EFFECTS OF BUFFER SIZE AND SHAPE ON ASSOCIATIONS BETWEEN THE BUILT ENVIRONMENT AND ENERGY BALANCE

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Uncertain Geographic Context Problem

- Inconsistent findings in built environment and energy balance research

- **Uncertain Geographic Context Problem**
  - "The spatial uncertainty in the actual areas that exert the contextual influences under study and the temporal uncertainty in the timing and duration in which individuals experienced these contextual influences"*

* Kwan M. *Annals of the Association of American Geographers*, 102(5) 2012, pp. 958–968.

Inconsistent Findings in Built Environment Literature

- Previous research has relied mainly on pre-defined areas, or **buffers**, around a geocoded home address

- Buffer definitions are based primarily on the **transportation literature** describing the upper limit of the distance that individuals will walk

- However, there is **no uniform buffer type** used across studies

Aims

- We examined how defining the **built environment** with different **buffer sizes and buffer shapes** could influence associations with **physical activity and BMI**

- We hypothesized that
  - Measures of **intersections** (count and density) and **businesses** (count and density) would be **positively associated with physical activity** and **negatively associated with BMI**
  - There would be an **optimal buffer shape and size** to isolate these associations

Population

- Participants were selected from two large states in the nationwide the Nurses Health Study II, a large ongoing prospective cohort study
  - All female
  - Predominantly white
  - Pennsylvania (n=11,178)
  - Texas (n=6,255)
  - Had a geocoded home address at the street level in Pennsylvania or Texas and data on BMI in the year 2009

Exposure

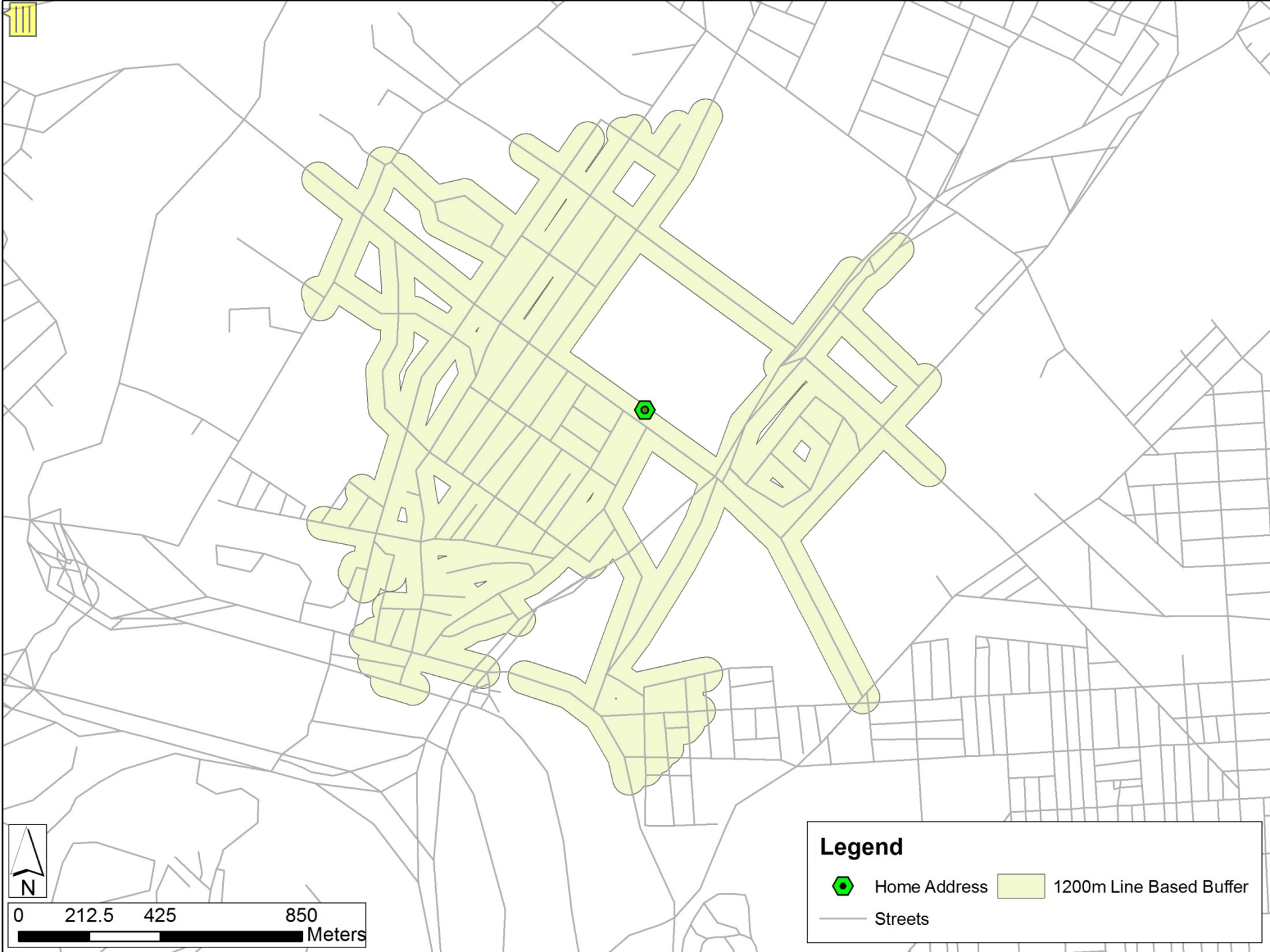
- Geocoded questionnaire mailing addresses
- Street network data from TIGER 2010-based road network (Streetmap USA, ESRI)
- Business data from the commercially available InfoUSA 2009 database

