

Breath carbon monoxide levels, smoking and adverse pregnancy outcomes

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BACKGROUND

Smoking in Pregnancy

Leading modifiable risk factor for adverse outcomes

Associated with low birth weight and preterm birth

Quitting significantly reduces risks

Despite record-low smoking rates in England, 7.4% of women smoked at the end of pregnancy (2023/24)

Important to identify pregnant smokers in order to provide appropriate cessation advice and increase fetal surveillance

Breath Carbon Monoxide

Not all women disclose smoking during antenatal visits (non-disclosure ranging from 3%–75%)

To address this, biochemical markers can be used

Breath carbon monoxide (CO) testing is a quick, cost-effective, and non-invasive way to assess smoking status

In the UK, CO testing is recommended at booking and 36-weeks appointments for all women

Bedfont piCO™ Smokerlyzer® breath CO monitor (Bedfont Scientific Ltd., UK)

METHODS AND COHORT CHARACTERISTICS

- Retrospective cohort study of one year of pregnancies (2023) in Oxford
- Statistical analysis in IBM SPSS Statistics version 29.0.2.0
- ANOVA with Games-Howell post-hoc tests, Cochran-Armitage test for trend, binary logistic regression, and univariate linear regression

- Mean birthweight of the cohort: 3439g ($\pm$ 560g)
- Mean birthweight centile: 54.25 ($\pm$ 28.00)
- Prevalence of small of gestational age (SGA): 6.7%
- Prevalence of preterm birth (PTB): 5.0%
- Incidence of self-reported smoking: 9.2%
- CO levels were $\geq$ 4 ppm in 7.0%

