WALKABILITY & CARDIOVASCULAR HEALTH

NICHOLAS ARAKI HOWELL, PHD

APR 21 2021

GEOHEALTH NETWORK & CANUE SEMINAR SERIES

@NICHOLASAHOWELL

Disclosures

- I declare no financial or professional conflicts of interest
- I declare no personal conflicts of interest, except that I am a pedestrian/cyclist who lives downtown
- NB some images removed from posted version of the slides

Learning Objectives

- Review a theoretical framework for how the built environment can influence cardiovascular disease risk
- Describe prior work demonstrating associations between the built environment and cardiovascular disease risk factors
- Analyze how built environment and air pollution exposures may jointly affect risk for diabetes and hypertension

- About me
- What is the built environment?
- Why would the built environment affect health?
- Could the built environment meaningfully affect cardio-metabolic health?
- How might the built environment interact with other environmental factors to affect cardio-metabolic health?

ABOUT ME

About Me

UNIVERSITY OF TORONTO	HBSc 2011	Psychology, Philosophy, Political Science
UNIVERSITY OF TORONTO	MSc 2013	Neuroscience/Medical Science
UNIVERSITY OF TORONTO	MD/PhD Program PhD 2019 MD 2021	Clinical Epidemiology PhD: Built Environments & Cardiovascular Health

About Me

UNIVERSITY OF TORONTO	HBSc 2011	Psychology, Philosophy, Political Science
UNIVERSITY OF TORONTO	MSc 2013	Neuroscience/Medical Science
UNIVERSITY OF TORONTO	MD/PhD Program PhD 2019 MD 2021	Clinical Epidemiology PhD: Built Environments & Cardiovascular Health
UNIVERSITY OF TORONTO	Residency 2021-2024	Internal Medicine

WHAT IS THE BUILT ENVIRONMENT?

The Built Environment

“Built environments are the totality of places built or designed by humans, including buildings, grounds around buildings, layout of communities, transportation infrastructure, and parks and trails.” Sallis et al., 2012

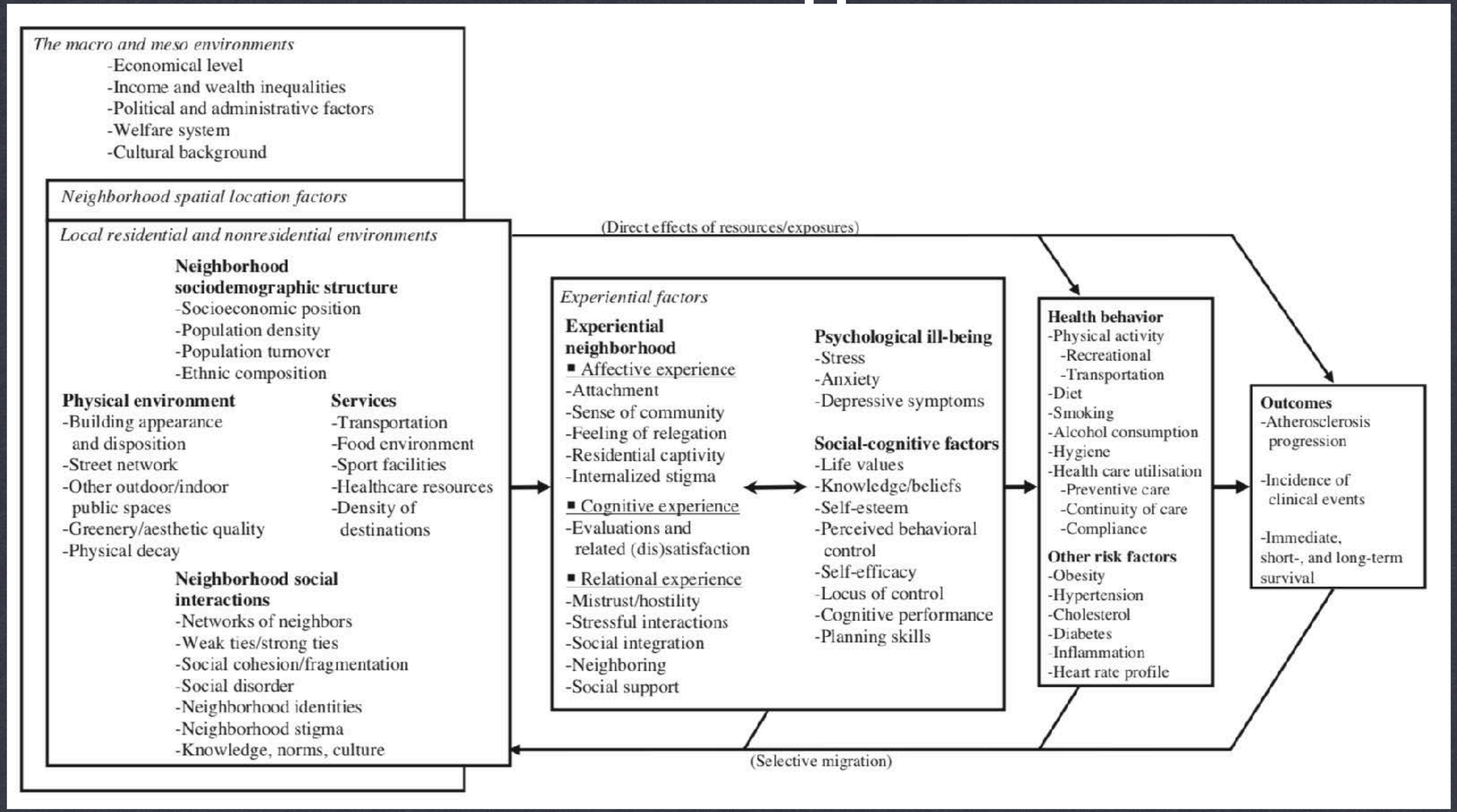
Walkability

- Measure of how supportive an area is for engaging in (transportation) physical activity in daily life

- Think **D**-variables
  - **D**ensity (of housing, jobs)
  - **D**estinations (within walking distance)
  - **D**iversity (of land use)
  - **D**esign (of streets, streetscapes)

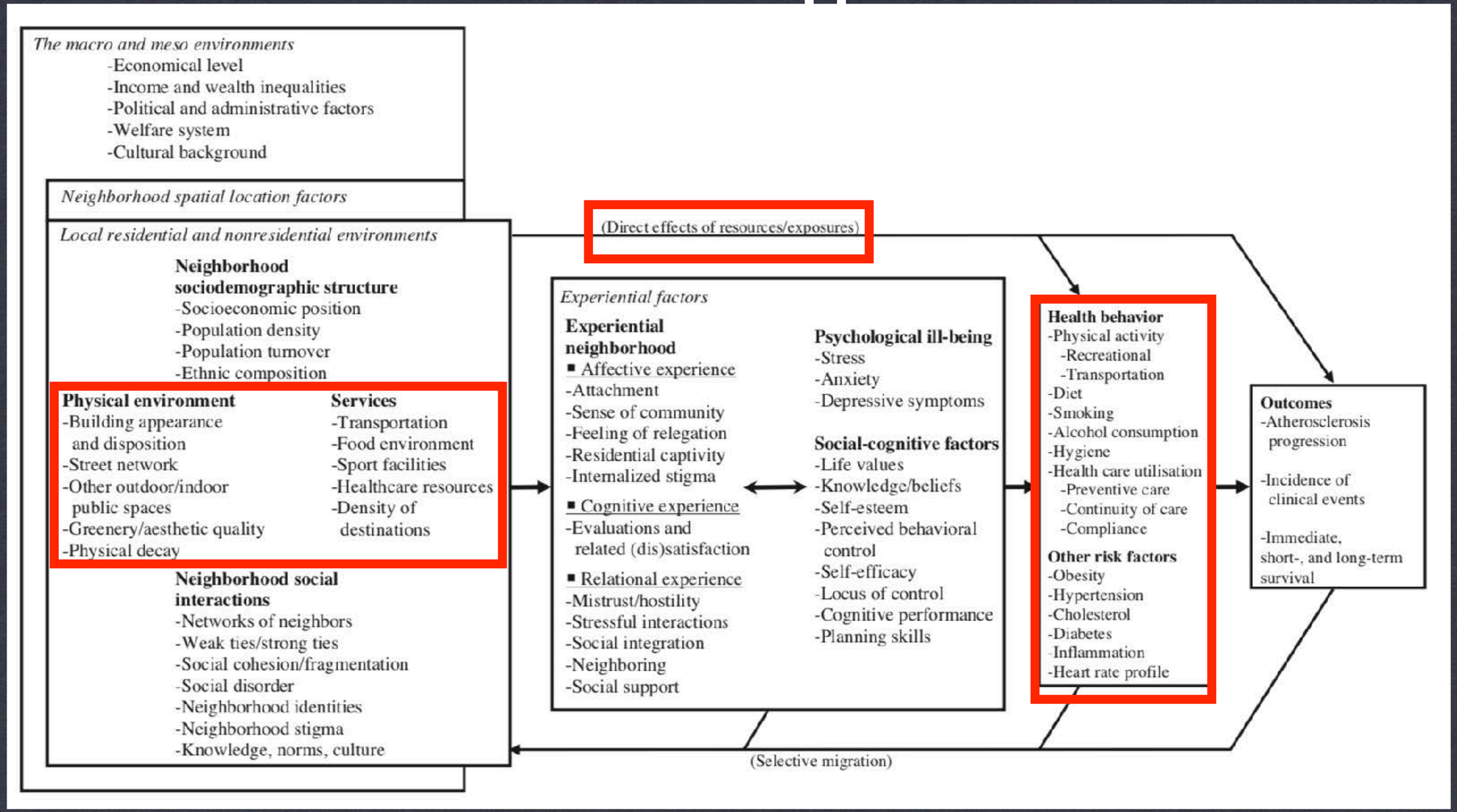
WHY WOULD THE BUILT ENVIRONMENT AFFECT HEALTH?

How is the built environment supposed to affect health?



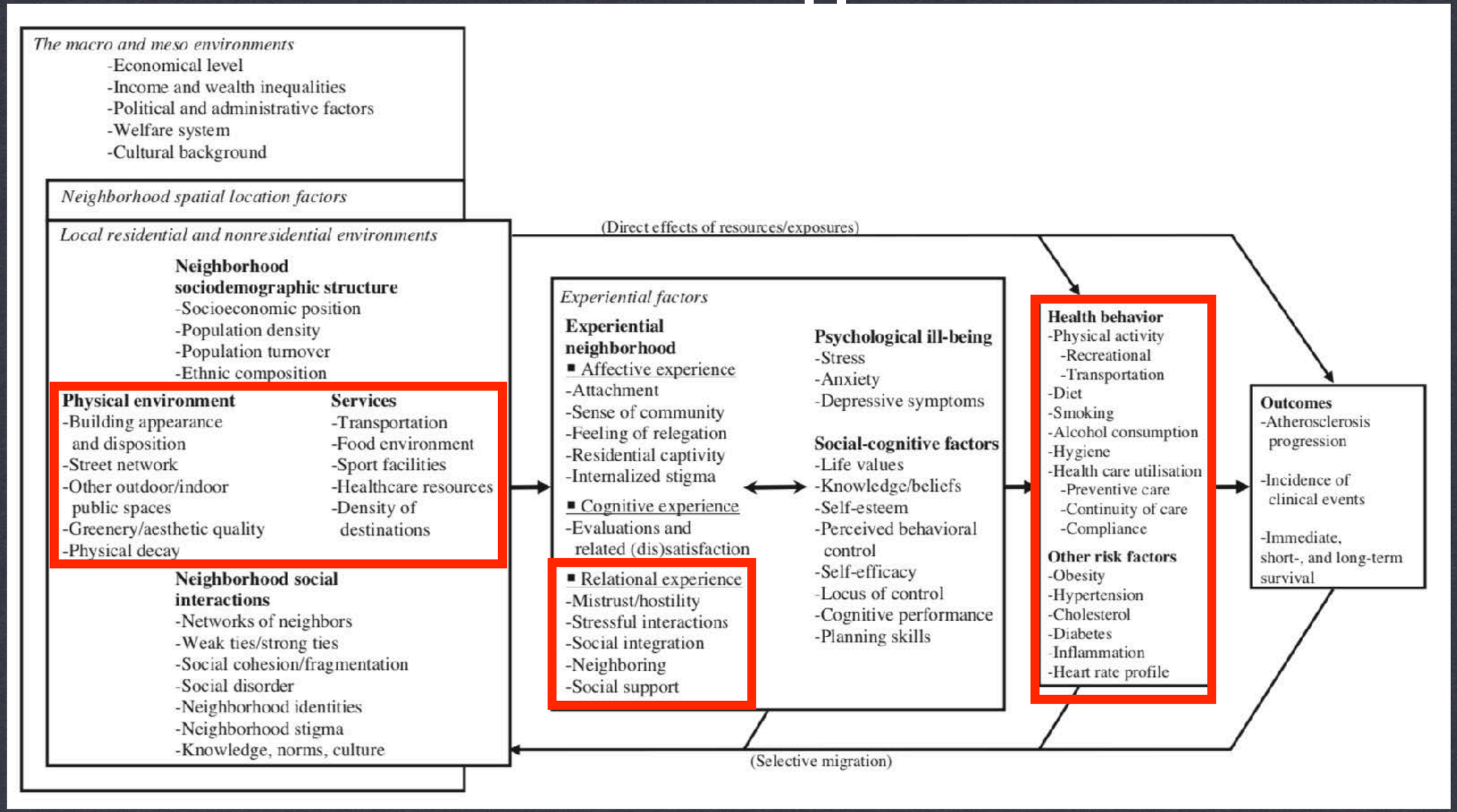
Chaix, 2009

How is the built environment supposed to affect health?



