Beyond traffic jam alleviation: evaluating the health and health equity impacts of New York City's congestion pricing plan

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Received 6 November 2023
Accepted 31 December 2023
Published Online First 9 January 2024

To cite: Ghassabian A, Titus AR, Conderino S, *et al*. *J Epidemiol Community Health* 2024;**78**:273–276.

ABSTRACT

New York City (NYC) is slated to be the first jurisdiction in the USA to implement a cordon-based congestion tax, which will be levied on vehicles entering its Central Business District. Several cities around the world, for example, London and Stockholm, have had similar cordon-based pricing programmes, defined as road pricing that charges drivers a fee for entering a specified area (typically a congested urban centre). In addition to reducing congestion and creating revenue, projections suggest the NYC congestion pricing plan may yield meaningful traffic-related air quality improvements that could result in health benefits. NYC is a large city with high air pollution and substantial racial/ethnic and socioeconomic health inequities. The distinct geography and meteorological conditions of the city also suggest that the policy's impact on air quality may extend beyond the NYC metropolitan area. As such, the potential breadth, directionality and magnitude of health impacts on communities who might be heavily affected by the nation's first congestion pricing plan should be empirically investigated. We briefly review evaluation studies of other cordon-based congestion pricing policies and argue that implementation of this policy provides an excellent opportunity to employ a quasi-experimental study design to evaluate the policy's impacts on air quality and health outcomes across population subgroups using a health equity lens. We discuss why real-time evaluations of the NYC congestion pricing plan can potentially help optimise benefits for communities historically negatively affected by traffic-related air pollution. Assessing intended and unintended impacts on health equity is key to achieving these goals.

INTRODUCTION

New York City (NYC) is slated to be the first jurisdiction in the USA to implement a cordon-based congestion pricing policy, which will tax vehicles driving on Manhattan streets south of and including 60th Street. The plan, referred to as the Central Business District (CBD) Tolling Program, is anticipated to go into effect in spring 2024. The CBD Tolling Program will include exemptions for emergency vehicles and vehicles transporting disabled persons, as well as discounts for low-income drivers. While further details are in development (eg, tolling structure), the ultimate goals of the NYC congestion pricing plan are to alleviate traffic congestion and to increase revenue to improve public transit. Mitigating unintended negative impacts in low-income neighbourhoods is another key objective of the policy.[1]

The impacts of urban policies, such as congestion pricing, can extend beyond traffic congestion alleviation and revenue creation to include potential air quality and health benefits that should be rigorously evaluated for several reasons. First, NYC is the country's most populous and densest city, with substantial health and economic inequities across neighbourhoods.[2] The policy will affect millions of people, and its potential influence on existing health disparities is unknown. Second, NYC is sitting in the middle of a regional 'ozone river', where a stripe of smog is often observed in the warm seasons along the northeast I-95 corridor.[3] The city's large population creates substantial traffic-related emissions, which also affect downwind air quality in Connecticut and other surrounding areas.[4] Therefore, this policy has potential regional implications. Finally, concerns over unintended effects of the policy on residents within the CBD, in neighbouring NYC boroughs and surrounding regions, particularly among communities with high commuter volume to the CBD, highlight the importance of empirical data that examine impacts through an equity lens across the region.

The congestion pricing plan in NYC is expected to reduce traffic-related air pollutant emissions in the congestion zone and nearby areas (figure 1). Lower emissions will mainly be due to reductions in vehicle miles travelled and time spent idling in traffic, ideally, while also preventing detours to avoid the tax that results in additional miles travelled. As presently designed, the policy is anticipated to provide discounts to drivers who already pay non-congestion tolls to enter the CBD. For-hire vehicles are exempted from daily charges but a per-ride toll will be added to each paid passenger trip fare. Hence, traffic reductions in the congestion zone (dark blue in figure 1) are anticipated to arise primarily from fewer private vehicle trips from the east yielding the anticipated impact zones to be north and east of the primary impact zone (light blue in figure 1). One analysis has projected that the NYC congestion pricing plan could result in a reduction of more than 3.5% of vehicle miles travelled, an increase in speed of more than 10%, and subsequently a ~7.5% reduction of fine particulate matter ($PM_{2.5}$) and ~7.0% reduction of carbon dioxide emissions in the congestion zone, and approximately 750 fewer auto-related crashes

