Image: MTA

COVID-19 and Transportation

A look at impacts, equity implications, virus transmission and transit, best practices, and looking forward

December 8, 2020

Presented to:

NSPE-NY

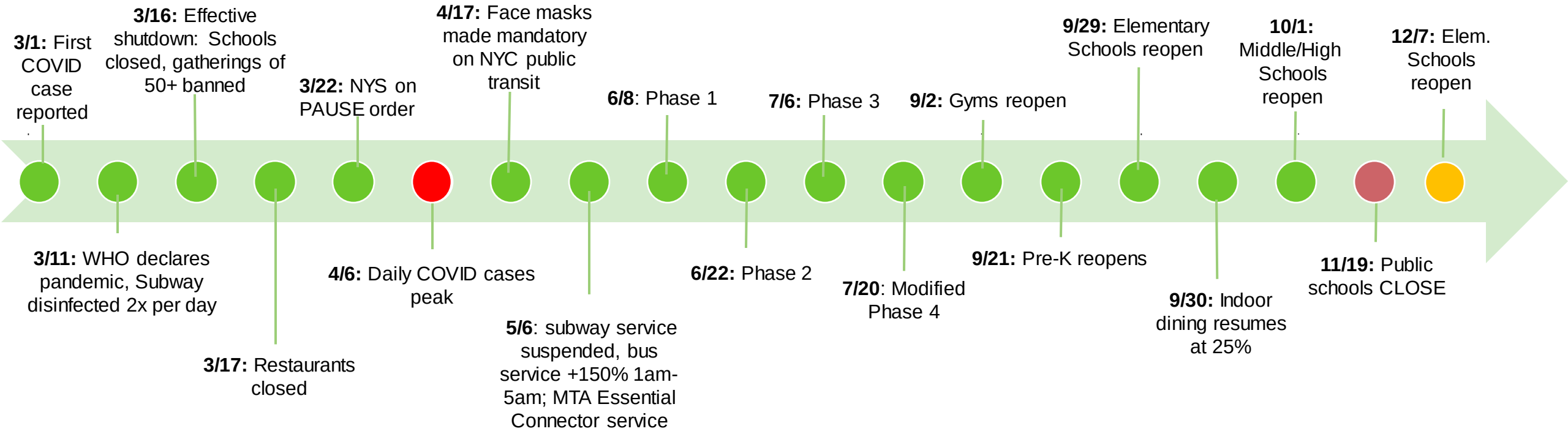
NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS

Presented by:

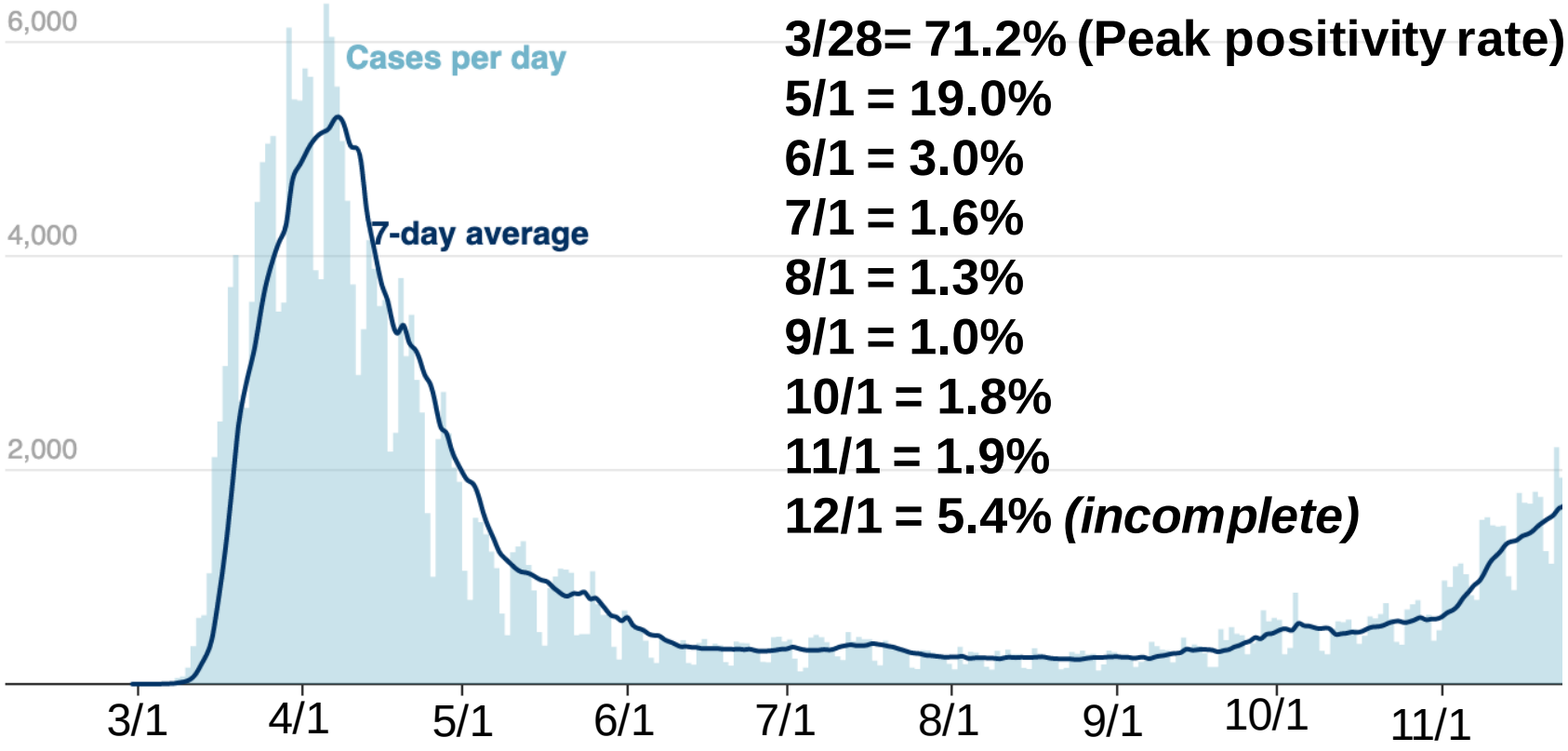
Sam Schwartz

Impacts of Coronavirus on Transportation in New York City

COVID-19 in NYC



New York City COVID-19 Cases & Deaths



3/28= 71.2% (Peak positivity rate)
5/1 = 19.0%
6/1 = 3.0%
7/1 = 1.6%
8/1 = 1.3%
9/1 = 1.0%
10/1 = 1.8%
11/1 = 1.9%
12/1 = 5.4% *(incomplete)*

Month	Deaths
Feb	0
Mar	2,190
Apr	12,731
May	2,829
Jun	755
Jul	335
Aug	137
Sep	126
Oct	159
Nov	306
Total	**19,568**

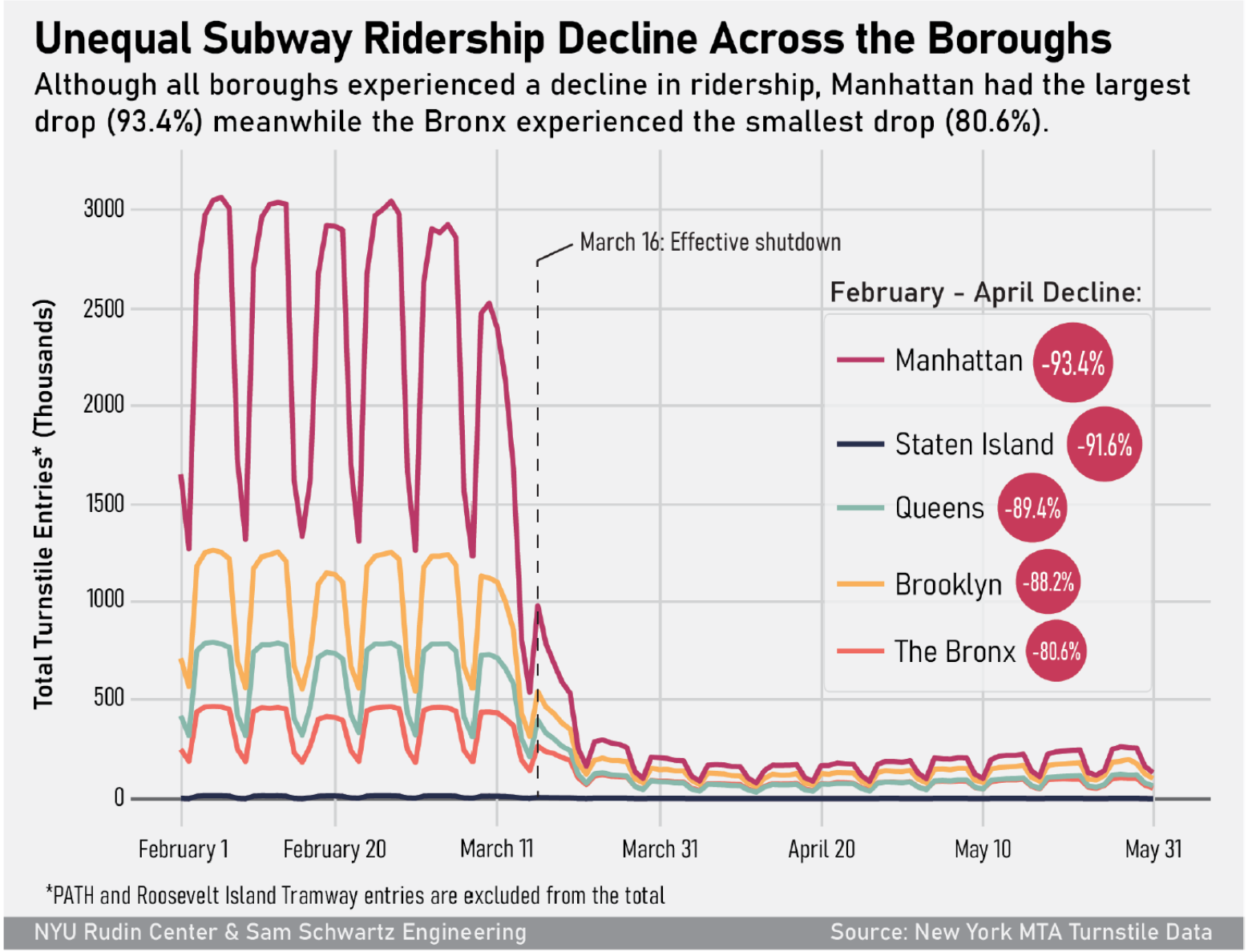
Source: https://www1.nyc.gov/site/doh/covid/covid-19-data.page

Peak pandemic impacts

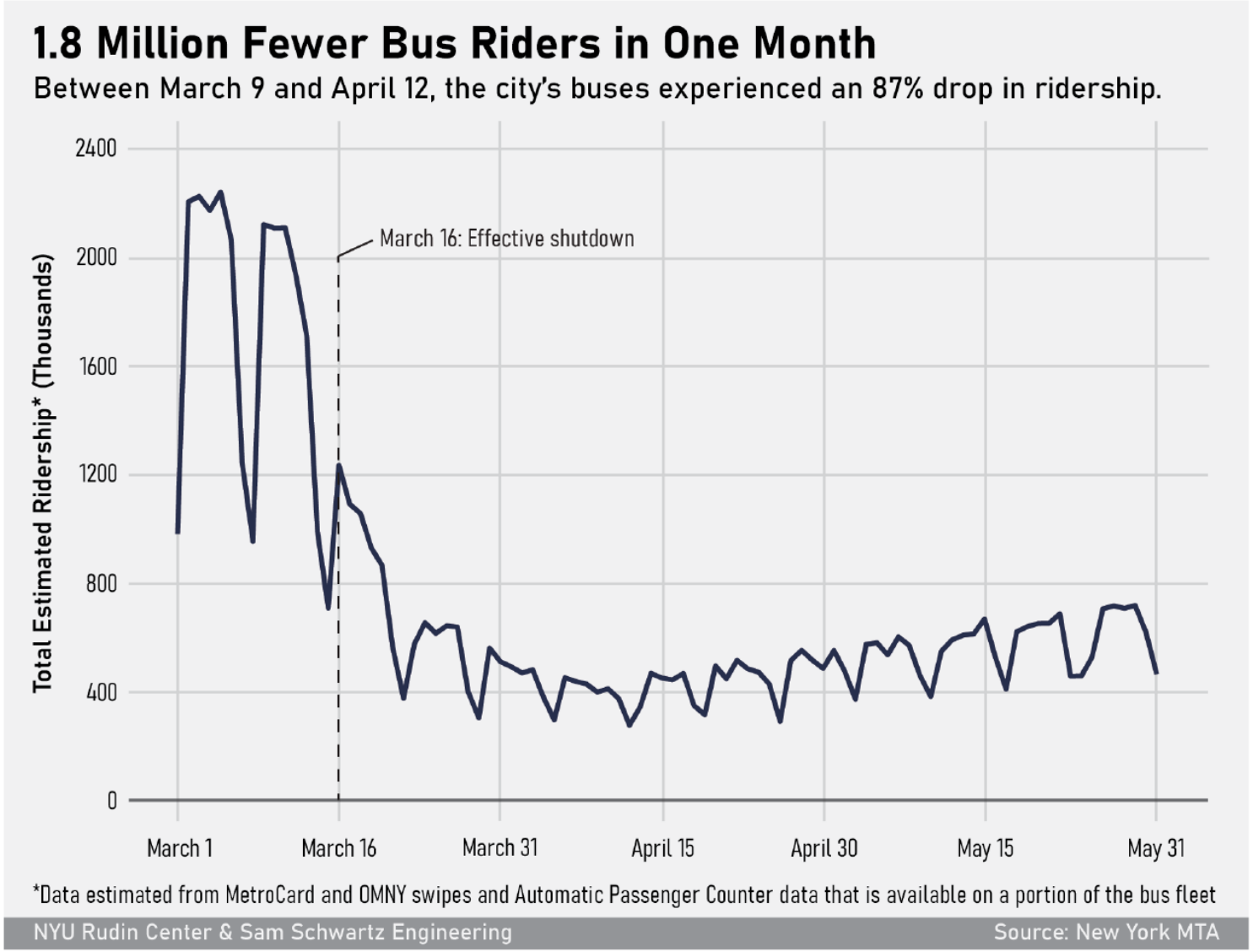
Times Square, March 17

Image: https://www.insider.com/photos-empty-us-cities-coronavirus-2020-3

Peak Pandemic: Overall subway use dropped by 92%



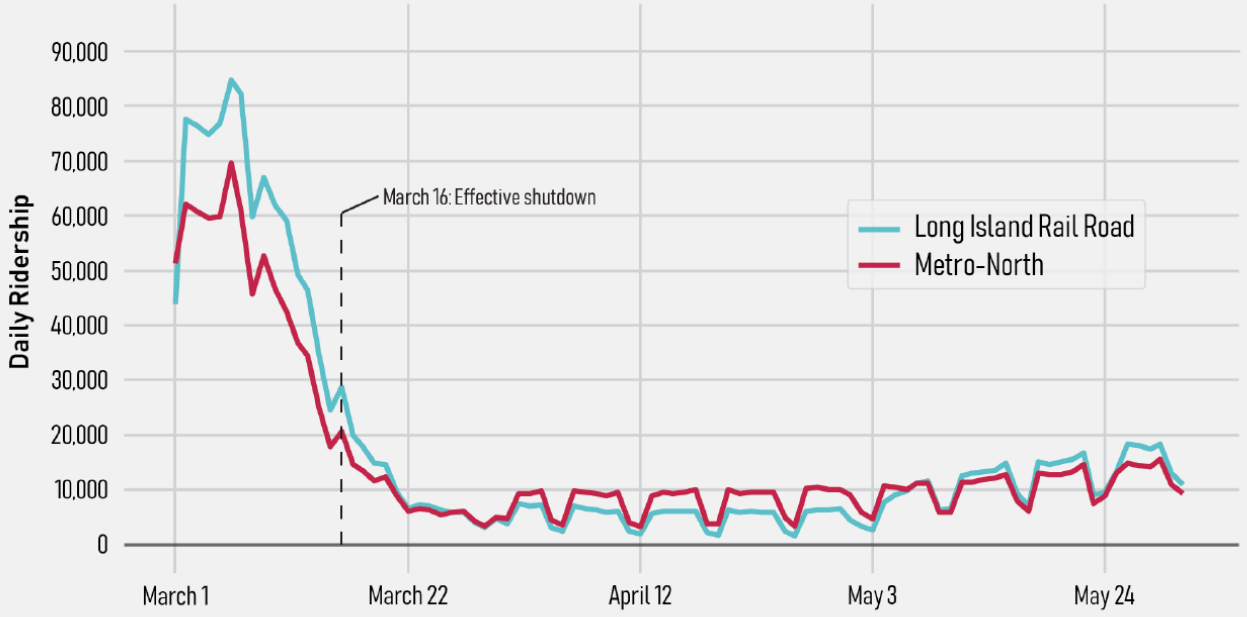
Peak Pandemic: Bus ridership dropped less (87%), but still dramatically impacted



Peak Pandemic: Commuter rail fell 93%-97%

MTA Commuter Rail Ridership Collapsed

Metro-North and Long Island Rail Road fell at similiar rates through April, both ending with a 93% decrease between March and May.