Chaix, 2009

How is the built environment supposed to affect health?



Chaix, 2009

COULD WALKABILITY MEANINGFULLY AFFECT…

Could walkability meaningfully affect…

Physical activity?

	5% lowest values of environmental features	5% highest values of environmental features	Differences in weekly minutes of MVPA between lowest 5% and highest 5% values of environmental correlate (95% CI)	Lowest average study-city value for environmental features	Highest average study-city value for environmental features	Differences in weekly minutes of MVPA between lowest and highest average study-city values of environmental features (95% CI)
Net residential density—1·0 km buffer	710	21 078	49 (15–86)*	1658·0	57 322·0	89 (29–161)*
Public transport density—1·0 km buffer	0	35	33% of PAG	2·2	29·1	59% of PAG
Net residential density—0·5 km buffer	652	28 917	48 (6–78)†	1669·0	57 276·0	68 (11–144)†
Public transport density—0·5 km buffer	0	46	32% of PAG	2·4	33·3	45% of PAG
Number of parks contained or intersected by 0·5 km buffer	0	6	..	0·6	7·4	..

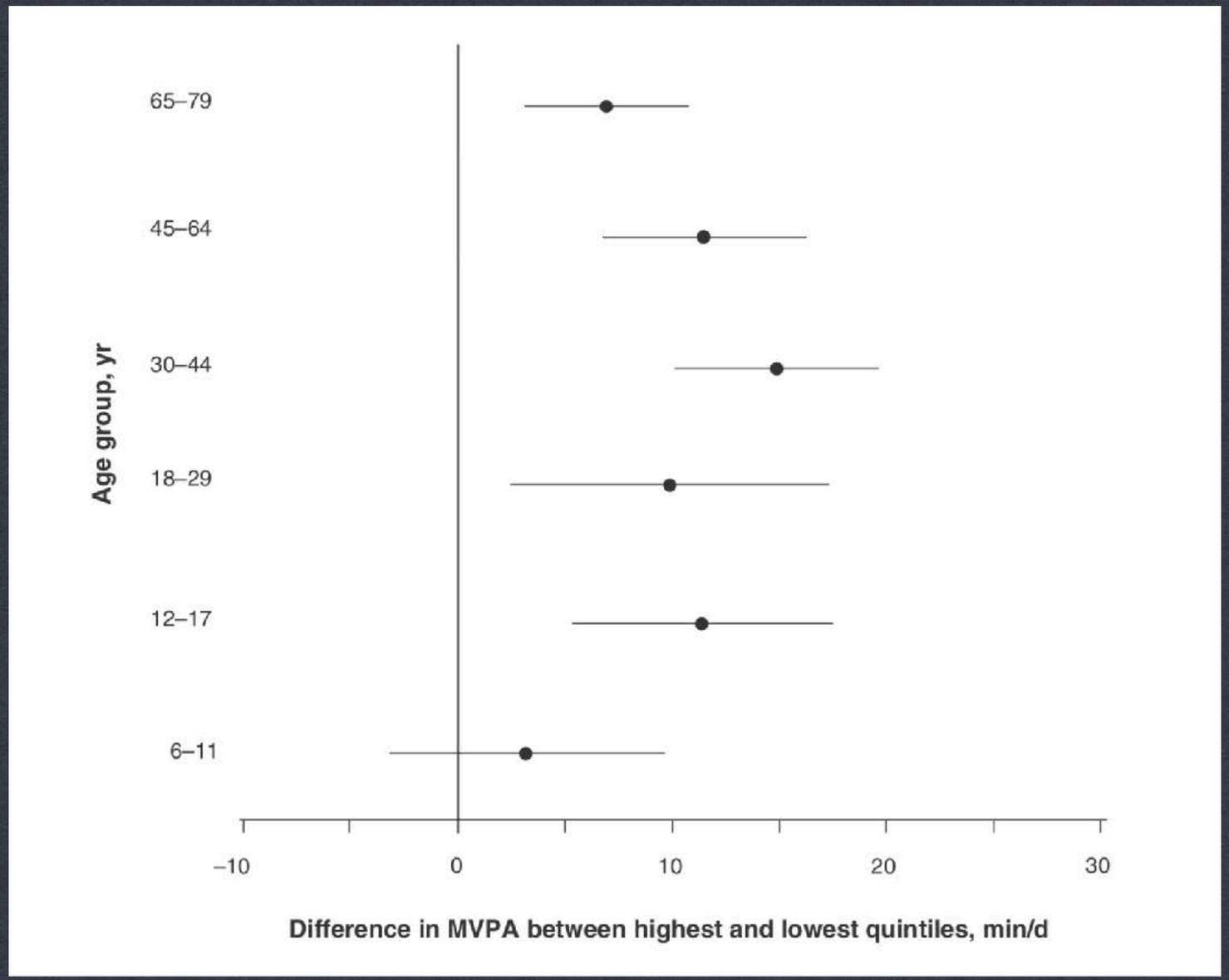
Sallis et al., 2016

Could walkability meaningfully affect…

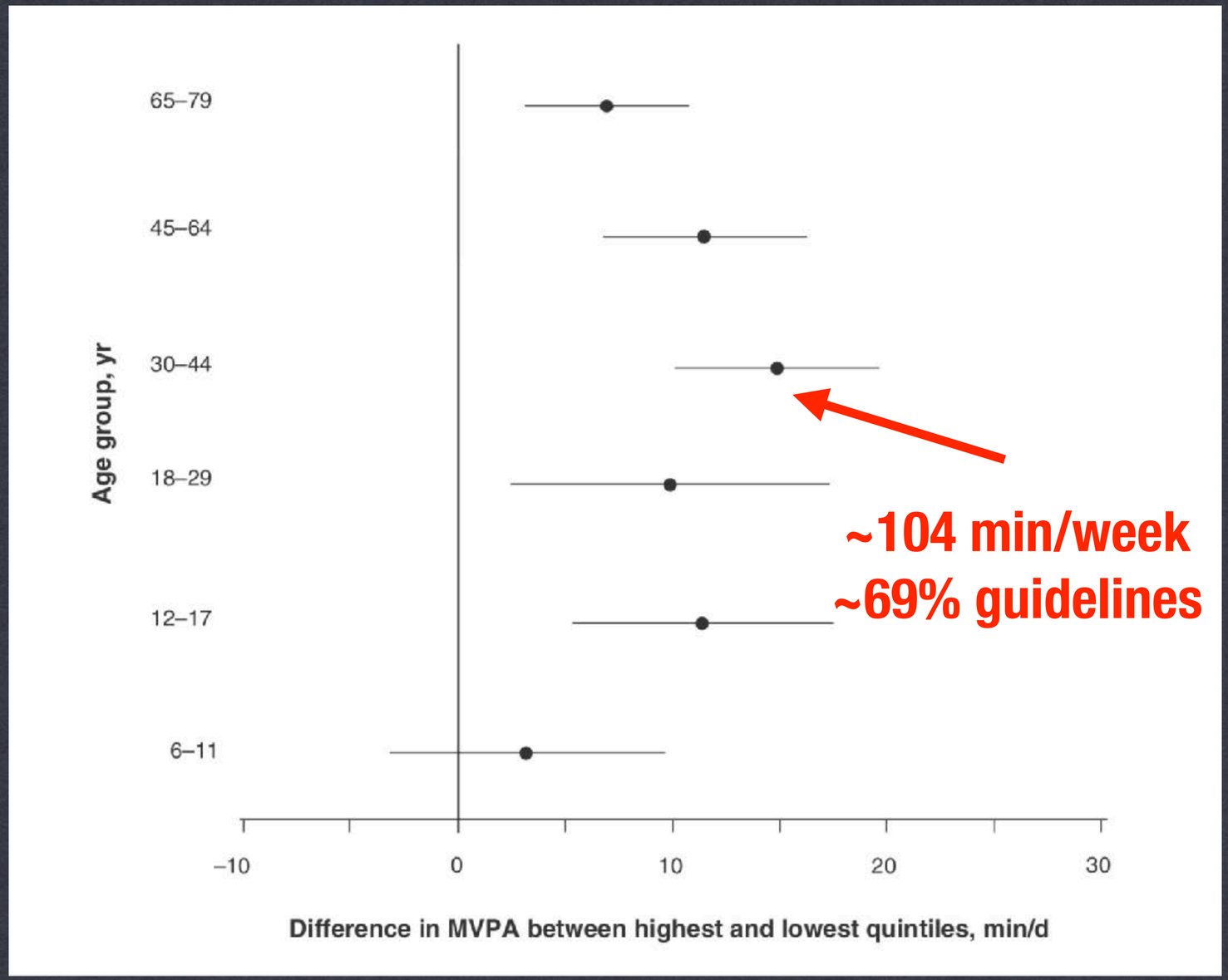
Physical activity?

	5% lowest values of environmental features	5% highest values of environmental features	Differences in weekly minutes of MVPA between lowest 5% and highest 5% values of environmental correlate (95% CI)	Lowest average study-city value for environmental features	Highest average study-city value for environmental features	Differences in weekly minutes of MVPA between lowest and highest average study-city values of environmental features (95% CI)
Net residential density—1·0 km buffer	710	21 078	49 (15–86)*	1658·0	57 322·0	89 (29–161)*
Public transport density—1·0 km buffer	0	35	33% of PAG	2·2	29·1	59% of PAG
Net residential density—0·5 km buffer	652	28 917	48 (6–78)†	1669·0	57 276·0	68 (11–144)†
Public transport density—0·5 km buffer	0	46	32% of PAG	2·4	33·3	45% of PAG
Number of parks contained or intersected by 0·5 km buffer	0	6	..	0·6	7·4	..