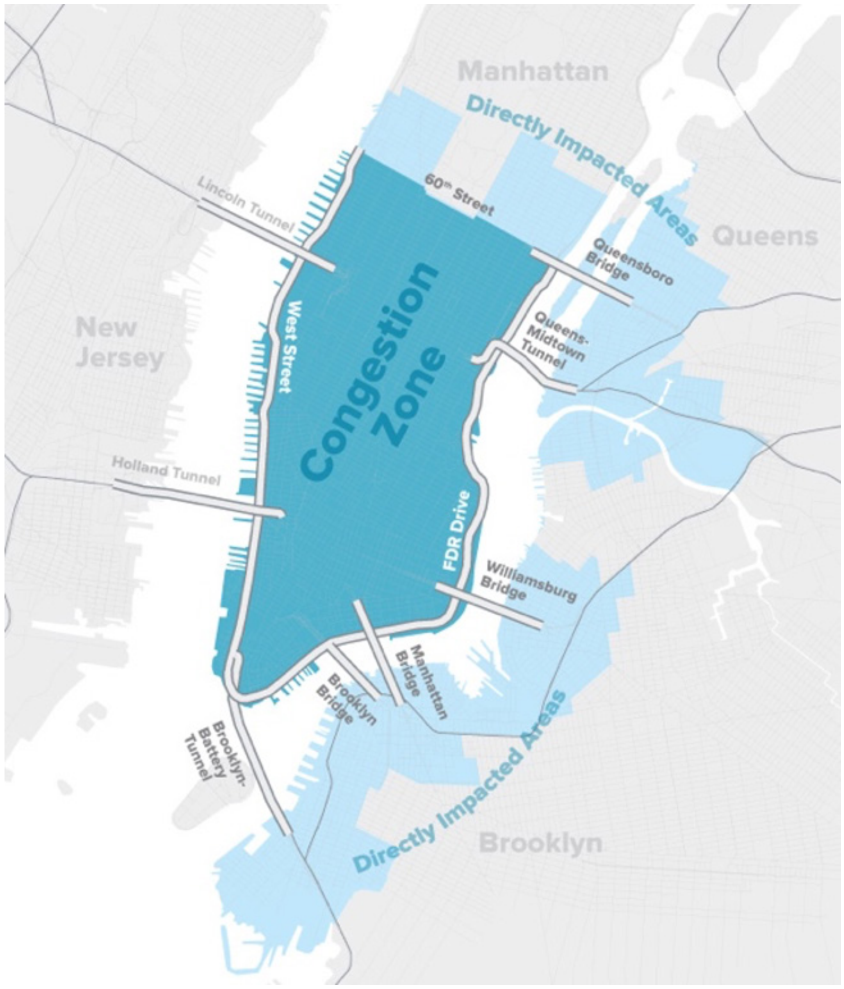

Figure 1 Congestion zone (dark blue) and potentially directly impacted areas (light blue), New York City Central Business District Tolling Program.

per year due to traffic flow changes.[5] Another simulation analysis predicts that the plan could also result in reduced vehicle miles travelled (including single occupancy and for-hire vehicles) and public transportation upgrades and increased ridership, further improving air quality even more than the initial estimate (eg, $PM_{2.5}$ reduction by 17.5%).[6] While traffic-related air quality improvements of this magnitude generally result in better health outcomes among affected residents, projections to date have mainly modelled traffic, auto-related crashes and air quality outcomes without consideration of health impacts. Only one study has considered the potential downstream benefits to health outcomes known to be associated with poor air quality.[7]

There is now a unique opportunity to gain empirical evidence from the rollout of this policy. Summarising findings from studies on the air quality and health impacts of congestion pricing policies in other countries, we delineate potential opportunities to assess the health and health equity impacts of NYC's congestion pricing plan, a potential landmark US policy.

