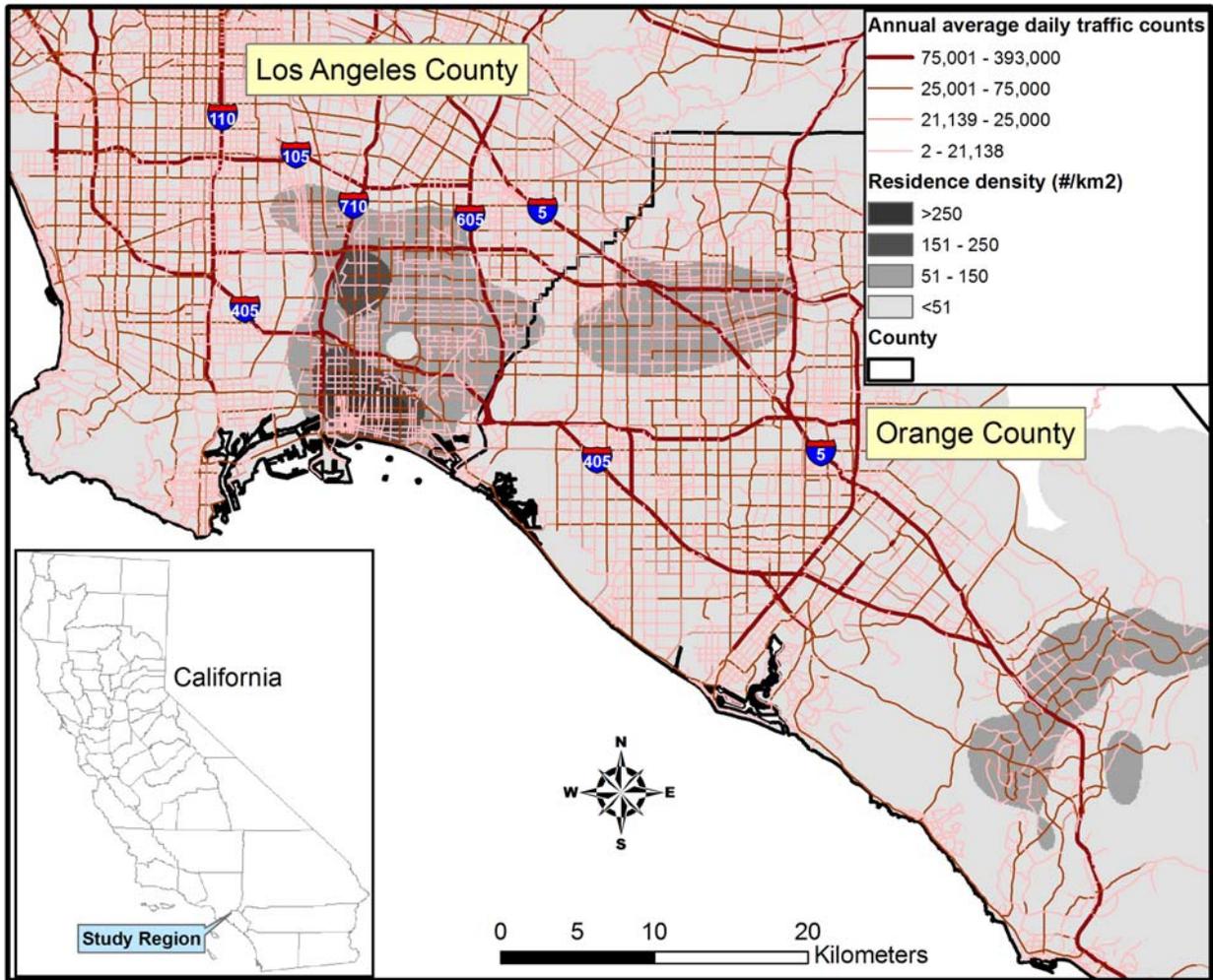
| Pollutant | Outcome | IOR (95% CI) ^b |
|-------------------|--------------------|---------------------------|
| NO _x | PTD (35-36 weeks) | 1.01 (0.98, 1.05) |
| | MPTD (30-34 weeks) | 1.09 (1.04, 1.14) |
| | VPTD (<30 weeks) | 1.24 (1.16, 1.33) |
| PM _{2.5} | PTD (35-36 weeks) | 1.01 (0.97, 1.04) |
| | MPTD (30-34 weeks) | 1.04 (0.99, 1.09) |
| | VPTD (<30 weeks) | 1.17 (1.10, 1.25) |

^aThe multilogit models were conducted using the polytomous function in R.

