
SUPPLEMENTAL MATERIALS

Mediation of an association between neighborhood socioeconomic environment and type 2 diabetes through the leisure-time physical activity environment in an analysis of three independent samples

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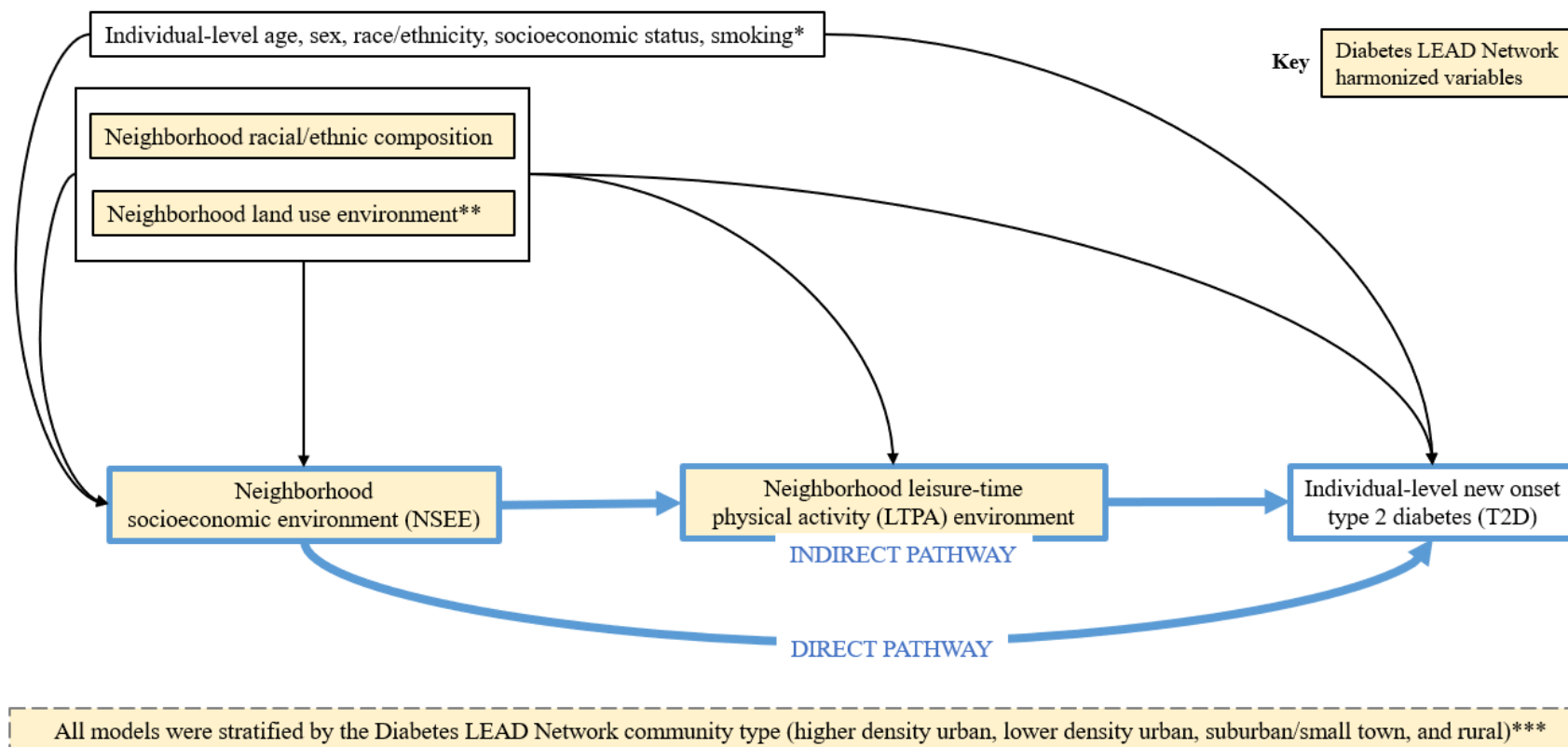
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Figure S1. Conceptual diagram of the hypothesized pathway between NSEE and T2D via the leisure-time physical activity environment



Notes:

Location, Environmental Attributes, and Disparities

*Only the REGARDS and Geisinger models adjusted for smoking status because of a high proportion of missing data on smoking status in the VADR.