Impacts of congestion pricing policies on air quality and health

Vehicle emissions are a major source of nitrogen oxides (NO_x) and $PM_{2.5}$ in urban areas. Emissions from road traffic, including NO_x and volatile organic compounds, might also increase surface ozone concentrations, particularly in summertime.[8] Over the past few decades, several metropolitan areas around the globe have implemented policies to reduce congestion, control emissions and create funds for public transport systems. Two of the best known and most studied are London and Stockholm. London has one of the largest congestion charge zones in the world, which has been in operation since 2003. Over time, the boundary for London's congestion charge zones was expanded and low emission zones were added to further improve air quality by limiting access of cars that did not meet emission standards. Stockholm also introduced a congestion pricing scheme in 2006, which includes a tax levied on vehicles entering and exiting the inner city. Studies in London and Stockholm have found substantial reductions in pollution levels after the policy implementation. For example, shortly after implementation of a congestion pricing policy across much of Stockholm, concentrations of nitrogen dioxide (NO_2) and particles with an aerodynamic diameter ≤ 10 µm dropped by 15%–20% and 10%–20%, respectively.[9] Such a decline was not present in comparable areas that did not implement congestion pricing policy. In London, the congestion charging scheme substantially reduced traffic flows (15% fewer vehicle kilometres travelled and 10% increase in speed).[10] A subsequent analysis found the policy resulted in a 12% reduction in NO_x emissions in congestion zones, mostly due to speed change and to some extent due to reductions in vehicle kilometres travelled. The London congestion pricing policy implementation had some unintended consequences too. The policy was associated with higher levels of NO_2—mainly due to a shift towards diesel-powered buses in the congestion zone area that happened, independent of the policy, during the same period.[11]

Based on an established 'chain of accountability' framework,[12] one question that can be asked is if the policy that reduces emissions and improves air quality can also improve related health outcomes. Studies conducted in Stockholm and London showed some health benefits. For example, rates of asthma-related doctor visits among young children dropped by 6 visits per 10 000 children in the congestion zone in Stockholm, relative to control areas.[9] Longer-term health benefits of Stockholm congestion pricing are yet to be defined. In the congestion area in London, predicted benefits were 183 years of life per 100 000 population compared with 18 years of life in areas outside the congestion zone.[13] It is important to note that while this manuscript is primarily focused on health outcomes associated with air quality, the health effects of congestion pricing may extend beyond air quality and include impacts on noise pollution, traffic-related injuries, traffic patterns and uptake of active transport. In addition, net impacts on health outcomes may be complex. For example, increases in active transport may lead to more individuals at risk for traffic-related injuries, even as traffic volume decreases.[14]

Policy evaluation and a chance to apply causal inference methods to improve rigour

The implementation of a congestion pricing plan in NYC offers an opportunity to leverage policy enactment as a natural experiment to examine associations between the policy and a range of immediate and downstream outcomes. Under certain conditions, natural experiments can 'mimic' randomisation by exploiting exogenous variation in exposure to an event or intervention, thereby lowering the risk of bias by confounding.[15] Prior evaluations of congestion pricing policies have used a difference-in-differences (DiD) design, which assumes that the outcome trends in a comparison area are a valid counterfactual for these outcome trends that would have been experienced in the congestion zone in the absence of the policy.[16] When evaluating the impacts of congestion pricing policies, however, selecting appropriate comparison areas is far from straightforward. Areas closest to the congestion zone may be the most similar to the congestion zone with regard to key factors that impact outcome trends, including baseline air quality, meteorological conditions and population characteristics. However, congestion pricing policies often have wide-ranging impacts on traffic and behaviour patterns. Consequently, areas nearest to the congestion zone are also likely to be 'contaminated' by spillover policy effects.

Selecting a comparison area for NYC's congestion policy is no less vexing, given the unique population and traffic dynamics associated with the largest metropolitan area in the USA. One approach that can overcome some of the challenges in control selection is the use of synthetic controls to augment the DiD model. A synthetic control method (SCM) combines data from multiple comparison areas, estimating weights for a donor pool of potential control units in order to create a 'synthetic' intervention zone when no single ideal comparison area exists.[17] The key assumptions underlying a synthetic control analysis are similar to a traditional DiD analysis: that there is similarity between the 'treatment' and 'control' areas with regard to important factors impacting the outcomes of the study; no 'contamination' or 'spillover' of intervention effects into comparison areas; and no 'external shocks' to the comparison areas during the study period.[18] In constructing the 'donor' set of geographies from a pool of multiple potential areas, a priori attention should be given to which factors are most salient to the study's primary outcomes. For example, given that congestion pricing is typically implemented in a dense, heavily trafficked urban area, studies may choose other densely populated urban cores as potential control areas.[11] Careful consideration of policy environments in comparison areas is also needed to characterise potential external shocks, such as other policies or urban plans that might influence environment and health in the period. In selecting comparison geographies for the SCM, one can also consider defining multiple potential donor sets. In the context of NYC's policy, for example, SCM may be used to select comparison census tracts within NYC (but outside of the CBD), as well as comparison tracts from other urban areas throughout the US Northeast. Assessing concordance between results across different SCM specifications offers an opportunity to consider potential sources of bias and strengthen causal inference.

