

Association between density of food retailers and fitness centers and gestational diabetes mellitus in Eastern Massachusetts



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Background

- Gestational diabetes mellitus (GDM) is onset of glucose intolerance during pregnancy
- Affects 2-10% of pregnant individuals in US¹
- Can result in long-term metabolic risks to mother and child²
- Diet and exercise are modifiable risk factors for GDM³, influenced by availability, accessibility, and affordability of retailers⁴
- Food & physical activity (PA) environment shown to affect diet and exercise during pregnancy⁵
- Also documented link between less healthy food environments and increased GDM risk^{6,7}
 - Previous studies used single exposure (e.g. grocery store density only)^{6,7}
 - Measured food retailer density at census tract or zip-code level
 - Unable to examine heterogeneity at granular scale
- No studies assessing fitness center density and GDM risk

Methods

Study population

- Prenatal and obstetric data obtained from Beth Israel Deaconess Medical Center (BIDMC) from 2000 through 2016
- BIDMC is a tertiary-care hospital in Boston, that serves Eastern MA
- 68,779 pregnancies in final sample

Exposures

- Density of food establishments and fitness centers across the contiguous US from every two-year period from 1998-2016, obtained from Infogroup US Historical Business Data⁸
- Classified as: “fast-food restaurant”, “full-service restaurant”, “convenience store”, “supermarket or grocery store” and “fitness center” based on North American Industry Classification System 6-digit (NAICS6)
- Retailers counter in 500 (10-minute walk), 1000, and 1500 meter (15–20-minute walk) circular buffers in each cell

Outcome

- GDM diagnosis as defined by International Classification of Diseases (ICD)-9 and ICD-10

Covariates

- Marital status, maternal age, maternal education, insurance type (public/private), parity, race/ethnicity and fetal sex, median household income and population density (obtained from the 2010 US census)

Analysis

- Exposure variables grouped into tertiles since they were skewed left
- High percentage of residences had zero retailers within 500-1,500 m
- Exposure variables linked to participants’ residential address on delivery date
- Logistic regression assessed the relationship between food and physical activity environment and odds of GDM
- Models built separately at each buffer (500 m, 1,000 m, 1,500 m)

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Results

GDM prevalence was 4.5% (n=3,094)

Table 1. Characteristics of study population by tertile of fast-food restaurant density at 1,500 m buffer

	Low (0-6) (N=24,409)	Middle (7-16) (N=24,317)	High (17+) (N=20,064)
Age (Mean (SD))	32.6 (4.8)	31.2 (5.5)	31.2 (5.2)
Race/ethnicity (N (%))			
White	16,869 (69)	11,809 (49)	8,983 (45)
Black	1,783 (7)	4,011 (16)	2,003 (10)
Hispanic	603 (2)	1,658 (7)	1,429 (7)
Asian	2,089 (9)	3,472 (14)	4,162 (21)
Unspecified	3,065 (13)	3,367 (14)	3,487 (17)
Insurance (N (%))			
Public/uninsured	1,964 (8)	4,908 (20)	4,083 (20)
Private	22,445 (92)	19,409 (80)	15,981 (80)
Maternal education (N (%))			
College or higher	7,312 (30)	6,645 (27)	5,364 (27)
Lower than college	2,844 (12)	5,085 (21)	4,096 (20)
Unspecified	14,253 (58)	12,587 (52)	10,604 (53)
Parity (N (%))			
First born	9,857 (40)	11,640 (48)	11,193 (56)
Second or more	14,552 (60)	12,677 (52)	8,871 (44)
Population density (N (%))			
Low (0-2,685 people/mile ²)	16,612 (68)	5,115 (21)	631 (3)
Middle (2,686-10,000 ppl/mile ²)	6,334 (26)	11,897 (49)	4,499 (22)
High (>10,000 people/mile ²)	1,457 (6)	7,303 (30)	14,931 (74)
Area deprivation index (Mean (SD))	13.36 (9.89)	18.59 (11.78)	15.33 (11.13)