**Factor scores from a multiple group confirmatory factor analysis of 7 components of the built environment (average block length, average block size, intersection density, street connectivity, establishment density, percent developed land, and household density)

***Community type categorized were created by modifying the US Department of Agriculture Rural-Urban Commuting Area methodology to better differentiate urban cores from surrounding non-rural areas,

Figure S2. Distribution of neighborhood socioeconomic environment (NSEE) by community type and study sample

The summed z-scores of NSEE were created for each census tract within community type and scaled to range from 0-100 within community type; thus, NSEE values should only be compared *within* a community type and cannot be directly compared *across* community types. NSEE was assigned to participants based on cohort entry or case/control selection as defined in the site-specific methods. Higher NSEE values indicate greater socioeconomic disadvantage compared to lower values. Within each boxplot, the shaded box represents the interquartile range (25th to 75th percentile) and the central horizontal line indicates the 50th percentile (median) value. The whiskers extend to 1.5 times the interquartile range. Values larger or smaller than 1.5 times the interquartile range are plotted as individual points.

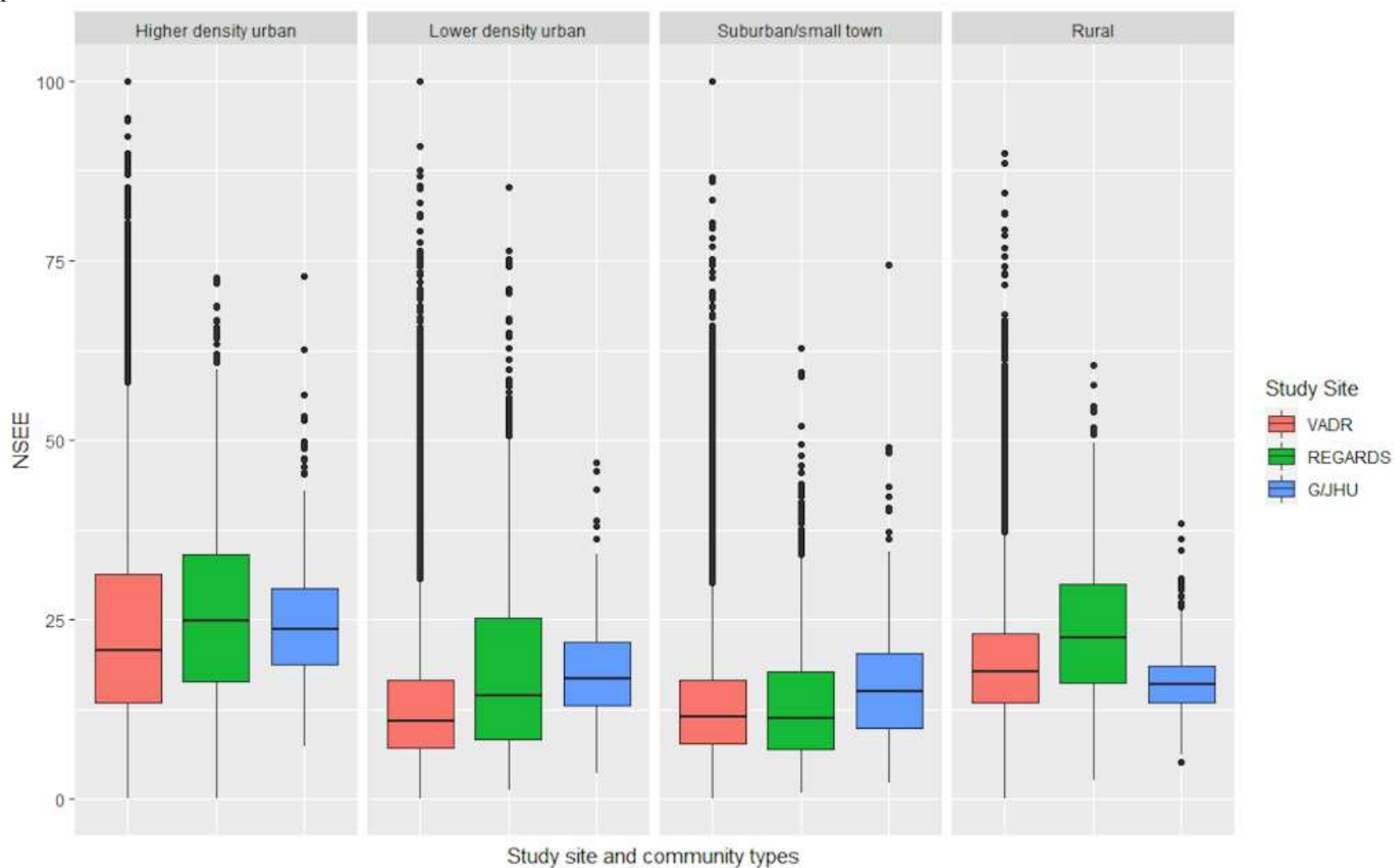


Figure S3. Distribution of physical activity facility density by community type and study sample

Within each boxplot, the shaded box represents the interquartile range (25th to 75th percentile) and the central horizontal line indicates the 50th percentile (median) value. The whiskers extend to 1.5 times the interquartile range. Values larger or smaller than 1.5 times the interquartile range are plotted as individual points.