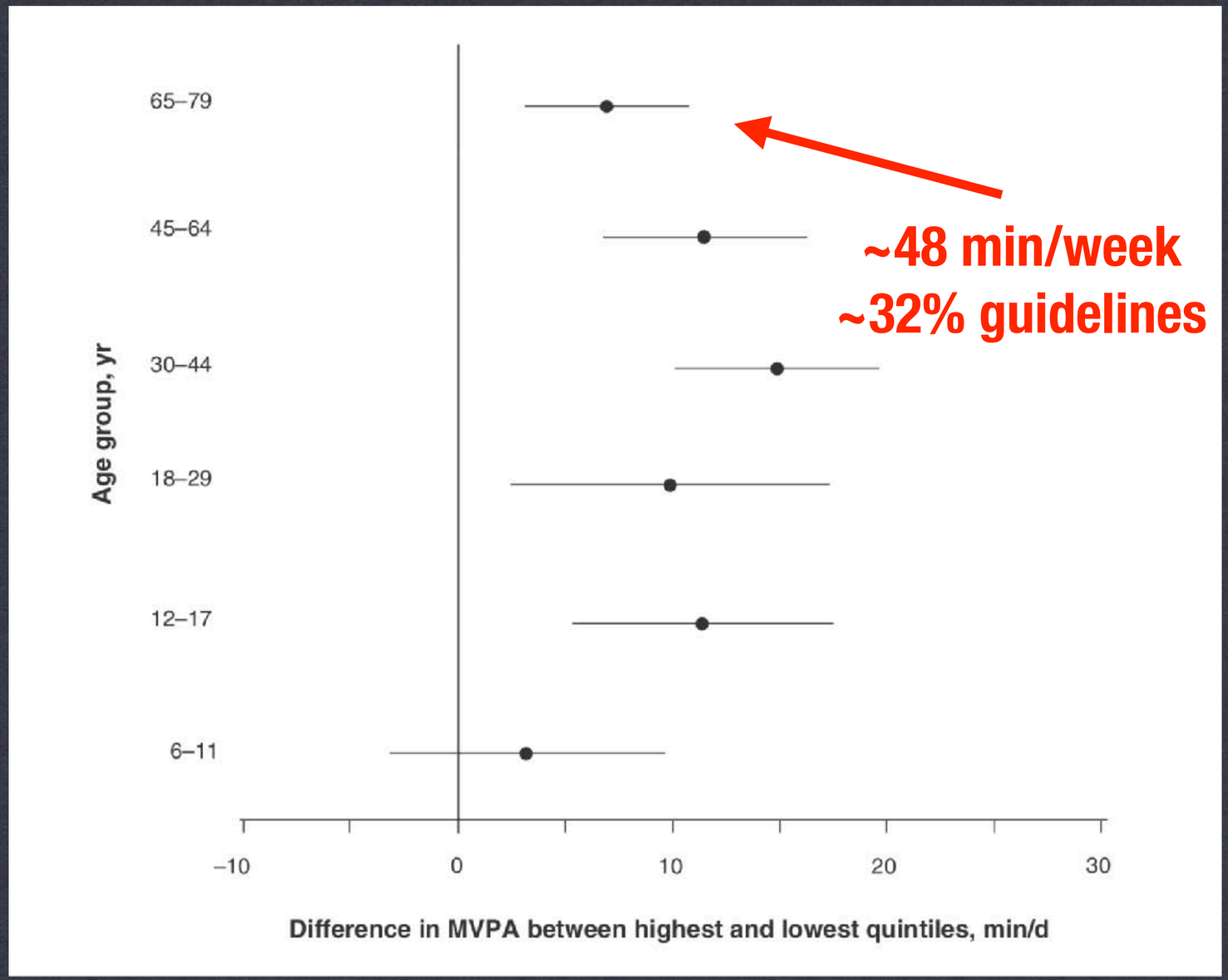
Sallis et al., 2016



Thielman et al., 2016



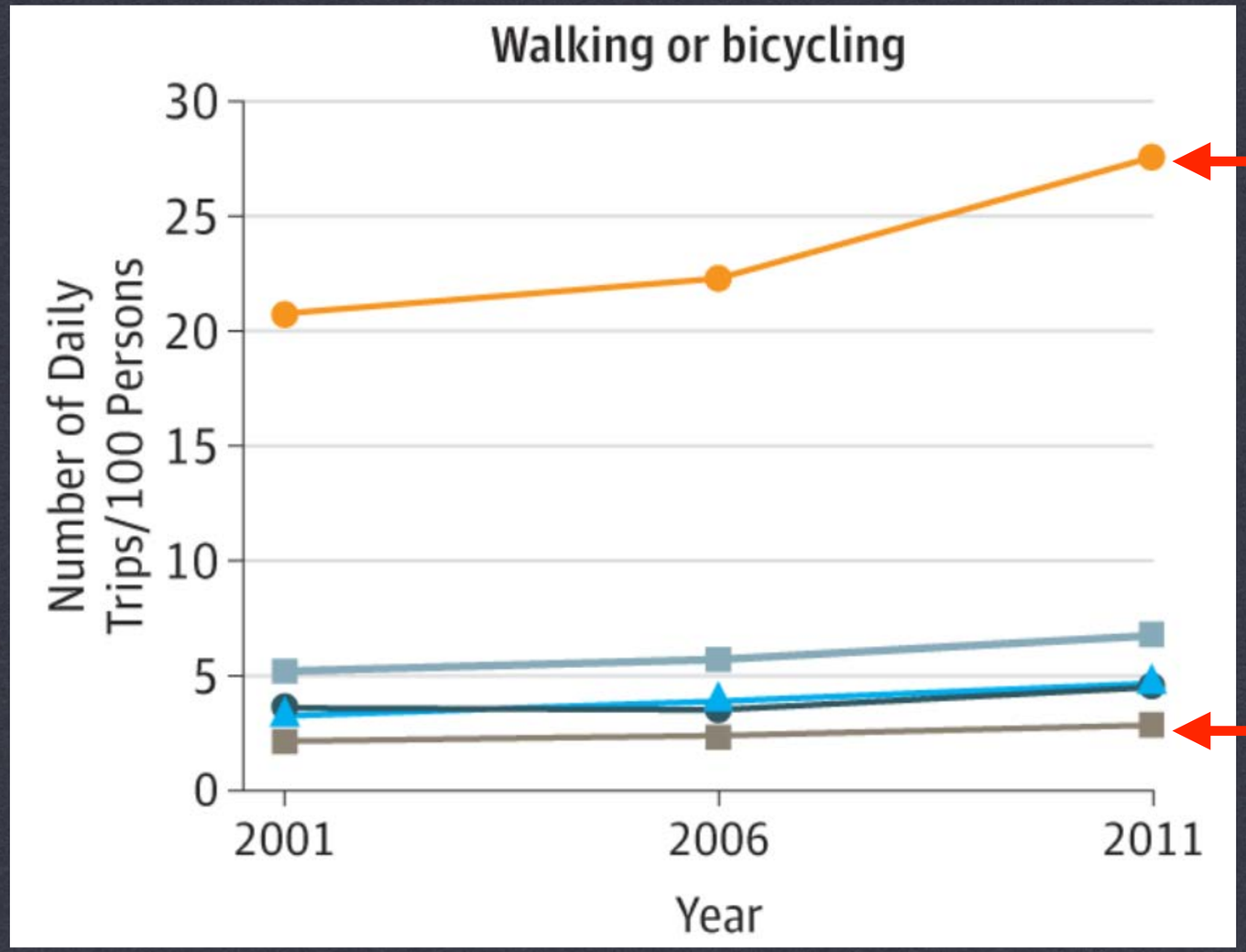
Thielman et al., 2016



Thielman et al., 2016

Could walkability meaningfully affect…

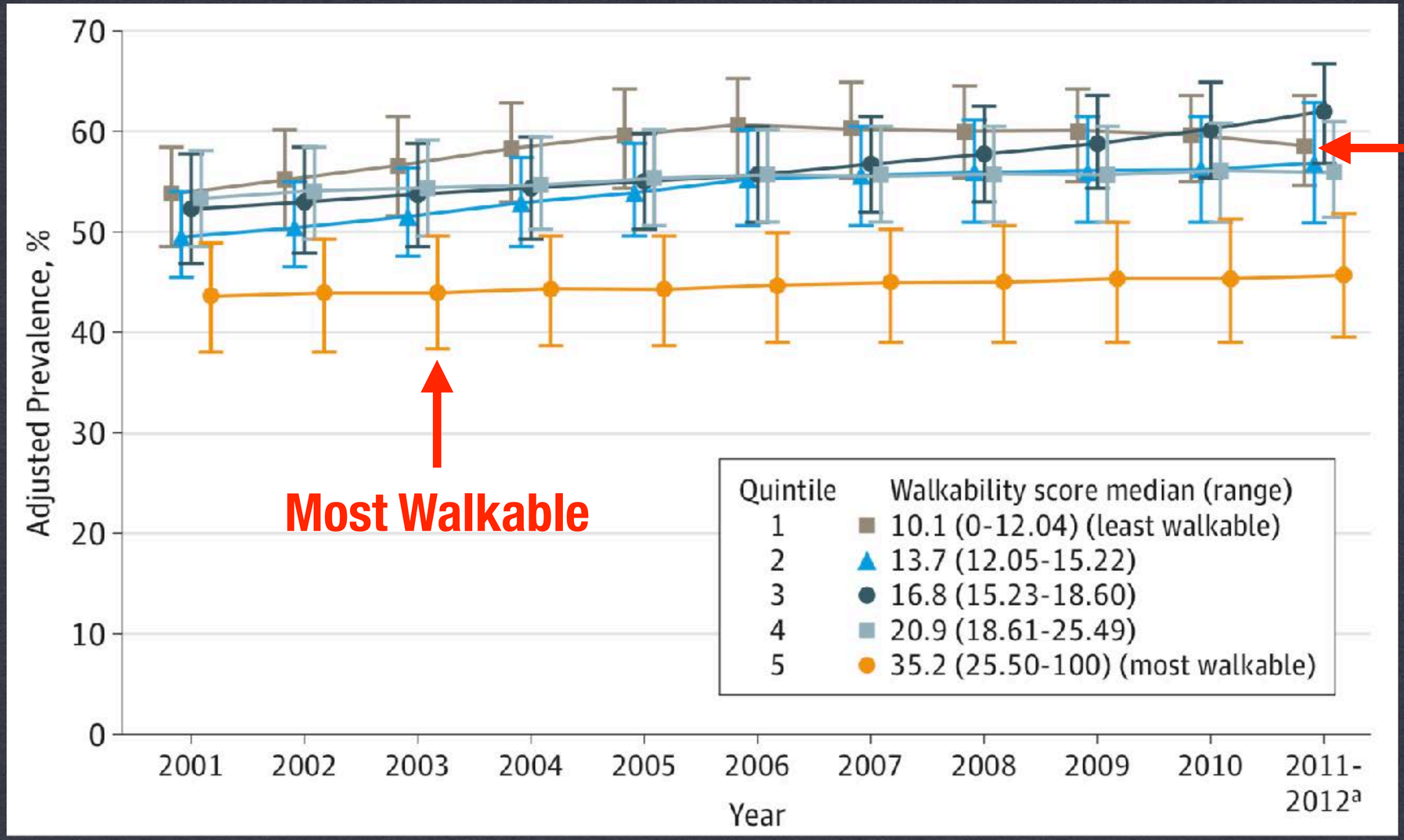
Physical activity?



Creatore et al., 2016

Could walkability meaningfully affect…

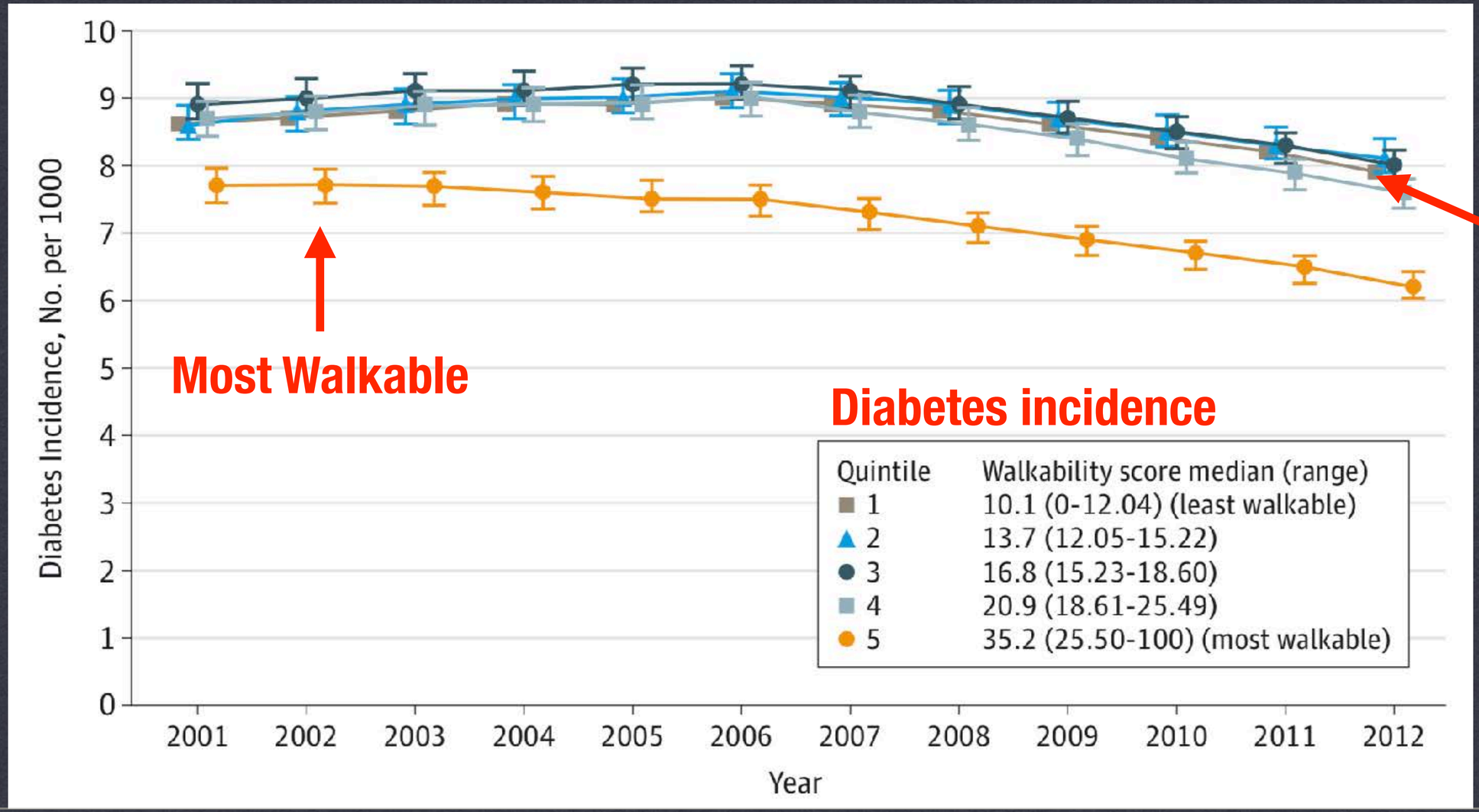
Obesity/overweight?



