EnviroAtlas

Applying EnviroAtlas to Public Health: Investigating the association between green space and birth outcomes in Durham-Chapel Hill, NC

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Abstract

Background: In urban areas, green space provides a variety of ecosystem services relevant to human health. Green space and tree cover can act as a buffer against environmental threats such as air pollution.

Methods: We examined the association between residential green space and tree cover with several birth outcomes, including birth weight (BWT), low birth weight (LBW), and preterm birth (PTB), controlling for maternal race, age, education, tobacco use, parity, and infant sex. We also explored proximity to major roads as a potential risk factor. Tree buffer along major roads was explored as a protective neighborhood feature.

Results: Women within 250m of a major road had increased odds of LBW, compared to the population beyond 500m. A 10% increase in both residential green space and tree cover was associated with increased BWT (50m, 100m, 250m). Tree buffer along major roads was also associated with increased BWT and decreased risk of PTB and LBW.

Conclusions: Evidence suggests that residential green space and tree cover may improve birth outcomes. In particular, tree cover along major roads may act as a buffer against near-road air pollution. Future work will explore trends across demographic characteristics such as race, income, and education.

Data

Data Sources:
- 2010 U.S. Census block groups within Durham-Chapel Hill, NC boundary
- 2010 1-m EnviroAtlas Land Cover for greater Durham, NC
- 2004-2009 North Carolina Detailed Birth Records (NC SCHS)
- 2011 NCDOT Road Characteristics Arc

Study Area & Study Population:
- Births occurring in Durham-Chapel Hill, NC (Figure 1) from 1 January 2004 - 31 December 2009 (n = 27,293)
- Area limited to geographic extent of EnviroAtlas boundary
- Restricted to: singleton births, birth order 1-4, born to Non-Hispanic White (NHW), Non-Hispanic Black (NHB), and Hispanic (H) mothers aged 15-44
- Excluded congenital anomalies, birth weight less than 400g, gestational age less than 24 weeks or over 42 weeks
- Final Study Population: n = 22,893

Objective 1: To explore the potential association between residential green space/tree cover and birth outcomes

