

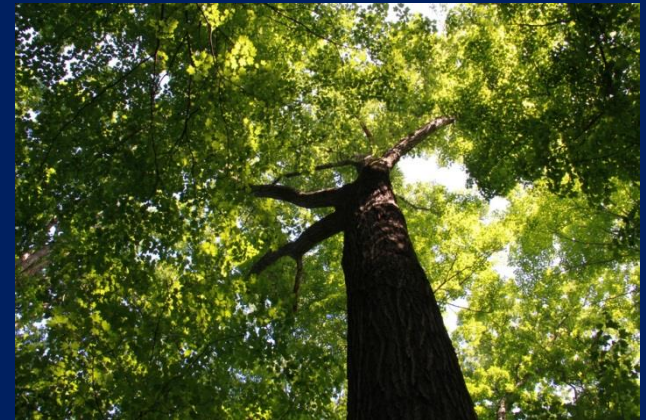
Urban greenness and associations with obesity, physical activity, and health outcomes

Paul Villeneuve, Carleton University, Ottawa, Canada



Early Study of Greenness and Health (Ulrich et al, 1984)

- Compared survival among individuals undergoing surgery
- 46 patients (gall bladder surgery)
- Patients matched on number of factors (age, smoking, paint color, sex, hospital floor)
- Two windows views: bricks or trees
- Those with view of the trees had
 - Shorter stays
 - Less complaints
 - Fewer complications
 - Took less pain medication



Green Space and Health

- Largely ignored in environmental epidemiology are exposures that may have positive health benefits.
- In urban settings, access to green space shown to be related to wide variety of health outcomes
- Green space (or greenness) includes:
 - Access to parks
 - Vegetation
- Multiple pathways could be involved



Environmental Impacts of Green Spaces

- Absorb air pollution
- Provide cooling
- Shelter from UV
- Reducing noise



Green Spaces & Healthy Lifestyles

- Restoration from stress
- Time spent outdoors associated with several chronic conditions (obesity, HBP, heart disease, back and joint pain).
- Especially important for some (e.g., elderly, mothers with infants, children, those with disabilities)
- Enhancing Social networks
- Increased opportunity for physical activities



Relevance of Physical Activity

- Over 50% of Canadians are physically inactive (*Liu et al., 2008*)
- Identified as the 4th leading global risk factor for mortality (*WHO 2014*)
- Related to obesity
- Physical inactivity is a modifiable behaviour

Previous Studies of green space and physical activity and obesity

- Results have been inconsistent
- Systematic review of 50 studies (Lachowycz & Jones, 2013) found
 - Positive associations for 40% of studies of physical activity
 - Positive associations for 23% of studies of obesity
 - Variations in ability to control for other factors (residual confounding)
 - Green space was one of many exposures being examined (multiple testing)
 - Self-reports of physical activity & BMI
- Few attempts to characterize association on national-level

National Scale Studies

- More generalizable
- Allow for a more socially and environmentally heterogeneous population to be captured
- Studies conducted in United Kingdom, Netherlands and New Zealand
- Relevance in terms of health promotion and policy development

US and Canadian national studies

Cross-sectional analyses

- US: Sister Study Cohort
- Canada: Canadian Community Health Survey

Research Objectives

- To investigate associations between residential measures of green space and physical activity, and obesity
- Examine whether associations are modified by income

The Sister Study

- conducted to better understand causes of breast cancer
- Participants: aged 35–74 and whose sister had breast cancer
- Enrollment opened in August 2003 and closed in July 2009.
- N= 50,884
- Participants completed computer-assisted telephone interviews at baseline
- The cohort will be followed for 10 or more years. Will evaluate factors that influence long-term survival and general health following breast cancer diagnosis and treatment.
- The study enrolled volunteers living in the US and Puerto Rico

THE SISTER STUDY

ABOUT SISTER STUDY
TWO SISTER STUDY
FOR PARTICIPANTS
FOR RESEARCHERS
PUBLICATIONS
FAQS
RESOURCES
CONTACT US

“Woman by woman, sister by sister, we can make a difference.”