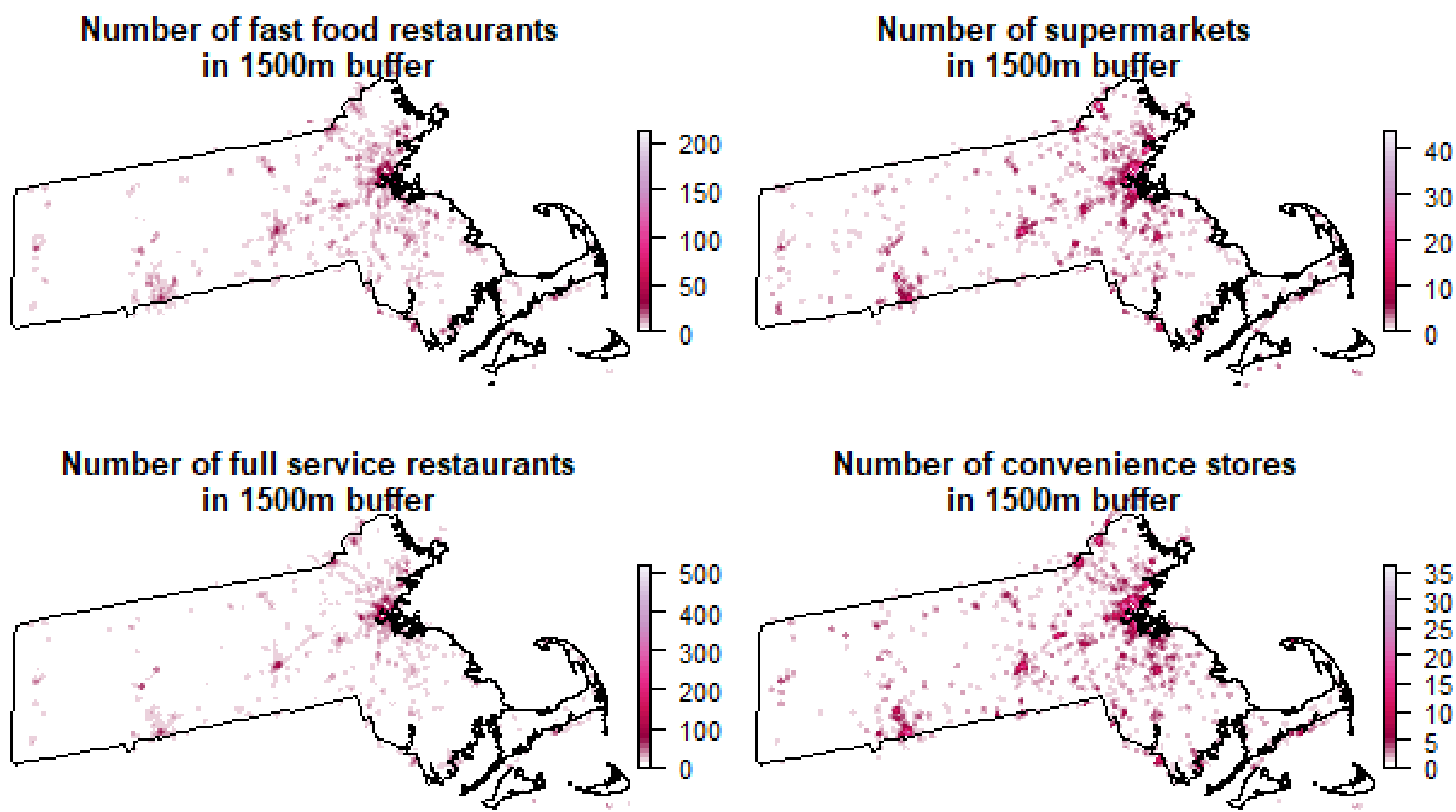


Figure 1. Map of food and physical activity environment (density at 1500 m) in Massachusetts