Objective 2: To explore the potential role of tree buffer along major roads in reducing the risk of poor birth outcomes
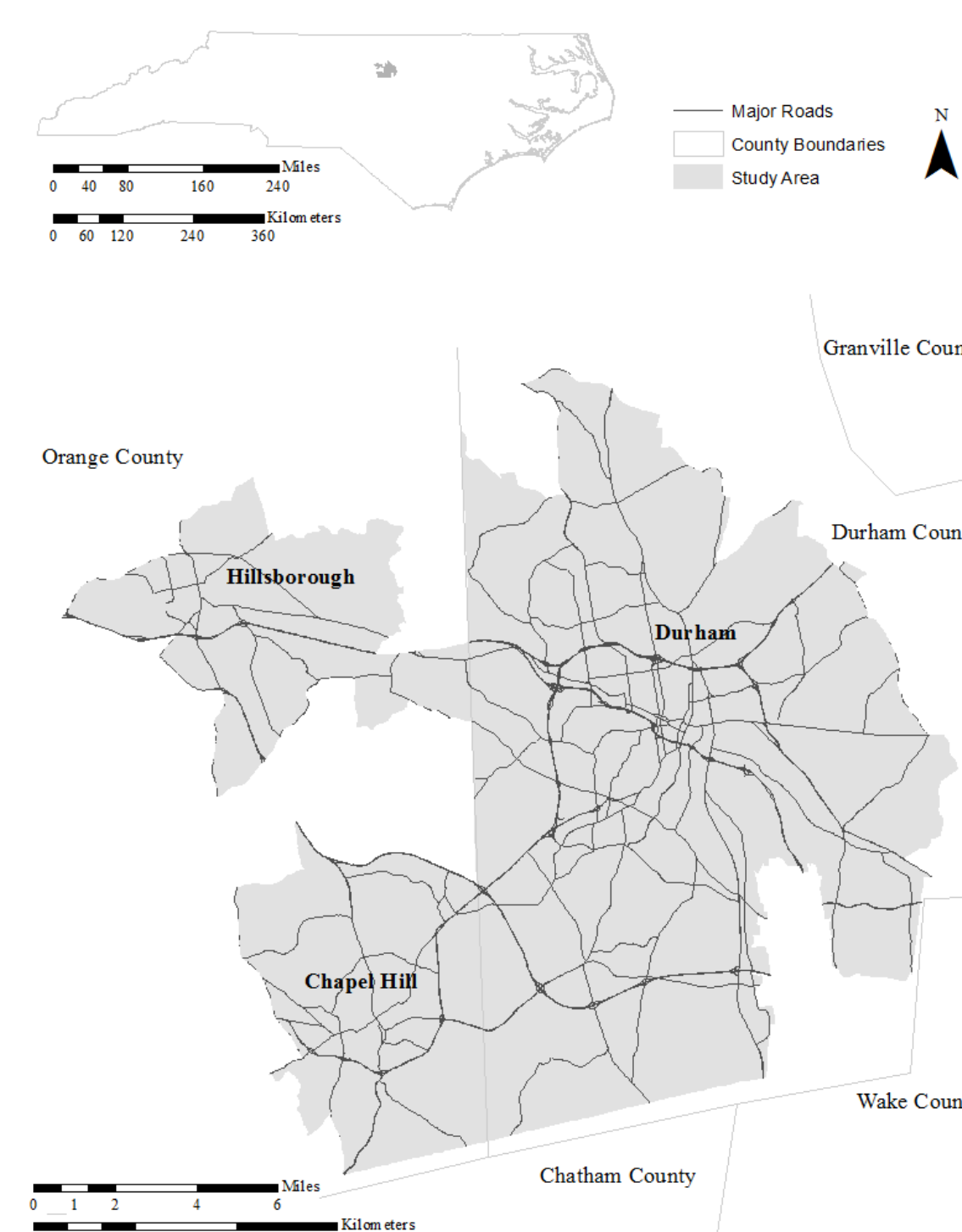

Figure 1. Study area in Durham, Chapel Hill, NC.

Methods

Creating Exposure Metrics:
1. Develop binary datasets
   a) Green space = 1
   b) Tree Cover = 1
2. Using focal statistics, calculate sum in circular buffers (50m, 100m, 250m, 500m)
   a) Total area within buffers
   b) Binary land cover within buffers
3. Extract values to points corresponding to residential address in birth dataset
4. Calculate percent values
   a) Percent green space / total area
   b) Percent tree cover / total area

