

Greenness and education inequalities in life expectancy and cause-specific mortality in Latin American cities: An ecological study

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The Equigenesis Hypothesis of greenspaces

- Greenspaces can reduce health inequalities by providing health benefits to various populations.
- Emerging evidence from high-income countries, link higher greenness with narrower socioeconomic health inequalities*.



Do greener areas in Latin American cities have smaller inequalities in mortality and life expectancy?

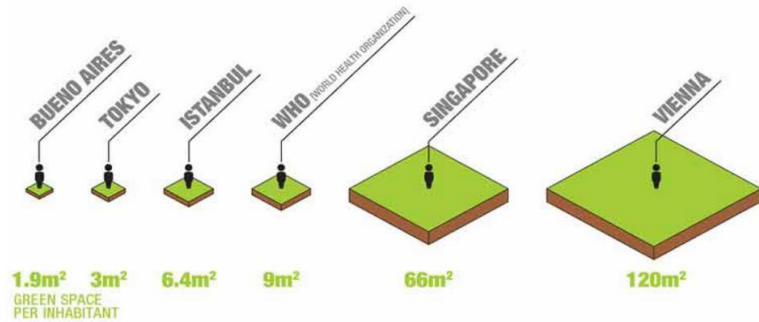
Research hypotheses

RH1: Higher area-level education* is associated with lower cause-specific mortality and with higher life expectancy (LE)

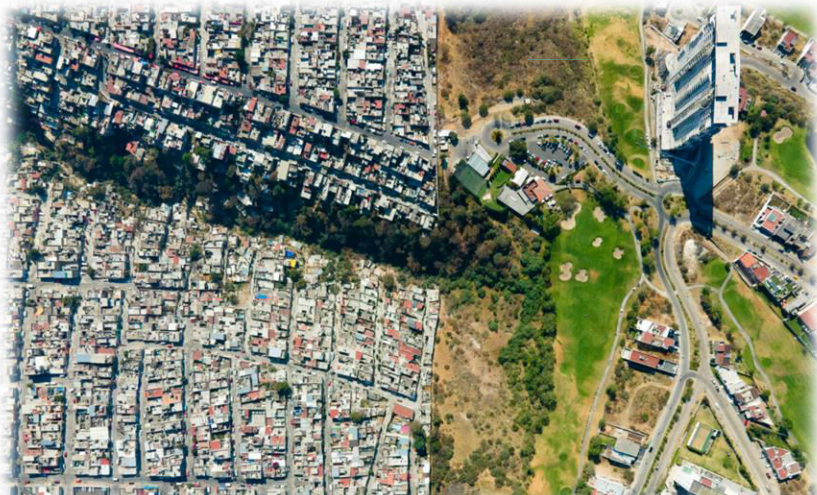
RH2: In greener areas the associations between area-level education with cause-specific mortality and LE are weaker