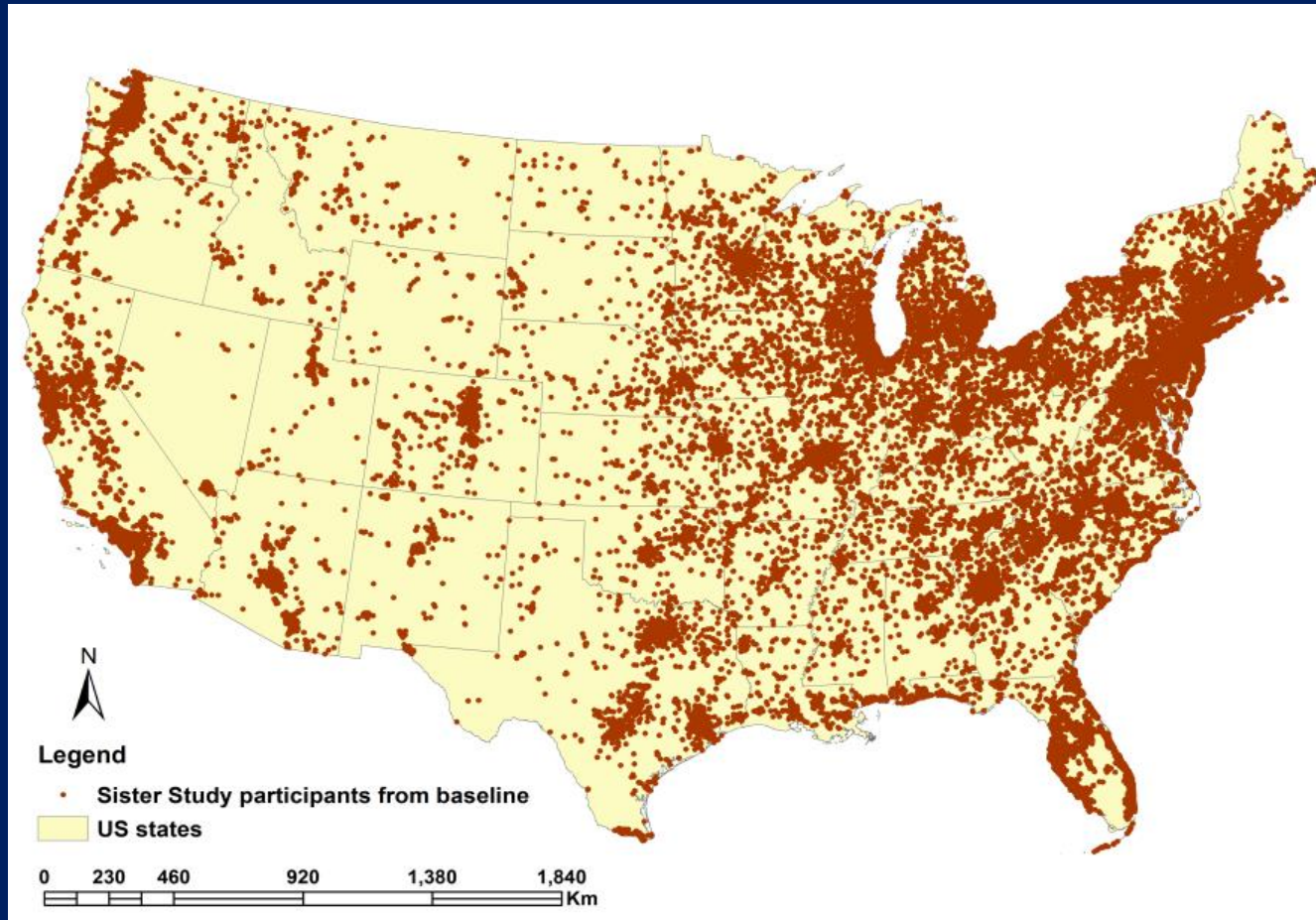
en español

A Study of the Environmental and Genetic Risk Factors for Breast Cancer.

NIH National Institute of Environmental Health Sciences USA.gov

www.sisterstudy.niehs.nih.gov

Place of residence, Sister Study Participants



Baseline data

- Demographic characteristics
- Environmental exposures
- Lifestyle factors including smoking, alcohol use
- Medical history, risk factors for breast cancer
- blood, urine, toenails, household dust

- **BMI**
 - Trained examiners measured participant's height and weight
- **Physical activity:**
 - included sports and exercise activities, other recreational activities and physically active chores during three time points: childhood, teenage years, and the past 12 months
- **Residential data**
 - Street address at baseline, childhood, and teenage years

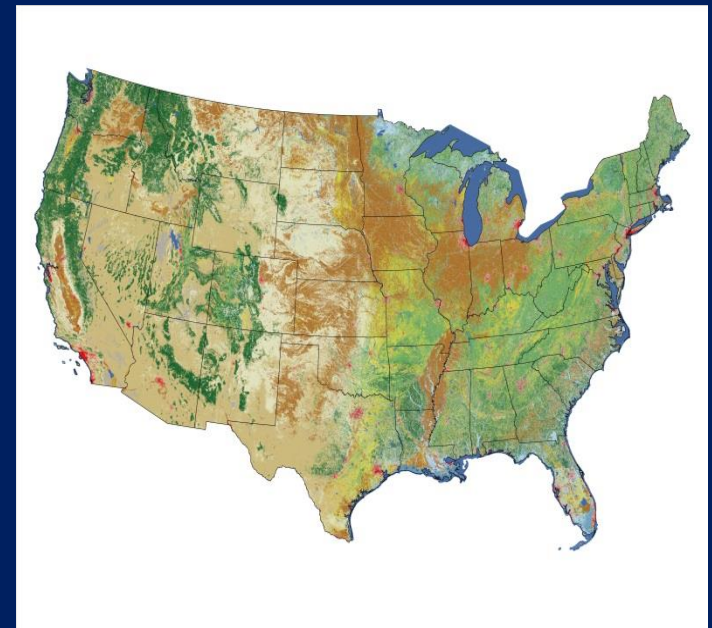
Characteristics of participants

Characteristic		N	Mean	IQR
Age		50884	55.2	49.0 – 62.0
BMI		50867	27.8	23.3 – 31.1
PA – Met hrs/week		50838	50.7	23.1 – 67.2
Household Income in US\$ (per person)		48874	48874	18750 – 50000
Characteristic	Level	N	%	
Ethnicity	White	42558	83.7	
	Black	4462	8.8	
	Other	3849	7.5	
Smoking status	Current	4233	8.3	
	Former	19186	37.8	
	Never	27397	53.9	
Marital Status	Married	35870	70.5	
	Never Married	2759	5.4	
	Divorced/Separated	7550	14.8	
	Widowed	2564	5.0	

Assignment of Green Space

US National Land Cover database

- 16-class land cover classification scheme
- Applied across US
- Spatial resolution of up to 30m
- Based on Landsat retrieval (2006)
- Could assign measures to 97% of study subjects



Assignment of Green Spaces

- Exposures assigned at 6 different spatial resolutions (30m, 250m, 500m, 1km, 2km, 5km)

Exposure	Description
VEG1	Forest (41, 42 and 43), shrubland (52) and herbaceous (71, 72 and 73)
VEG2	Veg1 + Developed open space (These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.)
DHI	Developed high intensity (Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover)
IMP	% of surface that is Impervious

Pearson Correlation Coefficients

	Veg 1	Veg 2	Impervious	Developed HI
Veg 1	1.0	0.78	-0.61	-0.19
Veg 2		1.0	-0.74	-0.31
Impervious			1.0	0.59
Developed HI				1.0

- Analyses focused on vegetation indices
- Analyses across different buffer resolutions

Statistical methods

- Logistic regression & General Linear Models analyses
- Spline analyses to look at nonlinear associations
- Obesity (BMI>35)
- Adjustment for other risk factors including
 - Income
 - Marital status
 - Smoking
 - Alcohol use
 - Race
- Stratified analyses by income, underlying health conditions

Adjusted Odds Ratios, Green Space and Obesity (250 m buffer, Obesity=BMI>35)

Vegetation Index	N	OR (1)	OR(1)
Low (0)	21910	1.0	1.0
>0 - < 6.9	6861	0.93 (0.86 – 1.01)	0.97 (0.89 – 1.05)
6.9 - < 18.8	6794	0.91 (0.84 – 0.99)	0.99 (0.91 – 1.08)
18.8 - < 42.2	7117	0.85 (0.79 – 0.93)	0.93 (0.85 – 1.01)
High (>42.2)	6862	0.74 (0.68 – 0.81)	0.87 (0.80 – 0.95)