Creating Near-road Buffers (Figure 2):
1. Extract 'major roads' from NCDOT Data (Func_Class <7)
2. Define road area as ½ surface width on either side of center line
3. Create 26m buffer along both sides of road area
4. Extract reclassified binary tree cover within 26m buffer along the road area
5. Using moving window analysis, calculate road area and tree buffer (tree cover=1) within 250m and 500m for every pixel
6. Extract values to points corresponding to residential address in birth dataset
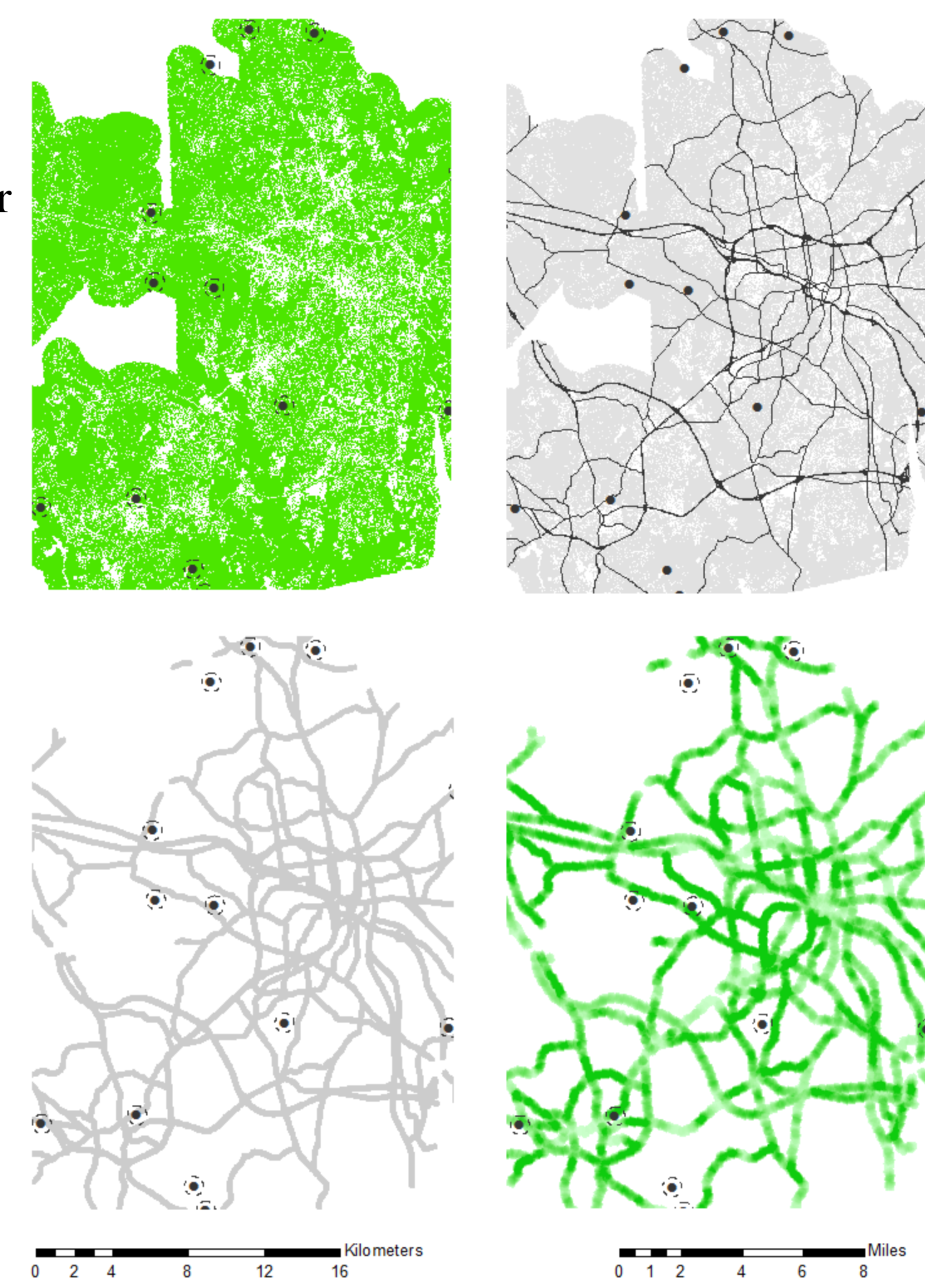

Figure 2. Methods used to calculate binary exposure metrics and percent tree cover along major roads, zoomed in on study area using hypothetical cases.

Descriptive Statistics

Table 1. Overall demographic characteristics for study population and stratified by proximity to major road

	All	Proximity to major road	
		<250m	≥250m
	n (%)	n (%)	n (%)
Total	22893 (100)	5003 (22)	17890 (78)
Maternal race/ethnicity			
Non-Hispanic white	9713 (42)	1497 (30)	8216 (46)
Non-Hispanic black	7357 (32)	1588 (32)	5769 (32)
Hispanic	5823 (26)	1918 (38)	3905 (22)
Maternal age			
15-19	2167 (10)	582 (11)	1585 (9)
20-24	4887 (21)	1426 (29)	3461 (19)
25-29	6132 (27)	1409 (28)	4723 (26)
30-34	6196 (27)	1033 (21)	5163 (29)
35-39	2949 (13)	462 (9)	2487 (14)
40-44	562 (2)	91 (2)	471 (3)
Maternal education			
<9th grade	2335 (10)	793 (16)	1542 (9)
Some high school	3480 (15)	1048 (21)	2432 (14)
Completed high school	4196 (18)	1163 (23)	3033 (17)
Some college	3060 (14)	682 (14)	2378 (13)
Completed college	9822 (43)	1317 (26)	8505 (47)
Marital status			
Married	13253 (58)	2361 (47)	10892 (61)
Not-married	9640 (42)	2642 (53)	6998 (39)
Maternal smoking status			
Smoker	1056 (5)	278 (6)	778 (4)
Non-smoker	21837 (95)	4725 (94)	17112 (96)
Maternal parity			
First birth	10143 (44)	2139 (43)	8004 (45)
Higher order birth	12750 (56)	2864 (57)	9886 (55)
Infant sex			
Male	11808 (52)	2554 (51)	9254 (52)
Female	11085 (48)	2449 (49)	8636 (48)