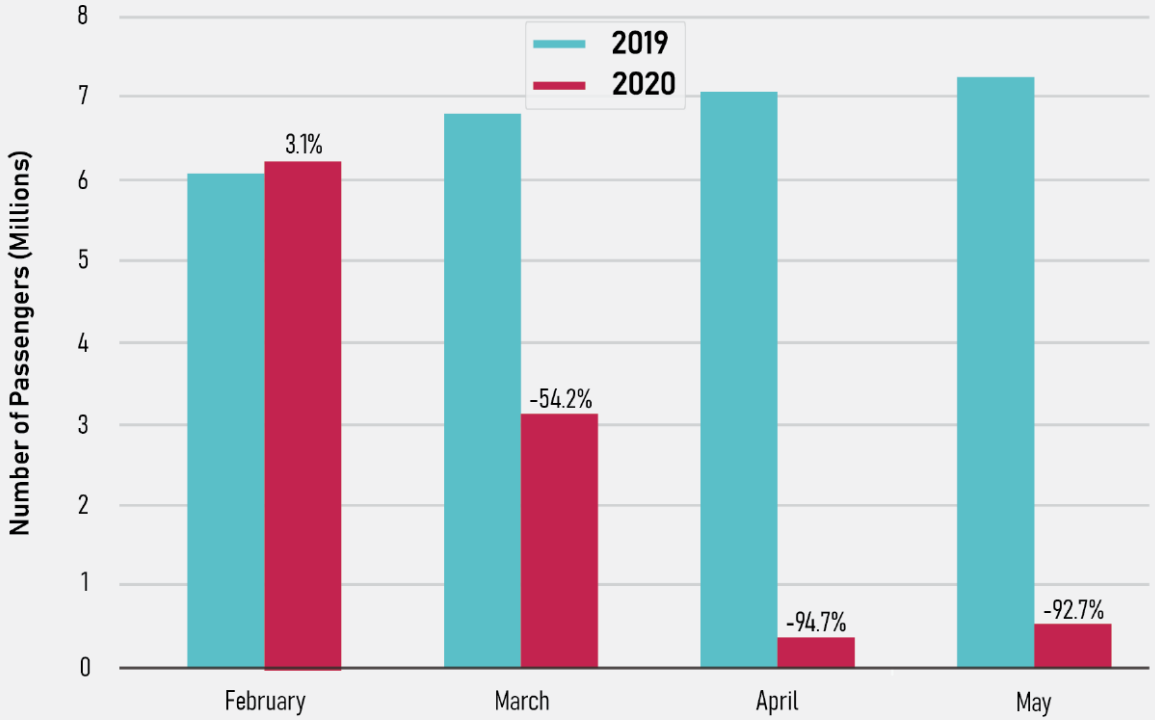


NYU Rudin Center & Sam Schwartz Engineering

Source: MTA MNR and LIRR Ridership Data

PATH Ridership Fell 95%

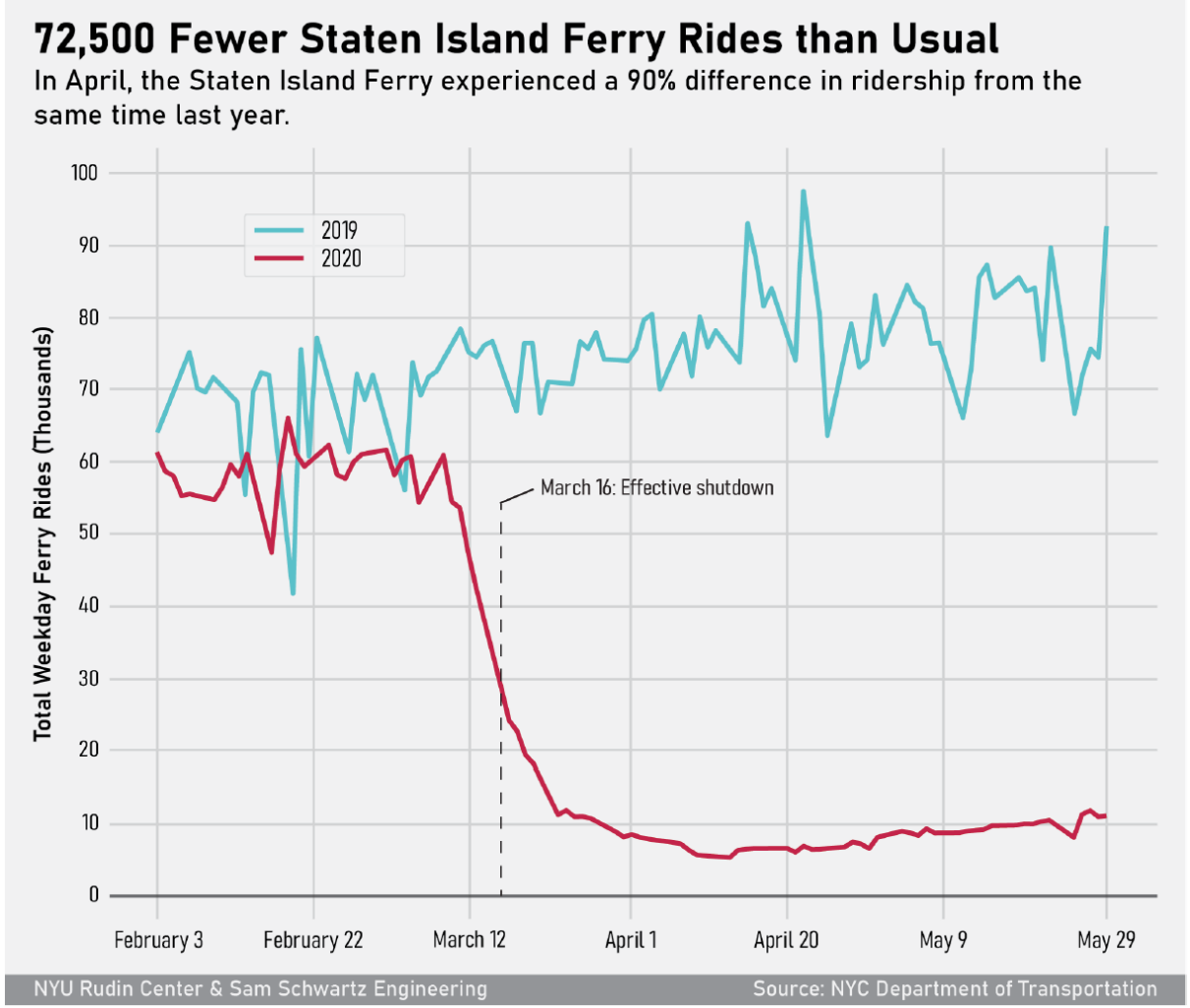
From February to April, the PATH system monthly ridership went from 6.2 million to approximately 377,000.

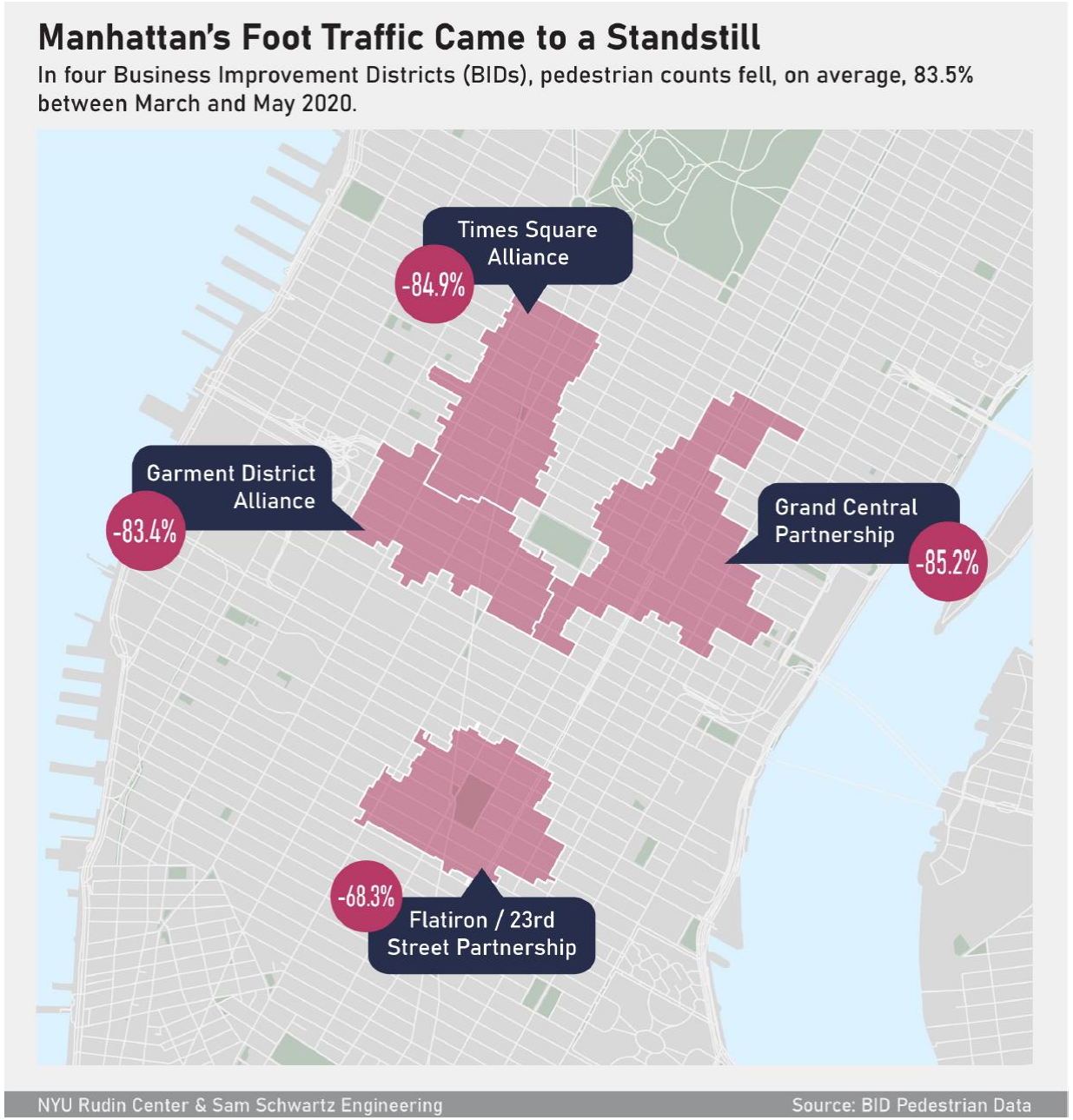


NYU Rudin Center & Sam Schwartz Engineering

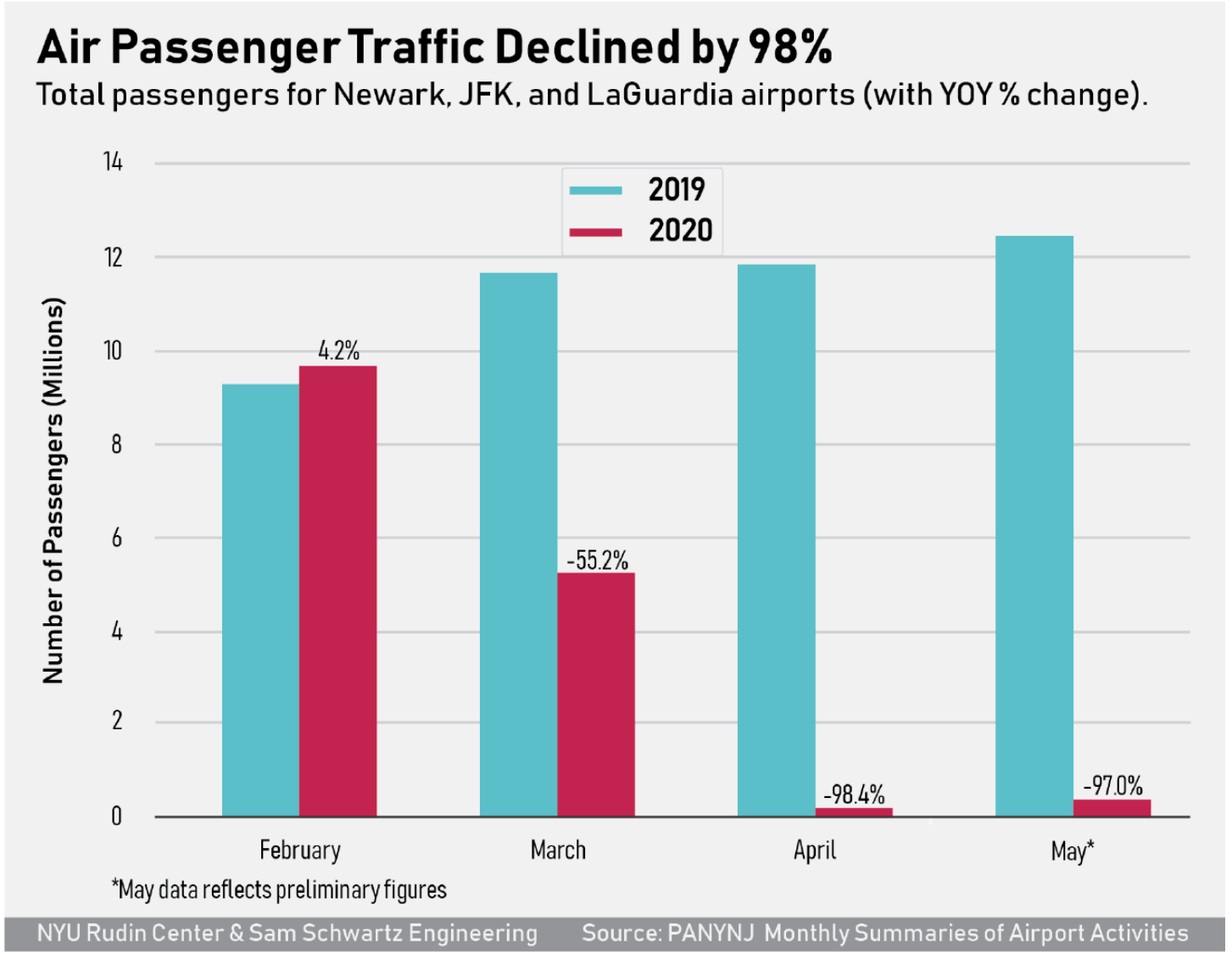
Source: Port Authority

Peak Pandemic:Staten Island Ferry down 90%, walking in Midtown down 84%





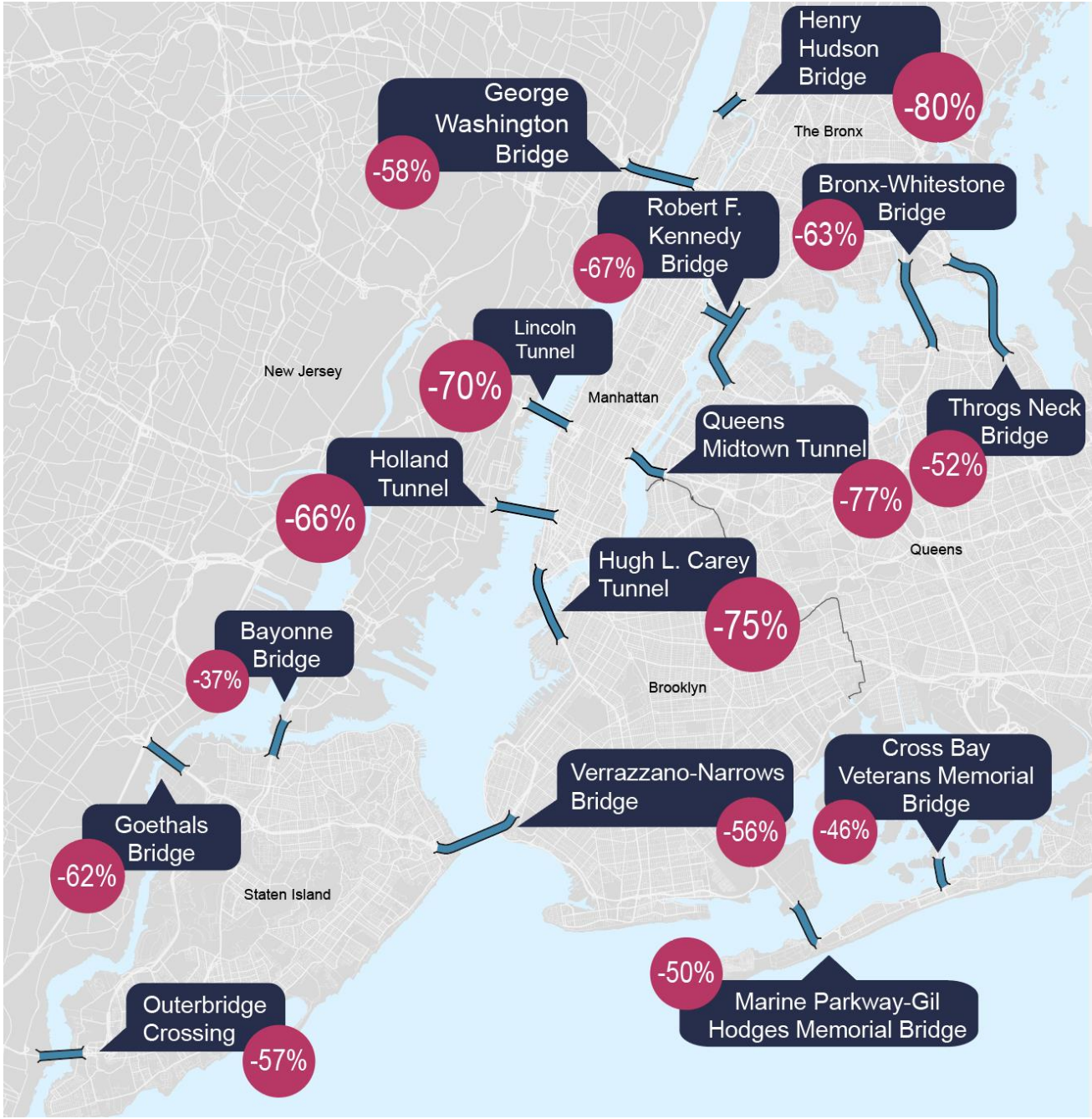
Peak Pandemic: Air travel fell 98%



Peak Pandemic: Traffic volumes dropped 50%-80%

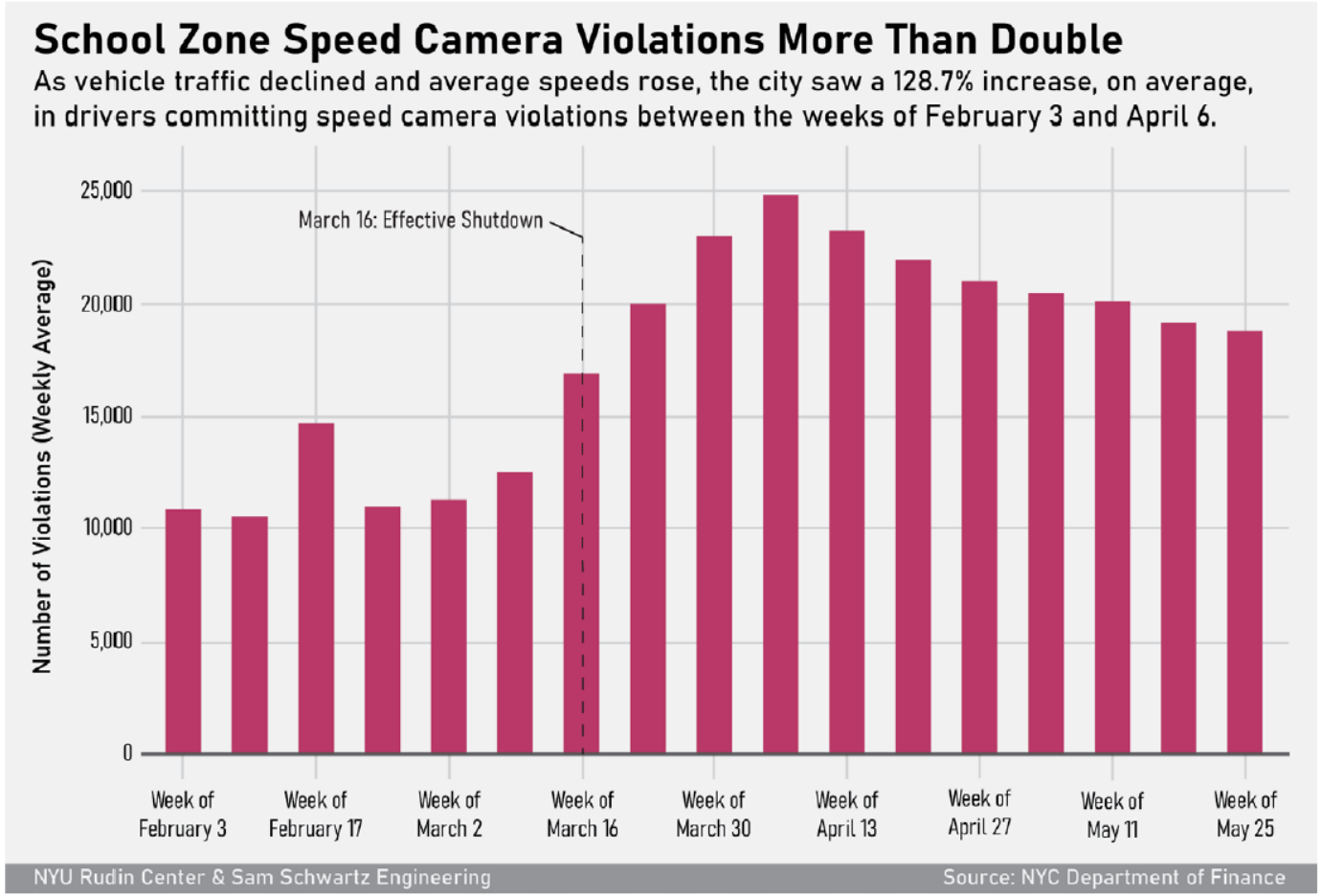
Note:

- *the higher shifts all occurred where there are untolled options*
- *CBD tunnels hit hard*
- *Trucks down 20-30%*



NYU Rudin Center/Sam Schwartz July 2020 report, Transportation During Coronavirus in New York City.
Graphics: Nicholas Cowan

Speeding doubled, fatalities down at first but exceeded 2019 levels by summer

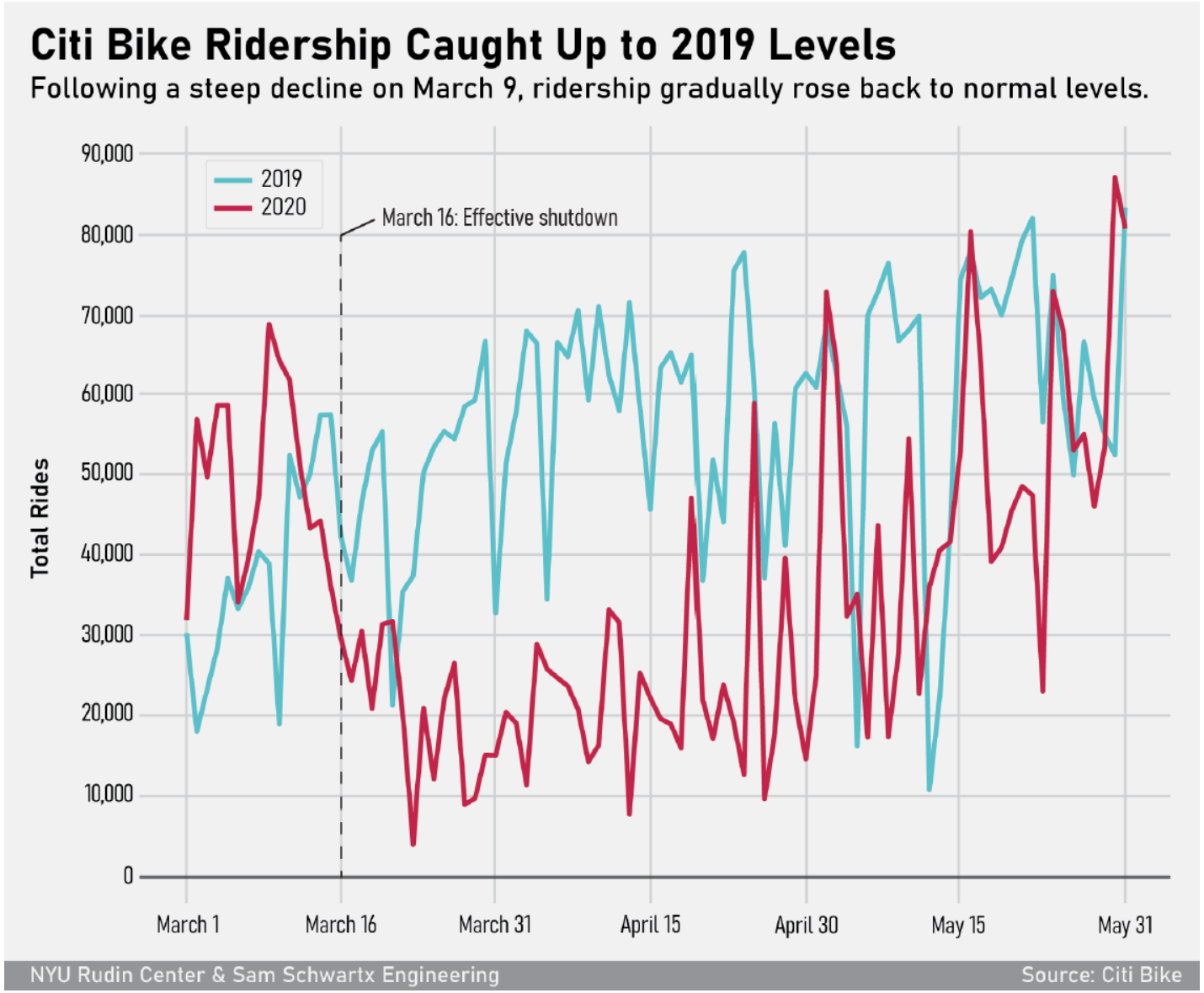


	2019	2020	YOY
Jan-Feb	36	40	***11%***
March-May	58	34	***-41%***
June-Aug	66	71	***8%***
Sep/Oct/Nov	59	89	***51%****

Source: NYPD

**estimated rate increase per VMT ~70%-80%*

Citi Bike ridership down 62%, some days at 2019 levels by May



Ridership is Gradually Recovering, Though Unevenly

Ridership as a % change from pre-pandemic levels:

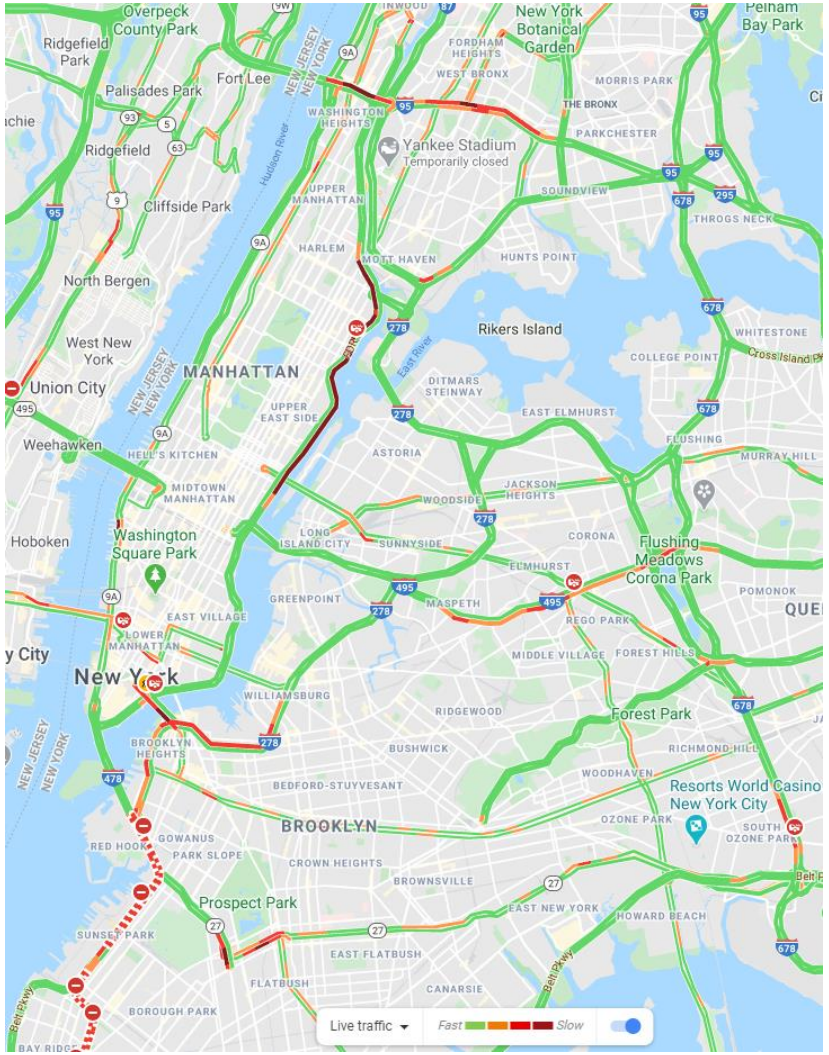
Mode	Peak Pandemic, early/mid-April	Most recent *(Sept/Oct/Nov 2020)*
Airports	-98%*	~ -78% *(Thanksgiving: -55%)* (*October*)
MTA Commuter Rail	-97%	-74%* *(November)*
Taxis	-97%*	-77% * *(October)*
Subways	-92%	-68%* *(November)*
Buses	-87%	-49%* *(November)*
For Hire Vehicles	-80%*	-37%* (*September*)
Bridges & Tunnels**	-64%*	-17%* *(-10% est)* (*November, Only TBTA*)
Citi Bike	-62%*	+3%* (*October*)
PANYNJ Trucks	-30%*	-1% *(September)*

**Average of PANYNJ and TBTA B&T

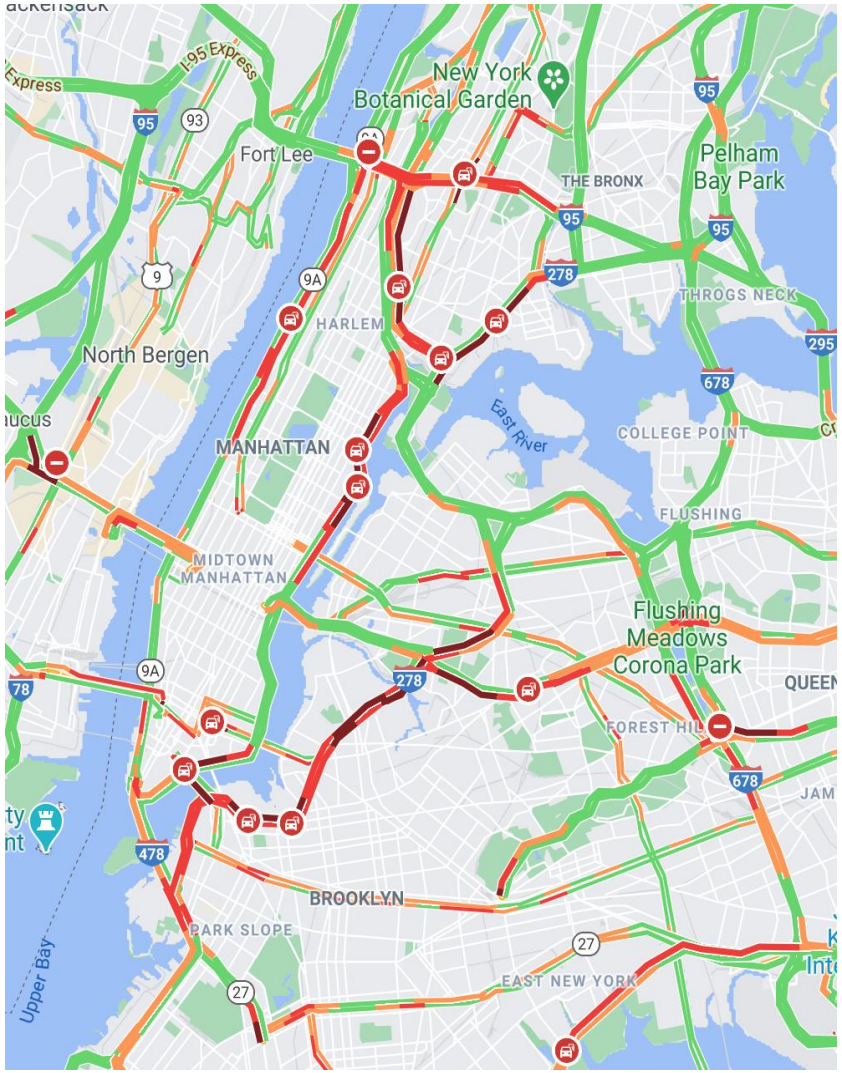
*Monthly total % change

Traffic Jams Returning

(Even though midtown activity is low)



Wednesday May 27, 2020, 6:15 PM

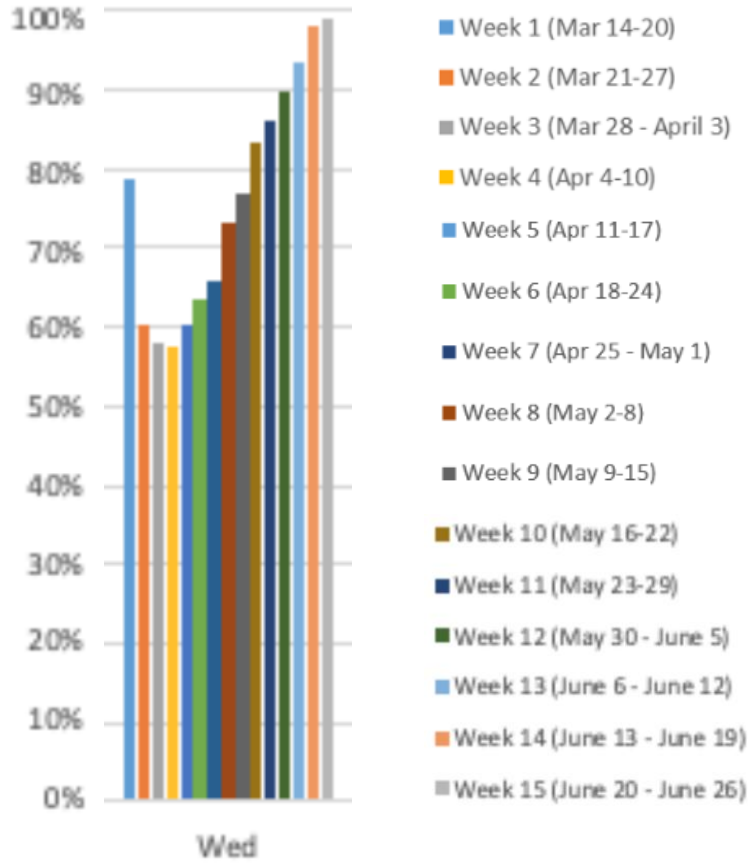


Wednesday December 2, 2020, 6:16 PM

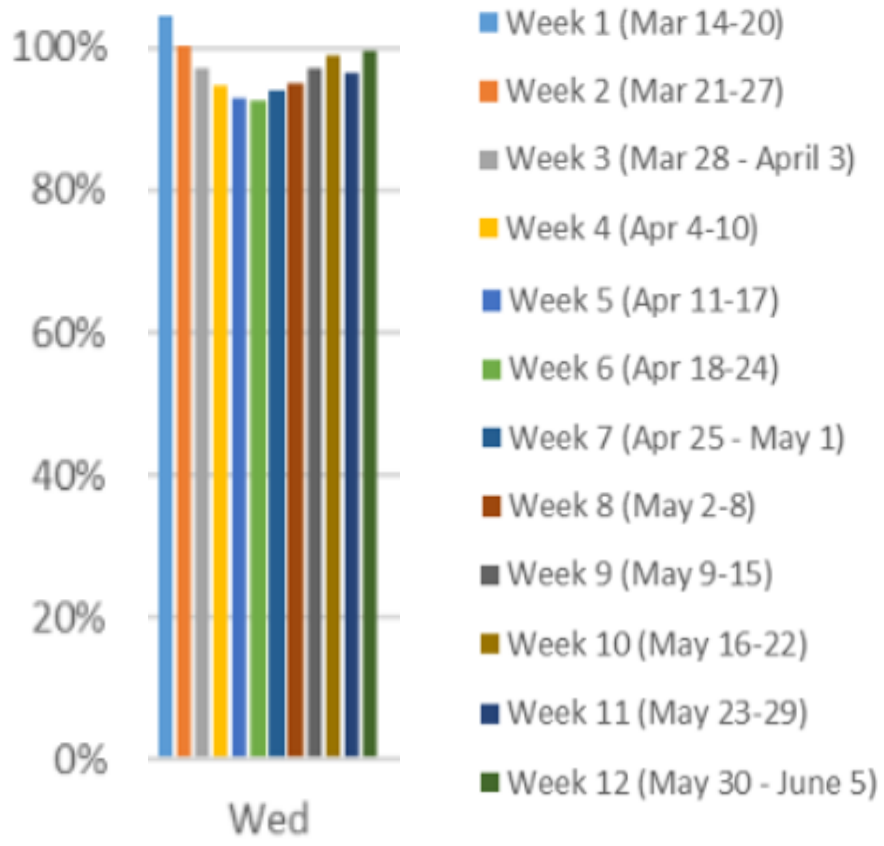
Source: Google Maps

National Trends: By June VMT returned to pre-Covid levels

Passenger Vehicle Travel
By Day of Week (100% = Feb 22 - 28, 2020)



Nationwide Truck Travel
By Day of Week (100% = Feb 22 - 28, 2020)



Most Recent
Highest numbers since pre-Covid the day before Thanksgiving: vehicle-miles traveled (VMT) **+9%**

-4% overall from last year

Source: INRIX

The Pandemic, Transportation, & Equity

We hailed our heroes

How do our heroes travel?