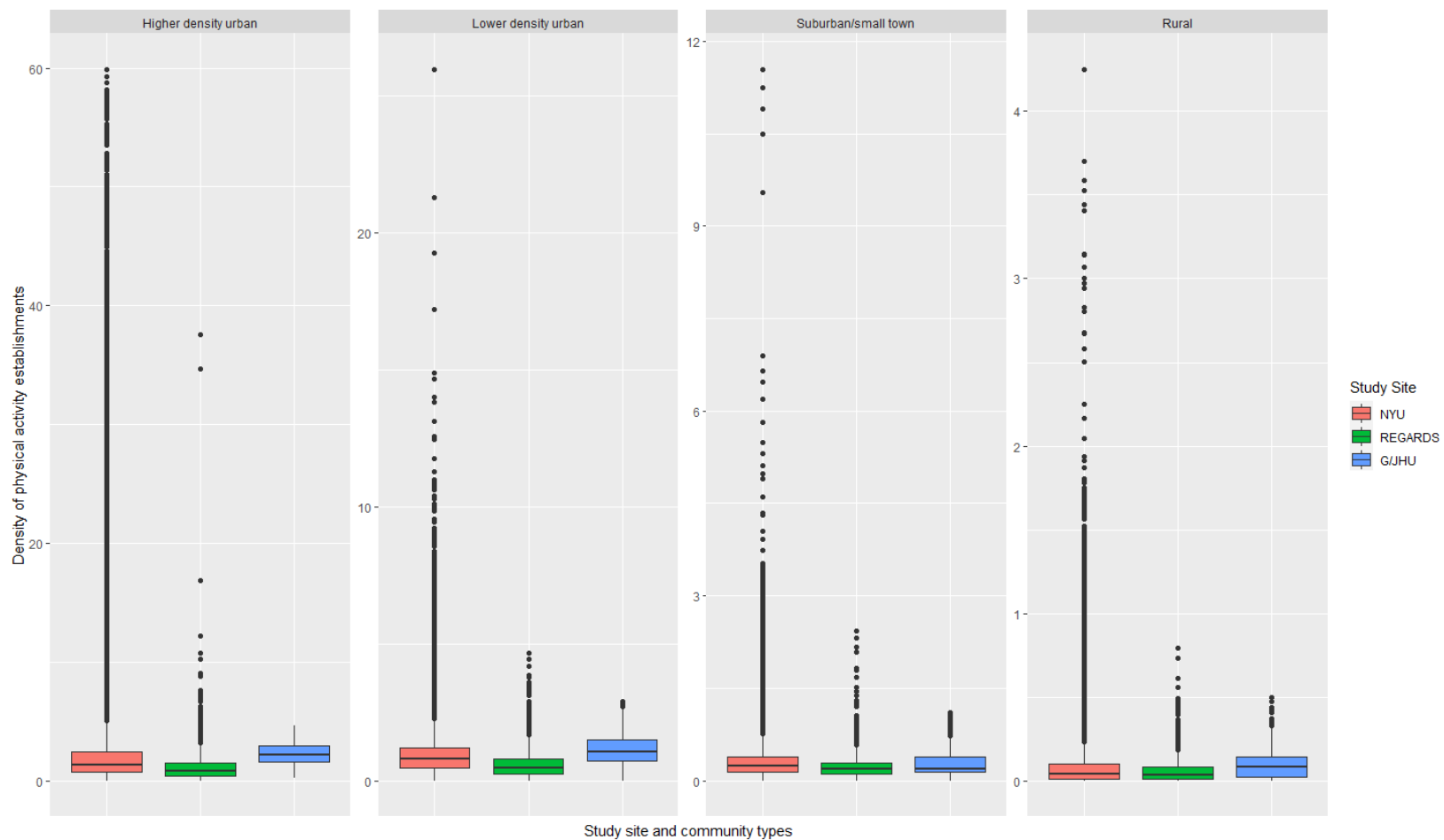


Figure S4. Distribution of population-weighted distance to seven closest parks by community type and study sample

Within each boxplot, the shaded box represents the interquartile range (25th to 75th percentile) and the central horizontal line indicates the 50th percentile (median) value. The whiskers extend to 1.5 times the interquartile range. Values larger or smaller than 1.5 times the interquartile range are plotted as individual points.

