Cataloguing and Assessing Urban Transportation Policies to Reduce Traffic-Related Emissions and Air Pollution
A Systematic Evidence Map

Haneen Khreis, Senior Research Associate
University of Cambridge, School of Clinical Medicine
Public Health Modelling Group, MRC Epidemiology Unit
Motivation

Urban areas are hotspots for traffic activity and exposures, and are growing. Cities are undertaking several “policies”, “actions”, “measures”, “strategies” and “practices” (“policy interventions”) to reduce emissions, air pollution, exposure, and negative health impacts.

Number of available options increasing + technologies emerging → Evidence base is large but sporadic and not systematically assessed.

Some reviews exist but only one reported methods a priori, and none hosted results in an open-access database or tool.
Urban policy interventions to reduce traffic-related emissions and traffic-related air pollution: Protocol for a systematic evidence map

Kristen A. Sanchez, Margaret Foster, Mark J. Nieuwenhuijsen, Anthony D. May, Tara Ramani, Joe Zietsman, Haneen Kheireldin

*Center for Advancing Research in Transportation Emissions, Energy, and Health (CARTHE), Texas A&M Transportation Institute (TTI), TX, USA
1 Texas A&M University, College Station, TX, USA
2 Texas A&M University, Medical Sciences Library, College Station, College Station, TX, USA
3 Global, Centre for Research in Environmental Epidemiology (CRESAL), Barcelona, Spain
4 Universidad Pompeu Fabra (UPF), Barcelona, Spain
5 CMU Epidemiology y Salud Publica (CMUSEP), Madrid, Spain
6 Institute for Transport Studies (ITS), University of Leeds, Leeds, UK

ABSTRACT

Introduction: Cities are the world's engines of economic growth, innovation, and social change, but they are also hot spots for human exposure to air pollution, mainly originating from road traffic. As the urban population continues to grow, a greater quantity of people risk exposure to traffic-related air pollution (TRAP), and therefore also risk adverse health effects. In many cities, there is scope for further improvement in air quality through targeted urban policy interventions. The objective of this protocol is to detail the methods that will be used for a systematic evidence map (SEM) which will identify and characterise the evidence on policy interventions that can be implemented at the urban level to reduce traffic emissions and/or TRAP from road mobile sources, thus reducing human exposures and adverse health impacts.

Methods: Articles will be searched for and selected based on a predefined search strategy and eligibility criteria. A variety of databases will be searched for relevant articles published in English between January 1, 2000 and June 1, 2020 to encompass the interdisciplinary nature of this SEM, and articles will be stored and screened using Rayyan QCER. Predefined study characteristics will be extracted and coded from included studies in a Microsoft Excel sheet, which will serve as an open access, interactive database, and two authors will review the coded data for consistency. The database will be queryable, and various interactive charts, graphs, and maps will be created using Tableau Public for data visualisation. The results of the evidence mapping will be detailed via narrative summary.

Conclusion: This protocol serves to increase transparency of the SEM methods and provides an example for researchers pursuing future SEMs.

Systematic Evidence Map

Urban policy interventions to reduce traffic-related emissions and air pollution: A systematic evidence map

Haneen Kheireldin, Kristen A. Sanchez, Margaret Foster, Jacob Burns, Mark J. Nieuwenhuijsen, Rohit Jaikumar, Tara Ramani, Josias Zietsman

*CMU Epidemiology y Salud Publica (CMUSEP), Madrid, Spain
1 Center for Advancing Research in Transportation Emissions, Energy, and Health (CARTHE), Texas A&M Transportation Institute (TTI), TX, USA
2 Texas A&M University, Center for Systems Review and Research Synthesis, College Station, TX, USA
3 Institute for Medical Information Processing, Biometry and Epidemiology, Ludwig Maximilians University of Munich, Munich, Germany
4 Barcelona Institute for Global Health (ISGlobal), Barcelona, Spain
5 Universitat Pompeu Fabra (UPF), Barcelona, Spain

ABSTRACT

Background: Urban areas are hot spots for human exposure to air pollution, which originates in large part from traffic. As the urban population continues to grow, a greater number of people risk exposure to traffic-related air pollution (TRAP) and its adverse, costly health effects. In many cities, there is a need and scope for air quality improvements through targeted policy interventions, which could extend to including rapidly changing technologies.