Creatore et al., 2016

Could walkability meaningfully affect…

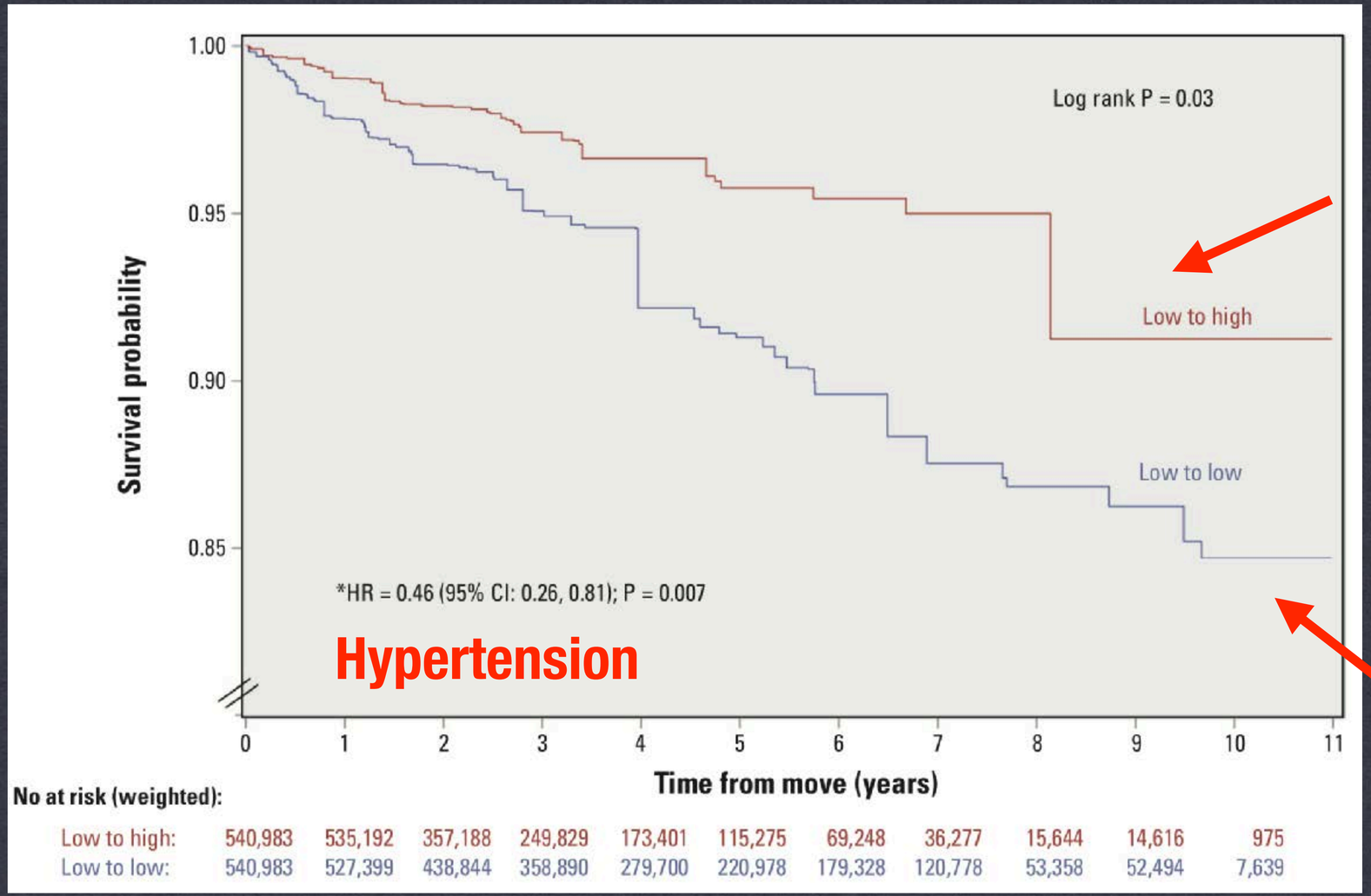
Diabetes?



Creatore et al., 2016

Could walkability meaningfully affect…

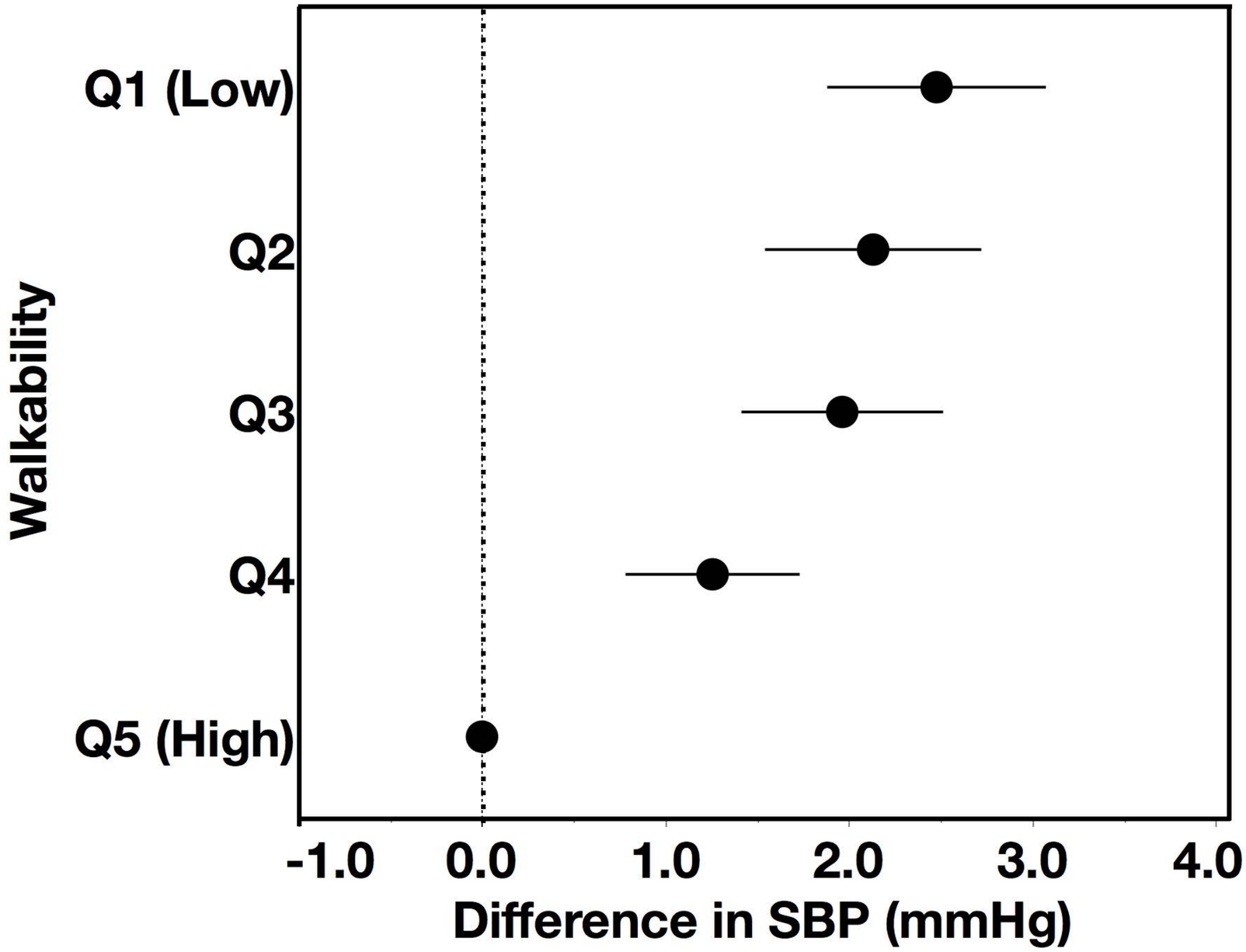
Hypertension?