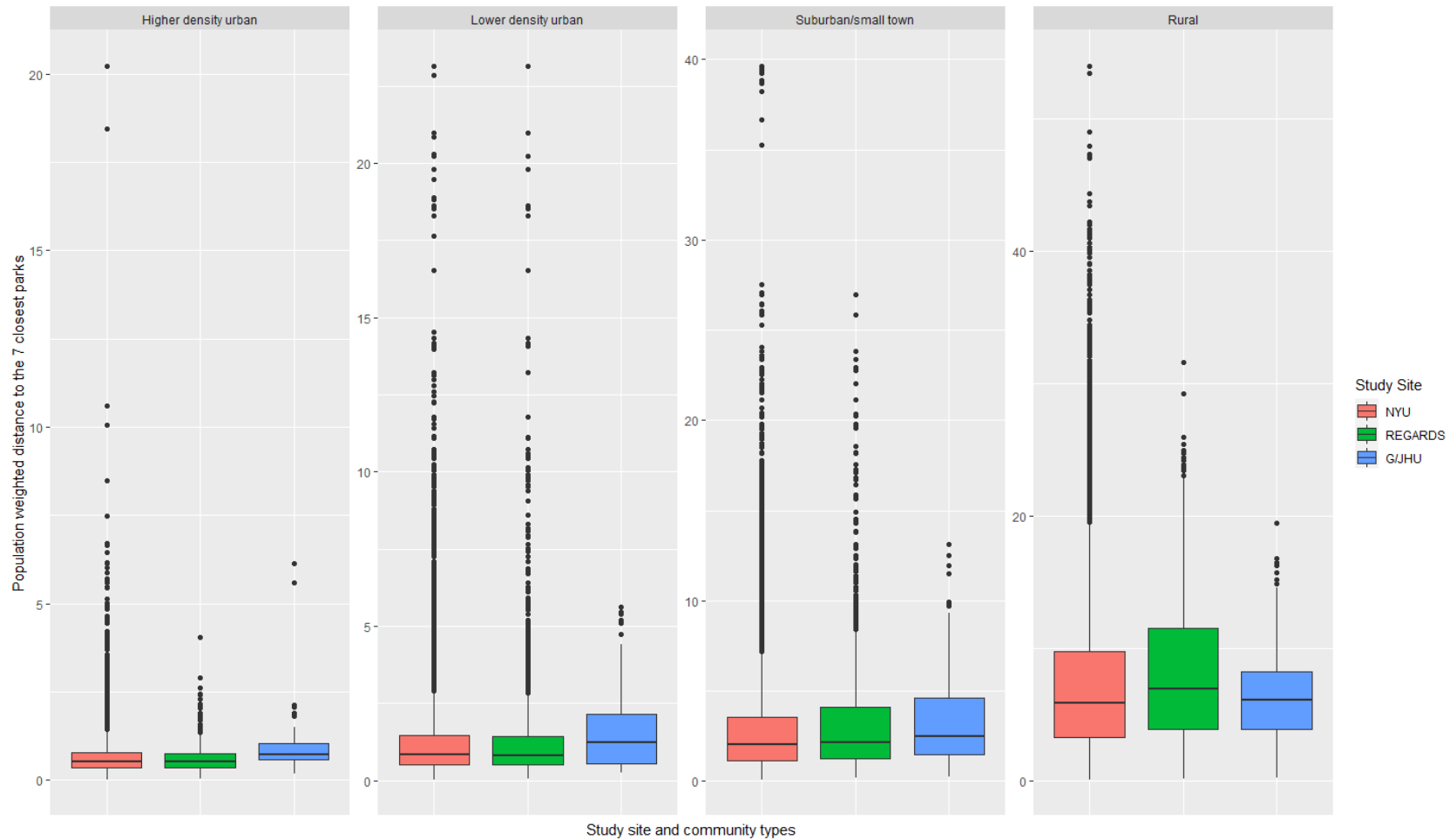


Table S1. Definition of type 2 diabetes across the three study samples in the Diabetes LEAD Network

Study sample	Definition of type 2 diabetes
Veterans Administration Diabetes Risk (VADR) cohort study (New York University)	<u>Incident diabetes:</u> <i>Met at least one of the following criteria during the study period, excluding prevalent diabetes (defined using the same criteria) prior to baseline:</i> <ol style="list-style-type: none"> 1. At least two separate inpatient or outpatient encounters with T2D ICD-9/10 code 2. Any prescription of T2D medication (excluding metformin or acarbose alone) 3. At least one encounter with a diabetes ICD-9/10 code and two elevated ($\geq 6.5\%$) HbA1c lab test results 4. One encounter with T2D ICD-9/10 code AND ≥ 2 HbA1c $\geq 6.5\%$ (on different days)
REasons for Geographic and Racial Differences in Stroke (REGARDS) cohort study (University of Alabama at Birmingham)	<u>New onset diabetes:</u> Fasting glucose ≥ 126 mg/dL or random glucose ≥ 200 mg/dL or use of oral or injectable diabetes medications or insulin at second visit, among those without prevalent diabetes (defined using the same glucose or medication criteria) at baseline
Geisinger EHR diabetes case control study (Geisinger-Johns Hopkins University)	<u>New onset diabetes:</u> <i>Cases met criterion #1 and at least one other criteria during the study period. Controls had at least two years of contact with the health system and were selected among those who never met any of the criteria #2-4.</i> <ol style="list-style-type: none"> 1. At least two years of contact with the health system prior to the first diabetes criterion being met 2. At least two separate encounter dates with T2D ICD-9/10 code or Geisinger specific EDG codes 3. At least one T2D medication order after age 10 years, other than metformin or acarbose if female 4. At least one encounter with T2D ICD-9/10 code and an abnormal laboratory result