* proxy for socioeconomic status

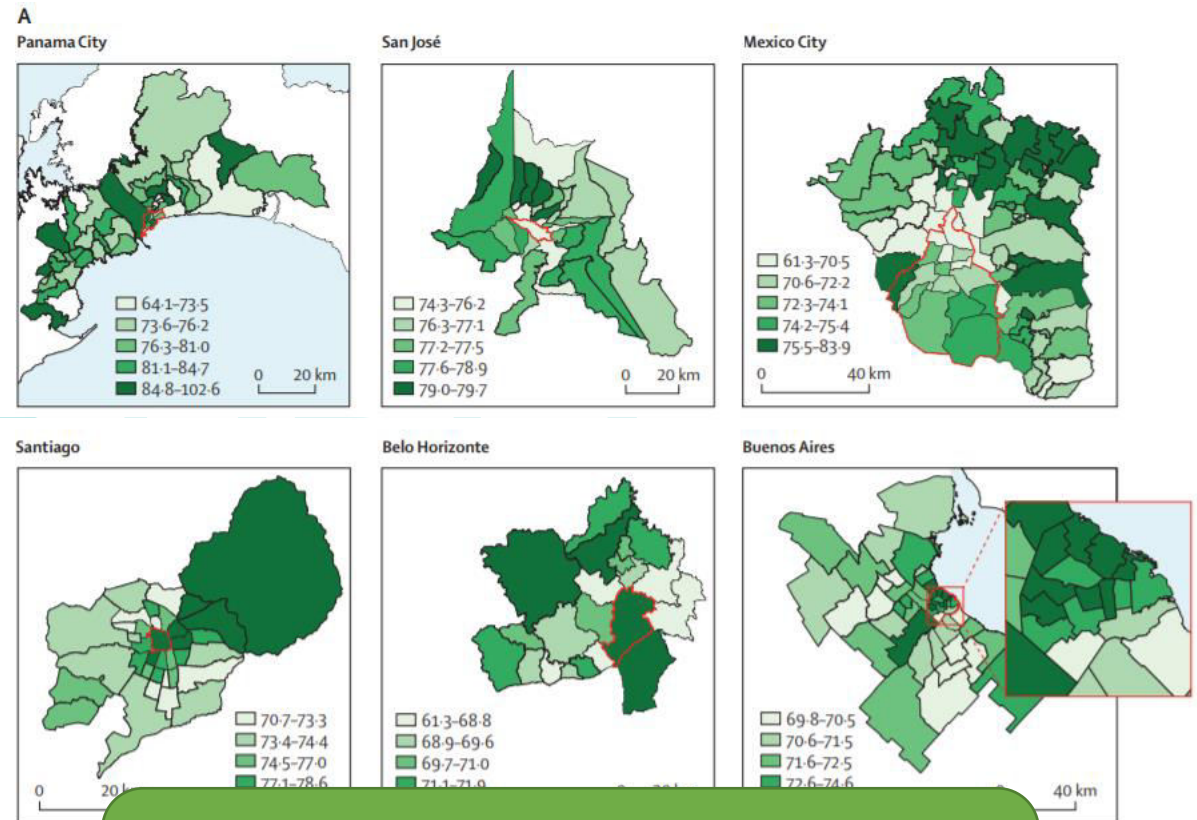
Study area – Latin America



* <https://pricetags.ca/2017/01/23/buenos-aires-3-wheres-the-green-space/>



Deficit and unequal distribution of greenspaces in Latin American cities

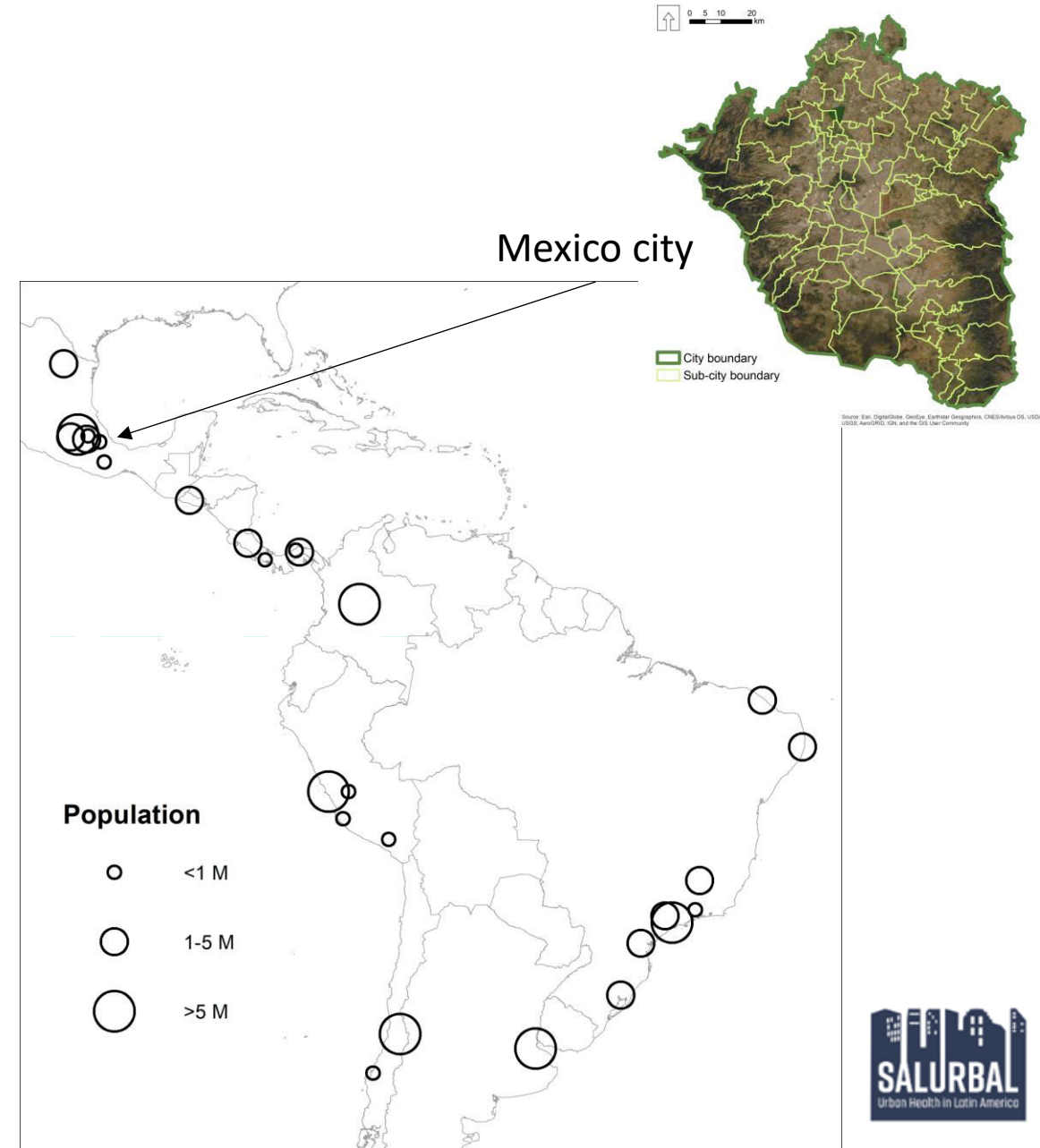


Wide within cities inequalities in life expectancy in Latin American cities