Objective: This systematic evidence map (SEM) examines and characterises peer-reviewed evidence on urban-level policy interventions aimed at reducing traffic emissions and/or TRAP from on-road mobile sources, thus potentially reducing human exposures and adverse health effects and producing various co-benefits.

Methods: This SEM delivers a previously peer-reviewed and published protocol with minor deviations, explicitly outlined here. Articles indexed in Public Affairs Index, THRID, Medline and Embase were searched, limited to English, published between January 1, 2000, and June 1, 2020. Covidence was used to screen articles based on previously developed eligibility criteria. Data for included articles was extracted and manually documented into an Excel database. Data visualizations were created in Tableau.

Results: We identified 5328 unique articles from database searches and included 376 unique articles in the final SEM. There were 56 unique policy interventions, and a total of 1,139 unique policy scenarios, comprising these...
Research aims

- Identify, describe, and summarize global evidence on urban policy interventions to reduce traffic emissions and/or TRAP

→ Primary outcomes of interest

- Recorded direction of impact reported (Increase, Reduction, No Change, Mixed Effect)
Research aims

• Secondary outcomes and items – direction of impact not reported:
  • Human exposure (yes/no + which pollutant)
  • Health effect or impact (yes/no + which pollutant + which outcome)
  • Co-benefits (which social, environmental + climate, economic)
  • Barriers and enablers to implementation (which ones)
Inclusion criteria

• Articles that investigate policy interventions implemented in urbanized areas (densely settled territory $\geq 50,000$ or more people) or urban clusters ($\geq 2,500$ people but $<50,000$ people) as defined by the United States Census Bureau.

• Articles that investigate urban-level policy interventions’ impact on traffic emissions (exhaust or non-exhaust) and/or TRAP originating from mobile on-road traffic.

• Articles that investigate past, current, future or hypothetical changes in traffic emissions and/or TRAP.

• Articles reported in the English language.
• Articles published between January 1, 2000, and June 1, 2020.
• Articles that are peer-reviewed.

→ No restriction on intervention type, pollutant, location or method for analysis.
Results

9130 records identified through database searches:
- 4405 from TRID
- 2282 from Embase
- 1536 from Medline
- 907 from Public Affairs Index

1602 duplicates removed

7528 records screened at the title and abstract level
- 6918 records excluded

610 records screened at the full-text level
- 234 records excluded

376 records included in the SEM
Results

- 1,139 unique policy intervention scenarios
- 380 packages (33%)
- From 376 unique articles
- 58 types of unique policies
- 6 categories
- 52 countries
- 307 unique urban/urbanized locations
- Most policies studied in Europe (463), Asia (355), North America (206)
- Least in South America (57), Africa (10), Australia (7)
- Cities most studied
  - Beijing 81 scenarios
  - London 78 scenarios

Map prepared by Rohit Jaikumar, Texas A&M Transportation Institute
Pricing – 216 studied times
• Parking charges
• Road pricing
• Congestion charges

Land-use – 77
• Development density and mix
• Transit oriented development
• Parking expansion

Infrastructure – 210
• Bus rapid transit
• Public and active transportation infrastructure
• Roadway development and intersection alterations

Behavioural – 116
• Public transport mode shift and promotion
• Active transportation mode shift and promotion
• Flexible working arrangements and ride sharing

Technology – 406
• Alternative fuel technology
• Vehicle retrofitting
• Alternative vehicle technology

Management, standards, and services – 807
• Vehicle emission regulation
• Vehicle retirement or replacement
• Vehicle use restriction
Results

• Only 3% of articles reported all elements of the full-chain
Co-benefits Recorded (raw data included in the database): reported a total of 1,047 times in 204 unique articles