Notes: LEAD, Location, Environmental Attributes, and Disparities; T2D, Type 2 diabetes; ICD, International Classification of Diseases, Clinical Modification; EDG, Electronic diagnosis group (Geisinger EPIC EHR diagnoses); HbA1c, Hemoglobin A1c

Table S2. Sensitivity analysis of mediation via PA facility density using larger street network buffers to define PA facility density

NSEE quartiles	Mediation via density of PA establishments (count/km ²)		
	Total effect (95% CI)	Average direct effect (95% CI)	Average indirect effect (95% CI)
Higher density urban (2-mi walking buffer)			
VADR cohort (Difference in incidence rates) #			
Q2 vs. Q1	0.1631 (0.0949, 0.2418)	0.1730 (0.1058, 0.2499)	-0.0099 (-0.0146, -0.0066)
Q3 vs. Q1	0.2348 (0.1707, 0.2989)	0.2516 (0.1883, 0.3147)	-0.0167 (-0.0232, -0.0105)
Q4 vs. Q1	0.2254 (0.1019, 0.3247)	0.2367 (0.1131, 0.3328)	-0.0113 (-0.0157, -0.0061)
REGARDS cohort (Difference in incidence rates) #			
Q2 vs. Q1	4.16 (-1.00, 9.19)	4.22 (-0.96, 9.39)	-0.06 (-0.48, 0.26)
Q3 vs. Q1	5.85 (0.10, 11.37)	5.86 (0.12, 11.29)	-0.01 (-0.29, 0.22)
Q4 vs. Q1	2.90 (-2.87, 8.50)	3.01 (-2.79, 8.45)	-0.11 (-0.66, 0.37)
Geisinger nested case control (Odds ratio) #			
Q2 vs. Q1	1.19 (0.92, 1.54)	1.15 (0.89, 1.50)	1.04 (0.96, 1.11)
Q3 vs. Q1	1.11 (0.89, 1.40)	1.08 (0.84, 1.39)	1.03 (0.96, 1.10)
Q4 vs. Q1	0.78 (0.56, 1.10)	0.75 (0.53, 1.07)	1.04 (0.95, 1.12)
Lower density urban (6-mile driving buffer)			
VADR cohort (Difference in incidence rates) #			
Q2 vs. Q1	0.1390 (0.1305, 0.1474)	0.1417 (0.1327, 0.1507)	-0.0027 (-0.0033, -0.0021)
Q3 vs. Q1	0.1555 (0.1381, 0.1728)	0.1622 (0.1451, 0.1794)	-0.0068 (-0.0070, -0.0066)
Q4 vs. Q1	0.1390 (0.1323, 0.1457)	0.1477 (0.1413, 0.1540)	-0.0087 (-0.0090, -0.0083)
REGARDS cohort (Difference in incidence rates) #			
Q2 vs. Q1	0.91 (-2.63, 4.05)	0.96 (-2.57, 4.12)	-0.05 (-0.34, 0.23)
Q3 vs. Q1	4.31 (0.65, 7.67)	4.47 (0.78, 7.96)	-0.15 (-0.97, 0.59)