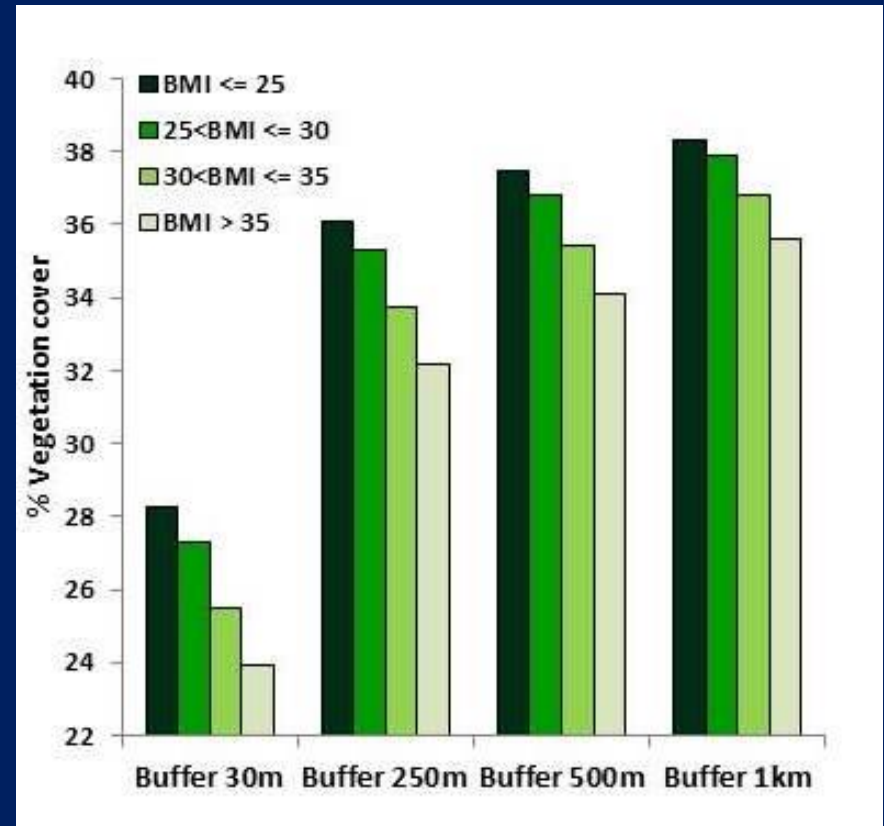
OR(1) = adjusted for age

OR(2) Adjusted for: age, race, marital status, smoking, and income

BMI and Green space

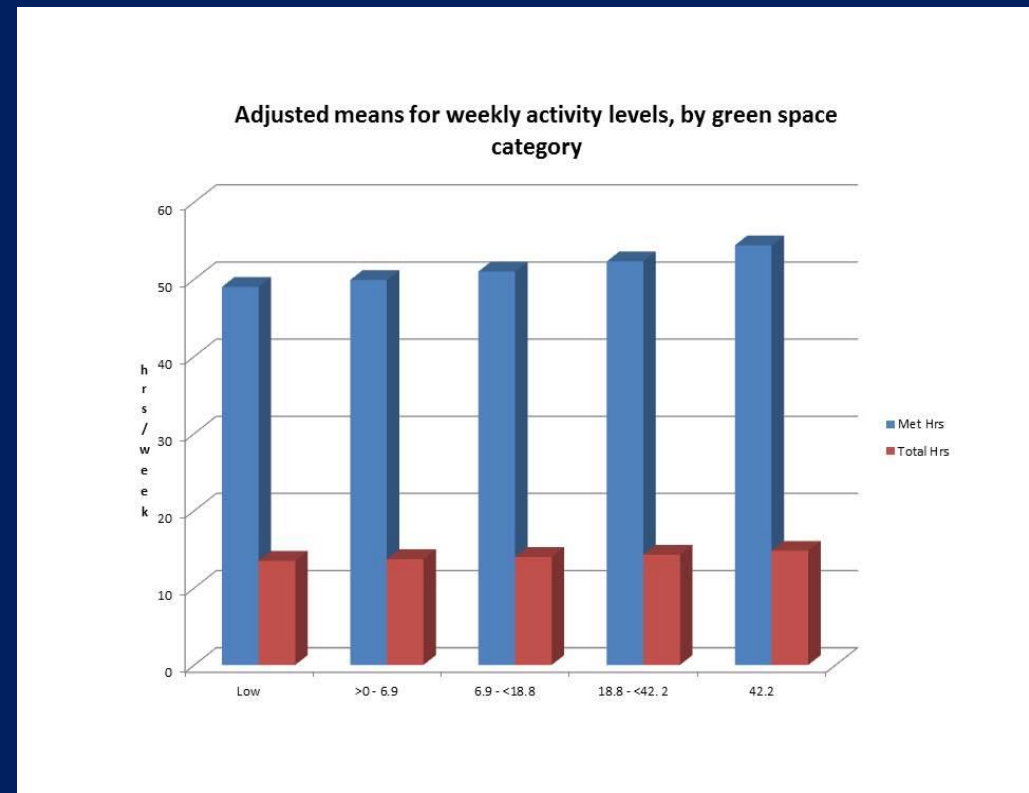
Varying Spatial resolutions

- % vegetation cover inversely associated with obesity
- Exposure-response pattern evident for all buffers considered



Physical activity and green space

- Adjusted mean MET-hours/ week increased from 49.0 to 54.5 across green space categories
- Adjusted hours of physical activity increased from 13.5 to 14.8 across green space categories



Conclusions

- Inverse associations between green space and measured BMI
- Inverse associations observed across different income groups; no effect modification evident ($p=0.68$)
- Positive association observed with levels of physical activity
- Additional analyses underway to look at
 - Associations with specific types of physical activity
 - Consider role of other factors (e.g., occupation)
 - Impact of obesity and activity patterns earlier in life
 - Nutrition

What about Canada ?



Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres



Urban greenness and physical activity in a national survey of Canadians

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Cross-sectional analyses of the 2001 CCHS

- Voluntary, annual, national survey used for health surveillance and population health research (Statistics Canada, 2013)
- Demographics, physical activity variables, income adequacy levels available for participants
- Participation rates of ~ 80%
- Restricted to those in urban areas, and adults (20+ years of age)

Assignment of Green Space

- Normal Difference Vegetation Index (NDVI)
- Used since 1973;
- Used to detect live green plant canopies in multispectral remote sensing data
- Derived from Landsat Thematic Mapper (1989 – 1997)
- Spatial Resolution of 30 m and 500m
- NDVI ranged from **-1 (less green)** to **+1 (more green)**
- Assigned to individuals 6 character postal codes

Methods

- Sedentary behaviour set at 15 minutes or less of physical activity/day
- Logistic regression to determine any relationship between green space quartiles and sedentary activity (Repeated for green space and obesity- BMI 30+)
- Logistic regression for green space and sedentary activity between income adequacy and age groups















Legend

Ottawa ND



0 1 2 4 6

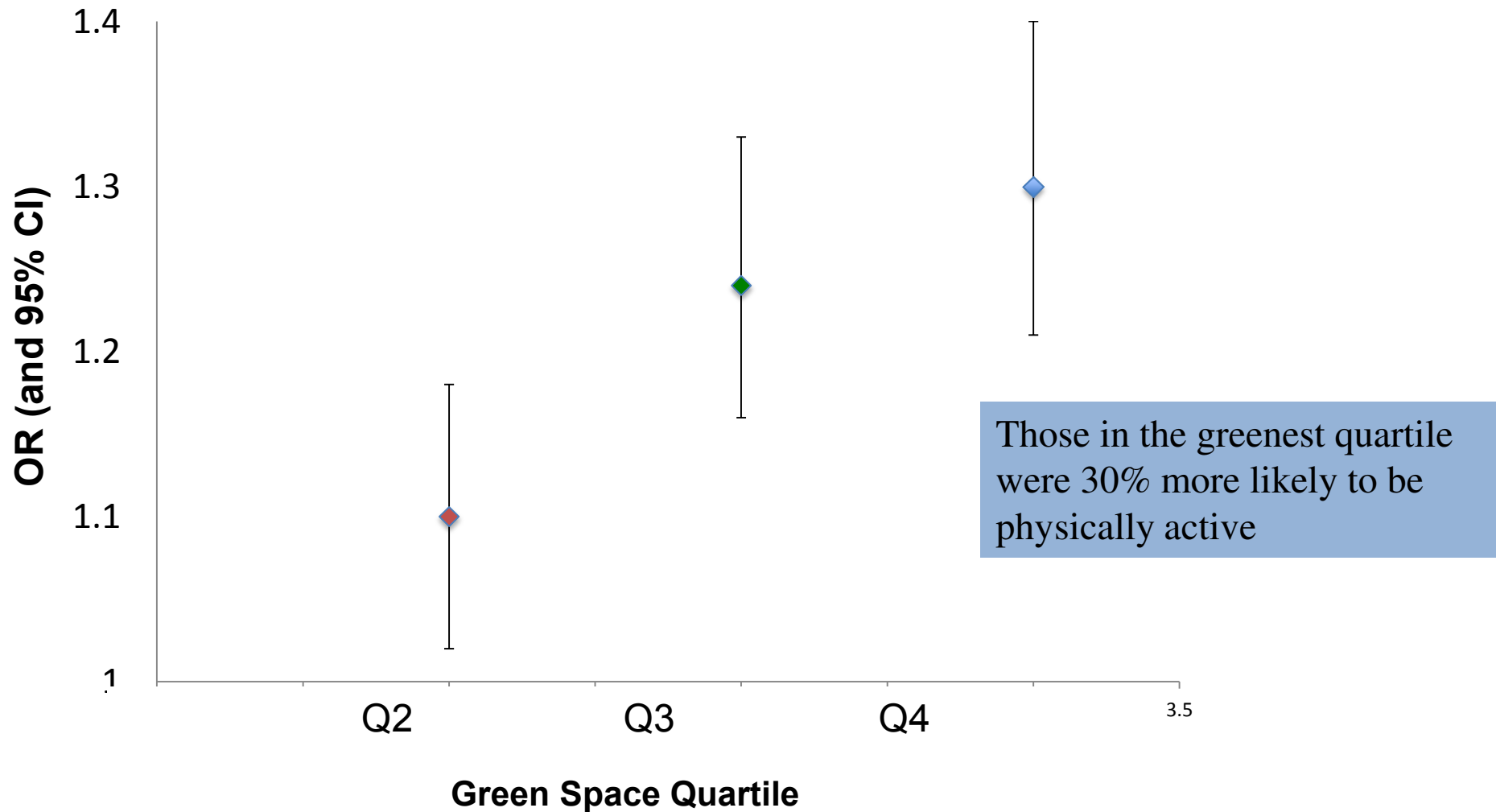
Descriptive characteristics

Sex	N	%	MeanNDVI
Male	31299	44.8	
Female	38611	55.2	
Age			
20-29	10767	15.4	
30-39	14450	20.7	
40-49	15100	21.6	
50-59	11119	15.9	
60+	18474	26.4	
Income Adequacy			
1 (Lowest)	3010	1.3	
2	5953	8.5	
3	14466	20.7	
4	22627	32.4	
5 (Highest)	17481	25.0	

Descriptive characteristics

Smoking Status	N	%	MeanNDVI
Daily	16474	23.6	
Occasional	2836	4.1	
Non-smoker	50577	72.4	
Marital Status			
Married	35217	50.4	
Common-Law	5395	7.7	
Widowed	7000	10.0	
Divorced/ Separated	8271	11.8	
Single	13949	20.0	
Region			
Western Canada	19138	27.4	
Prairies	5733	8.2	
Central Canada	38186	54.6	
Maritimes	6853	9.8	
Total Population	69910	100	