Table 2. Birth outcomes across demographic groups

|	Total n (%)	Birth weight (grams) mean (sd)	Pre-term birth n (%)	Low birth weight n (%)
Total	22893	3329	1795	1519
Maternal race/ethnicity				
Non-Hispanic white	9713 (42)	3460 (527)	555 (31)	365 (24)
Non-Hispanic black	7357 (32)	3132 (622)	876 (49)	871 (57)
Hispanic	5823 (26)	3359 (521)	364 (20)	283 (19)
Maternal age				
15-19	2167 (10)	3144 (566)	213 (12)	231 (15)
20-24	4887 (21)	3229 (570)	438 (25)	417 (28)
25-29	6132 (27)	3359 (565)	412 (23)	341 (22)
30-34	6196 (27)	3400 (565)	435 (24)	330 (21)
35-39	2949 (13)	3410 (575)	239 (13)	163 (11)
40-44	562 (2)	3370 (596)	58 (3)	37 (3)
Maternal education				
<9th grade	2335 (10)	3345 (499)	154 (9)	112 (8)
Some high school	3480 (15)	3193 (595)	355 (29)	347 (23)
Completed high school	4196 (18)	3225 (605)	416 (23)	386 (25)
Some college	3060 (14)	3272 (606)	306 (17)	260 (17)
Completed college	9822 (43)	3435 (541)	564 (31)	414 (27)
Marital status				
Married	13253 (58)	3412.2 (549.8)	857 (48)	626 (41)
Not-married	9640 (42)	3213.7 (589.6)	938 (52)	893 (59)
Maternal smoking status				
Smoker	1056 (4)	3030 (621)	151 (8)	163 (11)
Non-smoker	21837 (96)	3343 (569)	1644 (912)	1356 (89)
Maternal parity				
First birth	10143 (44)	3282.5 (578)	829 (46)	770 (51)
Higher order birth	12750 (56)	3354.5 (571)	966 (54)	749 (49)
Infant sex				
Male	11808 (52)	3396.0 (580)	944 (53)	677 (45)
Female	11085 (48)	3256.8 (562)	851 (47)	842 (55)
Proximity to busy road				
<250m	5003 (22)	3296.4 (593)	432 (24)	383 (25)
≥ 250m	17890 (78)	3337.6 (570)	1363 (76)	1136 (75)