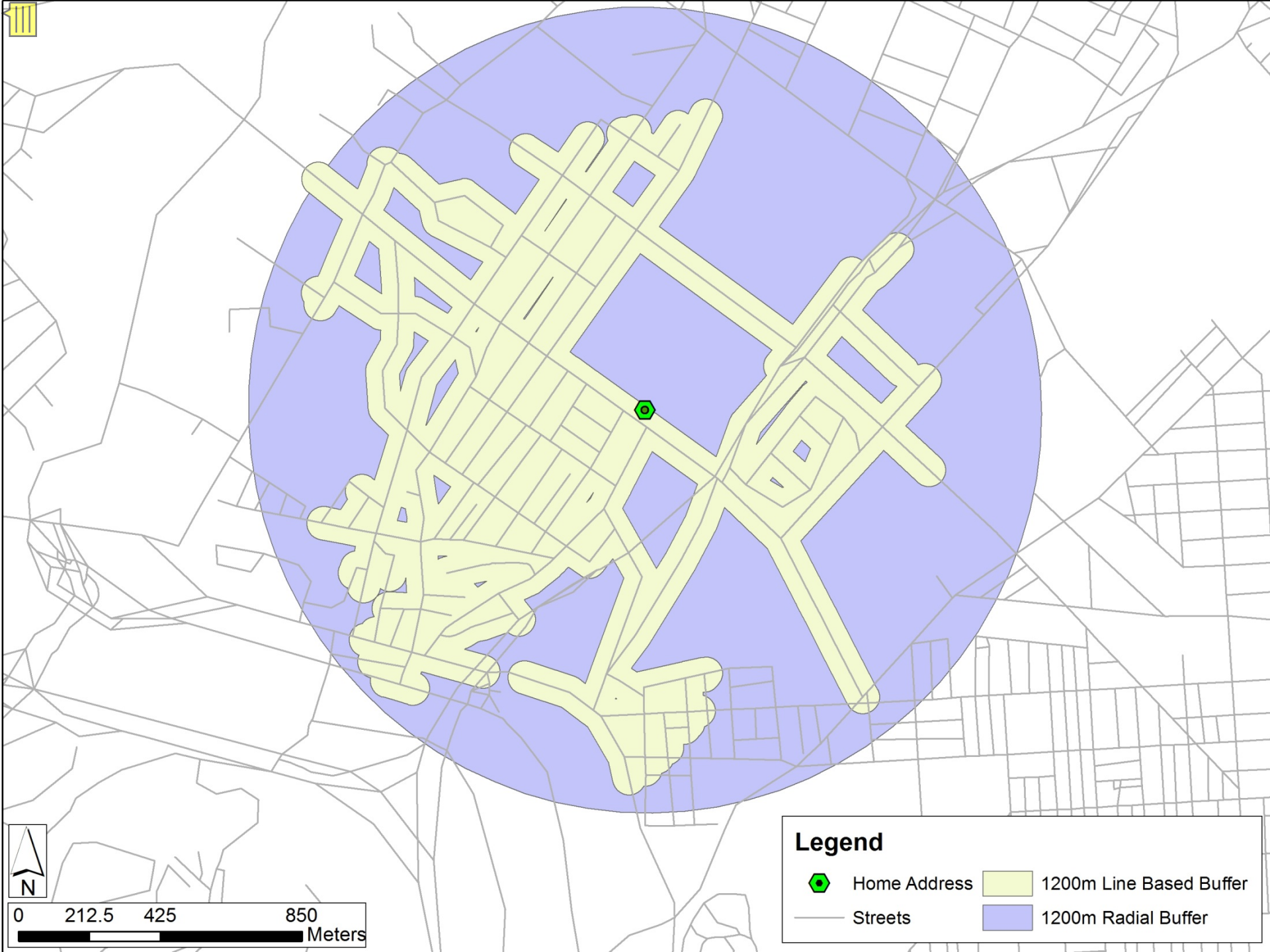
Methods: Exposure

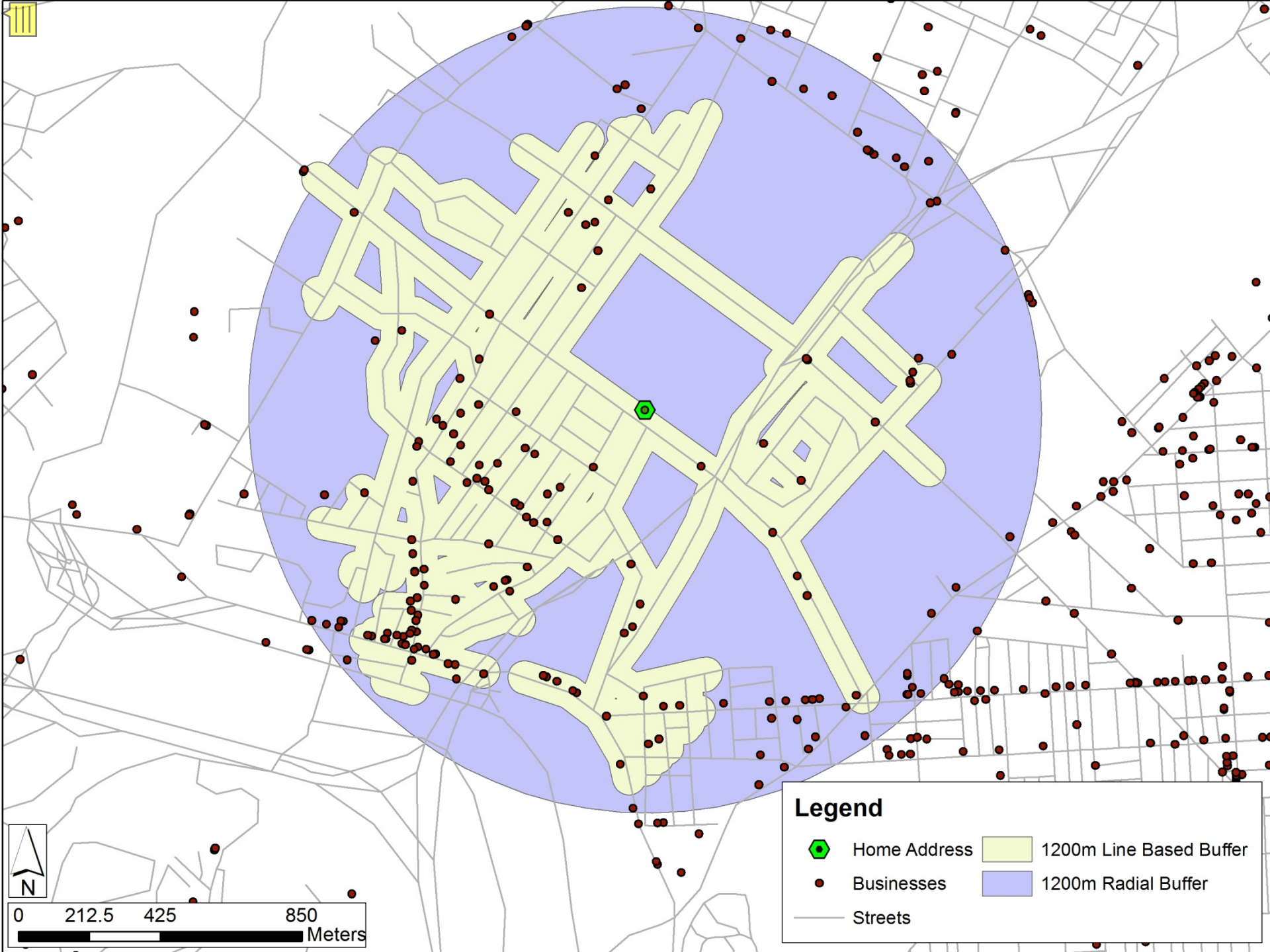
- Geographic information systems (GIS) created
  - **Line-based network and radial buffers**