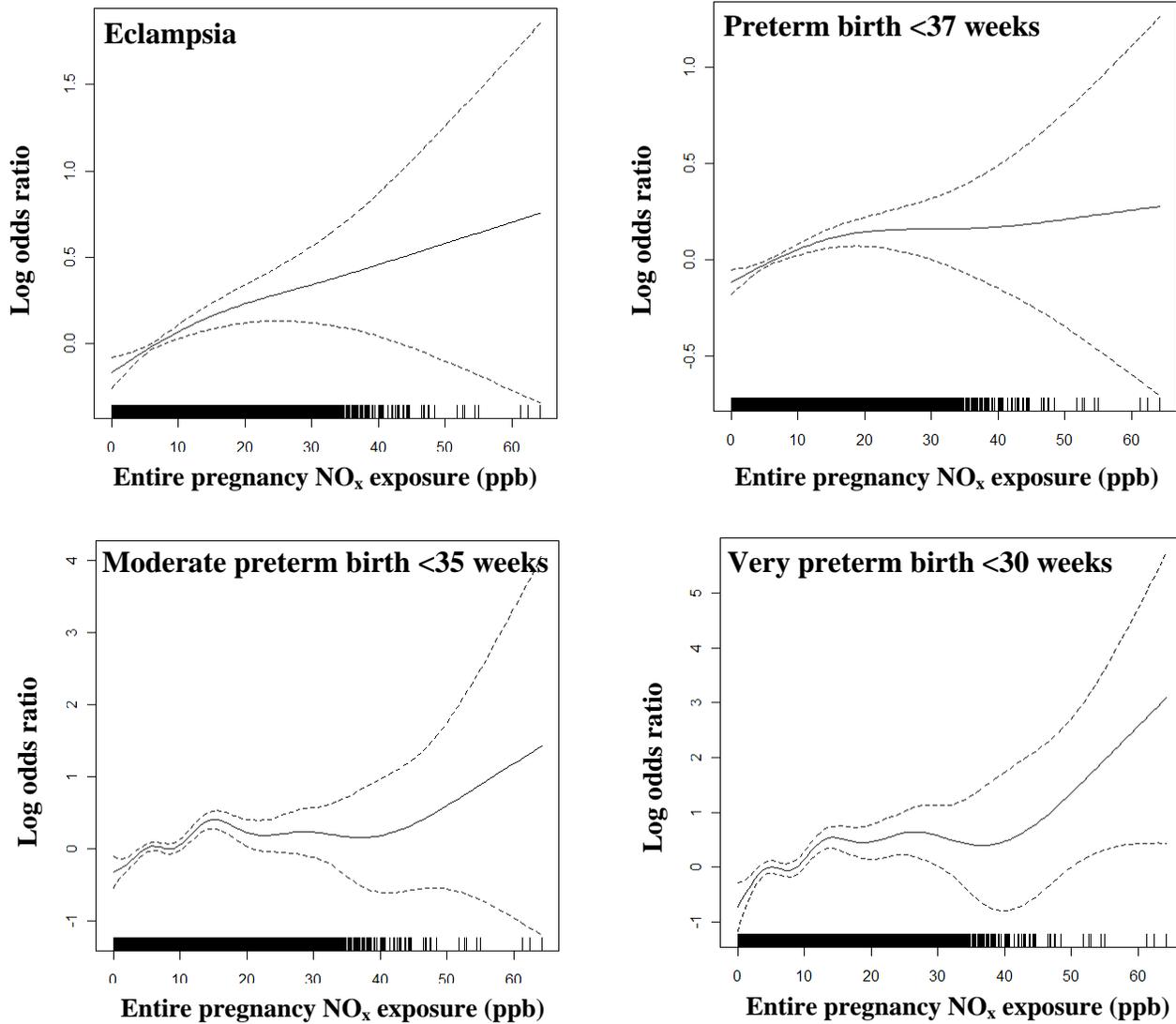
^bBased on entire estimated pregnancy exposure.

In the manuscript, the three definitions of preterm birth were not exclusive (<37 weeks: PTD; <35 weeks: MPTD; <30 weeks: VPTD). In the polytomous models, we treated preterm birth in different weeks as three exclusive categories, 35-36 weeks (PTD), 30-34 weeks (MPTD), and <30 weeks (VPTD). However, the results in Table 7 were not substantially different from the Table 3 results in the main manuscript.

Supplemental Material, Figure 1. Map of the study region



Supplemental Material, Figure 2. Smooth curves^a of dose-response relationship



^aAdjusted for maternal age, maternal race/ethnicity, parity, prenatal care insurance type, poverty, and season of conception in all models. Additionally adjusted for pyelonephritis in PTD, MPTD, and VPTD models, and for diabetes in preeclampsia models.