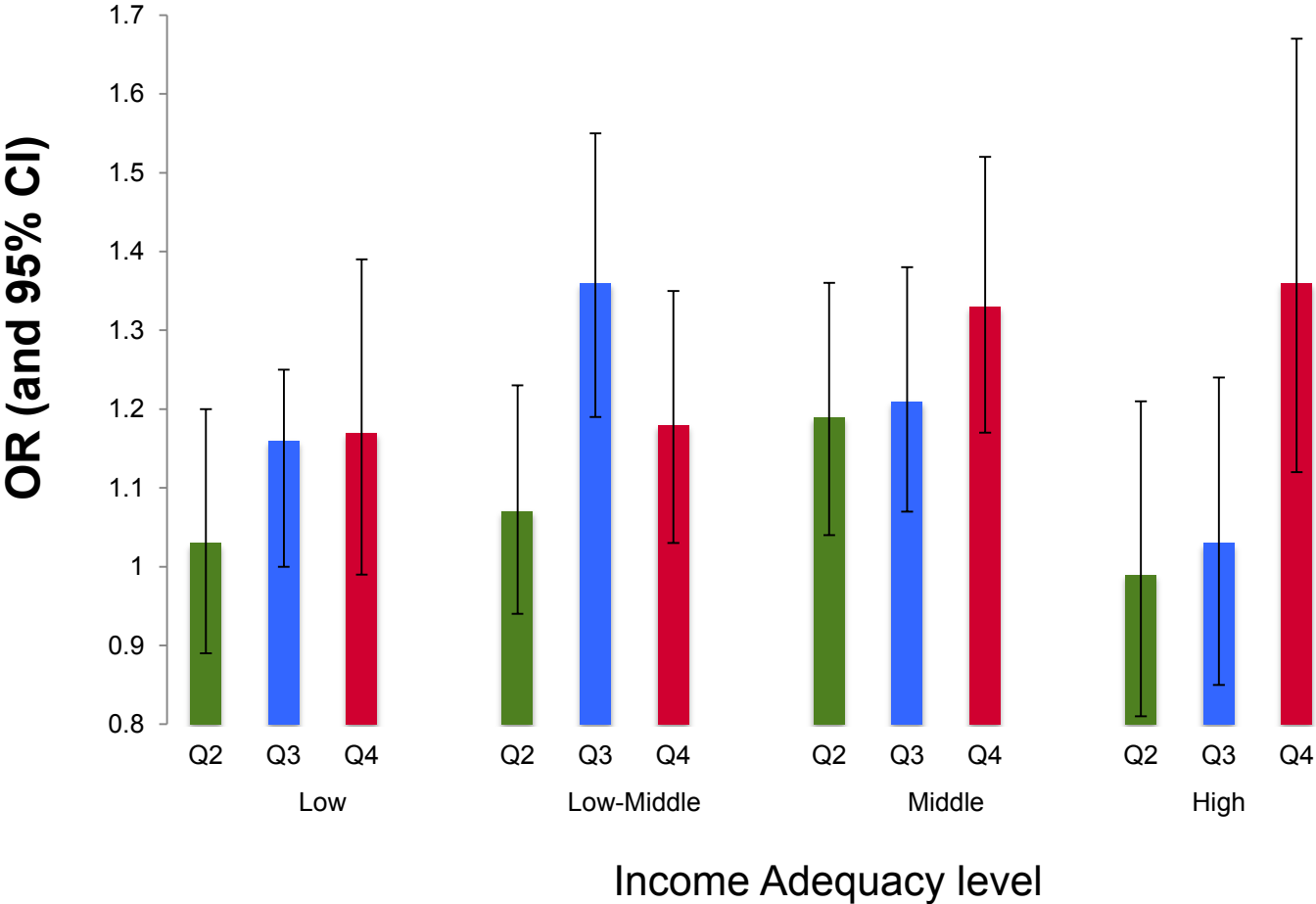
Adjusted Odds ratio of participating in leisure-time physical activity by quartile of green space



Those in the greenest quartile were 30% more likely to be physically active

Reference category is Q1 (least green)
Adjusted for age, sex, smoking status, marital status, latitude & longitude

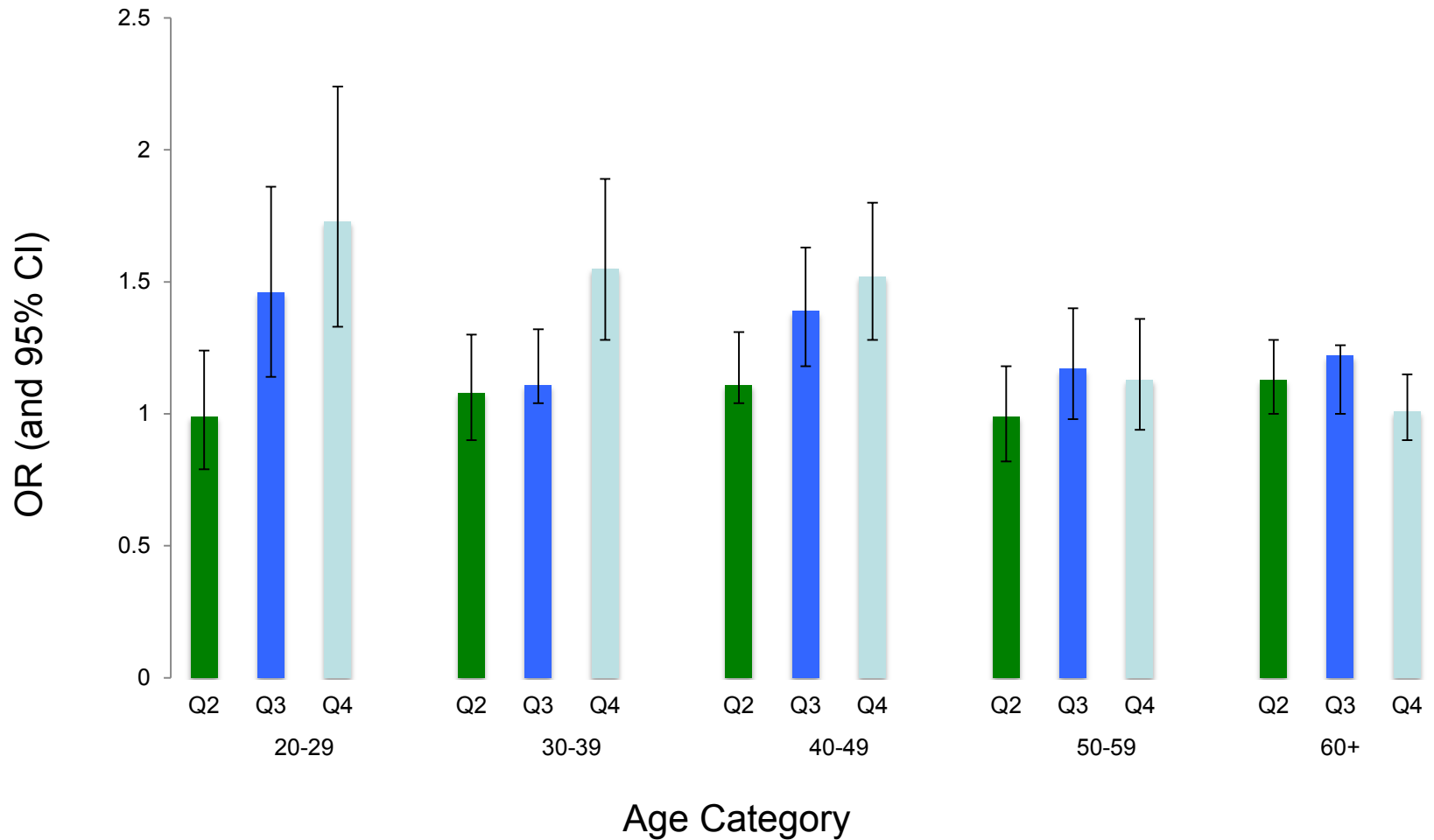
Adjusted odds ratios of participating in leisure physical activity across green space quartiles, by income level