  - **400m, 800m, 1200m, and 1600m**

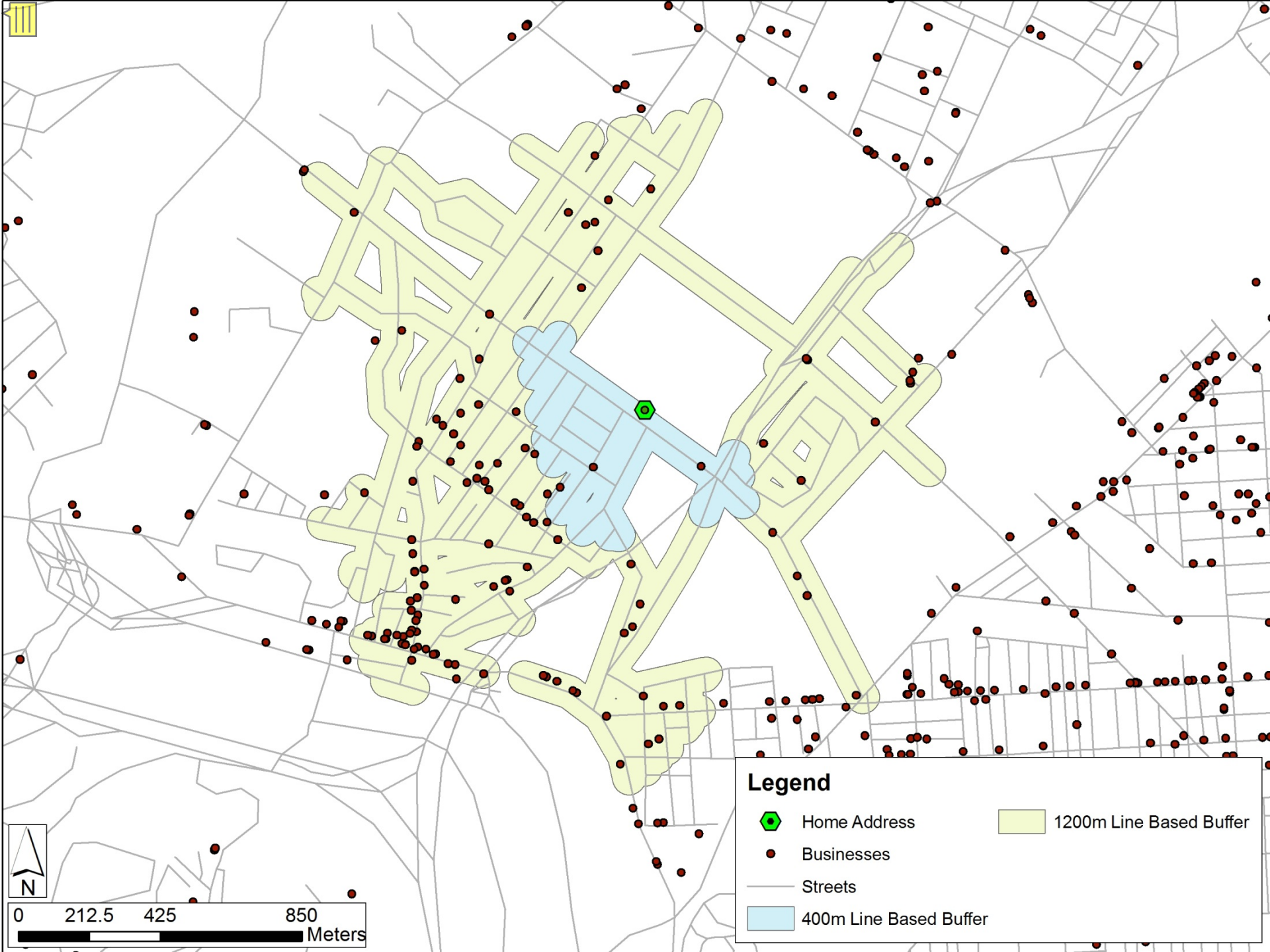
- Estimated business and intersection counts and densities within each buffer