* Bilal et al. (2019). Inequalities in life expectancy in six large Latin American cities... *The lancet planetary health*, 3(12), e503-e510.

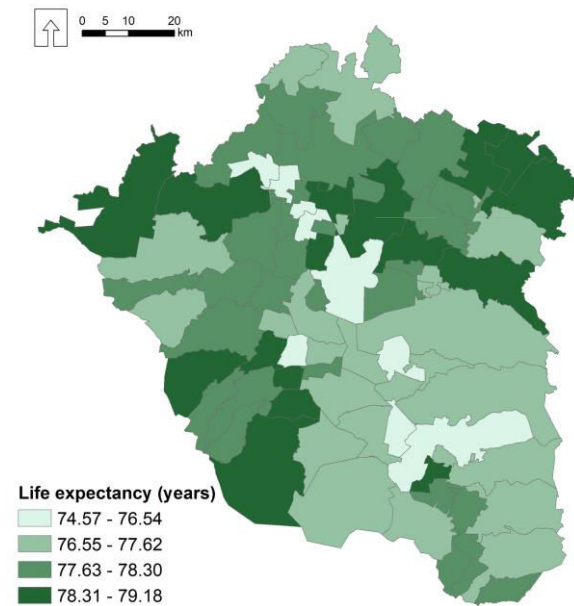
Study area and data

- 9 countries (Argentina, Brazil, Chile, Colombia, Mexico, Panama, and El-Salvador)
- 28 cities
- 671 sub-city units
- 137M residents
- Data for the period 2012-2016