Results
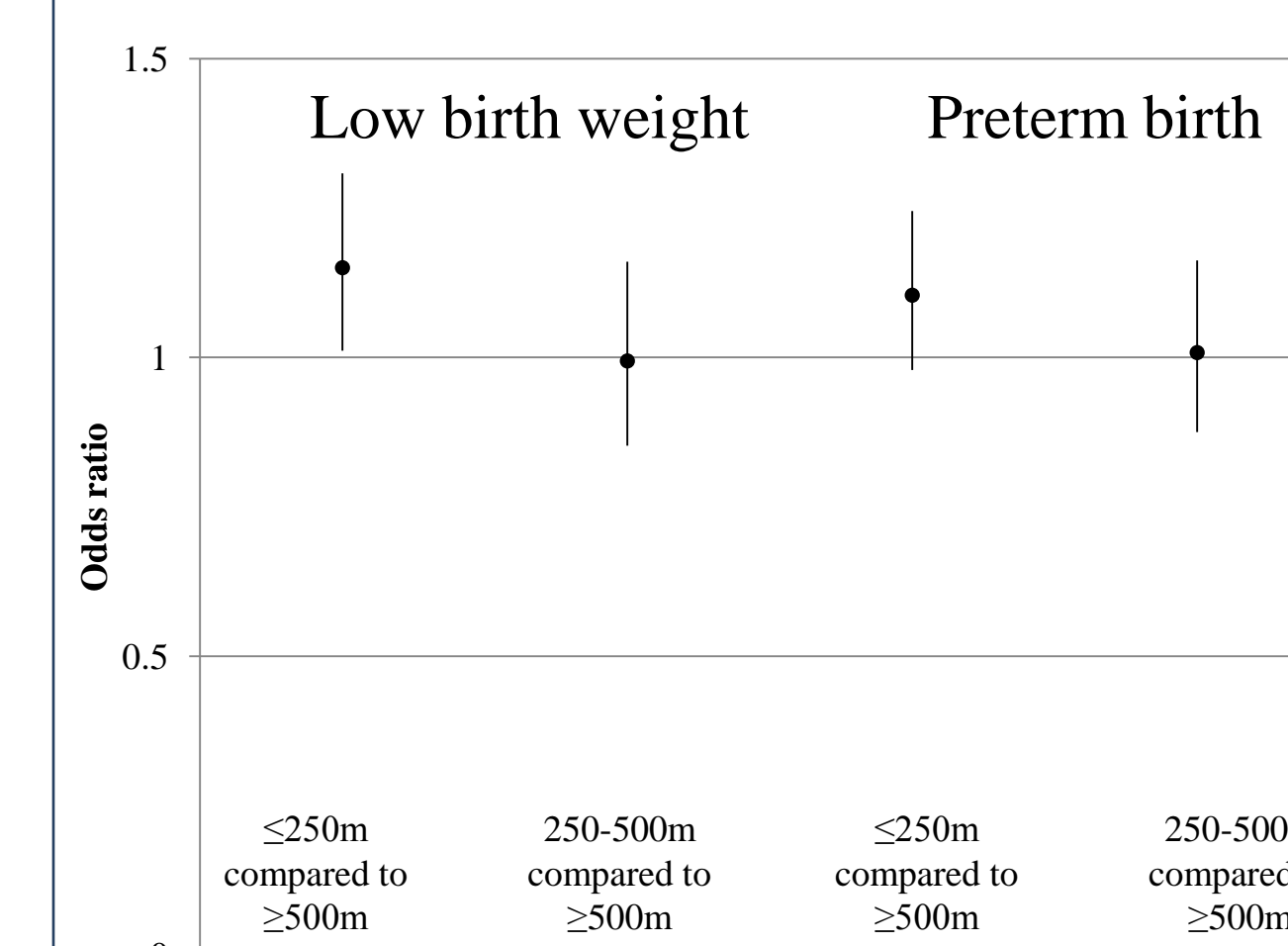
Figure 3. Effect of distance to a major