Q4 vs. Q1	3.98 (-0.11, 7.89)	4.17 (-0.17, 8.38)	-0.19 (-1.12, 0.73)
Geisinger nested case control (Odds ratio) #			
Q2 vs. Q1	1.55 (1.16, 2.06)	1.53 (1.13, 2.06)	1.01 (0.98, 1.05)
Q3 vs. Q1	1.67 (1.25, 2.23)	1.66 (1.24, 2.22)	1.01 (0.98, 1.04)
Q4 vs. Q1	1.70 (1.28, 2.27)	1.71 (1.29, 2.29)	0.99 (0.97, 1.02)
Suburban/small town (10-mile driving buffer)			
VADR cohort (Difference in incidence rates) #			
Q2 vs. Q1	0.1244 (0.0964, 0.1718)	0.1331 (0.1039, 0.1810)	-0.0086 (-0.0161, -0.0032)
Q3 vs. Q1	0.2353 (0.1860, 0.3043)	0.2530 (0.2079, 0.3224)	-0.0177 (-0.0264, -0.0125)
Q4 vs. Q1	0.2835 (0.1973, 0.3664)	0.3042 (0.2231, 0.3787)	-0.0207 (-0.0271, -0.0117)
REGARDS cohort (Difference in incidence rates) #			
Q2 vs. Q1	0.15 (-4.23, 4.40)	-1.98 (-6.57, 2.12)	2.13 (0.82, 3.81)
Q3 vs. Q1	3.15 (-1.75, 7.71)	-0.38 (-5.13, 4.12)	3.53 (1.19, 6.07)
Q4 vs. Q1	5.69 (-0.31, 11.35)	0.43 (-5.59, 6.55)	5.26 (1.82, 9.17)
Geisinger nested case control (Odds ratio) #			
Q2 vs. Q1	1.06 (0.88, 1.27)	1.06 (0.88, 1.27)	1.00 (0.99, 1.01)
Q3 vs. Q1	1.15 (0.97, 1.35)	1.15 (0.97, 1.36)	1.00 (0.98, 1.02)
Q4 vs. Q1	1.22 (1.00, 1.46)	1.22 (1.00, 1.47)	1.00 (0.98, 1.01)
Rural (10-mile driving buffer)			
VADR cohort (Difference in incidence rates) #			
Q2 vs. Q1	0.0552 (0.0405, 0.0700)	0.0579 (0.0428, 0.0731)	-0.0027 (-0.0032, -0.0023)
Q3 vs. Q1	0.1398 (0.1325, 0.1470)	0.1383 (0.1306, 0.1459)	0.0015 (0.0011, 0.0019)
Q4 vs. Q1	0.1539 (0.1454, 0.1625)	0.1598 (0.1541, 0.1655)	-0.0059 (-0.0087, -0.0031)
REGARDS cohort (Difference in incidence rates) #			
Q2 vs. Q1	5.77 (1.06, 10.75)	3.98 (-0.69, 8.79)	1.79 (0.46, 3.39)
Q3 vs. Q1	3.80 (-0.97, 8.49)	1.38 (-3.60, 6.38)	2.42 (0.54, 4.44)
Q4 vs. Q1	3.22 (-2.05, 8.39)	0.04 (-6.02, 5.32)	3.18 (0.70, 6.19)
Geisinger nested case control (Odds ratio) #			
Q2 vs. Q1	1.04 (0.94, 1.15)	1.02 (0.92, 1.14)	1.02 (0.99, 1.03)
Q3 vs. Q1	1.15 (1.06, 1.26)	1.13 (1.03, 1.24)	1.02 (0.99, 1.05)
Q4 vs. Q1	1.17 (1.06, 1.32)	1.14 (1.03, 1.29)	1.03 (0.99, 1.06)