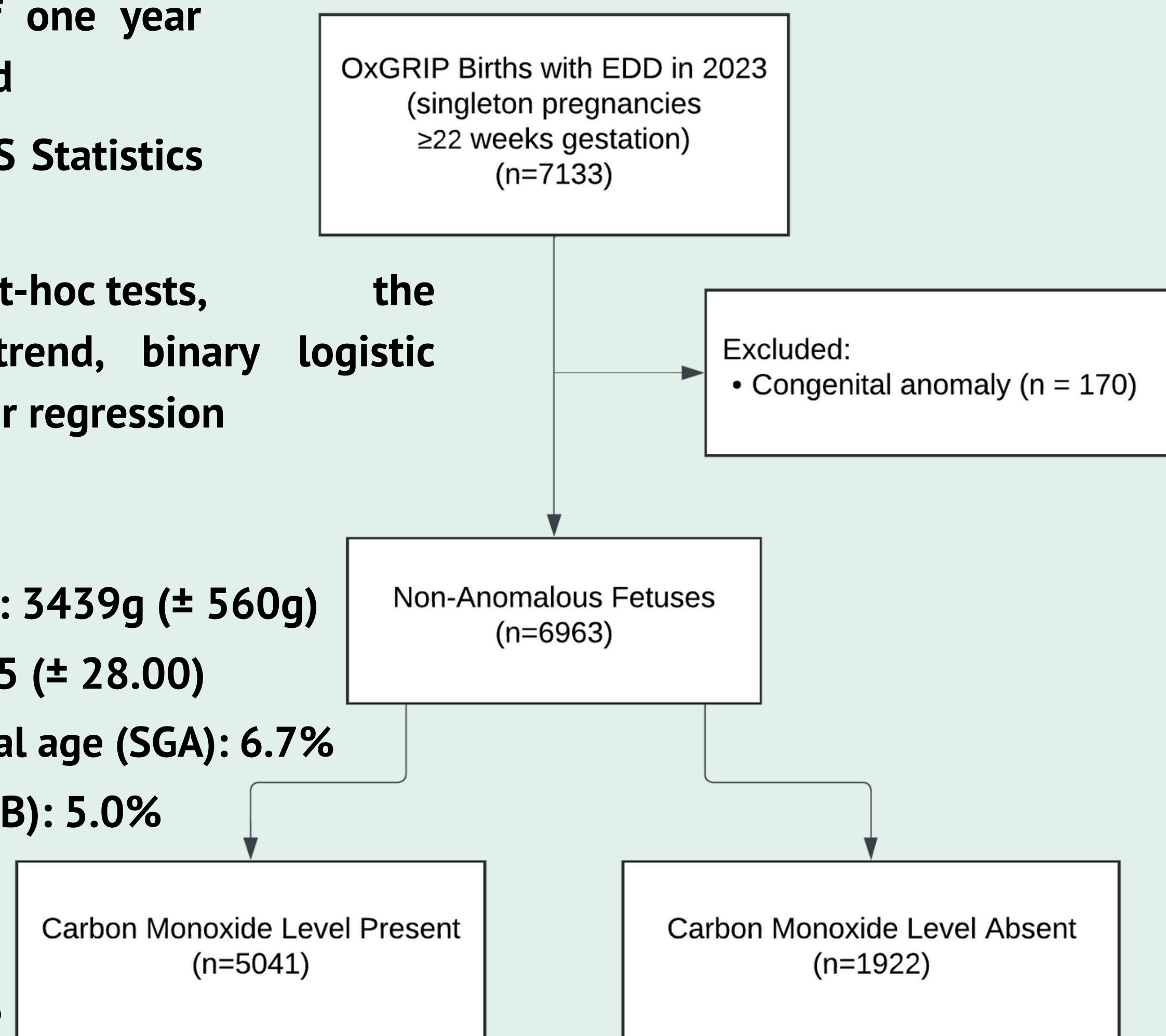


Figure 1: Flowchart summarizing population selection

GAPS IN LITERATURE

- Previous studies examined best CO thresholds for identifying smokers, but not for predicting adverse pregnancy outcomes
- Unclear whether CO is a more reliable predictor of adverse outcomes than self-reported smoking status

AIMS

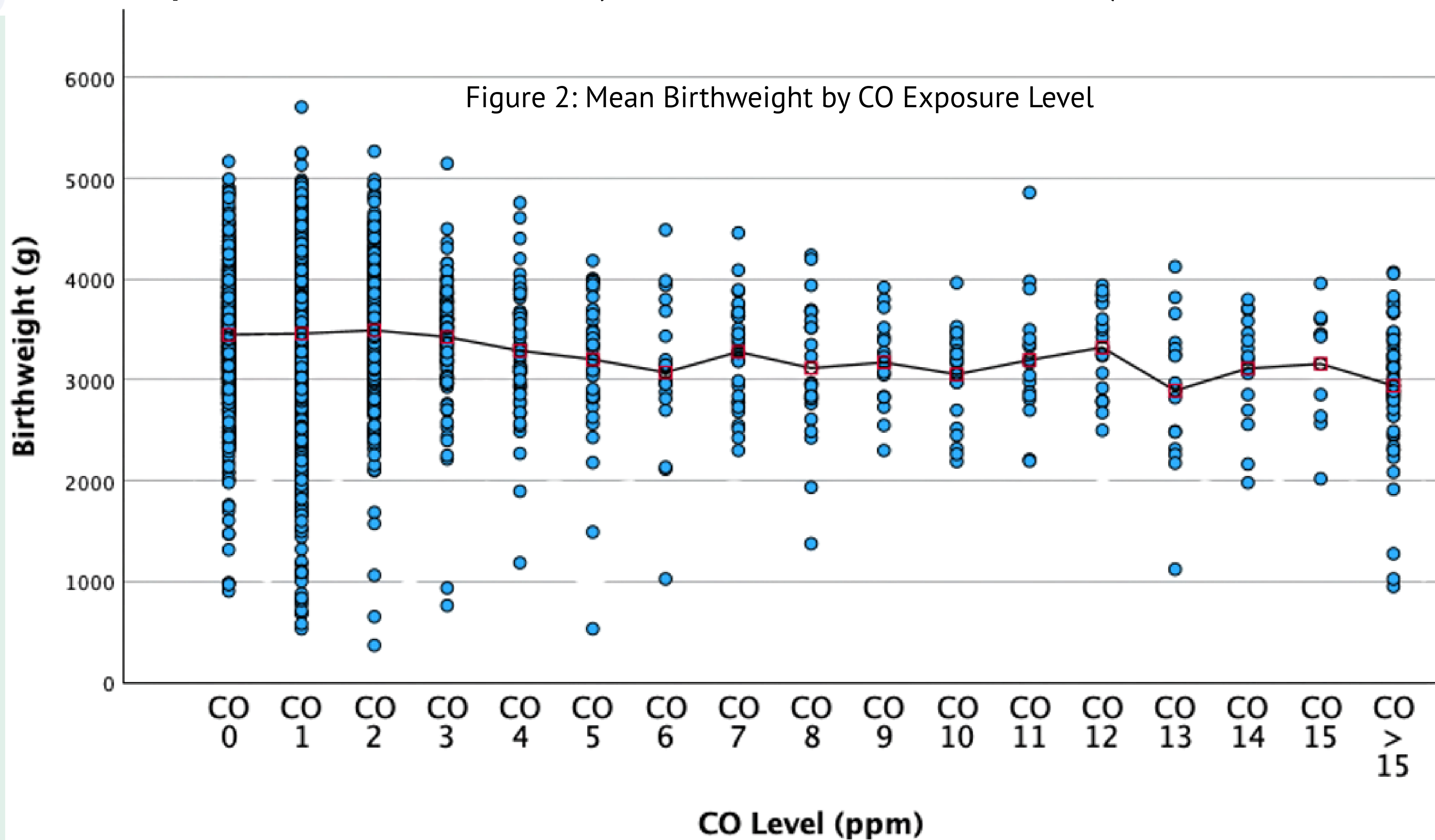
- To identify the CO threshold and relationship with adverse neonatal outcomes
- To compare the use of CO versus self-reported smoking as risk indicators