Reference category is Q1 (least green)

Adjusted for age, sex, smoking status, marital status, latitude & longitude

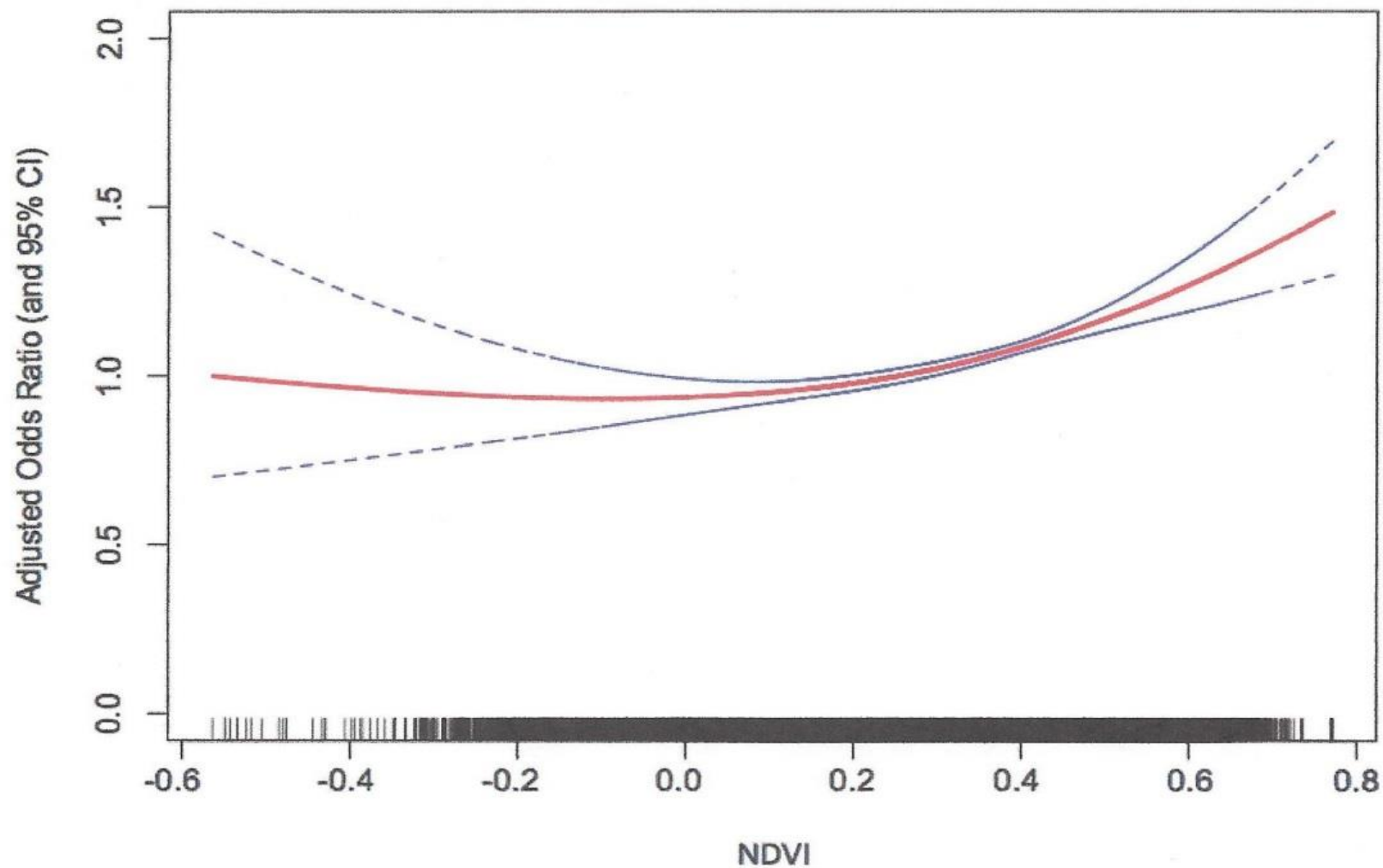
Adjusted Odds ratios of participating in leisure physical activity across green space quartiles, stratified by age



Reference category is Q1 (least green)

Adjusted for age, sex, smoking status, income adequacy, marital status, latitude & longitude

Figure 1: Adjusted Odds ratios for participating in leisure physical activity in green space in relation to the lowest green space level for urban subjects, 20 years of age and older who participated in the 2001 Canadian Community Health Survey



NDVI data transformed to positive values for analysis

Conclusions

- Green space positively associated with physical activity independent of income
- Association strongest among young adults
- Creating and maintaining urban green space may help improve participation in physical activity among urban Canadian adults