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Times Mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced greenhouse gas emissions/climate change</td>
<td>330</td>
</tr>
<tr>
<td>Reduced vehicle miles or kilometers traveled</td>
<td>115</td>
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<tr>
<td>Reduced energy/fuel consumption</td>
<td>98</td>
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<tr>
<td>Reduced traffic congestion</td>
<td>95</td>
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<td>Economic growth or savings</td>
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<tr>
<td>Reduced trip time or length</td>
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<tr>
<td>Increased network speed</td>
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<tr>
<td>Reduced number of trips</td>
<td>37</td>
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<td>Increased transit use</td>
<td>34</td>
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<td>Increased safety</td>
<td>31</td>
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<td>Increased active transportation</td>
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<td>Increased social welfare</td>
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<td>Increased accessibility</td>
<td>9</td>
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<tr>
<td>Reduced health costs</td>
<td>7</td>
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<td>Job growth</td>
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<td>Reduced traffic noise</td>
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<td>Reduced heat/urban heat island</td>
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<td>Increased petrol savings</td>
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<td>Increased greenspace</td>
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</table>
**Query-able database (online)**

Vehicle emission norms and fuel specifications that were introduced from 1991 to 2004 across India as well as locally in Bangalore.

### Table: General Article Info

<table>
<thead>
<tr>
<th>Entry ID</th>
<th>Article ID</th>
<th>Ref ID</th>
<th>Title</th>
<th>Author(s)</th>
<th>Publication Year</th>
<th>Journal</th>
<th>URL to article</th>
<th>Study Type</th>
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<tr>
<td>8</td>
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<td>Evaluating the effectiveness</td>
<td>Huang, X., Zhang, Y., Wang, Y., Ou, Y., Cl</td>
<td>2020</td>
<td>Science of I</td>
<td><a href="https://doi.org/10">https://doi.org/10</a></td>
<td>CS</td>
<td>Vehciles with “Yellow label” (~ 136 thousand)</td>
</tr>
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<td><a href="https://doi.org/10">https://doi.org/10</a></td>
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</table>
Query-able database (online)
Interactive visualization tool (online)
Section 1

Pie charts display the proportion of policy scenarios which report traffic emissions, TRAP, exposures, health effects and impacts. Click on "Yes" or "No" in each pie chart to select the studies associated with it.

Section 2

A geographic map displays the frequency of policy scenarios studied in each country. Click on a country to select the studies associated with it.
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A geographic map displays the frequency of policy scenarios studied in each country. Click on a country to select the studies associated with it.

Country Map

Country: United States
Frequency Studied: 42

Frequency Studied
1
### Article List

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<thead>
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<tr>
<td>Acero et al. 2012</td>
<td>Impact of local urban design and traffic restrictions on air quality in a medium-sized town</td>
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<tr>
<td>Adhag et al. 2017</td>
<td>Projecting impacts of two-wheelers on urban air quality of Doula, Camaroon</td>
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<tr>
<td>Aggarwal and Jain 2015</td>
<td>Impact of air pollutants from surface transport sources on human health: A modeling and epidemiological approach</td>
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<td>Alam et al. 2014b</td>
<td>Traffic Emissions and Air Quality Near Roads in Dense Urban Neighborhood: Using Microscopic Simulation for Evaluating Effects of Vehicle Fleet, Travel Demand, and Road Network Changes</td>
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<td>Amann et al. 2017</td>
<td>Managing future air quality in megacities: A case study for Delhi</td>
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<td>Amato et al. 2010</td>
<td>A comprehensive assessment of PM emissions from paved roads: Real-world Emission Factors and intense street cleaning trials</td>
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<td>Arghavani et al. 2019</td>
<td>Numerical evaluation of urban green space scenarios effects on gaseous air pollutants in Tehran Metropolis based on WRF-Chem model</td>
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<td>Bai et al. 2012</td>
<td>Effects of building roof greening on air quality in street canyons</td>
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<td>Baldasano et al. 2010</td>
<td>Air pollution impacts of speed limitation measures in large cities: The need for improving traffic data in a metropolitan area</td>
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<td>Begum et al. 2008</td>
<td>Impact of Banishing of Two-Stroke Engines on Airborne Particulate Matter Concentrations in Dhaka, Bangladesh</td>
</tr>
<tr>
<td>Reale and Hidalgo 2018</td>
<td>Evaluation of the impact of Rail Rapid Transit on air pollution in Mexico City</td>
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</table>
Saturday Driving Restrictions Fail to Improve Air Quality in Mexico City