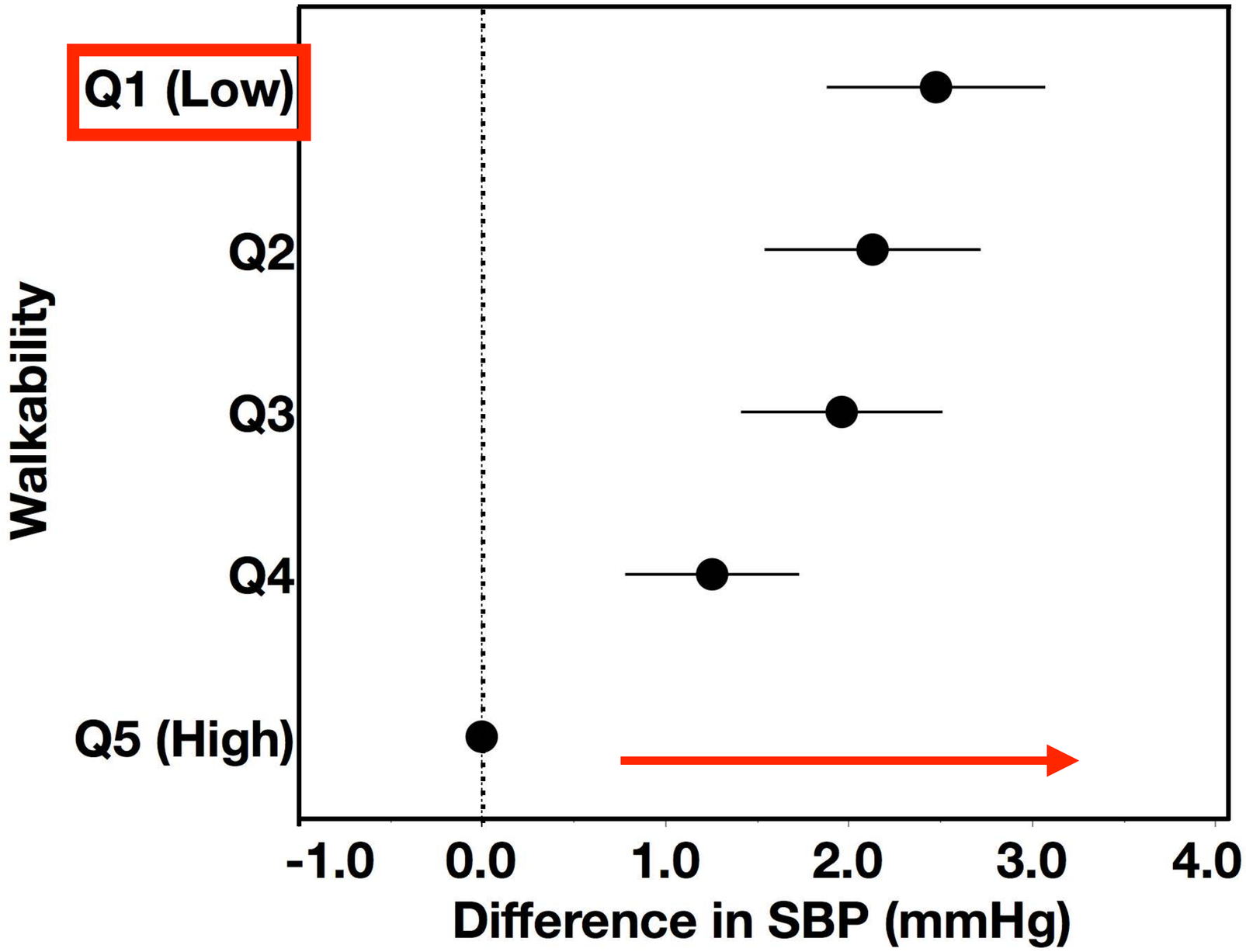
Moved from Low to High Walkability

Moved from Low to Low Walkability

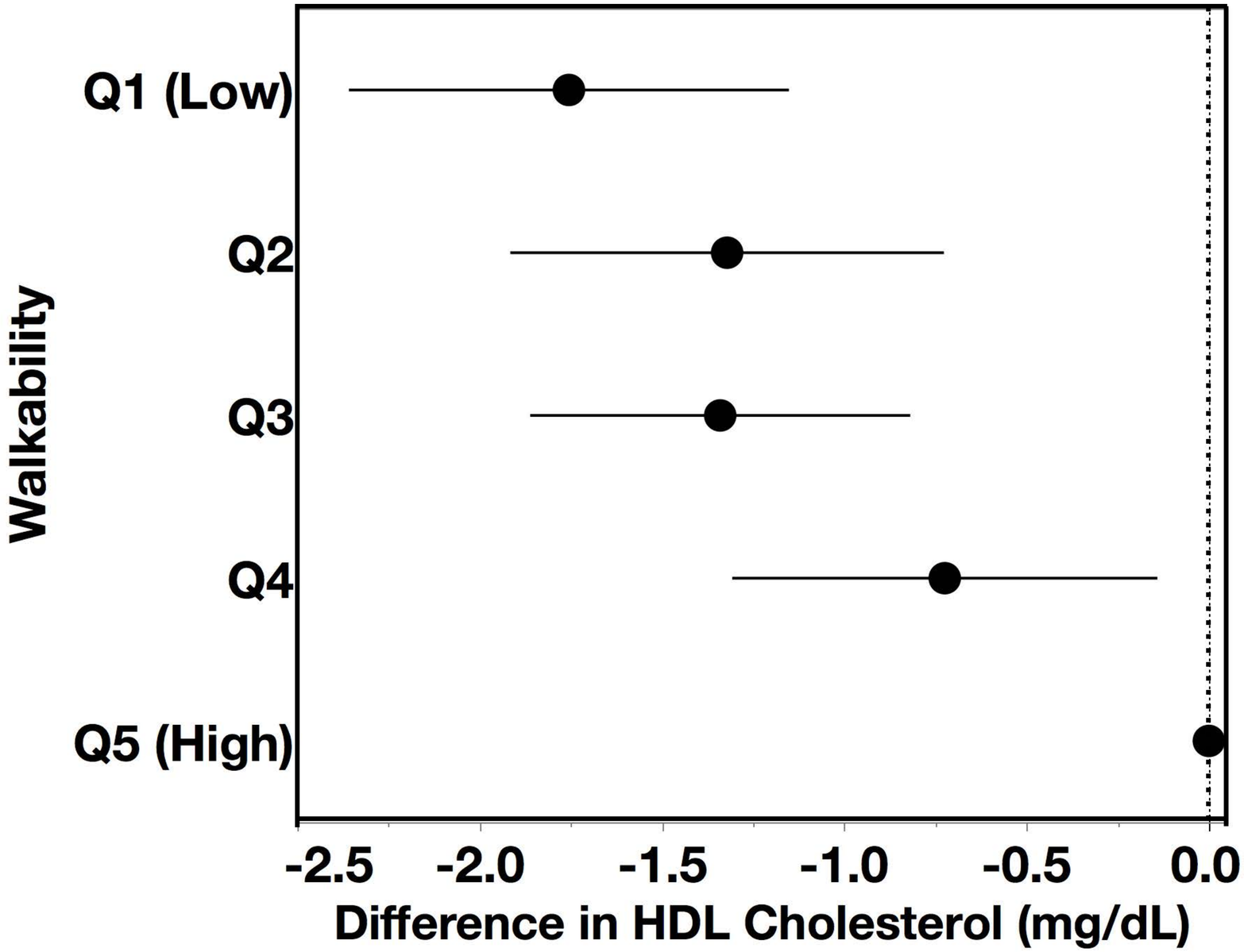
Chiu et al., 2016



Howell et al., JAHA (2019)



Howell et al., JAHA (2019)



Howell et al., JAHA (2019)

Walkability and CV Risk Factors - Conclusions

- Based on prior work, it seems possible that the built environment could have a meaningful effect on cardiovascular health
- Relationships between walkability and most established cardiovascular risk factors

Could the built environment meaningfully affect CV health — Conclusions

- But conceptual frameworks in built environment literature frequently highlight the inter-relationships between different contextual factors
- Despite this, there has been little work examining potential interactions between walkability (and other built environment factors) and other contextual variables

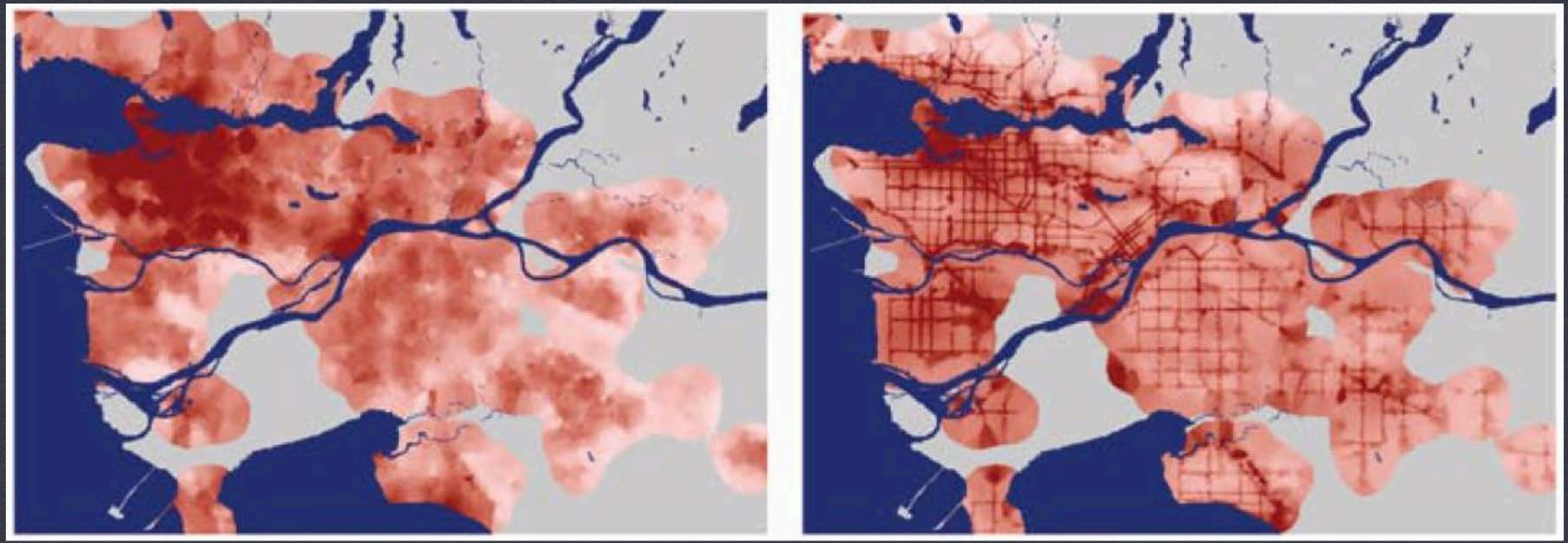
BUILT ENVIRONMENT INTERACTIONS WITH OTHER ENVIRONMENTAL FACTORS

Walkability & Traffic Related Air Pollution

- Associations between higher walkability and higher air pollution[1,2]
- Several air pollutants are established risk factors for CVD
- May predispose individuals in walkable neighbourhoods to higher cardiovascular risk

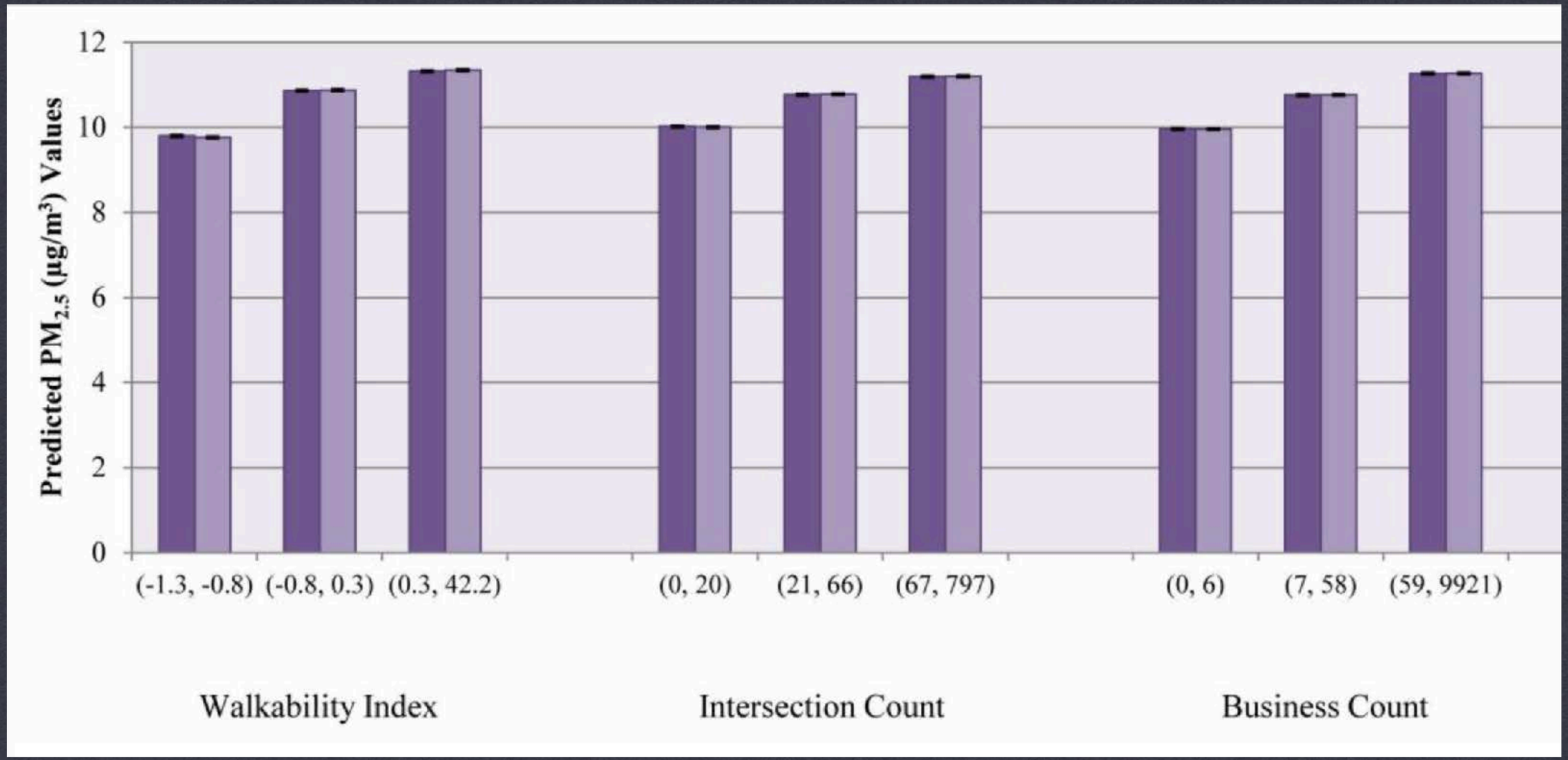
[1]Marshall, Brauer, Frank, 2009; [2]James et al., 2015; [3]Cepeda et al., 2017

Walkability (Vancouver) & Traffic Related Air Pollution



[1]Marshall, Brauer, Frank, 2009

Walkability (USA) & $PM_{2.5}$



James et al., 2015

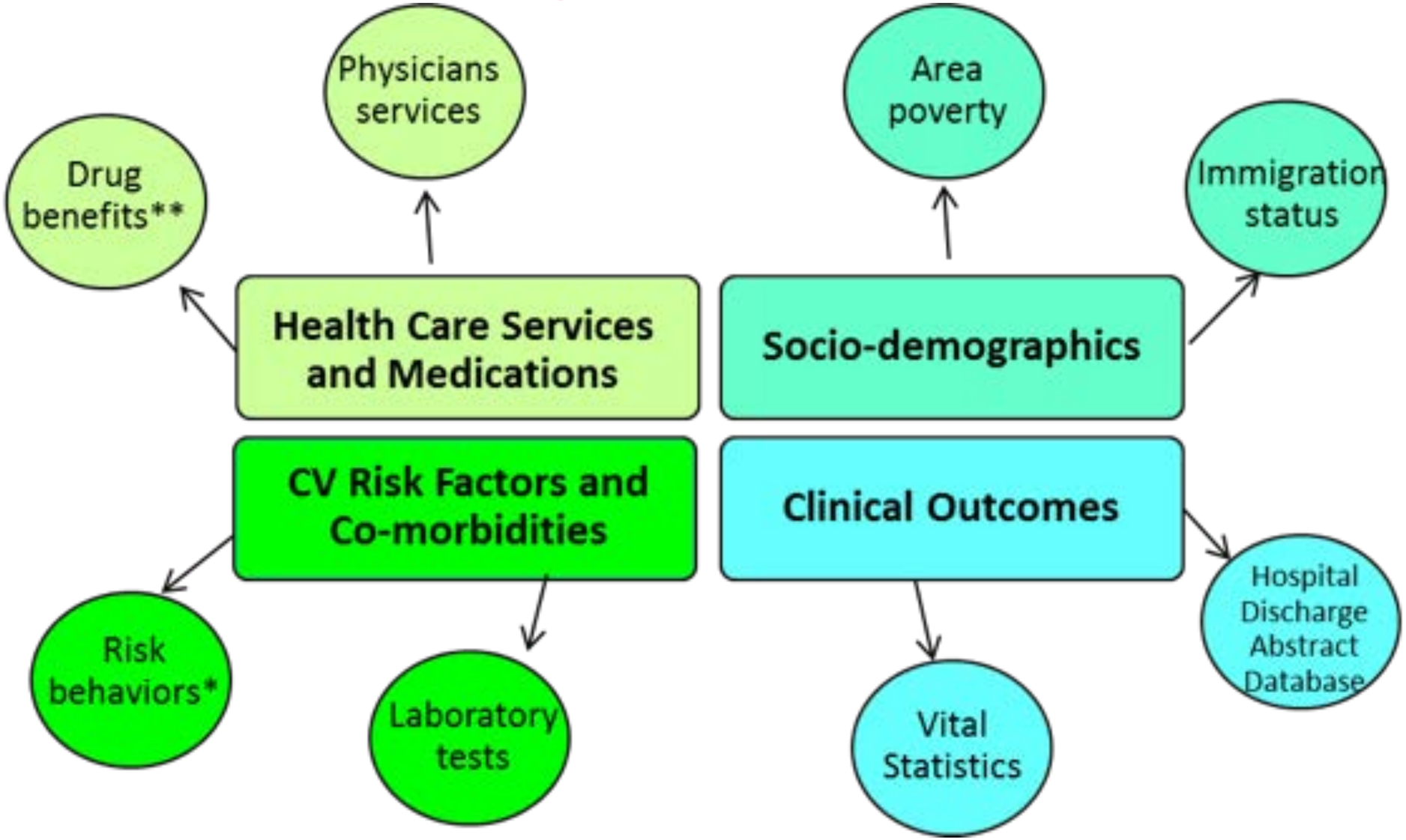
IS THERE ANY INTERACTION BETWEEN TRAFFIC-RELATED AIR POLLUTION AND WALKABILITY ON CARDIOVASCULAR RISK FACTORS?