NSEE, Neighborhood socioeconomic environment; Q, Quartile; PA, Physical activity; CI, Confidence interval
 Bolded values indicate statistically significant (p<0.05).

Table S3. Sensitivity analysis of mediation via PA facility density and population-weighted distance to parks examining VADR models restricted to REGARDS census tracts

Mediation via PA facility density (count/km ²)			
NSEE quartiles	Total effect (95% CI)	Average direct effect (95% CI)	Average indirect effect (95% CI)
Higher density urban (Difference in incidence rates)			
Q2 vs. Q1	0.0011 (-0.0014, 0.0038)	0.0013 (-0.0013, 0.0038)	-0.0137 (-0.0411, 0.0124)
Q3 vs. Q1	0.0017 (-0.0009, 0.0043)	0.0019 (-0.0007, 0.0045)	-0.0151 (-0.0496, 0.0113)
Q4 vs. Q1	-0.0008 (-0.0036, 0.0026)	-0.0007 (-0.0034, 0.0029)	-0.0128 (-0.0380, 0.0104)
Lower density urban (Difference in incidence rates)			
Q2 vs. Q1	0.0011 (-0.0005, 0.0022)	0.0011 (-0.0004, 0.0022)	-0.0023 (-0.0040, -0.0001)
Q3 vs. Q1	0.0018 (0.0006, 0.0031)	0.0018 (0.0006, 0.0031)	-0.0047 (-0.0089, 0.0001)
Q4 vs. Q1	0.0003 (-0.0008, 0.0021)	0.0003 (-0.0007, 0.0022)	-0.0088 (-0.0145, -0.0010)
Suburban/small town (Difference in incidence rates)			
Q2 vs. Q1	0.0014 (0.0007, 0.0025)	0.0014 (0.0009, 0.0025)	-0.0003 (-0.0139, 0.0105)
Q3 vs. Q1	0.0018 (0.0003, 0.0032)	0.0018 (0.0120, 0.0032)	0.0023 (-0.0245, 0.0234)
Q4 vs. Q1	0.0005 (-0.0008, 0.0022)	0.0005 (-0.1086, 0.0023)	-0.0027 (-0.0267, 0.0362)
Rural (Difference in incidence rates)			
Q2 vs. Q1	-0.0010 (-0.0027, 0.0005)	-0.0009 (-0.0024, 0.0006)	-0.0087 (-0.0288, 0.0108)
Q3 vs. Q1	0.0011 (-0.0003, 0.0024)	0.0012 (-0.0006, 0.0027)	-0.0165 (-0.0456, 0.0116)
Q4 vs. Q1	0.0018 (0.0004, 0.0034)	0.0020 (0.0007, 0.0036)	-0.0208 (-0.0577, 0.0113)
Mediation via population-weighted distance to parks (miles)			
NSEE quartiles	Total effect (95% CI)	Average direct effect (95% CI)	Average indirect effect (95% CI)
Higher density urban (Difference in incidence rates)			
Q2 vs. Q1	0.0011 (-0.0014, 0.0038)	0.0013 (-0.0013, 0.0038)	-0.0137 (-0.0411, 0.0124)
Q3 vs. Q1	0.0017 (-0.0009, 0.0043)	0.0019 (-0.0007, 0.0045)	-0.0151 (-0.0496, 0.0113)
Q4 vs. Q1	-0.0008 (-0.0036, 0.0026)	-0.0007 (-0.0034, 0.0029)	-0.0128 (-0.0380, 0.0104)
Lower density urban (Difference in incidence rates)			
Q2 vs. Q1	0.0011 (-0.0005, 0.0022)	0.0011 (-0.0004, 0.0022)	-0.0023 (-0.0040, -0.0001)
Q3 vs. Q1	0.0018 (0.0006, 0.0031)	0.0018 (0.0006, 0.0031)	-0.0047 (-0.0089, 0.0001)
Q4 vs. Q1	0.0003 (-0.0008, 0.0021)	0.0003 (-0.0007, 0.0022)	-0.0088 (-0.0145, -0.0010)
Suburban/small town (Difference in incidence rates)			
Q2 vs. Q1	0.0014 (0.0007, 0.0025)	0.0014 (0.0009, 0.0025)	-0.0003 (-0.0139, 0.0105)
Q3 vs. Q1	0.0018 (0.0003, 0.0032)	0.0018 (0.0120, 0.0032)	0.0023 (-0.0245, 0.0234)
Q4 vs. Q1	0.0005 (-0.0008, 0.0022)	0.0005 (-0.1086, 0.0023)	-0.0027 (-0.0267, 0.0362)
Rural (Difference in incidence rates)			
Q2 vs. Q1	-0.0010 (-0.0027, 0.0005)	-0.0009 (-0.0024, 0.0006)	-0.0087 (-0.0288, 0.0108)
Q3 vs. Q1	0.0011 (-0.0003, 0.0024)	0.0012 (-0.0006, 0.0027)	-0.0165 (-0.0456, 0.0116)
Q4 vs. Q1	0.0018 (0.0004, 0.0034)	0.0020 (0.0007, 0.0036)	-0.0208 (-0.0577, 0.0113)

NSEE, Neighborhood socioeconomic environment; Q, Quartile; PA, Physical activity; CI, Confidence interval

Bolded values indicate statistically significant (p<0.05).

Table S4. Sensitivity analysis of mediation via PA facility density and population-weighted distance to parks examining VADR models restricted to Geisinger census tracts