- **55% of NYC's essential workers** rely on public transit; **75%** of essential workers are people of color (POC)*
- Black New Yorkers comprise largest share of workforce in rail (47%) and bus (48%) transportation**
- Nationally: minorities = **60% of all public transit ridership*****
- Nationally: Essential workers that rely on public **67%=POC**, **26%= low income******

*https://comptroller.nyc.gov/wp-content/uploads/documents/Frontline_Workers_032020.pdf
**https://nycfuture.org/research/stark-disparities-in-employment-and-wages-for-black-new-yorkers
*** https://www.nytimes.com/2020/08/15/us/virus-transit-congress.html
**** https://transitcenter.org/tailoring-transit-service-for-essential-workers-is-a-matter-of-racial-justice/

But, Then We Discriminated Against Them and Cut the Service They Rely On - Public Transit

- Local and national policies discriminated against transit users and ergo, low income people

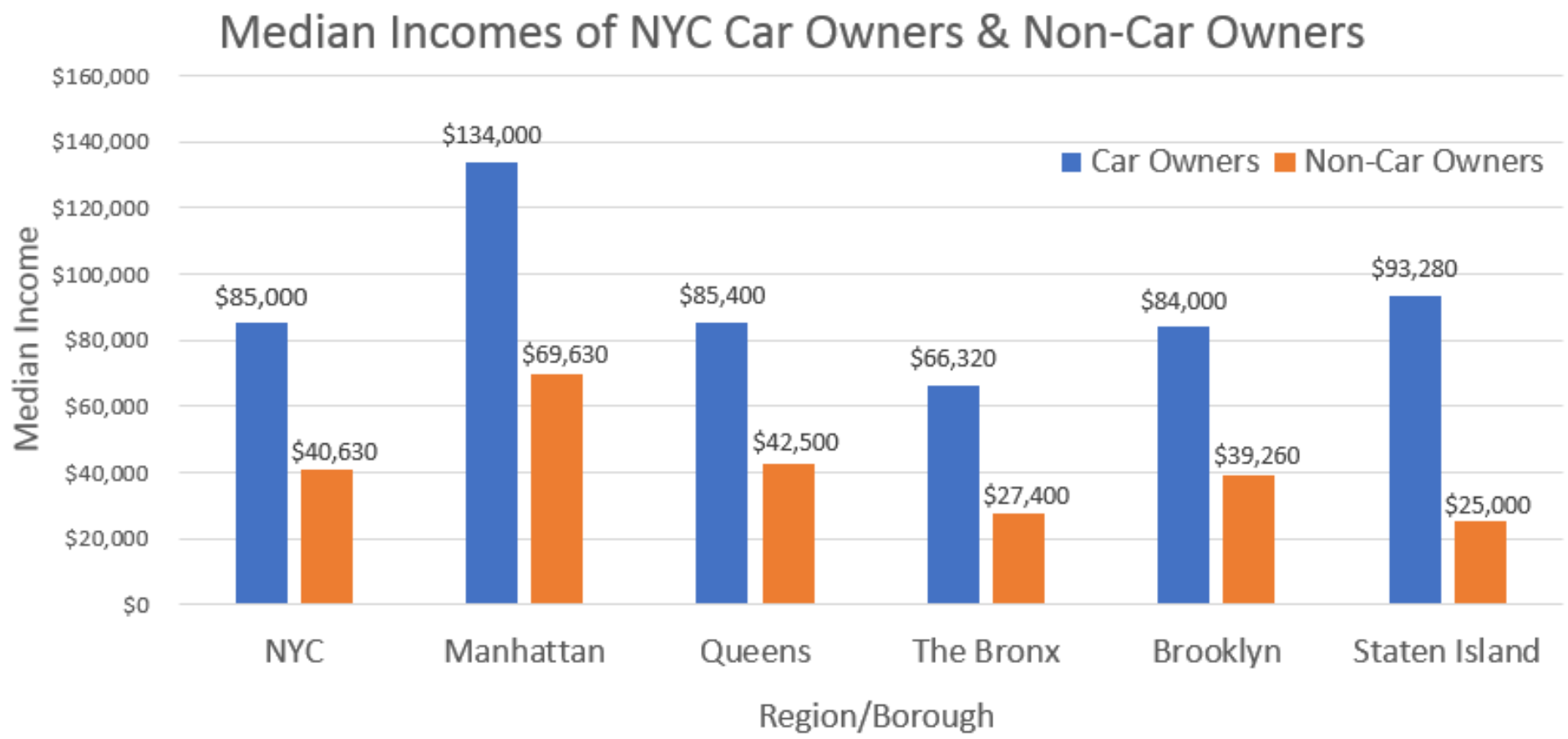
- New York Stock Exchange: **transit riders prohibited from trading floor** (May 2020; *rescinded June 15*); **discounted parking fees** (October 2020)

- Centers for Disease Control: **advises reimbursements/incentives to drive alone** (May 2020)

- A major NY real estate firm: **subsidizes 1/2 monthly parking** $; ~1/5 employees using the benefit (October 2020)

- And we cut service

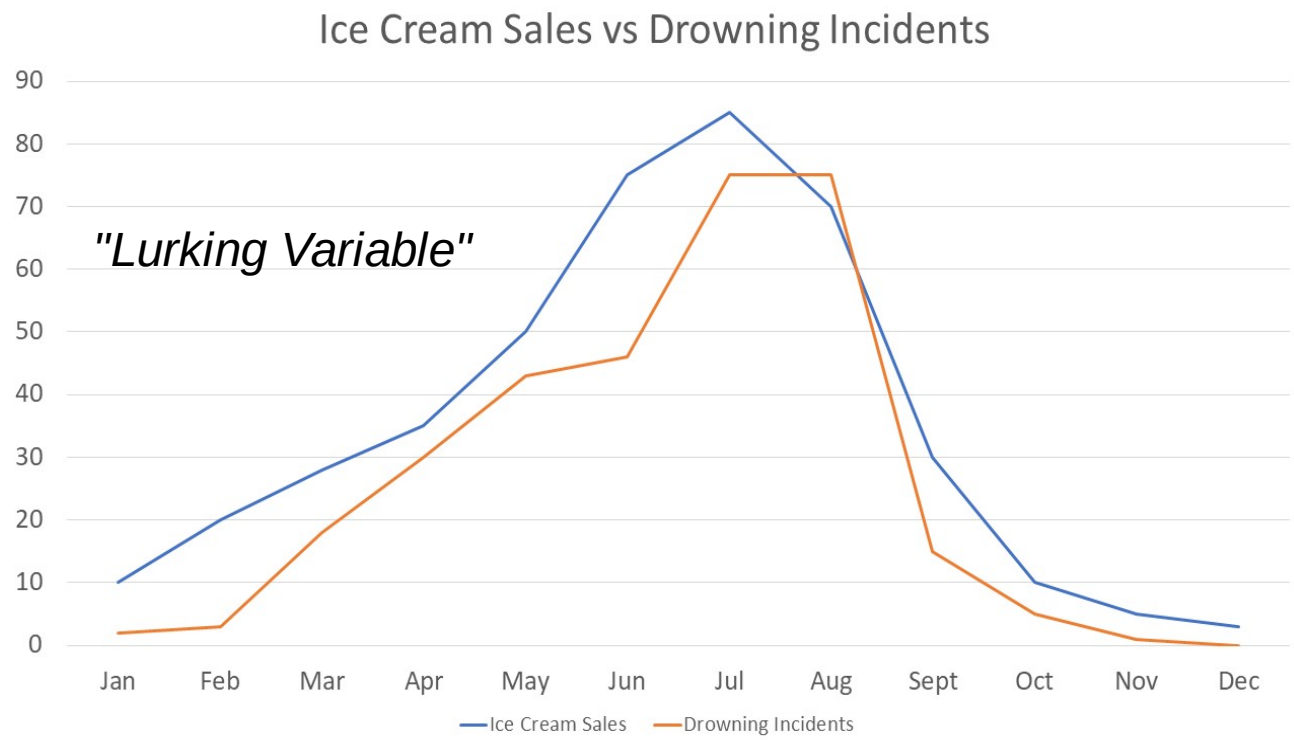
Local and national policies discriminated against transit users and consequently, low income people



Data From "How Car-Free is NYC?" Fact Sheet by Tri-State Transportation Campaign, 2015

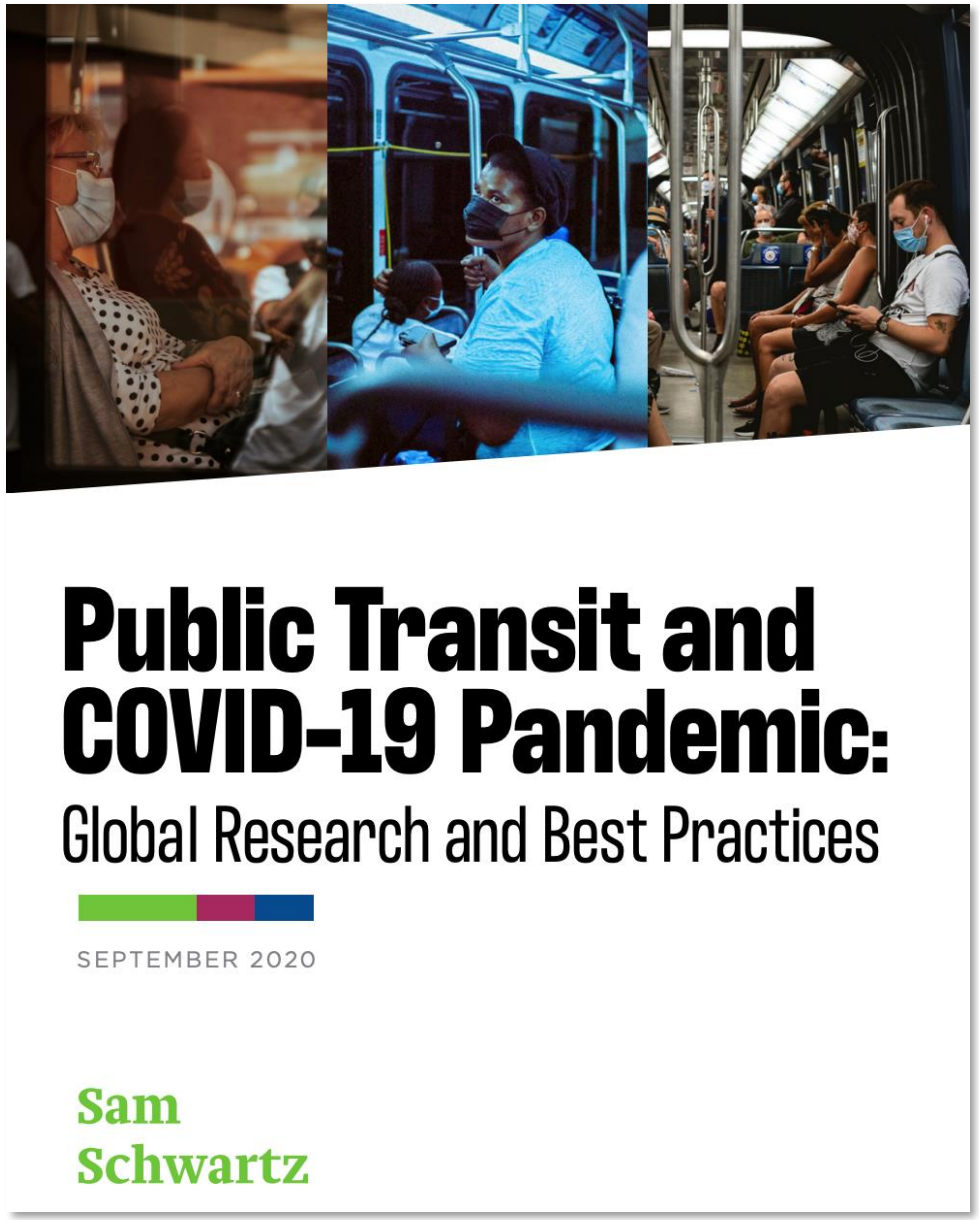
Why? Irresponsible Research and Reporting

- ***"The Subways Seeded the Massive Coronavirus Epidemic in New York City"*** -MIT (April 2020)
- ***"Public Transit Use Is Associated With Higher Coronavirus Death Rates"*** - WSJ, based on two economic studies (June 2020)
- It's like saying ice cream causes drowning



https://enwueconsulting.com/3-mistakes-people-make-when-analyzing-data-to-drive-business-decisions/

COVID-19 and Transmission in Transit



Disclaimer: The science around COVID-19 pandemic is **evolving**. As new evidence emerges, it may affect the following information.

I am not a medical professional, but I am a professional engineer.

Sam Schwartz/APTA report, September 2020. ***Public Transit and COVID-19 Pandemic: Global Research and Best Practices.***

Glossary

- **Respiratory Droplets:** particles 5 -10 micrometers (microns)/diameter of saliva, mucus, etc. produced by exhalation, talking, sneezing, coughing
- **Aerosols/droplet nuclei:** particles <5 micrometers (microns)/diameter; can remain in the air for long periods
- **Fomites**: inanimate objects (door handles, furniture) that can transfer disease. Occur when droplets fall from air to surface
- **Vector:** any organism which carries/transmits infectious pathogens into another living organism; now commonly applied to fomites/inanimate objects
- **Viral Load:** amount of measurable virus in a sample; not yet known the amount of virus necessary for COVID-19 infection
- **R0 (pronounced "R naught"):** epidemiological term for reproduction number; average number of people who become infected by an infectious person. Values > 1.0 = disease is spreading, values < 1.0 = disease is declining; *NY peak: R0= 6.4; 12/7/2020= 1.2*

Glossary, continued

- **Source Control:** strategy for reducing disease transmission by blocking respiratory secretions; ie: face coverings and face masks
- **Surgical Masks**: meant to help block large-particle droplets; may help protect wearer
- **Respirator Masks:** achieve a very close facial fit, providing filtration/protection from even small aerosol particles; ie: N95, KN95, N99 masks; 95-99% effective at blocking small particles

Principal Findings:

Researchers and media, **without much evidence,** were quick to point to transit as a major cause of the virus's spread.

The New York Times

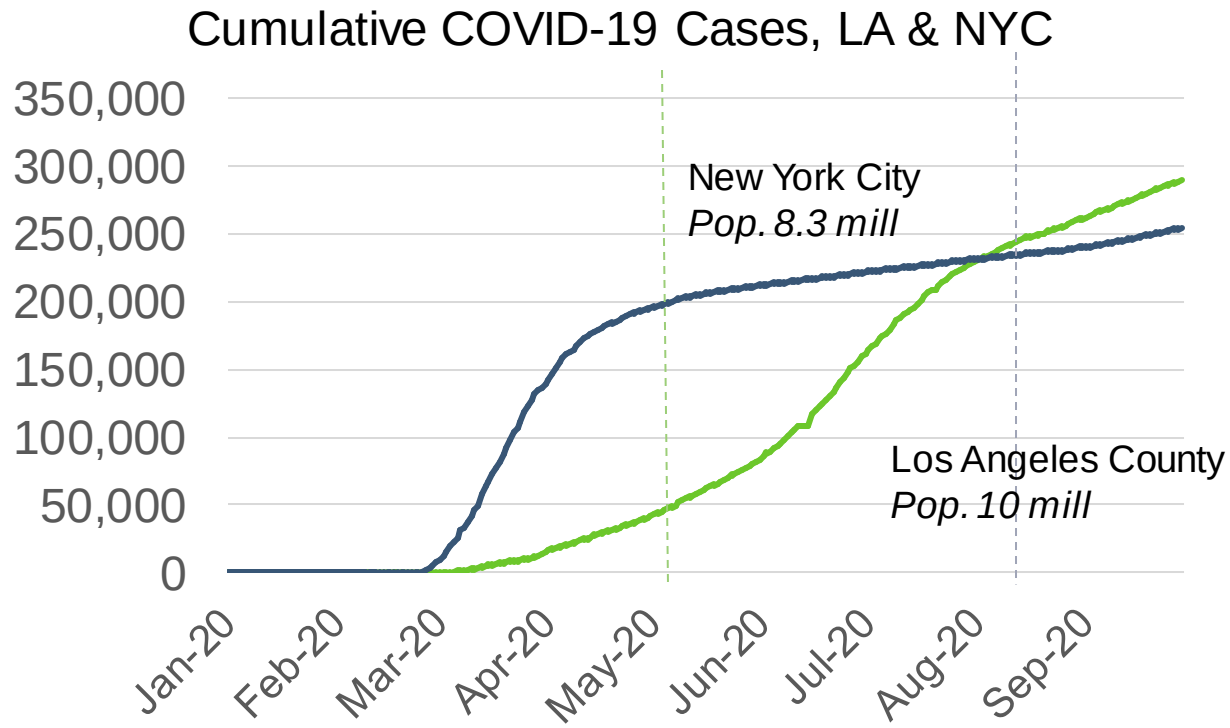
Opinion

Are Cars Protecting Los Angeles?

May 23, 2020

Is the Subway Risky? It May Be Safer Than You Think

August 2, 2020



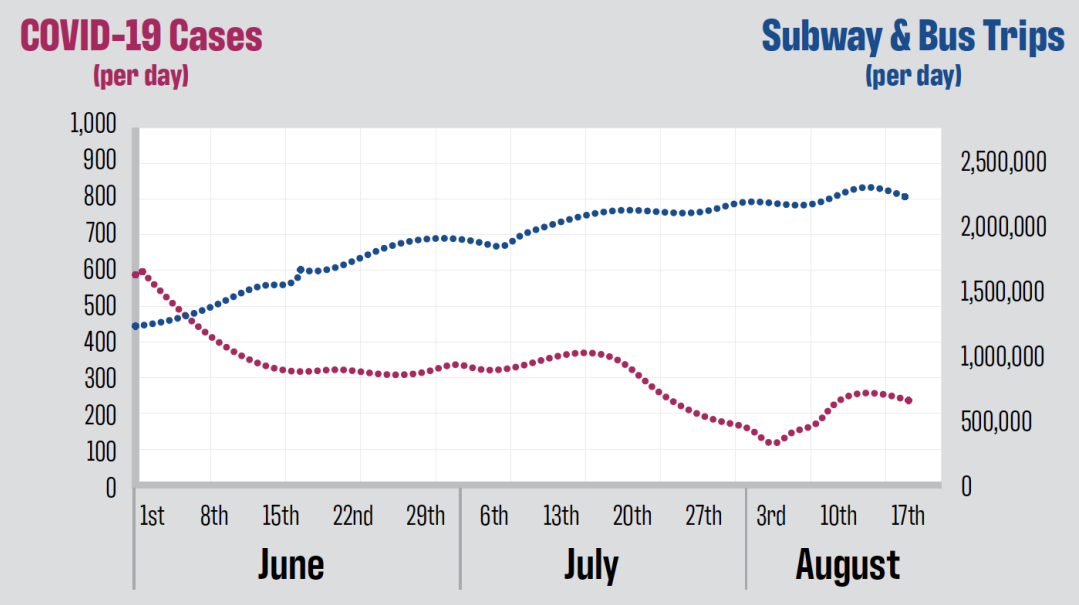
Data: USAFacts

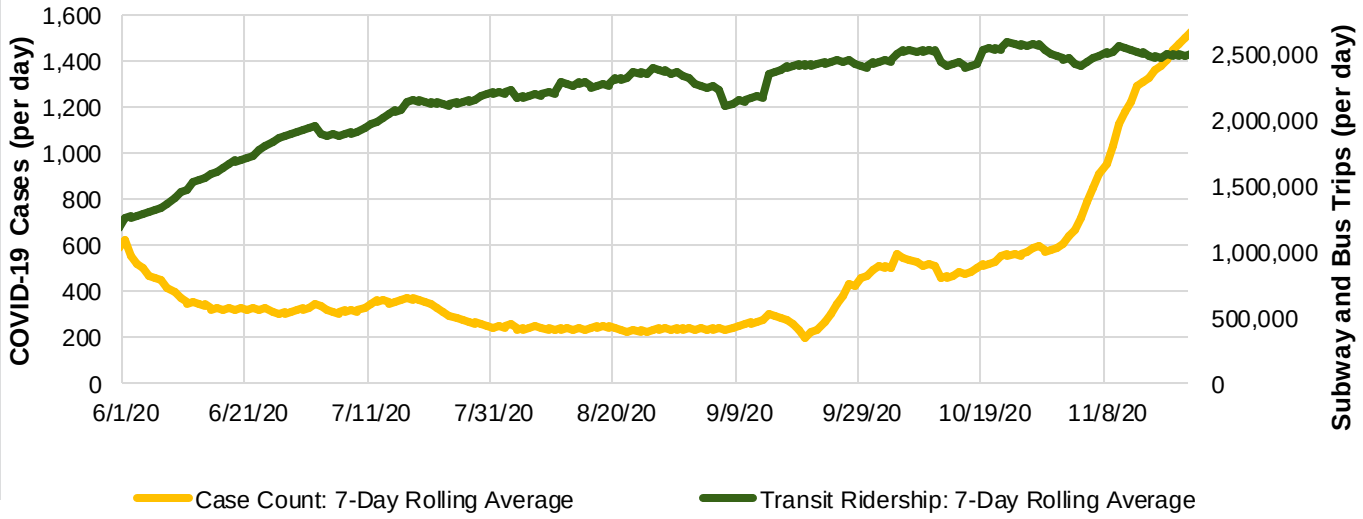
Health experts have looked at transit as a potential major source of infection, have **found no clear links to date.**