Access to Green Space and other Health Measures in Canadians

- Very few studies
- Associations noted with
 - Mortality
 - Pregnancy Outcomes

Greenness and mortality

- Ontario Tax Cohort (Villeneuve et al, 2012)
- Identified from Statistics Canada's T1FF income tax filing (>95% coverage)
- Cohort of ~ 600,000 Ontario residents
 - Age 35+
 - Linked to Canadian mortality database
 - Lived in one of 10 Ontario centres
 - Followed between 1981 and 2004
- Assigned NDVI to postal code at place of residence at entry



Thunder Bay

Lake Superior

Province of Ontario

Greater Sudbury

Manitoulin Island

Ottawa
★
Ottawa

Kingston

Michigan

Toronto

Toronto

Wisconsin

Lake Michigan

Milwaukee

Hamilton

St. Catharines - Niagara

Sarnia

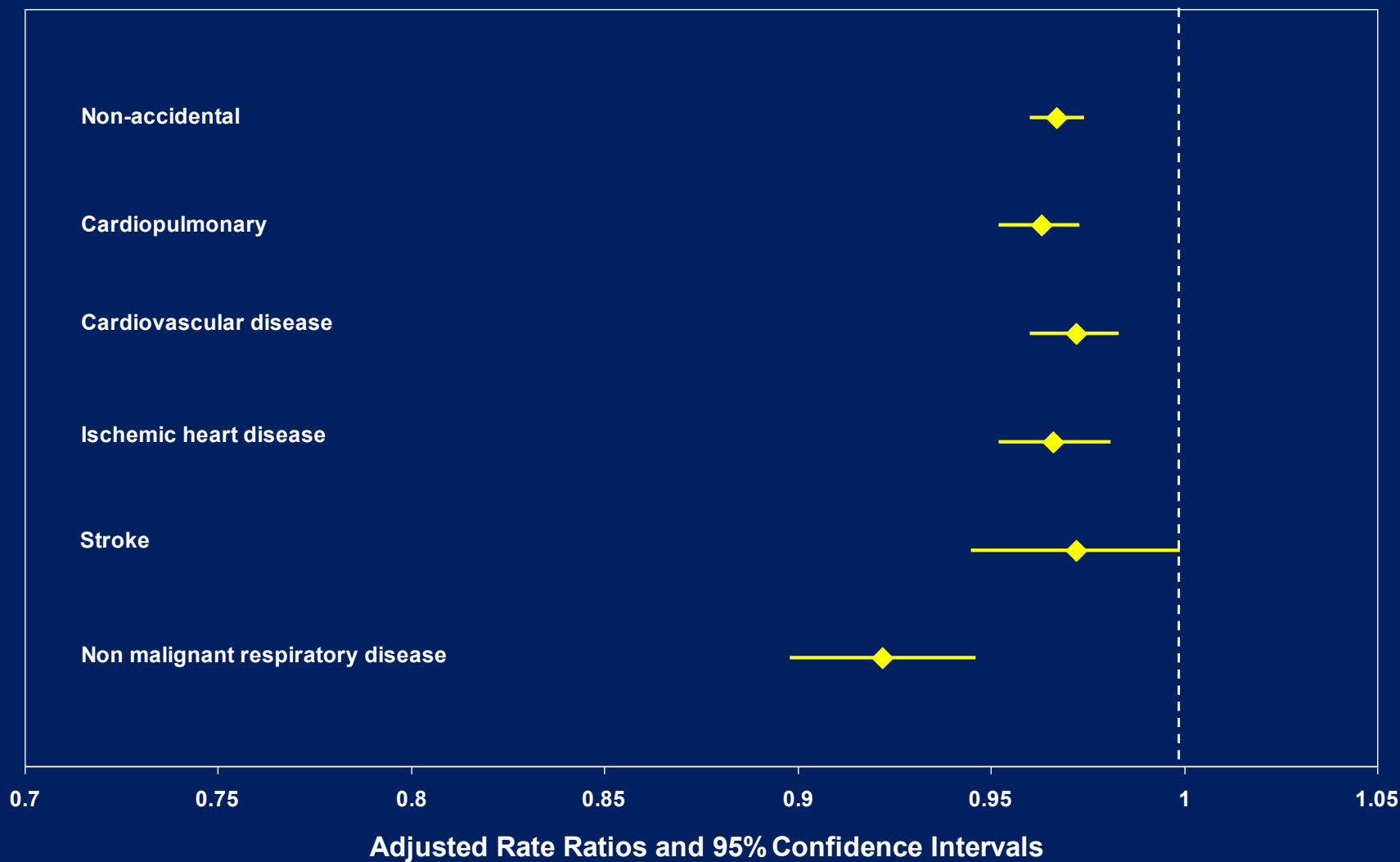
London

Detroit

Windsor

Chicago

Figure 1: Adjusted RRs and 95% C.I.'s per increase in the interquartile range of the Normalized Difference Vegetative Index, by underlying cause of death,



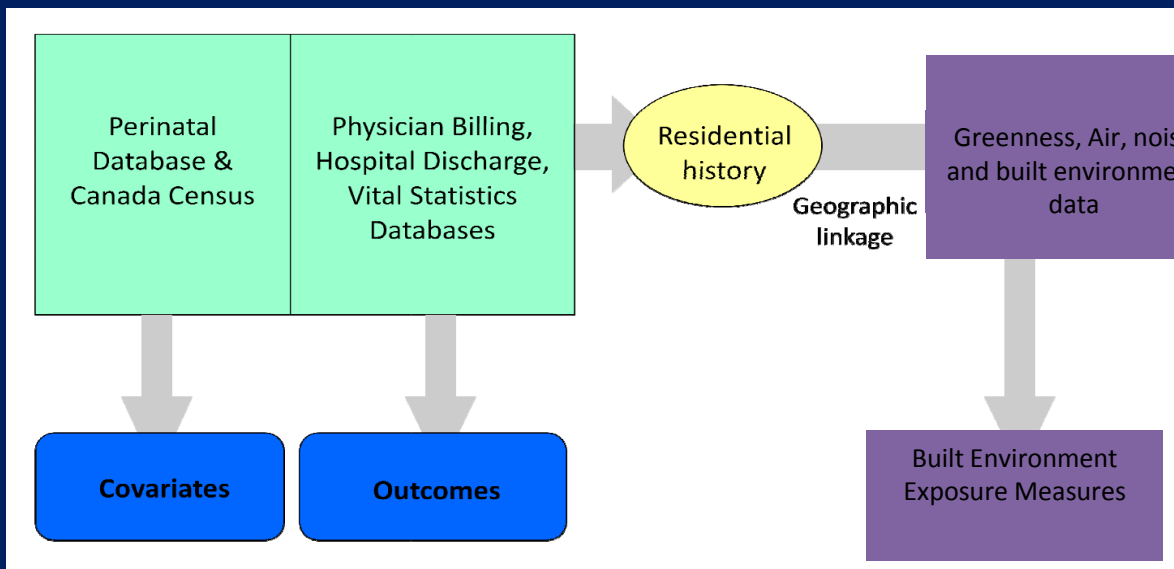
* RRs were adjusted for age, sex, household income, marital status, and area measures of income, immigration, unemployment and ambient PM_{2.5}