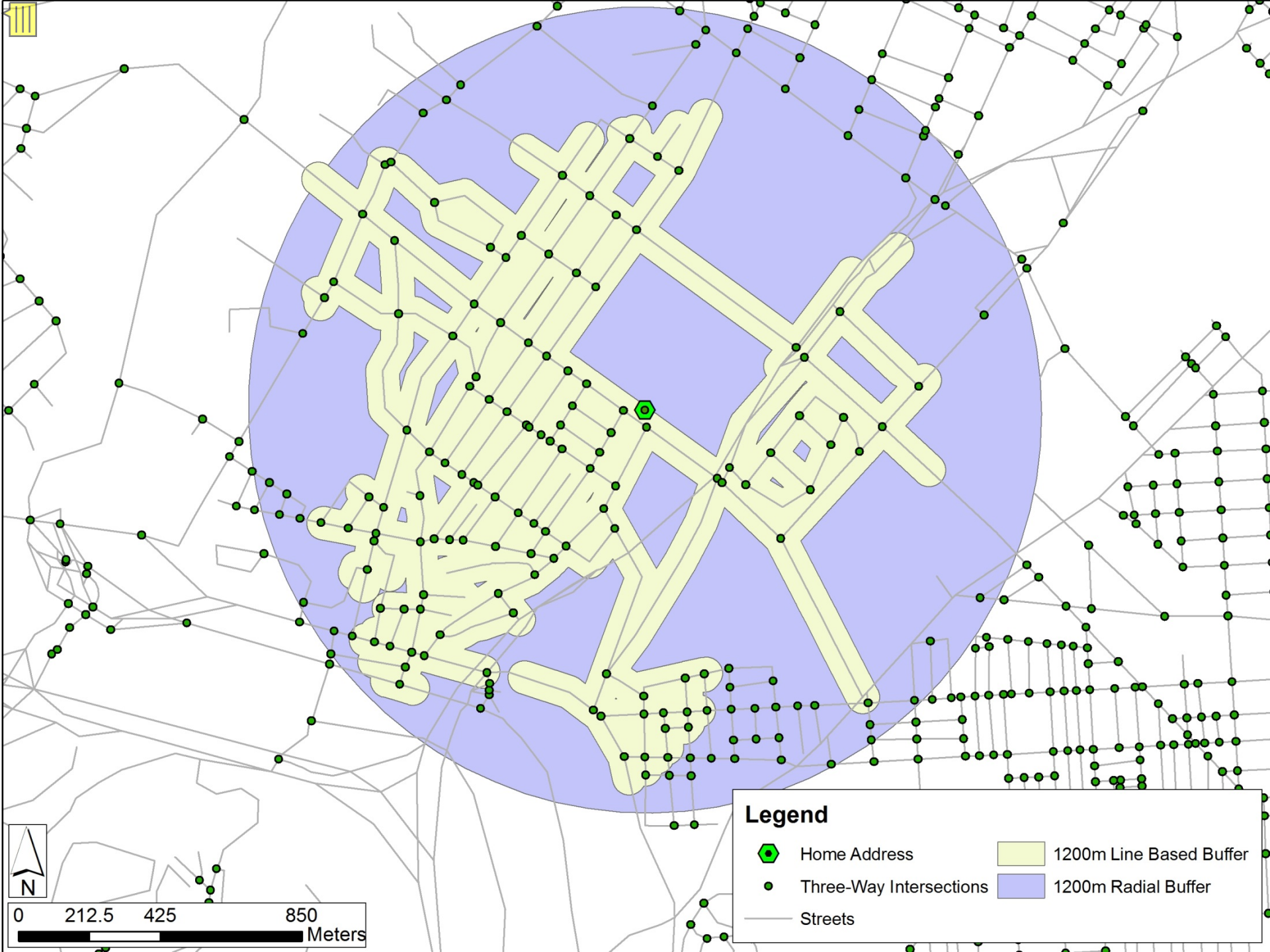

N
0
212.5
425
850
Meters
Legend
Home Address
Streets


Legend
Home Address
1200m Line Based Buffer
Streets
N
0
212.5
425
850
Meters


Legend
Home Address
1200m Line Based Buffer
Streets
1200m Radial Buffer
N
0
212.5
425
850
Meters