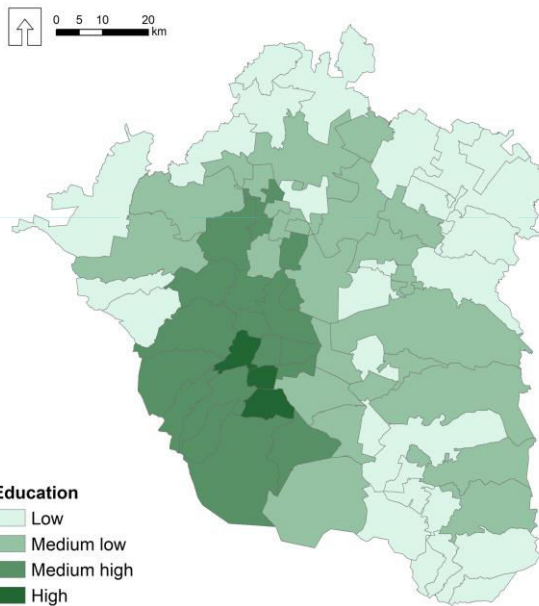


Ecological analysis - sub-city units

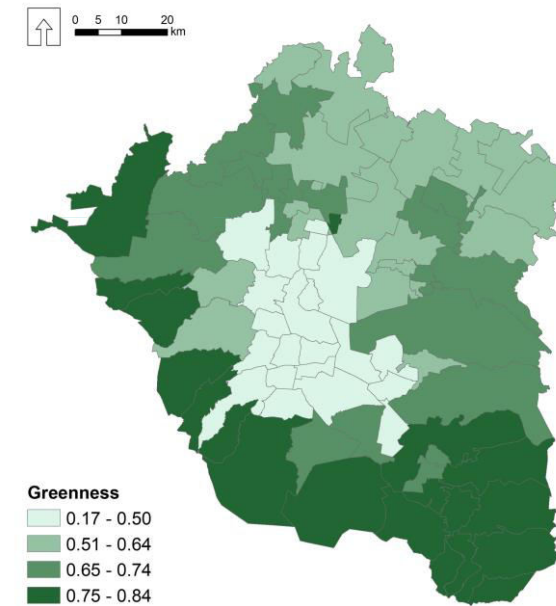
Life expectancy (Outcome)



Education (Exposure)



Greenness (Effect modifier)



Mexico city

Outcomes

1. Life expectancy (LE) at birth
2. Communicable, maternal, perinatal and nutritional conditions (CMNN)
3. Cardiovascular diseases (CVD)
4. Violence related mortality

Exposures

- **Education**: % adults (25+) with high school and college education or higher
- **Greenness**: Normalized Difference Vegetation Index (NDVI)



- **Covariates**: % children, % older-adults, etc.

Associations between area-level education and life expectancy and cause-specific mortality (n=671)

	Violence- mortality [^]	CVD mortality [^]	CMNN mortality [^]	Life expectancy*
	RR (95% CI)	RR (95% CI)	RR (95% CI)	β (95% CI)
Women				
Education	0.96 (0.93; 0.99)	0.96 (0.95; 0.97)	0.96 (0.94; 0.97)	0.34 (0.23; 0.45)
Greenness	0.99 (0.92; 1.06)	1.01 (0.98; 1.04)	0.96 (0.93; 1.00)	-0.04 (-0.33; 0.24)
Men				
Education	0.90 (0.87; 0.92)	0.96 (0.95; 0.98)	0.96 (0.94; 0.97)	0.51 (0.36; 0.65)
Greenness	0.93 (0.87; 1.00)	0.99 (0.96; 1.02)	0.95 (0.91; 0.99)	0.39 (0.03; 0.75)

[^] Rate Ratios: The relative change in Violence/CVD/CMNN mortality per 1 SD increase in education or greenness.

* Beta coefficients: The increase in years of life expectancy per 1 SD increase in education or greenness.