Health equity impacts of the NYC congestion pricing plan

The NYC congestion pricing plan is not without controversy, particularly with respect to an equitable implementation of the policy and potential unintended effects on subgroups of residents in the CBD and in surrounding areas. Non-residents who commute to CBD can be disproportionately affected by the policy, particularly those with limited access to public transport.[7] Concerns have also been raised that the policy may lead to traffic diversion to surrounding areas, including the Bronx, a NYC borough with communities disproportionately exposed to traffic-related air pollution and burdened by higher rates of paediatric asthma compared with city averages.[19 20] While data from mainly European cities suggest better health outcomes association with the congestion pricing plans in high-income groups, men and individuals aged 35–55 years,[21] we argue that these data might not directly translate to the US population.

In the USA, racial/ethnic minority populations are exposed to significantly higher levels of air pollution compared with white populations across income levels.[22] Adverse health effects of poor air quality are substantially higher in communities of colour and/or low-income populations and this is magnified in metropolitan areas with high levels of residential segregation.[23] In the New York metropolitan area, more than 50% of the population identifies as non-white and about 13% of the population has low income.

Municipal decisions regarding reinvestments of revenue garnered from the NYC congestion pricing plan is another important factor that may contribute to the directionality of health equity policy impacts. If revenues are used for improving public transportation (as currently proposed in the Environmental Review by the Federal Highway Association), we can anticipate the benefit to be shifted to women and low-income groups rather than men and high-income groups, especially due to low rates of car ownership in these populations. Moreover, attention should be directed towards how the fund is used in public transportation, for example, prioritising areas with immediate need or bus electrification. More generally, air pollution reduction interventions tend to benefit vulnerable groups more susceptible to health effects of air pollution, such as children and the older people.[24] However, the true magnitude and directionality of health equity impacts by congestion pricing policies need to be empirically assessed as the policy is implemented.

A health equity-oriented evaluation can contrast differential trends in rates of health outcomes across areas with various levels of diversity in race/ethnicity, income and other social determinants of health at the time of policy implementation.[25] This can be done by comparison of population-level characteristics across different parts of the metro area or by using survey-based studies on sociodemographic indicators and travel behaviour. Urban policies such as congestion pricing plans are implemented by transportation authorities but often in close collaboration with public health experts. Strong engagement with communities affected by the policy in various stages of policy design, implementation and evaluation will ensure that the major concerns of the communities are addressed and benefits are maximised for all subgroups of the community. By incorporating multiple environmental exposures and their interaction with social determinants of health, the evaluation can address questions of policy and community relevance.

CONCLUSIONS

As a first-of-its-kind policy implementation in the USA, the NYC congestion pricing policy will serve as a case study for other municipalities considering similar policies. A careful evaluation of the policy's implementation within a natural experiment framework may allow researchers to disentangle changes in traffic-related air pollutant concentrations and health outcomes due to the policy from changes due to secular trends and to identify potential unintended consequences associated with policy implementation. The NYC congestion pricing plan aims to create a healthier and more equitable city for residents. Assessing the policy's intended and unintended impacts on health equity as it rolls out is key to achieving these goals.

Contributors Conception and design: AG, RW and LET. Manuscript drafting: AG, RW, LET and ART. Acquisition of data or analysis: ART, SC and AA. Interpretation of data and final review of the manuscript: all authors. AG and LET are responsible for the overall content of the manuscript. AG is the author acting as guarantor.

Funding AG and ART received funding from the Robert Wood Johnson Foundation Evidence for Action Program (grant #78922) to perform this research. The sponsor had no role in design, interpretation or submission of the report for publication. This work is also supported by P2CES033423 (to LET).

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Commissioned; externally peer reviewed.

Data availability statement There are no data in this work.