Legend
Home Address
1200m Line Based Buffer
Businesses
1200m Radial Buffer
Streets
N
0
212.5
425
850
Meters


Legend
Home Address
Businesses
Streets
400m Line Based Buffer
1200m Line Based Buffer
N
0
212.5
425
850
Meters


Legend
Home Address
Three-Way Intersections
Streets
1200m Line Based Buffer
1200m Radial Buffer
N
0
212.5
425
850
Meters

Methods: Outcome

- Two self-reported energy balance-related variables:
  - Body mass index (BMI) (kg/m^2)
  - Walking in metabolic equivalent hours per week (MET hrs/wk)
    - Questionnaires included recreational physical activity during the past year, with questions on the average time per week spent walking or hiking outdoors
    - Multiplied the reported time spent weekly at each activity by its typical energy expenditure requirements expressed in MET hours per week score

Methods: Statistical Analysis

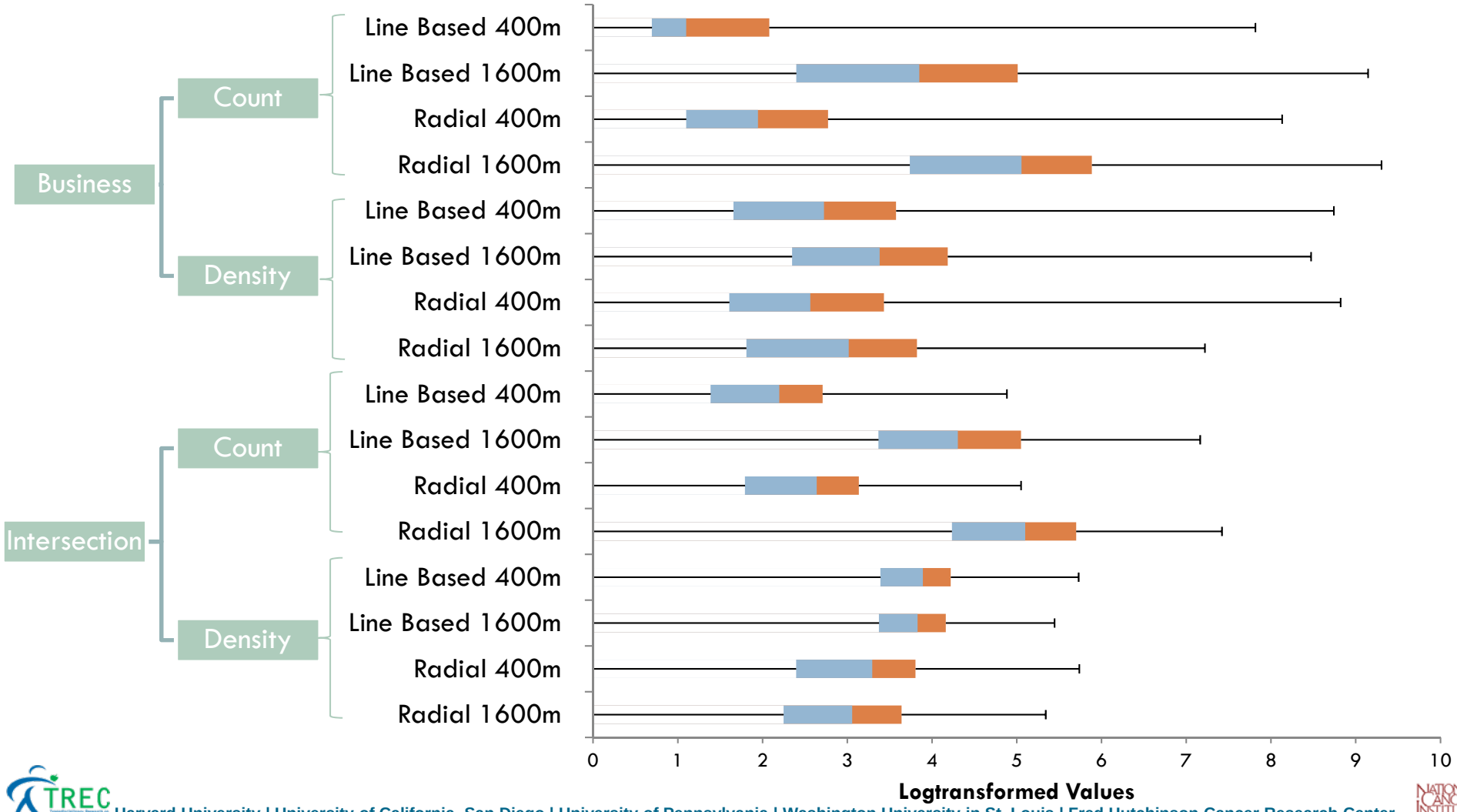
- Cross-sectional linear regression
- Log-transformed built environment variables
- Adjusted for
  - Age (in years)
  - Census tract median income (in $) and household value (in $)
  - Smoking status (never, past, current <15/day, current ≥15/day)
  - Husband's education (<HS, HS, College, Grad School, Missing or Not Married)

