Effect of Transportation Systems on the Health of Urban Populations: Evidence from Latin America

OLGA L. SARMIENTO

Health-Focused Public-Private Partnerships in the Urban Context

The National Academies of Sciences, Engineering, and Medicine

June 13-14, 2019
<table>
<thead>
<tr>
<th>Latin America is highly urbanized and unequal</th>
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<tbody>
<tr>
<td>Of the population lives in urban areas</td>
</tr>
<tr>
<td>80%</td>
</tr>
</tbody>
</table>

| 19 cities |
| Of the 30 most unequal cities in the world are in Latin America |
Latin America is dense, diverse and fragmented
Air pollution levels in major cities frequently exceed WHO air quality guidelines for health

**Air Pollution (PM$_{2.5}$)**-- (Atmospheric Composition Analysis Group of the Dalhousie University (2016)- SALURBAL

![Graph showing 2016 annual average concentration of PM2.5 in 11 Latin American countries.](chart)

36% of the cities exceed WHO guidelines
Latin America is highly congested: 5 of the 20 most congested cities are in this region. Urban Travel Delay Index.
Innovative Transportation Policies and Interventions in Latin American Cities:
Beyond Traditional Systems

- Cable cars
- Cycling policies and infrastructure
  - Ciclovías Recreativas
- BRT (Bus Rapid Transit System)
- Cable Cars
- Open Streets
- Cycling policies
Innovative policies

**55 Cities**

- BRT: 55 cities from 13 countries

**8 Cities**

- Cables cars: 8 cities in 4 countries

**51 Cities**

- Infrastructure for cycling: 3476km in 10 countries

**246 Cities**

- Ciclovias Recreativas: at least 800 km in 16 countries
Global BRT
171 cities from 42 countries in all the continents
32% are in Latin America
Funding Scheme: TransMilenio SA is public but all the operators of the buses and the fare collection company are private.

45% of the trips in Bogotá are made by public transport (TransMienio 18%).

Average of 2.4 million passengers per day
- 35.5 million passengers per year 2017

Average speed 26km/h
Mean difference of 12 minutes/day of MVPA (95% CI 4.5–19.4).

Pablo D. Lemoine, Olga L. Sarmiento et al. TransMilenio, a Scalable Bus Rapid Transit System for Promoting Physical Activity. Journal of Urban Health 2016 1-15
TransMilenio Expansion
The effect of increased BRT infrastructure on walking for transportation
Agent Based Model

Pablo D. Lemoine, Juan Manuel Cordovez, Juan Manuel Zambrano, Olga L. Sarmiento.

Using agent based modeling to assess the effect of increased Bus Rapid Transit system infrastructure on walking for transportation Preventive Medicine
Users of formal transit are 4.8% less likely to be screened positively for depression than drivers.

Wang et al. Commute patterns and depression: evidence from 11 Latin American cities. Under Review
“As you see it, the congestion is terrible, the doors have not even finished opening and people are getting stuck. It is cruel that there is no good TransMilenio service because health also gets affected, there are people trying to go for medications, medical appointments and however much they want, they are late. And because of the environment, health is also affected, there is a lot of pollution within the TransMilenio”. (Citizen scientist)
• Inaugurated on December 2018
• Funding scheme: TransMilenio SA is public but the operator is private (Consortium Cable Móvil)
• Length 3.43 Km and 163 cabins
• Average of 21,000 passengers per day
• Reduced the travel time from 62 minutes to 13 minutes
• 16 urban projects (parks, library, administrative office, tourism, museum)—social urbanism
Natural experiment-TransMiCable

**Intervention: Ciudad Bolívar**

- UPZ: Lucero, San Francisco
- Neighborhoods: N=27
- Blocks: N=225

**Control: San Cristóbal**

- UPZ: San Blas, La Gloria, Libertadores
- Neighborhoods: N=27
- Blocks: N=228

- Adults aged ≥18
- Adults who have lived in the locality for at least 2 years
- Adults who are not planning to move to another neighborhood in the next 2 years

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T0
Feb – Nov 2018

TransMiCable opening
Dic 2018

T1
Jul – Dic 2019
TransMiCable Objective Tools

- **Objective**
  - Tools
    - PEM (PM$_{2.5}$)
    - DUSTTRAK II (PM$_{2.5}$)
    - MICROAETH (eBC)
    - DELTAOHM (CO$_2$)
    - GPS & Discovery tool
    - ACCELEROMETRY

- **Citizens Science**
- **Physical Activity**
- **Air Pollution**
Min/day MVPA: 39.2 ± 30.4

Meeting recommendations:
Leisure time: 16.2%
Walking leisure time: 8.9%
Walking transport: 41.0%
Inhaled daily dose:

Sleep

Transport

Transport

Work- other

Transport

1

2

3
Inhaled dose per minute

$$\hat{D}_{trip} \left( \frac{\mu g}{min} \right) = \frac{\sum C_i^j I R_i \Delta t_{30}}{\sum \Delta t_{30}} = I R_i \ast C_i$$
Contribution of a typical round trip in the Feeder and TransMilenio to the daily inhaled dose in CIUDAD BOLÍVAR

<table>
<thead>
<tr>
<th>Activity</th>
<th>D_{PM2.5} (µg)</th>
<th>D_{eBC} (µg)</th>
<th>D_{CO} (µg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleeping</td>
<td>26</td>
<td>14</td>
<td>1337</td>
</tr>
<tr>
<td>Transport</td>
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<td></td>
<td></td>
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<tr>
<td>Feeder</td>
<td>39</td>
<td>16</td>
<td>1769</td>
</tr>
<tr>
<td>Portal</td>
<td>14</td>
<td>8</td>
<td>616</td>
</tr>
<tr>
<td>TransMilenio</td>
<td>498</td>
<td>149</td>
<td>6488</td>
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<td>Work</td>
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<td>Working</td>
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<td>2014</td>
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<tr>
<td>Other</td>
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<td>17</td>
<td>1074</td>
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<td>Transport</td>
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Total: 1239 417 23405

80% PM₂.₅
16% eBC
12% CO
9% Trip
11% Rest of day
20% TransMilenio
56% TransMilenio
24% Trip
72% Rest of day
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- BRT
- Cable cars
- Ciclovías Recreativas
- Cycling policies and infrastructure

Planetary Health
Gracias!
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