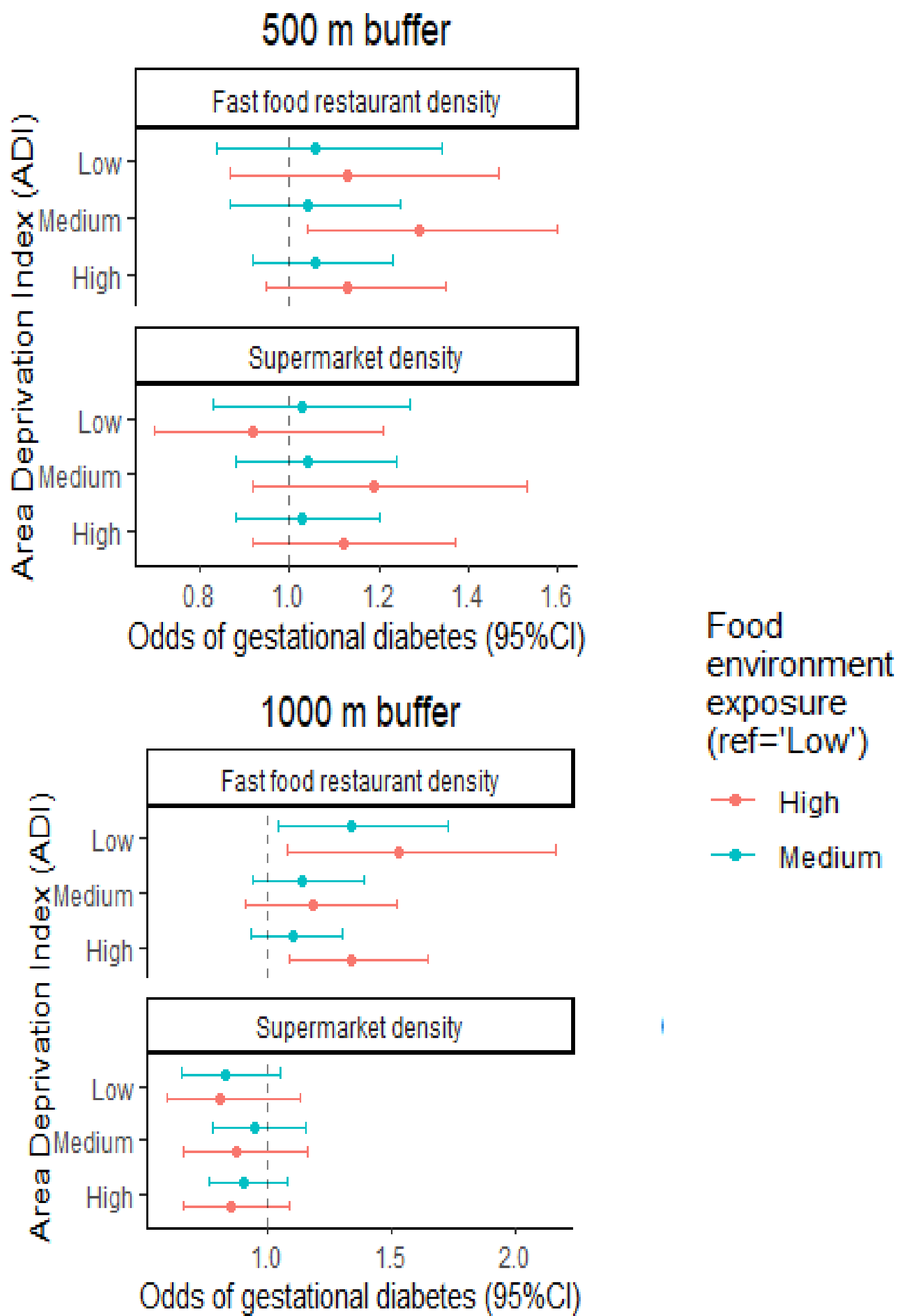


Figure 2. Association between density of fast-food restaurants and supermarkets stratified by Area Deprivation Index (ADI)

Table 2. Association between food and physical activity environment variables and odds of having gestational diabetes mellitus (GDM) in Eastern Massachusetts

Exposure	Buffer	Density tertile (ref = lowest)	Adjusted odds ratio (95% CI) ²
Supermarkets	500 m	1-2	1.04 (0.94, 1.15)
		3+	1.02 (0.89, 1.17)
	1000 m	1-4	0.90 (0.81, 1.00)*
		5+	0.86 (0.74, 0.99)*
	1500 m	3-10	1.02 (0.90, 1.15)
		11+	0.86 (0.72, 1.01)
Fast-food restaurants	500 m	1-2	1.08 (0.97, 1.19)
		3+	1.19 (1.06, 1.33)*
	1000 m	3-8	1.17 (1.04, 1.31)*
		9+	1.33 (1.15, 1.53)*
	1500 m	7-16	1.11 (0.98, 1.24)
		17+	1.18 (1.01, 1.38)*
Full-service restaurants ³	500 m	1-6	1.19 (1.06, 1.33)*
		7+	0.99 (0.84, 1.16)
	1000 m	6-22	0.99 (0.86, 1.13)
		23+	0.93 (0.77, 1.12)
	1500 m	16-50	1.07 (0.92, 1.23)
		51+	1.14 (0.92, 1.42)
Convenience stores	500 m	1	1.01 (0.91, 1.12)
		2+	1.01 (0.90, 1.13)
	1000 m	2-5	0.96 (0.86, 1.07)
		6+	0.95 (0.82, 1.10)
	1500 m	2-7	0.92 (0.82, 1.03)
		8+	0.98 (0.83, 1.16)
Fitness centers	500 m	1	0.97 (0.87, 1.07)
		2+	0.87 (0.76, 0.99)*
	1000 m	1-2	1.08 (0.98, 1.20)
		3+	1.00 (0.88, 1.13)
	1500 m	3-5	0.96 (0.87, 1.06)
		6+	0.89 (0.79, 1.01)

Adjusted models control for maternal race/ethnicity, maternal age, maternal education, parity, type of insurance (public/private), zip code-level median household income, zip code-level population density and Area Deprivation Index. Odds ratios for full-service restaurant density do not include other food environment variables due to multicollinearity
*=significant at alpha=0.05 level

Conclusion

- Greater density of fast-food retailers associated with increased odds of GDM after adjusting for socioeconomic and individual factors
- Higher density of supermarkets and fitness centers associated with a lower odds of GDM
- No effect modification by area-level socioeconomic status
- Policymakers and city planners should consider zoning laws that lower the number of fast-food restaurants and replace with supermarkets or other affordable healthier food options to potentially help mitigate the burden of GDM.
- Expanding access to affordable indoor fitness centers may also help lower prevalence of GDM in Eastern Massachusetts.

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