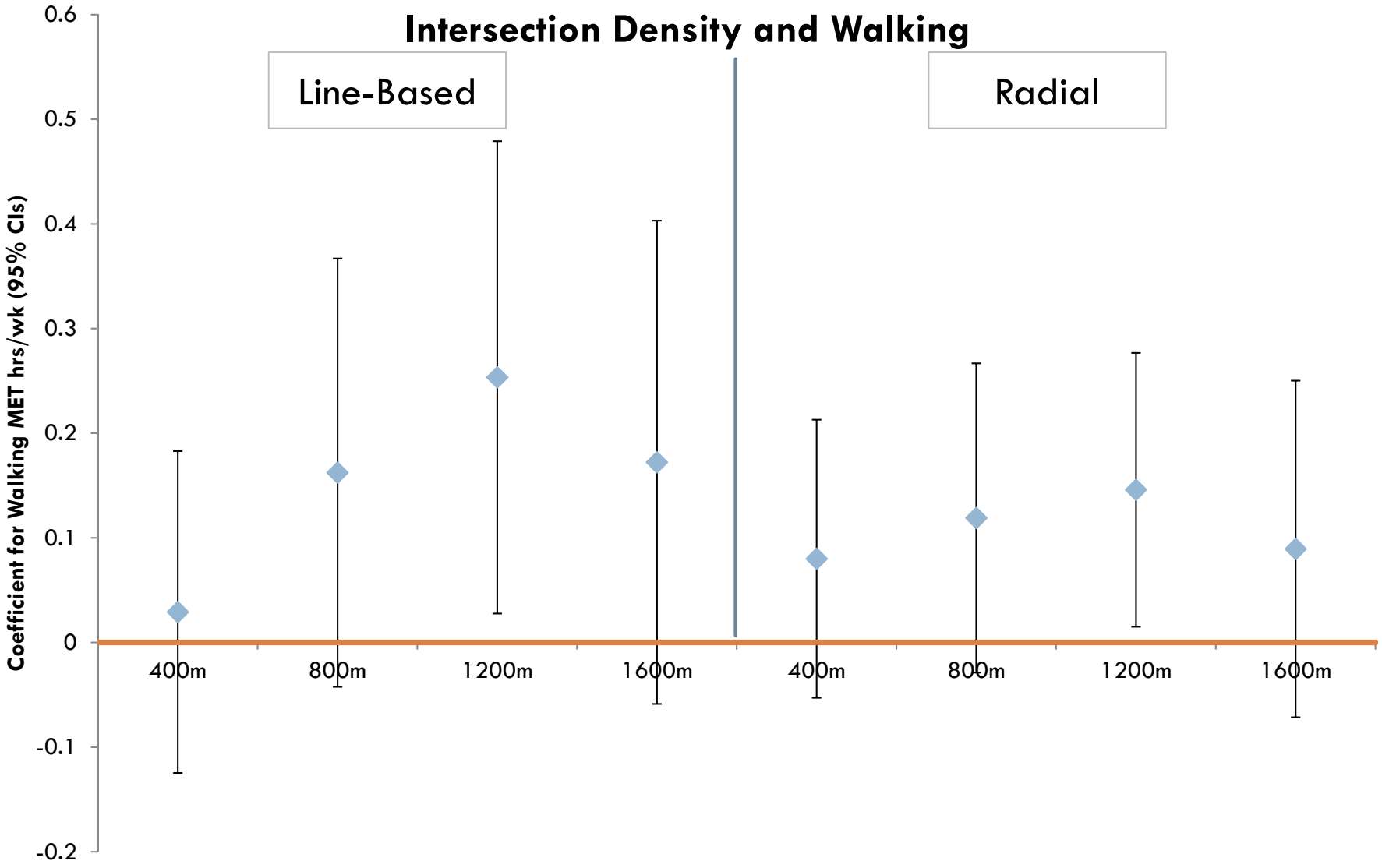
Results: N=17,433

Variable	Mean	Std Dev
BMI	28.2	6.7
Walking METs (hrs/wk)*	6.4	8.9
Census Tract Median Income	$ 63,571	$ 23,532
Census Tract Median Household Value	$ 129,349	$ 66,884
Census Tract Percent White	89.9	12.8
Census Tract Population Density	2378.2	3368.1
Census Tract Percent Urban	79.2	32.8
Census Tract Percent No High School Ed	13.3	8.6