road, categorized in 250m increments, on LBW and PTB.
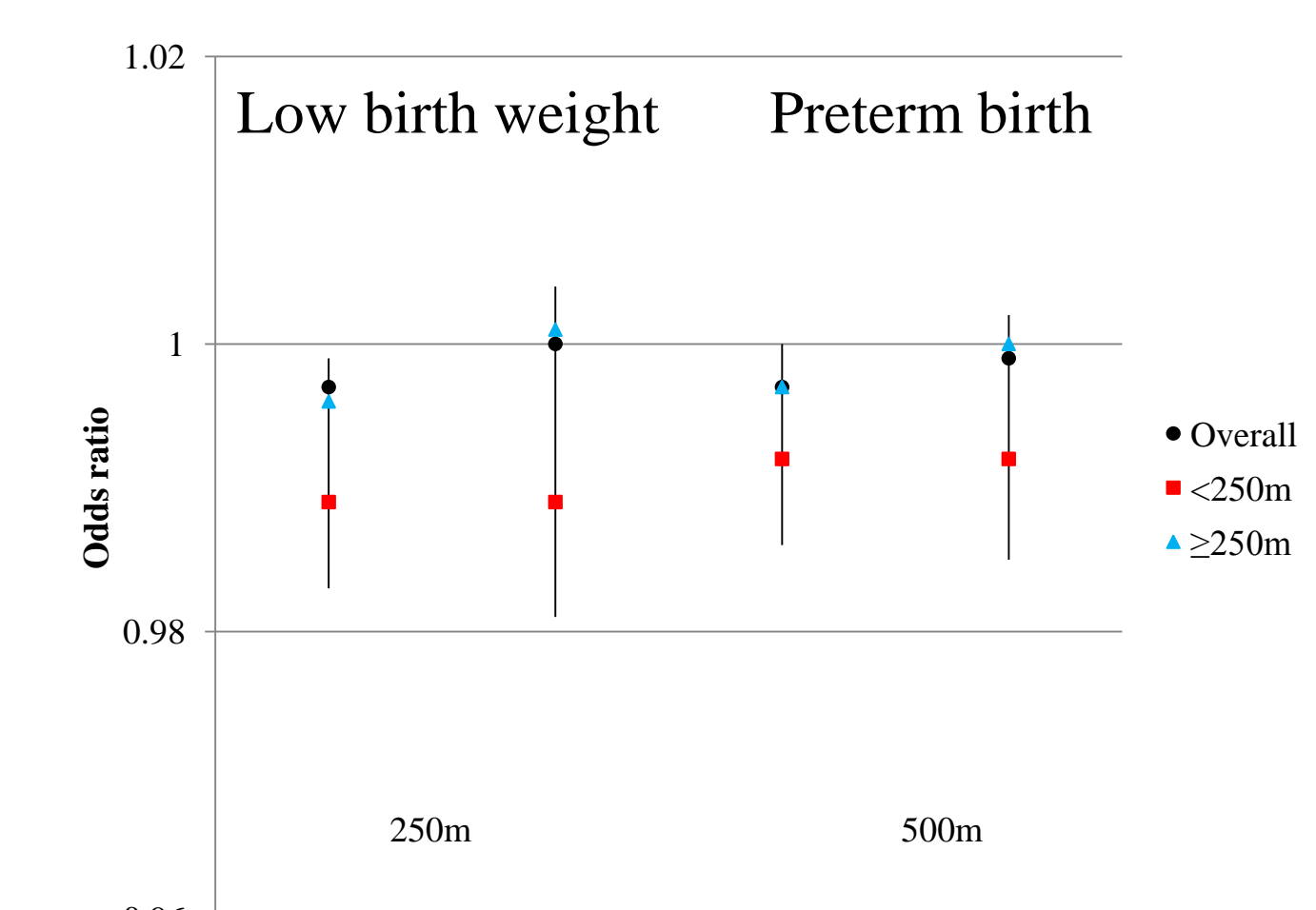