Lucas W. Davis

Policymakers around the world are turning to license-plate based driving restrictions in an effort to address urban air pollution. The format differs across cities, but most programs restrict driving once or twice a week during weekdays. This paper focuses on Mexico City, home to one of the oldest and best-known driving restriction policies. For almost two decades Mexico City's driving restrictions applied during weekdays only. This changed recently, however, when the program was expanded to include Saturdays. This paper uses hourly data from pollution monitoring stations to measure the effect of the Saturday expansion on air quality. Overall, there is little evidence that the program expansion improved air quality. Across eight major pollutants, the program expansion had virtually no discernible effect on pollution levels. These disappointing results stand in sharp contrast to estimates made before the expansion which predicted a 15%+ decrease in vehicle emissions on Saturdays. To understand why the program has been less effective than expected, the paper then turns to evidence from subway, bus, and light rail ridership, finding no evidence that the expansion was successful in getting drivers to switch to lower-emitting forms of transportation.
Table 2. The Effect of Driving Restrictions on Saturday Pollution Levels. Note: This table reports estimates and standard errors from 18 separate regressions all estimated using daily observations from 2005 to 2011. The dependent variable varies across regressions as indicated in the panel and column headings. CO is carbon monoxide, NO is nitric oxides, NO_2 is nitrogen dioxide, NO_3 is nitrogen oxides, O_3 is ozone, PM_{10} is large particulates, PM_{2.5} is small particulates, and SO_2 is sulfur dioxide. All dependent variables are measured in logs and all regressions control for a fifth-order polynomial in time, meteorological variables, and fixed effects for week-of-year and day-of-week. Standard errors, in parentheses, are robust to heteroskedasticity and arbitrary serial correlation within week-of-sample. An asterisk indicates statistical significance at the 5% level.

![Figure 1. Mean Daily Air Pollution on Saturdays in Mexico City.](image-url)
• No information in our database on statistical significance level
• It is meant a starting point – not developed/final answers
• User engagement and critical assessment is expected (a lot of nuance that summarized info does not do justice)
We did not...

• Look at effects of other pathways, comparable to – or with larger impact than - air pollution e.g. physical inactivity, motor vehicle crashes (Mueller et al., 2015)

• But if you do → land-use and behavioural policies are very promising!

• 50-70% statistically significant reduction in injuries in London Low Traffic Neighbourhoods (LTN) (Laverty et al, 2021; Goodman et al., 2021)

• Physical activity from walking + cycling increased by 2 hours/week in LTN residents after 2 years (Aldred and Goodman, 2021)

• Modest (5.7-8.9%) NO₂ reduction effect (Yang et al., 2022)

Land-use – 77
• Development density and mix
• Transit oriented development
• Parking expansion

Behavioural – 116
• Public transport mode shift and promotion
• Active transportation mode shift and promotion
• Flexible working arrangements and ride sharing
Summary

• Created an open access database + tool for researchers, practitioners and policy makers

• Address some of the principal weaknesses in policy generation and selection: e.g. over-reliance on preconceived ideas; a lack of awareness of range of measures available; and their effectiveness, no systemized evidence base

• Limited by:
  • Recency of studies included, up to 2020
  • Potential publication bias
  • Concentration of evidence in high income countries and on certain categories
  • Most studies assess traffic emissions and not exposures and health impacts
  • Some studies lump and simultaneously study $\geq 2$ policies in one scenario
  • Not assessing other pathways (each can be a SEM of its own!)
Glazener et al., 2021