Design, Setting & Population

- **Setting**
  - Major urban centres in Southern Ontario (2008)
- **Data Sources**
  - Health Administrative Databases
- **Population**
  - CANHEART cohort

CANHEART

Cardiovascular Health in Ambulatory Care Research Team

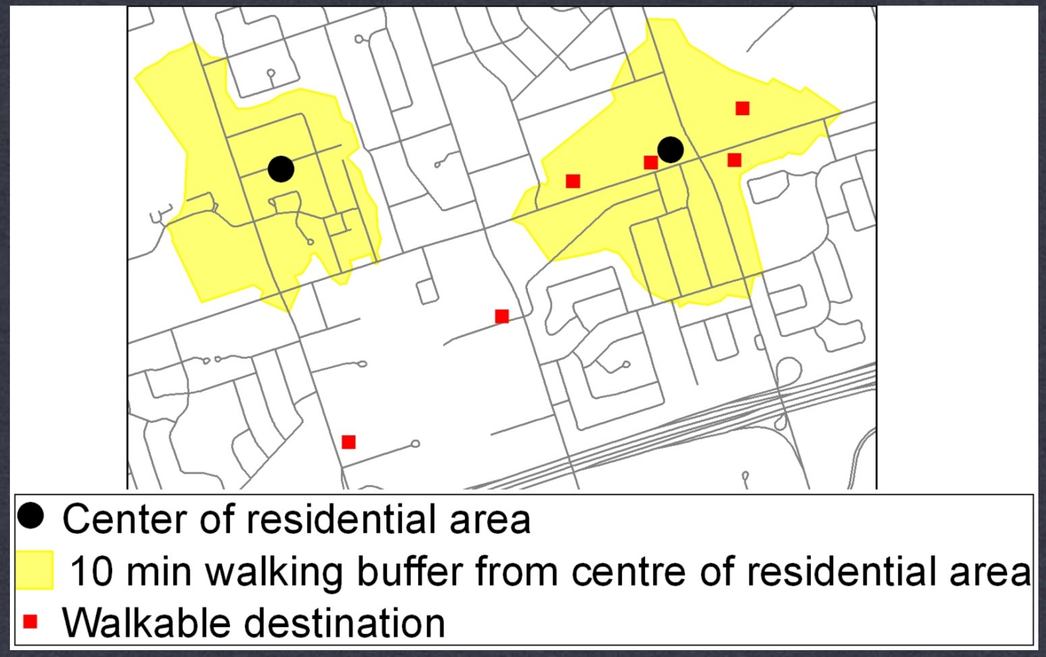


Design

- **Data sources**
  - CANHEART Cohort
- **Study Design**
  - Cross-sectional

Walkability

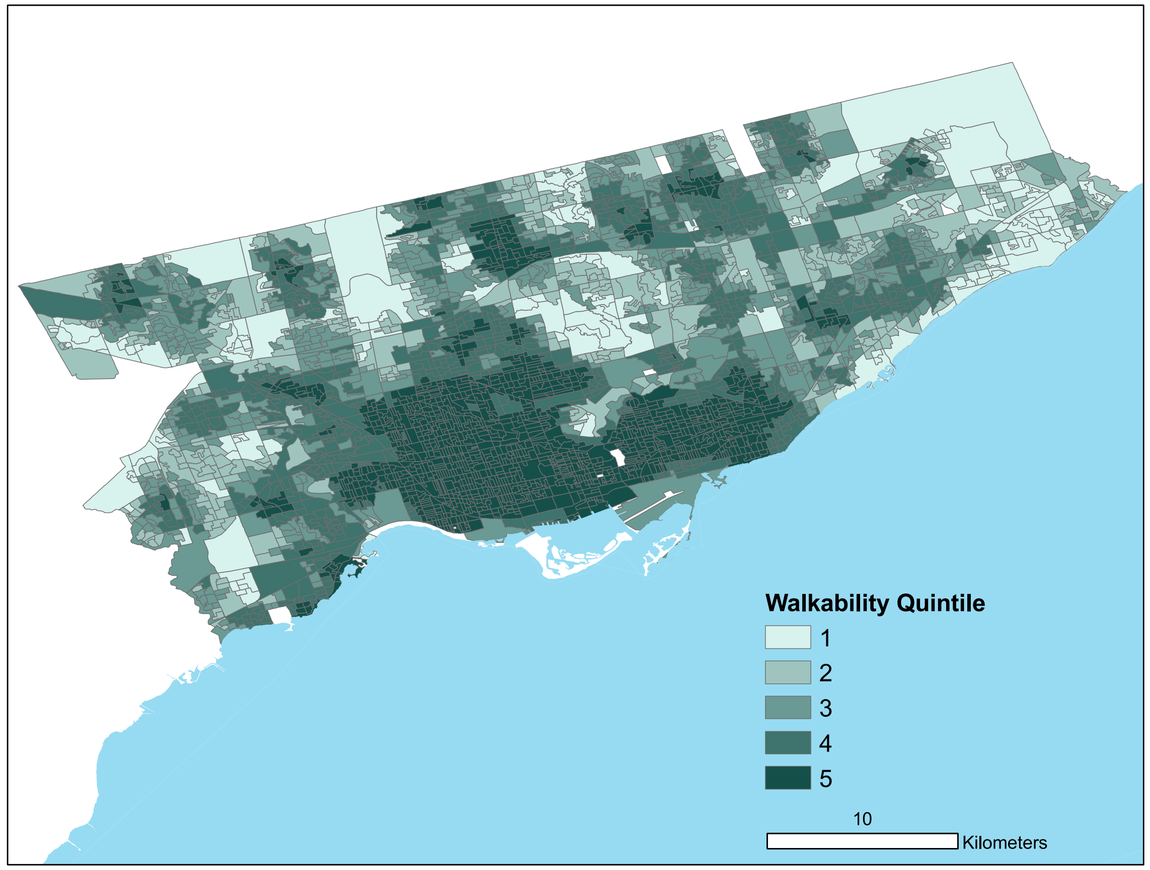
- Assessed at neighbourhood level
- Validated index composed of
  - (i) **population density**
  - (ii) **dwelling density**
  - (iii) **number of destinations and**
  - (iv) **street connectivity**

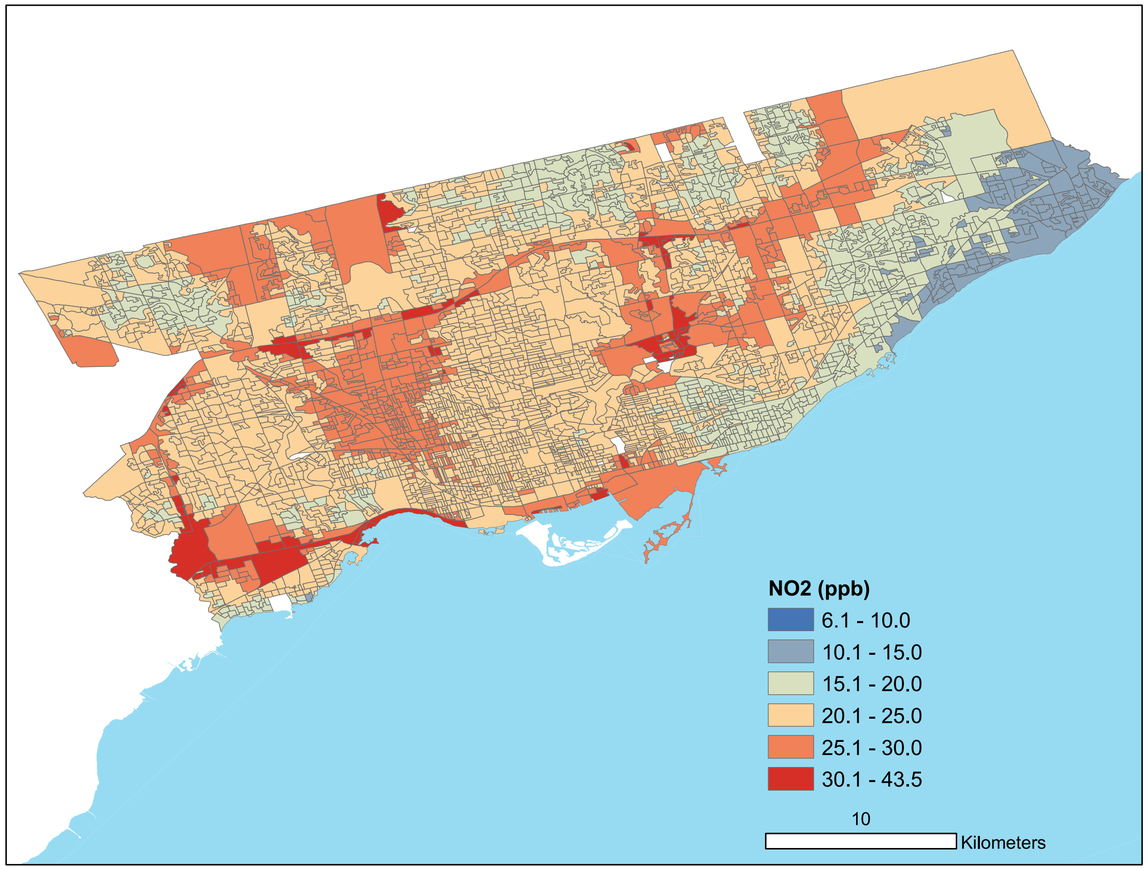


Exposure - Traffic-related Air Pollution

- Assessed using land use regression model for surrogate pollutant (NO_2)
- Linked to individuals using postal codes
- Data: CANUE& Environment Canada's National Air Pollution Surveillance Network
  - Land use
  - Meterological
  - Satellite imaging
- Outdoor NO_2 (2006) $R^2 = 0.73$