*N=13,666 for walking analyses

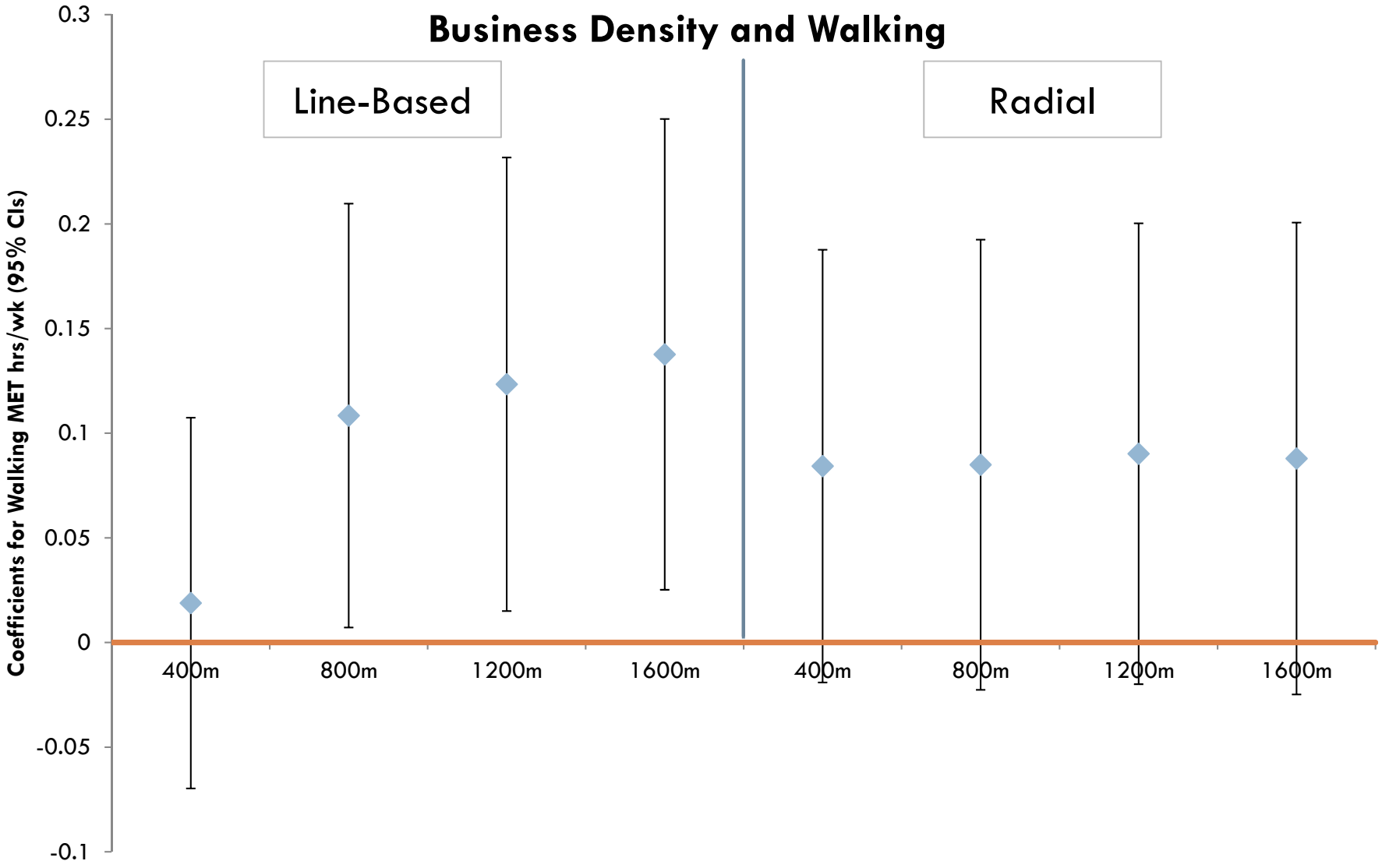
Results: N=17,433





Coefficients are presented as the effect on each outcome of a one unit increase in the lognormal value of each built environment measure

All analyses adjusted for age, Census tract median income and household value, smoking status, and husband's education



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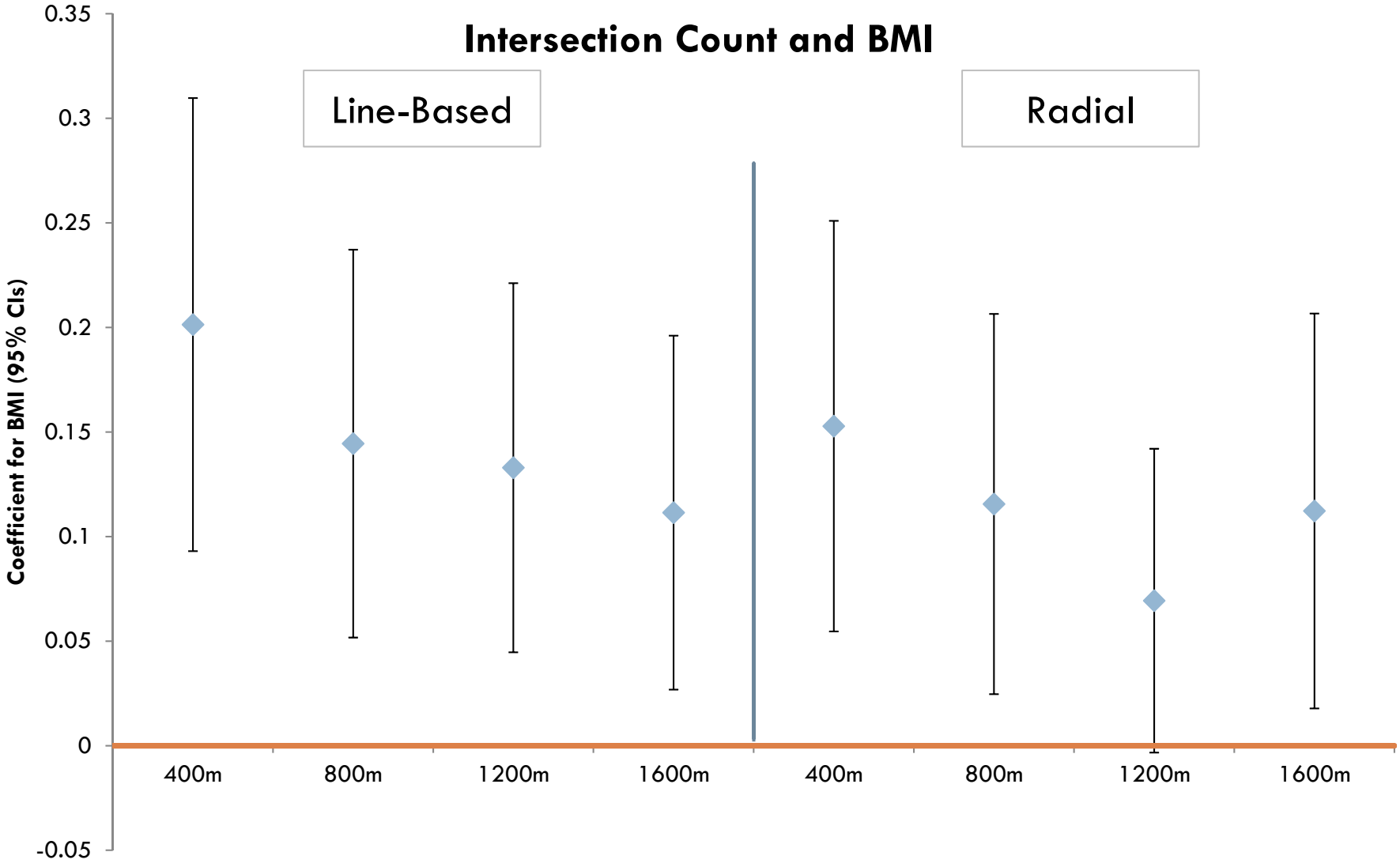