Mediation via PA facility density (count/km ²)			
NSEE quartiles	Total effect (95% CI)	Average direct effect (95% CI)	Average indirect effect (95% CI)
Higher density urban (Difference in incidence rates)			
Q2 vs. Q1	0.0032 (-0.0002, 0.0003)	0.0032 (-0.0064, 0.0121)	0.0039 (-0.0002, 0.0003)
Q3 vs. Q1	0.0082 (-0.0007, 0.0188)	0.0083 (-0.0005, 0.0189)	-0.0058 (-0.0005, 0.0004)
Q4 vs. Q1	0.0038 (-0.0066, 0.0157)	0.0038 (-0.0066, 0.0150)	-0.4646 (-0.1613, 0.1748)
Lower density urban (Difference in incidence rates)			
Q2 vs. Q1	0.0086 (0.0007, 0.0167)	0.0086 (0.0007, 0.0168)	-0.0056 (-0.0002, 0.0015)
Q3 vs. Q1	0.0095 (0.0029, 0.0161)	0.0094 (0.0029, 0.0160)	0.0081 (-0.0007, 0.0002)
Q4 vs. Q1	0.0139 (0.0050, 0.0218)	0.0139 (0.0049, 0.0214)	0.0145 (-0.0075, 0.0370)
Suburban/small town (Difference in incidence rates)			
Q2 vs. Q1	0.0021 (-0.0008, 0.0059)	0.0021 (-0.0009, 0.0060)	-0.0063 (-0.0521, 0.0470)
Q3 vs. Q1	0.0054 (0.0014, 0.0088)	0.0055 (0.0014, 0.0087)	-0.0048 (-0.0004, 0.0003)
Q4 vs. Q1	0.0078 (0.0038, 0.0128)	0.0078 (0.0038, 0.0128)	-0.0006 (-0.0117, 0.0093)
Rural (Difference in incidence rates)			
Q2 vs. Q1	-0.0006 (-0.0024, 0.0019)	-0.0006 (-0.0025, 0.0019)	0.0066 (-0.0021, 0.0135)
Q3 vs. Q1	-0.0002 (-0.0025, 0.0017)	-0.0003 (-0.0027, 0.0016)	0.0103 (-0.0009, 0.0238)
Q4 vs. Q1	0.0029 (-0.0015, 0.0067)	0.0027 (-0.0016, 0.0067)	0.0192 (-0.0071, 0.0415)
Mediation via population-weighted distance to parks (miles)			
NSEE quartiles	Total effect (95% CI)	Average direct effect (95% CI)	Average indirect effect (95% CI)
Higher density urban (Difference in incidence rates)			
Q2 vs. Q1	NA*	NA*	NA*
Q3 vs. Q1	NA*	NA*	NA*
Q4 vs. Q1	NA*	NA*	NA*
Lower density urban (Difference in incidence rates)			
Q2 vs. Q1	0.0084 (-0.0014, 0.0158)	0.0085 (-0.0016, 0.0158)	-0.0013 (-0.0066, 0.0028)
Q3 vs. Q1	0.0091 (0.0027, 0.0176)	0.0092 (0.0029, 0.0179)	-0.0134 (-0.0349, 0.0155)
Q4 vs. Q1	0.0122 (0.0052, 0.0196)	0.0123 (0.0054, 0.0192)	-0.0183 (-0.0674, 0.0420)
Suburban/small town (Difference in incidence rates)			
Q2 vs. Q1	0.0022 (-0.0012, 0.0054)	0.0021 (-0.0013, 0.0054)	0.0059 (-0.0148, 0.0235)
Q3 vs. Q1	0.0050 (0.0006, 0.0089)	0.0050 (0.0006, 0.0089)	0.0011 (-0.0084, 0.0081)
Q4 vs. Q1	0.0069 (0.0027, 0.0110)	0.0069 (0.0027, 0.0110)	-0.0005 (-0.0050, 0.0019)
Rural (Difference in incidence rates)			
Q2 vs. Q1	-0.0006 (-0.0029, 0.0012)	-0.0007 (-0.0029, 0.0012)	0.0003 (-0.0044, 0.0113)
Q3 vs. Q1	0.0030 (-0.0030, 0.0032)	-0.0034 (-0.0031, 0.0030)	0.0064 (-0.0091, 0.0216)
Q4 vs. Q1	0.0030 (-0.0010, 0.0072)	0.0029 (-0.0011, 0.0069)	0.0097 (-0.0002, 0.0003)

NSEE, Neighborhood socioeconomic environment; Q, Quartile; PA, Physical activity; CI, Confidence interval

* NA, Model estimates were not available due to small sample size.

Bolded values indicate statistically significant (p<0.05).

Table S5. Sensitivity analysis of mediation via PA facility density in REGARDS rural communities modeling PA facility density as a binary variable (\leq median vs. $>$ median)

Mediation via PA facility density (count/km ²)			
NSEE quartiles	Total effect (95% CI)	Average direct effect (95% CI)	Average indirect effect (95% CI)
REGARDS cohort (Difference in incidence rates) #			
Q2 vs. Q1	5.55 (0.82, 10.51)	5.04 (0.47, 9.95)	0.51 (0.11, 1.10)
Q3 vs. Q1	3.70 (-0.88, 8.10)	2.78 (-2.12, 7.19)	0.91 (0.22, 1.78)
Q4 vs. Q1	2.71 (-2.47, 7.73)	2.05 (-3.08, 7.08)	0.66 (0.13, 1.32)

NSEE, Neighborhood socioeconomic environment; Q, Quartile; PA, Physical activity; CI, Confidence interval

Bolded values indicate statistically significant ($p < 0.05$).