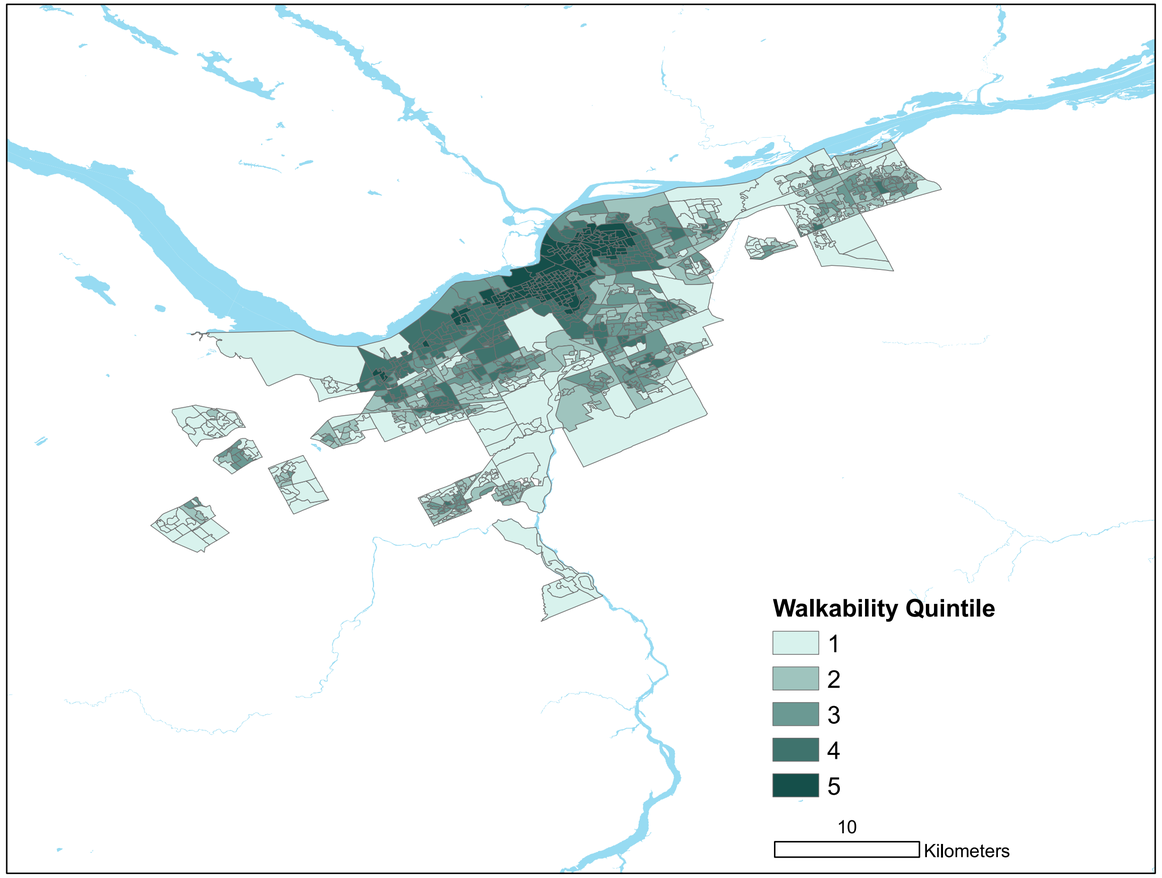
Walkability & NO_2 in Toronto

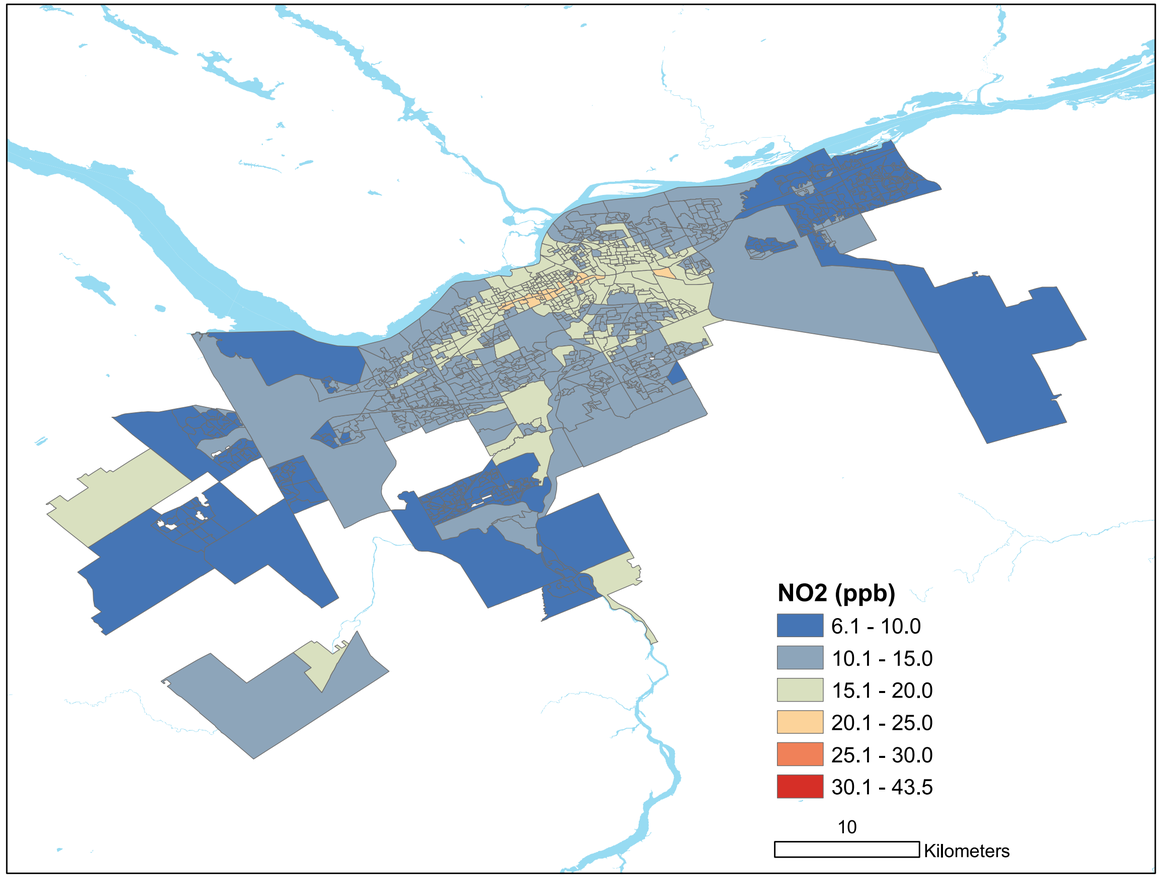




All-Region Spearman Rho = 0.44

Walkability & NO_2 in Ottawa





All-Region Spearman Rho = 0.44

Associations B/W Walkability, NO2 & Hypertension, Diabetes

N = 2,496,458	Hypertension	Diabetes Mellitus
Variable/Statistic	**Joint OR (95% CI)**	**Joint OR (95% CI)**
Walkability Quintile Q1 (Lowest) Q2 Q3 Q4 Q5	 1.34 (1.32, 1.37) 1.33 (1.30, 1.35) 1.29 (1.27, 1.31) 1.19 (1.17, 1.21) Ref	 1.25 (1.22, 1.29) 1.21 (1.18, 1.24) 1.19 (1.17, 1.22) 1.16 (1.13, 1.19) Ref
Traffic-related air pollution (NO_2) (per 10 ppb)	1.09 (1.08. 1.10)	1.16 (1.14, 1.17)
Adjustment variables	Age, sex, ethnicity, immigration history, neighbourhood income	

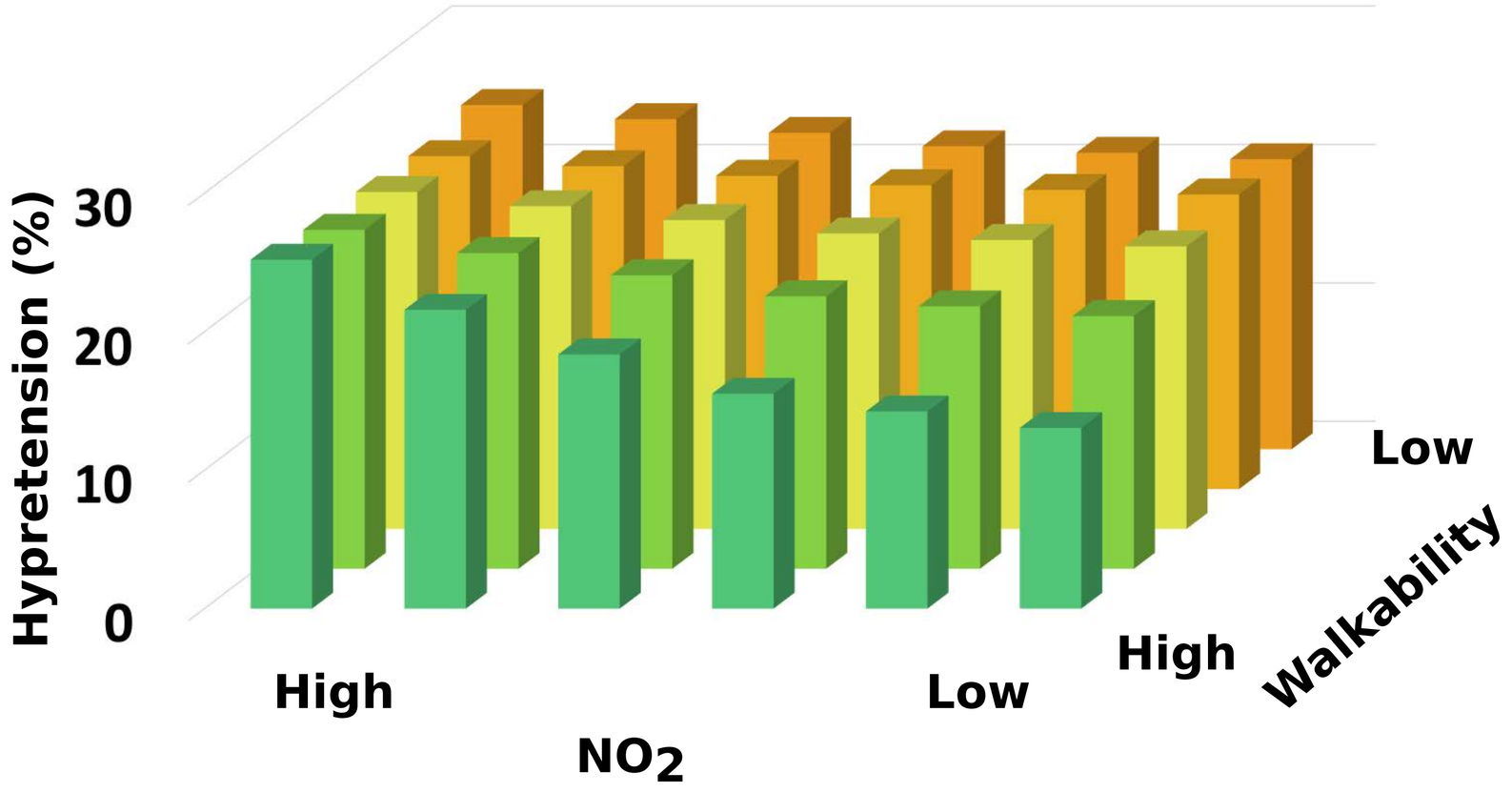
Associations B/W Walkability, NO2 & Hypertension, Diabetes

	Hypertension	Diabetes Mellitus
Variable/Statistic	**Joint OR (95% CI)**	**Joint OR (95% CI)**
Walkability Quintile		
Q1 (Lowest)	1.34 (1.32, 1.37)	1.25 (1.22, 1.29)
Q2	1.33 (1.30, 1.35)	1.21 (1.18, 1.24)
Q3	1.29 (1.27, 1.31)	1.19 (1.17, 1.22)
Q4	1.19 (1.17, 1.21)	1.16 (1.13, 1.19)
Q5	Ref	Ref
Traffic-related air pollution (NO_2) (per 10 ppb)	1.09 (1.08. 1.10)	1.16 (1.14, 1.17)
Adjustment variables	Age, sex, ethnicity, immigration history, neighbourhood income	