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Conclusions

- Results indicate that **the scale and type of built environment measures can have an impact on study results** and may partly explain inconsistent findings from past studies of the built environment and energy balance

- These findings underscore the issue of the **Uncertain Geographic Context Problem,** an emerging key concern for studies of associations between environment and behavior

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- Any questions or comments, please contact me

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Built Environment Measures Positively Associated with Walking

Walking		Intersection		Business	
Buffer Size	**Buffer Shape**	**Count**	**Density (count per km$^{2)}$**	**Count**	**Density (count per km$^{2)}$**
400m	Line Based	0.10 (-0.06, 0.27)	0.03 (-0.12, 0.18)	0.10 (-0.02, 0.22)	0.02 (-0.07, 0.11)
	Radial	0.09 (-0.06, 0.24)	0.08 (-0.05, 0.21)	0.10 (-0.01, 0.22)	0.08 (-0.02, 0.19)
800m	Line Based	0.14 (-0.01, 0.28)	0.16 (-0.04, 0.37)	**0.12 (0.02, 0.21)**	**0.11 (0.01, 0.21)**
	Radial	0.12 (-0.02, 0.25)	0.12 (-0.03, 0.27)	0.08 (-0.02, 0.18)	0.08 (-0.02, 0.19)
1200m	Line Based	**0.16 (0.02, 0.29)**	**0.25 (0.03, 0.48)**	**0.10 (0.01, 0.19)**	**0.12 (0.02, 0.23)**
	Radial	**0.13 (0.02, 0.24)**	**0.15 (0.02, 0.28)**	0.08 (-0.02, 0.17)	0.09 (-0.02, 0.20)
1600m	Line Based	0.12 (-0.01, 0.25)	0.17 (-0.06, 0.40)	**0.10 (0.02, 0.19)**	**0.14 (0.03, 0.25)**
	Radial	0.09 (-0.05, 0.23)	0.09 (-0.07, 0.25)	0.07 (-0.02, 0.17)	0.09 (-0.02, 0.20)

All analyses adjusted for age, Census tract median income and household value, smoking status, and husband's education

Coefficients are presented as the effect on each outcome of a one unit increase in the lognormal value of each built environment measure

Bolded coefficients indicate $p < 0.05$

BMI Positively Associated with Built Environment Measures

BMI		Intersection		Business	
Buffer Size	**Buffer Shape**	**Count**	**Density (count per km$^{2)}$**	**Count**	**Density (count per km$^{2)}$**
400m	Line Based	**0.20 (0.09, 0.31)**	**0.16 (0.06, 0.26)**	**0.10 (0.02, 0.19)**	**0.08 (0.02, 0.14)**
	Radial	**0.15 (0.05, 0.25)**	**0.13 (0.04, 0.22)**	**0.11 (0.03, 0.19)**	**0.11 (0.04, 0.18)**
800m	Line Based	**0.14 (0.05, 0.24)**	**0.15 (0.01, 0.28)**	**0.09 (0.03, 0.16)**	**0.09 (0.03, 0.16)**
	Radial	**0.12 (0.02, 0.21)**	**0.13 (0.03, 0.22)**	**0.09 (0.03, 0.16)**	**0.10 (0.02, 0.17)**
1200m	Line Based	**0.13 (0.04, 0.22)**	**0.17 (0.02, 0.32)**	**0.09 (0.03, 0.14)**	**0.09 (0.02, 0.16)**
	Radial	**0.07 (0.00, 0.14)**	**0.09 (0.00, 0.18)**	**0.07 (0.01, 0.13)**	**0.08 (0.00, 0.15)**
1600m	Line Based	**0.11 (0.03, 0.20)**	0.15 (-0.01, 0.30)	**0.08 (0.02, 0.14)**	**0.09 (0.02, 0.17)**
	Radial	**0.11 (0.02, 0.21)**	**0.13 (0.02, 0.23)**	**0.07 (0.01, 0.13)**	**0.07 (0.00, 0.15)**

All analyses adjusted for age, Census tract median income and household value, smoking status, and husband's education

Coefficients are presented as the effect on each outcome of a one unit increase in the lognormal value of each built environment measure

Bolded coefficients indicate $p < 0.05$