RESULTS

CO Threshold And Dose-Response Relationship

For each 1 ppm increase in CO:

- 28.03 g decrease in BW ($R^2 = 0.021$; 95% CI: -33.38, -22.69) (Figure 2)
- 0.98-point decrease in BW centile ($R^2 = 0.010$; 95% CI: -1.250, -0.712)



- Post hoc tests showed that BW in the CO <4 ppm group was significantly higher than in the CO 4–5 ppm ($p = 0.008$)
- Chi-square for trend showed a significant association between higher CO levels and increased risk of both SGA ($p < 0.001$), and PTB ($p = 0.001$), indicating a dose-response relationship

Smoking Status Versus CO Level As Predictors

- SGA risk increased with high CO levels in both smokers and nonsmokers ($p < 0.001$) (Table 1)
- PTB risk was higher in smokers, even with low CO ($p < 0.001$)
- 18% of women with CO $\geq$ 4 ppm self-identified as non-smokers
- Missing CO data: 27.6 % of 2023 births, Mean BW was lower and PTB was more frequent in the missing CO group

	Nonsmoker CO <4 N=4510	Nonsmoker CO ≥4 N=65	Smoker CO <4 N=175	Smoker CO ≥4 N=291
BW (g), mean (SD) (95% CI)	3466.64 (547.81) (3450.65 to 3482.63)	3297.15 (573.63) (3155.02 to 3439.29)	3325.16 (544.11) (3243.98 to 3406.34)	3114.80 (631.48) (3041.95 to 3187.66)
BW (centile), mean (SD) (95% CI)	55.11 (27.78) (54.32 to 55.91)	46.47 (29.93) (40.76 to 52.18)	44.48 (29.36) (36.22 to 52.74)	40.39 (27.18) (36.57 to 44.21)
SGA n (%)	266 (5.9%)	12 (18.5%)	14 (8.0%)	46 (15.8%)
SGA OR (95% CI)	1.00	3.61 (1.91 to 6.84)	1.39 (0.79 to 2.43)	3.00 (2.14 to 4.20)
PTB n (%)	200 (4.4%)	2 (3.1%)	18 (10.3%)	31 (10.7%)
PTB OR (95% CI)	1.00	0.68 (0.17 to 2.82)	2.47 (1.49 to 4.11)	2.57 (1.73 to 3.83)

Table 1: Mean Birthweight And Neonatal Outcomes by Combined Smoking Status and CO Level

CONCLUSIONS

- Breath carbon monoxide is associated with low birthweight and adverse neonatal outcomes with a clear dose response
- It can identify self-declared non-smokers who are nevertheless exposed
- The best threshold is $\geq$ 4 ppm
- The actual CO level, not just a threshold, should be used in future predictive models
- Implementing universal CO testing could help to identify at-risk pregnancies