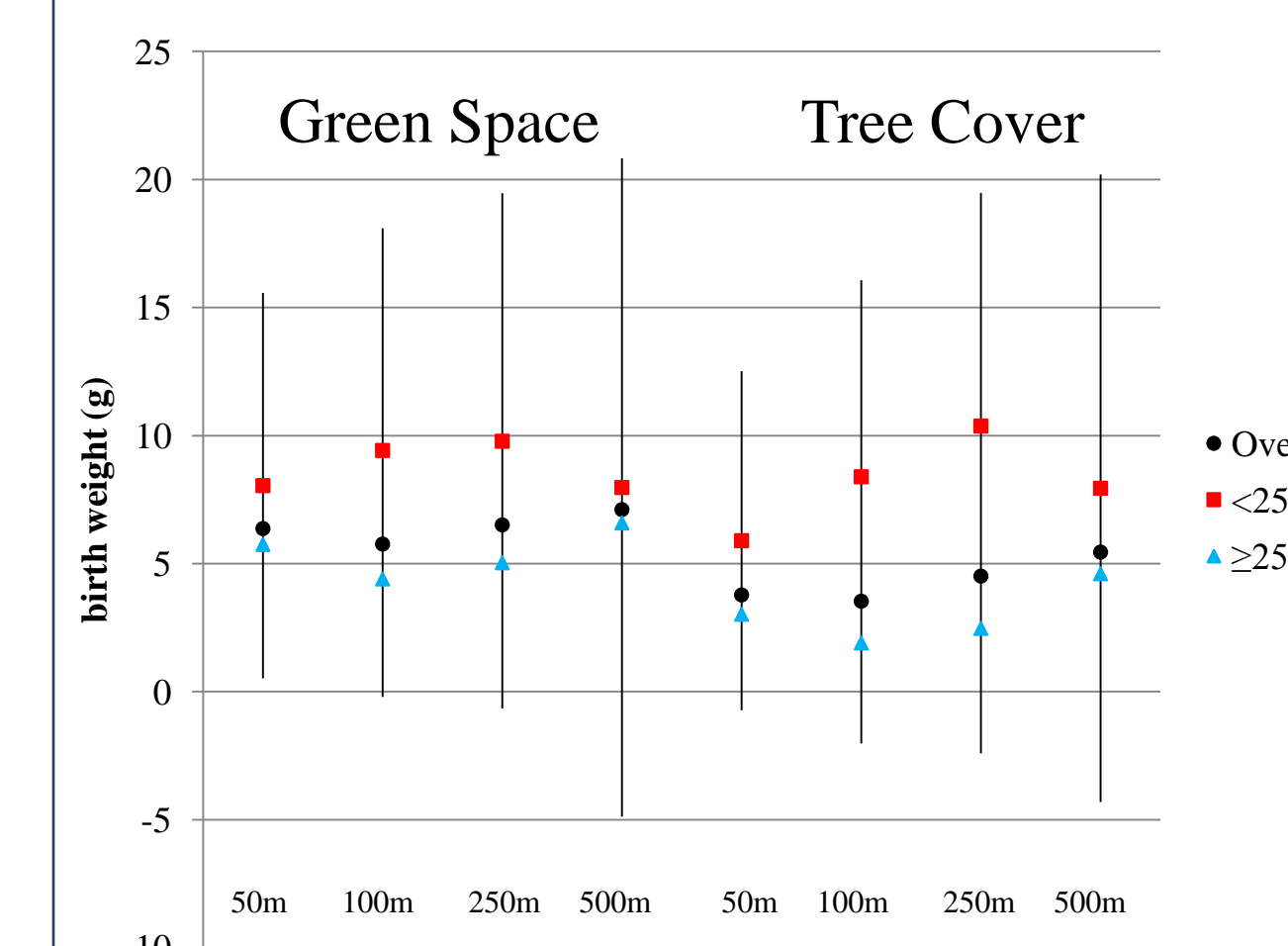Figure 5. Effect of tree buffer along major roads on LBW and PTB.

Figure 4. Effect of a 10% increase in green space and tree cover on BWT (g).

Figure 6. Effect of a 10% increase in tree buffer along major roads on BWT (g).

Results & Conclusions

Descriptive Analysis (Table 1 and Table 2):
- Study population was 42% NHW, 32% NHB, and 26% H
- 22% of study population lived within 250m of a major road
- This more vulnerable population was 38% H and 26% completed college
- Mean BWT was 3,329g (overall); 3,296g (<250m); 3,338g (≥250m)
- 8% of all births were PTB and 7% were LBW

Multivariate Analysis:
- Women living within 250m of a major road have increased odds of LBW, compared to women living beyond 500m; trend was not significant for PTB (Figure 3)
- Both percent residential green space and tree cover were associated with increased BWT, across several buffers (Figure 4)
- No significant association between green space or tree cover with PTB or LBW (results not shown)
- Tree buffer along major roads is associated with reduced odds of LBW and PTB, especially for the population within 250m of a major road (Figure 5)
- A 10% increase in tree buffer along major roads is associated with an increase in BWT (Figure 6)

Acknowledgments

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