The interaction effect by area-level education and greenness on life expectancy and cause-specific mortality (n=671)

	Violence-mortality [^]	CVD mortality [^]	CMNN mortality [^]	Life expectancy*
Education*Greenness	RRR (95% CI)	RRR (95% CI)	RRR (95% CI)	β (95% CI)
Women	1.01 (0.98; 1.03)	0.99 (0.98; 0.99)	0.99 (0.98; 1.00)	0.15 (0.05; 0.24)
Men	1.03 (1.01; 1.06)	0.99 (0.98; 1.00)	0.99 (0.98; 1.00)	0.20 (0.08; 0.32)

[^] Relative Rate Ratios: The relative change in Violence/CVD/CMNN mortality per 1 SD increase in the education*greenness interaction.

* Beta coefficients: The increase in years of life expectancy per 1 SD increase in education or greenness.

Association between area-level education and life expectancy and mortality by levels of greenness

		Violence related mortality		CVD mortality		CMNN mortality		Life expectancy
		RR, 95% CI	Relative change	RR, 95% CI	Relative change	RR, 95% CI	Relative change	β , 95% CI
Women								
-2SD greenness	NDVI=0.24	0.95 (0.91; 0.99)	-5%	0.99 (0.97; 1.01)	-1%	0.98 (0.96; 1.01)	-2%	0.05 (-0.13; 0.23)
-1SD greenness	NDVI=0.47	0.96 (0.93; 0.98)	-4%	0.97 (0.96; 0.99)	-3%	0.97 (0.96; 0.99)	-3%	0.19 (0.08; 0.31)
Mean greenness	NDVI=0.70	0.96 (0.93; 0.99)	-4%	0.96 (0.95; 0.97)	-4%	0.96 (0.94; 0.97)	-4%	0.34 (0.23; 0.45)
+1SD greenness	NDVI=0.93	0.97 (0.93; 1.01)	-3%	0.94 (0.93; 0.96)	-6%	0.95 (0.92; 0.97)	-5%	0.49 (0.32; 0.66)
Men								
-2SD greenness	NDVI=0.24	0.84 (0.80; 0.88)	-16%	0.99 (0.97; 1.01)	-1%	0.98 (0.95; 1.00)	-2%	0.10 (-0.14; 0.33)
-1SD greenness	NDVI=0.47	0.87 (0.84; 0.89)	-13%	0.98 (0.97; 0.99)	-2%	0.97 (0.95; 0.98)	-3%	0.30 (0.15; 0.45)
Mean greenness	NDVI=0.70	0.90 (0.87; 0.92)	-10%	0.96 (0.95; 0.98)	-4%	0.96 (0.94; 0.97)	-4%	0.51 (0.36; 0.65)
+1SD greenness	NDVI=0.93	0.92 (0.89; 0.96)	-8%	0.95 (0.93; 0.97)	-5%	0.95 (0.92; 0.97)	-5%	0.71 (0.49; 0.93)

Summary and discussion

Education ↔ mortality/LE by greenness -

- Education ↔ violence mortality are stronger in less green areas.
- Education ↔ CVD mortality/LE are stronger in more green areas.

Greenness ↔ mortality/LE by education -

- Greenness ↔ violence mortality are stronger in less educated areas.
- Greenness ↔ CVD mortality/LE are stronger in more educated areas.

- *Greenspaces' restoration effect (stress and aggression reduction) may be stronger in areas with low education.*
- *Greenspaces' recreation effect (physical activity) may be stronger in areas with high education.*

Future research may benefit from using nuanced greenspace metrics (parks, street trees, vacant lots).

Conclusion

- The equigenesis hypothesis is confirmed for violence mortality.
- However, contrary to evidence from high-income countries, in Latin American cities greenness was linked to wider inequalities in CVD mortality and life expectancy.



Policy implications

- Future greening policies need to ensure that unequal access to greenspaces does not exacerbate existing health inequalities.



* Mexico city, Source: <https://unequalscenes.com/mexico-city-df>

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