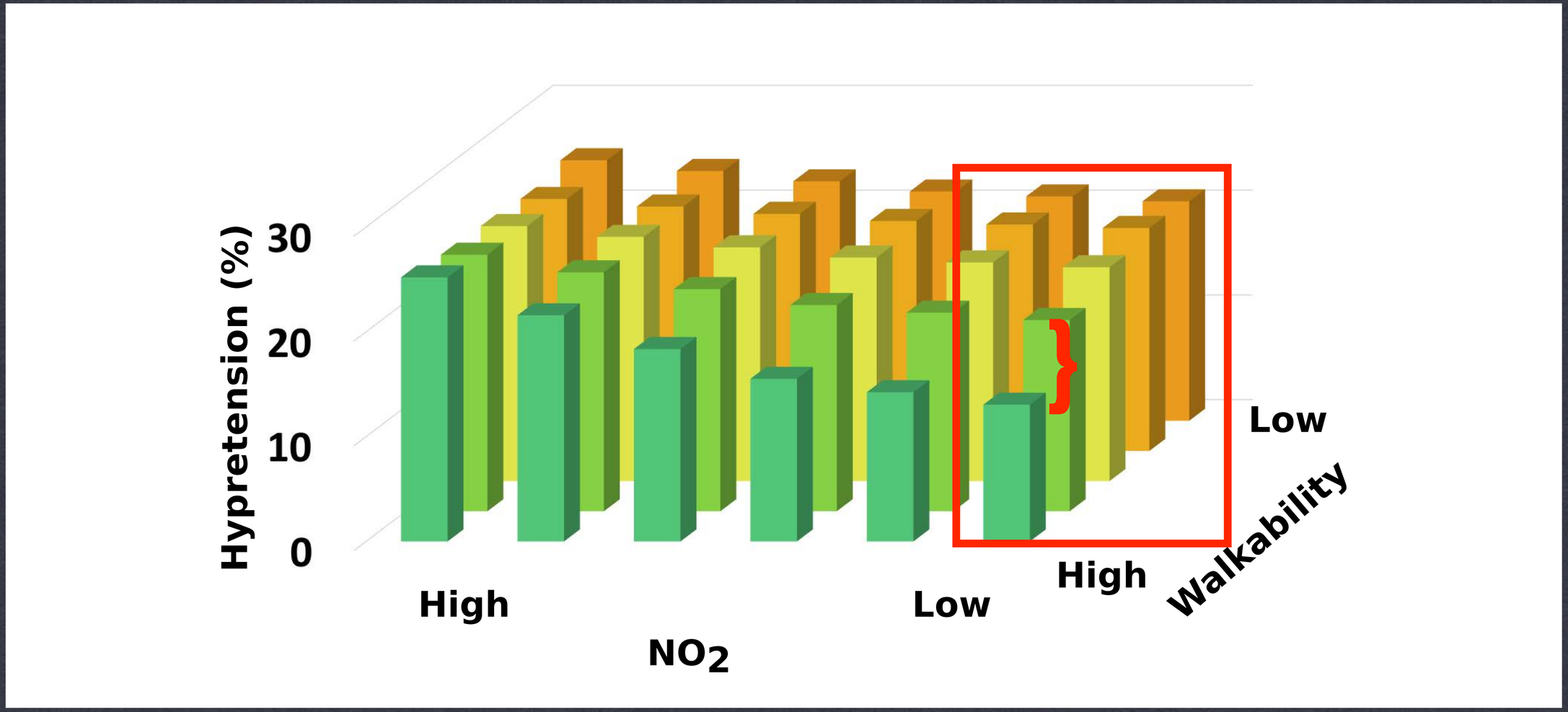
Associations B/W Walkability, NO2 & Hypertension, Diabetes

	Hypertension	Diabetes Mellitus
Variable/Statistic	**Joint OR (95% CI)**	**Joint OR (95% CI)**
Walkability Quintile		
Q1 (Lowest)	1.34 (1.32, 1.37)	1.25 (1.22, 1.29)
Q2	1.33 (1.30, 1.35)	1.21 (1.18, 1.24)
Q3	1.29 (1.27, 1.31)	1.19 (1.17, 1.22)
Q4	1.19 (1.17, 1.21)	1.16 (1.13, 1.19)
Q5	Ref	Ref
Traffic-related air pollution (NO_2) (per 10 ppb)	1.09 (1.08. 1.10)	1.16 (1.14, 1.17)
Adjustment variables	Age, sex, ethnicity, immigration history, neighbourhood income	

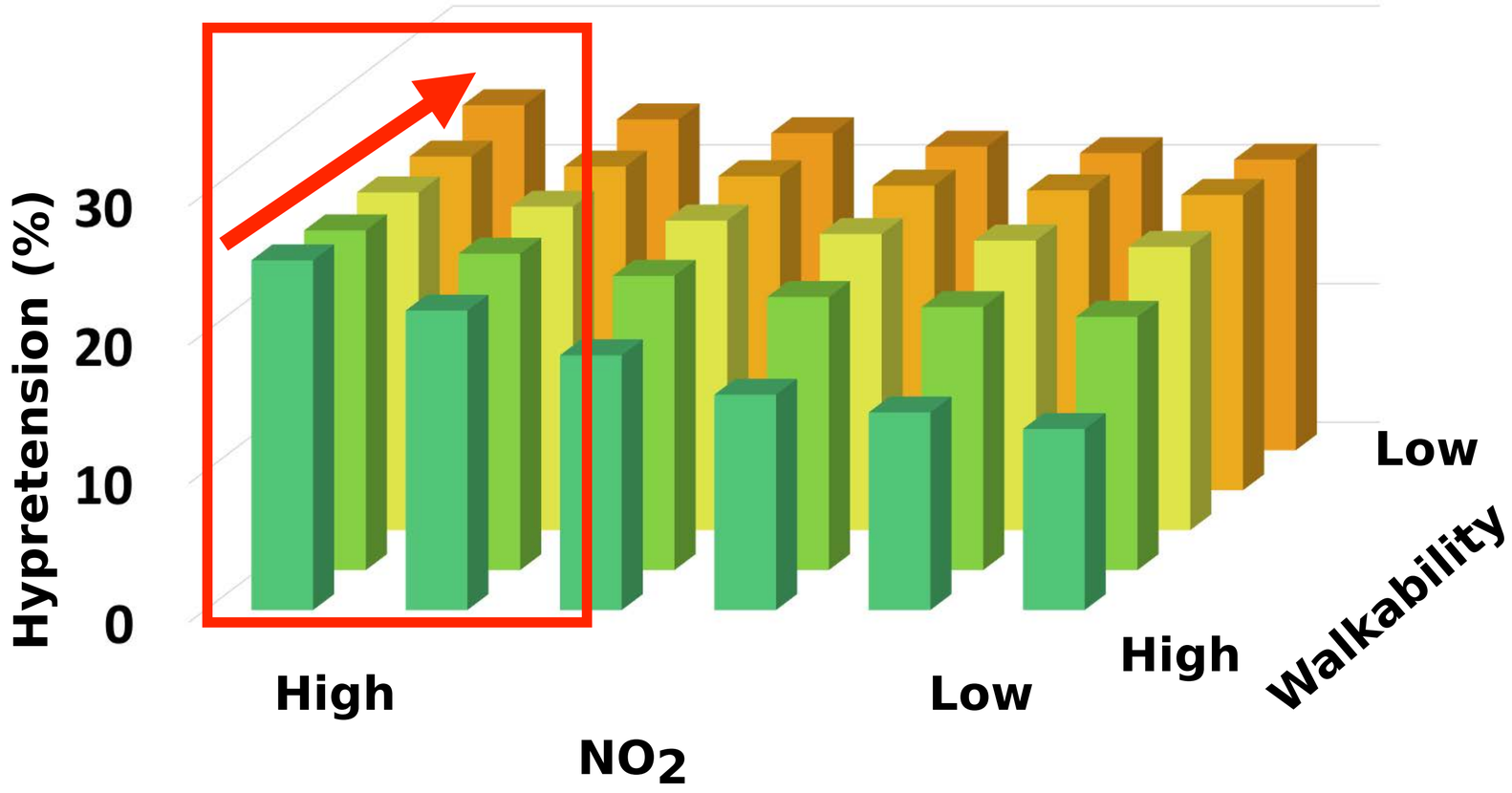
Interaction Effects - Walkability x NO_2 (Fully Adjusted)



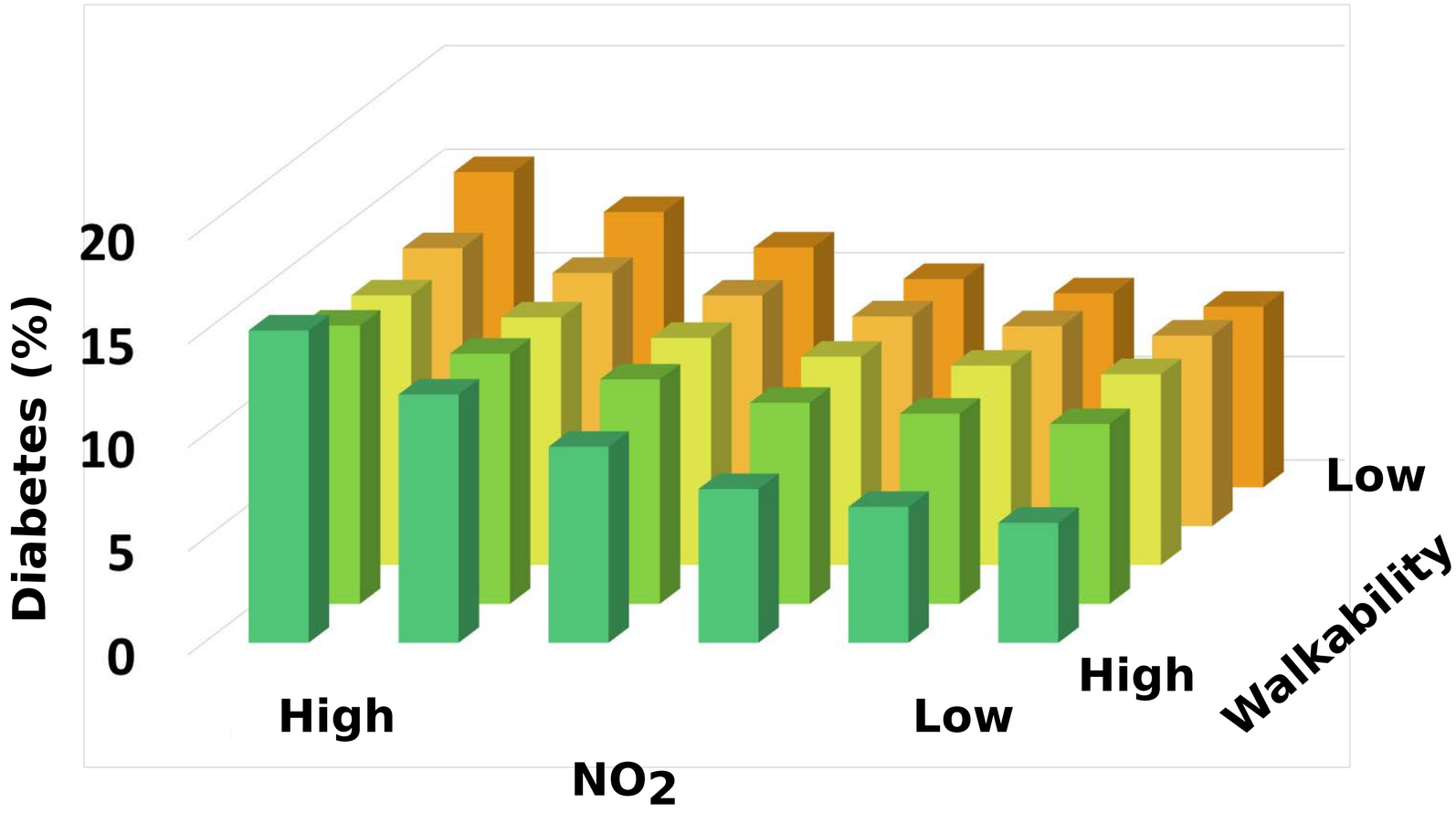
Interaction Effects - Walkability x NO_2 (Fully Adjusted)



Interaction Effects - Walkability x NO_2 (Fully Adjusted)



Interaction Effects - Walkability x NO_2 (Fully Adjusted)



Walkability & Traffic-related Air Pollution - Conclusions

- Low walkability associated with higher likelihood of hypertension and diabetes
- High traffic-related air pollution associated with increased likelihood of hypertension and diabetes
- Significant interaction between two exposures
- Protective associations between walkability and risk factors are not seen in the most polluted environments

Strengths & Limitations

- **Limitations**
  - Cross-sectional design
  - Cannot adjust for self-selection
  - Unmeasured confounders/residual confounding
- **Strengths**
  - Large, population-based sample from multiple regions
  - Use of validated measures of key variables

Overall Implications

- Encouraging development of new walkable neighbourhoods may promote physical activity and improve population cardiovascular health
- Facilitate re-development of existing neighbourhoods to permit more mixed use and density
- Help facilitate links between unwalkable and walkable neighbourhoods
- Strategies to ameliorate pollution in walkable neighbourhoods

SUMMARY

Summary

- More walkable neighbourhoods associated with increased physical activity
- More walkable neighbourhoods associated with improved cardiovascular disease risk factor profiles
- Walkability and traffic related air pollution jointly affect likelihood of cardiovascular disease risk factors

Summary

- Increasing housing density, number and types of services, and encouraging connected street networks may increase population physical activity and improve cardiovascular risk factors

- But we need to consider how other environmental factors play a role in shaping urban cardiovascular health

Acknowledgements

Supervisor

- Dr. Gillian Booth

Committee

- Dr. Jack Tu
- Dr. Rahim Moineddin
- Dr. Robert Fowler

Collaborators

- Dr. Hong Chen
- Dr. Perry Hystad

ICES Central

- Anna Chu

U of T Geo.

- Dr. Michael Widener
- Dr. Steve Farber

Centre for Urban Health Solutions

- Dr. Jane Polsky
- Dr. Ghazal Fazli
- Peter Gozdyra
- Anne-Marie Tynan

Ashley Jones

U of T MD/PhD

IHPME/Dalla Lana

SAUSy Lab

CANUE

CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada

Bourses d'études supérieures du Canada Vanier Canada Graduate Scholarships

THANK YOU!
QUESTIONS?


nicholas.howell@mail.utoronto.ca


@NicholasAHowell