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REFERENCES

1 Federal Highway Association. *Environmental Assessment of the Central Business Tolling Program*. U.S. Department of Transportation, 2022.
2 Krieger N, Van Wye G, Huynh M, *et al*. Structural racism, historical redlining, and risk of preterm birth in New York city, 2013-2017. *Am J Public Health* 2020;110:1046–53.
3 Tong DQ, Muller NZ, Kan H, *et al*. Using air quality modeling to study source-receptor relationships between nitrogen oxides emissions and ozone exposures over the United States. *Environment International* 2009;35:1109–17.
4 Tong DQ, Mathur R, Kang D, *et al*. Vegetation exposure to ozone over the Continental United States: assessment of exposure indices by the Eta-CMAQ air quality forecast model. *Atmospheric Environment* 2009;43:724–33.
5 Jones C, Slevin K, Weinberger R, *et al*. Congestion pricing in NYC: getting it right. New York, NY Regional Plan Association; 2019. 12–3. Available: https://rpa.org/work/reports/congestion-pricing-in-nyc
6 Baghestani A, Tayarani M, Allahviranloo M, *et al*. Evaluating the traffic and emissions impacts of congestion pricing in New York City. *Sustainability* 2020;12:3655.
7 Baghestani A, Tayarani M, Allahviranloo M, *et al*. New York City cordon pricing and its' impacts on disparity, transit accessibility, air quality, and health. *Case Stud Transp Policy* 2022;10:485–99.
8 Granier C, Brasseur GP. The impact of road traffic on global tropospheric ozone. *Geophysical Research Letters* 2003;30.
9 Simeonova E, Currie J, Nilsson P, *et al*. Congestion pricing, air pollution and children's health. *J Human Resources* 2021;56:971–96.
10 Beevers SD, Carslaw DC. The impact of congestion charging on vehicle emissions in London. *Atmospheric Environment* 2005;39:1–5.
11 Green CP, Heywood JS, Navarro Paniagua M. Did the London congestion charge reduce pollution. *Reg Sci Urban Econ* 2020;84:103573.
12 Rich DQ. Accountability studies of air pollution and health effects: lessons learned and recommendations for future natural experiment opportunities. *Environment International* 2017;100:62–78.
13 Tonne C, Beevers S, Armstrong B, *et al*. Air pollution and mortality benefits of the London congestion charge: spatial and socioeconomic inequalities. *Occup Environ Med* 2008;65:620–7.
14 Singichetti B, Conklin JL, Hassmiller Lich K, *et al*. Congestion pricing policies and safety implications: a scoping review. *J Urban Health* 2021;98:754–71.
15 de Vocht F, Katikireddi SV, McQuire C, *et al*. Conceptualising natural and quasi experiments in public health. *BMC Med Res Methodol* 2021;21:32.
16 Abadie A, Cattaneo MD. Econometric methods for program evaluation. *Annu Rev Econ* 2018;10:465–503.
17 Abadie A, Gardeazabal J. The economic costs of conflict: a case study of the Basque country. *American Economic Review* 2003;93:113–32.
18 Bouttell J, Craig P, Lewsey J, *et al*. Synthetic control methodology as a tool for evaluating population-level health interventions. *J Epidemiol Community Health* 2018;72:673–8.
19 Peters A, Hernández D, Kioumourtzoglou M, *et al*. Assessing neighborhood-scale traffic from crowd-sensed traffic data: findings from an environmental justice community in New York City. *Environ Sci Policy* 2022;133:155–63.
20 NYC Health Epi Data Brief. Disparities among children with asthma in New York City. 2021. Available: https://www.nyc.gov/assets/doh/downloads/pdf/epi/databrief126.pdf
21 Hosford K, Firth C, Brauer M, *et al*. The effects of road pricing on transportation and health equity: a scoping review. *Transp Rev* 2021;41:766–87.
22 Hajat A, Hsia C, O'Neill MS. Socioeconomic disparities and air pollution exposure: a global review. *Curr Environ Health Rep* 2015;2:440–50.
23 Lane HM, Morello-Frosch R, Marshall JD, *et al*. Historical redlining is associated with present-day air pollution disparities in U.S. cities. *Environ Sci Technol Lett* 2022;9:345–50.
24 Burns J, Boogaard H, Polus S, *et al*. Interventions to reduce ambient air pollution and their effects on health: an abridged Cochrane systematic review. *Environment International* 2020;135:105400.
25 Benavides J, Rowland ST, Shearston JA, *et al*. Methods for evaluating environmental health impacts at different stages of the policy process in cities. *Curr Environ Health Rep* 2022;9:183–95.