Residential Greenness and Birth Outcomes: Evaluating the Influence of Spatially Correlated Built-Environment Factors

Perry Hystad,¹ Hugh W. Davies,² Lawrence Frank,^{2,3} Josh Van Loon,² Ulrike Gehring,⁴ Lillian Tamburic,² and Michael Brauer²

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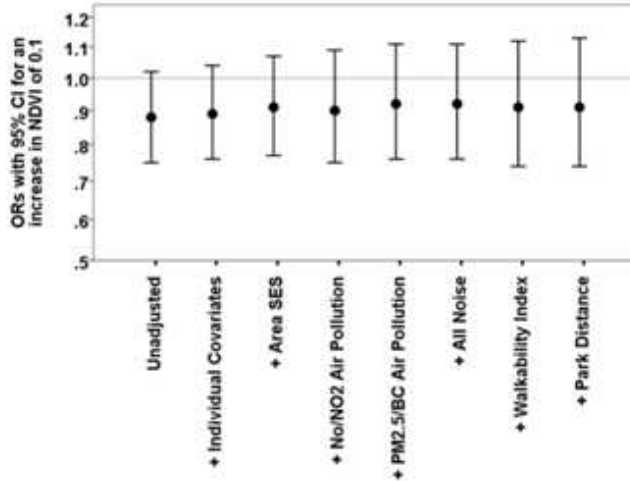
- Birth cohort identified 92,158 children born in the Vancouver metropolitan area from 1999–2002.



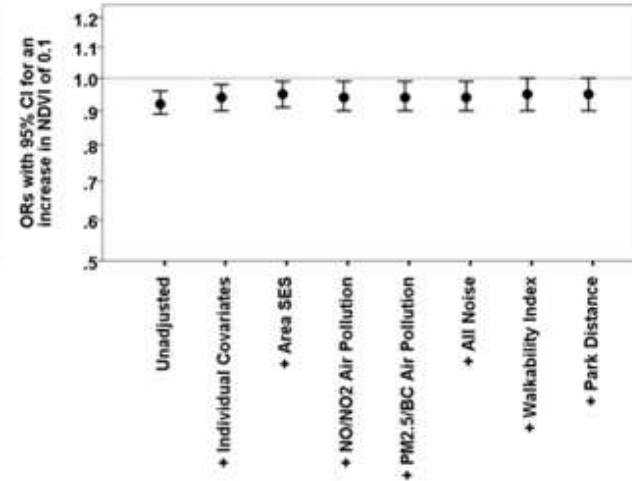
- 34.9 % of cohort had 2 addresses during pregnancy.
- 81% of mothers had complete residential history (9 months of pregnancy).

Joint Exposures – Greenness and Birth Outcome Associations

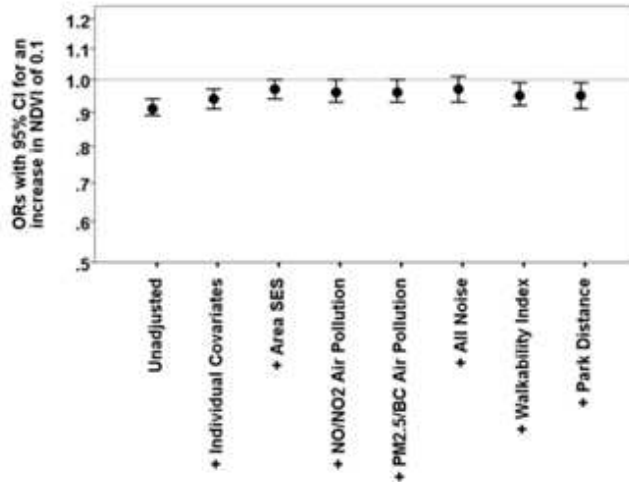
Very Preterm Birth (<30 weeks)



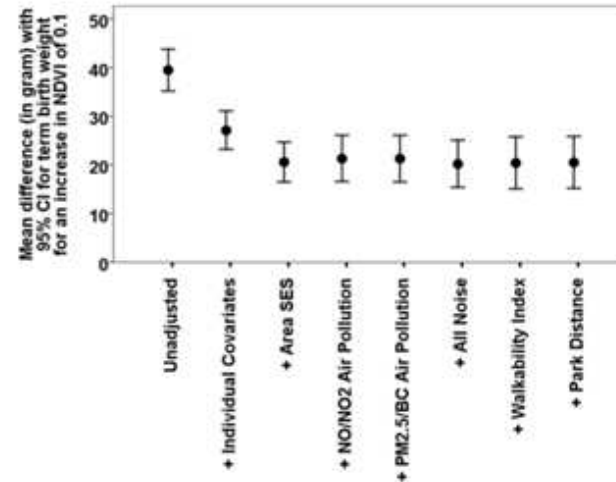
Moderate Preterm Birth (30-36 weeks)



Small for Gestational Age



Term Birth Weight



Where to go from here....

1. Do healthy people choose to live in green areas, or do green areas make people healthier?
2. Do certain characteristics of green space offer more benefits?
3. What are the nature of the associations using more refined measures of physical activity, and spatial monitoring?



Collaborators

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Jason Su, *University of California Berkley*

Owen McMorris, *Carleton University*

Thank –you!

Paul Villeneuve

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