Image: https://www.independent.co.uk/news/world/asia/coronavirus-japan-train-emergency-stop-cough-no-mask-latest-a9350736.html

Paris	0 of 150 case clusters in May/June originated on city transit; to date no cases linked to city transit
Vienna	0 of 2,407 case clusters in April-September traceable to transit
Tokyo	None of the infection clusters traced to the country's famously crowded rail systems; ridership remains high
Hong Kong	Despite >12mm transit riders, known cases citywide remained low (until recently – and current outbreak not connected to transit); ridership remains 70%+
Seoul	Able to maintain low case rates despite never severely restricting mobility; despite pop. of 10 mill. daily new cases topped near 1,000 before declining. Ridership has only declined ~30%
Singapore	Even with rigorous contact tracing, no cases traced to public transportation; new case increases linked to dense living conditions of migrant workers
Milan	No increase in case rates when restrictions were lifted in Italy's most impacted area; ridership reached 80% in September

Analysis shows **no correlation with the rise or fall of local COVID-19 cases.**





New York City: June 1st - August 18th, more than 150 million rides were taken on subways and buses; case counts dropped from 616 per day to 247 per day (-60%)

Positive rates dropped 70% from 3.3% to 1.0%

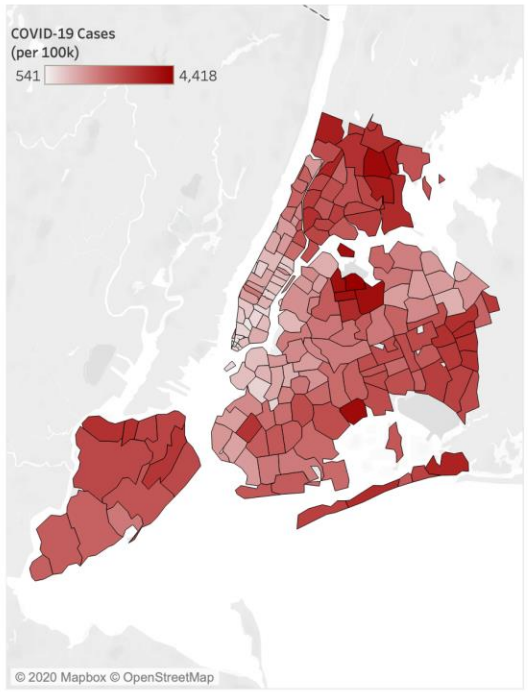
June 1st – November 27th, 400 million rides were taken on subways and buses; case counts rose to 1,304 (+112%)

Positive rates from 3.3% to 3.2%

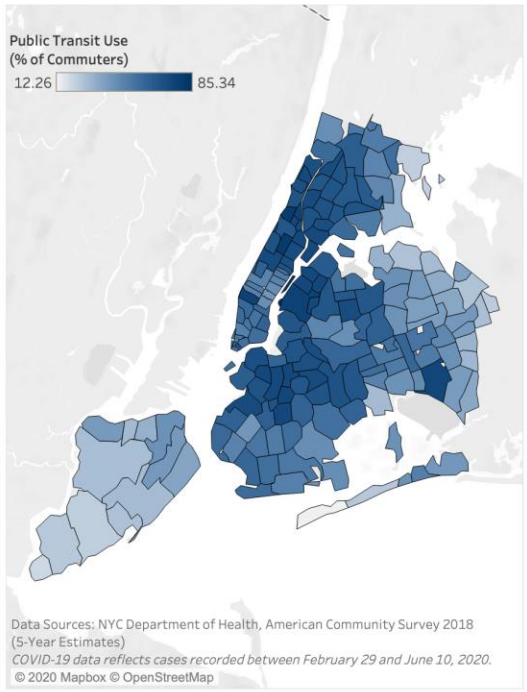
Source: MTA, NYC Dept of Health

Within City: Little Correlation With Transit Usage (peak pandemic)

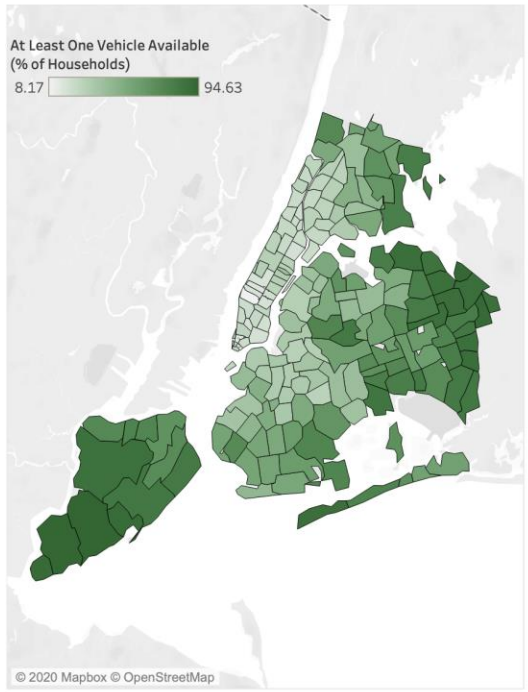
Map 1. Confirmed COVID-19 Case Rate by Modified ZCTA
per 100,000



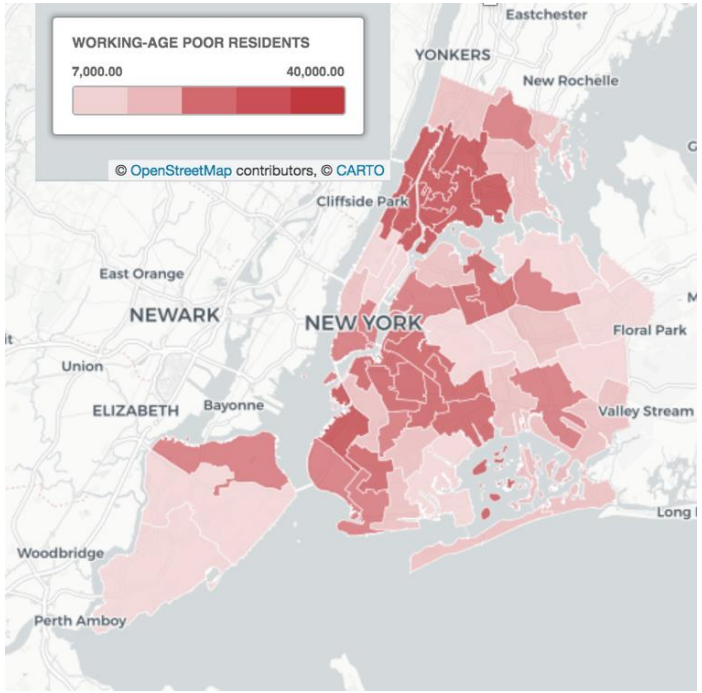
Map 2. Public Transit Use by Modified ZCTA
Percent of Commuters 16 years and Older



Map 3. At Least One Vehicle Available by Modified ZCTA
Percent of Households



Map 4. Working-age Poor By City Council District 2017



- 10 highest transit usage zones (excluding Manhattan) **31% lower case rate** than 10 lowest zones
- Staten Island rate **50%** > Manhattan, **28%** > than Brooklyn
- 10 highest case rates **57% households had cars**, lowest 10 **21% had cars**
- 10 highest case rates **53% transit users**, lowest 10 **55% transit users**

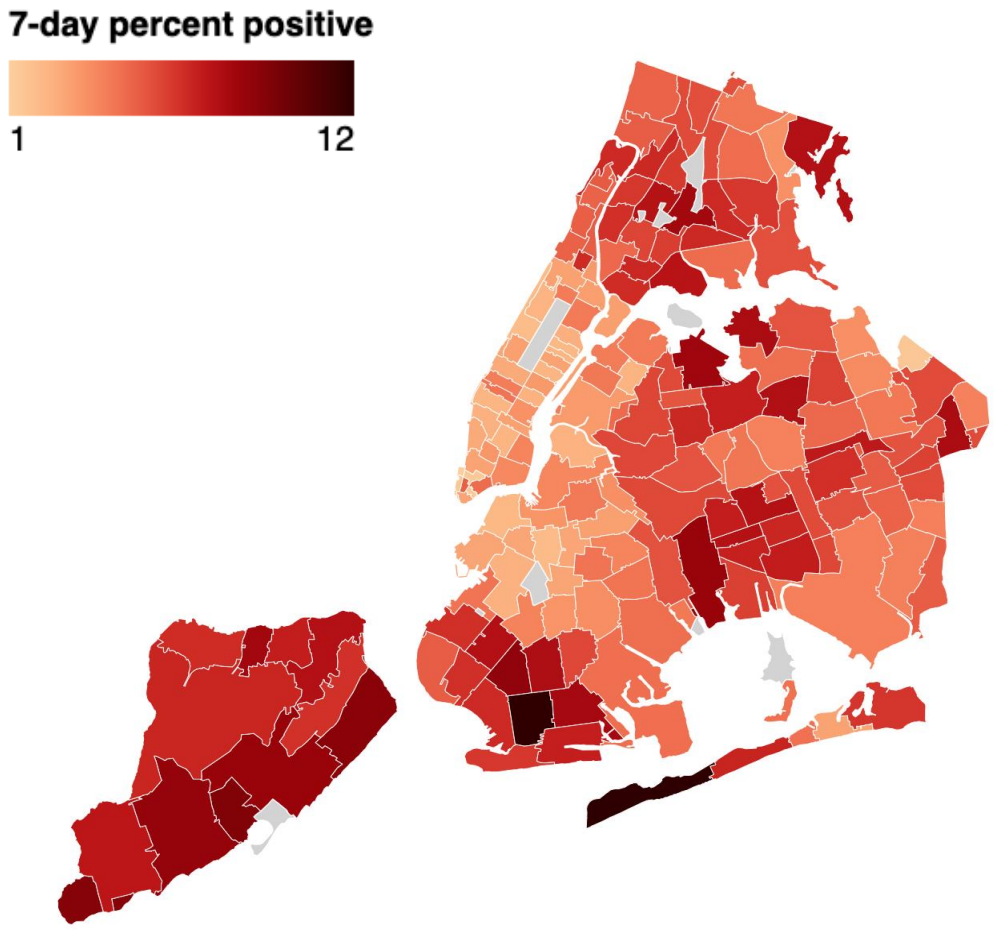
NY Suburbs (peak pandemic)

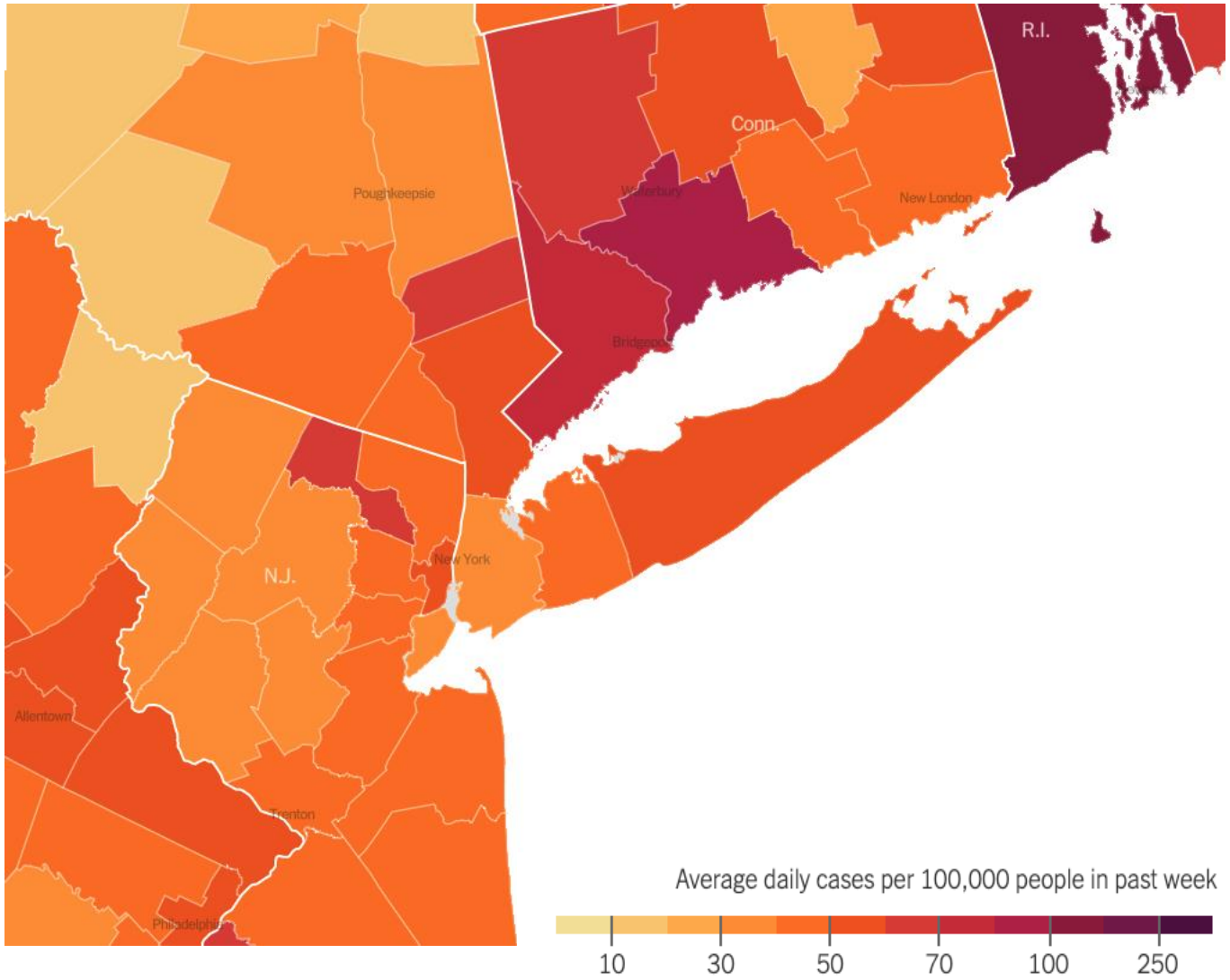
- Most suburban counties in region have higher infection rates than NYC (**2,550 cases per 100,000**):

New York		New Jersey	
Rockland	4,158	Passaic	3,306
Westchester	3,546	Union	2,951
Nassau	3,044	Hudson	2,803
Orange	2,801	Essex	2,317
Suffolk	2,738	Bergen	2,032

Source: New York Times, Coronavirus Interactive Dashboard accessed June 16, 2020

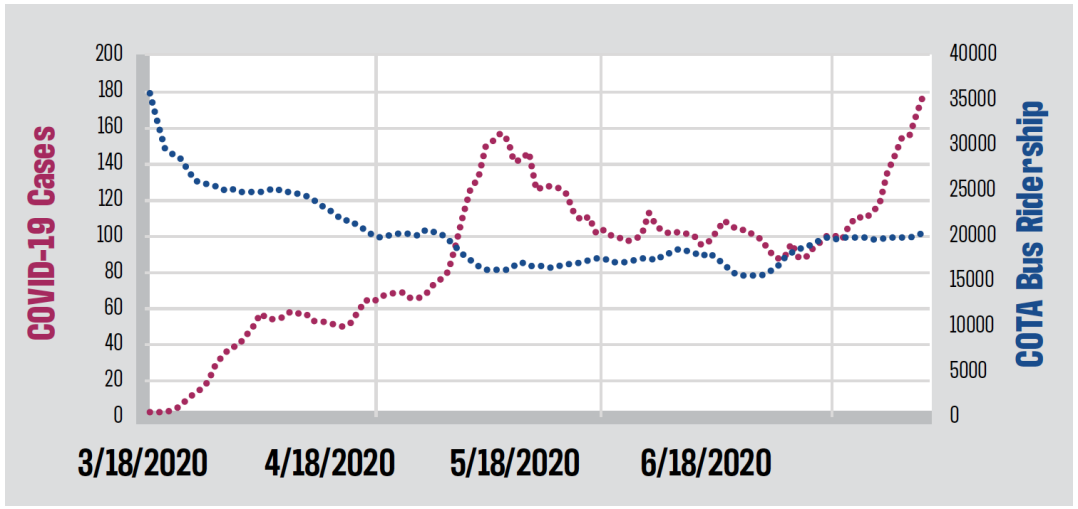
Similar Pattern Today



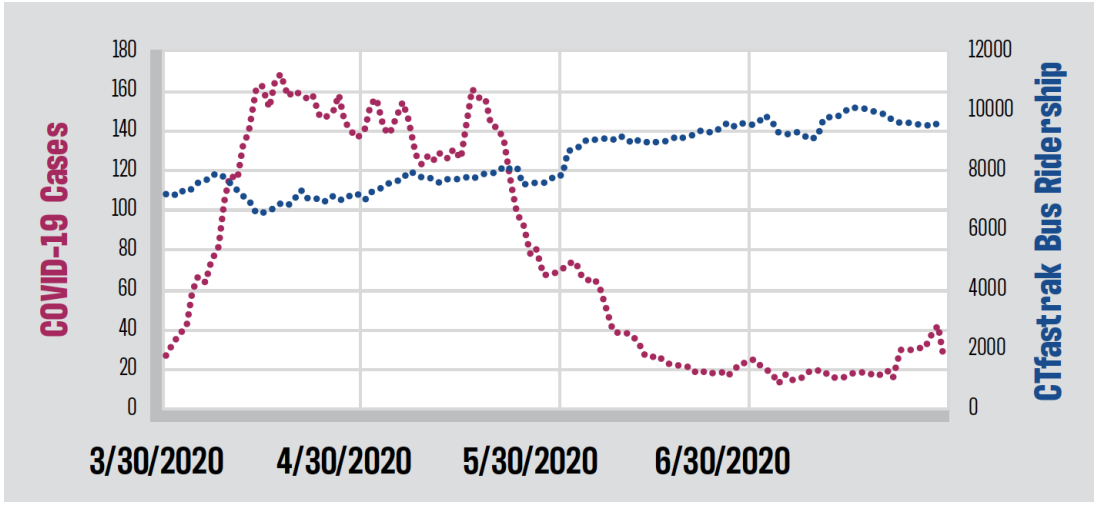


December 1, 2020

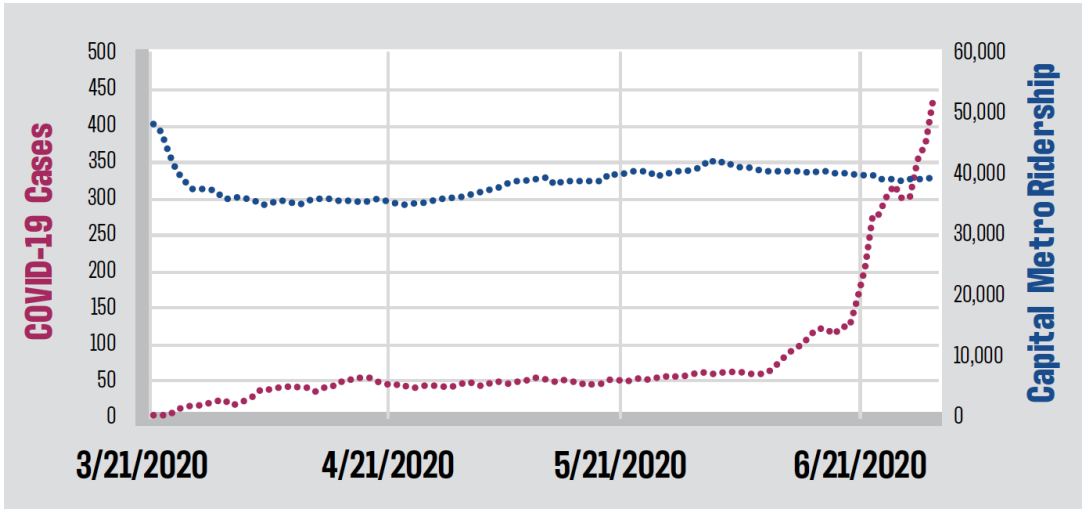
Case studies underscore that case rates are tied primarily to local community spread, rather than correlated to transit ridership rates.



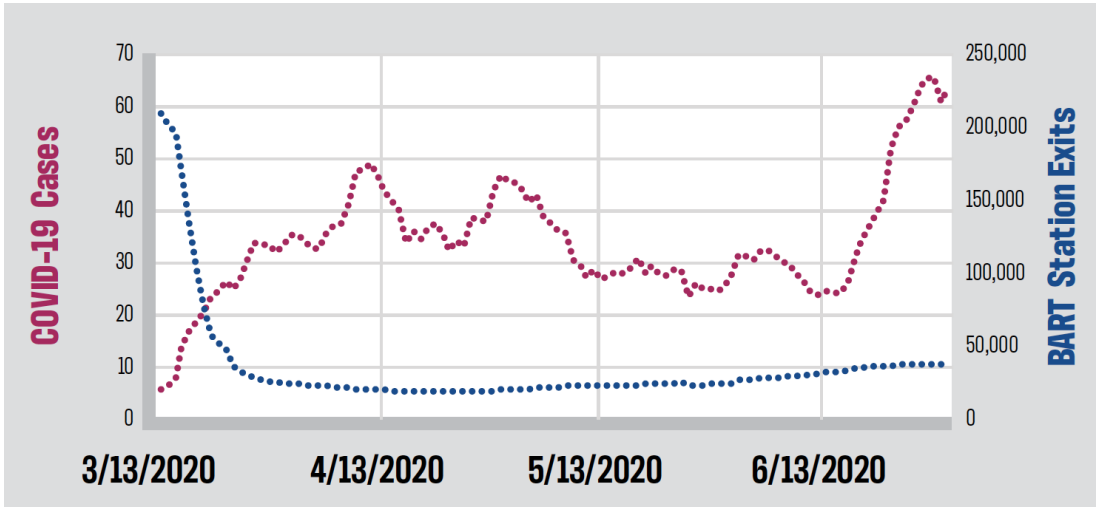
Columbus, OH



Hartford, CT



Austin, TX



San Francisco, CA

There are **several possible explanations for the lack of correlation:**

- Little talking
- Enhanced airflow
- Short duration

Successful Infection = Exposure to Virus x Time*

*Dr. Erin Bromage; Biologist, University of Massachusetts https://www.erinbromage.com/post/the-risks-know-them-avoid-them

Evidence points to concentrated environments with a strong social element

I.e. bars, clubs, indoor restaurants, houses of worship

Hitoshi Oshitani, virologist at Tohoku University: **clusters of the disease originated in gyms, pubs, live music venues…places where people gather to eat and drink and chat.**

Did not trace any clusters to Japan's heavily packed commuter trains. **Riders are usually alone, not talking** to other passengers, and **wearing masks**. *"An infected individual can infect others in such an environment [on trains], but it must be rare."*

NYU PLOS Journal: "**no evidence of a positive relationship between city-level transit ridership and influenza/pneumonia mortality rates**, suggesting … transit use are not a singularly important factor in the transmission of influenza … transit riders **generally do not speak** to one another and often try to **avoid physical contact**."

Sources: https://www.sciencemag.org/news/2020/05/japan-ends-its-covid-19-state-emergency ; https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0242990

Good ventilation can further reduce risk

- CDC, **American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)** recommend minimum air change/hour (ACH) of **12x for infectious airborne disease isolation rooms**, and 2 complete replacements with outdoor air.
- **ACH** = measure of the air volume added to or removed from a space / volume of a space.
- **Infectious disease isolation rooms in medical facilities** = used for isolating the airborne spread of infectious diseases, such as measles, chicken pox, or tuberculosis.

https://www.cdc.gov/infectioncontrol/guidelines/environmental/appendix/air.html#tableb1

Ventilation is above the recommended amount on NYC subway cars

- ACH on NYC subway cars = **18-times an hour, 50 percent more frequently than the 12-times recommended ventilation rate for air quality**
- Experts recommend MERV filters level 13; NYC subway was level 7 (under review)
- Note: for offices recommended ACH rate = 6-8x/hr, classrooms recommended ACH = 3-4x/hr

https://www.nytimes.com/interactive/2020/08/10/nyregion/nyc-subway-coronavirus.html

Airplane Ventilation

- Airplanes utilize **displacement ventilation:** air enters at the ceiling and exits at floor; most efficient at limiting airborne transmission risks since air is not passed among passengers.
- ACH: ~20; air replaced every 3 minutes
- Utilize High-Efficiency Particulate Air (HEPA) filter
- Combination of (cleaned) recirculated and fresh air

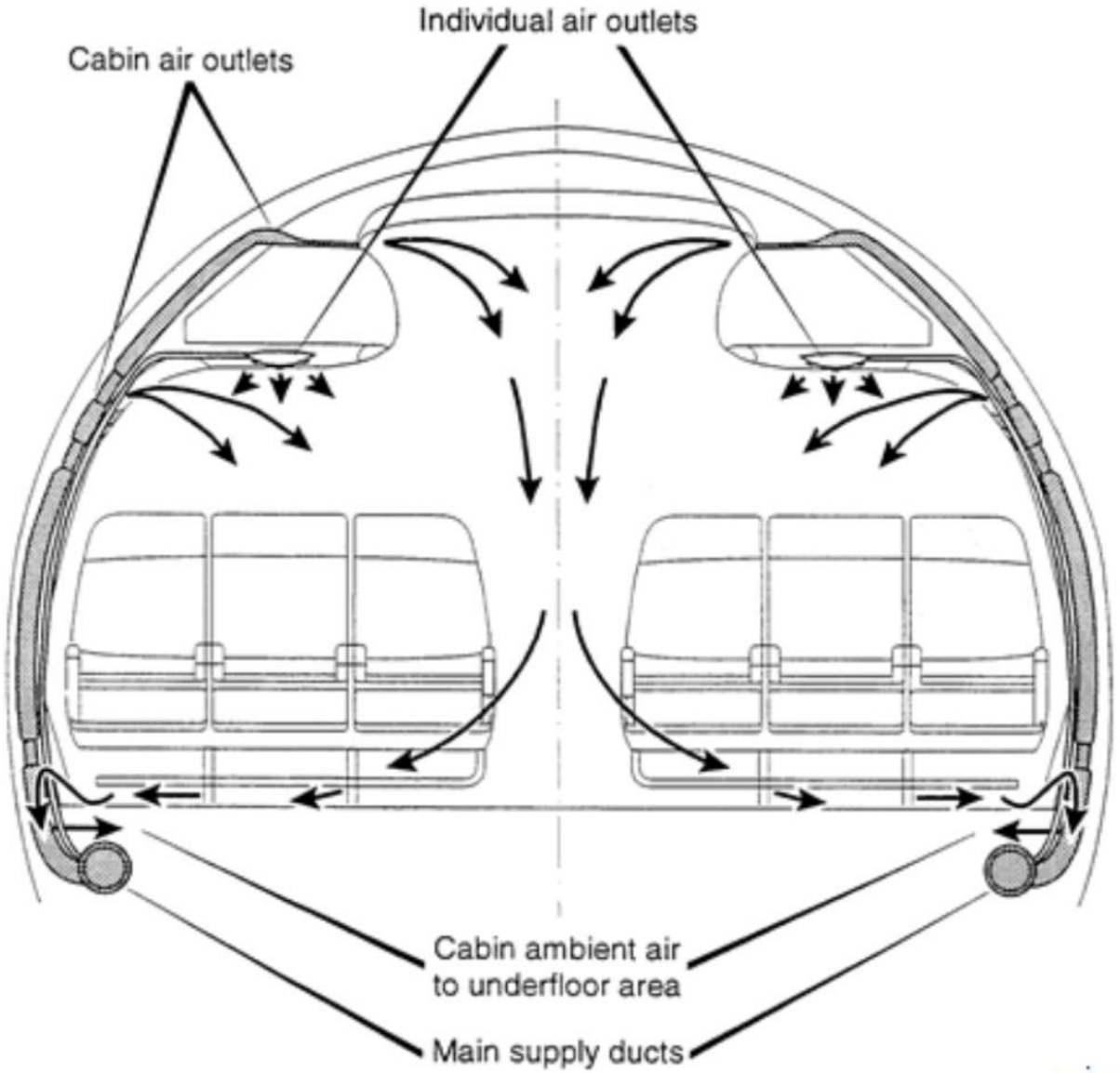
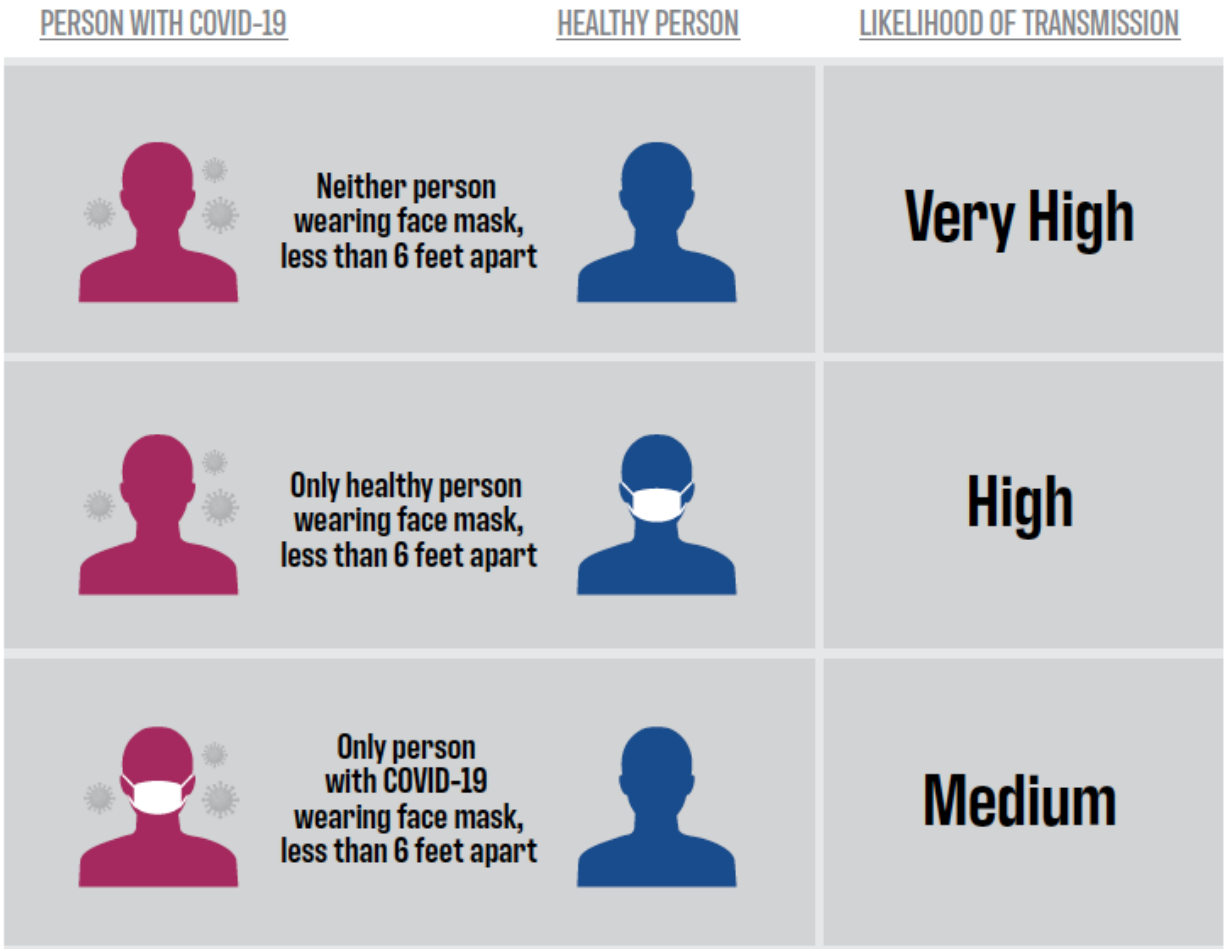
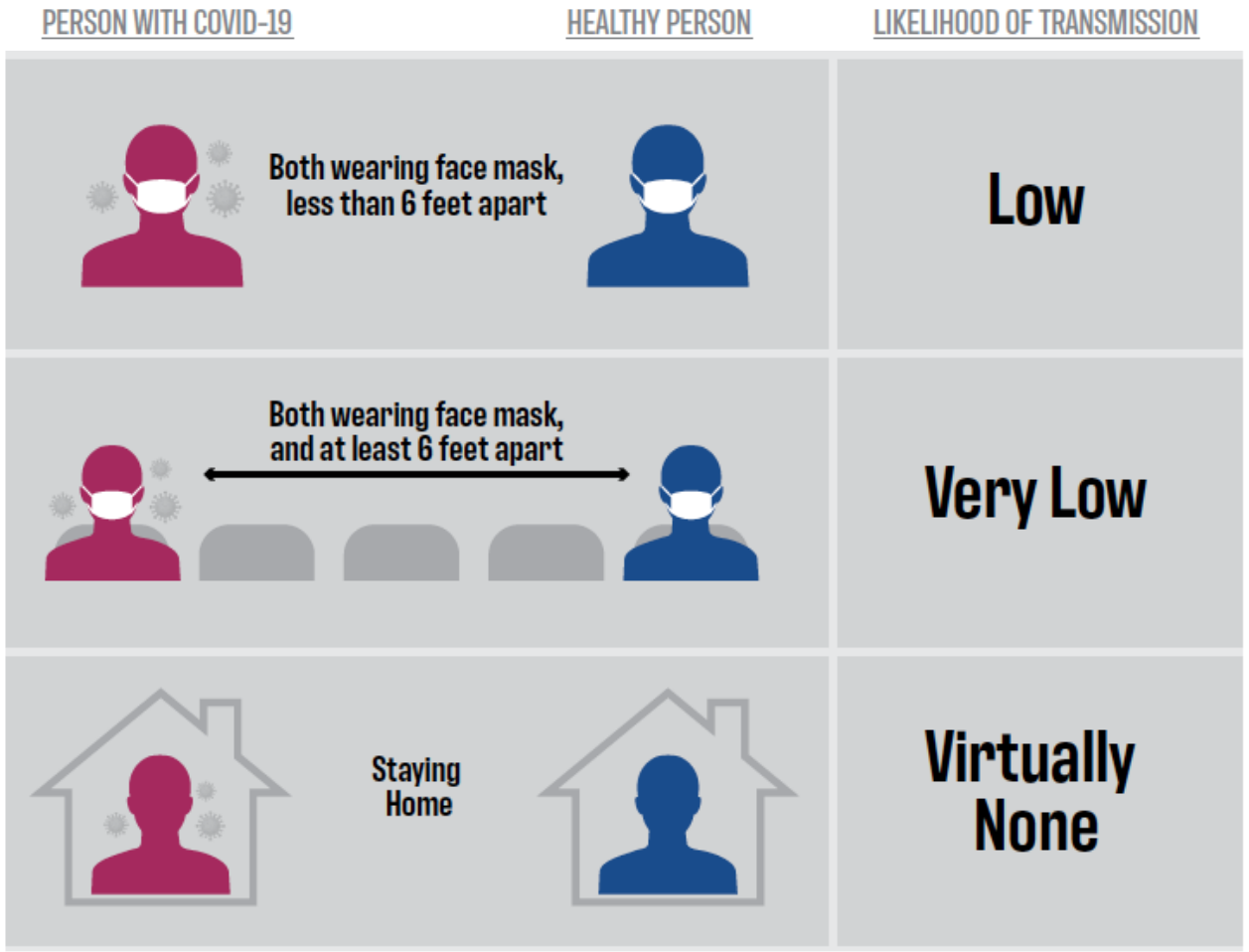


Image Source: Airbus

Masks are effective in reducing transmission.





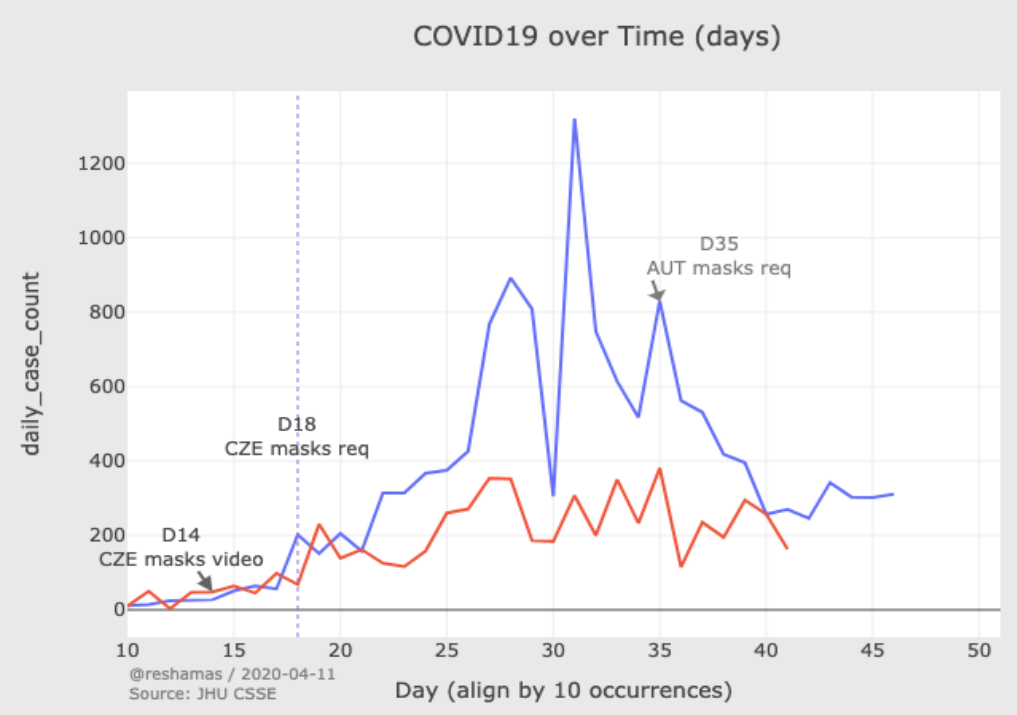
Source: Based on infographic prepared by Washington State Department of Health

- Masks = ***source control*****:** stopping the transmission of disease by blocking its source, thus protecting others.*
- Most Masks = offer some ***protection*** to the wearer. Respirator masks (N95 and N99) are 95% and 99% efficient at filtering aerosols.**
- Countries where masks weren't recommended = 62.1% weekly increase in coronavirus deaths per capita.***
- Places with guidelines/cultures supporting mask use = 15.8% growth.***

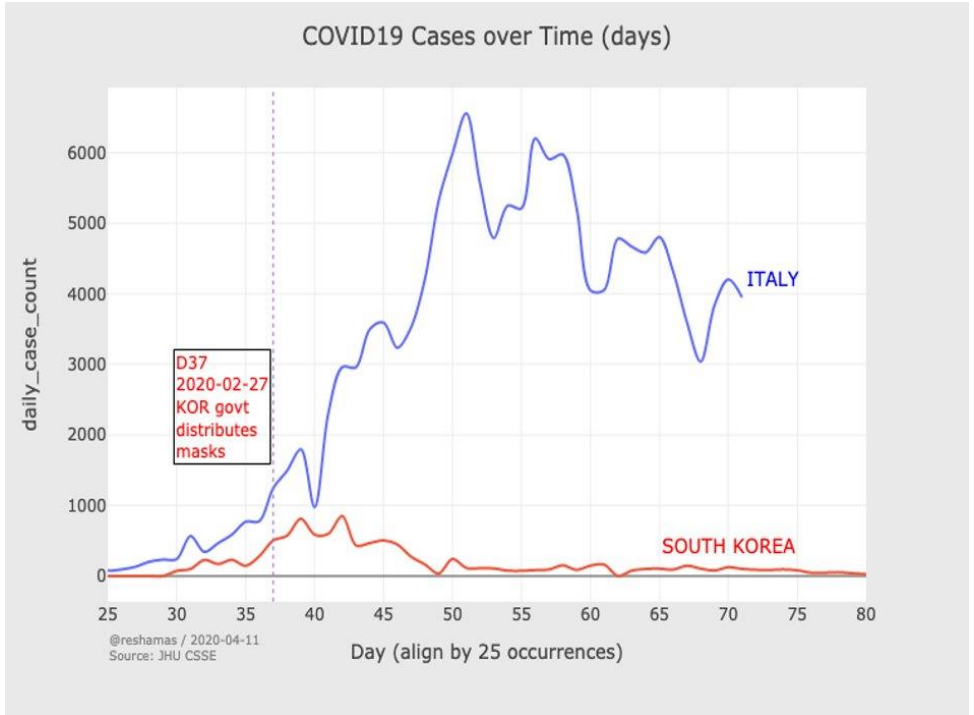
*https://www.nejm.org/doi/full/10.1056/NEJMc2007800
**https://journals.plos.org/plospathogens/article?id=10.1371/journal.ppat.1003205
***https://doi.org/10.1101/2020.05.22.20109231

Masks are effective in reducing transmission

[Masks are] *"the most important, powerful public health tool we have. I might even go so far as to say that* ***this face mask is more guaranteed to protect me against Covid than when I take a Covid vaccine,"*** Dr. Robert Redfield CDC Director, before U.S. Senate committee



Both Austria and Cechzia instituted physical distancing on the same day, but only CZE required masks (March 18); Austria mask mandate April 6



S. Korea distributed masks in Feb, w/ mask mandate May 13; Italy mask mandate August 16

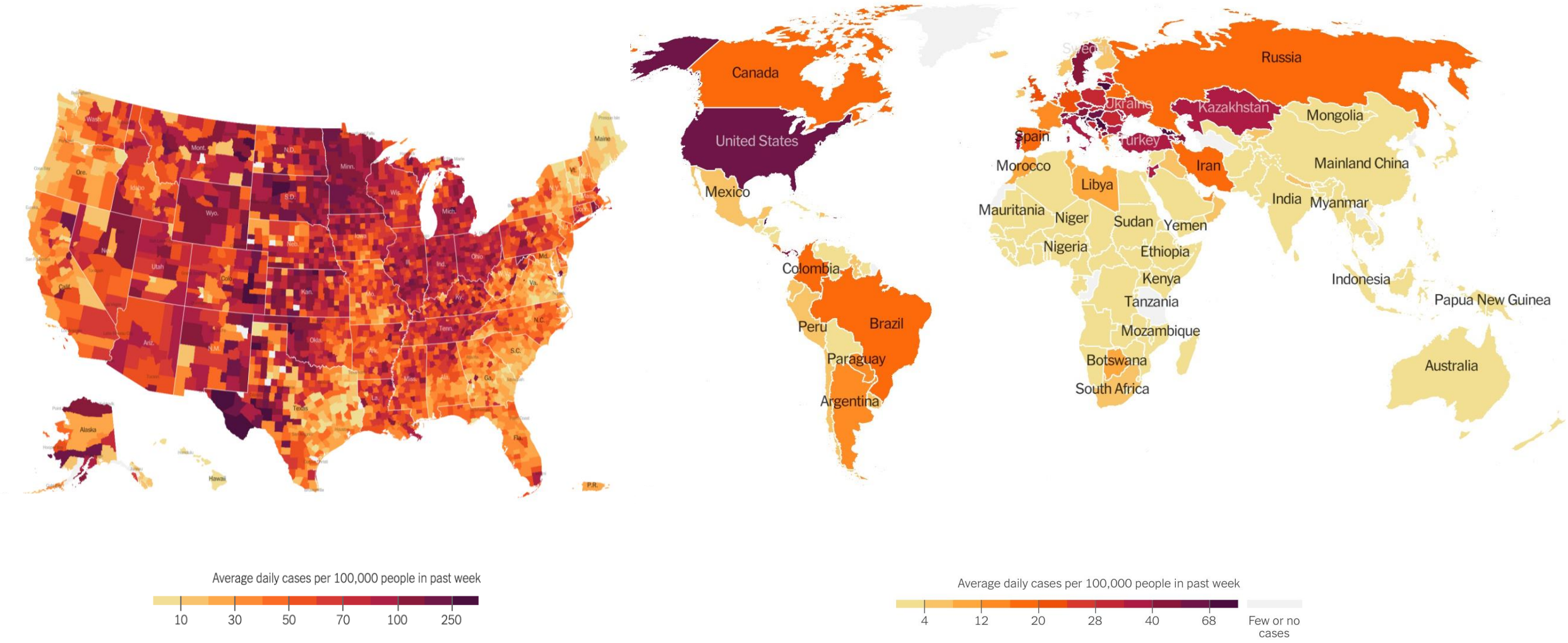
Source: https://www.fast.ai/2020/04/13/masks-summary/

The communities with the highest per capita case rates in the U.S. **rely mostly on cars.**

Rank	Metro or Micro Area	Metro or Micro Area Population	Total Cases	Cases per 1,000 (as of 11/30/2020)	Metro Area Transit Share
1	Bismarck, ND	133,179	16,574	124.4	0.2%
2	Minot, ND	75,713	8,294	109.5	0.5%
3	Grand Forks, ND	100,815	10,707	106.2	0.9%
4	Sioux City, IA	169,878	17,921	105.5	0.5%
5	El Paso, TX	844,124	85,952	101.8	1.5%
6	Lubbock, TX	322,257	32,756	101.6	0.9%
7	Sioux Falls, SD	268,232	27,242	101.6	0.6%
8	Beaver Dam, WI	87,839	8,718	99.2	0.1%
9	Gallup, NM	71,367	7,043	98.7	0.8%
10	Dubuque, IA	97,311	9,234	94.9	0.9%
304	***New York City***	***18,351,295***	***794,908***	***39.7***	***31.1%***

Source: https://www.nytimes.com/interactive/2020/04/23/upshot/five-ways-to-monitor-coronavirus-outbreak-us.html; US Census Bureau, ACS 5-Year Estimate 2012-2018: Table B0141. Means of Transportation to Work.

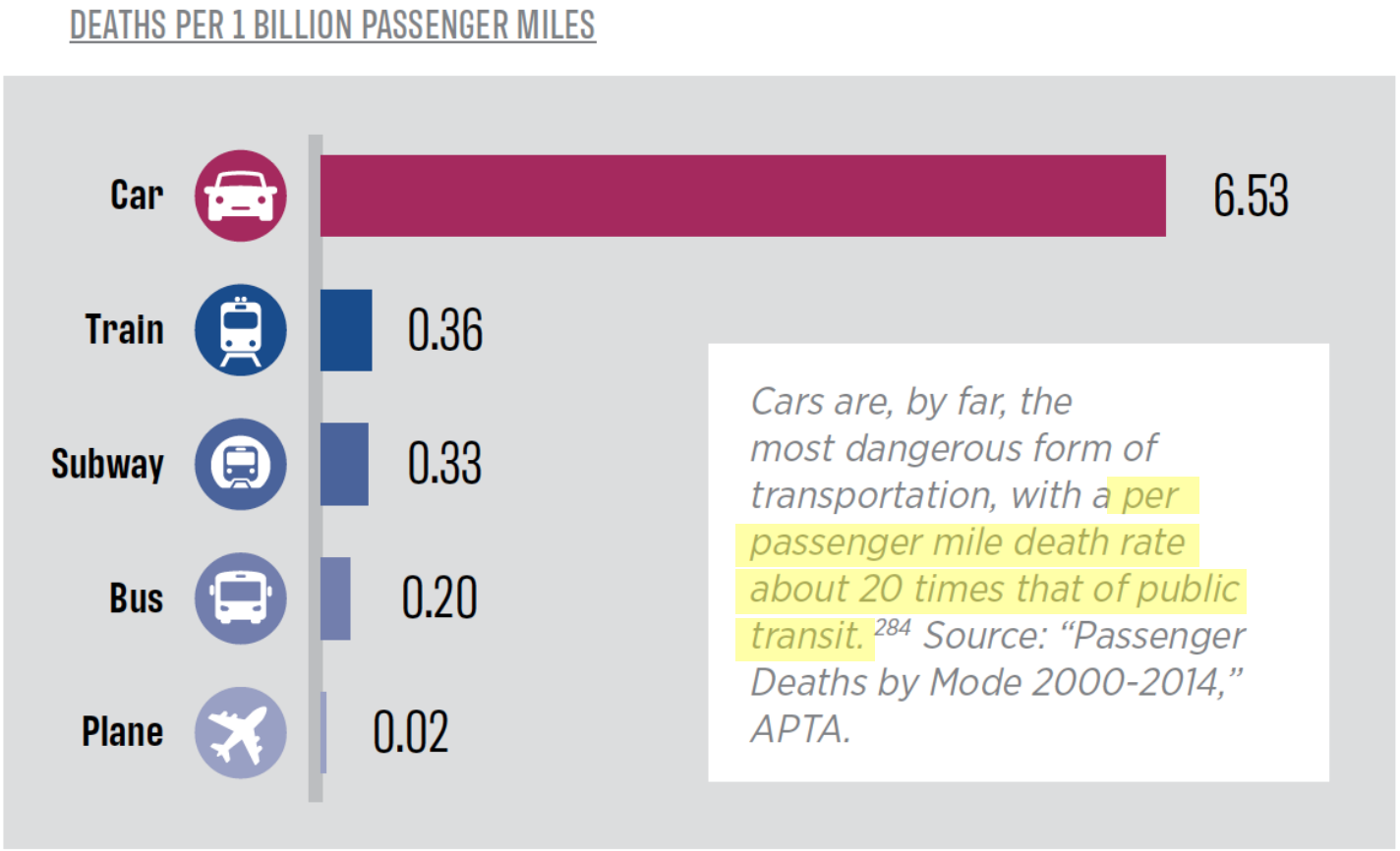
National and Global Covid Case Rates in the Past Week
December 6, 2020



A conclusion: **what you do at a trip end, not necessarily the mode,** affects probability of contracting the virus.

Many people who traveled by car or transit over the first few months were essential workers; they had higher case rates regardless of their commute mode

Safety and Health consequences if people in large numbers switch from transit to private cars.



+ more pollution, inactivity diseases and climate change

Instances where transportation mode was significant

- 24 out of 67 passengers on Buddhist tour bus infected; 50 minutes each way, air conditioning system in re-circulating mode, and no masks. No passengers sitting adjacent to an open window contracted the virus.
- 12 of 313 infected on 5-hour commercial flight; no passengers wore masks, but no cases were reported among the crew members, who wore face masks.
- *Diamond Princess* cruise ship one infected passenger infected 712 people -- 20% of the ship's population of 3,711.

Best Practices

"The Coronavirus Is Airborne Indoors. Why Are We Still Scrubbing Surfaces?" NYTimes (November 2020)

- Scientists increasingly say that **there is little to no evidence that contaminated surfaces spread the virus –** "Exaggerated risk of transmission of COVID-19 by fomites" *The Lancet* (July 2020)

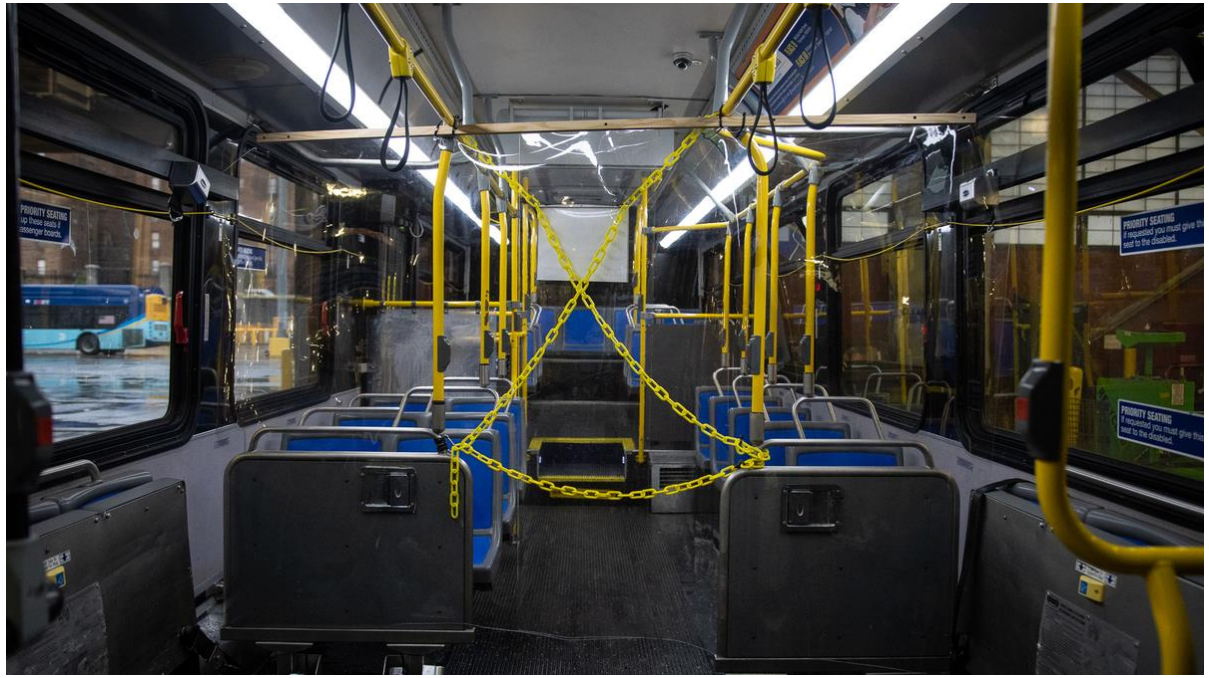
- Time, energy, money diverted away from other purposes and towards cleaning – may be **false sense of security**

- **Cleaning is still recommended but should not be main focus**

Recommended Best Practices

- ***Service adjustments:*** Restoring service, shifting to demand response service, micro-transit, or suspending service until conditions warrant reopening
- ***Health Procedures and Policies:*** Mandating face coverings, PPE available, limiting capacities, instruct operators to skip bus stops at capacity limit, cleaning efforts, shifting to rear-door-only boarding, physical separators
- ***Employee Practices:*** Educating in COVID-19 prevention, daily health checks, installing protective barriers
- ***Rider Communications:*** Communicating service changes, rider etiquette, agency efforts regarding cleaning and prevention via webpages, short videos, tweets, and other social media posts
- ***Data technology:*** inform riders and operations staff of real-time ridership and crowding conditions.

Best Practices

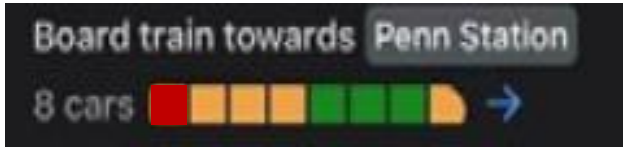


Bus partition

Physical Distancing Markings

Best Practices

PPE Machine



Not Crowded

Moderately Crowded

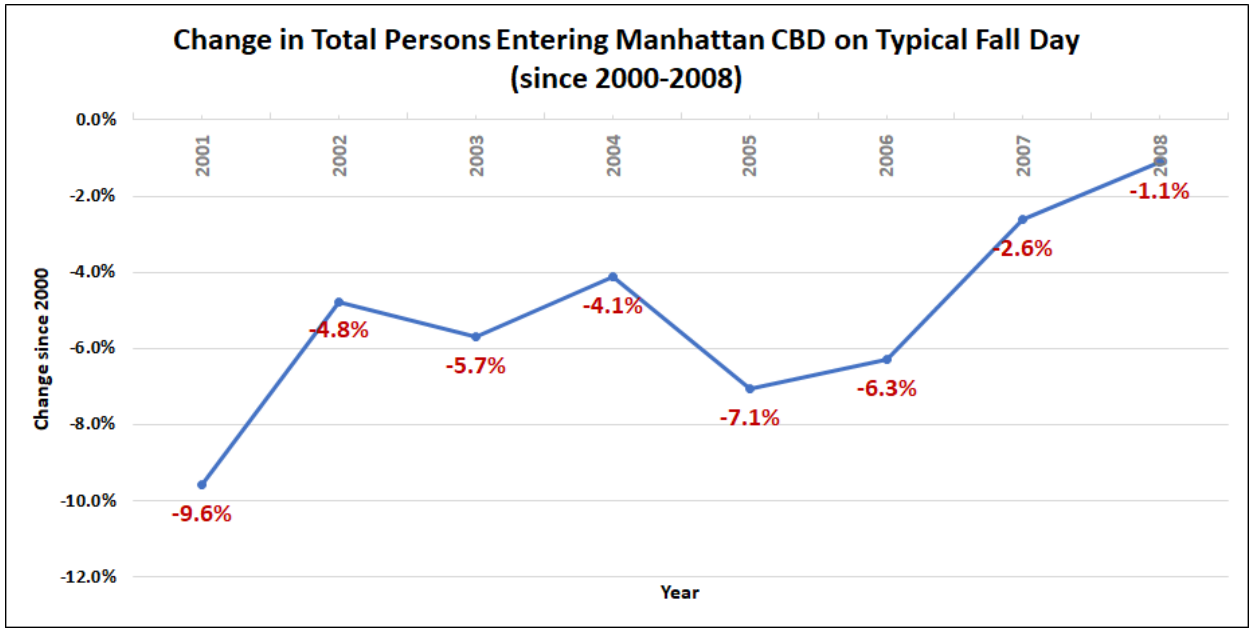
Crowded

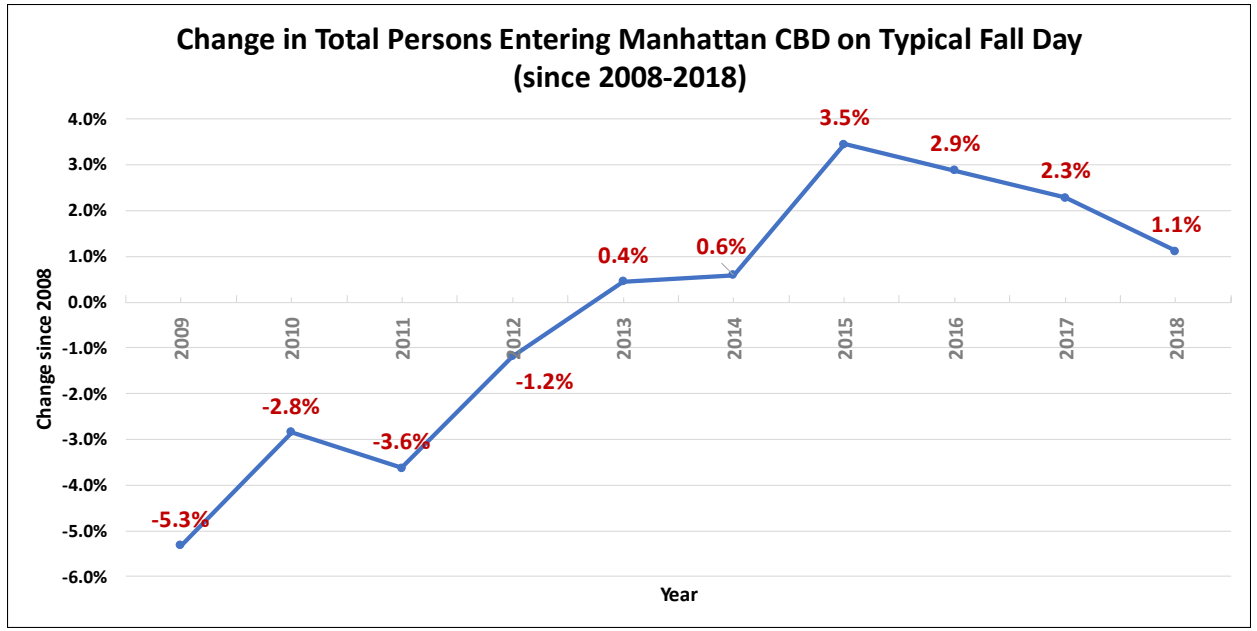
Crowding data

Forecasting Traffic Volume to Manhattan's Central Business District

Predicting Recovery by looking at history

Manhattan CBD – Person Entry Trends
(9/11 and Great Recession)



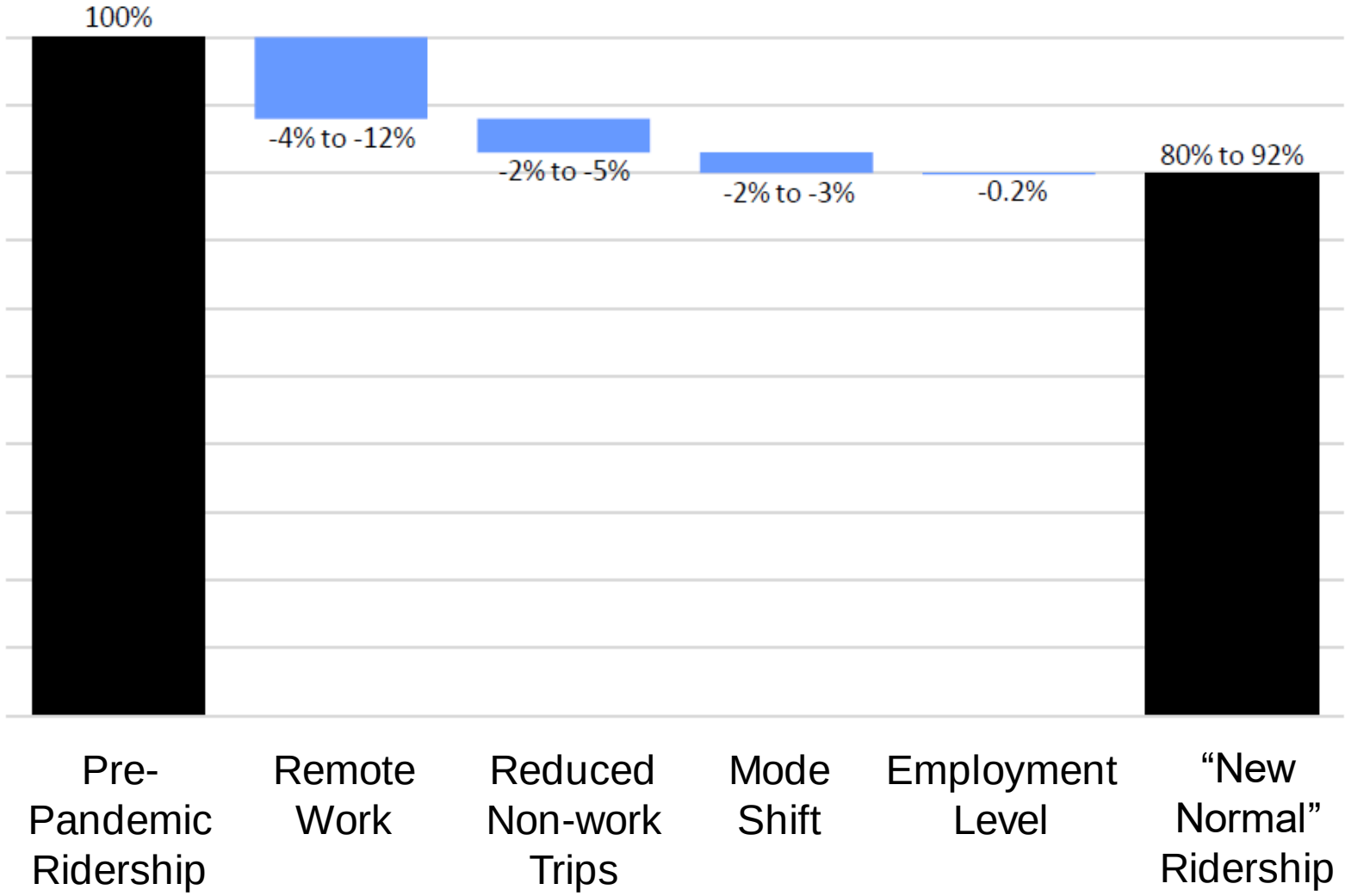


- **September 11th Attacks**
  - Year One: -9.6%
  - Year Two – Year Five: -7.1 to -4.1%
  - Recovery to 99%: 7 years

- **Great Recession**
  - Year One: -5.3%
  - Year Two – Year Five: -3.6% to +0.6%
  - Recovery to 99%: 3 years

Source: NYMTC Hub-Bound Reports

Looking beyond 2020, McKinsey (commissioned by MTA) estimates ridership may remain at 80% to 92% of pre-pandemic levels through the mid-2020s



Source: MTA

Factors Affecting CBD Traffic Volumes for Spreadsheet Sensitivity Analysis

- Shift from Transit to Auto
- Work from Home (WFH) Rate
- Economic Activity (including employment rate)
- Vehicle Occupancy

Projections: Shift from Transit

- Shift to private vehicles expected, varying estimates:
  - **C2Smart** (June 2020) – transit share: 35% to 26% (-26%); **vehicle share: 30% to 42%** (+40%).
  - **IBM Institute for Business Value** (May 2020) – Survey: **20% who use transit would switch**; 28% will use less frequently.
  - **MassINC Polling Group (**May 2020) – Survey: 33% - 36% will use transit less frequently; overall **net mode-shift -28% to -30%.**
  - **Elucd** (May 2020) – Survey: **44.4% of NYC residents plan to avoid public transit**, 18.5% plan to resume, 31.5% plan to use transit less, and 5.5% would work from home.
  - **Vanderbilt University** (May 2020) – Model: significant traffic increase (ex: **25% mode shift** from transit = +11.4 minutes).

Sources: C2Smart; Hu, Yue & Barbour, William & Samaranayake, Samitha & Work, Dan. "Impacts of Covid-19 Mode Shift on Road Traffic;" IBM Study: COVID-19 Is Significantly Altering U.S. Consumer Behavior and Plans Post-Crisis;" MassIncPolling; Elucd.

Projections: Work from Home (WFH)

- Pre-pandemic – 4.7% of NY/NJ MSA full-time WFH; 7.0% WFH/typical day.
- Post-pandemic - expect significant increase, varying estimates:
  - National Bureau of Economic Research – ~42% of NYC workers could perform jobs at home.
  - C2Smart – 44% of workers to WFH.
  - Port Authority – 17.5% of workers to WFH in 2021.
  - Stantec – ~18% increase in WFH.
  - RPA – Q4 2020: 33-34% of NYC workers will WFH; 48-51% of CBD workers will WFH
  - Fed. Reserve Bank of Atlanta – 16.6% of workers to WFH post-pandemic

Scenario	Telecommuting		
	Percent	Days/Wk	Typical Day
Pre-COVID-19	20%	1.75	7.0%
Peak COVID-19	80%	5.00	80.0%
End 2020	50%	5.00	50.0%
End 2021	35%	2.50	17.5%

Source: US Census Bureau. American Community Survey (2018 5-Year Estimates); C2Smart; National Bureau of Economic Research; Stantec; RPA Presidents Report; Port Authority of New York and New Jersey; Federal Reserve Bank of Atlanta

Sensitivity analysis: Manhattan CBD

	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Return to Normal %	-	30.0%	60.0%	75.0%	90.0%	95.0%
% Change in CBD Transit Travel Demand Due to Auto Mode Shift	-	-30.0%	-30.0%	-20.0%	-10.0%	-5.0%
Average Inbound Auto Vehicle Occupancy	1.26	1.10	1.20	1.20	1.25	1.26

Vehicle Volume % Change (from 2018)	0%	-32%	24%	30%	20%	10%
Total Volume Change		**-357,000**	**+164,000**	**+209,000**	**+170,000**	**+92,000**
Williamsburg Bridge		-24,000	+11,000	+14,000	+12,000	+6,000
Manhattan Bridge		-20,000	+9,000	+12,000	+10,000	+5,000
Brooklyn Bridge		-30,000	+14,000	+17,000	+14,000	+8,000
Brooklyn-Battery Tunnel		-14,000	+6,000	+8,000	+6,000	+3,000
Queens-Midtown Tunnel		-26,000	+12,000	+15,000	+12,000	+7,000
Queensboro Bridge		-38,000	+18,000	+23,000	+18,000	+10,000
Holland Tunnel		-22,000	+10,000	+13,000	+10,000	+6,000
Lincoln Tunnel		-23,000	+11,000	+14,000	+11,000	+6,000
Crossing at 60th St		-159,000	+73,000	+94,000	+76,000	+41,000

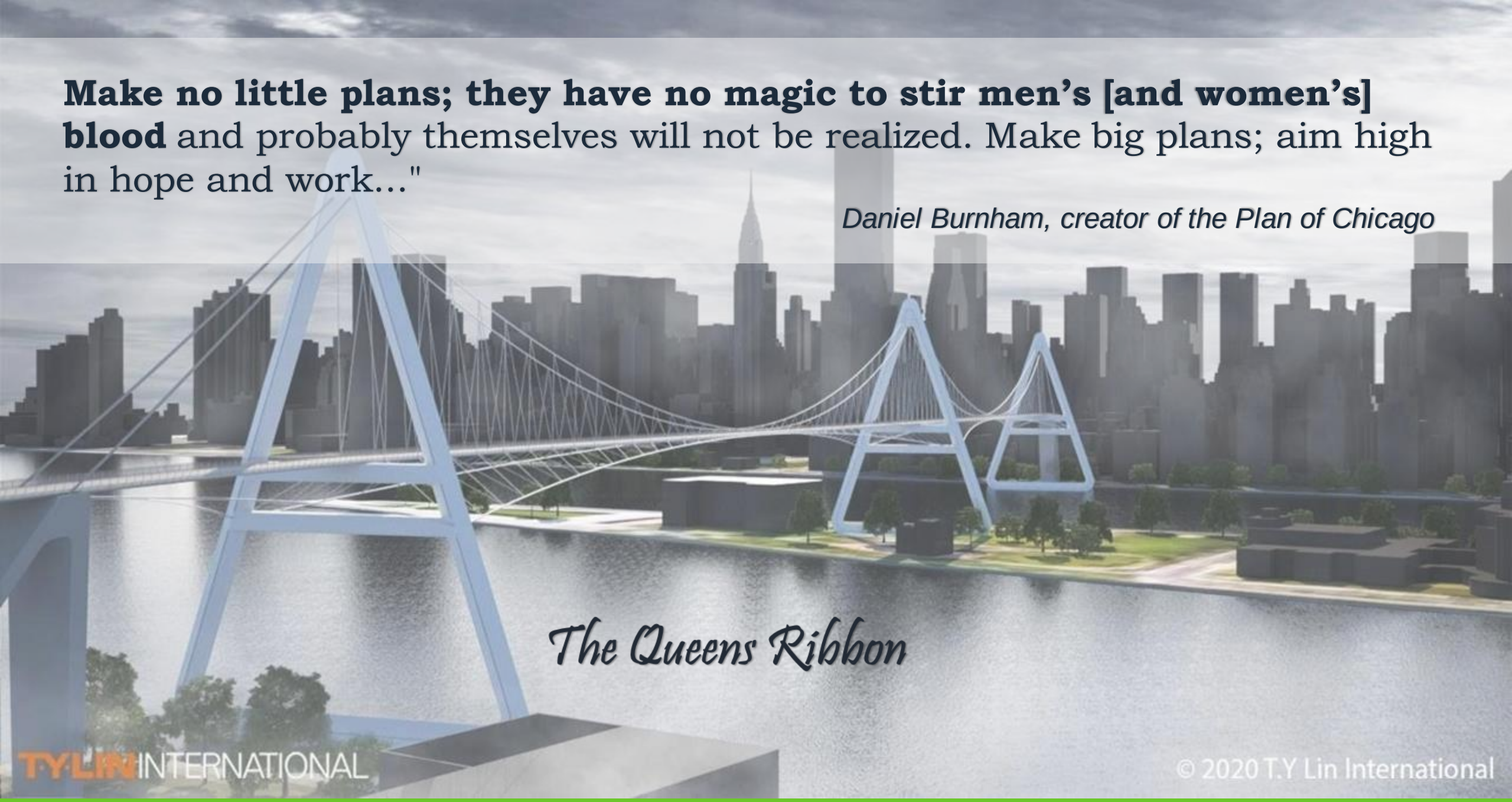
Projections represents vehicle demand; in actuality, tunnel, roadway, and parking constraints will affect vehicle volumes.
If Lincoln and Holland Tunnels exceed capacity, there would likely be diversions to the George Washington Bridge (and to a much lesser extent, the Goethals Bridge).
It is expected that there would be temporal distribution as well, with peak period surges spreading throughout the day.

City Initiatives

Image Sources: https://www.6sqft.com/nyc-makes-14th-street-busway-permanent-adds-five-more-car-free-routes/
https://nyc.streetsblog.org/2020/05/02/live-from-nyc-open-streets-hailing-first-day-success-dot-says-position-on-cops-has-evolved/
https://nyc.streetsblog.org/2020/03/20/breaking-mayor-announces-emergency-bike-lanes-for-smith-street-second-ave-gap/
https://www.6sqft.com/nyc-open-streets-outdoor-dining-summer/

Make no little plans; they have no magic to stir men's [and women's] blood and probably themselves will not be realized. Make big plans; aim high in hope and work..."

Daniel Burnham, creator of the Plan of Chicago



Source: Sam Schwartz, NYU IDC Innovation Hub, T.Y. Lin International, June 2020.

Questions

- Explain the difference between an aerosol and a droplet.
- What is a fomite?
- What is the recommend minimum air change/hour (ACH) for infectious airborne disease isolation rooms? What is the ACH of the NYC subway?
- What modes were most affected by the virus? Which modes the least? And why.
- Name four parameters that will affect traffic volumes in the aftermath of COVID-19.

www.samschwartz.com

New York + Jersey City + Chicago + Washington, DC + Tampa + Los Angeles + White Plains + Oakland